Use of Healthcare Services for People with Pain

PhD dissertation

Søren Mose

Health

Aarhus University

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Preface and acknowledgments

This PhD dissertation is rooted in the tradition for research in musculoskeletal disorders at the Department of Occupational Medicine in Herning. The highly engaged staff at the department has been involved in research within this field for decades and established population- and work-based cohorts with the aim to explore the prognosis and consequences for people with musculoskeletal disorders. Professor Johan Hviid Andersen was so far-sighted that he established a population-based Danish cohort of working adults in 2008 with the aim of examining determinants of contacts to the General Practitioner – a project carried out by Jens Christian Jensen, PhD, MD. This database and population were introduced to me when I did my master's thesis and has formed the foundation for this project.

The need for more research and focus on the life and management of people with pain is clear. In recent decades, the proportion of people with pain has increased globally despite increased focus on preventive initiatives, tests/examination, and management methods. This paradox emphasizes that healthcare systems and societies have failed to understand and help people living with pain.

This PhD dissertation is the latest chapter in my personal endeavor to understand pain and this paradox. This journey started many years ago. I graduated as a physiotherapist in 1999 and worked the following 13 years as a primary care physiotherapist. During that period, I gradually realized how little I understood about the lived experiences and behavior related to people with musculoskeletal pain, and I realized that I had to learn more. Understanding behavior and its consequences in the context of pain is still a huge motivation for me and the main driver of my work life, and I still have a lot to learn. Despite time and effort, I have to realize that most days I am still a clinician struggling to understand what drives people in the context of pain.

In this project I have had the opportunity to meet and work with many talented and inspiring people, and I would like to express my gratitude to them all. There is some whom I would like to give a special thanks for their help and contributions. First, I would like to thank all my supervisors for their help throughout the project. David Høyrup Christiansen and Johan Hviid Andersen, you have both been there from the beginning of my academic journey and you supported and believed in me and the project, also when no funding organizations did. Without you, this project would never have been born. Peter Kent, you agreed to join this project in the planning phase and your reflective questions, suggestions, and comments have been a huge inspiration and improved all phases of the project. Thank you for inviting me to Curtin University and for welcoming me and my family to Perth and making my research stay abroad an experience for life. Anne Smith, you were, luckily for me, dragged into this project when I was at Curtin University, and you have qualified and improved all aspects of this project ever since. It has been a privilege to work with all of you, and I would not have made it without your help.

I would like to thank all my colleagues at School of Physiotherapy & School of Occupational Therapy, VIA University College, Holstebro and Department of Occupational Medicine, Herning. Thanks for lots of fun, thank you for your interest in the project, the highly valued talks, laughs, and encouragements. Thanks to my officemate Nickolaj Hove for support and help and a special thanks to Mia Klinkvort Kempel and Cecilie Rud Budtz. This journey would never have been the same without you.

I would like to thank all the participants in this project. Thanks for taking time to share your data, opinions, experiences, and thoughts. Without your contributions, this kind of research would not be possible.

I would like to thank Jesper Medom Vestergaard for assistance with the collection of register data, data management, and the distribution of the follow-up questionnaire. Jesper, you have made a priceless contribution to this project, and without your assistance I would not have made it past study 1. I would also like to thank Jens Christian Jensen for baseline data collection and Susanne Nissen Sagoo for assistance with the transcription of the interviews.

Last, I would like to express my heartfelt thanks to my friends and family for being there through the whole process. Your encouragement, support, and love have been vital. Ida, Fie, and Mette, without your love and support there would have been no project.

Søren Mose
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Disclosure and conflicts of interest, funding

Declarations of interest: none.

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None of the funding organizations had any influence on study design, analysis, or interpretation of data.

Contents

Chapter 1 - Outline and list of papers

This dissertation is based on three studies carried out during my time as a PhD student at the Department of Occupational Medicine – University Research Clinic, Gødstrup Hospital. Chapter 1 presents the outline of the dissertation and provides an overview of papers, definitions, abbreviations, tables, and figures. Chapter 2 is an introduction to the topic of this project and provides an overview of the most relevant literature regarding healthcare behavior in the context of pain and pain management. The specific aims of this project are outlined in the last part of chapter 2. Chapter 3 provides details about the project's design, materials, and methods. Chapter 4 summarizes key findings from all three studies. In Chapter 5, the results from the three studies are merged and discussed in order to answer central questions related to healthcare-seeking behavior in the context of pain. Chapter 6 provides a discussion of the methods and materials used in the project, and in chapters 7 and 8, the main conclusions and future perspectives are presented.

List of papers

Number of musculoskeletal pain sites leads to increased long-term healthcare contacts and healthcare related costs – a Danish population-based cohort study. S. Mose, P. Kent, A. Smith, J. H. Andersen and D. H. Christiansen. BMC Health Services Research (2021) 21:980. https://doi.org/10.1186/s12913-021-06994-0

Trajectories of Musculoskeletal Healthcare Utilization of People with Chronic Musculoskeletal Pain – A Population-Based Cohort Study. S. Mose, P. Kent, A. Smith, J. H. Andersen, D. H. Christiansen. Clinical Epidemiology 2021:13 825–843.

https://doi.org/10.2147/CLEP.S323903

How do people with chronic pain explain their use, or non-use, of pain-related healthcare services? A qualitative study of patient experiences. S. Mose, C. R. Budtz, H. R. Smidt, P. Kent, A. Smith, J.H. Andersen, D. H. Christiansen (under review – Disability and Rehabilitation)

Central definitions

Table A. Central definitions

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* (1). This recently revised definition includes key notes acknowledging that 1) pain is always a personal experience influenced by biological, psychological, and social factors, 2) pain and nociception are different phenomena, 3) Through their life experiences, individuals learn the concept of pain, 4) A person's report of an experience as pain should be respected. 5) Although pain usually serves an adaptive role, it may have adverse effects on function and social and psychological well-being. 6) Verbal description is only one of several ways to express pain and inability to communicate does not negate the possibility of experiencing pain (1).
Chronic pain	According to the recently updated International Classification of Diseases - 11th Revision (ICD-11), chronic pain is defined as pain that persists or recurs for longer than 3 months (2). Chronic pain is divided into chronic primary pain and a number of chronic secondary pain syndromes (cancer-related pain, postsurgical pain, neuropathic pain, secondary headache of orofacial pain, visceral pain, and musculoskeletal pain) (3). This means that chronic pain is either a symptom, consequence, or co-diagnosis of another chronic diagnosis (chronic secondary pain) or a disease in itself in situations where no known underlying chronic disease or diagnosis better explains the pain (chronic primary pain) (2). Additionally, a criterion for primary chronic pain is that the pain must be: "associated with significant emotional distress or functional disability (interference with activities of daily life and participation in social roles)" (3).
Healthcare seeking	Any activity undertaken by individuals who perceive themselves as having a health problem or are too ill to find an appropriate remedy (4)
Musculoskeletal	The term "musculoskeletal" covers a diverse group of conditions related to disorders related to muscles and joints. Musculoskeletal conditions are characterized by pain and functional limitations and comprise a spectrum of conditions that can vary in origin, duration, and location (e.g., osteoarthritis, low back pain, rheumatoid arthritis) (5).
Healthcare contacts for any reason	Refers to variables derived from national healthcare registers. Healthcare contacts for any reason are face-to-face primary or secondary healthcare contacts/admission days or municipality rehabilitation contacts related to any kind of condition/disease (see Appendix A).
Musculoskeletal healthcare contacts	Refers to variables derived from national healthcare registers. Musculoskeletal healthcare contacts are face-to-face primary or secondary healthcare contacts/admission days or municipality rehabilitation contacts registered with a musculoskeletal diagnostic code or where scope of practice for the profession encountered or details related to the encounter indicate a musculoskeletal reason for contact. Redeemed medication for pain relief is also considered to be a musculoskeletal healthcare contact in study 2.

Pain-related healthcare contacts	Refers to healthcare encounters (primary, secondary, municipality rehabilitation, redeemed pain medication for pain relief, or alternative/complementary healthcare) where the reason for contact was pain. This term is used in relation to personal narratives regarding healthcare due to pain.

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Abbreviations (alphabetical order)

BMI	Body mass index
CI	Confidence intervals
CSM	Common sense model of self-regulation
CP	Chronic pain
DAGs	Directed acyclic graphs
DCR	Danish Civil Registration System
DER	The Danish Education Register
D-ISCO	The Danish version of the International Standard Classification of Occupations
DREAM	The Danish Register-based Evaluation of Marginalized Individuals
DRG	The Diagnosis Related Group Grouped National Patient Register
E-boks	The Danish mandatory secure public mailbox system
GEE	Generalized estimating equations
HC	Healthcare
HCP	Healthcare provider
ICD	International Classification of Diseases and Related Health Problems
IRR	Incidence rate ratios
JEM	Lower and Upper Body Job Exposure Matrix
MCS	Short Form 12, version 2 – Mental component score: SF12
MSK	Musculoskeletal
NHSR	The National Health Insurance Service Register
NPR	The National Patient Register
PCS	Short Form 12, version 2 – Physical component score: SF12
Rehab	The Rehabilitation According to “The Danish Act of Health §140” register
RMPS	Register of Medicinal Product Statistics
SD	Standard deviation
SEQ	Standard evaluation questionnaire

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Chapter 2 - Introduction

Chronic pain – prevalence and consequences

Chronic pain negatively impacts the lives of millions (1, 2) and is prevalent in populations globally, with prevalence estimates varying between 20 and 50% (1, 3-8). The most common cause of chronic pain is musculoskeletal disorders (5). Chronic pain has negative consequences for the individual, society, and the healthcare system (3, 4, 8, 9). For example, chronic pain is associated with disability (2), reduced physical function (10), poor quality of life (5, 10, 11), poor sleep (10), poor mental and general health (1, 4, 7, 8), reduced work ability, and sickness absence (4, 12, 13), and it has negative effects on personal/social relationships (1, 10). The connection between these factors and chronic pain is bidirectional, and these factors can be both a cause of and a risk factor for chronic pain (8). Chronic pain entails a significant economic and social burden (8, 14). Annual healthcare costs for low back pain, neck pain, and osteoarthrosis are estimated to be approx. 700 million Euros and costs due to loss of production and social transfer payments are estimated to be approx. 1,200 million Euros according to a Danish disease burden report from 2015 (15).

Classification of pain

Pain is often classified based on duration (acute, chronic) and location (e.g., low back pain, shoulder pain). Acute pain is defined as pain lasting less than 3 months, whereas chronic pain is pain that persists or recurs for more than 3 months (16). The definition of chronic pain has recently been updated in the International Classification of Diseases - 11th Revision (ICD-11) diagnostic classification and divided into chronic primary pain (pain as a disease) and chronic secondary pain (pain as a symptom, consequence, or co-diagnosis of another chronic disease or diagnosis) (17).

Even though pain is classified based on location, local pain is relatively rare, and musculoskeletal pain often coexists with pain in other (often adjacent) body regions (18-23). Furthermore, the sum of pain complaints has been shown to be more important than the location of pain in determining the functional and health-related consequences of pain (24-27), and the location of pain adds little predictive value to genetic prognostic factors for poor outcomes across pain locations (28). Additionally, a review of pain management guidelines for different musculoskeletal pain diagnoses lists comparable recommendations (29). This suggests that counting the number of body regions with pain provides a meaningful way to classify pain and that musculoskeletal pain in different body regions shares similar features with respect to mechanisms, prognostic factors, clinical course, and management strategies (30-32).

Chronic pain management

Chronic pain is a personal experience influenced by a variety of biological, psychological, and social factors (33), and chronic pain management should align with this understanding and hence be based on the biopsychosocial model (8, 29). This poses a challenge because healthcare providers often feel uncertain about delivering all the aspects of biopsychosocial and person-centered approaches (34). Delivery of pain management is also a challenge from a societal point of view because healthcare delivery systems should offer the right care to the right person at the right time (35). The health of people with chronic pain could be threaten if they do not receive the healthcare they need (36), and too much healthcare with a narrow biomechanical/biomedical focus may also introduce the risk of iatrogenic harm due to unwarranted diagnoses and unnecessary tests and treatments that do not benefit patients (35, 37). Thus, balancing delivery of pain management in a biopsychosocial framework while meeting patients' wishes and expectations is complicated and challenged by economic, educational, cultural, and individual factors and the organization of healthcare systems and the labor market (38-40). Pain management is further complicated by the fact that relatively few people with chronic pain fully recover (41), and pain management options show only moderate effect sizes (30). Recent reviews have summarized pain management recommendation across musculoskeletal pain diagnosis. These recommendations concern delivery of patient-centered care that includes a thorough physical examination with screening for red flags and psychosocial factors, provision of management that includes physical activity/exercise and education/information with only adjunct use of manual therapy, monitoring of progress, encouraging labor market attachment, and delivering non-invasive care prior to surgery (29). A recent evidence synthesis confirms these recommendations and encourages healthcare providers to establishing a diagnosis and to use multidisciplinary and tailored approaches (8). The effectiveness of pain management strategies varies but strong to moderate evidence supports the effectiveness of exercise therapy and psychosocial interventions to relieve pain and improve function (30) and the use of non-steroidal anti-inflammatory drugs (NSAIDs) and opioids as beneficial for short-term pain relief (8, 30).

Organization of chronic pain management in the Danish healthcare system

Denmark has a public healthcare system where most healthcare services are free of charge (42). Primary care general practitioners (GPs) are the first point of contact with the healthcare system for the majority of people seeking healthcare due to pain (42, 43), except in situations where alternative healthcare or direct access to primary care physiotherapists or chiropractors is preferred, or in cases where direct access to emergencies departments or ambulances is required (42, 43). According to estimates from the Association of Danish Physiotherapists from 2018, direct access in primary care accounts for approx. 15% of all contacts to physiotherapists and chiropractors, and this proportion has probably increased since (44). The GP preforms the initial examination and evaluates the need for referral to specialists (42). Depending on the outcome of this evaluation, the patient with chronic pain can be referred for further examination and/or treatment with other healthcare specialties in different sectors (primary/secondary care or municipal rehabilitation) (43). This means that people seeking care due to chronic pain move in sequential pathways back and forth between the different specialties and sectors involved, depending on the results and reports of the initiatives taken. Figure 1 is a graphical illustration of the organization of the Danish healthcare system for management of pain.

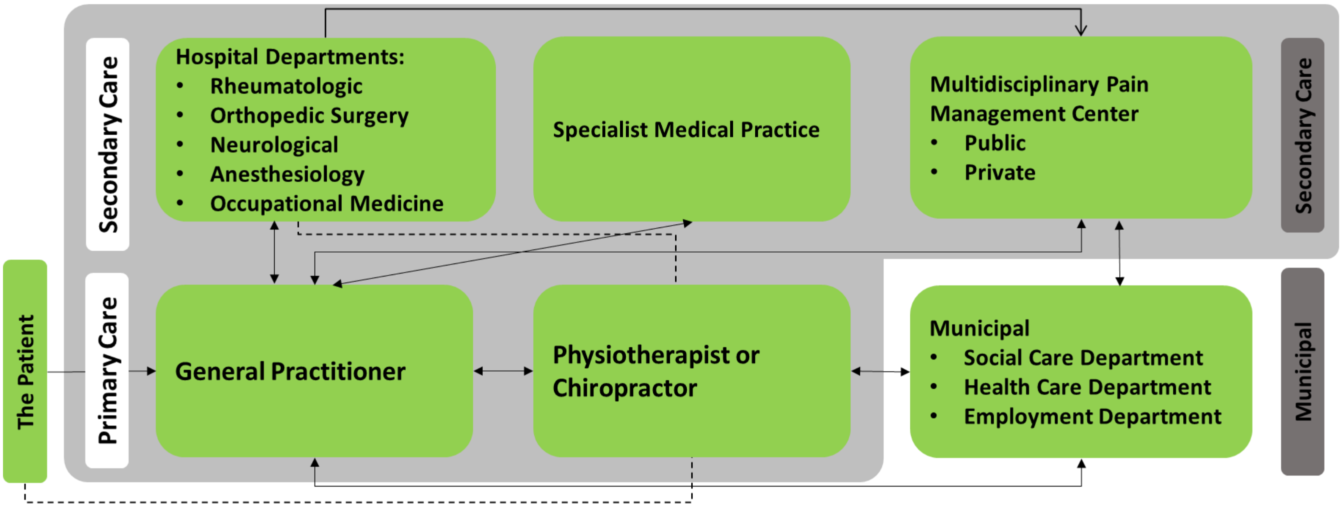


Figure 1. Organization of chronic pain management in the Danish healthcare system (Figure with permission from Ørtenblad et al.) (42, 43)

Healthcare-seeking behavior in the context of pain

Pain is one of the most common reasons for seeking healthcare (4, 45, 46). According to estimates based on interviews with Danish GPs, about half of all consultations are related to pain (43), and a study from the US estimates that chronic pain accounts for 57% of all healthcare encounters (47). A recent systematic review estimates that the annual prevalence of healthcare utilization for low back pain across different populations is 51% (95% CI: 40–62) but with variation across studies and populations (48). GPs, chiropractors, and physiotherapists are most often engaged in pain management (48). In general, healthcare-seeking behavior can be considered to be the result of an interpretation and decision-making process where symptoms are transformed into signs of potential illness influenced by a variety of individual, functional, psychological, social/contextual, cognitive, and health-related factors (49-51). Not all health problems or symptoms have the same capacity to trigger healthcare seeking, and only about one-third or less of people reporting pain consult a GP (52). People with self-reported musculoskeletal pain use general healthcare services more often than the general population (53-56), but this use varies significantly, and a minor group of high healthcare users account for a disproportionately large proportion of healthcare contacts and costs (57, 58)

Drivers of healthcare in the context of pain

Factors associated with healthcare use in the context of chronic pain have been mainly explored with regard to specific pain conditions and clinical populations (e.g., shoulder pain and low back pain) (48, 49, 59, 60), but factors associated with healthcare use across chronic pain conditions have also been explored. Despite inconsistency in the literature and scarcely studied associations (61), factors like increasing age, female sex, high pain severity, pain-related disability, symptom-related anxiety, and psychological distress are associated with higher use of healthcare services (61). The belief that pain is the result of an aging process, fear of healthcare provider disbelief, negative expectations of healthcare outcome, poor experiences with healthcare, and healthcare expenses may delay or inhibit healthcare seeking (61-63), while social influence and advices can both facilitate and inhibit healthcare dependent on the advice given (61, 62). These factors have been confirmed by primary studies that also add depression, anxiety, fear-avoidance beliefs, insurance status, more pain diagnosis, longer duration of sickness absence, pain interference with life, lower socioeconomic status, poor self-rated health, comorbidity, and poorer sleep quality to the list of factors associated with higher use of healthcare due to pain (56, 57, 64-71). A recent Swedish study found that the number of pain sites differed significantly between different trajectory groups of long-term musculoskeletal healthcare users, with higher number of pain sites among people with consistently high use of healthcare (71).

Theories about healthcare use for pain

Conceptually, care seeking has been framed by different theories. One of the most dominant theoretical frameworks is Ronald Andersen’s “Behavioral Model of Health Services Use” (72). This model suggests that care seeking is a function of predisposing factors, enabling factors, and perceived need for care (73, 74). The operationalization of the model in the literature has mostly considered factors like sex, age, marital status, education, and ethnicity as predisposing factors; financial situation, health insurance and usual source of healthcare (family doctor) as enabling factors; and health status/perceived health and a variety of diseases and pain-related diagnoses as need factors (74). In a Danish context, where local healthcare services are available in all parts of the country and most healthcare services are fully or partly publicly funded, enabling factors might not be a strong determinant for care seeking. However, predisposing and need factors like negative health beliefs and health worries have been found to be important determinants of healthcare (52, 53, 55, 75). Another theoretical model that is often used to understand beliefs about health and the impact of such beliefs is Howard Leventhal's "Common Sense Model of self-regulation (CSM)" (76, 77). According to the CSM, people with pain draw on a set of beliefs to understand (make sense of) their situation and decide what to do about it. This set of beliefs, composed of beliefs about the identity, causes, consequences, controllability, and duration of pain symptoms, is informed by personal experiences and external sources of information such as healthcare professionals and the media (77).

The lived experience of pain

There is a growing body of research exploring the lived experiences of people with chronic pain, and this knowledge has been synthesized in a recent review. Toye and colleagues (78) conducted a meta-ethnographic literature review to understand the process of recovery for people with chronic pain. This review was based on 195 qualitative reports and experiences from more than 3500 individuals with chronic pain and concludes that healing is a journey – not a destination. The ability to embark on this healing journey in the context of chronic pain rests on two different but interconnected aspects. The first is validation of the pain and the person with pain. This means that the person with pain must be listened to and understood in order to fearlessly accept and understand the pain. The second is reconnecting with the world and themselves, which requires that the person with pain accepts a new identity with pain, lives peacefully alongside pain, is kind to themselves, feels connected to others, and is met as a fellow human being by others (e.g., healthcare providers). Validation and reconnection are fundamental empowering processes in order to move forward to a brighter future and to believe in a future. Feeling empowered also rests on the development of an equal partnership with a healthcare provider and learning new ways of doing and being (79). To believe in a future aligns with finding meaning and being determined to live well with pain and accept that this journey can be a struggle with ups and downs (79).

First-person narratives of people reporting chronic pain show that healthcare management sometimes fails and exacerbates the situation (80). Some people with chronic pain experience repeated treatment failures, leaving them feeling hopeless and trapped by the pain (78, 80, 81). Some seek healthcare in the search for an explanation or a diagnosis to validate the pain, and this search can continue for a long time (78). Some people with chronic pain experience healthcare providers who appear skeptical and lack understanding of their situation, leaving the person with chronic pain feeling stigmatized and disbelieved, which gives rise to feelings of anger, frustration, and despair (81).

Synthesis

Understanding behaviors is a complex process, and healthcare-seeking behavior in people with chronic pain has been studied in different designs and with different types of data. This has provided knowledge about how different factors are associated with healthcare use by people with chronic pain. However, these associations are inconsistent and sometimes findings are contradictory (48, 61, 62). Furthermore, these associations are mostly examined in exploratory prognostic frameworks, while research on determinants of healthcare use in a confirmatory framework are sparse. The number of pain sites has been shown to be a relevant and meaningful clinical classification, but the causal relationship between the number of pain sites and healthcare use has not yet been explored, nor have the consequences of negative health concerns. It is also known that people with chronic pain use healthcare services more often than people without pain and that a minor group of people with chronic pain account for the use of the majority of healthcare resources. However, healthcare behavior in the context of pain has mostly been studied using cross-sectional, retrospective, or short-term longitudinal designs for specific pain conditions with small samples sizes (<1000) and are often based on self-reported data with inherent risk of bias (61, 62) Thus, studies are needed that explore in detail long-term pain-related healthcare use by people with chronic pain using longitudinal data from high quality national health registers.

Optimal use of healthcare resources is a challenge, and first-person narratives document unhelpful and even counterproductive healthcare encounters in various health systems and sectors (78-80). More knowledge about how beliefs, expectations, and experiences influence and determine healthcare use offers the opportunity to understand healthcare-seeking behavior and its underlying processes and could provide valuable insight into the interplay between the different healthcare professions involved in pain management and people experiencing chronic pain, but such studies are lacking. More understanding of these relationship could be key to improving pain management and the healthcare system.

The overall purpose of this project is to describe and better understand long-term healthcare use in the context of chronic pain. In this endeavor we will try to answer the following questions: 1) How do individuals with chronic pain use the healthcare system?, 2) Why do individuals with chronic pain seek healthcare?, 3) How do chronic pain-related healthcare user groups differentiate?, and 4) What modifies healthcare use in the context of chronic pain?

Answering these questions is beyond the reach of a single method and data source. Therefore, we will explore healthcare-seeking behavior in the context of chronic pain with the use of multiple methods and data sources including longitudinal national registers with long-term follow-up. Until now, only a few studies have approach this topic using a mix of methods, designs, and data (10) . In a sequential process we will, therefore, test determinates for long-term healthcare use, describe long-term musculoskeletal healthcare-seeking trajectories and gain insight into drivers for selecting or de-selecting healthcare due to pain, and merge findings from these different phases into a joint interpretation.

Aims

The specific aims governing the different phases of this project are listed below:

i. To evaluate whether increasing number of pain sites and health anxiety are causally related to more healthcare contacts and costs. We hypothesized that a higher number of pain sites and high level of health anxiety would be associated with more use of healthcare services and increased cost over a subsequent 10-year period independent of other factors.

ii. To describe long-term musculoskeletal healthcare trajectories for people with chronic pain and explore what individual; sociodemographic; and health-, belief-, and work-related profiles characterize people with different long-term use of musculoskeletal healthcare services.
iii. To understand how people with chronic pain and different long-term musculoskeletal healthcare trajectories explain their use of healthcare services, and explore what emerges from comparing perspectives, experiences, beliefs, and perceived needs for healthcare for people with different pain-related healthcare use.

Chapter 3 - Methods

Research paradigm

In the first two studies, a post-positivistic research paradigm was the overarching perspective informing the data collection, analysis, and interpretation. Post-positivism is a singular reality paradigm where the researcher objectively observes the phenomena of interest from a distance and uses deductive tests of one or more predefined hypothesis (82). In the first study, we tested the predefined hypotheses, and in the second, we described the behavior of interest and individuals' characteristics that were associated with different patterns of behavior. This was done with the use of quantitative data and framed within theories about prognostic research, health behavior and scientific literature. Data were analyzed with the use of statistical methods. From a positivistic standpoint, observations and measurements, analysis, and interpretations are perceived to be minimally influenced by the researcher. Results are presented quantitatively with the use of tables and graphs. In study 3, the paradigm for data collection and analysis shifted to a phenomenological paradigm, acknowledging that there are multiple realities and meanings, and inherently, the researcher will influence data collection and analysis and interpretation. The addition of the phenomenological paradigm allows for perspectives that cannot be captured by a post-positivistic paradigm. Analysis in study 3 was based on transcripts of narratives and performed by a group of researchers in which trustworthy patterns of meaning were conceptualized through discussions and agreement. In this analytic process, we strived to be transparent and explicated all steps and decisions in an audit trail (Appendix C1). Results from study 3 will be presented as themes, subthemes, and condensed aspects of meaning. Last, for discussion and the overall interpretation of results, a more dialectic approach is used.

Design

This project was built on three studies with different designs. As a whole, the project is an explanatory sequential mixed method design with integration through connecting, building, and interpreting (82, 83). This form of method-level integration commonly follows sequential designs, and the purpose is to gain deeper insight into the topic of interest than what could be achieved by the single studies alone (82, 83). In this case, we used results from the first two studies to inform sampling, and data collection for the last study before a joint interpretation of key findings was made. Therefore, informants, data collection, and analysis for study 3 connect and build on key findings from studies 1 and 2. This approach was chosen to integrate the findings from the different phases into a coherent and understandable whole and gain more insight into healthcare seeking in the context of pain. Figure 1 is a graphical illustration of how the different studies connect and how methods were synthesized. The synthesis integrates the discussion and results from all three studies using a modified weaved approach (83) to answer central questions about pain-related healthcare-seeking behavior. For a detailed description of design and methodology for each single study, please see Appendix A-C (studies 1–3).

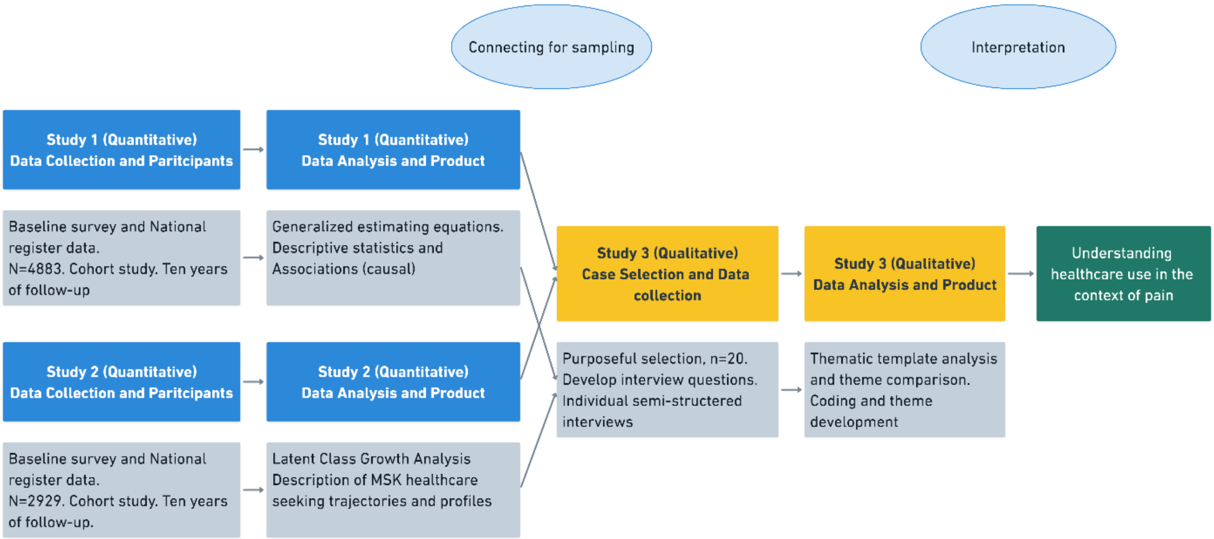


Figure 2. Project overview - Explanatory Sequential Mixed Methods Design

Literature search strategy

At the beginning and the end of this PhD project, a structured literature search was undertaken to identify relevant papers published on healthcare use and musculoskeletal pain between 2000 and 2018 in English, Danish, Norwegian, and Swedish through the Ovid (Medline, Embase, PsycINFO) and PubMed interfaces. To update this search, a monthly alert for new publications was set at Pubmed, Embase and Scopus databases throughout the project period. For a more detailed description of the literature search strategy please see Appendix E.

Participants and survey rounds

Data for all phases of this project were from a population-based Danish cohort. The cohort has been described in detail elsewhere (20, 84, 85). In brief, the cohort was established in 2008 and consists of adults between 17 and 64 years of age (in 2008) registered with one of eight GPs at the same primary medical healthcare center in the town of Odder, Denmark. The eight GPs did not share patients but shared facilities, patient software, staff, etc. Odder is a medium-sized Danish town located in the eastern part of Jutland, close to larger cities and main thoroughfares, and it has a quite typical Danish population. The Municipality of Odder, which includes the town of Odder and its rural surroundings, was inhabited by 21,500 people in 2008. The age category and location were chosen to establish a representative cohort of working-aged adult Danes. In February 2008, a postal or web-based baseline questionnaire was sent to 8,517 adult men and women registered with the medical healthcare center. At total of 5,097 (60%) individuals returned the baseline questionnaire, 5,068 (60%) of whom could be identified (29 (<0.01%) responders could not be identified) (84, 85). In October 2020, we digitally distributed a web-based follow-up questionnaire to the 4,673 (55%) members of the cohort who responded to the baseline questionnaire and who were still alive and registered in the Danish mandatory secure public mailbox system (e-Boks). In October 2020, about 93% of the citizens of Odder were registered with the e-Boks system (86). A total of 3,302 individuals responded to the 12-year follow-up questionnaire (39% of the original cohort and 71% of those sent the questionnaire). A flowchart for the cohort describing the study sample for each study is presented in Figure 3.

Study samples

For study 1, we included identifiable baseline questionnaire responders who were alive until 2018 (died: n = 153) and not living abroad for more than 2 years from 2008 to 2018 (lived abroad > 2 years: n = 32). This left us with 4,883 participants eligible for analysis (87). For the aim of study 2, we also considered domestic resident (not living abroad > 2 years from 2008 to 2018) baseline questionnaire responders alive until 2018, but because of ambiguous data, we excluded 155 individuals due to death and 42 individuals who had lived abroad > 2 years. As the population of interest in this study was people with chronic pain, we also excluded 1816 individuals reporting pain for less than 3 months at baseline and 126 individuals not reporting any pain. This left us with 2,929 eligible participants. For study 3, we purposely selected and invited 20 informants with different sex, age, health, work and well-being profiles who reported chronic pain in both 2008 and 2020 and who accepted to be contacted for an interview. This approach was chosen to have a variety of voices represented in the sample. For a more detailed description of recruitment and participant selection, please see Appendix A-C (Studies 1–3) and Figure 3.

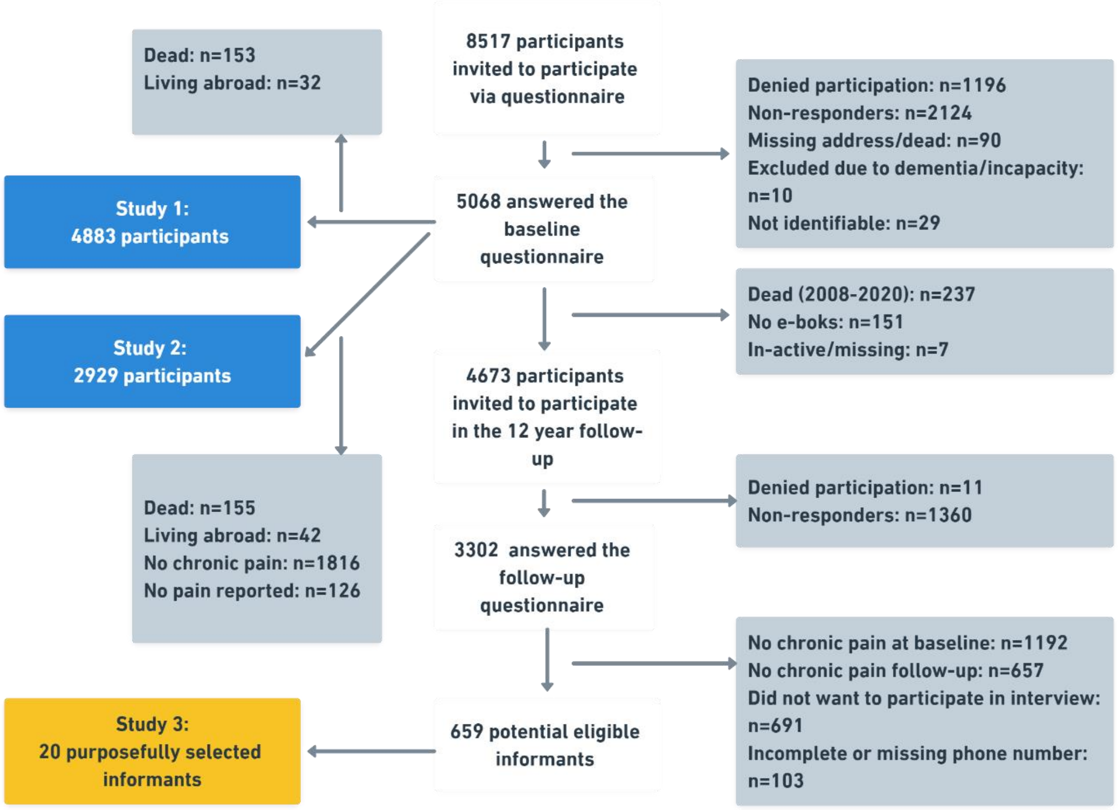


Figure 3. Flowchart

Data, data sources, and data collection

There were three main data sources for this project: 1) questionnaires (2008 and 2020), 2) national registers (2006–2017), and 3) individual interviews. Data and data sources for the quantitative (study 1 and study 2) and qualitative (study 3) studies will be presented below with a description of data extracted from each source. Table 1 presents an overview of aims, data sources, variables (exposure, outcome, covariables, descriptive profiling variables and variables for informant selection) and methods of analyses for all three studies.

Table 1. Study overview – methodology

	Phase 1 - Study 1 (Quan)	**Phase 2 - Study 2 (Quan)**	**Phase 3 – Study 3 (Qual)**
Study aim	Examine the consequences of number of pain sites and health anxiety on HC-related costs and long-term HC-seeking.	Describe trajectories of long-term MSK HC use for people reporting chronic pain and describe profiles for such trajectories.	Explore drivers for use, or non-use of pain-related HC services and explore how such drivers differ between groups of pain-related HC services use.
Data sources	Questionnaire data from 2008. National health and social registers 2006-2017	Questionnaire data from 2008. National health and social registers 2006-2017	Twenty-one individual, semi-structured interviews conducted by telephone or online. Questionnaire data from 2008 and 2020 and national social registers.
Primary Variables or topic of interest:	**Exposure:** Number of pain sites – Range 0–7. Health anxiety – Low/High. **Outcome:** Annual number of face-to-face HC contacts (All contacts and MSK contacts). Healthcare costs (€)	**Primary variable:** Annual number of face-to-face HC contacts for MSK conditions and redeemed pain medication from 2008 to 2017.	**Primary topics of interest:** Self-reported use of pain-related HC (low, medium, high). - Individual pain stories. - Beliefs about pain. - Pain-related healthcare experiences (if any). - Thoughts/beliefs/experiences underlying selecting or deselecting healthcare. - Advice to other people with chronic pain and HCPs.
Co-variables (study 1)/ Descriptive profiling variables (study 2)/ Variables for participant selection (study 3)			
Questionnaire:	Duration of pain, risk of depression, personality.	Number of pain sites, pain intensity, health anxiety, risk of depression, risk of anxiety, personality, BMI, mental health, physical health, participation restriction, fear-avoidance beliefs.	Number of pain sites (2008 & 2020), health anxiety (2008 & 2020), labor market status (2020), self-rated work ability (2020), well-being (2020), musculoskeletal health (2020).

National registers:	Sex, age, level of education, comorbidity (Charlson index), marital status, previous healthcare utilization, upper & lower body job exposure.	Sex, age, level of education, comorbidity (Charlson index), marital status, labor market status, previous healthcare utilization (MSK).	Sex and age.
Data analysis	Negative binomial regression with generalized estimating equations. Spearman correlation. Missing data handled with multiple imputation technics.	Latent Class Growth Analysis with a zero-inflated Poisson distribution model. Profiling of descriptive variables according to trajectory group membership and test of differences.	Thematic template analysis. Comparison of codes and themes across groups of pain-related HC use.
Abbreviations: Healthcare: HC. Musculoskeletal: MSK. Standard evaluation questionnaire: SEQ. Body Mass Index: BMI. Healthcare Provider: HCP			

Data collection and data sources for studies 1 and 2

Baseline questionnaire data

The baseline questionnaire covered a range of demographic, individual, work-related, psychosocial, and health-related domains using validated scales. Detailed description of the baseline data collection and questionnaire has been reported elsewhere (84, 85, 88). Variables from the baseline questionnaire were used in all studies but especially study 1 and study 2. In study 1, baseline variables were used as exposure and co-variables, and in study 2, variables extracted from the baseline questionnaire were used as profiling variables. For the purpose of these two studies, we used responses to the following variables from the baseline questionnaire:

Number of pain sites, pain intensity, and *duration of pain* was measured with parts of the Standard Evaluation Questionnaire (SEQ), which is a validated scale for assessing pain in population-based studies (89). *Number of pain sites* (range 0–7) was generated by summarizing pain the last 4 weeks reported on a 1- (no pain) to 7- (worst imaginable pain) point rating scale in the following body regions: right/left upper and lower extremity, front, back, and head. In study 1 we only counted pain sites with an intensity above 2 to exclude trivial pain. *Pain intensity* (range 1–7) was generated by extracting the highest reported pain intensity across body regions, and *duration of pain* was generated by dichotomizing (no chronic pain/chronic pain) a 4-point Likert into pain duration ≤ 3 months/>3 months. Pain intensity was used in study 2.

Risk of Health anxiety (Low/High), *risk of depression* (Low/High), and *risk of anxiety* (Low/High) were measured using subscales from the Common Mental Disorder Questionnaire (CMDQ), a validated case-finding tool for mental disorders useable in primary care settings (90). For *Risk of Health anxiety,* we used the Whiteley-7 index (range 0–28). R*isk of depression* and *risk of anxiety* were measured with the 6-item depression sub-scale (range 0–24) and the 4-item anxiety sub-scale (range 0–16) from the Symptom Checklist-90-R (90, 91). We dichotomized the Whiteley-7 index, the 6-item depression sub-scale, and the 4-item anxiety sub-scale based on clinical interpretation recommendations from the Danish College of General Practitioners (high risk of health anxiety ≥6, high risk of depression ≥5, and high risk of anxiety ≥5,) (92). Risk of anxiety was only used in study 2.

Personality was measured with the 20-item Mini International Personality Item Pool (93). Mini International Personality Item Pool is a psychometrically acceptable and practical measure of the Big Five personality traits (extraversion, agreeableness, conscientiousness, neuroticism, and openness). Each of these personality traits was measured with four items, generating a 0–16 score for each trait, and each trait was analyzed as a continuous variable.

Body mass index (BMI) was based on self-reported height and weight, and participants were categorized into four groups based on standard BMI categories for adults used by the World Health Organization (under/ normal weight (<25), pre-obesity (25-<30), obesity class I (30-<35), obesity class II & III (≥35).

Physical and Mental health was measured with the physical and mental health component score of the Short Form 12 – version 2 scale (94, 95). Both scales were summed on a 0–100 scale according to the developed guideline algorithm (96).

Participation restriction due to pain (low/high) was measured with two novel questions about how pain had influenced participant experience of 1) satisfaction and joy and 2) ability to participate in social and leisure-time activities. Each question was rated on a 7-point numeric ranking scale (1 = No influence/7 = Influenced a lot). The two items were summed and dichotomized based on the median of score distribution (high participation restriction ≥4). Participation restriction due to pain was used in study 2.

Fear avoidance beliefs were measured with four items on physical function from the Fear Avoidance Belief Questionnaire (97) and two additional items on appropriate actions in the context of pain. Each question was rated on a 5-point Likert scale. All six items were summed for the analyses done in this project. BMI, physical/mental health, participation restriction due to pain, and fear-avoidance beliefs were used in study 2.

National registers

We used variables derived from national registers in all studies (see Table 1) but especially in study 1 and study 2. In these studies, national health and social registers were key data sources. Denmark (and all Nordic countries) has a tradition of record keeping across a large number of health-related and social domains (42). With the use of the unique personal identification number assigned to all Danish residents, it is possible to create an extensive network of inter-linkable longitudinal population-based registers (98-100). Most national registers are made for administrative purposes, but are also valid data sources for epidemiologic studies (98, 99, 101). For the purpose of this project, we applied for register data access from The Danish Health Data Authority (https://sundhedsdatastyrelsen.dk/da/english) and Statistic Denmark (https://www.dst.dk/en/TilSalg/Forskningsservice) from 2006 to 2018 for all 5097 responders to the baseline questionnaire. We applied for and used data from the following national registers and databases: National Health Insurance Service Register (NHSR), the National Patient Register (NPR), the Rehabilitation According to “The Danish Act of Health §140” register (Rehab register), the Register of Medicinal Product Statistics (RMPS), the Diagnosis Related Groups (DRGs)-Grouped National Patient Register, the Danish Civil Registration System (DCR), the Danish Education Register (DER), the Danish Register-based Evaluation of Marginalized Individuals (DREAM), the Register-Based Labor Force Statistics (RAS), and the Upper and Lower Body Job Exposure Matrix (JEM). For description of each register/database please see Table 2.

Table 2. Danish national health and social registers

Domain	Register	Description
Health Registers	The National Health Insurance Service Register (NHSR)	Central register for primary care contacts. All public reimbursements (fully or partly) for all types of consultations, type of service provided, and public expenditure are listed for a large number of professions (e.g., GPs, physiotherapists, chiropractors, dentists, psychologists). Fully self-funded healthcare services are not recorded in the NHSR. The NHSR was established in 1990 (102, 103).
	The National Patient Register (NPR)	Central register for all hospital contacts (secondary healthcare). The NPR contains of a number of inter-likeable sub-registers containing information on hospital admissions since 1978 and all outpatient hospital contacts since 1994. Information in the NPR includes the start and end date/time for all in- and out-patient hospital arrivals/courses. Diagnostic registrations in NPS are based on the International Statistical Classification of Diseases and Related Health Problems (ICD) diagnostic codes. The NPR is considered to be a valid source of healthcare data (104)
	The Rehabilitation According to "The Danish Act of Health §140" register (Rehab register)	Central register for all publicly funded rehabilitation (physiotherapy and occupational therapy) after in/out patient hospital contacts. According to Danish law, a patient can be referred for publicly funded rehabilitation after hospital contacts if indicated. Dates, numbers of, and types of contacts for this type of rehabilitation have been recorded in the rehab-register since 2007. Data from the rehab-register have not been validated.
	The Register of Medicinal Product Statistics (RMPS)	Central register for information about prescription and redeemed medicinal products sold over-the-counter and used by hospitalized or GP patients. The RMPS contains information on dates for dispensing, prescriber identification, medical product data, etc. This information has been recorded since 1994. The product identification information in the RMPS is based on the Anatomical Therapeutic Chemical Classification System codes (101, 105).
Health economy register	The Diagnosis Related Groups- (DRGs) - Grouped National Patient Register	Central register for costs related to in- and out-patient contacts in the NPR. DRGs data itemize payment instances and rates in the Danish healthcare system. Estimated grouped rates for each hospital service are based on the average costs for all hospitals in Denmark and are used for health authority payments, reimbursement between healthcare sectors, and economy administration in the Danish healthcare system. The payment rates for DRGs-grouped NPR items are re-evaluated each year (104, 106).
Social registers	The Danish Civil Registration System (DCR)	The Danish parliament and the citizens of Denmark decided to record the population electronically in 1968, and the DCR was introduced, and a unique identification number was assigned to all residents of Denmark. This number is the key information for linking registers. The DCR also contains information on name, gender, the date and place of birth, citizenship, nationality of parents, etc. (98, 99).
	The Danish Education	Central register on educational achievements of more than 80 hours duration for all residents in Denmark. The DER is administrated by the Danish Ministry of Education and Statistics Denmark and has been in use

	Register (DER)	since 2007. The DER consists of a number of linkable sub-registers, and the validity and coverage of the Danish education registers are considered to be very high (107)
	The Danish Register-based Evaluation of Marginalized Individuals (DREAM)	The DREAM contains longitudinal information on all Danish citizens who have received social benefits or any other public transfer income. This information is recorded on a weekly basis based on a hierarchical coding system where only one code can be recorded for each person per week, even though that person might have received several types of transfer payments. The DREAM provides valid data regarding labor market status (108, 109).
Work-related registers	The Register-Based Labour Force Statistics (RAS)	Central register for information about the Danish population's affiliation to the labor market recorded at a given time point each year. Annual information about each person's most important employment activity based on the International Standard Classification of Occupations (D-ISCO) job titles is also recorded in the RAS. This information has been recorded since 1976 (110).
	The Upper and Lower Body Job Exposure Matrix (JEM)	Register-based matrix for upper and lower body physical exposure estimates. This matrix is based on expert evaluations and measurement estimates of physical exposure. Ratings are summoned into 121 job groups with expected homogeneous physical exposure patterns based on 689 occupational D-ISCO titles. The JEM is considered valid for evaluating work-exposure related consequences in population-based epidemiological studies (111-113)

Variables derived from registers

Annual healthcare cost and annual healthcare contacts (contact for any reason and musculoskeletal healthcare contacts) were the outcome variables in study 1 and the primary descriptive variables in study 2. Annual healthcare costs were operationalized as all public healthcare-related costs. Annual healthcare contacts were operationalized as all face-to-face contacts with a healthcare professional registered in the Danish national health register system and also as any redeemed prescription of medication for pain relief. Inpatient admission days, face-to-face healthcare contacts and redeemed prescription were counted as one contact. We derived variables describing healthcare-related cost and number of healthcare contacts by counting and summarizing cost and contacts per year for each participant from 2008 to 2017 (10 years). In order to do so in a stringent and transparent way, we developed algorithms describing the procedure in detail (please see Appendix A1 and B1). In brief, the following variables and procedures were used:

Annual healthcare costs for any reason (€) were derived by summarizing all public healthcare-related costs per year using the NHSR, DRG, and Rehab registers. Annual rehabilitation costs were calculated based on the estimated salary for the healthcare professional responsible for the rehabilitation and other operational costs. This variable was used as outcome in study 1.

Number of annual healthcare contacts for any reason was derived by counting and summarizing annual face-to-face contact obtained in the NHSR, NPR, and Rehab registers. This variable was used as outcome in study 1

Number of annual musculoskeletal healthcare contacts was derived by counting and summarizing annual musculoskeletal face-to-face contact in the NHSR, NPR, and Rehab registers. For this variable, we only considered consultations from professions where their scope of practice indicated musculoskeletal reasons for contact (e.g., physiotherapists, chiropractors, and musculoskeletal medical specialists) and hospital contacts registered with musculoskeletal diagnostic ICD-codes (chapter 13). To count musculoskeletal GP and rehabilitation contacts, we developed a special algorithm. For detailed description of this algorithm, please see Appendix B1. The number of musculoskeletal healthcare contacts was used as an outcome in study 1. In study 2, we added more detail to this variable by identifying and summarizing musculoskeletal surgery, physiotherapist, chiropractor, and GP contacts. Furthermore, we counted annual redeemed prescription of medication for pain relief from the RMPS using the Anatomical Therapeutic Chemical Classification System codes for local anesthetics, opioids, other analgesics and antipyretics, antiepileptics, anxiolytics/hypnotics, and anti-inflammatory/anti-rheumatic products. These specific product codes were chosen after guidance from medical doctors with expertise in musculoskeletal pain management. The number of musculoskeletal healthcare contacts was the primary variable in study 2.

Previous healthcare utilization was used as covariables in study 1 and study 2. For this variable, we applied the same algorithm as for “Number of healthcare contacts” to national health registers for 2006–2008. This variable was included as a continuous variable.

From social and work-related registers, we derived the following variables:

Sex and a*ge* (baseline) were derived from the DCR register data. Sex was included using male/female as nominal categories (99, 100). In study 1, we used six ordinal groups for age (17–20, 21–30, 31–40, 41–50, 51– 60, and 61–65), and in study 2, age was included as a continuous variable (99, 100).

Level of education was derived from the DER register data (107). Highest level of education was recorded in one of the following three ordinal groups based on the “The International Standard Classification of Education” (114): primary and lower secondary education, upper secondary education or skilled worker, Bachelor’s/Master’s/Doctorial.
Comorbidity was obtained by applying the register-based algorithm for Charlson comorbidity index using ICD10 diagnostic codes for data from the NPR (115, 116). We recorded comorbidity in three groups: no comorbidity, low level of comorbidity, high level of comorbidity.
Marital status was derived from DCR register data (99, 100). We recorded the most frequent marital status in the follow-up period (2008–2017) in the following four nominal categories: Cohabitant with resident children, Cohabitant without resident children, Single with resident children. Single without resident children.
Most frequent *labor market status* in the follow-up period was derived from DREAM registry data and divided into four nominal groups: working or student, unemployed, permanent or temporary health-related benefit, retirement (108, 109). Level of education, comorbidity, marital status, and labor market status were used as covariables/descripting profiling variables in both study 1 and study 2.
We applied JEM data on to D-ISCO job codes from the RAS register to estimate physical job exposure. For *Upper physical body job exposure,* we dichotomized the variable “Total shoulder score”, which is a combined measure of seven different shoulder exposures (range 0–10), at the 75th percentile (low/high) (112, 113), and for *Lower physical body job exposure,* we dichotomized the variable “Total kilograms lifted per day” (low/high) at </≥ 1000 kg/lifted per day (117). Physical job exposure was used as covariable in study 1.

Data collection and data sources for study 3

Follow-up questionnaire data

In study 3, we used variables from both survey rounds for participant selection and description (see Table 1). To comply with Danish law and get participation approval, we distributed the follow-up questionnaire before study 3. Besides approval to participate in the interviews, the follow-up questionnaire covered questions related to health (including number of pain sites, duration of pain, pain intensity, general health, and musculoskeletal health), psychosocial (fear-avoidance beliefs, self-efficacy, health anxiety), well-being, and work-related domains (work-ability, labor marked status, work demand and satisfaction) measured with the use of validated scales.

In study 3, we used the following variables from the follow-up questionnaire:

Number of pain sites, duration of pain, risk of health anxiety: For description of these variables and method of measurement, please see the baseline questionnaire section.

Labor market status was measured with a single-item question. Participants were asked to specify their current work status according to one of the following 10 nominal categories: work, temporarily absent due to illness, student, health-related work placements, temporarily absent due to leave, trainee/apprentice, social assistance recipient, unemployed, retirement, or other.

Self-rated work ability was also measured with a single-item question. Participants were asked to rate their work ability on a 10-point Likert scale, where 0 indicated unable to work and 10 indicated full work ability.

Well-being was measured with the 5-item WHO-5 Well-Being Index, which is a widely used cross-country validated measure of well-being (118). The five items were summed on a 0 – 100 scale according to algorithm guidelines, where 0 represented worst and 100 represented best imaginable well-being (119).

Musculoskeletal health was measured with the Danish version of the 14-item Musculoskeletal Health Questionnaire (MSK-HQ). This scale is a validated scale for measuring musculoskeletal health across musculoskeletal conditions and settings (120, 121). For scoring, all 14 items are summed, with the sum score ranging from 0 to 56. Higher scores indicate better musculoskeletal health. For a more detailed description of variables and data management and rational for variables selection, please see Appendix A-C (Studies 1–3).

Interviews

Interviews were the central data source for study 3. We conducted 20 individual interviews from April 2021 to October 2021. Due to government recommendations regarding the COVID-19 pandemic, all interviews were conducted online (n = 2) or over the phone (n = 19). All interviews were conducted by me, and audio recorded. Transcription was done by a research assistant with extensive experience in transcription and qualitative research. Before data collection, I received training from two experienced colleagues (one a co-author of study 3, Helle Rønn Smidt [HRS], and one a supervisor, Anne Smith [AS]). The interviews lasted between 30 and 90 minutes and explored experiences, beliefs, and thoughts underlying healthcare use. Before conducting the interviews, I together with HRS and AS prepared a semi-structured interview guide with open-ended questions about the pain and pain-related healthcare experiences (including pain medication and alternative healthcare). In brief, the informants were invited to: 1) tell their pain story, 2) explain their beliefs about their pain, 3) describe pain-related healthcare experiences (if any) and thoughts/beliefs/experiences underlying selecting or deselecting healthcare and/or different treatment modalities, 4) suggest any advice to other people with chronic pain and healthcare professionals. At the beginning of each interview, informants were asked to (i) estimate their pain-related healthcare use during the last year (number of contacts with GPs, physiotherapists, chiropractors, complementary and alternative medicine, hospital, and emergency room), and (ii) their use of pain medication and recall whether this pattern of healthcare use had changed over the last 5 years. This information was evaluated by me and grouped into one of the following three categories to comply with findings in study 2: Low (no or very few annual musculoskeletal healthcare contacts), Medium (five to 15 annual musculoskeletal healthcare contacts), and High (More than 15 annual musculoskeletal healthcare contacts). As recommended by qualitative research guidelines, data collection and analysis were an iterative process where evaluation and analysis informed and qualified subsequent interviews and recruitment. For detailed and transparent description of recruitment of informants, data collection, analysis, and reflections, please see Appendix C1 (audit trail).

Data analysis

Quantitative strands

The statistical analysis in study 1 was based on a causal inference framework (122, 123), and selection of variables for adjustment was based on the principle of minimal sufficient adjustment sets of co-variables for estimating the total effect (124) and guided by a theoretical framework illustrated by Directed Acyclic Graphs (DAGs) (www.dagitty.net) (125) (see Appendix A1). The development of these frameworks for adjustment were based on a literature review and discussions with my supervisors. DAGs were challenged, discussed, and updated until agreement was reached. The rational for the final versions was described and included as an appendix within the publication (Appendix A1). Each hypothesis was tested via a negative binomial distribution regression model using Generalized Estimating Equations (GEE) to account for multiple observations on the same person over the 10-year study period and zero inflated count data using an unstructured correlation structure. With this approach, we calculated adjusted incidence rate ratios (IRR) for the total effect between number of pain sites and healthcare contacts (musculoskeletal contact and contacts for any reason) or costs with 95% confidence intervals (CI). All models were adjusted for sex, age, duration of pain, level of education, comorbidity, personality traits, risk of depression, marital status, physical job exposure, and previous healthcare utilization. Missing baseline questionnaire data were handled with chained multiple imputation techniques. To analyze sensitivity, estimates from the regression analysis on multiple imputation data were compared with estimates from a full case analysis of non-imputed data. To understand the relationship between number of pain sites and health anxiety, as well as between the three healthcare utilization outcomes, we tested correlation between these variables with Spearman's correlation coefficients with 95% CIs using bootstrapping methods with 100 repetitions.

In study 2, we used Latent Class Growth Analysis (126) (LCGA) with a zero-inflated Poisson distribution model to explore trajectories of musculoskeletal healthcare utilization in people with chronic pain. We tested models with up to 10 groups to assess the optimal number of trajectory groups to best describe long-term musculoskeletal healthcare utilization. Choice of the optimal number of groups was guided by 1) goodness-of-fit statistic criteria (Akaike information criterion and Bayesian information criterion), 2) evaluation of the distribution of participants in no less than 5% of the sample in one trajectory group, 3) average predicted posterior probability of group membership above 70% , and 4) the clinical plausibility of trajectory groups and trajectories (127). Next, we profiled participants based on trajectory group membership using descriptive variables from the baseline questionnaire and registers. Last, we compared differences in profiles between the lowest/highest trajectory group and each other trajectory group using the Kruskal–Wallis test with Bonferroni correction to adjust for multiple testing. All statistical analyses were preformed using STATA version 16 (StataCorp LLC, College Station, TX, USA).

Qualitative strand

For study 3, the authorship team agreed that the most suitable analysis approach was thematical template analysis (128). This across-case approach is flexible and allows for both inductive and deductive orientations to coding (128). Thematical analysis methods can be categorized into several types, and the type that aligned best with the purpose of this project was that described by Brooks and colleagues (129). In thematic template analysis, it is permissible to start with some tentative a priori semantic or summary themes and then redefine or remove these as new themes are conceptualized based on inductive coding of data and further analysis/interpretation of these codes. It is also possible to develop a coding template on the basis of a subset of data and then apply this initial template to further data and modify as necessary. In this case, we approached the process of coding inductively without a priori defined themes. Three co-authors (HRS, AS, and Cecilie Rud Budtz [CRB]) and I (all of whom were physiotherapists with extensive clinical and teaching experience and expertise in both qualitative and quantitative research) were responsible for the analysis. Overall, the analysis was an integrated process where initial analytic steps informed and qualified later sampling and analysis, and the research group followed the steps laid out for thematic template analysis: 1) read and re-read transcripts for familiarization, 2) do preliminary coding, 3) create themes based on preliminary codes, 4) define an initial coding template based on a subset of data, 5) apply the initial coding template to further data and modify accordingly, 6) finalize the coding template and apply it to the full data set (129). All transcripts were coded and analyzed using NVivo 13 (QSR International, Melbourne, Australia) or Microsoft Word. For detailed description of the analytic process please, see Appendix C1 (audit trail).

Comparison of themes across healthcare user groups

In this comparative analysis, we explored how the identified qualitative themes differed across levels of pain-related healthcare use. This analysis was undertaken by comparing codes across groups of pain-related healthcare use (low, medium, high). In this process, CRB and I individually reread the thematized codes for each group of pain-related healthcare use and prepared summaries with condensed aspects of meaning for each group. After this, the summaries were reviewed, discussed, and challenged until consensus was obtained.

Ethical aspects

This project was approved by the Danish Data Protection Agency (project number 1–16–02-141-18). Participation in all studies was based on informed consent, and we only contacted informants for the interview that had a priori accepted to be contacted. All data were stored and handled according to Danish law. Audio recordings and transcripts will be deleted at the end of the project. According to Danish law, this type of study does not require approval by a biomedical research ethics committee (130).

Chapter 4 - Results

Study population

Some of the main characteristics of the study populations in each study are presented in Table 3.

Table 3. Overview of study population characteristics in the three studies

	Study 1	**Study 2**	**Study 3**
Population, n (%)	4883 (100)	2929 (100)	20 (100)
Sex: females, n (%)	2735 (56)	1666 (57)	11 (55)
Age, baseline, mean (SD)	45 (12.8)	47 (12.0)	47 (11.8)
Number of sites, baseline	(A)*	(a)	
0, n (%)	1365 (29)	N/A	N/A
1, n (%)	914 (19)	329 (12)	3 (15)
2, n (%)	810 (17)	521 (18)	4 (20)
3, n (%)	642 (14)	556 (19)	4 (20)
4, n (%)	464 (10)	474 (17)	1 (5)
5, n (%)	265 (6)	405 (14)	3 (15)
6, n (%)	175 (4)	310 (11)	1 (5)
7, n (%)	75 (2)	271 (10)	4 (20)
Duration of pain, baseline	(B)		
Chronic pain (>3 month), n (%)	2941 (64)	2929 (100)	20 (100)
Pain intensity (range 1–7), baseline, mean (SD)	3.7 (1.7) (C)	4.1 (1.5) (b)	4.1 (1.2)
BMI Groups, baseline	(D)	(c)	
Under/Normal weight (<24.9)	2402 (51)	1395 (49)	10 (50)
Pre-obesity (25-29.9)	1686 (36)	1,061 (37)	7 (35)
Obesity Class I (30–34.9)	443 (9)	302 (11)	3 (15)
Obesity Class II & III (>35)	154 (3)	100 (3)	0 (0)
Highest level of educational §	(E)		N/A
Primary and lower secondary education, n (%)	992 (20)	443 (15)	
Upper secondary education or skilled worker, n (%)	2570 (53)	1637 (56)	
Bachelor's/Master's/Doctorial, n (%)	1301 (27)	849 (29)	
Marital Status ¤			N/A
Cohabitant with resident children, n (%)	2267 (46)	1006 (34)	
Cohabitant without resident children, n (%)	1726 (35)	1307 (45)	
Single with resident children, n (%)	272 (6)	130 (4)	
Single without resident children, n (%)	618 (13)	486 (17)	
Physical health (range 0–100) (PCS - SF 12), mean (SD)	42 (5) (F)	42 (5) (d)	N/A
Mental health (range 0–100) (MCS - SF 12), mean (SD)	48 (6) (F)	48 (6) (d)	N/A

Musculoskeletal health (range 0–56), follow-up	N/A	N/A	38 (9.6)
Health anxiety, baseline	(G)	(e)	
Low, n (%)	3811 (80)	2166 (75)	14 (70)
High, n (%)	933 (20)	716 (25)	6 (30)
Risk of depression, baseline	(H)	(f)	
Low, n (%)	3982 (84)	2330 (80)	18 (90)
High, n (%)	772 (16)	562 (19)	2 (10)
Comorbidity, Charlson index			N/A
No comorbidity, n (%)	4638 (95)	2758 (94)	
Low level of comorbidity, n (%)	137 (3)	101 (4)	
High level of comorbidity, n (%)	108 (2)	70 (2)	
Big five personality traits (range 0 – 16)	(I)	(g)	
Neuroticism, mean (SD)	6.5 (3.0)	6.8 (3.0)	6.2 (3.4)
Extraversion, mean (SD)	8.6 (3.1)	8.4 (3.1)	9 (2.4)
Agreeableness, mean (SD)	11.6 (2.2)	11.6 (2.2)	11.7 (1.7)
Conscientiousness, mean (SD)	10.7 (3.0)	10.7 (3.0)	11.5 (2.5)
Openness, mean (SD)	9.1 (3.1)	8.9 (3.1)	9.5 (3.1)
Missing: A: n = 173. B: n = 273 C: n = 107. D: n = 198. E: n = 20. F: n = 323. G: n = 139. H: n = 129. I: n = 198–240. a: n = 63. b: n = 17. c: n = 71. d: n = 164. e: n = 47. f: n = 37. g = 62–83.			
Comments: *: pain intensity >2/7. §: Highest level of education 2008–2017. ¤: Most frequent status 2008–2017			

The distribution of males and females (55–57% female), age (mean age 45–47 years), pain intensity (3.7–4.1), BMI (49–51% under/normal weight), and all five personality traits were almost the same in all three studies. However, mean age, pain intensity, and health anxiety were slightly higher in the chronic pain populations in studies 2 and 3. The study population in study 3 had more participants with higher number of pain sites (>=5 pain sites: 40%) and a high level of health anxiety (30%) than in studies 1 and 2, which reflects that we purposefully sampled more informants with these profiles. The proportion of participants with high risk of depression at baseline was slightly lower in study 3 (10%) compared to the study populations in study 1 (16%) and study 2 (19%). Register-based information on marital status, level of education, and comorbidity and information about mental/physical health were not available for study 3. The distribution of educational level (low level of education 20% versus 15%, medium level of education 53% versus 56%, and high level of education 27% versus 29%) comorbidity (low level of comorbidity 95% versus 94%) and physical/mental health (physical health: mean 42 (SD 5) and mental health: mean 48 (SD 8)) were similar in the study populations in studies 1 and 2. The participants in study 1 were most often cohabitants with children

(46%), while the chronic pain population in study 2 was most often living as cohabitants without children (45%).

Summary of key findings

Results study 1

The median number of contacts for any reason over the 10-year follow-up period was 74 (25;75 percentile: 42;124), the median cost was €197 (25;75 percentile: 84;611), and median number of musculoskeletal contacts was 11 (25;75 percentile: 2;33). The median number of healthcare contacts for any reason and musculoskeletal healthcare contacts increased with increasing number pain sites and with a high level of health anxiety.
We found a causal association between increasing number of pain sites at baseline and greater healthcare use and cost over the following 10 years. This was especially true for musculoskeletal healthcare contacts. For every additional pain site a participant had at baseline, the number of healthcare contacts for any reason over the subsequent 10 years was 4% higher (IRR 1.04 (95% CI: 1.03–1.05), healthcare-related costs were 6% higher (IRR 1.06 (95% CI 1.03–1.08), and musculoskeletal healthcare contacts were 11% higher (IRR 1.11 (95% CI 1.09–1.14). Level of health anxiety did not influence the strength of this association. People with a high level of health anxiety at baseline had a slight increase in healthcare contacts for any reason of 6% (IRR:1.06 (95% CI: 1.01–1.11)), an increase in healthcare-related cost of 9% (IRR: 1.09 (95% CI: 0.99–1.20)) but almost no increase in musculoskeletal healthcare contacts (IRR: 1.02 (95% CI: 0.92–1.12)). Estimates from analyses on multiple imputation data and non-imputation data were similar. Females below the age of 50 had more contacts for any reason and higher healthcare costs than age-matched males. The correlation between healthcare contacts for any reason and healthcare costs was 0.85 (95% CI 0.84–0.85), between healthcare contacts for any reason and musculoskeletal healthcare contacts the correlation was 0.60 (95% CI 0.59–0.61), and between musculoskeletal healthcare contacts and healthcare costs was 0.44 (95% CI 0.43–0.45).

Results study 2

Long-term use of musculoskeletal healthcare services for people with chronic pain varies. We identified five distinct trajectories of long-term musculoskeletal healthcare utilization in which 39% coped without seeking care (no or very few (<3) annual musculoskeletal healthcare contacts), whereas 8% had consistent high use of healthcare services (20 to 25 annual musculoskeletal healthcare contacts) (Figure 4). Between them, we found another three groups: a low ascending group (no or very few annual musculoskeletal healthcare contacts at beginning of follow-up increasing to between 5 and 10 annual contacts (17%)), a low descending group (between 5 and 10 annual musculoskeletal healthcare contacts at beginning of follow-up, decreasing to very few contacts (20%)), and a medium stable group (around 10 annual musculoskeletal healthcare contacts (16%)). Together, these groups represent 53% of the study population with medium use of musculoskeletal healthcare services. The five-group model was chosen to balance model parsimony and interpretability. The evaluation was based on Akaike information criterion and Bayesian information criterion performance statistics, distribution of participants, and probability of group membership.

Chronic musculoskeletal pain was managed mostly in primary care settings, and primary care contacts increased incrementally from the low to the high stable group. Both surgery and opioid consumption were only used to a limited extent and almost exclusively in the high musculoskeletal healthcare user group. Municipality rehabilitation contacts were rare. Pain medication accounted for the largest share of healthcare in the high musculoskeletal healthcare user group, whereas primary care contacts accounted for the largest share in all other musculoskeletal healthcare trajectory groups.

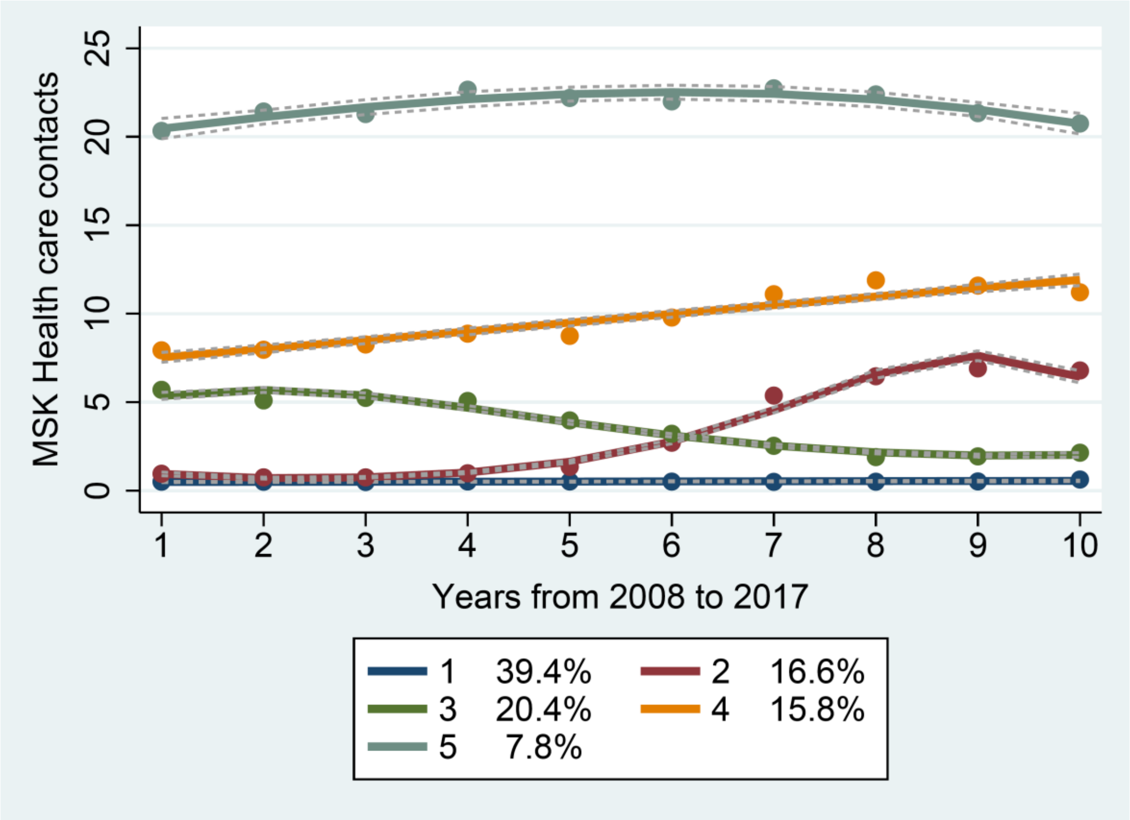
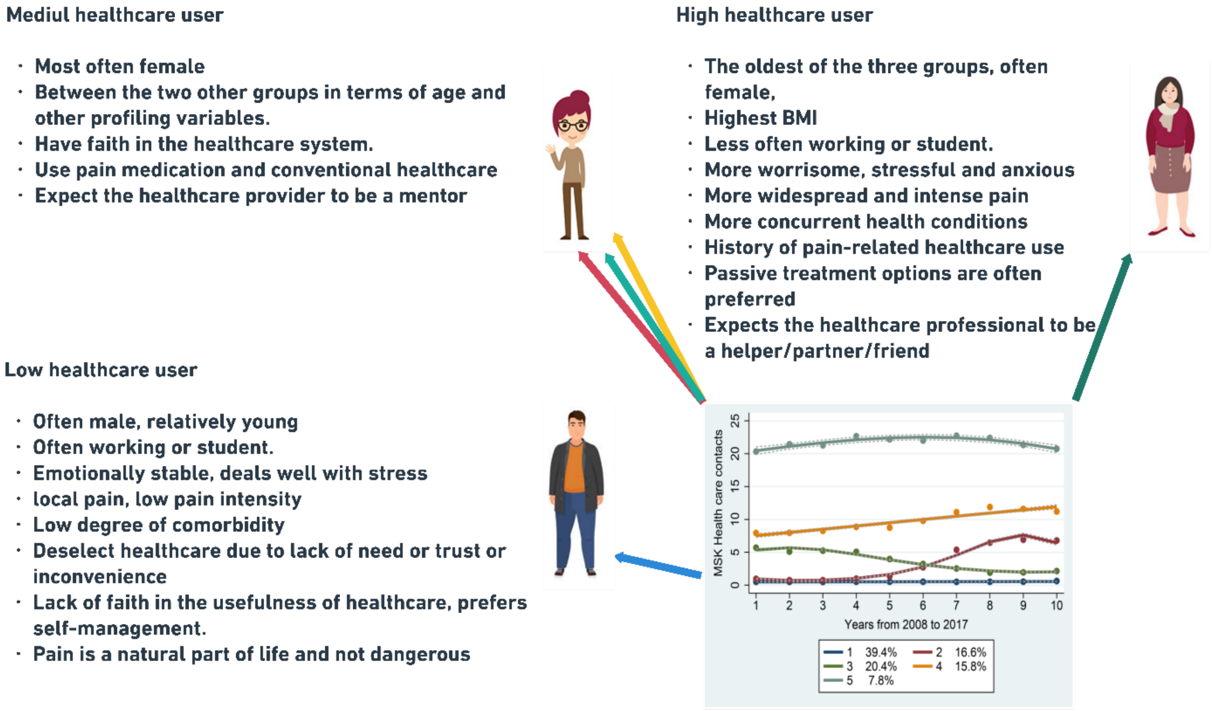


Figure 4. Trajectories of musculoskeletal (MSK) healthcare utilization in people reporting chronic musculoskeletal pain

Trajectory profiles

People with chronic pain and different musculoskeletal healthcare trajectories have different individual, sociodemographic, health, belief, and work-related profiles. Figure 5 illustrates these different profiles. The low stable healthcare user group rarely seeks any kind of musculoskeletal healthcare. This group of individuals is most often male, relatively young, and working or a student. The low healthcare user group is emotionally stable, relaxed, deals well with stress, and in general does not worry much about health. Their chronic pain is relatively local, not perceived to be very intense and with minor influence on the ability to participate in daily activities. This low healthcare user group has a low degree of comorbidity and has not used pain-related healthcare very often in the past. The high stable healthcare user with chronic pain is relatively small group of individuals (≈8%) with a consistent high annual use of pain-related healthcare services. This group is the oldest of the three groups, often female, has a higher BMI, and is less often working or a student. This high healthcare user group is often a more worried, stressed, and anxious, with shifts in mood. The pain is experienced as being more widespread and more intense, and it influences participation in daily activities. Signs of depression are more frequent, and the high pain-related healthcare user group has more concurrent health conditions and a history of pain-related healthcare use. The medium healthcare user group with chronic pain (low increasing, low decreasing, and medium stable (≈53%)) has between 3–15 pain-related healthcare contacts per year. The medium healthcare user is a mix between the other two groups. This group is most often female and in between the two other groups in terms of age and other profiling variables.



Mediul healthcare user

- Most often female
- Between the two other groups in terms of age and other profiling variables.
- Have faith in the healthcare system.
- Use pain medication and conventional healthcare
- Expect the healthcare provider to be a mentor

High healthcare user

- The oldest of the three groups, often female,
- Highest BMI
- Less often working or student.
- More worrisome, stressful and anxious
- More widespread and intense pain
- More concurrent health conditions
- History of pain-related healthcare use
- Passive treatment options are often preferred
- Expects the healthcare professional to be a helper/partner/friend

Low healthcare user

- Often male, relatively young
- Often working or student.
- Emotionally stable, deals well with stress
- local pain, low pain intensity
- Low degree of comorbidity
- Deselect healthcare due to lack of need or trust or inconvenience
- Lack of faith in the usefulness of healthcare, prefers self-management.
- Pain is a natural part of life and not dangerous

Figure 5. Trajectory profiles

Results study 3

We identified four key themes with 11 sub-themes that conceptualize how people with chronic pain in our sample explained their use or non-use of pain-related healthcare services. Key themes were 1) system-facilitated pathways, 2) appraisal of healthcare, 3) autonomy, belief and values, and 4) recommendations for healthcare. The meaning conceptualized by each theme (and sub-theme) is briefly explained below. For more detailed descriptions and citation examples, please see Appendix C (Study 3)

System-facilitated pathways consists of two sub-themes and captures the drivers for pain-related healthcare that are facilitated by the healthcare system ("System pathways" and "Referral"). This were evident in cases where the patient moves back and forth or circles between different specialties and sectors involved in pain management in pathways defined by the organization of the healthcare system or cases where the healthcare journey is initiated and defined by referrals, typically by the GP.

Appraisal of healthcare consists of three subthemes ("Treatment prototypes", "Patients with chronic pain desire to be seen, heard, and approached with interest by the Healthcare provider", and "No, or sparse, improvement or the 'chemistry' is not right") and capture the drivers for healthcare seeking related to previous healthcare experiences and appraisal of such experiences. We found that, healthcare-experiences are constantly being evaluated by the patient, and this evaluation influences future healthcare. People with chronic pain also expect to be seen, heard, and approached with interest with an appropriate level of empathy, but commonly patients with chronic pain experience a lack of time, interest, and empathy from healthcare providers. Such experiences modify pain-related healthcare and lead to resignation, frustration, and/or continuous use. We also found that, if the patient is approached with interest and satisfactory examination and information, this can lay the ground for acceptance of the situation and self-management strategies. To be worth the effort, healthcare should result in some improvement and a relevant therapeutic alliance should be established.

Autonomy, belief, and values consists of four subthemes ("Healthcare should fit my needs, beliefs and values", "Healthcare has to be manageable/feasible for me in my situation", "Illness representation – biomechanical beliefs about pain drives my healthcare behavior (cause and control)", and "The pain or functional limitations necessitates healthcare") and captures drivers for pain-related healthcare related to personal beliefs, needs, and values. Such drivers are powerful influencers to modify, initiate, determine, or cease pain-related healthcare, and they are often related to assumptions about cause and control. Personal beliefs and values related to pain-related healthcare often outrank the healthcare providers' expertise and/or available evidence. If the suggested management or examination conflicts with the patient's rationale/thinking framework, traditional healthcare pathways may be bypassed, healthcare initiatives disregarded, or alternative healthcare options approached. Financial, timely, and personal resources are also important for pain-related healthcare behavior. If the pain-related initiatives are not perceived to be financially, timely, or geographically appealing, they could be disregarded and considered irrelevant. Such practical aspects are important and can both facilitate and inhibit the use of pain-related healthcare services. Beliefs about cause and control of the pain are often grounded in a biomechanical paradigm. Pain management and examination (imaging) that aligns with this framework is preferred and considered valid. Such beliefs drive healthcare in the quest for diagnostic certainty and a fix of tissue damage. We also found that, pain flairs and functional limitations necessitate healthcare to get through the day or the night – often without consultations. Pain medication or alternative healthcare options are often used in such situations.

Recommendations from others about healthcare consists of two subthemes ("Recommendations from relatives/others" and "Recommendations from healthcare providers) and captures drivers for healthcare related to recommendations. Recommendations about healthcare are often followed and are powerful drivers of pain-related healthcare. Recommendations to try out different pain-related healthcare initiatives can initiate new untried or even unknown clinical pathways.

Explained in context, beliefs about cause and control, perceived need, pain, and functional limitations, recommendations from trusted persons, and the search for a diagnostic labels/reassurance often initiate pain-related healthcare use in people with chronic pain. The pathways laid out within the healthcare system are often followed if such pathways are considered feasible. However, healthcare due to chronic pain is highly influenced and modified by two interconnected systems: 1) perceived needs, beliefs, and values and 2) appraisal of previous healthcare experiences/treatment prototypes. These systems could explain some of the differences in the use of pain-related healthcare. Additionally, it is essential for people with chronic pain to be seen, heard, and approached with interest by the healthcare provider.

Differences and similarities in experiences and expectations between groups of pain-related healthcare use

Eight informants were classified as “High” healthcare users, seven were “Medium” users, and five were “Low” users in our sample. We identified considerable differences in experiences and expectations between these groups. These differences are shown in Figure 5.

The low healthcare user had in some cases rejected referral or ceased pain-related healthcare seeking due to lack of need or trust or if the available healthcare option had been inconvenient. The low healthcare user group expressed a lack of faith in the usefulness of healthcare and often preferred to self-manage. The low healthcare user used healthcare to rule out serious conditions and was hesitant to follow pain-related healthcare recommendations when they were given. Pain was considered to be a natural part of life and not dangerous.

The high healthcare user expected to continually revisit the healthcare system for (temporary) pain-relief in the future. Passive treatment options were often preferred (alternative therapy, pain medication, chiropractor) and were considered reassuring pain relief options. The high healthcare user expected the healthcare professional to be a helper/partner/friend that meet and complied with their needs. If this expectation was not meet, this group of individuals went somewhere else and approached other healthcare providers or accessed other types of pain-related healthcare.

The medium healthcare user in general, expressed faith in the healthcare system. Healthcare management strategies for this group of individuals were characterized by pain medication and conventional healthcare. They expected the healthcare provider to be a mentor or collaborator that honestly and empathetically guided them and also inform them if nothing could be done about the pain. However, such guiding was not always provided, which often left the medium healthcare user feeling that their care seeking was unresolved.

Groups of individuals with different use of pain-related healthcare also expressed a number of interesting similarities related to experiences and beliefs. For example, reports of disappointing healthcare experiences and pain-related healthcare initiatives with no or little effect were common, but the consequences of such experiences were different across the groups. The low pain-related healthcare user became resigned, while the high pain-related healthcare users sought other healthcare options. Beliefs that the pain was caused by biomechanical damage and that imaging was a required and valid source of diagnostic information were also common across groups. This was also the case regarding skepticism toward medication, even though the high pain-related healthcare users often took pain medication regularly because he or she considered it to be necessary. Informants across healthcare user groups also expressed a profound desire to be seen, heard, and approached with interest and empathy by the healthcare provider.

Chapter 5 - Discussion of results

Summary and discussion of results

In this study, we explored the phenomenon "Healthcare-seeking behavior in the context of chronic pain". Healthcare-seeking behavior is a complex decision-making process influenced by multiple factors, and we therefore approached the topic using different data sources and methods in a sequential design. This summary and discussion of results will be presented in a modified weaving approach in which quantitative and qualitative results are presented and discussed together and organized around some of the central questions about healthcare-seeking behavior in the context of pain (83). In this discussion, I will aim to answer the following questions: 1) How do individuals with chronic pain use the healthcare system?, 2) Why do people with chronic pain seek healthcare?, 3) How do chronic pain-related healthcare user groups differentiate?, and 4) What modifies healthcare use in the context of chronic pain? These central questions are listed in Table 4 (Overview of questions and studies). This table also illustrate how results from the different studies are merged and contribute to answer the questions.

Table 4. Overview of questions and studies

Central questions related to healthcare-seeking behavior in the context of pain			
	Study 1 (Quan)	Study 2 (Quan)	Study 3 (Qual)
How do individuals with chronic pain use the healthcare system?		39% had few or no annual contacts. 8% had a continuously high number of annual contacts (high stable) (> 20 contacts per year). Between these trajectory groups, we found three groups with a low ascending (17%), low descending (20%), and stable medium (16%) trajectory patterns.	
Why do people with chronic pain	Increasing number of pain sites and health anxiety are causally associated with higher		Recommendations from trusted others, beliefs, and expectations about cause and control of pain, pain and functional limitations,

seek healthcare?	number of healthcare contacts and cost.		and the need for reassurance/explanation for the pain influence healthcare-seeking behavior and initiate pain-related healthcare.
How do chronic pain-related healthcare user groups differentiate?		Low healthcare seeking group versus others: male, low neuroticism, lower number of pain sites, lower pain intensity score, lower anxiety scores, a lower degree of participation restriction due to pain, less comorbidity, less healthcare contacts before baseline, more often working or student. High healthcare seeking group versus others: Higher neuroticism, higher pain intensity score, higher BMI, higher depression score, higher degree of participation restriction due to pain, more comorbidity, more healthcare contacts before baseline, less often working or student	Low healthcare seeking group: Lack of belief in the usefulness of healthcare. Prefers self-management. The pain is not dangerous. Medium healthcare seeking group: Trust the healthcare system. Expects to meet a health professional (mentor) that clearly explain pain and management options, even if there is none. High healthcare seeking group: Want to be met by an empathetic and caring health provider who complies with their expectations and needs. If this expectation is not met, this group will continue their healthcare journey and seek other forms of care.
What modifies healthcare use in the context of chronic pain?			The pathways laid out and referrals given are often followed if they are considered to be feasible and convenient. Healthcare is modified by two interconnected systems: 1) personal beliefs, needs, and values, and 2) appraisal of previous healthcare experience

How do individuals with chronic pain use the healthcare system?

Individuals reporting chronic pain access healthcare services more often than individuals without pain (53, 131); however, not all with chronic pain use the healthcare system equally often (57). Using national health registers, we generated a detailed description of the long-term use of musculoskeletal healthcare services by people with chronic pain. With the use of LCTA, we found a five-group model that optimally fit the data and exhibit meaningful long-term trajectories of musculoskeletal healthcare use. Results showed that people with chronic pain use musculoskeletal health services differently. About 39% of our sample had no or very few annual musculoskeletal healthcare contacts over a 10-year follow-up period (low stable care seeking), while approx. 8% had a continuously high number of annual musculoskeletal healthcare contacts (high stable care seeking) (> 20 contacts per year). Between these trajectory groups, we found three groups with a low ascending (17%), low descending (20%), and stable medium (16%) care-seeking trajectory patterns. The most common form of healthcare was primary healthcare (GP, physiotherapist, chiropractor) except for the high stable group, who most frequently used pain medication. Opioids was almost exclusively used in the high stable group, and surgery was rare in all trajectory groups.

Healthcare-seeking behavior due to chronic pain has also been studied by others. Linton et al. (58) and Lentz et al. (57) showed that a relatively small group of people reporting chronic pain account for the majority of medium-term healthcare resource use (over 1 and 2 consecutive years). Our results confirm these findings and show that this also accounts for long-term use of healthcare services. We also found that a large group of people reporting chronic pain rarely seeks healthcare. Others have also identified this group of very low healthcare users with chronic pain with the use of different compositions of healthcare, populations, and profiles. Mann and colleagues (132) studied healthcare seeking over the past year for chronic pain among adults and found that only six percent were non-healthcare seekers, and this group was most often female with negative healthcare experiences and expectations. Emilson et al. (71) conducted a 21-year follow-up study (using three measurement points) to identify trajectories of healthcare utilization in the general population. Based on visual analyses of self-reported use of healthcare services, they found that a very small group (<1%) were classified as consistent high users of healthcare and the majority (≈80%) were classified as consistent low healthcare users. There were significant differences in profiles in terms of number of pain sites, gender, and general health status between these groups with chronic pain (widespread and local), and women were much more prevalent in the high healthcare-seeking group. Both of these studies rely on self-reported data on healthcare visits to specific healthcare settings (GP, emergency room, physiotherapist, etc.). In line with Emilson et al., we found a relatively large group of individuals that rarely seeks healthcare due to pain. This is in line with findings from previous studies and suggests that although individuals with pain use healthcare services more often that individuals without pain (133, 134), healthcare seeking behavior is very diverse.

The literature indicates that musculoskeletal healthcare is not delivered according to clinical guidelines and often includes referral to orthopedic surgeons and overuse of opioids (29, 135). Reassuringly, we found that the majority of chronic pain management in this Danish sample was in primary care, pain medication prescribed for chronic pain management was primarily NSAIDs, and antidepressants, and referrals for secondary care specialist and surgery were rare, which aligns with most clinical guidelines (136, 137).

Why do people with chronic pain seek or deselect healthcare?

We found that public healthcare contacts and costs increased with each incremental increase in number of pain sites, and we concluded that this relationship may be causal and independent of the other factors. Number of pain sites has previously been identified as an important prognostic factor for poor prognosis, functional problems, and poor treatment outcomes, and number of pain sites has also been associated with healthcare seeking in other studies (48, 138). Number of pain sites can be seen as a proxy of disease burden (25, 139), and pain in several body regions is significantly stronger associated with other risk factors for poor outcome (sex, age, stress symptoms) than more local pain (21), which indicates that number of pain sites is an important marker of the degree of disease and the consequences of pain (25, 27). Therefore, it is understandable that the number of pain sites and healthcare contacts/costs increase proportionally. In the interviews, we expanded our understanding of drivers for healthcare-seeking behavior and the association between number of pain sites and healthcare contacts, and we found that multiple factors initiate healthcare-seeking behavior. Individuals with chronic pain report that the pain characteristics (intensity) and functional consequences of pain influence the decision to seek healthcare or take pain medication. The informants also described that recommendations from trusted others, beliefs, and expectations about the cause of pain and pain management, and that the need for reassurance/explanation for the pain also influenced the decision-making process. Beliefs about cause and control were often based on a biomechanical understanding, and this rationale of thinking together with beliefs about the diagnostic power of imaging, initiate and influence pain-related healthcare-seeking behavior in some people with chronic pain. However, we did not observe narratives suggesting that number of pain sites was considered to be a driver of pain-related healthcare.

Cornally and colleagues (61) identified some of the same influencing factors in a systematic review on help-seeking behavior in individuals with chronic pain. They found that needs and expectations for cause and management, understanding of the symptoms, and influence from relatives impact healthcare-seeking behavior and that individuals with negative expectations for the effectiveness of management delay or omit healthcare. A mixed methods study exploring drivers of healthcare seeking due to chronic knee pain in a sample of older adults also found that high pain intensity, pain that impacts daily life, and recommendations from relatives are common drivers of healthcare (140). Reasons for not seeking healthcare in this study included explanations about justification of deserving care compared to others with more serious health problems; negative beliefs; and lack of trust in the effectiveness, opportunities for action, and value of the consultation (140). Hence, the results of our project are in line with findings in the literature and suggest that healthcare-seeking behavior in people with chronic pain is influenced by cognitive, pain-related, and external factors.

In study 1, we also examined the relationship between health anxiety and healthcare contacts/costs, and the interaction between number of pain sites and health anxiety for these outcomes. We found only a relatively weak association between high level of health anxiety and contacts/costs. This was surprising as concerns and negative beliefs about pain and health, as well as need for reassurance, were found to be important influencing factors in the interviews. Others have also shown that seeking reassurance is prevalent in people with high levels of health anxiety, and individuals with high levels of health anxiety tend to make stronger requests to healthcare providers for diagnostic tests and treatments and have higher use of healthcare services (141, 142). Furthermore, health anxiety has also been found to be a relatively stable trait (143). A possible explanation could be that by dichotomizing the Whiteley-7 Index, we diluted the importance of health anxiety. We have not yet conducted supplementary analysis with continuous Whiteley-7 scores to explore whether this is the case.

Additionally, we analyzed the correlation between number of pain sites and health anxiety in study 1 and found it to be low (0.39 (95% CI 0.38–0.40). This suggests that health anxiety and number of pain sites are not strongly dependent and have different relationships to healthcare contacts/costs.

Integration of results on drivers of healthcare for pain

Paradoxically, strong quantitative causal determinants for seeking healthcare in this study (number of pain sites) were not found in patient narratives, while weak quantitative determinants (health anxiety) were found to be a recurring theme in the qualitative results. There is an interesting mismatch between determinants identified via various data and methods. Determinants of a given outcome often relate to characteristics of the individuals (e.g., sex, socioeconomic status, age, pain sites) in quantitative research, and such factors are easy to measure. In the qualitative data collection, we have been in contact with several individuals with a high number of pain sites. However, these individuals refer to this as "*this is how I am*", and they do not consider it to be of significance in relation to their behavior. Number of pain sites seems to be an unconscious characteristic icon for the individual. Conversely, informants with pain were very conscious about cognitive and emotional factors and considered such factors to be important when asked to explain behavior and choices. Despite valid and reliable methods of measurement, cognitive and emotional factors are more difficult to quantify and recognize than individual or pain-related characteristics, which could explain the week association between health anxiety and healthcare contacts and cost in study 1. Another explanation could be that worries about general health measured with the Whiteley-7 index are a different construct and have a different relationship to healthcare behavior, than conceptualized qualitative themes related to negative beliefs about pain cause and control. Still, this mismatch could be interesting to explore in future research.

How do chronic pain-related healthcare user groups differentiate?

To answer this question in a clinically meaningful way, we collapsed the low ascending care-seeking group, low descending group, and medium stable trajectory group into one "medium" group. We did so despite differences in healthcare use and profiles.

Participants in the low ascending and low descending groups were quite similar, but post hoc comparison of profiles showed that participants in the medium stable group were significantly more often female with higher level of neuroticism; more pain sites; higher pain intensity, and this group had a higher proportion of participants with sign of depression, anxiety, health anxiety, participation restriction due to pain, and comorbidity. They had a higher level of fear-avoidance beliefs, more healthcare contacts before baseline, and were less often working than participants in the low ascending and low descending groups (data not shown). However, precise categorization of informants and the clinical interpretability of the results guided us in this decision. This resulted in three pain-related healthcare user groups (low, medium, high). Our analyses showed that there was a between-group difference in profiles. Individuals in the high healthcare-seeking group were predominantly women, and individuals in this group had the highest mean age, highest depression score, highest BMI, highest pain intensity, highest number of pain sites, highest degree of comorbidity and functional consequences of pain, and lowest degree of attachment to the labor market. Individuals in this group also had the highest level of neuroticism (a personality trait with a tendency toward negative emotions) and had most musculoskeletal contacts prior to baseline compared to the other groups. Individuals in the low healthcare-seeking group had the opposite profiles (predominantly men, lowest mean age, lowest BMI, lowest pain intensity, lowest number of pain sites, lowest level of anxiety and depression, lowest degree of comorbidity, low level of functional consequences of pain, highest degree of attachment to the labor market, lowest level of neuroticism, and least musculoskeletal contacts prior to baseline compared to the other groups), while individuals in the medium healthcare-seeking group had profile variable scores that were intermediate between those in the other two groups. Not surprisingly, these profiles correspond to previously identified risk factors for high and low use of healthcare services due to pain. This suggests that these different profiles explain some of the differences in behavior (48, 57, 61, 62, 144). We were interested in exploring healthcare behavior further and did so by comparing themes and codes from the qualitative interviews across the healthcare trajectory groups. This analysis expanded our understanding and showed differences beyond the quantitative profiles. Individuals in the low healthcare-seeking group expressed a lack of belief in the usefulness of the healthcare and preferred to self-manage their pain. They did not consider the pain to be dangerous. Instead, pain was seen as a natural part of life, and healthcare was primarily used to dispel suspicion of serious illness. Individuals in the medium healthcare-seeking group generally trusted the healthcare system and sought out both conventional healthcare services and pain medication. This group expected to meet a health professional that would clearly explain pain and management options, even if there were none. When this expectation was not met, the individual was left feeling frustrated and unresolved. Individuals in the high healthcare-seeking group stood out by having different expectations of the health provider. This group wanted to be met by an empathetic and caring health provider who would comply with their expectations and needs, and stand by their side as a helper or partner. If the healthcare provider did not meet this expectation, this group would continue their healthcare journey and seek other healthcare providers or other forms of care. This poses a special challenge to the healthcare provider's ability to comply with guideline recommendations about promoting self-management, education, and exercise as first-line treatment (29, 30). Self-management means that the individual actively participates in maintaining and promoting health. Jensen and colleagues (145) recently proposed a theoretical framework for understanding expectations of patients with musculoskeletal pain in primary physiotherapy care. This work also shows considerable diversity in patients' expectations about management and the patients' ability to engage in self-management. Some patients attended therapy with self-management intentions/expectations, while others expressed hope for pain relief and expected the healthcare providers to take care of their problems with low level of the patient's internal locus of control. These different expectation typologies accentuate that patient-centered care and shared decision-making is complicated, and might require healthcare provider-led management and goalsetting in some cases. Determining the patient's motivation and readiness to change is therefore a vital part of the assessment process (146).

Our findings suggest that some individuals with chronic pain could be overusers of pain-related healthcare and recipients of low-value care, while others could be underusers. Overuse and underuse of healthcare services can have major consequences for the individual and society. Underuse of healthcare services is defined as: *Failure to access a service that is highly likely to improve the quality or quantity of life, that represents good* *value for money, and that patients who were fully informed of its potential benefits and harms would have wanted* (36, 39). Underuse of pain-related healthcare can potentially result in unnecessary suffering, reduced quality of life, loss of function, and (for some) loss of life (36). Overuse of healthcare services is defined as: *Access of a service that is unlikely to increase the quality or quantity of life, that poses more harm than benefit, or that patients who were fully informed of its potential benefits and harms would not have wanted* (35, 37). Both overuse and underuse have been documented for a wide range of diseases and diagnoses globally (35, 36). In musculoskeletal pain management in the Western world, overuse is probably the more common scenario (29, 37). Overuse of pain-related healthcare can, despite best intentions, lead to overdiagnosis and unnecessary tests and treatment that do not benefit the patient and may have unintended negative consequences or even be harmful (37). The results from this project show that many individuals with chronic pain have few or no contacts, which speaks against a general overuse for this population. However, there are groups of people with chronic pain who seem to be 'stuck' in the healthcare system, and our analyses show that this group more often have known risk factors for poor prognosis. Furthermore, overdiagnosis is not unlikely in some members of this group, as informants representing this group unanimously expressed biomechanical beliefs about cause of pain and considered radiological examinations to be safe diagnostic techniques. However, radiological tests are not routinely recommended for musculoskeletal conditions and may give rise to unnecessary concerns or treatment (147). Such beliefs could push GPs to initiate defensive medicine actions (actions that are not professionally well founded, but are carried out due to demands and pressure (148)) and lay the ground for ongoing circles of healthcare consultations, tests, and treatments. Narratives from the interviews also show that many informants have experienced receiving nominal disease subgroup diagnoses (e.g., instability, spinal malalignment) from both conventional and alternative healthcare providers as an explanation for their pain. The use of these contested biomedical diagnoses could contribute to healthcare overuse, unnecessary concerns, and continuing treatments (unreported results).

Clinical guidelines across musculoskeletal clinical diagnoses recommend self-management strategies and encourage healthcare providers to initiate management that minimizes dependency (30). Only a few informants in this project had been introduced to self-management strategies. Instead, informants who preferred self-management had opted out of healthcare due to a lack of faith or trust. We also found that individuals with high use of pain-related healthcare do not want to self-manage. Instead, they want hands-on treatment and search for clinicians who provide such treatment. Thus, providing effective self-management strategies to individuals with chronic pain and high use of pain-related healthcare can be a challenge. Still, gaining more insight regarding factors that drive overuse and the incentives that work in clinical encounters provides an opportunity to change and optimize pain-related healthcare.

What modifies healthcare use in the context of chronic pain?

Up to this point, we have presented factors influencing the decision-making process and potentially initiating pain-related healthcare. However, we also found that certain factors influenced and modified how people with chronic pain used pain-related healthcare. Often a person with chronic pain followed the pathways laid out and referrals given by the healthcare professional if such were considered to be feasible and convenient. This appraisal process was influenced by two interconnected systems: 1) needs, expectations, and beliefs and 2) previous healthcare experience. Needs, expectations, and beliefs could influence healthcare seeking in several ways. For example, a recommendation to take pain medication could be deselected if the person with chronic pain believed that pain medication was harmful and that the side effects outweighed benefits. Or alternative treatment might be selected if the person with chronic pain considered such treatments to be beneficial, despite no proven effect and/or recommendations advising against this treatment. Individuals with chronic pain also expected to be seen and heard, and approached with interest and empathy by their healthcare provider. If this expectation was not met, this would also have an impact the healthcare-seeking pathway, and the person with chronic pain could discard certain types of healthcare or find another health provider. Similarly, treatment would be deselected if the person with chronic pain did not trust healthcare or preferred self-management. These results also showed that beliefs and expectations, and hence healthcare trajectories, could be altered by the healthcare professional if the patient story was recognized and the patient received a satisfactory examination and relevant information in a proper way.

Appraisal of previous healthcare experiences also modified pain-related healthcare, and positive experiences could create treatment prototypes that were consistently followed in case of pain. In this way are past healthcare experiences and future healthcare behavior linked, because previous healthcare experiences create or shape treatment prototypes that become first-line management strategies if set-backs or reoccurrence of pain occur. Treatment prototypes can also be self-management if such strategies are experienced to be effective.

These findings align with the framework for healthcare behavior outlined in the Common-Sense Model of Self-regulation (CSM). CSM describes how individuals understand and respond to symptoms and health threats (77). CSM is based on the premise that every symptom (e.g., pain) or health threat activates a cognitive and emotional response, and this response determines healthcare behavior and initiatives. Central to CSM is the development of illness representation. Illness representation is based on the evaluation of the current symptoms against previous illness experiences. This evaluation serves as a decision guide for the individual in relation to appropriate actions or behavior. Actions may be to seek medical attention, take painkillers, or watchful waiting. Subsequently, the symptom response is appraised, and this appraisal can modify the subsequent actions in a feedback loop until the individual reaches some kind of balance where symptoms are relived or accepted. According to the CSM, management initiatives are evaluated in the same way as the symptoms, and the variation in the use of health services for pain can be explained by differences in illness representation and evaluation of the healthcare initiatives taken. The results from the qualitative interviews support that this may well be the case. Reassuringly, we also found narratives about modified illness representation and reevaluation of (unnecessary) healthcare actions (knee surgery due to knee osteoarthritis) based on a validation of the pain, time, empathy, relevant examination, and information from the healthcare provider. Thompson et al. (79) suggest that a cornerstone of management of patients with chronic is validation and a sense of partnership with a trustworthy healthcare professional and that this will make it possible for an individual with chronic pain to deliberately and successfully move on with life and live well. This insight has important clinical implications and emphasizes the importance of establishing a strong therapeutic alliance or partnership with the patient. Our results imply that, from a

patient perspective, time to listen and explain, validation of the patient, and the pain and empathy from the healthcare provider are the building blocks of such partnership. Our results about healthcare experiences from persons with chronic pain also imply that such an approach is relatively rare, which may negatively impact future healthcare utilization.
According to Andersen's "Behavioral Model of Health Services Use" healthcare seeking is a function of predisposing factors, enabling factors, and perceived need for care (73, 74). Our findings support that perceived need for care is important and that it explains some of differences in healthcare-seeking behavior in the context of pain, and that predisposing factors like sex, age, marital status, and educational level characterize different healthcare user profiles. Despite the fact that local healthcare services are available in all parts of Denmark and that most healthcare services are fully or partly publicly funded, we also retrieved narratives about enabling factors as determinants of healthcare seeking, and some informants selected or deselected healthcare services because they found them to be financially, timely, or geographically inconvenient.

Optimally, healthcare providers should deliver pain-related healthcare that is needed, wanted, effective, affordable, and responsible in its use of resources (39). It is, however, difficult to balance the reported action taken and advice given to each patient with what is needed, wanted, effective, and affordable. Our results also show that what is needed and wanted might not be what is effective, affordable, and responsible for all. This is further complicated by the recognition that most treatment of chronic pain has only a small to moderate effect (30), and management of pain is often guideline discordant and inadequate, with an overuse of medical appointments and healthcare resources (10, 149). In the evidence-based model, decisions about healthcare are based on the integration of best research evidence, clinical expertise, and patient choice (150). Results from this project can contribute to optimizing the quality of care by emphasizing the importance and impact of the patients' perspective for both healthcare providers and policy makers.

Chapter 6 - Discussion of methods

Strengths

The design of the project and the methods used have several strengths. The longitudinal design using register-based individual data ensured a consistency of data, with full follow-up for all participants for a range of the variables, without risk of lag time or recall bias and the validity completeness of Danish national healthcare register data are considered to be high (102, 104, 151). Furthermore, data from various independent data sources and timepoints reduced the likelihood of differentiated misclassification in the studies. Therefore, the results of the quantitative analyses have a low probability of being subject to those types of bias. Non-differentiated misclassification, on the other hand, cannot be ruled out. However, this kind of bias will, in principle, blur the results and can therefore hardly explain our results.

Mixed Methods

This project strives to test, describe, and understand the very complex interplay between healthcare and pain. Therefore, one type of data would have been inadequate to provide a thorough understanding of this topic. The use of mixed methods has made it possible to explore information that is not accessible with the use of a single method. We, therefore, harnessed the strengths of both quantitative and qualitative methods in a sequential design, we used the quantitative phases to test and describe, and we used the subsequent qualitative phase to enhance and nuance our understanding. By combining methods, we believe that this project provided knowledge than is more than just the sum of its different parts (82). In the research process, we allowed for new aspects, knowledge, and perspectives to emerge and inform the later research phases in a dynamic process. We believe that this strengthened the project, because the PhD student and the supervisor group, throughout the project, discussed the most relevant next steps as new themes arose and adjusted the project accordingly.

In the reporting of this project, I have strived to comply with the recommendations of Good Reporting of a Mixed Methods Study (GRAMMS) described by O’Cathain and colleges (152) in order to justify the design and to be transparent about the different components and progress of the study.

Limitations

Consideration regarding selection of participants (studies 1 and 2)

About 60% of the original cohort responded to the baseline questionnaire. Non-responders were more often male (57% male non-responders versus 44% male responders). The mean baseline age of male non-responders was 40 years compared to 47 years for responders, and the mean baseline age of female non-responders was 41 years compared to 45 years for responders. It was possible to compare GP healthcare contact in an 18-month follow-up period between non-responders and responders. This showed no significant differences in level of GP healthcare seeking due to back pain (11% non-responders versus 12% responders), but non-responders had a lower level of GP contacts due to upper extremity pain compared to responders (9% non-responders versus 11% responders) (84). Non-responders were slightly less often working compared to responders, but more than 80% of both non-responders and responders were working at baseline according to data from the DREAM register. Additional register data on non-responders were not available, hence additional comparisons have not been possible. Available data do, however, suggest that responders differ from non-responders in terms of demographics and healthcare behavior, which could challenge the representativeness of this population-based study. Modest participation rates comparable to the ones in this project are not uncommon in long-term follow-up studies, and while simulation studies indicate that such participation rates do not necessarily affect estimated associations (153), the possibility of selection bias cannot be ruled out.

Sampling considerations for study 3

We purposefully sampled informants from the original cohort who responded to the follow-up questionnaire and accepted participation in a qualitative interview. We aimed to select cases with maximum variation to document unique and diverse voices in the target population to achieve a deeper understanding of the phenomenon under study

(154). We selected and invited informants with different demographic, pain, health, and social characteristics in order to sample a variety of voices. In this process, we might have sampled a group of informants with specific characteristics (e.g., high health literacy). However, based on an evaluation undertaken after the data collection, we believe that this is not likely to be the case. We contacted a divergent group of informants with very different lives, stories, and health problems, which strengthens our belief that a large variation has been achieved. Furthermore, we evaluated the sampling strategy and data collection on several occasions and adjusted the criteria for selection of informants accordingly (Appendix C1).

Information, data collection, and analysis considerations

Questionnaire data – scales and subscales

In almost all the questionnaire-derived variables we used, validated scales/sub-scales and data were managed according to recommendations for optimal interpretation of each scale. However, some issues should be considered.

Chronic pain

We used a sample of individuals with chronic pain in studies 2 and 3. In this research, we defined chronic pain as recurrent or persistent pain lasting more than 3 months, which is a common definition, but chronic pain has also been defined in various other ways in the literature. For example, Bonica (155) defined chronic pain as pain that persists beyond normal tissue healing time, whereas Breivik et al. (4) used a 6-month threshold in a large multinational European survey. However, in epidemiological studies the 3-month criterion has often been used, and it is also the criterion used in the recently updated ICD-11 definition of chronic pain (16). According to that definition, chronic pain is either a symptom, a consequence, or a co-diagnosis of another chronic diagnosis (chronic secondary pain) or a disease in itself in situations where no known underlying chronic disease or diagnosis better explains the pain (chronic primary pain) (16). Unlike most previously used definitions of chronic pain, a mandatory requirement of the ICD-11 chronic primary pain definition is that the pain must be associated with significant emotional distress and/or impaired functioning (156).This means that by definition primary chronic pain must be concerning enough to cause healthcare seeking (156). However, Watkins and colleges (144) showed that 22% of adults with chronic pain (duration >3 month) did not inform their GP about this pain even though 71% had moderate to severe pain and their reports of problems with sleep and general activity were similar to the GP-seeking group. Similarly, Jinks and colleges (140) found that over half (53%) of older adults (>50 years of age) with chronic and severe knee pain or functional limitations reported no visits to their GP due to pain. It is not clear in these studies whether participants could be classified with primary or secondary chronic pain or neither, but there does not seem to be a 1:1 relationship between emotional distress/impaired function and healthcare seeking in individuals reporting pain for longer than 3 months, which makes the ICD-11 definition of chronic primary pain somehow ambiguous. However, it also emphasizes the complexity of healthcare-seeking behavior in the context of pain. The ICD-11 pain definition provides better opportunities to understand and work with chronic pain for both clinicians and researchers (16). In this study, we used the 3-month criteria to define chronic pain, but we did not differentiate between primary/secondary chronic pain nor did we limit the chronic pain populations to those where the emotional and functional consequences of pain resulted in healthcare seeking. Our interest was to understand the phenomenon of healthcare seeking due to pain, also from the perspective of individuals who deselect healthcare and individuals where pain is a symptom of an underlying disease.

Chronic pain, number of pain sites – change over time

Self-reported pain (number of pain sites, pain intensity, and duration of pain) has been a central variable throughout all phases of this project. Pain was measured with use of sections of the SEQ, which is a valid and reliable measurement tool for assessing pain in population-based observational studies (89). The classification of pain in the first two phases of the project (n = 4,883 and n = 2,929) was based solely on baseline measurement, while in the last study (n = 20 interviews), a new survey round was performed, and updated information on pain was collected via SEQ (n = 3,302). The additional survey was also considered in the planning phase of this project, but at that time, such data collection was very costly and this option was not pursued. However, technological development did enable a supplementary survey round at the end of the project. Instead, we based our assumptions about the stability of the duration of pain and number of pain sites on findings from other studies. A number of studies have examined how pain changes over time. Kamaleri et al. (19) showed that the number of pain sites was almost unchanged for 46% of a Norwegian population over a 14-year period. Later, a number of others have studied the same phenomenon in different populations with very different follow-up times (1–28 years). The results indicate that the number of regions with pain is relatively stable over time, but some experience an increase or decrease in number of pain sites, and in some cases, the number of pain sites shows fluctuating patterns over time (23, 157-162). Based on the answers provided by the 2,328 follow-up questionnaire responders without missing data, it was possible to explore whether this study population was similar to previously studied populations, and the results confirm earlier studies. About 50% report almost unchanged number of regions with pain over this 12-year period, and very few report large fluctuations (<4%) (unpublished data). If these data had been included in the analyses in studies 1 and 2, we would have been able to better identify individuals with stable and fluctuating (increasing/decreasing) number of pain sites, but as our aim was to test and describe future healthcare behavior, use of data collected after the end of follow-up would not have been relevant.

Health anxiety, risk of anxiety, risk of depression were measured with use of subscales from CMDQ and dichotomized based on recommendations for clinical use. Dichotomization was also applied to participation restriction due to pain. BMI was collapsed into ordinal groups, as were register-based variables like marital status and level of education. This approach could have led to loss of information and residual confounding. While there is a possibility that this may have influenced the results, we believe that any such influence is likely to be minor.

Registers

Register data are primarily collected and managed for administrative purposes and made available for research under special strict requirements regarding data security, which means that desired information is not always available and data can only be used for certain purposes. For example, it was not possible to match musculoskeletal healthcare contacts in the NPR for all the follow-up years with the relevant payment rate from the DRG because the NPR register is dynamic and the DRG register is static. This means that these two registers only match 100% on one date each year because the NPR is constantly updated with disease courses, diagnostic codes, treatments, tests, etc. Therefore, we could not with satisfactory precision calculate cost related to musculoskeletal healthcare contacts in study 1.

Furthermore, it would be a violation of Danish law to identify individuals for research purposes based on register data. This means that we could not use musculoskeletal healthcare trajectory membership for the recruitment of informants for the interview, which challenged the bridging between study 2 and study 3. Instead, we had to classify informants based on self-reported information about healthcare utilization after recruitment. This might have given rise to misclassification because the informants were asked to estimate their use of healthcare services some years ago. Additionally, informants might have taken other healthcare-related activities (e.g., alternative treatment) into consideration in this estimate than those on which the longitudinal healthcare trajectories were based. However, we do not think that this potential misclassification has any meaningful impact, as it was relatively clear from the informants' narratives to what extent they had used healthcare services, especially when we merged informants with a medium use of musculoskeletal healthcare services into one group rather than using all five groups from study 2.

Since the closing and deletion of data from the National Danish General Practice Database (DAMD) in 2015, it has not been possible to extract register-based information about diagnoses/patient’s reason for contact with GPs (DAMD was closed and deleted due to problems with the approval procedures). A central variable in this project was a count of face-to-face musculoskeletal healthcare contacts based on register data. In order to determine whether a face-to-face GP contact in the NHSR was related to a musculoskeletal disorder, we therefore developed a simple algorithm. In a two-step approach, the algorithm built on available information about each contact registered in the NHSR as well as information about succeeding healthcare initiatives registered in the NHSR, NPR, and RMPS. The algorithm has been described in detail in studies 1 and 2 (87, 163). Similar algorithms using register-based data to link patients and practices have been developed and validated with promising results (164). However, validation of the algorithm we used is still lacking, and we do not know whether we correctly identified the right patients and GP contacts. Jordan and colleagues (165) estimated that approximately 14% of all GP contacts in the UK were related to musculoskeletal diagnoses. Our algorithm estimates it to be 18% in these Danish data, which we consider to be credible.

Registration of contacts in the NHSR is based on information about public reimbursement to the health professionals. In Danish primary care, most health contacts are fully or partly publicly funded, and hence registered in the NHSR. However, an increasing proportion of musculoskeletal treatment is paid for by private health insurance or out-of-pocket payment by the patient. In 2018, the Association of Danish Physiotherapists estimated that such contacts account for approximately 15% of primary care physiotherapist and chiropractor contacts, and this proportion has probably increased since (44). Also, all forms of alternative treatment in Denmark are paid fully out-of-pocket by the patient and are therefore not registered. This means that certain musculoskeletal health contacts were not visible in the national health registers. This also became evident in the interviews because the majority of informants reported one or more contacts obtained through health insurance schemes or with alternative therapy providers. Therefore, the number of identified musculoskeletal healthcare contacts in this project is probably an underestimation of the actual number. Given that we do not know if non-registered pain-related healthcare use mimics the patterns observed in the registered data, the associations when all types of pain-related healthcare are considered may be different than the ones found in these studies.

Comorbidity was derived by applying the register-based algorithm for the Charlson comorbidity index to the NPR data, which means that only hospital-verified ICD-10 diagnostic codes were considered. The comorbidity in this project is therefore most likely an underestimation of the actually level of comorbidity.

The qualitative study

All interviews were conducted by the PhD student, who had no experience with interviews and data collection for use in qualitative research prior to study 3. Therefore, the PhD candidate was trained and guided by experienced researchers in the first data collection rounds. This training led to alterations in sequence and formulation of questions and interview technique to enhance the level of data quality and saturation. A more experienced qualitative researcher may have collected different data. Our impression is, however, that while the lack of experience resulted in longer interviews with more stories and extraneous details, the collected data were still rich with information about the topics of interest. All interviews were conducted online or by telephone to accommodate governmental COVID-19 regulations. This could potentially have led to different answers and reflections than face-to-face interviews. However, our impression was that this physical distance created a judgement-free environment and that all informants brought forward honest and frank perspectives on pain-related healthcare, and about potential undesirable or stigmatizing healthcare activities (like high use of opioids or alternative therapies). Several authors and supervisors with different experiences and background were involved in the coding and analysis process, and reflective notes and memos were made after all meetings and discussions to ensure transparency and document the process and the decisions made.

In the analysis phase, we decided not to approach data through a priori specified theoretical lens or define any a priori coding categories, and the results were reached through discussions and agreement. A theory-guided analytic approach could have led to other interpretations than those presented. However, we have attempted to make the process explicit and ensure a high degree of transparency via the audit trail (Appendix C1).

External validity

Some issues should be considered when generalizing results from this project to other settings. Lack of internal validity could affect external validity, and the representativeness of this population-based cohort might be challenged by the relatively large group of non-responders with different sex, age, labor market, and healthcare user profiles compared to the group of responders. In study 3, we sampled informants with very different profiles, backgrounds, and healthcare experiences. This was done to strengthens the generalizability of themes and subthemes conceptualized from the interview data. However, results might not be representative for all the chronic pain population and should be cautiously interpreted. Furthermore, register-based information on healthcare seeking is considered to be valid; however, it is only possible to identify publicly funded (fully or partly) services and diagnostic information for GP contacts are missing, which makes some underestimation of healthcare service use and misclassification of reason for contact likely.

The reader should also be mindful that the mainly government-funded Danish healthcare system might differ from their own healthcare system. We still believe that our findings could be cautiously transferred to other settings and will be helpful for researchers and clinicians in other Western countries with comparable healthcare systems.

Chapter 7 - Conclusions

The aim of this project was to provide a more detailed understanding of healthcare-seeking behavior in the contest of pain. Therefore, we conducted a mixed methods project including three studies with different methodology (aim, framework, design, data, methods of analysis, etc.). The conclusions from the different studies are as follows:

Conclusion study 1

Findings show a causal association between increasing number of pain sites and greater long-term (10 years) healthcare use and cost, and high levels of health anxiety did not increase the strength of this association. We found only a weak association between high level of health anxiety and higher number of healthcare contacts in this sample.

Conclusion study 2

Long-term (10 years) use of pain-related healthcare services for people with chronic pain vary. A large group (almost 39% in this sample) cope without seeking care, whereas a minor group (8% in this sample) have consistent high use of pain-related healthcare services. The majority of people with chronic pain (53% in this sample) have a medium use of pain-related healthcare services. Chronic pain is mostly managed in primary care settings. Use of opioids and surgery is rare and almost exclusively found in the high healthcare user group. People with chronic pain and different pain-related healthcare-seeking trajectories have different individual, sociodemographic, health, belief, and work-related profiles.

Conclusion study 3

Pain-related healthcare in people with chronic pain is often initiated by beliefs about the course, control, and functional limitations of pain, recommendations from trusted persons, and the search for a diagnostic label/reassurance. The pathways laid out within the healthcare system are often followed if considered feasible. Use of healthcare and clinical pathways are modified by two interconnected systems: 1) perceived needs, beliefs, and values and 2) previous healthcare experiences, and differences related to these systems could explain some of the different pain-related healthcare behaviors seen in people with chronic pain.

Mixed Interpretation

We boldly set out to answer the following questions related to healthcare-seeking behavior in the context of chronic pain by a joint interpretation of finding from the three studies:

1) How do individuals with chronic pain use the healthcare system?

2) Why do individuals with chronic pain seek healthcare?

3) How do chronic pain-related healthcare user groups differentiate?

4) What modifies healthcare use in the context of chronic pain?

Findings from study 2 were used to answer question 1, findings from studies 1 and 3 were used for question 2, findings from studies 2 and 3 were used for question 3, and findings from study 3 were used for question 4.

Ad 1: Individuals with chronic pain use the healthcare system differently (please see conclusion of study 2 for more detail).

Ad 2: Individuals with chronic pain explain their pain-related healthcare seeking with recommendation from trusted others, beliefs and expectations about cause of pain and pain management, pain and functional limitations, and to get reassurance about or explanation for the pain. We found that public healthcare contacts and costs increased with each incremental increase in number of pain sights and levels of health anxiety, but the association between health anxiety and healthcare contacts and costs was relatively weak in this sample. Findings from studies 1 and 3 also showed that determinants/drivers for pain-related healthcare seeking found by quantitative and qualitative methods are quite different.

Ad 3: We explored these differences for three pain-related healthcare user groups (high, medium, low), and we found significant between-group difference in individual, sociodemographic, health, belief, and work-related profiles. We also found differences between these groups in terms of understanding of pain, trust in healthcare, and expectations for the healthcare provider, and these different expectation typologies seem to impact the use of pain-related healthcare services.

Ad 4: Use of pain-related healthcare services for individuals with chronic pain seem to be modified by two interconnected systems: 1) needs, expectations, and beliefs and 2) previous healthcare experience. These systems can overrule advice or recommendations given by healthcare providers and available evidence. This has clinical implications because modifications of these factors may impact and change future pain-related healthcare use.

When interpreting the results from this project the reader should take into consideration the modest participation rates and a likely underestimation of healthcare service use.

Chapter 8 - Perspectives and future research

Implications of findings and future research

Knowledge about trajectories of healthcare use in people with pain and thoughts about healthcare from the perspective of the patient are key in order to understand how healthcare systems work and identify areas where improvement is needed. Some of the findings from this project combined with available scientific literature indicate that organization of public pain-related healthcare services and the general framework for understanding pain leave room for improvement. A healthcare system that offers an emphatic and holistic approach with willingness and time to listen is vital for the patient, but is often not provided. This can lead to frustrations and non-guideline-adherent over- and potentially underuse of healthcare services. One informant expresses the mismatch between organizational framework and patient needs like this:

Informant16 (Male, 53 years of age, high healthcare user, few pain sites): ... She (The GP) has the most hopeless working conditions for a person like me…. She only has 15 minutes for each patient, and if she spends more time, it costs her money - and there is nothing about me that can be handled in 15 minutes.

Despite the high individual and societal impact of pain, this condition does not seem to have high priority on a policy level in terms of funding for research, redesign of clinical pathways, and education, and it would be desirable to make chronic pain a higher priority alongside other chronic diseases (6, 38, 166). On the policy level, attention also needs to be paid to system-level factors (e.g., reimbursement systems) that can enable more flexibility for the healthcare provider to meet the patient’s expectations. More awareness also needs to be paid to the interaction between patient and healthcare provider and the communication that take place during the clinical encounter across professions at both under- and postgraduate levels. The clinical encounter is an art form that requires skills, training, and supervision. It is, however, beyond the scope of this project to develop, implement, test and evaluate initiatives to enhance pain management competences for healthcare providers, but future projects with such aims could take some of the perspectives from this project into account. It also needs to be acknowledged that all patients are different, have different problems, expectations, beliefs, and needs, and the healthcare provider has a relatively short time to tune in on each patient. This is a difficult mission and will never reach a 100% success rate.

Other professional competencies (e.g. manual examination skills, clinical reasoning) should also not be underestimated, but interestingly, the expertise of the healthcare provider was most often questioned by the informants in this project in cases where communication and the therapeutic alliance failed. This could indicate that communication and the relation between healthcare provider and patient are the fundamental clinical skillset in pain management.

In this project, we also found evidence that expectations, beliefs, and clinical pathways can be altered into a more guideline-concordant management strategy if the patient is approached in an appropriate way. Future projects could aim to explore and understand the mechanisms behind such change and design/test initiatives and strategies to modify healthcare trajectories for potential over-users of pain-related healthcare. This could include exploring the clinical encounter, communication, and potential for acknowledging the patient's story and situation. It could also be relevant to explore whether healthcare-seeking behavior can be modified in the long term. We have described healthcare-seeking trajectories in the context of pain and explored how healthcare-seeking behavior works from the perspective of the individual with pain; however, we still need to understand more about the mechanisms that underlie healthcare behavior and understand behavior-modifying strategies.

Deloitte's life sciences and healthcare industry group recently published a report about future healthcare delivery systems in light of the COVID-19 pandemic. This report suggests a shift in framework for understanding health and healthcare delivery systems where health is viewed holistically as an overall state of well-being and that care should be organized around the needs of the patient rather than the convenience of the healthcare provider. This calls for organizational changes and delivery of tailored healthcare outside the traditional healthcare arenas. In the context of pain, the needs of the patient could be adequate consultation time, sincere interest, clear and relevant guidance/information/answers provided in an understandable manner. We have not explored the best setting for delivery of healthcare services for people with pain, but it could also be that other venues and healthcare delivery systems are more relevant than the traditional.

In a recently press release, the Danish Ministry of Health launched a new national strategy for chronic pain management (167). The strategy aims to implement five initiatives (professional recommendations and guidelines about management of people with chronic pain, strengthen patient involvement, public information about chronic pain, and improvement of interdisciplinary initiatives) during the next 2 years. We hope that findings and perspectives from this project will inspire and assist this implementation process and help to improve the lives of the 1.2 million adult (> 16 years old) Danes living with chronic pain.

English summary

Chronic pain negatively impacts the lives of millions worldwide and chronic pain has major consequences for the individual, for the healthcare system, and for the society. Not all with chronic pain seek healthcare, but chronic pain still one of the most common causes of healthcare seeking and people with chronic pain use the healthcare system more frequently than people without pain. Chronic pain management is a challenge, and people with chronic pain often report unsatisfactory healthcare courses.

The overall purpose of this project is to explore how and why people with chronic pain use healthcare, as well as to explore what defines and modifies healthcare seeking behavior. This project is a sequential mixed method project based on 3 studies, each with its own design and data sources.

Study 1 is designed as a population-based cohort study with ten years of follow-up. The purpose was to analyse whether number of pain sites (range 0-7) and health anxiety (low/high level) cause increased healthcare contacts and costs. We included 4,883 adults Danes aged 17-64 (in 2008). The study was based on questionnaire data from 2008, national register data from 2006-2018 and data were analyzed with generalized estimating equation. We found that contacts (all types of contacts and specific musculoskeletal contacts) and healthcare costs increase incrementally for each additional pain site but the association between health anxiety and healthcare contacts and costs was relatively weak in this sample.

Study 2 is designed as a cohort study with ten years of follow-up. The purpose was to describe long-term musculoskeletal healthcare trajectories for people with chronic pain and profiles associated with such trajectories. We included 2,929 adults aged 17-64 (in 2008). The study was based on questionnaire data from 2008, national registry data from 2006-2018 and data were analyzed with latent class growth analysis. We identified 5 different musculoskeletal healthcare trajectories. Thirty-nine percent of the study population had no or few annual musculoskeletal healthcare contacts (low stable), whereas 8% had a continuously high annual number of musculoskeletal contacts (high stable). Between these two groups, we found three groups (low ascending (17%), low

descending (20%), and medium stable (16%)) with a medium number of annual musculoskeletal healthcare contacts. Participants in the *low stable* group were more often men with low tendency to negative emotions, few pain sites, lower pain intensity, low risk of anxiety, lower degree of activity limitation due to pain, low degree of co-morbidity, fewer health contacts before baseline, and more often at work or student, compared to the other groups. Participants in the *high stable* group were more often women with higher tendency to experience negative emotions, higher pain intensity, higher BMI, higher risk of depression, higher degree of activity limitation due to pain, more co-morbidity, more health contacts before baseline, and less frequently at work or studying compared with the other groups.

Study 3 is designed as a qualitative study with semi-structured interviews. The purpose was to explore how people with chronic pain and different pain-related healthcare use explain healthcare behavior. Based on transcripts of 20 interviews and thematic template analysis, we identified four key themes with 11 sub-themes. These themes are: 1) system-facilitated courses, 2) assessment of health contacts, 3) autonomy, beliefs and values, and 4) recommendations. We found differences between the healthcare user groups in terms of understanding pain, trust in healthcare, expectations for the healthcare provider. These different expectation typologies seem to influence healthcare seeking behavior. The analyzes also showed that it is important for people with chronic pain to be seen, heard and approached with interest by the healthcare provider.

Perspectives from this project can be considered in order to optimize chronic pain management.

Dansk resumé

Kroniske smerter påvirker livet negativt for millioner af personer på verdensplan, og kroniske smerter har store konsekvenser for den enkelte, for sundhedsvæsenet og for samfundet generelt. Ikke alle med kroniske smerter søger kontakt med sundhedsvæsenet. Alligevel er kroniske smerter en af de hyppigste kontaktårsager i sundhedsvæsenet, og personer med kroniske smerter kontakter sundhedsvæsenet hyppigere end personer uden smerter. Mere indgående viden om kontaktadfærd for personer med kroniske smerter, kan danne grundlaget for forbedring af sundhedsvæsenets tilbud. Det overordnede formål for dette projekt er derfor at undersøge, hvordan og hvorfor personer med kroniske smerter bruger sundhedsvæsenet, samt undersøge hvad der definerer og modificerer kontaktadfærd.

Projektet er et sekventielt mixet metodeprojekt baseret på 3 studier med hvert sit design og datagrundlag.

Studie 1 er designet som et populationsbaseret kohortestudie med ti års opfølgning. Formålet var at undersøge, om udbredelse af smerte (0-7 kropsregioner) og helbredsangst (lavt/højt niveau) er årsag til flere kontakter og øgede omkostninger i sundhedsvæsenet. Vi inkluderede 4.883 voksne i alderen 17-64 år (i 2008). Studiet var baseret på spørgeskemadata fra 2008, nationale registerdata fra 2006-2018. Data blev analyseret med generalized estimating equation. Studiet viser, at kontakter (alle typer kontakter og specifikke muskuloskeletale kontakter) og omkostninger i sundhedsvæsenet stiger for hver ekstra kropsregion med smerte mens sammenhængen mellem højt niveau af helbredsangst og kontakter/omkostninger i sundhedsvæsenet var relativ svag.

Studie 2 er designet som et kohortestudie med ti års opfølgning. Formålet var at beskrive muskuloskeletale kontaktmønstre i sundhedsvæsenet for personer med kroniske smerter, herunder at beskrive profiler associeret med sådanne kontaktmønstre. Vi inkluderede 2.929 voksne i alderen 17-64 år, som alle rapporterede kroniske smerter (i 2008). Studiet var baseret på spørgeskemadata fra 2008 og nationale registerdata fra 2006-2018. Data blev analyseret med latent class growth analyse. Vi identificerede 5 forskellige muskuloskeletale kontaktmønstre. I alt 39% af studiepopulationen havde ingen eller få årlige muskuloskeletale kontakter (lavt stabil), hvorimod 8% havde et kontinuerligt højt årligt antal (højt stabil). Imellem disse to ydergrupper fandt vi tre grupper (lavt stigende (17%), lavt faldende (20%) og medium stabil (16%)) med et middel antal årlige muskuloskeletale sundhedskontakter. Personer i lav stabil-gruppen var oftere mænd med: lav tendens til negative følelser, få kropsregioner med smerter, lav smerteintensitet, lav risiko for angst, en lavere grad af aktivitets- og deltagelsesbegrænsning på grund af smerte, lav grad af ko-morbiditet, færre sundhedskontakter før baseline, og oftere i arbejde eller studerende sammenlignet med de øvrige grupper. Personer i høj stabil-gruppen var oftere kvinder med: øget tendens til at opleve negative følelser, højere smerteintensitet, højere BMI, højere risiko for depression, højere grad af aktivitets- og deltagelsesbegrænsning på grund af smerte, højere grad af ko-morbiditet, flere sundhedskontakter før baseline, og sjældnere i arbejde eller studerede, sammenlignet med de øvrige grupper.

Studie 3 er designet som en kvalitativ undersøgelse med semistrukturerede interviews. Formålet var at undersøge, hvordan personer med kroniske smerter og forskellige kontaktmønstre forklarer deres adfærd i forhold til sundhedsvæsenet. Baseret på transskriptioner af 20 interviews og tematisk analyse identificerede vi fire nøgletemaer med 11 undertemaer, der begrebsliggør, hvordan mennesker med kroniske smerter forklarer deres kontaktadfærd. Disse temaer er: 1) system-faciliterede forløb, 2) vurdering af sundhedskontakter, 3) autonomi, overbevisninger og værdier, og 4) anbefalinger til behandling. Vi fandt forskelle hos informanter med forskellige kontaktmønster med hensyn til forståelse af smerte, tillid til sundhedsvæsenet, forventninger til den sundhedsprofessionelle. Disse forskelle synes at påvirke kontaktmønsteret. Analyserne viste desuden, at det er vigtigt for personer med kroniske smerter at blive set, hørt og mødt med interesse af den sundhedsprofessionelle. Perspektiver fra dette projekt kan inddrages i forhold til optimering af sundhedsvæsenets tilbud til personer med kroniske smerter.

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Appendix list

Appendix A

PAPER 1

Number of musculoskeletal pain sites leads to increased long-term healthcare contacts and healthcare related costs – a Danish population-based cohort study.

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Number of musculoskeletal pain sites leads to increased long-term healthcare contacts and healthcare related costs – a Danish population-based cohort study

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Abstract

Background: People with musculoskeletal pain seek more healthcare than the general population, however little is known about the long-term effect on healthcare use. The aim of this study was to examine the consequences of number of musculoskeletal pain sites on long-term care-seeking and healthcare-related costs and explore how health anxiety influences this relationship.

Methods: We conducted a Danish population-based longitudinal cohort study of 4883 participants combining self-reported survey data from 2008 with ten-year follow-up data from national health registers. Using a causal inference framework, we examined associations between number of pain sites (range 0–7)/level of health anxiety (high/low level) and face-to-face healthcare contacts/healthcare-related costs. Data were analyzed using negative binomial regression with generalized estimating equations. Regression models were adjusted for sex, age, duration of pain, level of education, comorbidity, personality traits, risk of depression, marital status, physical job exposure, and previous healthcare utilization.

Results: For each additional pain site general healthcare contacts (Incidence Rate Ratio (IRR): 1.04 (95% CI: 1.03–1.05)), healthcare-related costs (IRR: 1.06 (95% CI: 1.03–1.08) and musculoskeletal healthcare contacts (IRR: 1.11 (95% CI:1.09–1.14) increased. Those with high levels of health anxiety at baseline had a slightly higher number of general healthcare contacts (IRR 1.06 (1.01–1.11), independent of number of pain sites. However, level of anxiety did not influence the effect of number of pain sites on any healthcare use or cost outcomes.

Conclusions: We found evidence for a causal association between increasing number of pain sites and greater healthcare use and cost, and high levels of health anxiety did not increase the strength of this association. This suggests that number of pain sites could be a potential target for biopsychosocial interventions in order to reduce the need for future care-seeking.

Keywords: Number of pain sites, Health anxiety, Healthcare utilization, Musculoskeletal pain, Cohort study

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Background

Musculoskeletal pain is common among adults and one of the most common reasons for care-seeking [1, 2]. People reporting musculoskeletal pain have a higher use of healthcare services than the general population regardless of primary pain site [3]. However, localized pain is relatively rare as musculoskeletal pain often occurs in various body regions simultaneously [4, 5]. This differentiation is important as the functional consequences of pain (sickness absence and disability) increase proportionally with the number of body regions in pain [5–8].

The choice to seek care due to pain has been conceptualized by different theories, with the dominant conceptual framework of health services use being the 'health behavioral model' [9]. This model describes care-seeking as a function of individual and contextual predisposing factors, enabling/impeding factors, and perceived need for care [9, 10], driven by an individual's subjective concerns about health, perception of need and health beliefs rather than an objective, evaluated need [11, 12]. In general, there is high variability in seeking care by different people for the same symptoms, which supports the theory that choice of care-seeking is driven by symptom appraisal [11, 13] and perception of need. Care-seeking could be viewed as a process [12, 14–16] that involves personality, psychological factors and beliefs/knowledge (e.g. fear avoidance, health anxiety, risk perceptions, stress, self-efficacy), comorbidity, type/nature of symptoms/diagnosis (e.g. location, duration, intensity, disability), and social factors [14, 17–20].

Healthcare utilization due to pain and psychological factors, such as health anxiety, has been studied for some years but most research has been undertaken using retrospective or cross-sectional designs of short-term care-seeking from specific healthcare professions or settings (e.g. general practitioner, physiotherapist, emergency department) based on self-reported data, with inherent risks of lag time and recall bias [14, 21]. Therefore, research on care-seeking behavior across professions from a longitudinal long-term perspective was needed. While a number of factors associated with care-seeking for localized pain have been identified in prediction models, few attempts have been made to examine theory-driven causal relationships and underlying determinants of care-seeking behavior for musculoskeletal pain in multiple body sites [14, 17]. Furthermore, knowledge is sparse about the influence of health concerns, such as health anxiety, on the relationship between number of musculoskeletal pain sites and health care utilization.

The aim of this study was to examine the consequences of number of musculoskeletal pain sites on long-term care-seeking and healthcare-related costs and explore whether health anxiety influences this relationship. Our hypotheses were that (i) increasing number of pain sites would result in higher total healthcare utilization and total healthcare-related costs over a subsequent 10-year period, (ii) this relationship would be stronger for people with high levels of health anxiety.

Methods

Population

This is a population-based, longitudinal cohort study. In February 2008, web-based and postal questionnaires were sent out to 8517 working age people, registered at the same medical center in the Danish city of Odder staffed by eight General Practitioners (GPs). Overall, 5097 people returned the baseline questionnaire, of whom 4883 were eligible for analysis in the current study. Detailed descriptions of the responders and non-responders have been published elsewhere [19]. In the current study, we excluded patients who were non-identifiable ($n = 29$), died during the 10-year follow-up ($n = 153$) or were living abroad for more than 2 years of the follow-up period ($n = 32$). Participants were between 17 and 65 years of age at baseline. Using validated scales, the questionnaire covered a wide range of information on individual, psychosocial and work-related factors. The following variables were extracted from those baseline questionnaires.

Exposure (independent variables) – Number of pain sites and Health anxiety

The number of pain sites at baseline was measured using the first part of the pain module of the Standard Evaluation Questionnaire (SEQ) [22]. Participants were asked to state the intensity of pain (if any) on a one (no pain) to seven (worst imaginable pain) point scale in seven different body regions (right/left upper and lower extremity, front and back of thorax and the head) within the last 4 weeks. We classified people as having pain in a body region if they reported pain intensity above 2/7 in that particular region (to exclude trivial pain). This cut-off point is comparable to the optimal cutoff point for a clinical important change on a 0–100 visual analog scale [23, 24]. Number of pain (0–7 sites) sites were analyzed as a continuous variable.

Health anxiety/Illness worry at baseline was measured using the Whiteley-7 Index [25]. Those seven items are included in the Common Mental Disorder Questionnaire (CMDQ). The CMDQ was developed and validated as a case-finding instrument in primary care [26]. This questionnaire contains questions about worries about illness and care-seeking within the last 4 weeks requiring answers using one of five categories from "Not at all" (0) to "Extremely" (4). The 0–28-point score was dichotomized at > 5 (0–5 = low risk, 6–28 = high risk) as the threshold of scores above five is recommended by The Danish College of General Practitioners as an indication of clinically relevant risk of health anxiety [27]. The

Whiteley-7 Index has shown acceptable psychometric properties in primary care settings [25].

Co-variables derived from baseline questionnaire

To capture the five basic dimensions of personality (Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness) we used the five-factor model of personality traits, derived from 20 items in the Mini International Personality Item Pool (IPIP) which is a validated tool for measuring personality traits [28, 29]. In the mini-IPIP, each personality trait is measured with four items. This questionnaire asks participants to state their level of agreement with statements like "I am the life of the party", "I have frequent mood swings", "I sympathize with others' feelings" in five categories from "Very Inaccurate" to "Very Accurate". Each personality trait scale was summed to a 0–16 score and analyzed as a continuous variable.

Risk of depression at baseline was measured using six items (SCL_DEP6) from the Symptom Checklist 90-items. These items are included in the Common Mental Disorder Questionnaire (CMDQ). The CMDQ was developed and validated as a case-finding instrument in primary care [26]. This questionnaire contains six questions about influence of negative mood and feelings within the last 4 weeks and requires answers using one of five categories from "Not at all" to "Extremely". We dichotomized the 0–24-point score at five (no risk of depression/risk of depression) based on recommendation from The Danish College of General Practitioners as scores above five indicate enlarged risk of depression [27].

Duration of pain at baseline was measured with a single question item from part 4D of SEQ [22]. Participants were asked to nominate the duration of their pain using one of the following four categories: "Less than a month", "One to three months", "Four to twelve months" and "More than a year". For the purpose of this study, duration of pain at baseline was dichotomized into 'no chronic pain' for participants reporting pain for less than 3 months and 'chronic pain' for participants reporting pain for more than 3 months. As this question was asked in a way where people without pain were left with no obvious choice, we decided to code missing on this item as 'no chronic pain' for those who reported no pain in any body region. Furthermore, we included participants who reported no pain in any body region within the last 4 weeks into the 'no chronic pain' group.

Variables derived from National registers

Using the civil registration number uniquely assigned to each resident of Denmark, baseline data was linked to Danish health and social registers to extract data for the subsequent 10-year period (2008–2017) [30, 31]. Number of healthcare contacts and related costs were based on information from the National Health Insurance Service Register [32], the National Patient Register [33, 34], the Register of Medicinal Product Statistics [35], the Rehabilitation According to "The Danish Act of Health §140" register and Diagnosed Related Grouped National Patient Register Data. Information about education level, death and migration was obtained from the Population Education Register and Population Statistics Registers.

The National Health Insurance Service Register (NHSR) was established in 1990 and contains information about all fully or partially public funded primary healthcare services. The NHSR contains information about the healthcare provider, public expenditure for each contact and the type of service provided based on the week reimbursement was claimed for [32, 36]. The diagnosis or reason for the consultation is not recorded in the NHSR. A minor proportion of primary care physiotherapy and chiropractor consultations are fully self-funded, and therefore not recorded in the NHSR. This proportion of physiotherapy and chiropractor healthcare has been estimated to about 15% by the Danish Physiotherapist Association.

The National Patient Register (NPR) is the central register for recording activity in the Danish secondary healthcare system. The NPR contains information on hospital admissions since 1978 and all outpatient hospital contacts since 1994. Information in the NPS includes the date and time for hospital arrival and departure, type of contact, diagnosis, treatment and tests. Registration in the NPS is based on the Healthcare Classification System [37] and diagnostic criteria are the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) diagnostic codes. In general, data from the NPS are considered valid, but the positive predictive values of diagnostic codes can vary for different diseases and types of treatment [34]. In this study, information from the NPR was used to identify number of contacts and reason for contact.

The Diagnoses Related Group (DRG) Grouped National Patient Register covers data about costs related to in- and out-patient contacts in the NPR. DRG-grouped NPR data itemize payment instances and rates in the Danish healthcare system. Estimated grouped rates for each hospital service are based on the average costs for all hospitals in Denmark and are used for government payments to Danish hospitals. The payment rates for DRG-grouped NPR items are re-evaluated each year.

The Rehabilitation According to "The Danish Act of Health §140" register (Rehab Register) was established in 2007. According to Danish law, after hospital admission or outpatient encounters, patients can be referred to publicly funded physiotherapy and occupational therapy rehabilitation if medically indicated. The Rehab Register contains information about contact dates and number of contacts during this type of rehabilitation.

Data on sex and age was obtained from the Danish Civil Registration System [30, 31, 38]. Age was analyzed in six ordinal groups (17–20, 21–30, 31–40, 41–50, 51–60 and 61–65 years of age).

Highest achieved level of education at each follow-up year was obtained from The Danish Education Register [39]. Classification was based on 'The International Standard Classification of Education' [40] and categorized into three ordinal groups: 1) primary and lower secondary education or equivalent, 2) upper secondary education or skilled worker/short cycle tertiary education or equivalent, and 3) Bachelor/Master/Doctorial or equivalent. Level of education was analyzed longitudinally, hence, participants were able to change education group during follow-up.

Comorbidity was obtained by applying an updated version of Charlson comorbidity index to ICD10 diagnostic codes in NPR [41]. The Charlson comorbidity index is a valid prognostic indicator for mortality in various disease subgroups and the index has been widely used as an indicator for comorbidity in epidemiology and clinical research, including research on pain and pain-related outcomes [41]. Using ICD-10 diagnostic codes to ascertain the Charlson comorbidity conditions in NPR data has shown high accuracy [42]. A higher Charlson comorbidity score indicates an increased amounts of comorbidity [43]. As data on comorbidity was zero inflated, we categorized the comorbidity index into three ordinal groups (0 - no comorbidity, 1 - low level of comorbidity and > =2 - high level of comorbidity). Comorbidity was analyzed longitudinally. Baseline index was calculated using the previous 2 years of NPS data and thereafter the index was updated each follow-up year; hence the comorbidity index across the whole study period was based on 12 years of NPS data.

Physical lower body occupational job exposure information was obtained by linking the Danish version of the International Standard Classification of Occupations (D-ISCO 88) job titles from the Register-Based Labour Force Statistics [44, 45] to the Lower Body Job Exposure Matrix (JEM) [46]. The lower body JEM estimates lower body occupational exposure based on five experts' ratings from 121 occupational groups including 689 occupational titles with similar exposure. For this study we used the variable 'total kilograms (kg) lifted per day' dichotomized into < 1000 kg/day (low) and ≥ 1000 kg/day (high) [47]. Similarly, we linked D-ISCO 88 job titles to the shoulder JEM [48, 49]. To estimate physical occupational shoulder exposure we used the total shoulder score (range 0–10), which is a combined measure of seven different shoulder exposures (upper arm elevation > 90°, repetitive shoulder movements, forceful shoulder exertions, lifting/carrying, and pushing/pulling, use of handheld vibrating tools and computer work) [49], and dichotomized that score into high and low scores at the 75th percentile. Most participants had follow-up years with missing or incomplete D-ISCO 88 codes, meaning that physical job exposure could not be calculated for all follow-up years. If possible, we carried forward previous years D-ISCO 88 code if information from "The Danish Register-based Evaluation of Marginalized Individuals" (DREAM-register) [50] indicated that the participants had been working more than 26 weeks that year.

Marital status and number of resident children under the age of eighteen was obtained from the Danish Civil Registration System [30]. We combined data on marital status and number of resident children under the age of eighteen into the following four categories: 1) Cohabitant with resident child/children, 2) Cohabitant without resident children, 3) Single with resident child/children, and 4) Single without resident children. Marital status was analyzed longitudinally, hence, participants were able to change status during follow-up.

Use of healthcare the last 2 years before baseline was derived by applying the procedure and algorithm for the dependent variable (Table 1 and Appendix A (see Additional file 1)) on 2006 and 2007 data from NPS, NHSR and the Rehab-register. Musculoskeletal-related healthcare contacts and all healthcare contacts for these years were summed separately and analyzed as a continuous variable.

Outcome (dependent variables) - healthcare contacts and healthcare-related costs

For the purpose of this study, two categories of outcomes were derived from these healthcare registers: the number of face-to-face contacts, and healthcare costs. Number of face-to-face contacts were derived separately for musculoskeletal healthcare (MSK-contacts) and for healthcare contacts for any reason (All-contacts). These two outcomes were derived by counting healthcare contacts per participant for each follow-up year (2008 to 2017) in the HSR, NPR and Rehab registers. Details for this procedure are displayed in Table 1 and Appendix A (see Additional file 1). Costs related to healthcare contacts (All-costs) per participant for each follow-up year was derived by summarizing DRG-costs, public expenditure for all primary care contacts and estimated expenditure for rehabilitation contacts. Details are presented in Table 1 and Appendix A (see Additional file 1). Due to the data structure in the DRG and the LPR it was not possible to match secondary healthcare cost and MSK-contacts with satisfactory precision; hence MSK related

Table 1 Outcome (dependent variables) - healthcare contacts and healthcare-related costs

	Register	Method
Number of **musculoskeletal healthcare contacts (MSK-contacts)**:	NPR	1) Counts of in- and out-patient hospital contacts and emergency department contacts registered with a primary or secondary musculoskeletal or pain-related ICD-10 diagnostic code. Every inpatient admission day counted as one contact. See Appendix A (Additional file 1). for more detail.
	NHSR	2) Counts of face-to-face primary care consultations with physiotherapists, chiropractors and musculoskeletal medical specialists. Excluded in this category was fully publicly reimbursed encounters with physiotherapists for non-musculoskeletal diagnoses.
	NHSR	3) Counts of face-to-face GP contact where the clinical tests, examination, coding and subsequent healthcare initiatives indicated a musculoskeletal reason for that consultation. For this purpose, a simple algorithm was developed. The algorithm evaluated each face-to-face GP contact in two steps and built on available information from all health registers. For a more detailed description, see Appendix B (Additional file 2) for more detail. Validation of this algorithm is pending.
	Rehab-register	4) Counts of face-to-face municipality musculoskeletal rehabilitation visits indicated by a prior musculoskeletal hospital in- or out-patient contact.
N**umber of healthcare contacts for any reason (All-contacts)**:	NPR	1) Counts of all in- and out-patient hospital contacts and emergency department contacts without regard for ICD-10 diagnostic codes. Each inpatient admission day counted as one contact. Derived from the NPR.
	NHSR	2) Counts of all face-to-face primary care physiotherapy, chiropractic, podiatrist/chiropodist, psychologist, dentist and medical specialist consultations.
	NHSR	3) Counts of all face-to-face GP consultations.
	Rehab-register	4) Counts of all municipality rehabilitation consultations.
Costs related to all healthcare contacts (All-costs):	DRG/NPR	1) DRG-cost from all in- and out-patient hospital contacts and emergency department contacts.
	NHSR	2) Public expenditure for all primary care physiotherapy, chiropractic, podiatrists/chiropodist, psychologist, dentist, GP and medical specialist consultations.
	Rehab-register	3) Calculated expense based on salary and other operating costs for all municipality rehabilitation settings.

costs were not be derived. All-costs are presented in Euro (€).

Statistical analysis

This study is based on a causal inference framework [51–53]. Each research question had its own theoretical framework which guided analysis and hypothesis testing. This framework was based on our interpretation of previous literature in this field and has been visualized using Directed Acyclic Graphs (DAGs) (www.dagitty.net) [54] (Appendix C) (see Additional file 3). The choice of co-variables for statistical adjustment for each research question has been guided by the principle of minimal sufficient adjustment sets of co-variables for estimating the total effect [54, 55].

To describe the sample, we used frequencies and percentages for categorical and dichotomous variables and means/medians with standard deviations or 25th /75th percentiles for continuous variables. To understand the relationship between key variables, the correlation between number of pain sites and health anxiety, as well as between the outcomes of costs and counts (MSK-contacts, All-contacts and All-costs), were tested with Spearman's correlation coefficients with 95% CI estimated using bootstrapping methods with 100 repetitions. Each hypothesis was tested via a negative binomial distribution regression model using Generalized Estimating Equations (GEE) to account for multiple observations on the same person over the study time periods and right skewed zero inflated count data (proportional differences in means accounting for zero-inflated data). We calculated adjusted incidence rate ratios (IRR) for the total effect between the independent variable (either pain areas or health anxiety) and healthcare visits or related costs with 95% CI. We tested for an interaction between number of pain sites and health anxiety in each outcome model. The choice of variable, and hence adjustment for each hypothesis test, was informed by theoretical considerations and DAGs (Appendix C (see Additional file 3)). Regression models were adjusted for sex, age, duration of pain, level of education, comorbidity, personality traits (extraversion, agreeableness, conscientiousness, neuroticism and openness), risk of depression, marital status, physical job exposure and previous healthcare utilization. Decisions about the correlation structure for GEE were informed by visual inspection and by Quasi-likelihood under Independence model Criterion test. Based on this evaluation, an unstructured correlation structure was chosen. To optimize the adjustment, we allowed for an interaction between sex and age within the adjustment of all three models.

All variables based on baseline questionnaire data contained some missingness (usually 3–5%) and some D-ISCO 88 codes were missing for one or more follow-up years. This was managed with chained multiple imputation techniques imputing ten datasets to account for the uncertainty in the imputation. As a sensitivity analysis, estimates from the primary regression analysis on multiple imputation data were compared with estimates from a full case analysis on non-imputed data. Only results based on multiple imputation data will be presented. Chained multiple imputation was applied on 1187 cases missing baseline variables or physical job exposure. Twenty-seven percent of these cases had missing values on one variable, 49% on two variables and 24% on three or more variables. Most missing values were on physical job exposure (54%).

All statistics were performed using STATA (College Station, Tx, USA). As advised by Bland and Altman [56], two-sided statistical tests were used despite the presence of directional hypotheses.

Results

Baseline characteristics

The characteristics of included participants are presented in Table 2. Twenty-nine percent of the participants reported no pain at any site at baseline, whereas participants reporting pain in five or more body sites were relatively rare (12% in total). Low level of health anxiety at baseline was reported by 80% of the participants. Fifty-six percent of the population were women and the mean age at baseline was 45 years (SD 12.8) with the largest age group being 50–60-year old's (28%). Most participants with pain reported chronic pain. Approximately one third of the study population reported pain for less than 3 months (36%, $n = 1669$). The vast majority of participants (95%) had no comorbidity at baseline. At baseline, 46% of the participants were living with a partner and had children residing with them. Most of the participants had low level of physical job exposure at baseline (Lower body: 87%. Upper body: 72%).

Number of healthcare contacts and costs

Women and participants above 50 years of age at baseline had higher median number, total All-contacts, total ALL-costs and total MSK-contacts compared to men and participants < 50 years of age at baseline. The median number of total ALL-contacts, total ALL-costs and total MSK-contacts increased with increasing number pain sites, high level of health anxiety, duration of pain and high risk of depression. For level of co-morbidity, educational level, marital status and physical job exposure this pattern was inconsistent (see Table 2).

The correlation between annual number of MSK-contacts and All-contacts was 0.60 (95% CI 0.59–0.61), between MSK-contacts and All-costs was 0.44 (95% CI 0.43–0.45), and between All-contacts and All-costs was 0.85 (95% CI 0.84–0.85). Correlation between the number of pain sites and health anxiety was 0.39 (95% CI 0.38–0.40).

Based on the theoretical model displayed in Appendix C (see Additional file 3), is was estimated that the consequence of each additional pain site was an increase in long term healthcare-seeking for All-contacts (IRR: 1.04 (95% CI: 1.03–1.05)), All-costs (IRR: 1.06 (95% CI: 1.03–1.08)) and MSK-contacts (IRR: 1.11 (95% CI:1.09–1.14)). Testing the same hypotheses with number of pain sites as an ordinal variable showed that this incremental increases in healthcare utilization were the same for each additional pain site (data not shown). This means that a person reporting no pain at baseline has an adjusted mean number of 8 (95% CI: 7.7–8.2) All-contacts, All-costs of € 895 (95% CI: 844–948) and 1.7 (95% CI: 1.6–1.8) MSK-contacts per follow up year, whereas the corresponding values for a person reporting pain in seven body sites are: 10.3 (95% CI: 9.7–11) All- contacts, € 1324 (95% CI: 1178–1489) All-costs and 3.6 (95% CI: 3.2–4) per follow up year.

Independent of number of pain sites, high level of health anxiety at baseline resulted in a slight increase in All-contacts (IRR:1.06 (95% CI: 1.01–1.11)) and All-costs (IRR: 1.09 (95% CI: 0.99–1.20)) (Table 3). This increase was only statistically significant for All-contacts. However, there was no evidence that low or high health anxiety influenced the effect of number of pain sites on any healthcare utilization outcomes (data not shown).

Allowing for different effect of sex and age in the adjustment model revealed that females below the age of 50 had more All-contacts and higher All-costs than age-matched males. This difference was not evident for MSK-contacts (Fig. 1). Estimates from analysis on multiple imputation data and non-imputation data were similar (only results from analysis on multiple imputed data are shown).

Discussion

Main results

Based on a causal inference framework, this population-based cohort study found that for every additional pain site a participant reported at baseline, over the subsequent 10 years their healthcare-contacts for any reason, healthcare-related costs and musculoskeletal-related healthcare contacts

Table 2 Baseline characteristics by total number of healthcare contacts and total health care costs (2008 to 2017)

	Total, n (%)	Total number of All-contacts(a)	Total All-cost(a)	Total number of MSK-contacts(a)
		Median (25;75 percentile)	**Median (25;75 percentile)**	**Median (25;75 percentile)**
Total, median (25;75 percentile)	4883 (100)	74 (42;124)	€197 (84;611)	11 (2;33)
Number of sites with pain intensity > 2/7 (b)				
0, n (%)	1365 (29)	55 (33;92)	€144 (67; 387)	6 (1;17)
1, n (%)	914 (19)	67 (38;109)	€160 (71;472)	9 (1;27
2, n (%)	810 (17)	77 (44;119)	€220 (101;684)	11 (3;34)
3, n (%)	642 (14)	87 (52;143)	€239 (105;636)	18 (5;43)
4, n (%)	464 (10)	105 (59;167)	€276 (118;910)	21 (7;54)
5, n (%)	265 (6)	105 (69;163)	€361 (132;991)	25 (10;53)
6, n (%)	175 (4)	125 (62;205)	€447 (143;1330)	31 (10;65)
7, n (%)	75 (2)	150 (87;209)	€331 (181;1581)	28 (15;67)
Health anxiety(c)				
Low, n (%)	3811 (80)	68 (38;112)	€171 (78;487)	10 (2;28)
High, n (%)	933 (20)	104 (62;177)	€365 (141;1068)	20 (6;50)
Covariates				
Sex				
Female, n (%)	2735 (56)	87 (54;140)	€253 (106;752)	15 (4;38)
Male, n (%)	2148 (44)	57 (31;101)	€150 (64;409)	8 (1;25)
groups, baseline, mean (sd)	45 (12.8)			
17–20, n (%)	301 (6)	53 (29;93)	€100 (46;246)	4 (1;14)
21–30, n (%)	399 (8)	68 (40;112)	€201 (71;827)	8 (1;21)
31–40, n (%)	918 (19)	59 (34;101)	€162 (67;527)	11 (2;32)
41–50, n (%)	1309 (27)	68 (39;111)	€180 (77;486)	13 (3;37)
51–60, n (%)	1389 (28)	86 (49;138)	€231 (108;705)	14 (3;36)
61–65, n (%)	567 (12)	105 (69;163)	€312 (121;889)	14 (4;37)
Duration of pain(d)				
No chronic pain, n (%)	1669 (36)	62 (36;103)	€165 (78; 512)	7 (1;22)
Chronic pain (> 3 month), n (%)	2941 (64)	82 (46;137)	€219 (91;656)	15 (4;39)
Educational level(e)				
Primary and lower secondary education, n (%)	992 (20)	75 (42;130)	€188 (78;535)	9 (2;28)
Upper secondary education or Skilled worker, n (%)	2570 (53)	76 (43;127)	€203 (86;628)	13 (3;36)
Bachelor/Master/Doctorial, n (%)	1301 (27)	70 (40;114)	€190 (87;620)	10 (2;28)
Comobidity				
No cormorbidity, n (%)	4638 (95)	71 (41;119)	€181 (81;508)	11 (2;31)
Low level of comorbidity, n (%)	137 (3)	177 (102;274)	€1167 (451;2966)	32 (10;75)
High level of comorbidity, n (%)	108 (2)	149 (80;256)	€1318 (494;3080)	15 (5;34)
Big five personality traits(f) (range 0–16)				
Neuroticism, mean (sd)	6.5 (3.0)			
Extraversion, mean (sd)	8.6 (3.1)			
Agreeableness, mean (sd)	11.6 (2.2)			
Conscientiousness, mean (sd)	10.7 (3.0)			
Openness, mean (sd)	9.1 (3.1)			

Table 2 Baseline characteristics by total number of healthcare contacts and total health care costs (2008 to 2017) *(Continued)*

	Total, n (%)	Total number of All-contacts(a)	Total All-cost(a)	Total number of MSK-contacts(a)
		Median (25;75 percentile)	Median (25;75 percentile)	Median (25;75 percentile)
Risk of depression (g)				
Low, n (%)	3982 (84)	69 (40;116)	€181 (81;533)	10 (2;30)
High, n (%)	772 (16)	100 (56;174)	€315 (116;873)	17 (5;45)
Marital Status				
Cohabitant with resident children, n (%)	2267 (46)	61 (36;105)	€158 (73;469)	10 (2;29)
Cohabitant without resident children, n (%)	1726 (35)	88 (51;149)	€257 (108;791)	14 (3;36)
Single with resident children, n (%)	272 (6)	80 (46;132)	€251 (96;658)	12 (3;40)
Single without resident children, n (%)	618 (13)	82 (42;135)	€196 (78;602)	11 (2;30)
Physical job exposure				
Total kilograms lifted (lower body) (h)				
< 1000 kg, n (%)	3807 (87)	71 (41;119)	€186 (82;576)	11 (2;32)
> 1000 kg, n (%)	551 (13)	68 (36;113)	€164 (73;444)	11 (2;32)
Total shoulder score (upper body) (i)				
Low, n (%)	3142 (72)	74 (42;125)	€197 (86;626)	11 (2;33)
High, n (%)	1220 (28)	63 (36;105)	€161 (71;431)	10 (2;29)

a: 2008–2017. b: Missing: *n* = 173. c: Missing: *n* = 139. d: Missing: *n* = 273. e: Missing: *n* = 20. f: Missing: *n* = 198–240. g: Missing: *n* = 129. h: Missing: *n* = 525. i: Missing = 521

increased. Non-overlapping confidence intervals for these estimates show that this increase was highest for musculoskeletal-related contacts (11%). Independently of number of pain sites, adults with high level of health anxiety at baseline had more healthcare-contact and higher healthcare-related costs compared to people with low level health anxiety, but this association was weak. Additionally, we found no evidence that level of health anxiety (high vs low) influenced the effect of number of pain sites on healthcare utilization. However, we did find that females below the age of 50 had more healthcare-contacts for any reason and higher healthcare-related costs than age-matched males.

Strengths and limitations

This study has several strengths. The prospective, population-based cohort design ensured that information about exposures and co-variables were collected prior to, and independently, of the outcome, which prevents differential misclassification. By linking national health registers and administrative outcomes data to self-reported baseline survey data via personal identification numbers, we insured person-level complete data linkage of healthcare contacts and costs in both the primary and the secondary healthcare sector over a ten-year follow-up period. The validity and completeness of Danish national healthcare register data for number of contacts is considered high [32, 34, 57].

Table 3 Associations between number of pain sites/health anxiety and number of healthcare contacts for any reason (All-contacts), healthcare-related costs (All-costs) and number of musculoskeletal healthcare (MSK-contacts)

***N* = 4883**	**All health care seeking**		**Musculoskeletal health care seeking**
Variable	**Number of contacts (All-contacts) Adjusted IRR (95% CI)**	**Costs (All-costs) Adjusted IRR (95% CI)**	**Number of contacts (MSK-contacts) Adjusted IRR (95% CI)**
Number of pain sites at baseline with pain intensity> 2/7 (0–7) (a)	1.04 (1.03–1.05)	1.06 (1.03–1.08)	1.11 (1.09–1.14)
Health anxiety (a)			
- Low score	Ref-	Ref-	Ref-
- High score	1.06 (1.01–1.11)	1.09 (0.99–1.20)	1.02 (0.92–1.12)

Detailed description and footnotes

a: Adjusted for: Sex, age, duration of pain, level of education, comorbidity, personality traits (extraversion, agreeableness, conscientiousness, neuroticism and openness), risk of depression, marital status, physical job exposure and previous healthcare utilization

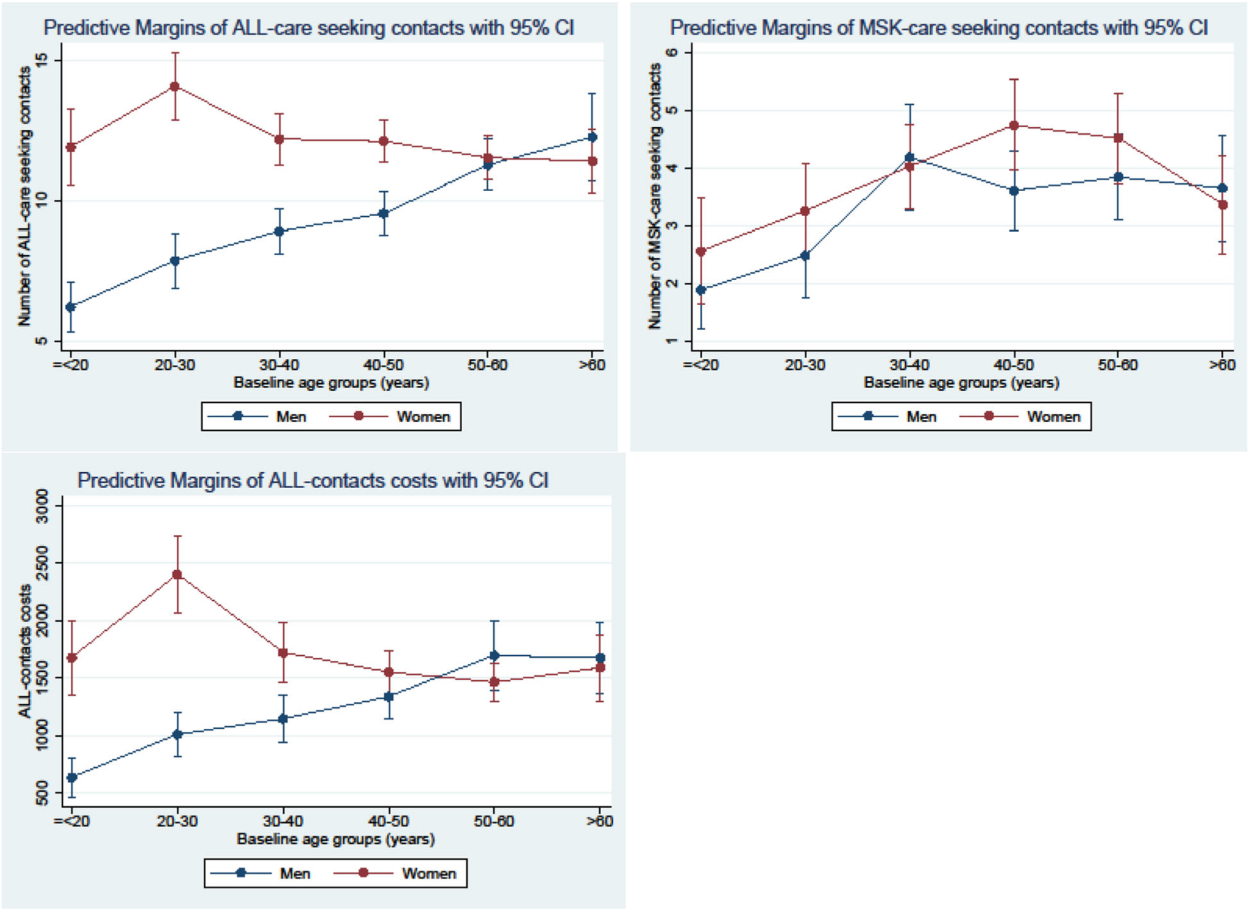

Fig. 1 Predictive margins of All-care-seeking, MSK-care-seeking and All-contacts costs for baseline age-groups for men and women

However, some limitations should be noted. As the NHSR database does not contain information on diagnostic coding, MSK-contacts in primary health were based on information about professional groups e.g. physiotherapists, chiropractors and orthopedic surgeons, where their scope of practice indicates that any consultations likely relate to musculoskeletal complaints. For GP contacts, we developed an algorithm to identify MSK-specific contacts (Appendix B (Additional file 2)). This approach may have led to some misclassification but similar approaches have been applied and validated using NHSR data for linking patients and general practices with promising results [58]. Based on self-reported data, about 78% of Danish adults consult their GP each year [59]. Approximately 14% of these consultations are related to musculoskeletal disorders [60, 61]. Our algorithm estimated 18% (95% CI 18–19%) of face-to-face GP consultations to be MSK-related, which is slightly higher than those previous studies but still credible. Another limitation with the NHSR database is that approximately 15% of chiropractors and physiotherapist consultations in primary care are payed either fully out-of-pocket by patients or insurance without any public reimbursement and hence not reported to the NHRS [62]. These consultations could therefore not be accounted for in our investigation. Furthermore, all secondary MSK healthcare contacts were based on ICD-10 diagnostic codes in the NPS database and the positive predictive values of diagnostic coding may vary. Nonetheless, the validity and completeness of the NPR database are considered to be relatively high [34]. The recoding of the baseline question about duration of pain may have led to some misclassification but sensitivity analysis indicates that this approach had no influence on the main results.

Exposure variables were only measured at baseline. However, previous research has shown that pain sites and prevalence are relatively stable phenomena [63]. Kamaleri et al. found that number of pain sites change relatively little over a 14-year follow-up period [64] and Paananen et al. found that 75% of boys and 88% of girls with widespread pain at age 16 subsequently reported a similar pain pattern at age 18 [65]. In both studies, only a few percent of participants with baseline pain reported no pain at follow-up. Likewise, health related concerns, such as health anxiety, are also considered a persistent trait despite reassurance [66, 67]. However, data quality would have been increased had we had repeated measures over time of pain sites.

We dichotomized the Whiteley-7 Index, while others have analyzed this scale as a categorical or continuous variable. The choice to dichotomize was guided by recommendations for clinical use [25, 27] and therefore the findings may be more relevant to clinical practice. Similarly, risk of depression and physical work exposure were dichotomized based on recommendations and former use of these scales, and comorbidity index were generated based on secondary health care data only, introducing a risk of residual confounding. Lastly, only 4883 (57%) of eligible participants responded to the baseline questionnaire, and while a description of non-participants has been published elsewhere [19], additional data on non-participants were not available. While such modest participation rates are not uncommon in large population studies, we cannot rule out the potential for some unquantified selection bias. However, simulation studies have shown that modest participation rates do not necessarily affect estimated associations between variables [68].

Results in light of theory and research literature

Only about one third of people with musculoskeletal pain seek care because of their pain [13] and the decision to seek care is influenced by a range of factors [9, 14, 21]. We chose to build our causal model with a primary focus on number of pain sites and explored the influence of health anxiety. Both factors have been identified as prognostic factors for care-seeking but, to our knowledge, no previous study has tested causal hypotheses about the consequences of these factors on healthcare-seeking and related costs.

Co-occurrence of musculoskeletal pain in different body regions are common [5, 7] and people reporting musculoskeletal pain also report comorbidities, and other symptoms than pain, more frequently than people without pain [6, 69, 70]. This suggests that musculoskeletal pain may be an indicator of poor general health and hence increased general healthcare utilization. Still, our findings show that pain in more body sites leads to a higher increase in long term musculoskeletal healthcare-seeking than general healthcare-seeking suggesting that general healthcare-seeking is different and potentially has different drivers. Relatively few in this sample had any comorbid diagnosis (95% of the sample have no comorbidity at baseline). Comorbidity was measured with Charlson comorbidity index on NPS data. Even though such approach is considered valid [42] it is likely an underestimation of comorbidity compared to self-reported comorbidity as we applied the Charlson comorbidity index algorithm on NPS data searching for only hospital verified ICD-10 diagnostic codes given in a period of no more than 2 years.

A priori we had anticipated that contacts and costs might show different results, as some contacts have significantly higher costs (e.g. in-patient hospital contacts or surgery), but number of pain sites show quite similar associations between All-contacts and All-costs. This is understandable given the high correlation (0.85) between these outcomes and indicate that general healthcare utilization is similarly estimated by either method.

Previous studies have found that health reassurance-seeking is prevalent among individuals with high levels of health anxiety and they tend to make stronger requests to healthcare professionals for expensive diagnostic tests and unnecessary treatments [71]. We found no interaction between number of pain sites and health anxiety on any of the outcomes, and the correlation between health anxiety and number of pain sites in this study was low which indicates that health anxiety and number of pain sites appear to act independently.

In designing this study, we took the position that increasing number of pain sites leads to more healthcare-seeking and costs and that this mechanism works through pathways of factors, such as catastrophizing, fear avoidance beliefs and health-related quality of life. This position aligns with behavioral models, e.g. the ‘fear avoidance model’ [72] or ‘the common sense model’ [73]. Adjustment in this study was based on ‘minimum set of confounders’ to estimate the total effect of each exposure on each outcome. Our variable selection and adjustment were informed by literature, theory and discussions between the authors and our hypothetical causal models were illustrated in directed acyclic graphs (Appendix C (see Additional file 3)). This approach was guided by the recommendations from 47 journal editors for control of confounding and reporting of results in causal inference studies [52].

Care-seeking and healthcare costs

In most Western countries, care-seeking has gained increasing attention as the prevalence of pain and healthcare-related costs has increased during the past two decades [74, 75]. One possibility is that the increase in care-seeking is the result of healthcare overuse (defined as “the provision of medical services that are more likely to cause harm than good” [74]). Examples of overuse are unnecessary tests with the detection of unimportant findings or redefining boundaries for disease that result in more healthcare treatment with little or no net benefit [75].

The purpose of this study was not to analyse if increased healthcare use with increased pain sites is helpful, or a result of healthcare overuse or if it is guideline-adherent and evidence based. However, such topics are important for future projects. Instead these results provide insight into the relationship between number of musculoskeletal pain sites, health anxiety and healthcare utilization and highlights factors that may contribute to non-guideline adherent clinical pathways.

Conclusion

Our findings show that increasing number of pain sites is associated with higher number of general healthcare contacts, higher healthcare-related costs and higher number of musculoskeletal healthcare contacts over a subsequent ten-year period. We found a weak association between health anxiety and higher number of general healthcare contacts and no evidence that level of health anxiety influences the effect of number of pain sites on healthcare utilization outcomes. In this context, our results add knowledge about drivers of care-seeking and may assist healthcare professionals in formulating patient communication and clinical decision-making in order to optimize healthcare utilization. This study is also a step towards better understanding of a population of patients that might not benefit from current clinical pathways and the organization of healthcare systems in most Western countries. The comorbid nature of pain characterized by multiple pain sites calls for comprehensive collaboration across disciplines which can be a challenge within the silo-organization of most healthcare systems and healthcare sectors. In order better embrace this population of patients in the healthcare system and avoid healthcare overuse, we need more knowledge about the healthcare pain management trajectories across sectors and disciplines. Such knowledge could potentially highlight management gaps or specific patient groups in high risk of non-guideline-adherent clinical pathways. Another important knowledge gap for future research projects of health care service use is the perspective of the health care user. Such knowledge could also guide healthcare providers in their communication with people with multi-site pain in order optimize patient-centered healthcare pain management.

Abbreviations

GP: General Practitioners; NHSR: The National Health Insurance Service Register; NPR: The National Patient Register; DRG: The Diagnoses Related Group Grouped National Patient Register; Rehab Register: The Rehabilitation According to "The Danish Act of Health §140" register; CMDQ: International Classification of Diseases and Related Health Problems version 10 - ICD10. Common Mental Disorder Questionnaire; SEQ: the Standard Evaluation Questionnaire; IPIP: The Mini International Personality Item Pool; D-ISCO 88: International Standard Classification of Occupations; JEM: Lower Body Job Exposure Matrix; DREAM-register: Danish Register-based Evaluation of Marginalized Individuals; MSK-contacts: Musculoskeletal healthcare contacts; All-contacts: Healthcare contacts for any reason; Cost: Costs related to all healthcare contacts; DAGs: Directed Acyclic Graphs; GEE: Generalized Estimating Equations; IRR: Incidence rate ratios

Supplementary Information

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Additional file 1.
Additional file 2.
Additional file 3.

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Authors' contributions

All authors contributed to the formation of the research question and review of the manuscript. JHA DHC, PK and SM planed, designed and founded the project. PK, AS and SM planned the statistical analysis for this publication. SM performed the statistical analyses and drafted the manuscript. All authors contributed to and approved the final manuscript.

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Availability of data and materials

Data from Danish National Registers are available from the Danish National Health and Medicines Authority for researchers who meet the criteria for getting access to micro data. According to Danish regulations, researchers who are interested can only apply for access through an affiliation to a Danish authorized research environment and apply for data access directly at Statistics Denmark (https://www.dst.dk/en/TilSalg/Forskningsservice) and The Danish Data Protection Agency (https://www.datatilsynet.dk/english). Interested researchers may contact the corresponding author of this article for further guidance on this procedure.

Declarations

Ethics approval and consent to participate

This project was approved by the Danish Data Protection Agency (project number 1–16–02-141-18). All participants signed informed consent at baseline. Baseline and register data were handled according to Danish law. According to Danish law, this type of study does not require approval by committees on biomedical research ethics [76].

Consent for publication

Not applicable.

Competing interests

None of the authors have any competing interests.

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Publisher's Note

Appendix A1

Additional files for paper 1

Appendix A: Data management plan for deriving healthcare contacts and healthcare-related costs from The National Patient Register (NPR), The National Health Insurance Service Register (HISR), The Rehabilitation According to "The Danish Act of Health §140" register (Rehab-register) and The Diagnoses Related Group (DRG) Grouped National Patient Register.

DATAMANAGEMENT - Health registers			
Registre	**Definitions**	**Annual number of contacts (2006 – 2017) for each participant based on counts of:**	**Annual health care costs (2006 – 2017) for each participant based on:**
The National Patient Register (NPR)	Contacts will be defined as a registered date with a health care encounter (out-patient visits (e.g. test, surgery, treatment), inpatient or emergency department visits). Each course may have several contacts but only one contact each day will be considered (e.g. examination, imaging and surgery on the same day, will be considered as one contact). Inpatient encounters will be considered as one contact per day.	**Primary (A) and secondary (B) diagnosis.** **1. Number of All face-to-face contacts:** All contacts registered with any ICD10 code **2. Number of Musculoskeletal face-to-face contacts**: M (Chapter XIII - Diseases of the musculoskeletal system and connective tissue) - All codes. G (Chapter VI Diseases of the nervous system) - Following codes: G43 (migraine), G44 (headache), G546+547 (phantom pain), G500A+501 (facial pain), G55 + G56 + G57 (nerve compression from discus/stenosis or in UE/LE) R (Chapter XVIII - Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) - Following codes: R52 (nonspecific pain syndrome), R51 (Headache) S (Chapter XIX - Injury, poisoning and certain other consequences of external causes) - Following codes: S12+13+16 (neck), S22+23 (Thorax), S32+33 (Low back/pelvis), S42+43+46 (Shoulder/Upper arm), S52+53+56(elbow/lower arm), S62+63+66(Hand) S72+73+76(Hip/thigh), S82+83+86(Knee/crus), S92+93+96(Ankle/foot), T02+03+06(Multiple) K (Chapter XI - Diseases of the digestive system) - Following code: K076A (mandibular joint pain)	No cost data in NPR.

The National Health Insurance Service Register (HISR)	Contacts will be defined as a health-related or medical service face-to-face encounter. E-mail and telephone contacts will not be considered. NISR service codes chosen to represent face-to-face health care contacts are based on agreements between The Danish health Authority and relevant professional organizations (see www.okportalen.dk).	**1. Number of all primary health care face-to-face contacts:** Anesthesiology (Spec. 01), Diagnostic radiology (Spec 03 + 05), Dermatology (Spec 04), Rheumatology (Spec 06), Gynecologist (Spec 07), Internal medicine (Spec 08), Surgery (Spec 09), Neuro-medicine (Spec 18), Ophthalmologist (Spec 19) Orthopedic surgery (Spec 20), Otolaryngology (Spec 21), Plastic surgery (Spec 23), Psychiatry (Spec 24 + 26), Dentist and Dental hygienist (Spec 49 + 50), Physiotherapist (Spec 51, 57, 62 and 65), Chiropodist (Spec 54 + 55 + 59 + 60), Chiropractor (Spec 53 and spec 64), Psychologist (Spec 63), General practitioner - all face-to-face contacts (Spec 80 and spec 81 + 82 + 83 +85 + 86 + 87 + 88 + 89 (out-of-hour medical service)). **2. Number of musculoskeletal face-to-face contacts:** Anesthesiology (Spec. 01) (encounters regarding pain management), Diagnostic radiology (Spec 03 + 05) (encounters regarding musculoskeletal diagnosis), Rheumatology (Spec 06) (all encounters), Orthopedic surgery (Spec 20) (all encounters), Physiotherapist (Spec 51) (musculoskeletal encounters), Chiropractor (Spec 53 and spec 64 (special clinical pathways for lumbar disc herniation, cervical disc herniation and lumbar spinal stenosis)), General practitioner (Spec 80) (musculoskeletal encounters based on algorithm (Appendix B).	Primary health care costs will be based on public subsidy for each service. Out of pocket charges for different health care services will not be considered.

The Rehabilitation According to "The Danish Act of Health §140" register (Rehab-register)	Contacts will be defined as a face-to-face encounter. Each course may have several contacts but only one contact each day will be considered.	**1 Number of all primary health care face-to-face contacts:** All visits at a municipality rehabilitation unit **2. Number of musculoskeletal face-to-face contacts:** Number of contacts in a clinical course at a municipality rehabilitation unit beginning no later than 2 months after a hospital discharge registered with a musculoskeletal ICD-10 diagnostic code (see NPR: A and B diagnostic codes (ICD-10) considered to be musculoskeletal contacts).	Calculated expense per hour based on staff salaries and other operating costs for all municipality rehabilitation settings.
The Diagnoses Related Group (DRG) Grouped National Patient Register	Costs related to in- and outpatient contacts and emergency department visits in the NPR will be summoned per year based on diagnosis-related group (DRG) tariffs for all NPR activity. DRG-grouped NPR data itemizes payment instances and rates in the Danish health care system. Estimated grouped rates for each hospital service are based on the average costs for all hospitals in Denmark.	No contact data derived from DRG.	All secondary health care costs summoned for each follow up year.

Appendix B: Algorithm to identify MSK-contacts at General practitioners at The National Health Insurance Service Register

To identify the number of face-to-face musculoskeletal health care contacts at General Practitioners (GP), the unique civil registration number (CPR number) (Mainz, Hess, & Johnsen, 2019; Pedersen, 2011; Schmidt, Pedersen, & Sorensen, 2014) assigned to all residents of Denmark was used to link individuals data from the medical records to register data from the National Health Insurance Service Register (HISR) (Andersen, Olivarius Nde, & Krasnik, 2011), the National Patient Register (NPS) (Lynge, Sandegaard, & Rebolj, 2011; Schmidt et al., 2015) and the Register of Medicinal Product Statistics (Johansen, Stenzhorn, Rosenzweig, Thirstrup, & Gazerani, 2013). The medicinal products register includes information about type of medication, price and prescriber of medicines sold on prescription and over-the-counter, as well as medication used by hospitalized patients. Information about sales of medicinal products in Denmark has been recorded since 1994 (Johansen et al., 2013; The Danish Health Data, 2016; Thygesen, Daasnes, Thaulow, & Bronnum-Hansen, 2011).

To determine if a face-to-face GP contact in the National Health Insurance Service Register was related to a musculoskeletal disorder a simple algorithm was developed. The algorithm built on available information from the National Health Insurance Service Register about each face-to-face GP contact, as well as information about subsequent health care activities from the National Health Insurance Service Register, the National Patient Register and the Register of Medicinal Product Statistics. Each face-to-face GP contact was evaluated in two steps. First, all activity codes for each face-to-face GP contact were evaluated. Those activity codes are supplementary administrative codes registered by GP at each face-to-face contact. According to the agreement between The Danish GP organization and the Danish Health Authority, activity codes initiate GP remuneration for services or activities taken at each contact. Such services could be specific diagnostic tests, laboratory tests such as B-hemoglobin (activity code 7108), C-reactive protein (CRP) (activity code 7120), strep-A test (activity code 7109), spirometry/peak flow (activity codes 7113, 7121, 7183) urinary stick (activity code 7101) or blood tests (activity codes 2601 and 2101). Face-to-face GP contacts were considered musculoskeletal contacts if they included activity codes 2109 (immobilizing bandages), 2111 (small fractures or relocations of small joints), 2119 (draining of liquid from joints), 2122 (first treatment – large fractures), 2123 (relocations of larger joints). In the second step, a face-to-face GP contact followed by primary care physiotherapy or chiropractor care seeking (within two months), collection of prescribed pain medication (within one month) or secondary health care seeking due to musculoskeletal disorders (within two months) were considered musculoskeletal contacts. All analyses were preformed using STATA 15.1 (StataCorp, College Station, Tx, USA).

Algorithm to identify face-to-face GP (spec. 80) contacts (0101) from The National Health Service Register related to a musculoskeletal disorder		
Original HISR-data	Step 1. Exclusion of GP contacts registered with non-musculoskeletal service or activity codes	Step 2. Exclusion of GP contacts <u>not</u> followed by:
All face-to-face General Practitioners (GP) contacts (0101) from The National Health Insurance Service	1. § 75 laboratory tests (7000 codes) 2. § 70 supplementary service codes (2000 codes) (except musculoskeletal codes: 2109,2111,2119,2122,2123) 3. Vaccine, child- and pregnancy examination codes (8000 codes)	1. Physiotherapy contact (Primary care) within the following two months (HISR-data) 2. Collection or prescribed pain medication within the following month (RMPS-data) 3. In- or out-patient hospital contact for an MSK disorder within the following two months (NPS-data)

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Appendix C: Directed Acyclic Graphs

The purpose of this study is to test causal association. This demands carefully considerations regarding the choice of variables and the hypothesized structure between those variables and pathways(Lederer et al., 2019). Directed acyclic graphs (DAGs) offer a systematic graphical representations of such causal relationships and hypothesized covariate structure (Textor, van der Zander, Gilthorpe, Liśkiewicz, & Ellison, 2016). In this study, each research question has its own theoretical framework based on previous literature, theoretical considerations about the potential target trial and discussions between author team. Choice of co-variables for statistical adjustment for each research question has been guided by the principle of minimal sufficient adjustment sets of co-variables for estimating the total effect (Knüppel & Stang, 2010; Textor et al., 2016). In this approach, we only attempt to adjust for open 'backdoor' paths in the association between exposures and outcomes.

Number of pain sites

Closed backdoor paths

We hypothesized that the causal relationship between number of pain sites and health care utilization is mediated through factors like health-related quality of life, depressive symptoms, fear avoidance beliefs, catastrophizing (unmeasured variable) and activity evoked pain. This creates closed backdoor paths without a need for adjustment.

Open backdoor paths

We consider duration of pain/chronic pain to be bidirectionally associated with number of pain sites and associated with health care use (Fayaz, Croft, Langford, Donaldson, & Jones, 2016; IsHak et al., 2018). In building this causal model, we took the position that duration of pain creates an open backdoor pathway in the association between number of pain sites and health care utilization with need for adjustment.

We consider comorbidity to be associated with number of pain sites in a bidirectional relationship and comorbidity is in itself a driver for health care seeking (Fayaz, Ayis, Panesar, Langford, & Donaldson, 2016). Sex and age are non-modifiable factors. None of these factors are considered the cause of pain, still, both are associated with number of pain sites, as women and older people report chronic and widespread pain more often than men/younger people (Fayaz, Croft, et al., 2016). Furthermore, women and older people seek health care more often than men/younger people (Ferreira et al., 2010). Higher level of education is not a cause of pain but higher level of education is associated with better general health and seems to protect against development of pain and people with higher education seek health care less often. This relationship could work through factors like health literacy and self-efficacy (unmeasured variables), job satisfaction etc. Personality traits and health anxiety may influence the development of pain and coping strategies. This relationship might work through pathways like harm avoidance, being fearful, being pessimistic, high dependence on reassurance, low level of motivation and meaningful personal goal setting (Naylor, Boag, & Gustin, 2017). Especially the personality trait neuroticism has been suggested as an important factor in development of pain and ability to cope with it (Naylor et al., 2017). Physical work exposures are associated with musculoskeletal pain. High level of work exposure might influence the development of pain and pain-related disability. We consider comorbidity, sex, age, level of education, personality traits, health anxiety and physical work exposure to be confounders of the relationship between number of pain sites and care seeking, and therefore adjustment is needed.

Other variables

High pain intensity is associated with higher health care utilization. In this study we wanted to analyse the consequences of number of pain sites with non-trivial pain on health care utilization. Therefore, we chose to incorporate data on pain intensity in the `number of pain sites´ variable. Factors like cause of pain, leisure time physical activity, type of pain (pain mechanism), musculoskeletal diagnosis could potentially be confounders in this study, but these data were not available.

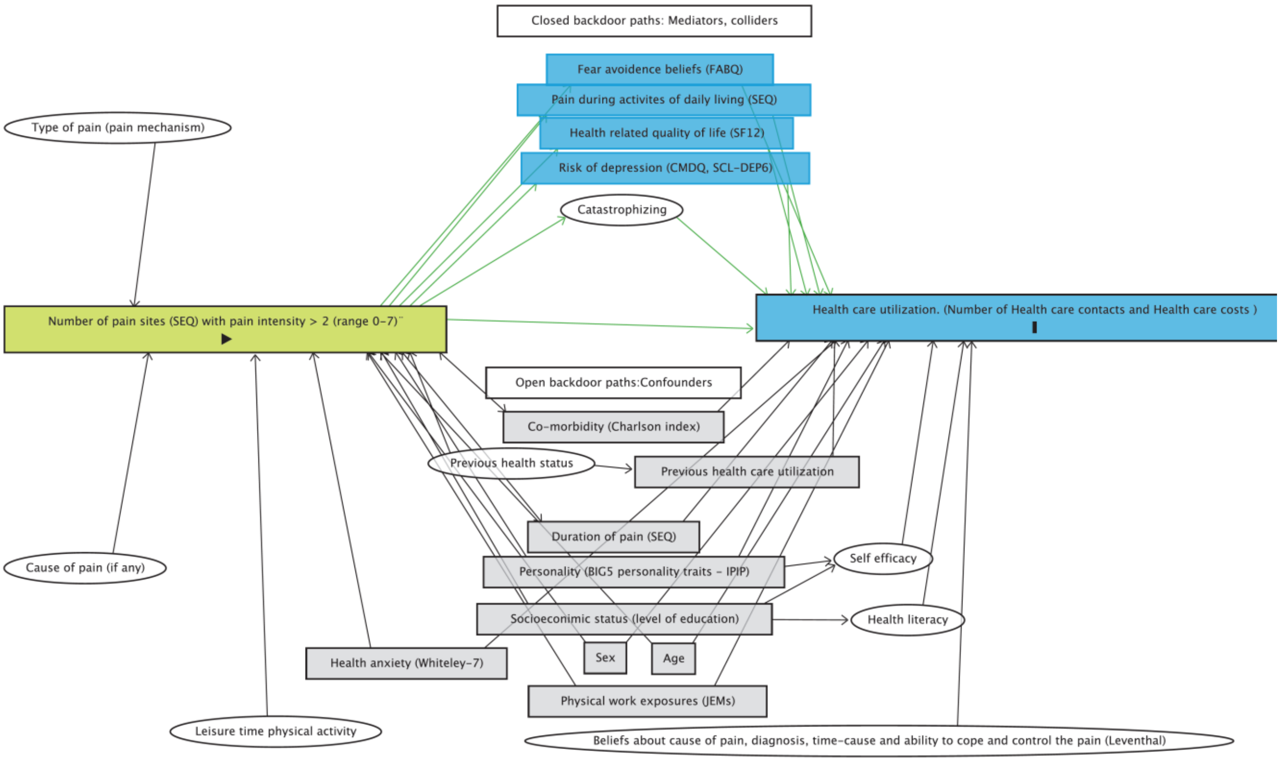

Figure 1. Hypothesized causal relationships between number of pain-sites and health care contacts/costs illustrated via Directed Acyclic Graphs (www.dagitty.net)

☐ Headline for groups of covariables. ▶ exposure. ▮ outcome. 🟦 mediator/collider. ▨ adjusted variable/confounders.

○ unmeasured variable. 🟩 causal/closed backdoor paths. ▬ confounding/open backdoor paths.

Arrows indicate hypothezied direction of relationships. Relationships between covariables in the DAG is not illustrated.

Health anxiety

Closed backdoor paths

We hypnotized that the causal relationship between health anxiety and health care utilization is mediated through factors like health-related quality of life, depressive symptoms/mental health, fear avoidance beliefs, catastrophizing (unmeasured variable), engagement in preventive strategies (unmeasured variable), information seeking/reassurance (unmeasured variable) and pain characteristics (number of pain sites, duration of pain, beliefs about pain). These factors interrelate in complex bidirectional relationships (not illustrated). This creates closed backdoor paths without need for adjustment.

Open backdoor paths

We consider comorbidity to be associated with health anxiety in a bidirectional relationship and comorbidity is in itself a driver for health care seeking (Fayaz, Ayis, et al., 2016). Sex and age are non-modifiable factors. Neither are considered the cause of health anxiety but we consider both factors to be associated with health anxiety, and women and older people seek health care more often than men/younger people. People with higher level of education seek health care less often. This relationship could work through factors like health literacy and self-efficacy (unmeasured variables), job satisfaction etc. We consider lower levels of education to be associated with higher level of health anxiety and higher levels of care seeing. Personality traits may influence the development health anxiety and coping strategies, including care seeking. This relationship might work through pathways such as a tendency to be fearful, pessimistic or high dependency of reassurance, because individuals with health anxiety are likely to exaggerate negative information or attend to information that supports their health concerns (Eastin & Guinsler, 2006). We consider health anxiety to be more prevalent among individuals with low level of social support and low level of social support to be associated with care seeking. This means that comorbidity, sex, age, level of education, personality traits and social support create open backdoor pathways in the relationship between health anxiety and care seeking and adjustment is needed.

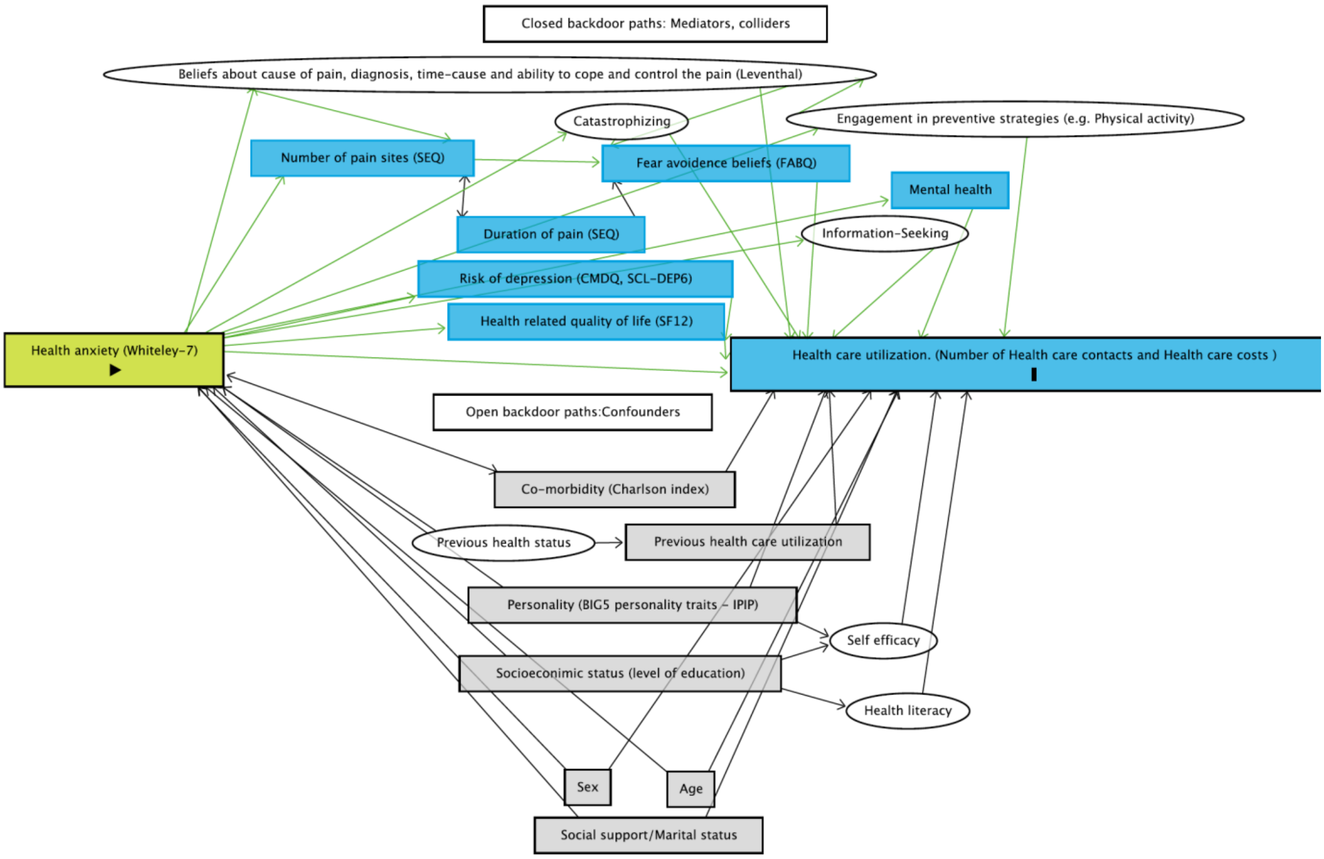

Figure 2. Hypothesized causal relationships between health anxiety and health care contacts/costs illustrated via Directed Acyclic Graphs (www.dagitty.net)

☐ Headline for groups of covariables. ▶ exposure. ▮ outcome. 🟦 mediator/collider. ☐ adjusted variable/confounders.
○ unmeasured variable. 🟩 causal/closed backdoor paths. ■ confounding/open backdoor paths.

Arrows indicate hypothesized direction of relationships. Relationships between covariables in the DAG is not illustrated.

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Appendix B

PAPER 2

Trajectories of Musculoskeletal Healthcare Utilization of People with Chronic Musculoskeletal Pain – A Population-Based Cohort Study. S. Mose, P. Kent, A. Smith, J. H. Andersen, D. H. Christiansen. Clinical Epidemiology 2021:13 825–843. https://doi.org/10.2147/CLEP.S323903

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ORIGINAL RESEARCH

Trajectories of Musculoskeletal Healthcare Utilization of People with Chronic Musculoskeletal Pain – A Population-Based Cohort Study

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Background and Aim: Chronic musculoskeletal pain is common and associated with more general healthcare-seeking. However, musculoskeletal-related healthcare utilization is underexplored. This study aimed to explore, describe and profile trajectories of long-term musculoskeletal healthcare for people reporting chronic musculoskeletal pain.

Methods: This exploratory prognostic cohort study combined survey and national health register data from a representative group of adult Danes reporting chronic musculoskeletal pain (N = 2929). Trajectories of long-term musculoskeletal healthcare use were generated using latent class growth analysis. Types of healthcare-seeking, individual, sociodemographic, health, belief and work-related factors were used to describe and profile identified trajectories.

Results: We identified five distinct trajectories of long-term musculoskeletal healthcare utilization (low stable, low ascending, low descending, medium stable and high stable). The low stable trajectory group (no or almost no annual contacts) represented 39% of the sample, whereas the high stable trajectory group (consistent high number of annual contacts) represented 8%. Most healthcare-seeking was in primary healthcare settings (GP/physiotherapy/chiropractor). Opioid consumption was primarily in the high stable trajectory group, and surgery was rare. There were statistically significant differences across the five trajectory groups in individual, sociodemographic, health, belief and work-related profiles.

Conclusion: Long-term use of musculoskeletal healthcare services varied in this chronic musculoskeletal pain population. Almost 40% coped without seeking care, whereas 8% had consistent high use of healthcare services. Chronic musculoskeletal pain was mostly managed in primary care settings, which aligns with musculoskeletal guidelines, as did the use of pain medication and surgery. People with different musculoskeletal healthcare trajectories had different individual, sociodemographic, health, belief and work-related profiles.

Keywords: musculoskeletal, chronic musculoskeletal pain, healthcare utilization, latent class growth analysis, healthcare registers

Introduction

Chronic pain is common with a prevalence of 20–40% across diverse populations around the world[1,2] and is associated with increased medical costs and considerable economic burden for individuals and society.[2,3] People reporting chronic pain have the largest morbidity (when measured as years lived with disability) and chronic pain negatively impacts physical function and quality of life.[2,4] Chronic pain is generally defined as pain lasting >3 months or as pain persisting beyond the time of expected healing[5] and among people reporting chronic pain, musculoskeletal pain is the most prevalent reported condition.[2]

Video Abstract

Point your SmartPhone at the code above. If you have a QR code reader the video abstract will appear. Or use:
https://youtu.be/o24sO5gidU4

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Chronic pain is associated with higher use of healthcare services,[6–10] even though only a proportion (16–46%) of people with chronic pain seek healthcare.[11,12] Those who seek healthcare due to pain seem to have varying pathways and consult diverse healthcare professionals in different healthcare sectors (eg, General Practitioners (GP), Chiropractors, Physiotherapists, Orthopaedic surgeons, Rheumatologists, Pain specialists) and may receive very different treatment modalities (eg, medication, rest, manual therapy, exercise, cognitive-based approaches, surgery).[7] People with chronic musculoskeletal pain who seek care often have healthcare-seeking pathways that do not align with musculoskeletal pain management guidelines.[13,14] Such pathways are often characterized by multiple referrals and examinations, and often lead to referrals or consultations with surgeons rather than to pain specialists or pain rehabilitation units.[14] However, types of musculoskeletal healthcare utilization for people with chronic musculoskeletal pain have not yet been thoroughly described.

Several factors are associated with high levels of healthcare utilization due to pain.[7,15] These include older age,[7,15,16] low socioeconomic status,[7,16] marital status (people never married seek healthcare less often than those married)[17] and being female,[7,15,18] high pain intensity,[18–20] high level of disability,[18,19,21] number of pain sites,[21] comorbidity,[16] body mass index (BMI), poor general health,[15,16,22] negative health beliefs (health anxiety, catastrophizing, fear avoidance),[15,22,23] being retired or unemployed,[8] and previous healthcare use.[22,24] Personality has also been suggested as an important factor in the development of pain and coping strategies – including healthcare-seeking.[25] However, these findings are inconsistent and contradictory across studies,[7,21,23,26] and few studies have explored factors associated with musculoskeletal healthcare utilization.

More knowledge about long-term trajectories of musculoskeletal healthcare utilization for people with chronic musculoskeletal pain could help to identify those at risk of non-guideline adherent pathways and help to design alternative clinical pathways in order to improve prognosis, quality of life and optimize the use of healthcare resources.

Therefore, the aims of this study were to 1) explore trajectories of musculoskeletal healthcare utilization in people with chronic musculoskeletal pain, 2) describe the types and use of musculoskeletal healthcare services (eg, primary/secondary healthcare, medication, rehabilitation) within such trajectories, and 3) profile any identified trajectories on individual, sociodemographic, health, belief and work-related factors.

Materials and Methods

Design

This is an exploratory prognostic cohort study[27] with ten-years of register-based follow-up data from adults reporting chronic musculoskeletal pain.

Population

We included individuals from a population-based cohort who reported musculoskeletal pain for more than three months in any body region when the cohort was originally established in 2008. This cohort has been described in detail elsewhere.[28–30] A baseline questionnaire was sent to 8517 people between 17 and 64 years of age of whom 5097 people responded. The baseline questionnaire covered a range of demographics, personal, work-related, psychosocial and health-related domains, including questions about pain. Duration of pain history was measured using the pain module of the Standard Evaluation Questionnaire (SEQ).[31] SEQ is reliable and valid for the assessment of pain in population-based observational studies and the Danish version of the SEQ has acceptable reliability and convergent construct validity has been confirmed.[31,32] We used the International Association for the Study of Pain (IASP) definition of chronic pain >3 months as it is a foundational criterion for the ICD-11 diagnosis of chronic pain.[33] This definition has been widely used to define chronic pain populations in epidemiological studies across clinical diagnoses.[34]

Of the 5097 individuals (59.7%) returning the baseline questionnaire in 2008, 4871 (57.2%) were identifiable, alive, and living in Denmark during the follow-up period. We excluded 1816 individuals without chronic musculoskeletal pain at baseline and 126 with ambiguous answers about pain duration, leaving 2929 individuals with chronic musculoskeletal pain suitable for analysis (see Figure 1).

Healthcare Contacts

In order to generate trajectories of musculoskeletal healthcare utilization, we counted the annual number of face-to-face healthcare contacts for musculoskeletal conditions and the redeemed pain medication prescriptions for the entire cohort from 2008 to 2017 in Danish healthcare registers.[35,36] In Denmark, nearly all healthcare is fully or partly funded by the state and therefore recorded at an

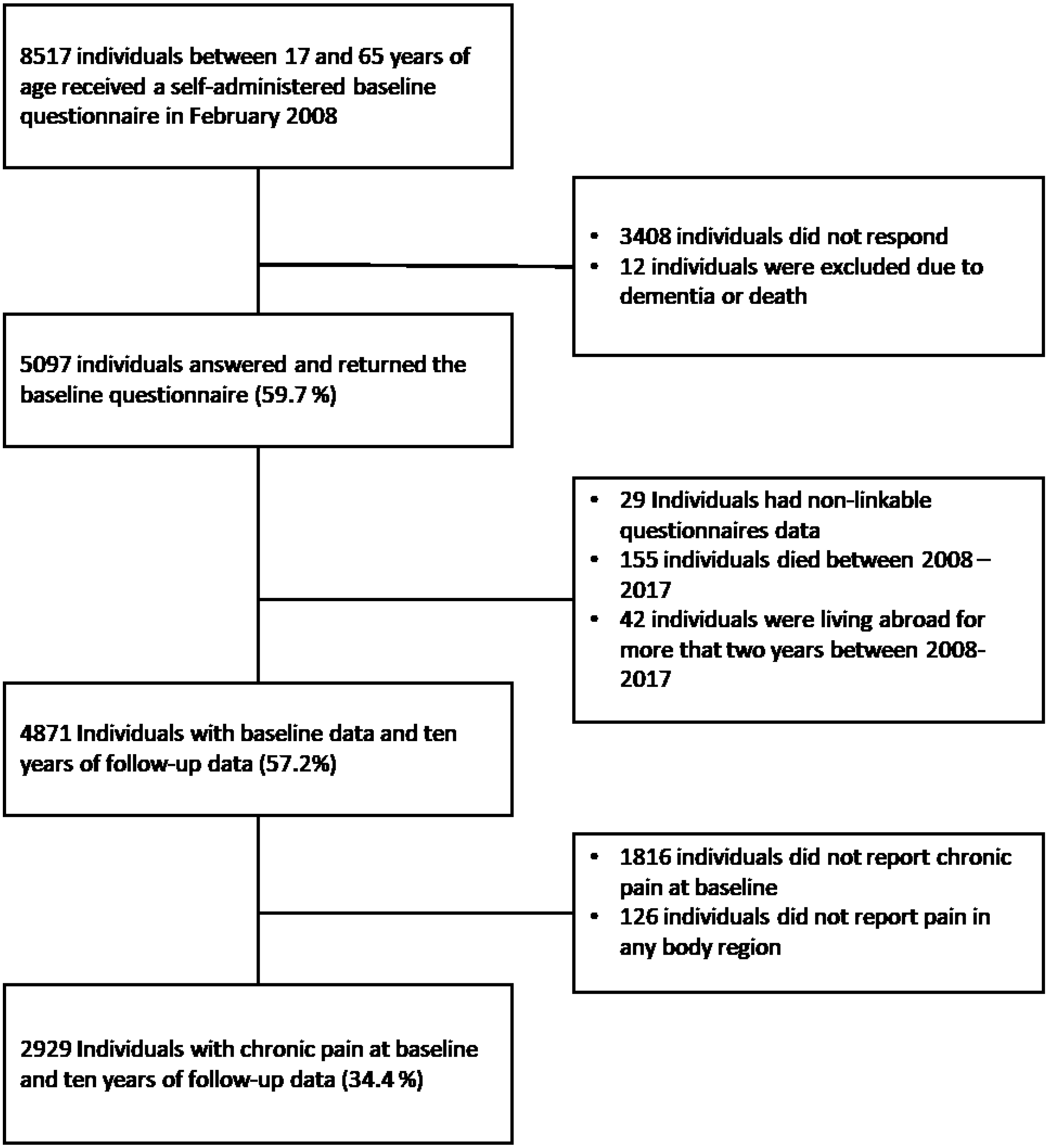


Figure 1 Flowchart.

individual person level across a number of registers by the national authorities. This Nordic tradition of record keeping results in extensive networks of inter-linkable longitudinal population-based registries suitable for epidemiological research. Using the unique Danish Civil Personal Register number assigned to all Danish residents, it is possible to link register data to other sources of data (like research questionnaires) at the individual person level.[35] Data on musculoskeletal healthcare utilization was obtained from the National Patient Register, the National Health Insurance Service Register, the Register of Medicinal Product Statistics and the Rehabilitation According to "The Danish Act of Health §140" register (Rehab-register).

The National Patient Register is the central register for recording activity in the Danish secondary healthcare system. The National Patient Register contains information on hospital admissions since 1978 and all outpatient hospital contacts since 1994. Registration in the National Patient Register is based on the Healthcare Classification System,[37] and diagnostic criteria are the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) diagnostic codes. In general, data from the National Patient Register are considered valid, but the positive predictive values of diagnostic codes can vary for different diseases and types of treatment.[38]

The National Health Insurance Service Register was established in 1990 and contains information on all fully or partly public founded primary healthcare services based on the week of reimbursement.[39,40] A minor proportion of primary healthcare physiotherapy and chiropractic consultations are fully self-funded, hence not recorded in the National Health Insurance Service Register. This proportion of physiotherapy and chiropractor healthcare has been estimated to about 15% by the Danish Physiotherapist Association.[41]

The Register of Medicinal Product Statistics includes information about prescription medicinal products sold over-the-counter, as well as medication used for hospitalized patients. Information about sales of medicinal products in Denmark has been recorded since 1994.[36,42,43]

Rehab-register was established in 2007. According to Danish law, after hospital admission or outpatient encounters, patients can be referred to publicly funded physiotherapy and occupational therapy rehabilitation if medically indicated. The Rehab-register contains information about this type of rehabilitation.

The algorithm for counting annual number of musculoskeletal healthcare contacts is presented in Table 1 and supplementary material - Appendix A.

Descriptive Profiling Variables

For descriptive multidimensional profiling, we use items and domains from the baseline questionnaire and national registers. As some variables may have different prognostic influence over time, we allowed for both baseline and longitudinal profiling variables. Variables measured at

Table 1 Algorithm for Counting Annual Number of Musculoskeletal Healthcare Contacts

Annual Number of Musculoskeletal Healthcare Contacts is Generated by	
Register	**Method**
National Patient Register	1)Counts of in- and out-patient hospital contacts and emergency department contacts registered with a primary or secondary musculoskeletal or pain-related ICD-10 diagnostic code. Every inpatient admission day counted as one contact. Please see supplementary material (Appendix A) for detailed description of musculoskeletal and pain related ICD-10 diagnostic codes. Counts of surgery contacts where Classification of Surgical Procedures code indicate musculoskeletal reason for surgery (Chapter ABC, ABD, ACC, N and TN).[44]
National Health Insurance Service Register	2)Counts of face-to-face primary healthcare consultations with physiotherapists, chiropractors and musculoskeletal medical specialists. Excluded in this category was fully publicly reimbursed encounters with physiotherapists for non-musculoskeletal diagnoses.
National Health Insurance Service Register	3)Counts of face-to-face GP contacts where the clinical tests, examination, coding and subsequent healthcare initiatives indicated a musculoskeletal reason for that consultation. For this purpose, a simple algorithm was developed. The algorithm evaluated each face-to-face GP contact in two steps and built on available information from all health registers. For a more detailed description, please see supplementary material (Appendix B). Validation of this algorithm is pending. This algorithm estimated 18% (CI 18–19%) of face-to-face GP consultations to be musculoskeletal related.
Register of Medicinal Product Statistics	4)Counts of prescribed and redeemed medication for pain relief. We searched the Register of Medicinal Product Statistics using the Anatomical Therapeutic Chemical Classification System codes for N01B (Anesthetics, local), N02A + B (Opioids, other analgesics and antipyretics), N03A (Antiepileptic), N05B + C (Anxiolytics and Hypnotics) and M01A (Anti-inflammatory/anti-rheumatic, non-steroids).
Rehab-register	5)Counts of face-to-face municipality musculoskeletal rehabilitation visits indicated by a prior musculoskeletal hospital in- or out-patient contact.

baseline will also be referred to as candidate prognostic factors.[27] The following items were used:

Individual and Sociodemographic Factors

Data on sex and age at baseline was obtained from the Danish Civil Registration System.[35,45,46] Age was analysed as a continuous variable.

Marital status and number of resident children under the age of eighteen were obtained from the Danish Civil Registration System.[46] We combined these data for each follow-up year into the following four nominal categories: 1) Cohabitant with resident child/children, 2) Cohabitant without resident children, 3) Single with resident child/children, and 4) Single without resident children. As marital status might change over time, we extracted the most frequent status for each participant for the follow-up period. The Danish Civil Registration System contains complete information on sex, age and marital status.[46]

Highest achieved level of education was obtained from the Danish Education Register, and the validity and coverage of the Danish education registers have shown to be very high.[47] Classification was based on "The International Standard Classification of Education"[48] and categorized into three ordinal groups: 1) primary and lower secondary education or equivalent, 2) upper secondary education or skilled worker/short cycle tertiary education or equivalent, and 3) bachelor/master/doctoral or equivalent. We extracted the highest level of education for each participant for the entire follow-up period for the analysis.

The Big 5 Personality traits (extraversion, agreeableness, conscientiousness, neuroticism and openness) were derived from the 20-item Mini International Personality Item Pool.[49,50] The Mini International Personality Item Pool is a psychometrically acceptable and practically measure of the Big Five personality traits.[49] Each of these personality traits was measured by four items, with answers for each personality trait being summed to a 0–16 score and analysed as a continuous variable.

Health, Belief and Work-Related Factors

Body Mass Index (BMI) at baseline was calculated based on self-reported height and weight. Participants were categorized into four groups based on standard BMI categories for adults used by the World Health Organization (under/normal weight (<25), pre-obesity (25-<30), obesity class I (30-<35), obesity class II & III (≥35)).

The number of body regions with pain and pain intensity at baseline was measured within the pain module of the Standard Evaluation Questionnaire (SEQ).[31] For these variables, participants were asked to state the intensity of pain on a 1–7 numeric ranking scale (1=no pain/7=worst imaginable pain) in seven different body regions (right/left upper and lower extremity, front and back of thorax and the head) within the last four weeks. For the analysis, we extracted highest reported pain intensity in any region and counted number of body regions with pain. Number of pain sites (range 1–7) and pain intensity (range 1–7) were analyzed as continuous variables.

Physical and mental health were measured by the physical (PCS) and mental (MCS) components of the Short Form 12 version 2 (SF12) questionnaire which is a validated measure of physical and mental health in the general population.[51,52] The PCS and MCS were summed on a 0–100 scale according to the developed guideline algorithms[53] and analysed separately as continuous variables.

Risk of depression, anxiety and health-related anxiety at baseline were measured with parts of the Common Mental Disorder Questionnaire.[54] The Common Mental Disorder Questionnaire is a validated short case-finding questionnaire for mental disorders useable in primary healthcare setting and consists of subscales from the Symptom Checklist-90-R.[54,55] For evaluation of risk of depression, the six-item depression sub-scale (SCL-DEP6) (range 0–24) from the Symptom Checklist-90-R was used and for risk of anxiety we used the four-item anxiety sub-scale (SCL-ANX4) (range 0–16) from the Symptom Checklist-90-R.[54] For health anxiety, we used Whiteley-7 Index (range 0–28).[56] Each of these variables was dichotomized based on clinical interpretation recommendations from the Danish College of General Practitioners (high risk of depression ≥5, high risk of anxiety ≥5, high risk of health anxiety ≥6).[57]

Participation restriction due to pain was measured with two novel questions. Participants were asked to rate how pain had influenced their 1) satisfaction and joy with participation in social and leisure-time activities and 2) their ability to participate in social and leisure-time activities on a 1–7 numeric ranking scale (1=No influence/7=Influenced a lot). The two items were summed (range 2–14), and the variable was dichotomized based on the median of score distribution (high participation restriction ≥4).

Fear avoidance beliefs were measured with four items on physical function from the Fear Avoidance Belief Questionnaire on a five-point Likert scale.[58] In order to ensure that people with symptoms in any body site could answer, we made the following addition: "Physical activity might harm my back or other parts of my body". This phrase has been validated in other studies.[59] Furthermore, we added these questions: "How much do you agree with the following statement: It is important to seek medical care when you have pain" and "If you negate pain, you could be permanently damaged". These six items were summed (range 0–24) and analysed as a continuous variable.

Comorbidity was obtained by applying an updated version of Charlson comorbidity index to ICD-10 diagnostic codes in the National Patient Register.[60] The Charlson comorbidity index has been widely used as an indicator for comorbidity in research of various disease groups, including research on pain and pain-related outcomes.[60] Using ICD-10 diagnostic codes with National Patient Register data for the Charlson comorbidity index has shown high accuracy.[61] In this study, the comorbidity index was categorized into three groups (0 – no comorbidity, 1 – low level of comorbidity and ≥2 – high level of comorbidity). This categorization was based on the distribution of data. We calculated the Charlson comorbidity index for each participant at baseline and also at end-of-follow up.

Information on labor market status was obtained from "The Danish Register-based Evaluation of Marginalized Individuals" (DREAM).[62] DREAM contains information on all Danish citizens who have received social benefits or any other public transfer income. This information is recorded on a weekly basis and provides valid data regarding labor-market status.[62] Based on DREAM-data, we generated the following four groups: 1) working or student, 2) unemployed, 3) permanent or temporary health-related benefit, 4) retirement. For the analysis, participants were assigned to the group representing their status for the majority of the follow-up period.

Use of musculoskeletal healthcare services two years before baseline was derived by applying the algorithm for the dependent variable (Table A) on 2006 and 2007 data from the National Patient Register, the National Health Insurance Service Register, the Register of Medicinal Product Statistics and the Rehab-register. Musculoskeletal related healthcare services use for these years categorized based on quartile of score distribution.

Types of Musculoskeletal Healthcare

Primary healthcare contacts were summarized overall, and for the following disciplines: Physiotherapy, Chiropractors, Medical specialists and GP. Secondary healthcare contacts were summarized overall and for surgery contacts. The number of redeemed medications for pain relief were summarized overall, and for the following types: non-steroidal anti-inflammatory drugs (NSAID) and analgesics; opioids; and antidepressives, antiepileptics, anxiolytic and hypnotics. Municipality musculoskeletal rehabilitation contacts were summarized overall.

Statistics

Firstly, we used Latent Class Growth Analysis (LCGA)[63] with a zero-inflated Poisson distribution model based on annual number of musculoskeletal contacts to explore trajectories of musculoskeletal healthcare utilization for people with chronic musculoskeletal pain. LCGA was chosen as it is a longitudinal technique that identify subgroups following similar progression according to the parameters of the individual growth curves.[63] We tested models with one to ten groups to assess the optimal number of trajectory groups to describe long-term musculoskeletal healthcare utilization. Choice of the optimal number of groups was guided by 1) goodness-of-fit criteria Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), 2) evaluation of distribution of participants with no less than 5% of the sample in one trajectory group, 3) average predicted posterior probability of group membership above 70%[64] and 4) the clinical plausibility of trajectory groups and trajectories. To achieve convergence of LCGA models, high values of maximum number of annual musculoskeletal contacts were truncated to 30 visits per year (in the data of 3% of participants). Participants were assigned to the trajectory group for which their posterior probability of membership was highest. Selection of the order of parameters to describe each trajectory (intercept, slope, quadratic term) within each model was guided by the estimated coefficients and associated p-value, and goodness-of-fit criteria. As a sensitivity analysis, we also analysed data with repeated measured Latent Class Analysis (LCA) with a negative binomial distribution model which estimates classes based solely on the repeated measure over time instead of using time as a continuous measure and clustering on the growth (time) parameters.[63,65]

Secondly, we calculated the annual number and types of musculoskeletal primary healthcare contacts, musculoskeletal secondary healthcare contacts, redeemed medication for pain relief and musculoskeletal municipality rehabilitation contacts per year within identified trajectory groups and presented them using boxplots. Additionally, we also described differences in proportions of types of musculoskeletal healthcare contacts (primary healthcare, secondary healthcare, redeemed medication for pain relief and rehabilitation) within trajectory groups. This was done to explore the composites of the variables used to generate trajectories of musculoskeletal healthcare utilization.

Lastly, we profiled descriptive variables according to trajectory group membership. For optimal data management, we initially tabulated or visually inspected the distribution of descriptive profiling variables. Heavily skewed variables (eg, with zero-inflated distribution) were categorized or dichotomized as described in the 'Descriptive profiling variables' section. Overall differences between descriptive profiling variables and trajectory groups were tested by comparing means, medians, or percentages using analysis of variance (ANOVA), Kruskal–Wallis test or Pearson's chi-squared test, respectively. If the overall test showed statistically significant differences between descriptive profiling variables and trajectory groups, we explored this in more detail by performing pairwise tests between the lowest/highest trajectory group and each other trajectory group using the Kruskal–Wallis test with Bonferroni correction to adjust for multiple testing, resulting in seven contrasts and

Table 2 Distribution of Participants and the Characteristics of Musculoskeletal Healthcare Utilization Trajectories for People Reporting Chronic Musculoskeletal Pain

		Group 1 Low Stable	**Group 2 Low Ascending**	**Group 3 Low Descending**	**Group 4 Medium Stable**	**Group 5 High Stable**
N = 2929.n (%)		1151 (39.4%)	486 (16.6%)	600 (20.4%)	463 (15.8%)	229 (7.8%)
Posterior probability of trajectory group membership Mean (SD)		98.9% (0.1%)	96.9% (0.1%)	97.5% (0.1%)	98.4% (0.1%)	98.9% (0.1%)
General trajectory characteristics		No or very few (<3) annual musculoskeletal healthcare contacts consistently throughout the follow-up period.	No or very few annual musculoskeletal healthcare contacts at beginning of follow-up increasing to between five and ten annual contacts at end of follow-up.	Between five and ten annual musculoskeletal healthcare contacts at beginning of follow-up decreasing to very few contacts at end of follow-up	Around ten annual musculoskeletal healthcare contacts. Slightly increasing trend of number of contacts over the follow-up period.	Twenty to twenty-five annual musculoskeletal healthcare contacts throughout the follow-up period. Peak years for some individuals with more than 100 musculoskeletal contacts
Median, Interquartile range (IQR) of musculoskeletal healthcare contacts	2008	0 (0–0)	0 (0–1)	3 (0–8)	6 (1–12)	22 (14–36)
	2009	0 (0–0)	0 (0–1)	3 (0–8)	7 (2–12)	24 (14–38)
	2010	0 (0–0)	0 (0–1)	3 (0–7)	6 (3–11)	23 (14–36)
	2011	0 (0–0)	0 (0–1)	3 (0–7)	7 (3–12)	25 (16–40)
	2012	0 (0–0)	0 (0–2)	2 (0–5)	7 (4–12)	25 (15–37)
	2013	0 (0–0)	0 (0–3)	2 (0–5)	8 (4–14)	24 (15–38)
	2014	0 (0–0)	3 (0–8)	1 (0–4)	9 (5–15)	27 (15–39)
	2015	0 (0–0)	5 (1–10)	0 (0–3)	10 (6–17)	27 (15–41)
	2016	0 (0–0)	5 (2–10)	0 (0–3)	9 (5–16)	24 (14–39)
	2017	0 (0–0)	4 (1–10)	1 (0–3,5)	9 (5–16)	24 (13–36)

Table 3 Total Number of Contacts and Proportions of Number of Contacts in Primary and Secondary Healthcare, Redeemed Medication for Pain Relief and Rehabilitation Within Trajectory Groups

	Group 1 Low Stable	**Group 2 Low Ascending**	**Group 3 Low Descending**	**Group 4 Medium Stable**	**Group 5 High Stable**
Total number of contacts from 2008–2017	5950	16,637	22,625	48,254	66,979
Types of musculoskeletal healthcare					
Primary healthcare contacts Total number of contacts (proportions)	3096 (52%)	8618 (52%)	13,519 (60%)	23,747 (49%)	25,909 (39%)
Secondary healthcare contacts - Total number of contacts (proportions)	950 (16%)	1792 (11%)	2370 (10%)	4250 (9%)	4032 (6%)
Redeemed medication for pain relief - Total number of contacts (proportions)	1840 (31%)	5303 (32%)	5935 (26%)	18,121 (38%)	35,544 (53%)
Rehabilitation contacts - Total number of contacts (proportions)	64 (1%)	924 (6%)	801 (4%)	2136 (4%)	1494 (2%)

p-value threshold at 0.007 (0.05/7). To meet the policy of Statistics Denmark and avoid potentially identifying individuals, minor adjustments of the categorization were made so that no descriptive profiling variable for any trajectory group contained less than 3 participants. For all analyses, we used STATA version 16 (StataCorp LLC).

Results

Register-based variables did not have missing data, but 16% of the sample had some missingness on one or more baseline questionnaire variables. Most missingness was in physical and mental health variables (SF12) and four percent had missingness on one of the twelve items from these two scales. The pattern of missingness on other baseline variables was diverse and random (missing completely at random test: p=0.09).[66] Analysis was performed on full case, and missingness is reported when relevant. Number of missings per baseline variable is shown in Table 4 and 5.

Trajectories of Musculoskeletal Healthcare Use

Based on evaluation of the AIC and BIC performance statistics, distribution of participants and probability of group membership, the authorship team agreed that a five-group model was optimal to describe distinguishable trajectories of musculoskeletal healthcare utilization for this sample. Comparison of fit statistics from LCGA of models with one to ten classes is provided in supplementary material (Appendix C). The posterior probability of trajectory group membership in the five-group model was very high (mean posterior probability between 96.9% and 98.9% (Table 1)). The relative decrease in AIC and BIC between LCGA group models with more than five groups was small (<3%) and did not identify new distinguishable trajectories or facilitate the clinical interpretation of trajectory profiles. Models with seven or more groups resulted in strata with less than 5% of the sample (supplementary material – Appendix C). Long-term trajectories of musculoskeletal healthcare utilization for the five-group model are shown in Figure 2. Trajectories and number of groups were confirmed by the sensitivity analysis using LCA (supplementary material – Appendix D).

The five-trajectory group model represents different and distinct trajectories of musculoskeletal healthcare utilization, as detailed in Table 4.

The high stable trajectory group (group 5) was estimated to include 7.8% of the sample and is clearly different compared to the other groups due to consistent high number of annual musculoskeletal healthcare contacts throughout the

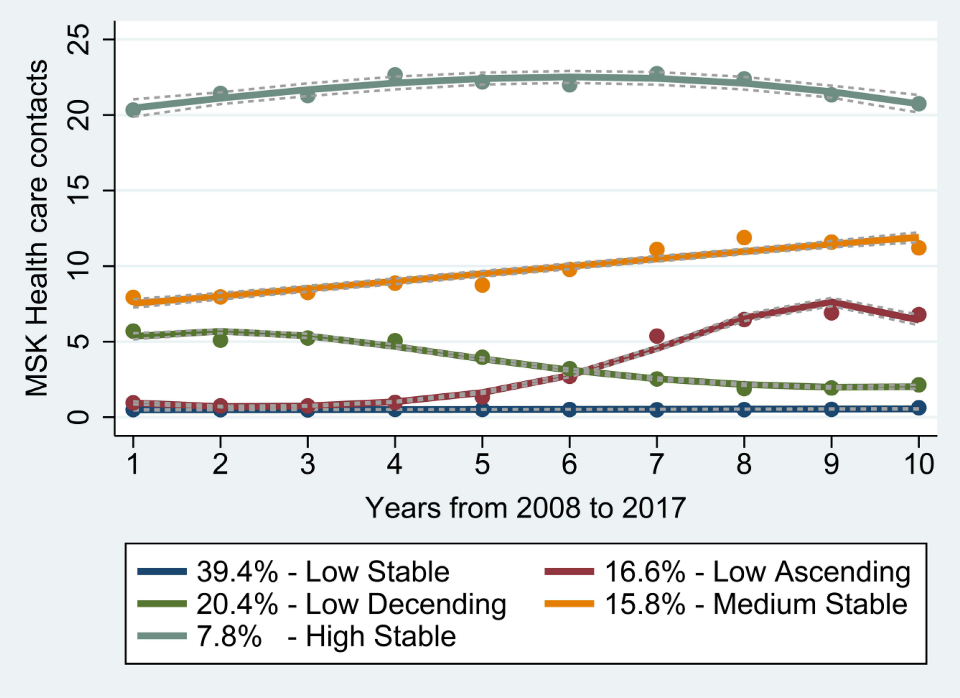


Figure 2 Trajectories of musculoskeletal (MSK) healthcare utilization for people reporting chronic musculoskeletal pain.

follow-up period. In contrast, the low trajectory group (group 1) was estimated to contain 39.4% of the sample had no or very few musculoskeletal healthcare contacts. In between, three trajectory groups were identified constituting the remaining 52.8% of the sample with different intermediate uses of musculoskeletal healthcare services (Figure 2). The low ascending group (group 2, 16.6%) demonstrated no or few annual musculoskeletal healthcare contacts in the first five years which initially increased and then plateaued to a low-moderate level in the subsequent five years. The low descending group (group 3, 20.4%) demonstrated a low-moderate level of annual musculoskeletal healthcare contacts in the first six years which later decreased to a very low level in the last four years. The medium stable group (group 4, 15.8%) demonstrated a stable moderate level of annual healthcare contacts throughout the entire follow-up period. The low stable and medium stable group were best described by linear terms, whereas the low ascending and low descending group fitted a cubic term and the high stable group a quadratic term.

Types of Musculoskeletal Healthcare Use Across Trajectories

Figure 3A displays the distribution of annual number of musculoskeletal primary healthcare contacts in total and by disciplines, stratified by trajectory groups. For primary healthcare contacts, we found significant overall differences across trajectory strata, with a pattern of increasing contacts from the low to the high stable group. This increasing pattern was observed for GP, physiotherapy and chiropractor contacts, whereas musculoskeletal medical specialist contacts were rare for all trajectory groups.

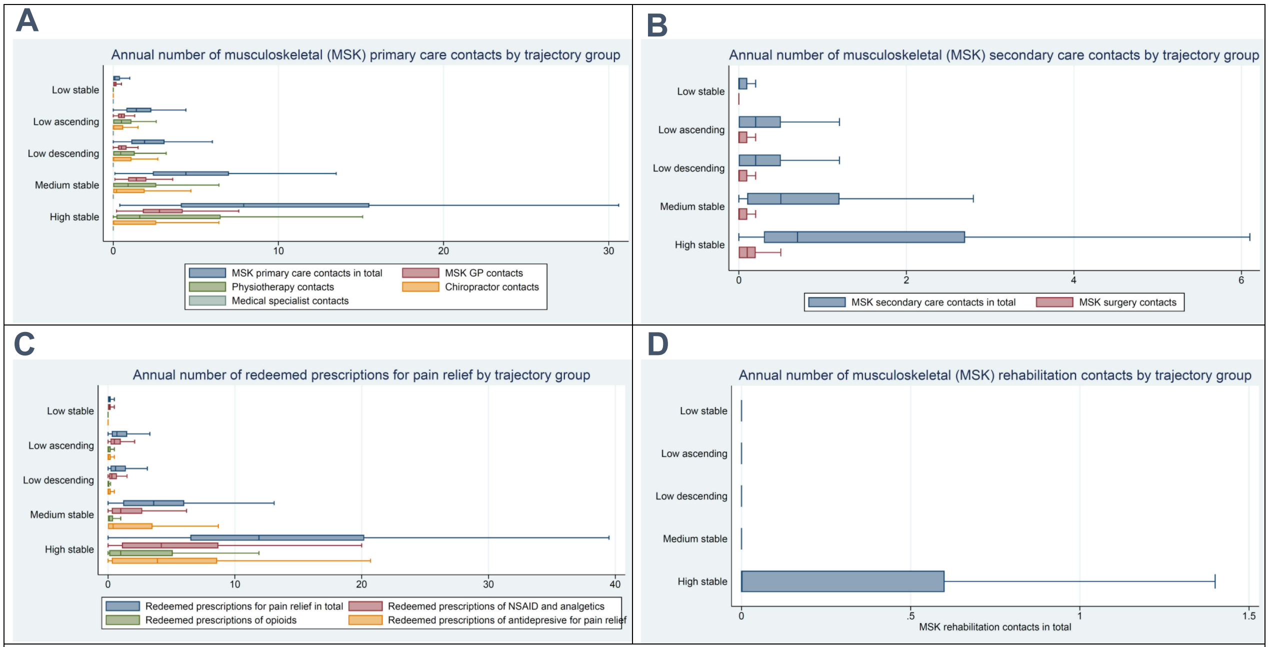
Figure 3B displays the distribution of annual number of musculoskeletal secondary healthcare contacts in total and musculoskeletal surgery contacts across trajectory groups. For secondary healthcare contacts, we found overall differences across trajectory strata in total secondary healthcare and surgery contacts, with a pattern of increasing contacts from the low to the high stable group even though musculoskeletal surgery contacts were rare for all trajectory groups.

Figure 3C presents the distribution of annual number of redeemed medications for pain relief, in total and by type stratified by trajectory groups. For redeemed medications for pain relief, we found overall differences across trajectory strata, with a pattern of increasing use of pain medication from the low to the high stable group. Opioids were almost exclusively prescribed for people in the high stable group (median (IQR) 1 (0.1–5.1)), whereas NSAID/analgesics and anti-depressive medication use were also found in the medium stable group (median (IQR) 0.4 (0–3.5)).

Table 4 Distribution of Individual and Sociodemographic Factors Across the Five Trajectory Groups

	Total	**Group 1 Low Stable**	**Group 2 Low Ascending**	**Group 3 Low Descending**	**Group 4 Medium Stable**	**Group 5 High Stable**	**Overall Test p-value**	**Pairwise Comparison Between Low Stable/High Stable Group and All Other Trajectory Groups**
	N=2929	N=1151	N=486	N=600	N=463	N=229		
Sex, n (%)							<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3
Men	1263 (43.1%)	605 (52.6%)	199 (40.9%)	260 (43.3%)	143 (30.9%)	56 (24.5%)		
Women	1666 (56.9%)	546 (47.4%)	287 (59.1%)	340 (56.7%)	320 (69.1%)	173 (75.5%)		
Age at baseline, mean (sd)	46.9 (12.0)	45.3 (12.6)	46.5 (12.2)	47.7 (11.7)	48.8 (10.7)	49.7 (10.4)	<0.001	Group 1 ≠ Group 3,4,5 Group 5 ≠ Group 1,2
Marital Status, n (%) (a)							<0.001	Group 1 ≠ Group 4,5 Group 5 ≠ Group 1,2,3
Cohabitant with children	1005 (34.3%)	451 (39.2%)	173 (35.6%)	193 (32.2%)	143 (31.0%)	45 (19.7%)		
Cohabitant without children	1307 (44.6%)	465 (40.4%)	207 (42.6%)	285 (47.5%)	217 (47.0%)	133 (58.1%)		
Single with children	130 (4.4%)	42 (3.6%)	26 (5.3%)	24 (4.0%)	28 (6.1%)	10 (4.4%)		
Single without children	486 (16.6%)	193 (16.8%)	80 (16.5%)	98 (16.3%)	74 (16.0%)	41 (17.9%)		
Highest level of education, n (%)							<0.001	Group 1 ≠ Group 4,5 Group 5 ≠ Group 1,2,3
Primary school/high school	443 (15.1%)	179 (15.6%)	66 (13.6%)	78 (13.0%)	70 (15.1%)	50 (21.8%)		
Skilled worker/short-term education	1637 (55.9%)	602 (52.3%)	275 (56.6%)	347 (57.8%)	282 (60.9%)	131 (57.2%)		
Long/medium-term higher education	849 (29.0%)	370 (32.1%)	145 (29.8%)	175 (29.2%)	111 (24.0%)	48 (21.0%)		
Extraversion (Mini-IPIP), mean (sd) (b)	8.4 (3.1)	8.3 (3.0)	8.6 (3.0)	8.6 (3.2)	8.5 (3.0)	7.9 (3.2)	0.004	Group 5 ≠ Group 2,3
Agreeableness (Mini-IPIP), mean (sd) (c)	11.6 (2.2)	11.4 (2.2)	11.6 (2.2)	11.7 (2.2)	11.8 (2.2)	12.0 (2.1)	<0.001	Group 1 ≠ Group 4,5 Group 5 ≠ Group 1,2
Conscientiousness (Mini-IPIP), mean (sd) (d)	10.7 (3.0)	10.5 (3.0)	10.6 (2.9)	10.9 (2.9)	10.8 (3.2)	10.6 (3.1)	0.084	
Neuroticism (Mini-IPIP), mean (sd) (e)	6.8 (3.0)	6.2 (2.8)	6.6 (2.9)	6.8 (3.0)	7.5 (3.0)	8.6 (3.3)	<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3,4
Imagination (Mini-IPIP), mean (sd) (f)	8.9 (3.1)	9.1 (3.1)	9.1 (3.1)	8.8 (3.2)	8.9 (3.0)	8.3 (3.1)	0.009	Group 1 ≠ Group 5 Group 5 ≠ Group 1,2

Note: Missings: (a) 1. (b) 62. (c) 67. (d) 83. (e) 60. (f) 74.



*Boxes represent median (middle line) and first/third quartile (ends). Whiskers represents lower/upper adjacent value (the smallest/largest observation less/greater than or equal to first quartile-1.5*Interquartile range (IQR)/third quartile+1.5*IQR). Outliers beyond these limits are not shown to avoid potentially identifiable individuals according to regulations of Statistics Denmark.*

Figure 3 Annual number of musculoskeletal primary, secondary and rehabilitation healthcare contacts and annual number of redeemed medication prescriptions for pain relief stratified by trajectory groups.

Figure 3D presents the distribution of the annual number of musculoskeletal municipality rehabilitation contacts. Again, we found overall differences across trajectory strata, with a pattern of increasing number of contacts from the low to the high stable group even though such contacts were rare and only visually observed in the high stable trajectory group.

Furthermore, we observed that Figure 3A–D show only slight differences in annual number of musculoskeletal healthcare contacts (all types) between the low ascending and low descending group.

Table 2 shows the total number of contacts and proportions of the different types of musculoskeletal healthcare service (primary and secondary healthcare, redeemed medication for pain relief and rehabilitation) within the five trajectory groups. Primary healthcare contacts account for the majority of services for groups 1–3 (52–60%) and about half of services in group 4 (49%) but only 39% in group 5. In contrast, redeemed medication for pain relief accounts for a much higher proportion in group 5 (53%) than in group 1–4 (ranging from 26% to 38%).

Multidimensional Profiling of Trajectories

Distribution for each descriptive profiling variable across the five trajectory groups data are detailed in Tables 3 and 5. Candidate prognostic factors measured at baseline are highlighted using asterisk.

Individual and Sociodemographic Factors

Distribution of sociodemographic factors and personality measures is presented in Table 3. The majority of the sample were women (56.7%), and the mean age at baseline was 46.9 years (SD 12.0). The proportion of women ranged from 47.4% in the low stable group to 75.5% in the high stable group. Overall test showed significant differences across trajectory groups for all individual and sociodemographic descriptive profiling variables ($p = <0.009$) except for conscientiousness ($p=0.084$). Pairwise comparison showed that participants in the low stable group were significantly more often male and reported lower neuroticism scores compared to participants in group 2–5 ($p < 0.006$), whereas participants in the high stable trajectory group reported significantly higher neuroticism score compared to participants in group 1–4 ($p < 0.006$).

Health, Belief and Work-Related Factors

Distribution of health, belief and work-related factors is presented in Table 5. Except for physical and mental health, the level of exposure to health, pain and belief-

Table 5 Distribution of Health, Belief and Work-Related Factors Across the Five Trajectory Groups

	Total	Group 1 Low Stable	Group 2 Low Ascending	Group 3 Low Descending	Group 4 Medium Stable	Group 5 High Stable	Overall Test p-value	Pairwise Comparison Between Low Stable/High Stable Group and All Other Trajectory Groups
	N=2929	N=1151	N=486	N=600	N=463	N=229		
Baseline BMI Groups, n (%) (a)							<0.001	Group 1 ≠ Group 5 Group 5 ≠ Group 1,2,3,4
Under/Normal weight (<24.9)	1395 (48.8%)	589 (52.4%)	237 (49.6%)	288 (49.1%)	207 (46.0%)	74 (33.8%)		
Pre-obesity (25–29.9), n(%)	1061 (37.1%)	404 (35.9%)	171 (35.8%)	218 (37.1%)	177 (39.3%)	91 (41.6%)		
Obesity Class I (30–34.9)	302 (10.6%)	103 (9.2%)	51 (10.7%)	63 (10.7%)	45 (10.0%)	40 (18.3%)		
Obesity Class II & III (>35)	100 (3.5%)	28 (2.5%)	19 (4.0%)	18 (3.1%)	21 (4.7%)	14 (6.4%)		
Number of painsites, mean (sd) (b)	3.7 (1.8)	3.3 (1.7)	3.7 (1.8)	3.8 (1.8)	4.3 (1.7)	4.7 (1.8)	<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3
Pain intensity, mean (sd) (c)	4.1 (1.5)	3.6 (1.4)	4.1 (1.4)	4.2 (1.4)	4.6 (1.4)	5.2 (1.2)	<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3,4
Physical health (PCS - SF 12), mean (sd) (d)	42.0 (4.6)	41.6 (4.4)	41.8 (4.7)	42.3 (4.7)	42.9 (4.8)	42.3 (5.1)	<0.001	Group 1 ≠ Group 3,4
Mental health (MCS - SF 12), mean (sd) (e)	48.5 (5.9)	48.8 (5.4)	48.6 (5.6)	48.4 (5.8)	47.6 (6.8)	47.8 (6.9)	0.003	Group 1 ≠ Group 4,5 Group 5 ≠ Group 1
Signs of depression (SCL-DEP6), n (%) (f)							<0.001	Group 1 ≠ Group 3,4,5 Group 5 ≠ Group 1,2,3,4
Low score	2330 (80.6%)	982 (86.2%)	404 (84.2%)	481 (81.0%)	327 (71.7%)	136 (61.0%)		
High score	562 (19.4%)	157 (13.8%)	76 (15.8%)	113 (19.0%)	129 (28.3%)	87 (39.0%)		
Signs of anxiety (SCL-ANX4), n (%) (g)							<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3
Low score	2508 (86.7%)	1055 (92.6%)	421 (87.3%)	512 (86.1%)	354 (77.8%)	166 (74.4%)		
High score	386 (13.3%)	84 (7.4%)	61 (12.7%)	83 (13.9%)	101 (22.2%)	57 (25.6%)		
Health anxiety (Whiteley-7), n (%) (h)							<0.001	Group 1 ≠ Group 3,4,5 Group 5 ≠ Group 1,2,3
Low score	2166 (75.2%)	947 (83.3%)	375 (78.1%)	434 (73.6%)	288 (63.7%)	122 (54.7%)		
High score	716 (24.8%)	190 (16.7%)	105 (21.9%)	156 (26.4%)	164 (36.3%)	101 (45.3%)		
Participation restriction due to pain, n (%) (i)							<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3,4
Low degree of restriction	1631 (56.9%)	785 (69.8%)	299 (62.0%)	303 (51.7%)	191 (42.4%)	53 (24.0%)		
High degree of restriction	1233 (43.1%)	339 (30.2%)	183 (38.0%)	283 (48.3%)	260 (57.6%)	168 (76.0%)		
Fear avoidance beliefs, mean (sd) (j)	11.2 (4.2)	10.9 (4.2)	10.9 (4.1)	11.3 (4.3)	11.3 (4.2)	13.0 (4.4)	<0.001	Group 1 ≠ Group 5 Group 5 ≠ Group 1,2,3,4

Charlson Comorbidity Index - Baseline, n (%)							<0.001	Group 1 ≠ Group 4.5 Group 5 ≠ Group 1,2,3,4
No comorbidity	2758 (94.2%)	1113 (96.7%)	459 (94.4%)	569 (94.8%)	424 (91.6%)	193 (84.3%)		
Comorbidity score = 1	101 (3.4%)	19 (1.7%)	10 (2.1%)	17 (2.8%)	32 (6.9%)	23 (10.0%)		
Comorbidity score ≥2	70 (2.4%)	19 (1.7%)	17 (3.5%)	14 (2.3%)	7 (1.5%)	13 (5.7%)		
Charlson Comorbidity Index - End of Follow-up, n (%)							<0.001	Group 1 ≠ 2,3,4,5 Group 5 ≠ 1,2,3,4
No comorbidity	2283 (77.9%)	985 (85.6%)	382 (78.6%)	466 (77.7%)	321 (69.3%)	129 (56.3%)		
Comorbidity score = 1	297 (10.1%)	74 (6.4%)	35 (7.2%)	58 (9.7%)	81 (17.5%)	49 (21.4%)		
Comorbidity score ≥2	349 (11.9%)	92 (8.0%)	69 (14.2%)	76 (12.7%)	61 (13.2%)	51 (22.3%)		
MSK-contacts in 2006 and 2007, n (%)							<0.001	Group 1 ≠ 2,3,4,5 Group 5 ≠ 1,2,3,4
No MSK-contacts	1331 (45.4%)	783 (68.0%)	266 (54.7%)	180 (30.0%)	91 (19.7%)	11 (4.8%)		
One MSK-contact	242 (8.3%)	94 (8.2%)	46 (9.5%)	62 (10.3%)	30 (6.5%)	10 (4.4%)		
2–7 MSK-contacts	674 (23.0%)	201 (17.5%)	106 (21.8%)	167 (27.8%)	137 (29.6%)	63 (27.5%)		
> 8 MSK-contacts	682 (23.3%)	73 (6.3%)	68 (14.0%)	191 (31.8%)	205 (44.3%)	145 (63.3%)		
Labor market status, n (%)							<0.001	Group 1 ≠ Group 2,3,4,5 Group 5 ≠ Group 1,2,3,4
Working or student	1877 (64.1%)	855 (74.3%)	348 (71.6%)	367 (61.2%)	240 (51.8%)	67 (29.3%)		
Unemployed	119 (4.1%)	66 (5.7%)	11 (2.3%)	26 (4.3%)	10 (2.2%)	6 (2.6%)		
Health-related benefit	333 (11.4%)	38 (3.3%)	30 (6.2%)	57 (9.5%)	103 (22.2%)	105 (45.9%)		
Retirement	600 (20.5%)	192 (16.7%)	97 (20.0%)	150 (25.0%)	110 (23.8%)	51 (22.3%)		

Note: Missings: (a) 71. (b) 63. (c) 17. (d) 164. (e) 164. (f) 37. (g) 35. (h) 47. (i) 65. (j) 69.

related factors increased from the low stable group to the high stable group. Overall test showed significant differences across trajectory groups for all health, belief and work-related factors (p = <0.003). Pairwise comparison showed that participants in the low stable group reported significantly lower number of pain sites, lower pain intensity score, lower anxiety scores, a lower degree of participation restriction due to pain, had less comorbidity, used less musculoskeletal healthcare services two years before baseline and were more often working or student and less often retired compared to participants in group 2–5 (p < 0.006). Whereas participants in the high stable group reported significantly higher pain intensity score, higher BMI, higher depression score, higher degree of participation restriction due to pain, had more comorbidity, more musculoskeletal healthcare contacts before baseline and were less often working or student and did more often receive social health-related benefit compared to participants in group 1–4 (p < 0.006).

Discussion

Main Results

In this sample of people reporting chronic musculoskeletal pain, we identified and profiled five distinct trajectories of long-term musculoskeletal healthcare utilization (low stable, low ascending, low descending, medium stable and high stable). A low stable trajectory (39% of the sample) had no or almost no annual musculoskeletal contacts, and a high stable trajectory group (8%) had a consistent high number of annual musculoskeletal contacts. Between those groups were three groups with ascending (17%), descending (20%) and medium stable (16%) musculoskeletal contacts.

Overall, the annual number of contacts in subtypes of musculoskeletal healthcare (primary and secondary healthcare, redeemed medication for pain relief, and rehabilitation) increased across the five trajectory groups, but proportional use within trajectory groups appeared to differ. Redeemed prescriptions for pain medication (NSAID/analgesics, opioids and anti-depressives for pain relief) were primarily found in the medium stable and high stable trajectory groups and were the most common type of musculoskeletal healthcare in the high stable trajectory group. Redeemed medication for opioids was almost exclusively found in the high stable trajectory group. Primary and secondary healthcare contacts were the most common type of musculoskeletal healthcare in the trajectory groups with low use of healthcare. Surgery and musculoskeletal municipality rehabilitation contacts were rare and almost exclusively found in the high stable group.

Profiling the identified trajectories on individual, sociodemographic, health, belief and work-related factors showed differences across trajectory groups. Further studying differences between the low stable group and high stable group in particular could provide insights into drivers of healthcare-seeking behavior.

Musculoskeletal Healthcare Utilization Trajectories

In general, people reporting chronic pain have higher use of healthcare services than people without pain.[6–8,10] Our results about the low stable (39%) and high stable (8%) trajectories suggest that the increased use of musculoskeletal healthcare resources due to chronic musculoskeletal pain is mainly driven by a relatively small group of ongoing high healthcare users and that the largest group of people reporting chronic musculoskeletal pain cope with no/few musculoskeletal healthcare consultations and no/very low use of pain medication.[10,15,16] Also, noteworthy is that a descending trajectory of musculoskeletal healthcare utilization was only found for 21% of the participants and only for participants with relatively few annual musculoskeletal healthcare contacts (low descending), whereas a decreasing trajectory for participants with high/medium use of healthcare was not identified. Subsequent studies could explore what case management characteristics are associated with these downstream healthcare-seeking differences (eg, the timing of interventions; patient/healthcare professional characteristics; the receiving of a "sense-making" diagnosis and "thrive despite pain" messages; a loss of confidence that healthcare can help; or guideline adherent versus non-adherent healthcare).

One of the challenges of using methods such as LCGA is to balance model parsimony and interpretability versus identifying smaller groups, the existence of which may have important clinical implications. However, while for some research questions the addition of more trajectory groups to the five we identified might have been of interest, we found that adding more groups separated the low musculoskeletal healthcare users in more detail but did not generate distinct groups in terms of new trajectory shapes involving higher use nor change the high stable trajectory group.

Musculoskeletal Healthcare

Reassuringly, our findings about the use of different types of musculoskeletal healthcare align quite well with most musculoskeletal clinical guidelines, which recommend that the majority of non-specific musculoskeletal disorders should be managed in primary healthcare, pain medication prescribed for chronic pain patients should be restricted to NSAIDs and antidepressants, and discourage referral for secondary healthcare specialists or surgical interventions unless specific or serious pathology is suspected.[13,67,68] Hence, our results do not support that healthcare-seeking pathways for people with chronic musculoskeletal pain often lead to consultations with surgeons as musculoskeletal surgery contacts were rare for all trajectory groups. Maybe also surprisingly, redeemed prescriptions for opioids were relatively rare and almost only found in the high stable trajectory group, which suggests that GPs generally follow recommendations of limited use of opioids for musculoskeletal pain. In pain populations around the world, high use of opioids been reported, and use of opioids in Denmark in generally is high compared to other Nordic countries.[69]

Most musculoskeletal clinical guidelines also encourage short-term use of healthcare,[67] but in this study, we found a continuing use of healthcare services for 24% of the sample (medium stable and high stable trajectory group). We do not know if this long-term use is due to one condition or several musculoskeletal conditions, but higher numbers of pain sites and higher comorbidity index in the medium and high stable trajectory group compared to group 1–3 (Table 3) could suggest that more pain conditions could influence.

Multidimensional Profiling

Different trajectories of musculoskeletal healthcare utilization had different individual, sociodemographic, health, belief and work-related profiles. These findings align with previous prognostic studies analysing factors associated with general healthcare utilization.[7,15,16,18,21–24] Notably, while the mean scores for neuroticism (and all other personality trait scores) for all trajectory groups were low compared to population norms,[49] they were significantly higher in the high stable trajectory group than the other trajectory groups. Higher neuroticism reflects a tendency to experience negative emotions,[70,71] and other studies have shown that neuroticism correlates with lower quality of life and reported severity of physical symptoms,[72] both of which are independently associated with high healthcare utilization.[7,15] Sixty-four percent of this sample were working for most of the follow-up period, but this was 29% in the high stable trajectory group and 46% in this trajectory group received health-related income benefits (Table 5). These findings could indicate that this trajectory of people finds it difficult to gain employment that accommodates their capacity and that facilitation of continuation or resumption of work requires continued social and therapeutic focus.

A subset of the profiling variables was measured at baseline and hence could be candidate prognostic factors (see Tables 3 and 5). The aim of this study was not to create a prediction model for musculoskeletal healthcare utilization or explore causal pathways, but future studies that aim to do so may consider including one or more of these candidate prognostic factors.

Strengths and Limitations

This study has several strengths, including the use of register-based information with ten-year complete person-level follow-up, high validity[38,39,73] and no risk of lag time/recall bias. We also used a population-based cohort of people reporting chronic musculoskeletal pain, rather than a clinical cohort, as it includes people not seeking healthcare. This study used LCGA allowing assignment of individuals to trajectory groups with statistical evaluation of the model performance. LCGA has better accuracy at identifying latent classes[63] compared to previously used methods.

However, some limitations should also be noted. This cohort derived from the 60% of eligible participants who responded to the baseline questionnaire in 2008, so we cannot exclude the potential for some unquantified selection bias. Ideally, prognostic studies occur in inception cohorts where participants are included at a uniform time, like the onset of a condition.[27] We do not know the course or trajectory of pain symptoms in this sample, but it is likely to have included people with varying pain duration. Furthermore, chronic musculoskeletal pain ceases in some people,[74] however studies exploring trajectories of pain symptoms indicate that people reporting chronic pain often continue to do so.[74–76]

The National Health Insurance Service Register does not contain information on diagnostic coding. This means that musculoskeletal contacts in primary healthcare were based on information about professional groups (eg, physiotherapists, chiropractors), where scope of practice indicates that most consultations relate to musculoskeletal complaints. For GP contacts, we developed an algorithm to identify musculoskeletal specific contacts (supplementary material – Appendix B). This approach may have led to some misclassification, although similar approaches have been applied and validated using National Health Insurance Service Register data for linking patients and general practices with promising results.[77] Another limitation with the National Health Insurance Service Register database is that approximately 15% of chiropractors and physiotherapist consultations in primary healthcare are paid either fully out-of-pocket by patients or by insurance without any public reimbursement and hence not reported to the National Health Insurance Service Register.[41] These consultations could therefore not be accounted for in our investigation and may have led to some underestimation of musculoskeletal healthcare use.

Conclusions

We found that people reporting chronic musculoskeletal pain have different trajectories of long-term musculoskeletal healthcare utilization. About 39% have no or almost no few annual musculoskeletal contacts, whereas almost 8% have a consistent high number of contacts. In between these trajectories, we found three groups with ascending (17%), descending (20%) and medium stable (16%) number of annual musculoskeletal contacts. Primary healthcare contacts were the most common type of musculoskeletal healthcare in the trajectory groups with low use of musculoskeletal healthcare and pain medication were primarily found in the medium stable and high stable trajectory groups, but opioids were almost exclusively found in the high healthcare trajectory group. Surgery was rare and almost exclusively found in the high healthcare trajectory group. Participants in the identified trajectories had different individual, sociodemographic, health, belief and work-related profiles.

Abbreviations

GP, General Practitioners; BMI, Body Mass Index; SEQ, Standard Evaluation Questionnaire; IASP, The International Association for the Study of Pain; ICD, The International Statistical Classification of Diseases and Related Health Problems; SF12, Short Form 12 questionnaire; PCS, Physical components score; MCS, Mental components score; SCL, The Symptom Checklist; DREAM, The Danish Register-based Evaluation of Marginalized Individuals; NSAID, Non-steroidal anti-inflammatory drugs; LCGA, Latent Class Growth Analysis; LCA, Latent Class Analysis; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; ANOVA, Analysis of variance; MSK, Musculoskeletal.

Data Sharing Statement

Data from the Danish National Registers are available from the Danish National Health and Medicines Authority for researchers who meet the criteria for getting access to micro data. According to Danish regulations, researchers who are interested can only apply for access through an affiliation to a Danish authorized research environment and apply for data access directly at Statistics Denmark (https://www.dst.dk/en/TilSalg/Forskningsservice) and the Danish Data Protection Agency (https://www.datatilsynet.dk/english). Interested researchers may contact the corresponding author of this article for further guidance on this procedure.

Ethics Approval and Consent to Participate

All participants signed written informed consent forms at baseline. This study was approved by the Danish Data Protection Agency (project number 1-16-02-141-18). All data are collected, stored and handled according to Danish law. Under Danish law, non-intervention studies do not require approval by biomedical research ethics committees.[78]

Consent for Publication

All authors have approved submission of this article for publication in Clinical Epidemiology.

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Author Contributions

All authors contributed to data analysis, drafting or revising the article, gave final approval of the version to be published, agreed to the submitted journal, and agreed to be accountable for all aspects of the work.

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Disclosure

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Appendix B1

Additional files for paper 2

Appendix A:

Plan for deriving musculoskeletal healthcare contacts from The National Patient Register, The National Health Insurance Service Register, The Register of Medicinal Product Statistics and The Rehabilitation According to “The Danish Act of Health §140” register (Rehab-register).

Registre	Definitions	Annual number of musculoskeletal contacts (2006 – 2017) for each participant based on:
The National Patient Register	A musculoskeletal contact was defined as a registered date with a healthcare encounter (out-patient visits (e.g. test, surgery, treatment), inpatient or emergency department visits) with a registered musculoskeletal-related primary or secondary diagnosis. Each course may have had several contacts with several service codes but only one contact each day was considered (e.g. examination, imaging and surgery on the same day, was considered as one contact). Hospitalizations of several days' duration were considered as one contact per day.	**To count number of musculoskeletal contacts each year, we searched The National Patient Register for the following primary (A) or secondary (B) diagnostic codes based on the Danish version of the International Classification of Diseases and Related Health Problems classification system (https://medinfo.dk/sks/brows.php?s_nod=6193).** **Number of Musculoskeletal face-to-face contacts**: M (Chapter XIII - Diseases of the musculoskeletal system and connective tissue) - All codes. G (Chapter VI Diseases of the nervous system) - Following codes: G43 (migraine), G44 (headache), G546+547 (phantom pain), G500A+501 (facial pain), G55 + G56 + G57 (nerve compression from discus/stenosis or in UE/LE) R (Chapter XVIII - Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified) - Following codes: R52 (nonspecific pain syndrome), R51 (Headache) S (Chapter XIX - Injury, poisoning and certain other consequences of external causes) - Following codes: S12+13+16 (neck), S22+23 (Thorax), S32+33 (Low back/pelvis), S42+43+46 (Shoulder/Upper arm), S52+53+56(elbow/lower arm), S62+63+66(Hand) S72+73+76(Hip/thigh), S82+83+86(Knee/crus), S92+93+96(Ankle/foot), T02+03+06(Multiple) K (Chapter XI - Diseases of the digestive system) - Following code: K076A (mandibular joint pain)

The National Health Insurance Service Register	A musculoskeletal contact was defined as a musculoskeletal health-related face-to-face encounter. E-mail and telephone contacts was not considered as contacts. The National Health Insurance Service Register service codes chosen to represent face-to-face musculoskeletal healthcare contacts were based on agreements between the Danish Health Authority and relevant professional organizations (see www.okportalen.dk).	**To count number of musculoskeletal contacts each year, we searched The National Health Insurance Service Register for the following encounters:** Anesthesiology (Spec. 01) (encounters regarding pain management), Diagnostic radiology (Spec 03 + 05) (encounters regarding musculoskeletal diagnosis), Rheumatology (Spec 06) (all encounters), Orthopedic surgery (Spec 20) (all encounters), Physiotherapist (Spec 51) (musculoskeletal encounters), Chiropractor (Spec 53 and spec 64 (special clinical pathways for lumbar disc herniation, cervical disc herniation and lumbar spinal stenosis)), General practitioner (Spec 80) (musculoskeletal encounters based on algorithm (Please see Appendix B).

The Register of Medicinal Product Statistics	A musculoskeletal contact was defined as a redeemed/collected medication for pain relief. Anatomical Therapeutic Chemical Classification System (ATC) codes considered to be relevant for musculoskeletal pain relief was guided by consensus between medical doctors with expertise in musculoskeletal pain treatment.	**To count number of musculoskeletal contacts each year, we searched The Register of Medicinal Product Statistics for collection of pain medication with the following ATC codes**: N01B (Anesthetics, local) N02A + B (Opioids, other analgesics and antipyretics) N03A (Antiepileptic) N05B + C (Anxiolytics and Hypnotics) M01A (Anti-inflammatory/anti-rheumatic, non-steroids)

The Rehabilitation According to "The Danish Act of Health §140" register (Rehab-register)	A musculoskeletal contact was defined as a musculoskeletal health-related face-to-face encounter. Only face-to-face encounters in courses after hospital contact with a musculoskeletal diagnosis were considered (Please see The National Patient Register). Each course may have several contact days with different service codes but only one contact each day was considered.	**To count number of musculoskeletal contacts each year, we searched The Rehabilitation According to "The Danish Act of Health §140" register for the following encounters:** Number of musculoskeletal contact days in a course at a municipality rehabilitation unit beginning no later than 2 months after a hospital discharge registered with a musculoskeletal ICD-10 diagnostic code (see the National Patient Register: A and B diagnostic codes (ICD-10) considered to be musculoskeletal contacts).

Appendix B:

Algorithm to identify musculoskeletal contacts at General practitioners at The National Health Insurance Service Register

Based on self-reported data, about 78% of Danish adults consult their GP each year (Illemann Christensen, 2014). Approximately 14% of these consultations are related to musculoskeletal disorders (Jordan et al., 2010; Kjøller et al., 2007).

To identify the number of face-to-face musculoskeletal health care contacts at General Practitioners (GP), the unique civil registration number (CPR number) (Mainz et al., 2019; Pedersen, 2011; Schmidt et al., 2014) assigned to all residents of Denmark was used to link individuals data from the medical records to register data from the National Health Insurance Service Register (HISR) (Andersen et al., 2011), the National Patient Register (NPS) (Lynge et al., 2011; Schmidt et al., 2015) and the Register of Medicinal Product Statistics (Johansen et al., 2013). The medicinal products register includes information about type of medication, price and prescriber of medicines sold on prescription and over-the-counter, as well as medication used by hospitalized patients. Information about sales of medicinal products in Denmark has been recorded since 1994 (Johansen et al., 2013; The Danish Health Data, 2016; Thygesen et al., 2011).

To determine if a face-to-face GP contact in the National Health Insurance Service Register was related to a musculoskeletal disorder a simple algorithm was developed. The algorithm built on available information from the National Health Insurance Service Register about each face-to-face GP contact, as well as information about subsequent health care activities from the National Health Insurance Service Register, the National Patient Register and the Register of Medicinal Product Statistics. Each face-to-face GP contact was evaluated in two steps. First, all activity codes for each face-to-face GP contact were evaluated. Those activity codes are supplementary administrative codes registered by GP at each face-to-face contact. According to the agreement between The Danish GP organization and the Danish Health Authority, activity codes initiate GP remuneration for services or activities taken at each contact. Such services could be specific diagnostic tests, laboratory tests such as B-hemoglobin (activity code 7108), C-reactive protein (CRP) (activity code 7120), strep-A test (activity code 7109), spirometry/peak flow (activity codes 7113, 7121, 7183) urinary stick (activity code 7101) or blood tests (activity codes 2601 and 2101). Face-to-face GP contacts were considered musculoskeletal contacts if they included activity codes 2109 (immobilizing bandages), 2111 (small fractures or relocations of small joints), 2119 (draining of liquid from joints), 2122 (first treatment – large fractures), 2123 (relocations of larger joints). In the second step, a face-to-face GP contact followed by primary care physiotherapy or chiropractor care seeking (within two months), collection of prescribed pain medication (within one month) or secondary health care seeking due to musculoskeletal disorders (within two months) were considered musculoskeletal contacts. All analyses were performed using STATA 15.1 (StataCorp, College Station, Tx, USA).

Our algorithm estimated 18% (CI 18%-19%) of face-to-face GP consultations to be musculoskeletal related, which is slightly higher than previous estimates based on self-report data, but still credible.

Algorithm to identify face-to-face GP (spec. 80) contacts (0101) from The National Health Service Register related to a musculoskeletal disorder

Original HISR-data	Step 1. Exclusion of GP contacts registered with non-musculoskeletal service or activity codes	Step 2. Exclusion of GP contacts not followed by:
All face-to-face General Practitioners (GP) contacts (0101) from The National Health Insurance Service	1. § 75 laboratory tests (7000 codes) 2. § 70 supplementary service codes (2000 codes) (except musculoskeletal codes: 2109,2111,2119,2122,2123) 3. Vaccine, child- and pregnancy examination codes (8000 codes)	1. Physiotherapy contact (Primary care) within the following two months (HISR-data) 2. Collection or prescribed pain medication within the following month (RMPS-data) 3. In- or out-patient hospital contact for an musculoskeletal disorder within the following two months (NPS-data)

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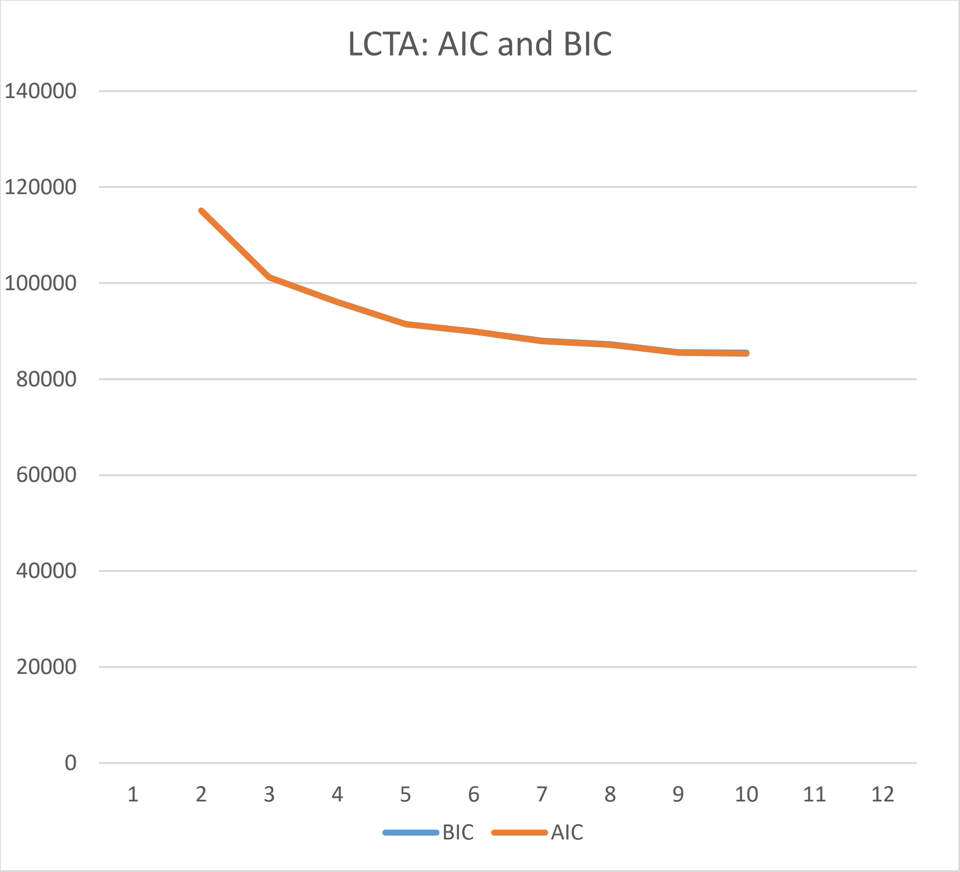
Appendix C:

Comparison of Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) from Latent Class Growth Analysis of models with one to ten classes

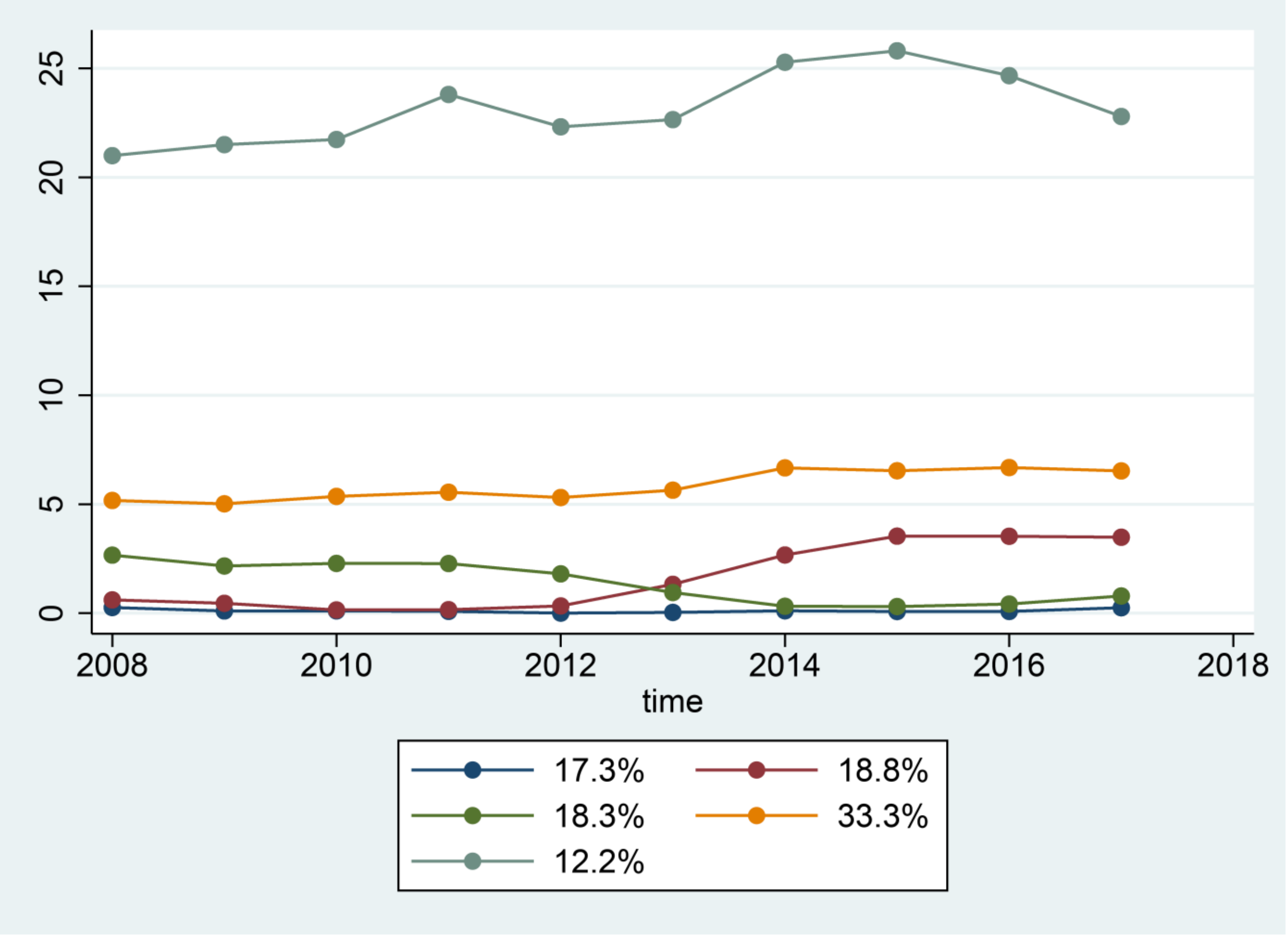
<table>
<tr><th colspan="10">Latent Class Growth Analysis (LCGA)</th></tr>
<tr><th colspan="10">Musculoskeletal health care contacts 2008 - 2017
BIC and AIC of a censored normal distribution model (zip)
N=2929. Adults between 17-64 reporting chronic pain at baseline.
Max number of annual MSK contacts was truncated to 30 visits per year.</th></tr>
<tr><th>Groups</th><th>Order</th><th>BIC</th><th>BIC Δ</th><th>BIC Δ%</th><th>AIC</th><th>AIC Δ</th><th>AIC Δ%</th><th>Group split (%)</th><th>Comments</th></tr>
<tr><td>1</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Likelihood could not be computed at start values.</td></tr>
<tr><td>2</td><td>33</td><td>115130</td><td>-115130</td><td>-100%</td><td>115093</td><td>-115093</td><td></td><td>72, 28</td><td>882 persons in high healthcare seeking group.</td></tr>
<tr><td>3</td><td>333</td><td>101234</td><td>13896</td><td>14%</td><td>101176</td><td>13917</td><td>14%</td><td>52,35,13</td><td>Quite similar patterns over time. Only frequency seems to vary.
383 persons in high healthcare seeking group.</td></tr>
<tr><td>4</td><td>2233</td><td>96106</td><td>5128</td><td>5%</td><td>96035</td><td>5141</td><td>5%</td><td>47,22,18,12</td><td>Quite similar patterns over time. Only frequency seems to vary.
346 persons in high healthcare seeking group.</td></tr>
<tr><td>5</td><td>13323</td><td>91463</td><td>4643</td><td>5%</td><td>91376</td><td>4659</td><td>5%</td><td>39,17,20,16,8</td><td>Different trajectories of MSK healthcare seeking.</td></tr>
</table>

									229 persons in the high healthcare seeking group.
6	212232	89942	1521	2%	89847	1529	2%	28,10,24,14,6,17	Different trajectories of MSK healthcare seeking. 192 persons in the high healthcare seeking group.
7	2112223	87996	1946	2%	87888	1959	2%	15,36,10,13,10,8,6	Different trajectories of MSK healthcare seeking. 184 persons in high healthcare seeking group.
8	21122212	87241	755	1%	87125	763	1%	14,27,18,8,4,10,14,5	Different trajectories of MSK healthcare seeking. 143 persons in high healthcare seeking group.
9	211111112	85580	1661	2%	85464	1661	2%	7,28,18,8,11,11,5,8,4	Different trajectories of MSK healthcare seeking. 139 persons in high healthcare seeking group.
10	1111111112	85513	67	0%	85288	176	0%	12,22,12,7,17,6,6,9,5,4	Different trajectories of MSK healthcare seeking. 116 persons in healthcare care seeking group.


LCTA: AIC and BIC
140000
120000
100000
80000
60000
40000
20000
0
1
2
3
4
5
6
7
8
9
10
11
12
BIC
AIC

Appendix D:

Trajectories of musculoskeletal (MSK) healthcare utilization for people reporting chronic pain using Latent Class Analysis (five group model)



Appendix C

PAPER 3

How do people with chronic pain explain their use, or non-use, of pain-related healthcare services? A qualitative study of patient experiences.

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1. Publication status: Under review – Disability and Rehabilitation

Title

How do people with chronic pain explain their use, or non-use, of pain-related healthcare services? A qualitative study of patient experiences.

Background

Chronic pain is common and impacts behavior, physical activity, social function, and quality of life [1,2]. A common behavior in the context of chronic pain is seeking healthcare and/or taking pain medication, although not all with chronic pain do so [3,4]. About 40% of people reporting chronic pain use no, or very few, annual pain-related healthcare services, whereas just under 10% have a continuous high use of pain-related healthcare services (more than 20 annual contacts/ prescriptions for pain-medication) [5]. Several factors have been associated with higher use of healthcare services by people reporting chronic pain, including: older age [6-8], low socioeconomic status [6,8], being female [7-9], high pain intensity [9-11], high level of disability [9,10,12,13], number of pain sites [12,14], comorbidity [6], body mass index (BMI), poor general health [6,7,15], negative health beliefs (health anxiety, catastrophizing, fear avoidance) [14-16] and previous healthcare use [15,17]. However, the choice of care seeking due to chronic pain or taking pain medication is more complex than the presence or absence of certain factors and such factors do not explain why people with chronic pain have different healthcare seeking behavior.

Others have suggested that healthcare seeking is the result of an interpretation process where pain sensations are transformed into symptoms and signs of potential illness in a complex interplay between biological, psychological and cultural factors [18-20]. Studies of first-person narratives of people reporting chronic pain have shown that some people with chronic pain experience repeated treatment failures, leaving them feeling hopeless, torn apart from the world and themselves, and trapped by the pain [21-23]. Some seek healthcare in the search for an explanation or a diagnosis to validate the pain and for some this search continues for a long time [22]. In this endeavor, some come across healthcare professionals (HCPs) who appear skeptical and lack understanding of their situation, leaving the person with chronic pain feeling stigmatized and disbelieved, which gives rise to feelings of anger, frustration and despair [21]. However, it is still unclear if such experiences account for the differences in the use of healthcare due to chronic pain. Therefore, to further understand use of pain-related healthcare due to chronic pain, it would be helpful to gain insights from the lived experiences and perspectives of people with chronic pain with different pain-related healthcare seeking trajectories. A better understanding of healthcare experiences and the beliefs and processes underlying use or non-use of pain-related healthcare services for people with chronic pain could be a key input to inform the optimization of chronic pain management. Therefore, the key questions underpinning this qualitatively study are: 1) How do people with chronic pain explain their use, or non-use, of pain-related healthcare services and what are their expectations for the HCP they approach? And 2) how do such explanations and expectations differ between people who have different levels of pain-related healthcare service use?

Methods

Design and setting

This cross-sectional study is the qualitative strand of an explanatory sequential mixed-methods project [24] seeking to describe and understand use of pain-related healthcare in people with chronic pain. The study builds on a inductive phenomenological methodology and is reported as recommended in the standards for reporting qualitative research [25].

It was conducted in Denmark, and hence the primarily publicly-funded healthcare system in Denmark forms the backdrop of in this study [26]. Figure 1 is a graphic illustration of organization of current pain-related pathways in, and organization of, the Danish healthcare system.

Figure 1 here

Participants and recruitment

Informants in this study were selected from a previously established Danish longitudinal cohort study. Details about recruitment, non-participants and characteristics for the entire cohort have been reported in detail elsewhere [27,28]. In brief, the cohort is a population-based cohort established in 2008 and consists of 5068 adults (17-64 years of age in 2008) who responded to a baseline questionnaire send to 8517 adults in 2008. The baseline questionnaire collected data on a wide range of socio-demographic, quality of life, health, work-related, lifestyle and psychosocial factors. A web-based follow-up questionnaire was distributed digitally in October 2020 to the 4865 responders of the baseline questionnaire who were still alive and registered in the Danish mandatory secure public mailbox system, in which about 93% of the cohort were registered at the time of follow-up [29]. The follow-up questionnaire collected data on health, psychosocial, quality of life and work-related factors. A total of 2947 individuals answered the follow-up questionnaire. To ensure that all informants had a history of long-term pain, we only considered participants who reported pain for longer than three months in both 2008 and 2020 (measured by a single item from the Standard Evaluation Questionnaire [30]) and who accepted to be contacted for interview in the 2020 survey. This left us with 659 potential eligible informants.

Data from questionnaires and registers

To select and describe the informants, we used variables collected by questionnaire in 2008 and 2020, and selected National registers. Sex and age were obtained from the Danish Civil Registration System [31,32]. Number of pain sites in 2008 and 2020 were measured with the Standard Evaluation Questionnaire, section 1 [30]. Participants were asked to rate the pain intensity (1=no pain, 7= worst imaginable pain) in seven different body locations (head and face, left upper extremity, right upper extremity, chest and stomach, neck and back, left lower extremity and right lower extremity). We considered a person to have pain in a particular region if they self-rated pain intensity in that region as >= 2. Health anxiety in 2008 and 2020 was measured with Whiteley-7 Index (range 0-28) [33] and dichotomized at > 5 (0-5 = low risk, 6-28 = high risk), as that threshold is recommended by The Danish College of General Practitioners as an indication of a clinically-relevant risk of health anxiety [34]. Labour market status was measured with a single-item question. Participants were asked to select their work status from one of the following ten nominal categories: work, temporarily absent due to illness, student, health related work placements, temporarily absent due to leave, trainee/ apprentice, social assistance recipient, unemployed, retirement, or other.

Self-rated work ability was also measured with a single-item question. Participants were asked to rate their work ability on a ten-point Likert scale, where 0 indicated unable to work and 10 indicated full work ability. Well-being was measured with the WHO-5 Well-Being Index (range 0-100), where 0 represented worst and 100 represented best imaginable well-being [35].The Danish population norm is 68. Musculoskeletal health status was measured with The Musculoskeletal Health Questionnaire (MSK-HQ). This scale consists of 14 items and is a validated scale for measuring musculoskeletal health across musculoskeletal conditions and settings [36]. For scoring, all 14 items are summed, with the sum score ranging from 0 to 56. Higher scores indicate better musculoskeletal health.

Selection of informants

To ensure a variety of voices represented across factors commonly associated with higher prevalence of chronic pain and higher use of healthcare services, we sought to select and invite informants with different profiles in terms of gender, age, number of pain sites (2008 and 2020), health anxiety (2008 and 2020), labour market status (2020) and well-being (2020). Potential informants were initially contacted by phone by one of the authors (SM) and invited to participate in an interview. If a person declined participation (3 cases), an informant with a similar profile was contacted. If initial participation approval was given, informants were mailed information about the study and an informed consent form. If the informant still agreed to participate, an interview date and time were scheduled. Data collection was ceased after 21 interviews (20 informants - one informant was interviewed twice) as sufficient information power to give a nuanced picture of the informants' perspectives and understanding of the research question had been obtained. At the beginning of each interview, the interviewer made sure that none of the following exclusion criteria applied: evidence of severe malignant pain or any other serious pathology or severe comorbidity (e.g. cancer, severe chronic obstructive pulmonary disease or cardiovascular disease), cognitive impairment that prevented them from providing meaningful responses to interview (e.g. currently being treated for a psychiatric disorder, senile dementia, Alzheimer's disease), and being unable to speak Danish or English. After both the fifth and fourteenth interviews, a group of authors (SM, HRS and AS) evaluated the data collection and interview profiles, and agreed on how to progress the recruitment to obtain the most information power. This led to alterations in recruitment. For example, we primarily invited informants with relatively few pain sites and a low well-being index score for the final interviews, to explore if such profiles could shed light on new perspectives on pain-related healthcare seeking.

Qualitative data collection

To accommodate government recommendations for the Covid-19 pandemic, all individual interviews were either conducted online (n=2) or over the phone (n=19). Interviews were conducted and audio recorded by a male physiotherapist and PhD student (SM) who received training from experienced qualitative researchers (HRS & AS). The interviewer was not previously known to any of the informants, nor involved in their treatment. Interviews lasted between 30 and 90 minutes. To explore experiences, beliefs and thoughts underlying healthcare use, a semi-structured interview guide was developed with open-ended questions about the pain, pain-related healthcare experiences (including pain medication and alternative healthcare), drivers for healthcare seeking and beliefs about pain. The interviewer aimed to remain flexible to explore new concepts as they arose. At the beginning of the interview, informants were asked to estimate their number of pain-related healthcare contacts during the last year (GPs, physiotherapist, chiropractor, complementary and alternative medicine, hospital and emergency room healthcare contacts) and their use of pain medication. Additionally, informants were asked to recall if this pattern of healthcare use had changed over the last five years. This information was evaluated by one of the authors (SM) and grouped into one of the following three categories to comply with previously identified long-term musculoskeletal healthcare trajectories [5]: Low (no or very few annual musculoskeletal healthcare contacts), Medium (five to 15 annual musculoskeletal healthcare contacts) and High (More than 15 annual musculoskeletal healthcare contacts).

Next, informants were asked to:

- Tell their pain story
- Explain beliefs about their pain
- Describe pain-related healthcare experiences (if any), including thoughts/beliefs/experiences underlying selecting or deselecting healthcare and/or different treatment modalities.
- Suggest any advice to other people with chronic pain and HCPs.

Before data collection for the study, we conducted three pilot interviews. These were recorded, transcribed, read and discussed by two of the authors (SM and HRS) to make sure that questions were understandable and that answers reflected topics of interest, leading to small adjustments to the interview guide.

Qualitative data analysis

All audio recordings were transcribed by a research assistant with extensive experience in transcription and competences in qualitative research. Data analysis was carried out in two rounds. Round one followed the process of thematical template analysis as described by Brooks and colleagues [37] in the following stages: 1) reading and re-reading transcripts for familiarization, 2) preliminary coding, 3) create themes based on preliminary codes, 4) define an initial coding template based on a subset of data, 5) apply the initial coding template to further data and modify accordingly, 6) finalize the coding template and apply it to the full data set. The authorship team decided not to define any a priori coding categories in order to remain open and via an inductive process to conceptualize meaning based on the raw data. Four authors (SM, HRS, AS and CRB) were responsible for the analysis. This group consisted of physiotherapists with extensive clinical and teaching experience, and expertise in both qualitative and quantitative research. Data collection and analysis were an integrated process where initial analytic steps informed and qualified later sampling rounds, data collection and analysis. Three authors (AS, HRS and SM) independently read and coded the first 5 transcripts to develop the initial coding template (steps 1-4). Next, one author (SM) applied the initial coding template to the next nine transcripts and refined it as new aspects of meaning were recognized in the data. To qualify this process, three authors (SM, HRS and CRB) independently read and coded four selected transcripts informed by the refined coding template. Interpretation of the coding/themes/subthemes development and organization were then discussed, and agreement reached before the coding template was applied to the final 6 transcripts. Finally, themes and subthemes were discussed and challenged by all four authors involved in analysis, until consensus was obtained, before the final coding template was applied to the full data set.

In round two, we explored how the identified themes differed across levels of pain-related healthcare use. This was undertaken by comparing the coding across groups of pain-related healthcare use (low, medium, high). In this process, two authors (SM and CRB) individually reread the thematized codes for each group of pain-related healthcare use and prepared summaries with condensed aspects of meaning for each group. After this, the summaries were reviewed, discussed and challenged until consensus was obtained. The main results will be presented as condensed aspects of meaning and each theme/subtheme will be accompanied with example citations. All transcripts were uploaded and analyzed using NVivo 13 (QSR International, Melbourne, Australia).

Ethical aspects

This project was approved by the Danish Data Protection Agency (project number 1–16–02-141-18). Participation was based on informed consent and we only contacted informants that had a priori accepted to be contacted. All data were stored and handled according to Danish law and will be deleted by the end of the project. According to Danish law, this type of study does not require approval by a biomedical research ethics committee [38].

Results

Characteristics of informants

Informants' profiles are presented in Table 1. Eleven women and nine men were interviewed. One informant was interviewed twice, as familiarization with the data revealed that more clarification was required. Ten informants were working, eight were retired, while one had a 'flex job' (a form of reduced capacity job) and one was not working due to other health conditions. Age ranged from 39 to 77 with a mean of 58. Number of pain sites ranged from one to seven with a median of three in both 2008 and 2020. Fourteen informants had low health anxiety scores in 2008 and nine in 2020. Self-rated workability ranged from one to ten with a median of eight. The Well-being Index scores ranged from 16 to 92 with a mean of 54 and Musculoskeletal Health Questionnaire score ranged from 16 to 49 with a mean of 38.

Table 1 here

Explanations for use, or non-use, of pain-related healthcare services and expectations about the HCP.

The outcome of the analytic process for the first question, four key themes were identified: 1) system-facilitated pathways, 2) appraisal of healthcare, 3) autonomy, belief and values, and 4) recommendations for healthcare. is illustrated in Figure 2. Each theme is described below, with subthemes and supporting quotes.

Figure 2 here

System-facilitated pathways

System-facilitated pathways both drive and modify use of pain-related healthcare services. The healthcare system has its own organization, traditions and procedures which often define clinical pathways and drive healthcare due to chronic pain. In the Danish healthcare system, the GP is the gate keeper and the initial healthcare contact in the majority of cases, but healthcare due to chronic pain often involves different professions in different sectors, influenced by referral from the GP (Figure 1).

System pathways

Patients with chronic pain move in system-defined sequences back and forth between the different specialties and sectors involved, depending on the results and reports from examinations and treatments. Patients need to comply with this system when seeking healthcare, even in situations where other HCPs and treatments are preferred, and these system pathways exhaust them.

> *I17: …but I also felt that you are being thrown around because everything is so divided. You have to wait for x months to get to a rheumatologist who you hope can help you. And once you have been there, you have to go back to your own GP to get a new referral to someone else who might be able to help. And that person cannot help either, so you spend a really long time getting through the system, and that's frustrating.*

Referral

Referral is a common driver of healthcare. Often patients with chronic pain follow the clinical pathway laid out by the GP, and many have trust and faith in the evaluation and expertise of the GP. However, referral can also be initiated by the patient, as some take control over their situation and suggest initiatives they have heard or read about. Others, in frustration or anger push the GP to act and initiate additional healthcare initiatives.

> *I13…then I said, "I have to tell you one thing", hm, "what is it then", she said (The GP). "We have a problem both of us". "Well, what was it", she said. "We have to do something about this pain somehow, and now it's up to you to figure out what to do because you are a doctor". "Well", she said then she chewed on it a bit and said, "well, I think I'm sending you to the pain clinic". "Okay, then we'll try that".*

Appraisal of pain-related initiatives

All pain-related healthcare initiatives are constantly evaluated, appraised and weighed by the person with chronic pain and the outcome of this appraisal process modifies the use of pain-related healthcare services.

Treatment prototypes

Previous healthcare experiences shape or create treatment prototypes (patterns) that influence future clinical pathways and the use of healthcare services. Treatment prototypes can facilitate ongoing healthcare or reduce healthcare use. Change in symptoms or function and/or trust and relationship with the HCP are often the outcome measure against which pain-related healthcare initiatives are evaluated.

> *I12: I have been using the same chiropractor since 1992. And he knows exactly how to unlock my back. I can go there 5 - 10 times, and then my back is fine again.*

Treatment prototypes can also be self-management in cases where useful healthcare guidance has led to empowerment and self-efficacy or in cases where self-initiated actions have led to improvement.

> *I20: I use my body in my daily life and I think that it really helps. It has always helped me. I remember when the pain in my back was at its worst, then I got a part-time job on the weekends and during the holidays with my cousin, who is a bricklayer and I really, really used my back quite extremely. So, when I came home from work and I sat down under the shower and whoops all the pain in my back disappeared. And it was simply because my muscles around my back just got stronger, and then that back pain stopped...*

The patient expects no cure but expects an examination and information from a committed and listening HCP

Often the person with chronic pain does not expect a miracle cure for pain when approaching the healthcare system, but they hope for a thorough clinical examination, an explanation for the pain, useful advice and reassurance. If such expectations are not meet, they can become frustratingly resigned or their uncertainty can be the driver of ongoing healthcare.

> *I8 …he x-rayed or scanned me, I do not remember. And then a doctor comes in and says you have to look at your baptismal certificate to find out why you're in pain. I do not think, that was a proper treatment. …I would have preferred that they said, well, that's what's wrong, but we cannot do anything about it, you have to live with it. It would have been nicer, I think*

People with chronic pain look for a HCP that approaches them with interest, with an appropriate level of empathy, from a holistic standpoint, and with sufficient time to listen, see and explain. However, experiences are common where a person with chronic pain has felt a nuisance and perceived a lack of interest from the HCP. Such experiences can lead to resignation or search for alternative healthcare options. If the patient gets a satisfactory examination and relevant information, then they can accept the situation and adopt active/self-management strategies, instead of invasive treatment.

> *I14 …I thought I was going to have surgery and it was just a matter of time, but I actually came out knowing that I should not have surgery. This, of course, was totally different than I expected but I was really confident that it was ok that I should not have surgery because he (the orthopedic surgeon) explained and put it in perspective in a way which was understandable. And you were met, and you*

> *were, well, not looked down on, but you were recognized that you have an injury that was not just something…- It was not just a sprain.*

No, or sparse, improvement or the 'chemistry' is not right.

To be worth the effort, healthcare has to cause some improvement and provide relevant rehabilitation opportunities. If not, the person with chronic pain may cease it and/or search for alternative healthcare options.

> *I5. …it occurred to me, well, now I have gone there for so long and it has actually not had any effect. And I just did not book a new appointment.*

Furthermore, if the person with chronic pain does not experience a therapeutic alliance with the HCP, then healthcare may be ceased.

> *I1: …and then you have another therapist, and it does not work at all. Or the chemistry is just not there. And then you say no, then it's probably best we stop.*

Autonomy, beliefs and values.

Pain-related healthcare use and clinical pathways for people with chronic pain are often determined and modified by preferences, beliefs and underlying assumptions about cause and control, as well as personal values (within the constraints of the healthcare system or their financial options).

Healthcare should fit my needs, beliefs and values

Beliefs and assumptions for healthcare often outrank the HCPs expertise and evidence. For example, healthcare initiatives that are trusted and perceived as needed will be well-regarded, despite being explicitly not recommended by their HCP or lack of evidence.

> *I8: …and it may well be that scientifically it has not been proven that massage helps, that it is only for well-being, like my doctor said. But I can feel that it helped...*

> *I10: …whether it's alternative or the established medical science - well, I kind of don't care. I lean towards the conclusion that if it is something that can help me in my daily life and my situation, well, then I gladly accept it.*

People with chronic pain often have their own rationale/thinking framework for how to control or relieve the pain and if suggested healthcare initiatives do not fit with this framework, they become skeptical or disregard it and maybe take initiative to go somewhere else and find another HCP. Sometimes, the person with chronic pain bypasses traditional clinical pathways to get the help they want.

> *I12 ...and then I got that injection, and it was simply glorious, and considering how awful it was last time...then I am glad that we called the ambulance this time. Because if I had waited and let it calm down, and then had to contact my GP the next day, and it is hopeless. The GP, they are… it is completely hopeless. And then you have to be referred for an X-ray and it takes days and weeks. No, then it was much better that we did this.*

A person with chronic pain can also disregard healthcare due to a lack of trust or their own belief that the pain is self-inflicted and caused by personal weakness and inactivity. Such beliefs may initiate overuse of physical activity strategies, causing a vicious circle with increasing pain and despair.

Healthcare has to be manageable/feasible for me in my situation

Perceived limitations and resources are important for healthcare behavior. If the available healthcare initiative is perceived to be expensive, unhelpful, if it becomes stressful/unmanageable, or if the time demands or perceived risk of side effects exceed the potential benefits, then that healthcare initiative may be disregarded or dismissed, despite referral/recommendation.

> *I13: I should have been attending a 13-week course, where I had to drive down there regularly (Specialized pain rehabilitation clinic) and I simply could not manage it. And then they finished me off. [S: So, why did it end?] Well, that was probably because I had not signed up for that course (pain education and cognitive therapy). But, I had to drive almost 100 km back and forth once or twice a week; I simply could not overlook to sit in the car for so long. ... I simply could not, I could not drive there twice a week, I just could not, it stresses me to be honest.*

To be relevant, healthcare due to chronic pain also has to be appealing and financially/geographically convenient and timely. Such practical aspects are sometimes beyond the influence of the person with chronic pain but still impede relevant healthcare options. What works and fits from a practical point of view for a person with chronic pain is important, and practical aspects can both facilitate and inhibit the use of pain-related healthcare services.

> *I5: I agreed to participate because I thought, I can manage this (back pain exercise team), it's four Tuesdays, and it's at a time that fits me. It's easy to go there, it´s free and it fits well with my everyday life. That was really it.*

Illness representation - biomechanical beliefs about pain drives my healthcare behavior (cause and control).

For some, beliefs about causes for pain grounded in a biomechanical paradigm (work/physical exposures, mechanical defect, injury, age or morbidity) and imaging considered a valid source of diagnostic information. Feelings of being fragile and/or permanently damaged often accompany such beliefs. Such a conceptual framework drives healthcare in the quest for diagnostic certainty or the endeavor to fix biomechanical damage. In some cases, such perceived biomechanical damage triggers thoughts about inevitability of future surgical procedures.

> *I9: I have used a chiropractor in the past, because I have had some joint slips because of high jump and gymnastics. Now my own GP can just pull me back in place. I've just visited him because I had acute back pain and he could just pull it into place.*

> *I10: ... the reason I got up there (Alternative therapy - Craniosacral Therapy), it turned out, that my skull was sitting wrong on the outer cervical vertebra. It simply sat in the wrong place.*

The pain or functional limitations necessitates healthcare

Pain flairs or functional limitations may call for actions to get through the day – or through the night. In some cases, the pain can make the person with chronic pain desperate and they may see no alternative to healthcare. Often such healthcare initiatives are taken without consultation with a HCP. Pain medication or alternative medicine is frequently used in such situations but also can involve contacts to alternative HCPs or primary care HCPs.

> *I8: …I am not a fan of painkillers but I've had to do it sometimes because I've been in so much pain and I only take the painkiller if it really hurts, and if I, it hurts in the evening and I know I need to sleep, then I might as well take just a few pain killers to fall asleep.*

Recommendations for healthcare

A recommendation can be a powerful driver of trying different pain-related healthcare modalities, including alternative medicine and therapy.

Recommendations from relatives/others

People with chronic pain experience that relatives or other caregivers are eager to assist in finding ways to relieve the pain. Such recommendations and advice are often trusted and followed.

> *I7: …what mattered to me was that I had heard from others that she (alternative therapist) was really good. And that's what matters to* me.

Recommendations from HCPs

In some cases, a patient is recommended alternative treatment by HCPs. HCPs can also influence healthcare by recommending to cease or pause a course of care. Ceasing healthcare can also be based on a joint decision between the HCP and the person with chronic pain.

> *I12: He said, you can come again if you need it [S: Did you need more treatments, or was it ok with you?] I thought it was fine for me.*

Differences in explanations and expectations between groups of pain-related healthcare use

Eight informants were classified as 'High' healthcare users, seven were 'Medium' users and five were 'Low' users. Some themes were evident across all groups of pain-related healthcare use. For example, reports of: i) disappointing healthcare experiences and pain-related healthcare initiatives with no or little effect, ii) the desire to be seen, heard and approached with interest by the HCP, iii) beliefs that pain is caused by biomechanical damage and imaging is required as it is a valid source of diagnostic information, and iv) skepticism towards medication (event though high healthcare users often take it because it is considered necessary), were similar across groups.

Considerable differences in the expectations for pain/healthcare/the HCP, and pain-related management strategies (treatment prototypes) were recognized between groups of pain-related healthcare use. The 'Low' healthcare user group expressed a lack of faith in the usefulness of healthcare and often prefer to self-manage their pain. They use healthcare to rule out serious conditions and pain is considered to be a natural part of life and hence not dangerous. The 'Medium' group have multiple pain-related healthcare experiences. They express faith in the healthcare system and healthcare management strategies are characterized by pain medication and conventional healthcare. They expect the HCP to be a mentor or collaborator that honestly and empathetically guides them and provide information – also if nothing can be done about the pain. However, such guiding is not always provided which leaves the medium healthcare user feeling unresolved. The 'High' group, by contrast, expect the HCP to be a helper or a partner that provides healthcare that complies with their expectations and needs. Where the HCP do not accommodate this, attention will be directed towards other healthcare options. They seek an explanation for pain. This group has multiple, often dissatisfying, pain-related healthcare experiences, and treatment prototypes include both conventional and alternative healthcare management strategies (including pain medication).

Discussion

Main results

People with chronic pain explained that beliefs about natural history/clinical course and pain control, pain and functional limitations, recommendations from trusted persons, and the search for a diagnostic label/reassurance, often initiate pain-related healthcare use. Once a person with chronic pain has decided to enter the healthcare system, the referrals given by the HCP, and the pathways laid out within the healthcare system, are often followed if such pathways are considered to be feasible. Healthcare due to chronic pain is highly influenced and modified by two interconnected systems. Firstly, perceived needs, beliefs and values are an important modifier of pain-related healthcare use. For example, pain medication will often be disregarded, despite recommendation, if the person with chronic pain is skeptical about it or if side effects are considered to outweigh the benefit. Similarly, alternative therapy/medicine might be selected as a pain management strategy if believed or experienced to be effective, despite recommendation against or no scientific evidence for effect. Likewise, biomechanical beliefs (e.g. beliefs that a displaced lumbar vertebra is the cause of back pain) can trigger perception of a need for certain treatments (e.g. lumbar manipulation) and examinations (e.g. scans). However, if the pain is not considered to be a threat and/or the person lacks faith in the helpfulness of healthcare, then 'wait-and-see' or self-management strategies might be preferred. Secondly, previous healthcare experiences and the appraisal of such experiences are another powerful modifier of future healthcare use. The appraisal process can, for example, lead to treatment prototypes characterized by continuous or recurrent use of pain-related healthcare in cases where needs and expectations (for e.g. pain relief) are met, and beliefs and values match the management provided. In contrast, that appraisal process can lead to self-management or wait-and-see prototypes if the healthcare provided did not match the needs, beliefs and values of the person with chronic pain. The desire to be seen, heard and approached with interest by the HCP is essential for people with chronic pain. When seeking healthcare, the care seeker will appraise if the HCP meet this expectation and that appraisal will influence future healthcare. These interconnected modifier-systems seem to explain some of the different pain-related healthcare seeking trajectories of people with chronic pain, as the explanations across levels of pain-related healthcare use show considerable differences related to those factors.

Discussion of results

People with chronic pain use healthcare services more often than people without chronic pain [39,40] but not all people with chronic pain have the same healthcare seeking behavior [5]. In this study, we attempted to capture some explanations for seeking or deselecting pain-related healthcare and our analysis showed that certain factors initiate new pain-related healthcare contacts, while beliefs and experiences modify future healthcare seeking trajectories. Leventhal et al introduced 'The Common-Sense Model of self-regulation' (CSM) [41,42] as a theoretical framework to understand how people respond to illness. According to that framework, pain initiates a cognitive and emotional response and a person with pain interprets their symptoms and that interpretation influences their actions. Beliefs about cause of the pain, consequences of the pain, controllability of the pain, expected duration of the pain, together with personal experiences and external sources of information (such as that from HCPs, relatives/friends and the media), are important in that process [42]. According to this evaluation, a person with chronic pain acts (which could involve healthcare) and subsequently appraises the effect of this action. In this way, the CSM resonates with the findings of this study and supports the importance of, and the potential for, HCPs addressing beliefs about the pain in order to modify how people with chronic pain respond to their condition. Our findings add to the elements of CSM by also shedding light on how healthcare systems referrals and pathways facilitate healthcare use in ways that can be helpful or not.

Studies have shown that people with chronic pain often seek alternative medicine/therapy management [43,44], which suggests that many people with chronic pain are not satisfied with conventional healthcare. This study confirms that alternative treatment options are commonly used or tried by people with chronic pain. Furthermore, dissatisfying conventional healthcare experiences were commonly reported in this sample of informants and the sources for dissatisfaction were multiple (e.g. not being engaged empathetically, not getting the help/information/examination/medication perceived as needed). Other who have also explored first person narratives of people with chronic pain have also reported dissatisfying healthcare experiences, which in some cases have led to ongoing use of healthcare services [22,23]. However, ongoing or high use of pain-related healthcare services is not always beneficial for patients as it can lead to overdiagnosis with unnecessary tests and treatment, in addition to challenging the provision of healthcare system resources [45,46]. Thompson et al [47] have suggested that in order to get on with life in the context of chronic pain, the person with chronic pain has to re-occupy him/herself, which involves a process of making sense of the pain, deciding to move on with life, and flexibly persisting (being committed in achieving goals in life while flexibly managing the challenges of chronic pain). On this journey, the role of the HCP is to help the person in pain to make sense of, and validate, the pain in order to empower the person and "open the door to the future" [22]. The desire to be approached with an appropriate level of empathy, by a HCP intent on listening and understanding, and to experience validation of the pain experience, was put forward by almost all participants in this study. This insight has clinical implications as pain-related healthcare trajectories potentially could be modified if HCPs deliberately and intentionally approach patients in this way. The importance of such an approach and pain validation for chronic pain management has also been emphasized by others [22,47]. What is less often recognized is that this has not only the potential to enhance management outcomes and help a person with chronic pain embark on a healing journey towards better quality of life and function, but it also could change their healthcare seeking trajectory.

Design and analysis considerations

Trustworthiness

We have aimed to establish trustworthy results worthy of attention by demonstrating reflectiveness and transparency throughout the study by the use of audit trails and reflexive journals [48]. We have accounted for the research process and provided the readers with evidence of the decisions and choices made throughout the data collection and analysis process.

Sampling

We purposefully selected informants from a large group of people reporting chronic pain. By that process, there was potential that we may have selected and included a group of informants with highly specific characteristics (e.g. high health literacy, which influenced their willingness to participate). However, we invited informants with very different profiles and only three declined participation, which strengthens our perception that a variety of voices are represented in this sample.

Data collection was ceased when information power for theme and subtheme development for cross-case analysis was considered to be sufficient. For the comparison of themes and subthemes between groups of pain-related healthcare use, additional purposeful sampled informants could have potentially provided the opportunity to capture more nuances between groups. However, in this comparison we narrowed the aim by exploring already developed themes/subthemes, and we focused on highly specific informant characteristics where the diversity of experiences was likely to be less diverse. We therefore believe that the included informants still provide access to useful and relevant insights with high information power [49]. Readers should, however, be aware that this sample may not be representative of the whole chronic pain population (even though recruited from a representative cohort). We sought to gain a rich description of experiences that explain the complexity of seeking, or deselecting, healthcare and have proposed hypotheses about what differentiates levels of healthcare use. We acknowledge that the insights from this sample may have limited generalizability to other settings and, in interpreting the results of this study, the reader should be mindful of ways the mainly government-funded healthcare system in Denmark might differ from their healthcare system. However, we still believe that our findings could be helpful and transferred to some other settings.

Qualitative data analysis

Although we aimed to create a judgement-free environment for all informants to bring forward all aspects of pain-related healthcare, some participants might have withheld undesirable or stigmatizing healthcare activities (like high use of opioids or alternative therapies), even though our impression was that informants were generally candid and frank. All interviews were conducted by the same person (SM), who was relatively inexperienced in qualitative data collection at the beginning of the study. Therefore, the first phases of data collection and analysis was governed and guided by experienced qualitative researchers (HRS, AS) to ensure data quality and data saturation. In accordance with the qualitative approach, several authors were involved in the coding and analysis process (SM, AS, HRS, CRB). In the analysis phase, we decided not to approach data through a priori specified theoretical lens or define any a priori coding categories. If a more theoretical analytic approach was applied, alternative interpretations to those presented in this article might be possible. However, we have attempted to make our audit trail explicit for the reader to ensure a high degree of transparency. We preformed no intra- or interobserver reliability test of the coding. Instead results were reached by discussions and agreement between authors.

Conclusion

Participants in this study all reported chronic pain in both 2008 and 2020. When invited to explain drivers for their use or non-use of pain related healthcare, we found that beliefs about pain course and control, pain and functional limitations, recommendations from trusted persons, and the search for a diagnostic label/reassurance, often initiate pain-related healthcare use. The referrals given and the pathways laid out within the healthcare system are often followed, when such pathways are considered to be feasible. However, healthcare due to chronic pain is highly influenced and modified by two interconnected systems: 1) perceived needs, beliefs and values and 2) previous healthcare experiences and the appraisal of such experiences. It is essential for people with chronic pain to be seen, heard and approached with interest by the HCP and whether this expectation is met will influence future healthcare. Comparing explanations between participants with high, medium and low use of pain-related healthcare services showed considerable differences in perceived needs, beliefs and values and previous healthcare experiences between these groups, which could explain some of their different pain-related healthcare behavior. This study highlights the importance for HCPs to approach a patient with an appropriate level of empathy, with the intention to listen and understand, and validate the pain experience, as such an approach provides a HCP the opportunity to modify future use of pain-related healthcare for people with chronic pain.

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Declaration of interest

Declarations of interest: none.

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Tables

Table 1
Demographics and health-related profiles of informants

Pseudonym	Pain-related healthcare use (low, medium, high)	Sex	Age	Number of pain sites (range 1-7)		Health anxiety		Labour market status	Self-rated work ability (range 1-10)	Well-being Index (range 0-100. Population norm = 68)	Musculoskeletal health (range 0-56)
				2008	2020	2008	2020				
I1	High	Female	55	5	7	Low	High	Working	9	64	31
I2	High	Male	72	5	3	Low	Low	Retired	4	56	20
I3	Low	Female	62	6	3	High	Low	Retired	8	72	37
I4	Low	Male	62	7	7	High	High	Retired	8	56	44
I5	Medium	Female	59	2	1	Low	Low	Working	9	56	41
I6	Medium	Male	50	1	2	Low	Low	Working	10	88	49
I7	High	Female	56	3	4	Low	Low	Working	9	84	35
I8	Low	Male	58	3	4	Low	High	Working	9	44	39
I9	Medium	Male	77	3	4	Low	Low	Retired	8	92	44
I10	High	Male	61	7	3	High	High	Flex job	7	24	39
I11	Medium	Male	39	7	7	Low	High	Working	7	68	34
I12	High	Female	66	4	2	Low	High	Retired	8	52	24
I13	High	Female	67	7	5	High	High	Retired	2	60	16
I14	High	Female	47	5	6	Low	High	Working	9	64	41
I15	Medium	Female	46	2	1	Low	Low	Working	9	60	52
I16	High	Male	53	3	1	Low	High	Other	1	20	40
I17	Medium	Female	38	1	3	Low	Low	Working	7	44	40
I18	Low	Female	76	1	2	Low	High	Retired	4	56	30
I19	Medium	Female	72	2	1	Low	Low	Retired	1	16	47
I20	Low	Male	63	2	1	High	Low	Working	7	28	49

Figures

Figure 1: Current organization of health care management of MSD care-seeking patients in Denmark (Figure with permission from Ørtenblad et al) [26,50]

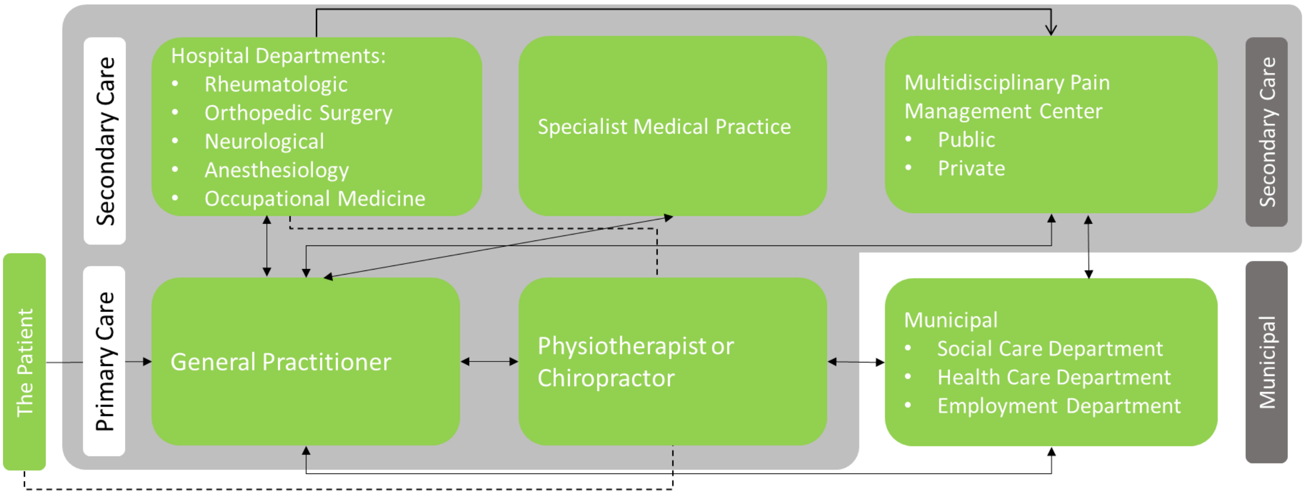
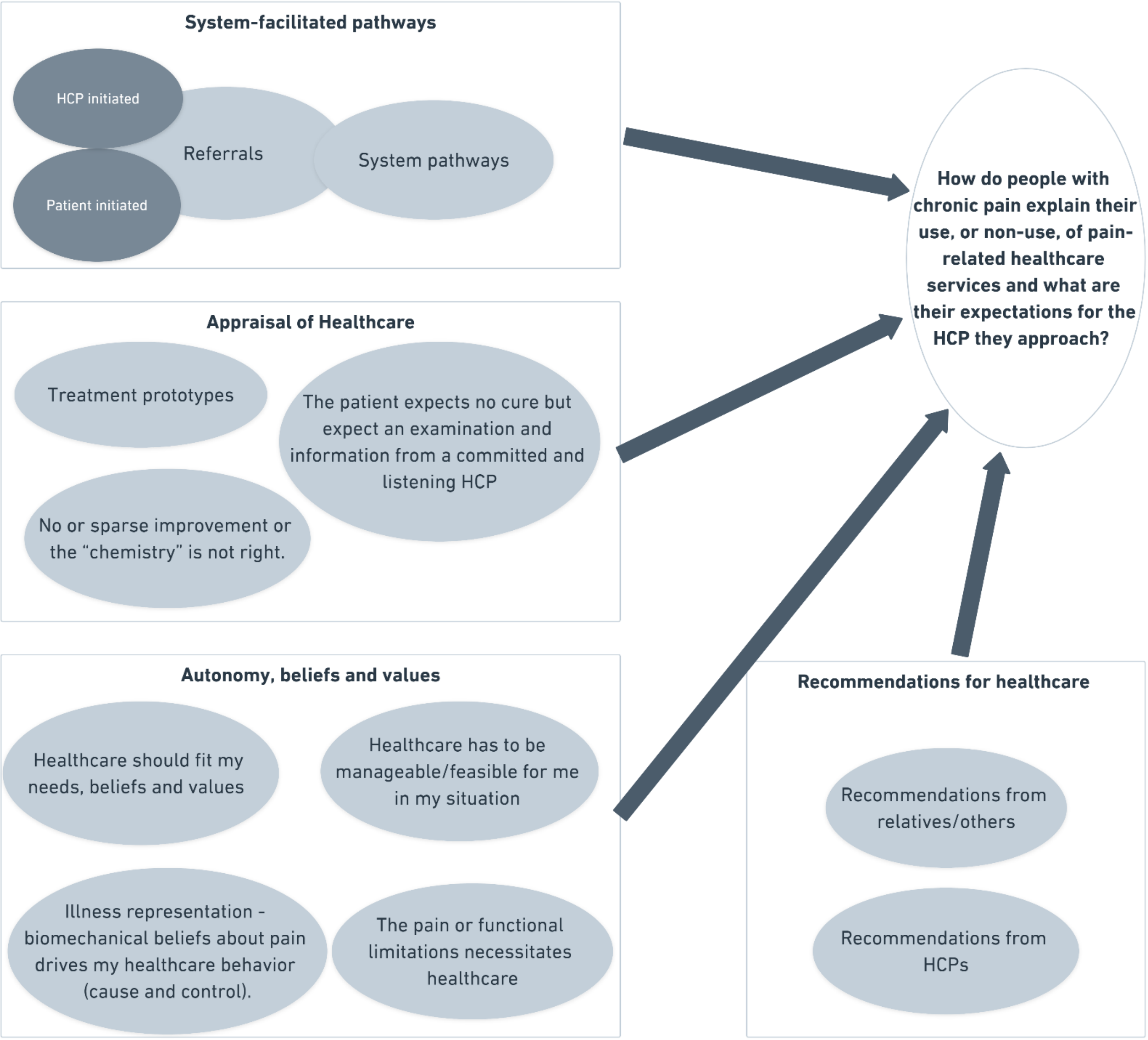


Figure 2. Explanations for use, or non-use, of pain-related healthcare services



Appendix C1

Project audit trail

Appendix: Project audit

This audit trail is prepared in order to demonstrate our thinking and reflections in data collection and analysis process. This serves to establish transparency of the research process and to meet the trustworthiness criteria as described by Nowell et al (1). According to Nowell and colleagues, trustworthiness depends on credibility, transferability and confirmability throughout the research process. The audit trail demonstrates how we have strived to achieve this and, therefore, includes examples of central working documents, descriptions and argumentation.

Sampling

We sampled informants from a population-based cohort of working aged Danes established in 2008. For the purpose of this study we only regarded those whom reported pain for longer than 3 months in both 2008 and 2020 and only individuals whom had accepted to participate in an interview.

A central criterion for the sampling of informants for this study was number of pain sites as we found more musculoskeletal pain sites to be causally associated with more healthcare contacts and increasing healthcare cost in the first part of this project. However, to ensure a variety of voices represented we also sampled participants with different profiles in terms of gender, age, health anxiety, well-being, labor market status. We sampled informants in three sampling rounds interrupted by analysis and meetings between the group of authors responsible for the analysis. Therefore, analysis and discussion in the authorship group influenced later sampling rounds as described in the article.

Pilot sampling was based on number of pain sites, and without much consideration about sex, age, use of pain-related healthcare use, well-being etc. The purpose of this initial sampling was to test the interview schedule, including formulation and sequence of questions.

First round sampling was more systematic and reflective and primarily focused on recruiting informants with different number of pain sites of both genders with different age.

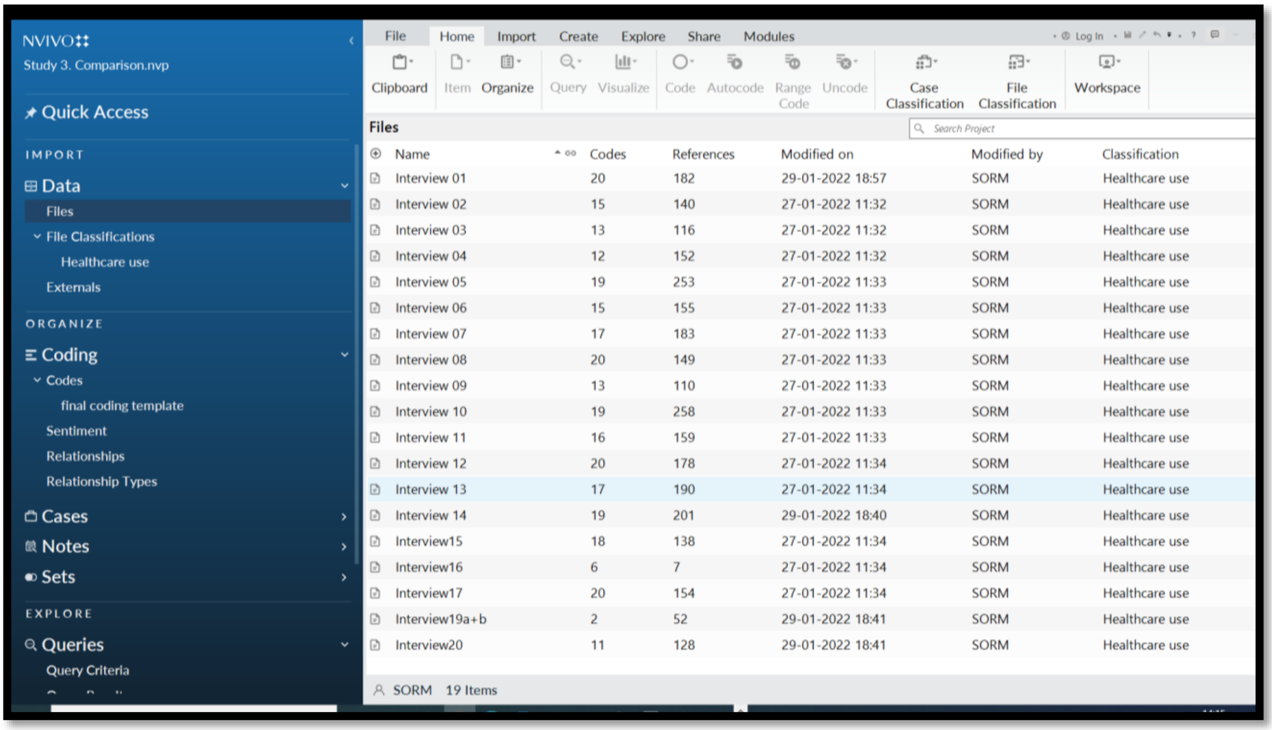
In the second sampling round was based on the same sampling criteria, but we also strived to invite informants with different profiles in terms of health anxiety and well-being.

For the third sampling round we focused on also sampling informants with fewer pain sites and low well-being index, as we became aware that these voices were sparsely represented in the sample.

Data collection and transcription

Anonymized transcripts were saved in separate folders labeled with a participant identification number. Each folder contained the original transcript and a copy of the transcript with initial open coding notes if such coding was performed in Microsoft Word. All transcripts were also uploaded to NVivo and labeled with the same identification number.

Figure 1. Transcripts uploaded to NVivo



Name	Codes	References	Modified on	Modified by	Classification
Interview 01	20	182	29-01-2022 18:57	SORM	Healthcare use
Interview 02	15	140	27-01-2022 11:32	SORM	Healthcare use
Interview 03	13	116	27-01-2022 11:32	SORM	Healthcare use
Interview 04	12	152	27-01-2022 11:32	SORM	Healthcare use
Interview 05	19	253	27-01-2022 11:33	SORM	Healthcare use
Interview 06	15	155	27-01-2022 11:33	SORM	Healthcare use
Interview 07	17	183	27-01-2022 11:33	SORM	Healthcare use
Interview 08	20	149	27-01-2022 11:33	SORM	Healthcare use
Interview 09	13	110	27-01-2022 11:33	SORM	Healthcare use
Interview 10	19	258	27-01-2022 11:33	SORM	Healthcare use
Interview 11	16	159	27-01-2022 11:33	SORM	Healthcare use
Interview 12	20	178	27-01-2022 11:34	SORM	Healthcare use
Interview 13	17	190	27-01-2022 11:34	SORM	Healthcare use
Interview 14	19	201	29-01-2022 18:40	SORM	Healthcare use
Interview15	18	138	27-01-2022 11:34	SORM	Healthcare use
Interview16	6	7	27-01-2022 11:34	SORM	Healthcare use
Interview17	20	154	27-01-2022 11:34	SORM	Healthcare use
Interview19a+b	2	52	29-01-2022 18:41	SORM	Healthcare use
Interview20	11	128	29-01-2022 18:41	SORM	Healthcare use

All audio recordings were saved in separate named folders on a secure double-password protected drive with access only for the Ph.D. student, the Danish supervisors and the research assistant responsible for transcription. Transcripts, audio files, notes, coding documents and folders concerning a specific informant were all labeled with the same informant identifier to keep track of all data and documents throughout the study. Meeting summaries and general notes were saved in a separate folder and labeled with date and topic.

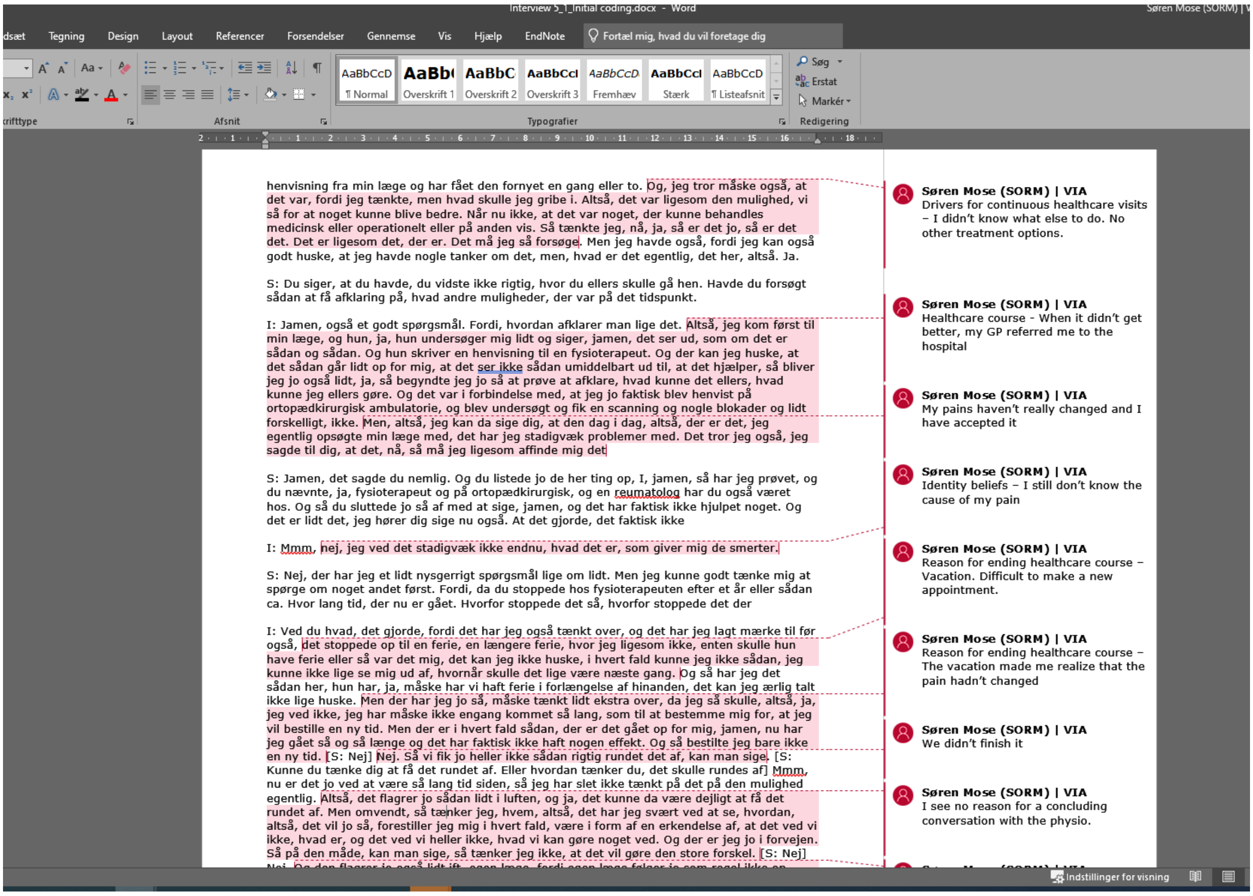
Data collection was organized in four rounds. The pilot interviews and three data collection rounds. Pilot interviews aimed to test/refine the interview schedule and train the PhD candidate. These first interviews were read and discussed by the PhD candidate and researcher with extensive experience in qualitative research. This process led to alterations in the formulation and sequence of questions and the PhD student responsible for conducting the interview got feedback on his interview technique.

Data collection and analysis were integrated processes where initial analytic steps informed and qualified later sampling rounds, data collection and analysis. This means that data collection rounds were integrated with analysis rounds with discussions and reflections. This process involved four of the authors. These analysis rounds did not only shed light on the research question but also led to slight alterations in sequence of questions, information to informants and follow-up question etc. Hence, this integrated process was a helpful learning experience for the PhD student and assisted him in qualifying the following interviews.

Coding, development of coding categories and themes

Each transcript was printed and read several times before openly coded using either Microsoft word or NVivo. Preliminary codes were condensed into preliminary coding categories/preliminary themes and later into initial coding template following the process described in the methods section.

Figure 2. Example of open coding using Microsoft Word



henvisning fra min læge og har fået den fornyet en gang eller to. Og, jeg tror måske også, at det var, fordi jeg tænkte, men hvad skulle jeg gribe i. Altså, det var ligesom den mulighed, vi så for at noget kunne blive bedre. Når nu ikke, at det var noget, der kunne behandles medicinsk eller operationelt eller på anden vis. Så tænkte jeg, nå, ja, så er det jo, så er det det. Det er ligesom det, der er. Det må jeg så forsøge. Men jeg havde også, fordi jeg kan også godt huske, at jeg havde nogle tanker om det, men, hvad er det egentlig, det her, altså. Ja.

S: Du siger, at du havde, du vidste ikke rigtig, hvor du ellers skulle gå hen. Havde du forsøgt sådan at få afklaring på, hvad andre muligheder, der var på det tidspunkt.

I: Jamen, også et godt spørgsmål. Fordi, hvordan afklarer man lige det. Altså, jeg kom først til min læge, og hun, ja, hun undersøger mig lidt og siger, jamen, det ser ud, som om det er sådan og sådan. Og hun skriver en henvisning til en fysioterapeut. Og der kan jeg huske, at det sådan går lidt op for mig, at det ser ikke sådan umiddelbart ud til, at det hjælper, så bliver jeg jo også lidt, ja, så begyndte jeg jo så at prøve at afklare, hvad kunne det ellers, hvad kunne jeg ellers gøre. Og det var i forbindelse med, at jeg jo faktisk blev henvist på ortopædkirurgisk ambulatorie, og blev undersøgt og fik en scanning og nogle blokader og lidt forskelligt, ikke. Men, altså, jeg kan da sige dig, at den dag i dag, altså, der er det, jeg egentlig opsøgte min læge med, det har jeg stadigvæk problemer med. Det tror jeg også, jeg sagde til dig, at det, nå, så må jeg ligesom affinde mig det

S: Jamen, det sagde du nemlig. Og du listede jo de her ting op, I, jamen, så har jeg prøvet, og du nævnte, ja, fysioterapeut og på ortopædkirurgisk, og en reumatolog har du også været hos. Og så du sluttede jo så af med at sige, jamen, og det har faktisk ikke hjulpet noget. Og det er lidt det, jeg hører dig sige nu også. At det gjorde, det faktisk ikke

I: Mmm, nej, jeg ved det stadigvæk ikke endnu, hvad det er, som giver mig de smerter.

S: Nej, der har jeg et lidt nysgerrigt spørgsmål lige om lidt. Men jeg kunne godt tænke mig at spørge om noget andet først. Fordi, da du stoppede hos fysioterapeuten efter et år eller sådan ca. Hvor lang tid, der nu er gået. Hvorfor stoppede det så, hvorfor stoppede det der

I: Ved du hvad, det gjorde, fordi det har jeg også tænkt over, og det har jeg lagt mærke til før også, det stoppede op til en ferie, en længere ferie, hvor jeg ligesom ikke, enten skulle hun have ferie eller så var det mig, det kan jeg ikke huske, i hvert fald kunne jeg ikke sådan, jeg kunne ikke lige se mig ud af, hvornår skulle det lige være næste gang. Og så har jeg det sådan her, hun har, ja, måske har vi haft ferie i forlængelse af hinanden, det kan jeg ærlig talt ikke lige huske. Men der har jeg jo så, måske tænkt lidt ekstra over, da jeg så skulle, altså, ja, jeg ved ikke, jeg har måske ikke engang kommet så lang, som til at bestemme mig for, at jeg vil bestille en ny tid. Men der er i hvert fald sådan, der er det gået op for mig, jamen, nu har jeg gået så og så længe og det har faktisk ikke haft nogen effekt. Og så bestilte jeg bare ikke en ny tid. [S: Nej] Nej. Så vi fik jo heller ikke sådan rigtig rundet det af, kan man sige. [S: Kunne du tænke dig at få det rundet af. Eller hvordan tænker du, det skulle rundes af] Mmm, nu er det jo ved at være så lang tid siden, så jeg har slet ikke tænkt på det på den mulighed egentlig. Altså, det flagrer jo sådan lidt i luften, og ja, det kunne da være dejligt at få det rundet af. Men omvendt, så tænker jeg, hvem, altså, det har jeg svært ved at se, hvordan, altså, det vil jo så, forestiller jeg mig i hvert fald, være i form af en erkendelse af, at det ved vi ikke, hvad er, og det ved vi heller ikke, hvad vi kan gøre noget ved. Og der er jeg jo i forvejen. Så på den måde, kan man sige, så tænker jeg ikke, at det vil gøre den store forskel. [S: Nej]

Søren Mose (SORM) | VIA
Drivers for continuous healthcare visits – I didn't know what else to do. No other treatment options.

Søren Mose (SORM) | VIA
Healthcare course - When it didn't get better, my GP referred me to the hospital

Søren Mose (SORM) | VIA
My pains haven't really changed and I have accepted it

Søren Mose (SORM) | VIA
Identity beliefs – I still don't know the cause of my pain

Søren Mose (SORM) | VIA
Reason for ending healthcare course – Vacation. Difficult to make a new appointment.

Søren Mose (SORM) | VIA
Reason for ending healthcare course – The vacation made me realize that the pain hadn't changed

Søren Mose (SORM) | VIA
We didn't finish it

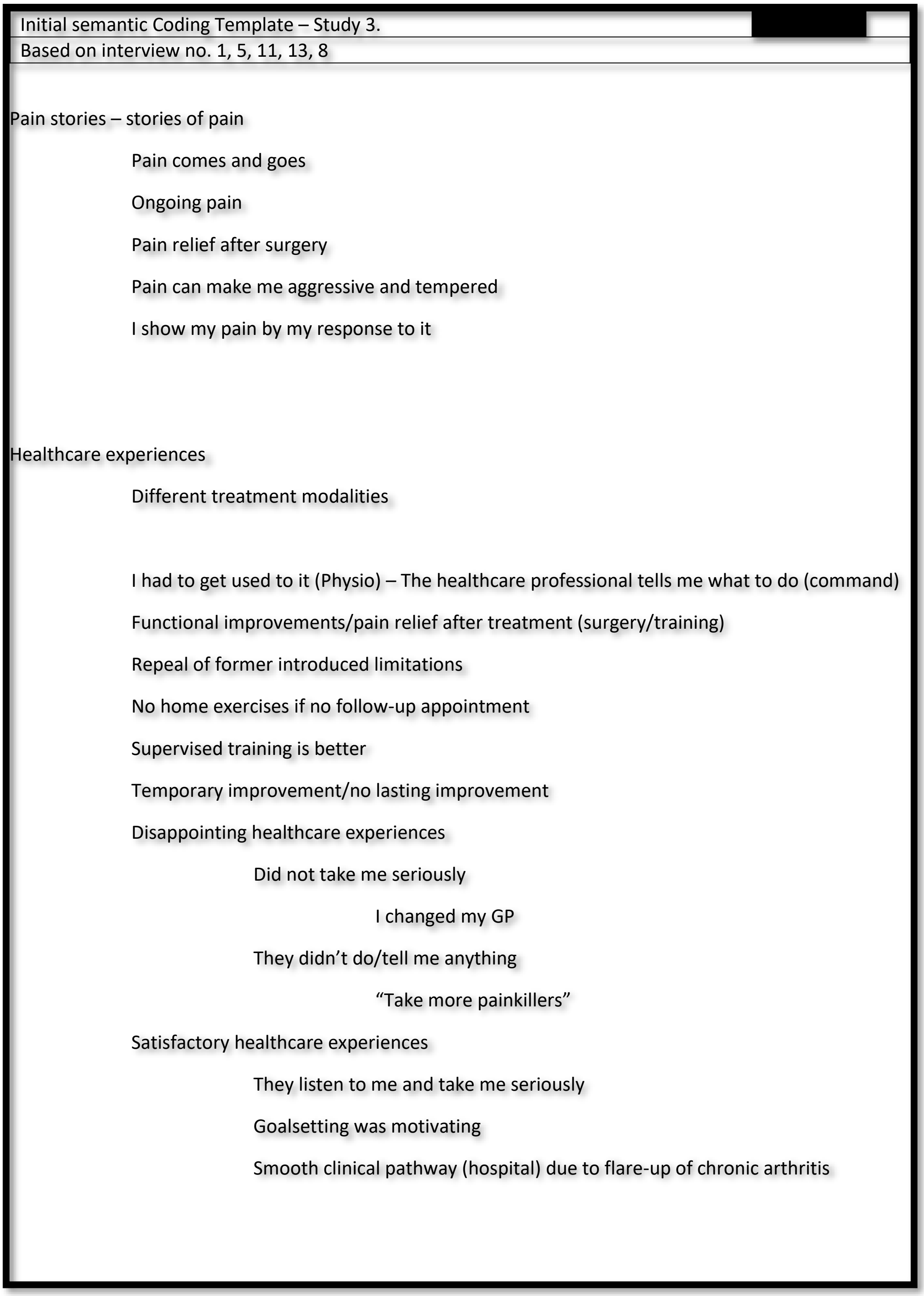
Søren Mose (SORM) | VIA
I see no reason for a concluding conversation with the physio.

Preliminary codes were collected in a document. This document was continuously updated as new data were included and new aspects of meaning were conceptualized in the raw data (please see figure 4 and 5 to illustrate coding template development). Reflective talks and discussions between authors and repetitive engagement with the data were important in this process and we gradually move from unstructured/preliminary coding to the development of themes based on ideas about meaning of the raw data. By involving four researchers with different background and research experiences in the data analysis, we aimed to triangulate and validate the analysis process.

Authors met face-to-face or online at several occasions. Before each meeting, authors had independently prepared the agreed parts of analysis. As an example, three authors (SM, HRS and CRB) independently read and coded four selected transcripts for one such meeting. The aim of this meeting was to develop and refined the coding template and organize coding categories for later themes and subthemes development. Following this meeting, eleven coding categories were collapsed into three categories that, at a later stage, were transformed into themes and subthemes with supporting quotes. Two of the authors have extensive expertise in qualitative research (HSR, AS) and they supervised the entire analysis process.

Figure 3. Pictures form a meeting between co-authors (the analysis)

Figure 4. Example of initial Coding template (extract).



Initial semantic Coding Template – Study 3. [redacted]
Based on interview no. 1, 5, 11, 13, 8

Pain stories – stories of pain

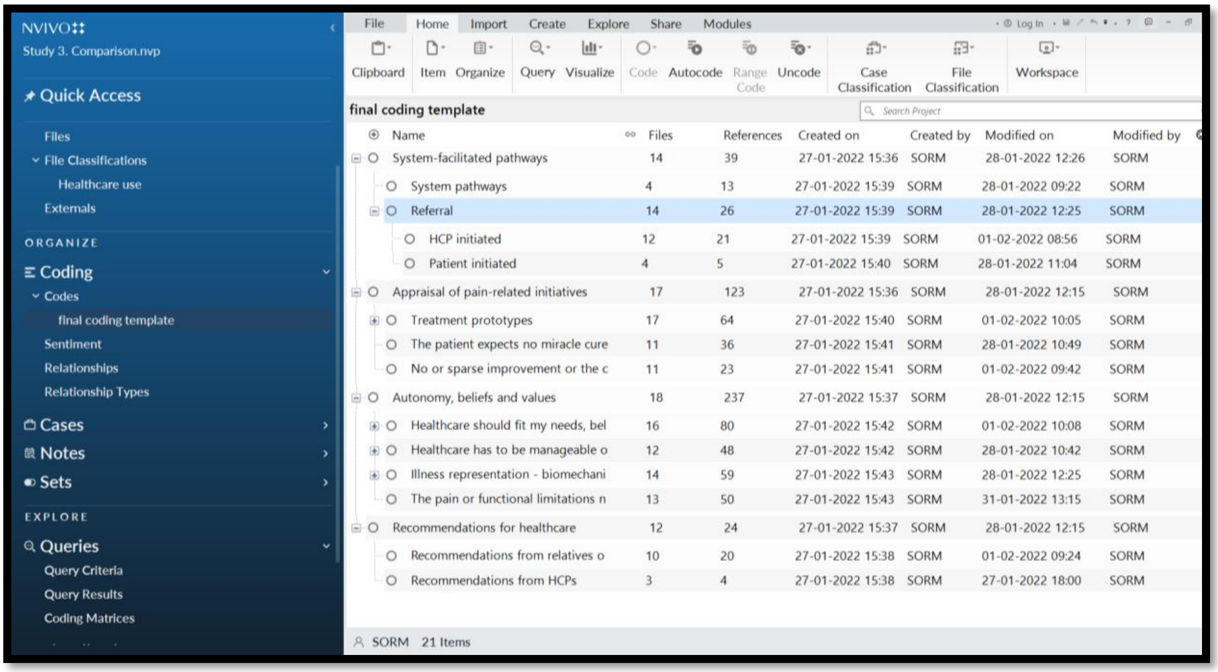
- Pain comes and goes
- Ongoing pain
- Pain relief after surgery
- Pain can make me aggressive and tempered
- I show my pain by my response to it

Healthcare experiences

- Different treatment modalities

- I had to get used to it (Physio) – The healthcare professional tells me what to do (command)
- Functional improvements/pain relief after treatment (surgery/training)
- Repeal of former introduced limitations
- No home exercises if no follow-up appointment
- Supervised training is better
- Temporary improvement/no lasting improvement
- Disappointing healthcare experiences
  - Did not take me seriously
    - I changed my GP
  - They didn’t do/tell me anything
    - “Take more painkillers”
- Satisfactory healthcare experiences
  - They listen to me and take me seriously
  - Goalsetting was motivating
  - Smooth clinical pathway (hospital) due to flare-up of chronic arthritis

Figure 5 Final Coding Template. NVivo



final coding template

Name	Files	References	Created on	Created by	Modified on	Modified by
System-facilitated pathways	14	39	27-01-2022 15:36	SORM	28-01-2022 12:26	SORM
System pathways	4	13	27-01-2022 15:39	SORM	28-01-2022 09:22	SORM
Referral	14	26	27-01-2022 15:39	SORM	28-01-2022 12:25	SORM
HCP initiated	12	21	27-01-2022 15:39	SORM	01-02-2022 08:56	SORM
Patient initiated	4	5	27-01-2022 15:40	SORM	28-01-2022 11:04	SORM
Appraisal of pain-related initiatives	17	123	27-01-2022 15:36	SORM	28-01-2022 12:15	SORM
Treatment prototypes	17	64	27-01-2022 15:40	SORM	01-02-2022 10:05	SORM
The patient expects no miracle cure	11	36	27-01-2022 15:41	SORM	28-01-2022 10:49	SORM
No or sparse improvement or the c	11	23	27-01-2022 15:41	SORM	01-02-2022 09:42	SORM
Autonomy, beliefs and values	18	237	27-01-2022 15:37	SORM	28-01-2022 12:15	SORM
Healthcare should fit my needs, bel	16	80	27-01-2022 15:42	SORM	01-02-2022 10:08	SORM
Healthcare has to be manageable o	12	48	27-01-2022 15:42	SORM	28-01-2022 10:42	SORM
Illness representation - biomechani	14	59	27-01-2022 15:43	SORM	28-01-2022 12:25	SORM
The pain or functional limitations n	13	50	27-01-2022 15:43	SORM	31-01-2022 13:15	SORM
Recommendations for healthcare	12	24	27-01-2022 15:37	SORM	28-01-2022 12:15	SORM
Recommendations from relatives o	10	20	27-01-2022 15:38	SORM	01-02-2022 09:24	SORM
Recommendations from HCPs	3	4	27-01-2022 15:38	SORM	27-01-2022 18:00	SORM

SORM 21 Items

Memos and reflexive notes

The PhD student wrote a reflexive memo immediate after each interview. These memos included early impressions and summaries of the interview, reflections of interview technique, questions, and ideas about the following sampling of informants. All memos were written in the same document to keep an overview over the data collection process, profiles of informants and alterations in the sampling and data collection. This document was a central worked document for the PhD student and served as a reflective research diary.

Table 1. Reflective memos and research diary

Interview profiles and research notes						
No	Initials	Email	Profile	Number	Healthcare trajectory group	Memo and notes
1	Anonymized	Interview takes place [redacted]	W/W 5/7 pain sites Female - working Age baseline = 43 (<50) WHO5 = 64 (Norm 68) Health anxiety L/H	Anonymized	High	Lifelong multisite pain with underlying biomechanical cause beliefs. Contradictions in some of the story. Almost as if the pain is a lever to avoid certain activities. Challenging interview but interesting perspectives on topics related to the research question. This was the first interview and I missed a number of opportunities for more detailed information and for the informant to clarify. Examples are: Only treating Symptom - what do you mean by that? Looking at the full picture - what do you mean by that? What do you mean by "the underlying cause" What do you mean by the treatment was "ok" Why were you disappointed with the doctor at the hospital? What do you mean by "looking at the whole body"?

						Relatively well-functioning woman. She seems to have self-efficacy in some aspects of life but she still considers herself to be dependent on healthcare and her underlying cause belief is that pain is caused by a uncurable biomechanical defect. She does however recognise and acknowledge that there is more to pain than damaged tissues. Based on the interview, I would consider this informant to be an over average healthcare user
2	Anonymized	Interview takes place [redacted]	W/L - 5/3 pain sites Male - retired Age baseline = 60 (>50) WHO5 = 56 (Norm 68) Health anxiety L/L	Anonymized	High	A challenging interview. On the surface a man whom seem to stay positive and manage despite severe chronic pain after a working accident but underneath a sorrowful and despairing person with disturbed sleep and massive functional limitations. More interesting perspectives on topics related to care seeking and beliefs. Again, a challenging interview and I missed the opportunity to ask more curious questions and explore his understanding in more detail. Based on the interview, I consider this informant to be a high healthcare user.
3	Anonymized	Interview takes place [redacted]	W/L - 5/3 pain sites Female - retired Age baseline = 50 (>50) WHO5 = 72 (Norm 68) Health anxiety. /L	Anonymized	Low	Retired Kitchen worker with chronic shoulder pain and very few healthcare contacts. Relevant perspectives on reasons for deselecting healthcare. Again, I missed the opportunity to get insight to more detail. She seems eager to resign form work but the pain hasn't changes since she stopped working. She seems to lack energy in general. Her beliefs about causes for pain was centred around work related exposures even though her left side shoulder pain didn't correlate with her former job exposures. The experience of work-related stress might also influence pain but I did not dig deeper into that. I consider her to be a low healthcare user.
4	Anonymized	interview takes place [redacted]	W/W - 7/7 pain sites Male - retired Age baseline= 60 (>50) WHO5 = 56 (Norm 68) Health anxiety H/H	Anonymized	Low	Very challenging interview. A man of few words and unfortunately, I did not get him to reflect on his actions and thoughts by my questions. Our community of concepts and conceptual understanding of central aspects of the interview (healthcare, pain) were different and I did not manage to enter his world in term of this. The mixing of more diseases made it difficult to interpret his response. Beside knee pain he also referred to neuritis as a source of pain and his beliefs around that was difficult to interpret. Again, I missed the opportunity to get a more in-depth understanding of why he deselected healthcare in most cases. Stoic personality as he described some of his pain as "walking on glass" but he didn't consider it bad enough for pain medication or healthcare. I would consider this informant to be a low healthcare user.
5	Anonymized	Interview takes place [redacted] Follow-up interview takes place [redacted]	L/L - 2/1 pain sites Female - working Age baseline = 47 (<50) WHO5 = 56 (Norm 68)	Anonymized	Medium	A totally different interview. Our community of concepts and conceptual understanding/language was aligned. She was af very reflective informant with detailed descriptions of belief and behaviour. Seems like an "easy" interview but I still missed the opportunity to get a deeper understanding og central themes like reasons for continuing healthcare courses with no effect and the messages she got form the HCP. Follow-up interview to understand more about drivers for selecting/deselecting healthcare. This

<table>
<tr><td></td><td></td><td></td><td>Health anxiety L/L</td><td></td><td></td><td>gave a more in depth understanding of these central elements.
This informant seems to be very high on self-efficacy and health literacy. She has much insight to the healthcare system and she knows “the language”. This meant that our conversation was quite smooth.
My best guess would be that this informant is an medium healthcare user.</td></tr>
<tr><td>6</td><td>Anonymized</td><td>Interview takes place [redacted]</td><td>L/L - 1 /2 pain sites
Male - working
Age baseline = 38 (<50)
WHO5 = 88 (Norm 68)
Health anxiety L/L</td><td>Anonymized</td><td>Medium</td><td>Well formulating and reflective informant. The worst pain for this person was long-term invalidating episodic headache but he also described bothersome shoulder and knee pain. He independently raised interesting aspects about the influence of friends and relatives. Again, I missed the opportunity to ask more why-questions. High degree of trust in his GP and the healthcare system. He seems to be high on empowerment, self-efficacy and health literacy. His relationship with the GP was a cooperation with goal-setting and tasks related to diet and exercise initiated by the GP.
Probably a low healthcare user but use of pain medication and one or more annual GP contacts could indicate medium use.</td></tr>
<tr><td colspan="7">[redacted]
After this point I had a meeting with Helle and Anne. It became clear that I have to change the interview schedule and dig much deeper into the choices and beliefs about healthcare seeking. WHY did they do what they did.
Selection based on number of pain sites is still reasonable.
Research questions are reasonable.
I do not need to be that concerned about Analytic approach. I must dig into individual cases features anyway before I look for across-case patterns. Deadline for data collection is end October.</td></tr>
<tr><td>7</td><td>Anonymized</td><td>Name from participant list does not match phone number. Excluded from the study</td><td>L/W - 3/5 pain sites
Female -
Age baseline = 43 (<50)
WHO5 = 28 (Norm 68)
Health anxiety L/H</td><td>Anonymized</td><td>-</td><td></td></tr>
<tr><td>7</td><td>Anonymized</td><td>Called 3 times [redacted]. Voice mail message. I have asked her to call back.
I will not try contact her again.</td><td>L/W - 3/6 pain sites
Female -
Age baseline = 47 (<50)
WHO5 = 60 (Norm 68)
Health anxiety L/H</td><td>Anonymized</td><td>-</td><td></td></tr>
<tr><td>7</td><td>Anonymized</td><td>Called [redacted]. No answer.
Called [redacted]. No answer
Called [redacted]. Has approved to be contacted on Monday morning

Interview takes place [redacted]</td><td>L/W - 3/4 pain sites
Female - Working
Age baseline = 44 (<50)
WHO5 = 84 (Norm 68)</td><td>Anonymized</td><td>High</td><td>Interesting interview. The informant reported manageable work-related pain in more pain sites for years but her menopause had caused intense episodic headache which had turned her lift around and reduced her QoL. Interesting aspects about finding relief and control belief in alternative healthcare which gave her a sense control over the pain and confidence. She distinguished between the MSK pain which she could manage and the headache which she could not. Different Healthcare experiences related to</td></tr>
</table>

			Health anxiety L/L			that. She seems to be a woman with high self-efficacy and empowerment to MSK pain. I would expect her to be a high healthcare user in the past 3-4 years but a low healthcare user before her menopause.
8	Anonymized	Declaration of consent and confirmation sent [redacted] Interview takes place [redacted]	L/W - 3 /4 pain sites Male - Working Age baseline = 46 (<50) WHO5 = 44 (Norm 68) Health anxiety L/H	Anonymized	Low	A surprisingly interesting interview. My preunderstanding was that we might not reach new interesting aspects in this interview, but I think that we did. The informant had long-term intermitted shoulder pain and based on that we had a reflective talk. In this case I managed to ask more why-questions and he elaborated on central aspect of his beliefs and experiences. A good experience and interesting healthcare experiences and perspectives on care seeking. He was not dependent on healthcare but he expected hands-on action from the HCP at the encounter. I consider his self-efficacy to be high. Based on the interview, I would expect this user to be a low MSK-healthcare user.
9	Anonymized	Declaration of consent and confirmation sent [redacted] Interview takes place [redacted]	L/W - 3 /4 pain sites Male – Retired Age baseline = 65 (>50) WHO5 = 92 (Norm 68) Health anxiety L/L	Anonymized	Medium	Both MSK and non-MSK related healthcare contacts. Active informant (active all his life) with high degree of trust in the GP and the healthcare system. He seems to be rather unaffected by serious cardiovascular problems. His pain cause beliefs are grounded in a biomechanical understanding but he also connects his positive mindset with the way he has handled his health issues. His understanding of healthy living is around being active and he doesn't fancy pain medication. Difficult to evaluate to what extent he self-manages as he tells about many MSK-related contacts related to e.g. sports injuries. Self-efficacy seems high. Medium healthcare user.
10	Anonymized	Declaration of consent, meeting link and confirmation sent [redacted] Interview takes place [redacted]	W/L - 7/3 pain sites Male – flex job Age baseline = 49 (<50) WHO5 = 24 (Norm 68) Health anxiety H/H	Anonymized	High	Spinal cord injury 20 years ago with a rehabilitation healthcare trajectory characterised with intensive rehab courses and ongoing use of healthcare services. Subsequent widespread chronic neuropathic pain. High user of many different MSK-healthcare services but he also seems quite resilient/resourceful and high on empowerment and self-efficacy. Articulative, reflective and eloquent informant. New perspectives related to the research question. Challenging interview as the informant talked a lot and much information about different healthcare experiences was mixed. The informant seeks and grasps all opportunities for healthcare and he was overall very satisfied and pleased with the healthcare system.
11	Anonymized	Declaration of consent and confirmation sent [redacted] Interview takes place [redacted]	W/W - 7/7 pain sites Male - working Age baseline = 27 (<50) WHO5 = 68 (Norm 68) Health anxiety L/H	Anonymized	Medium	This was one of the first second round interviews. The informant had primarily experienced knee pain. This informant deselected healthcare if it was self-payed or inconvenient for him. Surgery had been effect-full in this case. The informant had reported widespread chronic pain in the questionnaire but I could not confirm this finding in the interview as he reported local intermittent pain. Comorbidity was also an issue in this case. The informant reported neurodevelopmental disorders from childhood. I am not sure how that might influence the interview and my interpretation of it. I consider this informant to be a medium MSK-healthcare user.
12	Anonymized	Called 3 times. Answering machine [redacted].	W/L - 4/2 pain sites	Anonymized	High	A different and challenging interview. The participant has experienced an MSK-treatment

		Calls back and asks for time to reflect. We agree that I may call a morning in the middle of the following week and ask again (She will probably accept to participate). Being emotional by the conversation. Interview takes place [redacted]	Female - Retired Age baseline = 54 (>50) WHO5 = 52 (Norm 68) Health anxiety L/H			that potentially have caused a spinal fracture. This experience and the healthcare trajectory and experiences following this event has caused intense pain, frustration, anger and despair. The informant had properly osteoporosis before a chiropractic low back manipulation. She expressed desperation and distress. According to her did the chiropractor intensified her pain and ignored signs on osteoporosis and fractur. Her GP did not meet her needs for pain relief and was unreachable when she needed help. Interesting experiences and perspectives on drivers for healthcare seeking. I would consider her to be a medium/low healthcare user until the time of the spinal fracture. I consider her to be high on health literacy. Her identity beliefs around osteoporosis was than it is a severe decease.
13	Anonymized	Do not want to participate	W/W - 5 /4 pain sites Female - Age baseline = 56 (>50) WHO5 = 56 (Norm 68) Health anxiety L/H	Anonymized	-	
13	Anonymized	Declaration of consent and confirmation sent [redacted] Interview takes place [redacted]	W/W -7 /5 pain sites female - Retired Age baseline = 55 (>50) WHO5 = 60 (Norm 68) Health anxiety H/H	Anonymized	High	Chronic multiple joint pain. Psoriasis arthritis and discus prolapse. Lots of healthcare contacts and pain medication use and probably a high healthcare user. Interesting aspects and paradoxes about pain medication and physiotherapy. She considered physiotherapy to cause temporary relief and she disregarded it because of that but she did not feel the same about pain medication which she took on a daily basis. She acknowledged the importance of physical activity but not in the context of physiotherapy - She wanted to decide for herself and she did. Self-efficacy and empowerment seemed high. She contributed with perspectives on satisfying and dissatisfying healthcare contacts and reasons for selecting and deselecting healthcare.
14	Anonymized	Declaration of consent and confirmation sent [redacted] Interview takes place [redacted]	W/W -5/6 pain sites female - working Age baseline = 35 (>50) WHO5 = 64 (Norm 68) Health anxiety L/H	Anonymized	High	Several recurrent pain-related diagnoses. The informant expressed biomechanical cause beliefs (low back injury in early adulthood). She had healthcare experiences form several different HCP but she seemed to expect and prefer hands-on treatment. She expressed knowledge about the importance of training for MSK related problems but she did not have the drive to initiate training herself. Pain medication experiences. I don't feel that this interview got me much deeper into the topic. However, after the initial reading and coding, I do believe that she raised some new sub-themes. I believe that my interview technic is improving. I expect her to be a medium or high healthcare user. She appraised the HCPs whom had informed her in detail about her health issues and provided advice but she seem to prefer passive coping strategies. Her health literacy is properly not so high as she does not to act to

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>improve her overall health. Self-efficacy in terms of training was not that high, but she had started walking on her own initiative.</td></tr>
<tr><td colspan="7">[redacted]
I get the feeling that I could change my approach to interviews and introduce the aim of the study clearer at the beginning of the interview. My feeling is that this might facilitate other stories of healthcare seeking and healthcare experiences. I will try to do that next time.</td></tr>
<tr><td colspan="7">[redacted]
After the supervisor meeting with Helle and Anne it became clear that I need more stories from people with few pain sites. I will try to recruit more informants with this profile</td></tr>
<tr><td colspan="7">[redacted]
I have uploaded all 13 transcripts for NVivo and made case classification on all. It is now also evident that people with low well-being score are underrepresented. I will also recruit more from this group.
I have now read all transcripts again. There are a lot of stories – good and bad, but I do not find more nuances in reasons or drivers for seeking care or deselecting care.</td></tr>
<tr><td>15</td><td>Anonymized</td><td>Informant has approved.
Interview takes place [redacted] by phone</td><td>L/L -2/1 pain sites female - working
Age baseline = 34 (<50)
WHO5 = 60 (Norm 68)
Health anxiety L/L</td><td>Anonymized</td><td>Medium</td><td>My feeling is that this interview hasn't brought much new insight. The informant was very honest and open-hearted about her situation and health issues with overweight and gastric bypass surgery. This interview was the first in sampling round 3 and I found it difficult to time the right questions in order to open for new thoughts and perspectives on pain-related healthcare seeking. I had decided to tell more about the research aim as an introduction to the interview but I only told the usual. My impression is that the informant is (evaluate self-efficacy, health literacy and empowerment)</td></tr>
<tr><td>16</td><td>Anonymized</td><td>Declaration of consent and confirmation sent [redacted]
Interview takes place [redacted]
The informant was not able to participate at our first appointment so we had to reschedule. He had too much going on and had been talking to too many people on one day. I wonder how this will affect the interview and his perspectives.</td><td>L/L -3/1 pain sites Male - Other
Age baseline = 41 (<50)
WHO5 = 20 (Norm 68)
Health anxiety L/H</td><td>Anonymized</td><td>High</td><td>Really intense and exhausting interview (1.45 hours). Really long case story with work-related PTSD. 30-50 min. continues talk explaining this trajectory. Difficult to turn the story into the most relevant topics as the informant was quite insisting on telling many details. We got to some interesting topics at the end of the interview but I had to end the interview due to time limits and battery capacity.
I think that I will need to do a follow-up interview to get the relevant details for the project.
Very well educated, articulative, reflective and eloquent informant. The informant seemed to have high level of health literacy and self-efficacy despite stress, depression and PTSD. His healthcare trajectory related to PTSD seemed to be interconnected with his healthcare trajectory related to pain as he experiences MSK pain after very low-load tasks as a consequence of his extremely sensitized nervous system (explained by his own words)</td></tr>
<tr><td colspan="7">13/10-21
These last participants are selected outside the predefined selection matrix. They are selected based on low number of pain sites/low well-being index and sex and age.</td></tr>
<tr><td>17</td><td>Anonymized</td><td>Called [redacted] – no answer
Called [redacted] – no answer
Declaration of consent and confirmation sent [redacted]
Interview takes place [redacted]</td><td>L/L -1/3 pain sites female - working
Age baseline = 26 (<50)
WHO5 = 44 (Norm 68)
Health anxiety L/L</td><td>Anonymized</td><td>Medium</td><td>Interesting interview. An informant with chronic pain and diagnosed with functional disorder. New healthcare experiences and new perspectives on pain management and self-management. High on health literacy (nurse) and she took initiative to be referred to a specialised pain rehabilitation unit with the right expertise to match her needs on her own. Boom/burst behaviour until she got the right advice. Despite chronic pain and functional limitations, she has been reluctant with pain medication</td></tr>
<tr><td>18</td><td>Anonymized</td><td>Declaration of consent and confirmation sent [redacted]</td><td>L/L -1/2 pain sites female - retired</td><td>Anonymized</td><td>Low</td><td>Challenging interview. I found it very difficult to get deeper insight in this case. An older woman of few words. The informant did currently not have any pain and she did not want to - or</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Interview takes place [redacted]</td><td>Age baseline = 64 (>50)
WHO5 = 56 (Norm 68)
Health anxiety L/H</td><td></td><td></td><td>remembered anything about previous pain symptoms. Her current health problem was dizziness. We touched on drivers for seeking care due to dizziness but I don’t think that is was very relevant for the research questions. Nothing much new in this interview and I am in doubt if it is relevant to transcript this interview.

I think that it would be relevant to exclude this interview.
I would expect this informant to be a low healthcare user</td></tr>
<tr><td colspan="7">[redacted]
I wonder if this is the right way to go. I have interviewed 2 informants with few pain sites but these interviews have not brought new insight of expanded my understanding. Instead I have talked with persons with very few pain related healthcare contacts. I will explore this group of informants more and then reevaluate.
Furthermore, I was thinking if I should try to compare experiences, drivers and beliefs from informants with many/few pain sites in a comparative analysis. This would be in line with the other studies in the project but I will need to approach later stages of the analysis differently.</td></tr>
<tr><td>19</td><td>Anonymized</td><td>Declaration of consent and confirmation sent [redacted].

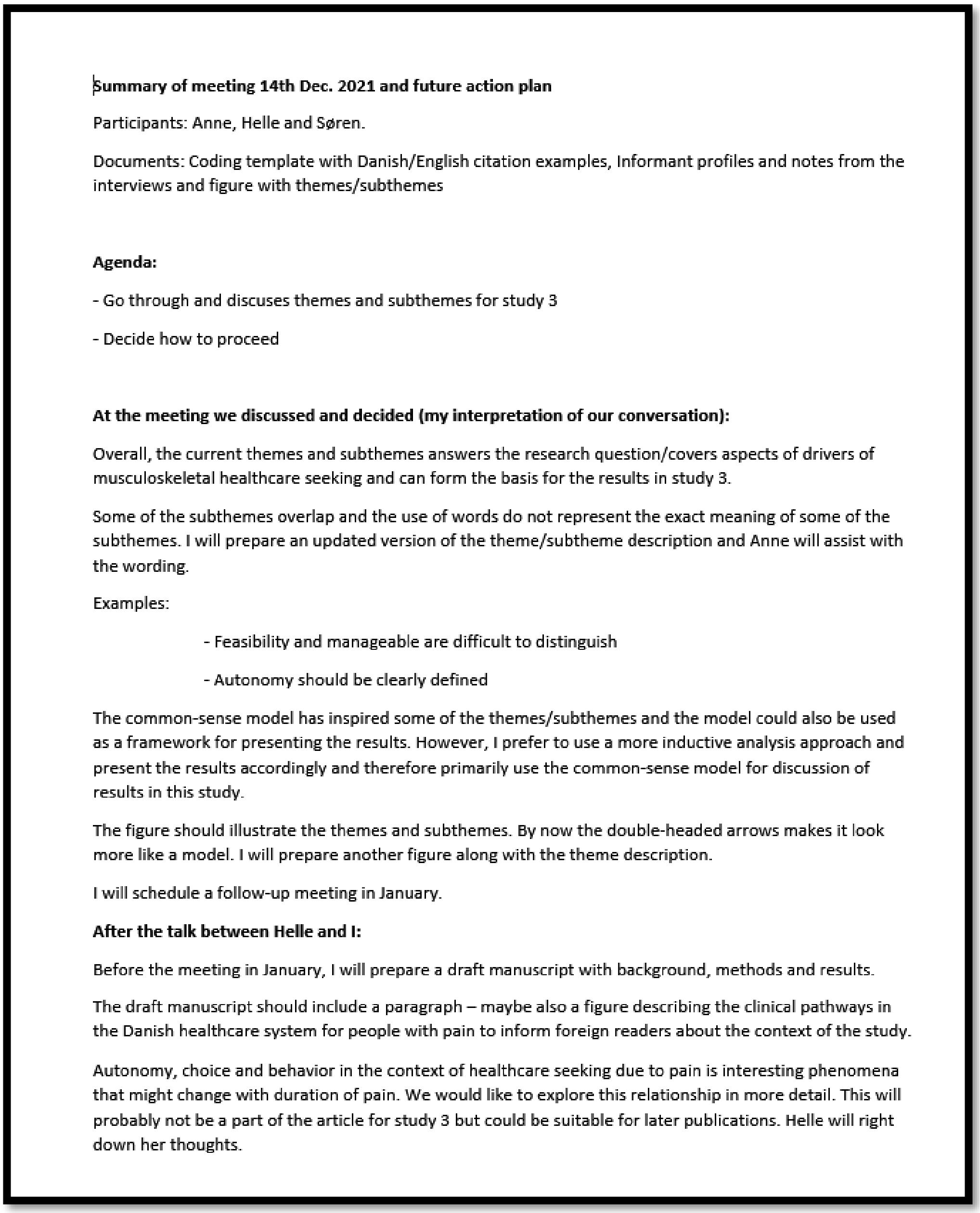
Interview takes place [redacted]</td><td>L/L -2/1 pain sites female - Retired
Age baseline = 60 (>50)
WHO5 = 16 (Norm 68)
Health anxiety L/L</td><td>Anonymized</td><td>Medium</td><td>I am not sure if I got much new information in this interview. New stories about spinal fractures and osteoporosis and cancer, but not that many new perspectives on care seeking. The informant had very high health literacy as a retired nurse. She has very low score on well-being index, however, I did not get that impression during the interview. Challenging to ask the right questions and to gain insight to new perspectives on care seeking due to pain. The informant was very satisfied with most of her experiences and she appeared to be empowered and have high degree of self-efficacy and trust in self-management.</td></tr>
<tr><td>20</td><td>Anonymized</td><td>Called [redacted] - No answer
Called [redacted] - No answer
Called [redacted] - No answer

Declaration of consent and confirmation sent [redacted].

Interview takes place [redacted]</td><td>L/L -2/1 pain sites Male – working (now retired)
Age baseline = 51 (>50)
WHO5 = 28 (Norm 68)
Health anxiety H/L</td><td>Anonymized</td><td>Low</td><td>Much of the first part of the interview was about covid-19 and his story about being infected. When asked specific about MSK pain he told about episodes with LBP in early adulthood and recent shoulder pain (passed by itself) and currently he had elbow pain related to overload from reconstruction work. None of these resent pain stories had led him to any HCP. It didn’t seem to worry him and his management strategy was time and being as active as possible. He had previously used pain medication but only for a short period of time. His experiences had taught him that being active was beneficial. He seemed to be very little worried and high on empowerment and self-efficacy. He also seemed to be high on health literacy as he explicitly told about seeking healthcare advice on the internet. His low well-being index score was not evident in the interview.
His wife had was a healthcare user and he explained their differences in management with different needs.
I don’t know if I got that much new information in this interview. Low healthcare user. Easy to talk as our community of concepts and conceptual understanding of central aspects matched.</td></tr>
</table>

The PhD student also wrote summary and reflective notes after each meeting between authors to keep track of thoughts, decisions, questions and the plan. These summary notes were shared in the authorship group. Central aspects of these notes were also integrated into the research diary.

Figure 6. Example of summary note



Summary of meeting 14th Dec. 2021 and future action plan

Participants: Anne, Helle and Søren.

Documents: Coding template with Danish/English citation examples, Informant profiles and notes from the interviews and figure with themes/subthemes

Agenda:

- Go through and discuses themes and subthemes for study 3

- Decide how to proceed

At the meeting we discussed and decided (my interpretation of our conversation):

Overall, the current themes and subthemes answers the research question/covers aspects of drivers of musculoskeletal healthcare seeking and can form the basis for the results in study 3.

Some of the subthemes overlap and the use of words do not represent the exact meaning of some of the subthemes. I will prepare an updated version of the theme/subtheme description and Anne will assist with the wording.

Examples:

- Feasibility and manageable are difficult to distinguish
- Autonomy should be clearly defined

The common-sense model has inspired some of the themes/subthemes and the model could also be used as a framework for presenting the results. However, I prefer to use a more inductive analysis approach and present the results accordingly and therefore primarily use the common-sense model for discussion of results in this study.

The figure should illustrate the themes and subthemes. By now the double-headed arrows makes it look more like a model. I will prepare another figure along with the theme description.

I will schedule a follow-up meeting in January.

After the talk between Helle and I:

Before the meeting in January, I will prepare a draft manuscript with background, methods and results.

The draft manuscript should include a paragraph – maybe also a figure describing the clinical pathways in the Danish healthcare system for people with pain to inform foreign readers about the context of the study.

Autonomy, choice and behavior in the context of healthcare seeking due to pain is interesting phenomena that might change with duration of pain. We would like to explore this relationship in more detail. This will probably not be a part of the article for study 3 but could be suitable for later publications. Helle will right down her thoughts.

Comparison of codes across groups of pain-related healthcare use

As a start of this analysis process the PhD student visually mapped the coding density across groups of pain-related healthcare use using NVivo Query Results. This served as a starting point to understand how coding might differ across groups.

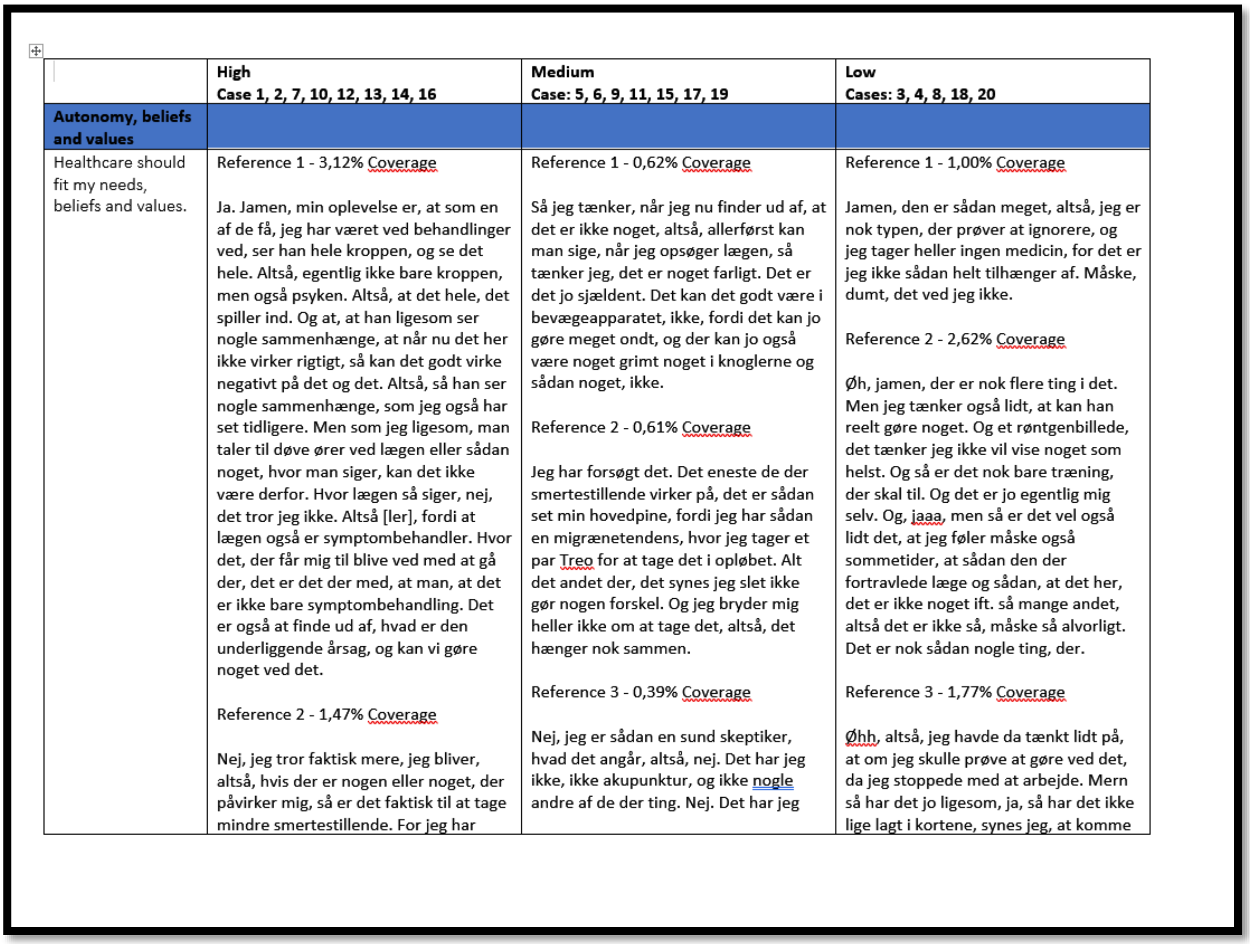
Figure 7. Example of NVivo Query Results (column percentage)

	Healthcare use = High	Healthcare use = Medium	Healthcare use = Low
1 : Treatment prototypes	14,5%	15,53%	6,22%
2 : The patient expects no miracle cure but wishes to be seen and heard	9,13%	14,83%	9,51%
3 : No or sparse improvement or the	6,13%	3,16%	7,47%

chemistry is not right.			
4 : Healthcare should fit my needs, beliefs and values.	22,04%	18,11%	36,7%
5 : Healthcare has to be manageable or feasible for me in my situation	5,79%	11,27%	6,33%
6 : Illness representation - biomechanical beliefs	12,9%	15,03%	16,6%
7 : The pain or functional limitations necissitates healthcare	13,28%	9,52%	6,62%
8 : Recommendations from relatives or others	4,42%	1,61%	3,9%
9 : Recommendations from HCPs	1,99%	0,38%	0%
10 : Referral	5,01%	7,35%	2,93%
11 : System pathways	4,81%	3,23%	3,72%

Two authors were involved in the comparison process (CRB and SM) both re-consulted the raw data and coding categories to explore how explanations and expectations differ between people with chronic pain and different levels of pain-related healthcare services use. Re-visiting the raw data and early coding categories also led to rephrase of descriptions of some already identified themes and subthemes.

Figure 8. Examples of comparing of coding across groups of pain-related healthcare use



	High **Case 1, 2, 7, 10, 12, 13, 14, 16**	**Medium** **Case: 5, 6, 9, 11, 15, 17, 19**	**Low** **Cases: 3, 4, 8, 18, 20**
Autonomy, beliefs and values			
Healthcare should fit my needs, beliefs and values.	Reference 1 - 3,12% Coverage Ja. Jamen, min oplevelse er, at som en af de få, jeg har været ved behandlinger ved, ser han hele kroppen, og se det hele. Altså, egentlig ikke bare kroppen, men også psyken. Altså, at det hele, det spiller ind. Og at, at han ligesom ser nogle sammenhænge, at når nu det her ikke virker rigtigt, så kan det godt virke negativt på det og det. Altså, så han ser nogle sammenhænge, som jeg også har set tidligere. Men som jeg ligesom, man taler til døve ører ved lægen eller sådan noget, hvor man siger, kan det ikke være derfor. Hvor lægen så siger, nej, det tror jeg ikke. Altså [ler], fordi at lægen også er symptombehandler. Hvor det, der får mig til blive ved med at gå der, det er det der med, at man, at det er ikke bare symptombehandling. Det er også at finde ud af, hvad er den underliggende årsag, og kan vi gøre noget ved det. Reference 2 - 1,47% Coverage Nej, jeg tror faktisk mere, jeg bliver, altså, hvis der er nogen eller noget, der påvirker mig, så er det faktisk til at tage mindre smertestillende. For jeg har	Reference 1 - 0,62% Coverage Så jeg tænker, når jeg nu finder ud af, at det er ikke noget, altså, allerførst kan man sige, når jeg opsøger lægen, så tænker jeg, det er noget farligt. Det er det jo sjældent. Det kan det godt være i bevægeapparatet, ikke, fordi det kan jo gøre meget ondt, og der kan jo også være noget grimt noget i knoglerne og sådan noget, ikke. Reference 2 - 0,61% Coverage Jeg har forsøgt det. Det eneste de der smertestillende virker på, det er sådan set min hovedpine, fordi jeg har sådan en migrænetendens, hvor jeg tager et par Treo for at tage det i opløbet. Alt det andet der, det synes jeg slet ikke gør nogen forskel. Og jeg bryder mig heller ikke om at tage det, altså, det hænger nok sammen. Reference 3 - 0,39% Coverage Nej, jeg er sådan en sund skeptiker, hvad det angår, altså, nej. Det har jeg ikke, ikke akupunktur, og ikke nogle andre af de der ting. Nej. Det har jeg	Reference 1 - 1,00% Coverage Jamen, den er sådan meget, altså, jeg er nok typen, der prøver at ignorere, og jeg tager heller ingen medicin, for det er jeg ikke sådan helt tilhænger af. Måske, dumt, det ved jeg ikke. Reference 2 - 2,62% Coverage Øh, jamen, der er nok flere ting i det. Men jeg tænker også lidt, at kan han reelt gøre noget. Og et røntgenbillede, det tænker jeg ikke vil vise noget som helst. Og så er det nok bare træning, der skal til. Og det er jo egentlig mig selv. Og, jaaa, men så er det vel også lidt det, at jeg føler måske også sommetider, at sådan den der fortravlede læge og sådan, at det her, det er ikke noget ift. så mange andet, altså det er ikke så, måske så alvorligt. Det er nok sådan nogle ting, der. Reference 3 - 1,77% Coverage Øhh, altså, jeg havde da tænkt lidt på, at om jeg skulle prøve at gøre ved det, da jeg stoppede med at arbejde. Mern så har det jo ligesom, ja, så har det ikke lige lagt i kortene, synes jeg, at komme

After re-consulting the coding for each group of pain-related healthcare use, both authors individually summarized their findings and the final results presented in the article were reached based on joint discussion and agreement. In this way we aimed to move beyond simple semantic descriptions of differences between groups, to interpretation of the broader meaning of the differences and the implications of such differences.

Table 2. Overview of findings from the thematized comparison of codes between groups of pain-related healthcare use made by the PhD student.

Complete overview of findings from the thematized comparison of codes between groups of pain-related healthcare use (low, medium, high) Selected findings presented and discussed in the article. _____	
Themes	Differences
System-facilitated pathways - System pathways - Referral	Low: - Healthcare system pathways are followed in case of increases in the pain or functional limitations. - Sparse experiences with referrals in the healthcare system. - Referrals suggested by the GP has been rejected in some cases, due to lack of need or trust and no informants have encourage referral by the GP. Medium: - System pathways have been followed but often accompanied by frustrating experiences leaving the informant unresolved. - Multiple experiences with referrals in the healthcare system often referral is decided in agreement between the HCP and Informant. High: - Dissatisfying experiences with system pathways that does not meet the need and expectations of the informant. - Multiple experiences with referrals in the healthcare system - sometimes initiated by the informant.
Appraisal of pain-related initiatives - Treatment prototypes - The patient expects no cure but expect an examination and information from a committed and listening HCP - No or sparse improvement or the 'chemistry' is not right.	All: - Disappointing healthcare experiences and pain-related healthcare initiatives with no or spars effect, have influenced healthcare behaviour across groups. - Desire to be seen, heard and approached with interest by the HCP are a common theme reported by informants in all groups. Low: - Treatment prototypes are characterized by wait-and-see or self-management. - Informants have approached the conventional healthcare system at more occasions but have lost faith that such initiatives can offer relief. - Informants have learned to accept their pain. Medium: - Treatment prototypes are characterized by passive treatments modalities or pain medication. - Pain-related healthcare experiences with sparse effect have caused resignation and search for alternative healthcare options. High: - Treatment prototypes most often characterized by passive treatment options – (alternative therapy, pain medication, chiropractor). - Informants revisit the healthcare system for (temporary) pain-relief and they expect to continually use healthcare in the future. - Known pain-relief options is reassuring. - Pain-related healthcare experiences with sparse effect have led to search for alternative pain-related healthcare options. - Some informants have ceased courses due to lack of therapeutic alliance.

Autonomy, beliefs and values - Healthcare should fit my needs, beliefs and values. - Healthcare has to be manageable/feasible for me in my situation - Illness representation - biomechanical beliefs about pain drives my healthcare behavior (cause and control). - The pain or functional limitations necessitates healthcare	All: - Pain is caused by biomechanical damage and imaging is required as it is a valid source of diagnostic information. - Trauma/work/physical exposures have caused wear and tear that causes pain. - Pain is perceived to be age-related. - Pain necessitates pain medication and/or GP contacts Low: - Skepticism towards pain medicine. - Informants handle the pain themself – pain is not considered to be dangerous. - Lack of faith in the usefulness of healthcare. - Practical aspects (Timely inconvenient, too expensive) have inhibited the use of pain-related healthcare Medium: - +/- Skepticism towards pain medicine/alternative care. - The HCP should be a mentor/collaborator and provide expert advice and guidance. - Practical aspects can facilitate (convenient time/location, healthcare payed by insurance company) or inhibit (too expensive, stressful, timely and geographically inconvenient) use of healthcare. - Manipulation can put joints back in place - Pain can The HCP should be a helper/partner/friend and should meet the needs of the person with chronic pain and provide information accordingly necessitate all kind of healthcare High: - Skepticism towards medicine – but informants take it because it is necessary. - The HCP should be a helper/partner/friend and should meet the needs of the person with chronic pain and provide information accordingly. - Practical aspects (Timely inconvenient, too expensive) and lack of resources have stopped pain-related healthcare courses (planed or ongoing). - Manipulation can put joints back in place and surgery is needed to correct biomechanical damages. - Pain necessitates any kind of healthcare and makes the informant try any kind of pain-relief.
Recommendations for healthcare - Recommendations from relatives/others - Recommendations from HCPs	All: - Recommendations for trying out different healthcare modalities are reported across groups. Low: - Informants are hesitant to following recommendation for pain-related healthcare visits. Recommendations followed are mostly related to pain medication or exercise. High/medium: - Informants benevolently follow advice and recommendation and hence recommendation is a powerful driver of healthcare. Willingness to try out a broad range of different pain-related healthcare initiatives are high.

Producing the report

All authors were involved in the reporting. The PhD student drafted the manuscript - all other authors review and accepted the final version. We aimed to describe the process of coding and analysis and the context of the study in sufficient detail and in a concise and logical way to give merit to the analysis. We used quotes for all themes and subthemes to aid the understanding of specific points of the interpretation of the data.

We have aimed to build a valid argument for the themes conceptualized in the data by referring back to the literature and theoretical models explaining behaviour in the context of pain.

References

1. Nowell LS, Norris JM, White DE, Moules NJ. Thematic Analysis: Striving to Meet the Trustworthiness Criteria. International Journal of Qualitative Methods. 2017;16(1):1609406917733847.

Appendix D

Declaration of co-authorship

Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Søren Mose

This declaration concerns the following article/manuscript:

Title:	Number of musculoskeletal pain sites leads to increased long-term healthcare contacts and healthcare related costs – a Danish population-based cohort study
Authors:	S. Mose, P. Kent, A. Smith, J. H. Andersen and D. H. Christiansen

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preperation ☐

If published, state full reference: https://doi.org/10.1186/s12913-021-06994-0

If accepted or submitted, state journal: BMC Health Services Research

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

A. Has essentially done all the work (>90%)
B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

Category of contribution	Extent (A-F)
The conception or design of the work:	C
Free text description of PhD student's contribution ***(mandatory)*** All authors contributed to the formation of the research question. JHA, DHC, PK and SM planed, designed and founded the project.	
The acquisition, analysis, or interpretation of data:	B
Free text description of PhD student's contribution ***(mandatory)*** SM applied for national register data and contributed to the preparation of data for the analysis, in coorlaboration with a Datamanager. PK, AS and SM planned the statistical analysis. SM performed the statistical analyses. All authors assisted in intrepeting the results.	
Drafting the manuscript:	B
Free text description of PhD student's contribution ***(mandatory)*** SM drafted the manuscript. All authors reviewed, corrected and approved the manuscript before submission.	
Submission process including revisions:	A

Free text description of PhD student's contribution ***(mandatory)*** SM submitted the work and was the corrosponding author. SM drafted the respons letter and all authors reviewed, corrected and approved the response letter to journal reviewers and editor. All authors approved the final manuscript.

Signatures of first- and last author, and main supervisor

Date	Name	Signature
6/7 -2022	Søren Mose	Søren Mose
5/7- 22	David H. Christiansen	

Date: 6/7- 2022

Søren Mose

Signature of the PhD student

Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Søren Mose

This declaration concerns the following article/manuscript:

Title:	Trajectories of Musculoskeletal Healthcare Utilization of People with Chronic Musculoskeletal Pain – A Population-Based Cohort Study
Authors:	S. Mose, P. Kent, A. Smith, J. H. Andersen and D. H. Christiansen1

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preperation ☐

If published, state full reference: https://doi.org/10.2147/CLEP.S323903

If accepted or submitted, state journal: Clinical Epidemiology

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

A. Has essentially done all the work (>90%)
B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

Category of contribution	Extent (A-F)
The conception or design of the work:	C
Free text description of PhD student's contribution ***(mandatory)*** All authors contributed to the formation of the research question. JHA DHC, PK and SM initially planed, designed and founded the project.	
The acquisition, analysis, or interpretation of data:	B
Free text description of PhD student's contribution ***(mandatory)*** SM applied for national register data and contributed to the preparation of data for the analysis, in coorlaboration with a Datamanager. PK, AS and SM planned the statistical analysis. SM performed the statistical analyses. All authors assisted in intrepeting the results.	
Drafting the manuscript:	B
Free text description of PhD student's contribution ***(mandatory)*** SM drafted the manuscript. All authors reviewed, corrected and approved the manuscript before submission.	
Submission process including revisions:	A

Free text description of PhD student's contribution ***(mandatory)***
SM submitted the work and was the corosponding author. SM drafted the response letter. All authors reviewed, corrected and approved the response letter to journal reviewers and editor. All authors approved the final manuscript.

Signatures of first- and last author, and main supervisor

Date	Name	Signature
6/7 -2022	Søren Mose	Søren Mose
5/7-22	David H. Christiansen	

Date: 6/7 -2022

Søren Mose

Signature of the PhD student

Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Søren Mose

This declaration concerns the following article/manuscript:

Title:	How do people with chronic pain explain their use, or non-use, of pain-related healthcare services? A qualitative study of patient experiences
Authors:	S. Mose, C. R. Budtz, H. R. Smidt, P. Kent, A. Smith, J.H. Andersen, D. H. Christiansen

The article/manuscript is: Published ☐ Accepted ☒ Submitted ☐ In preperation ☐

If published, state full reference:

If accepted or submitted, state journal: Disability and Rehabilitation

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

A. Has essentially done all the work (>90%)
B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

Category of contribution	Extent (A-F)
The conception or design of the work:	C
Free text description of PhD student's contribution ***(mandatory)*** SM contributed to the conception and design of the article in coorporation with all co-authors.	
The acquisition, analysis, or interpretation of data:	A
Free text description of PhD student's contribution ***(mandatory)*** SM collected all data and was involved in all parts of the analysis and the interpretation of the data	
Drafting the manuscript:	A
Free text description of PhD student's contribution ***(mandatory)*** SM drafted the manuscript. All co-authors review, corrected and approved the manuscript	
Submission process including revisions:	A

Free text description of PhD student's contribution ***(mandatory)***
SM submitted the work. SM is the corresponding author will draft the response letter to the journal reviewers and editors.

Signatures of first- and last author, and main supervisor

Date	Name	Signature
6/7 -2022	Søren Mose	Søren Mose
5/7-22	David H. Christiansen	

Date: 6/7 -2022

Søren Mose
Signature of the PhD student

Appendix E

Literature search strategy

Literature search strategy and argumentation

At the beginning and the end of this PhD project, a literature search was undertaken to identify relevant papers published on healthcare use and musculoskeletal pain between 2000 and 2018 in English, Danish, Norwegian and Swedish languages through the Ovid (Medline, Embase, PsycINFO) and PubMed interfaces by combinations of the following keywords: Healthcare, Health care, Healthcare use, Healthcare utilization, Healthcare utilization, Healthcare seeking, Healthcare behavior, Musculoskeletal pain, Chronic pain, Pain Sites.

A paper was considered eligible when the main aim of the study matched the topics of this project. This means that I primarily regarded articles about healthcare seeking or healthcare use related to musculoskeletal pain across pain conditions. Furthermore, I decided to primarily include systematic reviews/meta-analysis and observational longitudinal study designs with adults.

During the PhD project period a monthly alert for new publications was set at Pubmed, Embase and Scopus databases using the following words and combinations:

Table x. Alert querys

Database	Search
Pubmed	((("health care" or "healthcare" or "careseeking" or "care seeking") AND musculoskeletal) AND pain) ((musculoskeletal pain)) AND care seeking
Embase	'pain':ti AND (('health care':ti OR healthcare:ti) AND (use:ti OR seeking:ti OR utilization:ti OR utilisation:ti OR consumer*:ti OR contact*:ti))
Scopus	((TITLE (healthcare OR "health care" PRE/2 use OR seeking OR utilization OR utilisation OR consumer* OR contact*)) AND (TITLE (pain)))

The different combinations and search limitations in each database were due to different search options and the desire to adequately cover the field.

Additionally, a search for similar articles as the ones on which this dissertation rests was performed in March, 2022 on https://jane.biosemantics.org/ which is a monthly updated, free web-based resource for identifying relevant journals, experts and articles, based on specific keywords or a samples of text (e.g. titles or abstract) (1).

References

1. Schuemie MJ, Kors JA. Jane: suggesting journals, finding experts. Bioinformatics. 2008;24(5):727-8.