

CARE-SEEKING ADOLESCENTS WITH LOW BACK PAIN FROM GENERAL PRACTICE: PREVALENT BUT UNDERSTUDIED

by

Christian Lund Nørgaard Straszek



AALBORG UNIVERSITY
DENMARK

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PhD supervisor: Professor Michael Skovdal Rathleff,
Aalborg University, Aalborg, Denmark

Assistant PhD supervisor: Professor Janus Laust Thomsen
Aalborg University, Aalborg, Denmark
Associate Professor Kieran O’Sullivan
University of Limerick, Limerick, Ireland

PhD committee: Associate Professor Mathias Vedsø Kristiansen (chair)
Aalborg University, Aalborg, Denmark
Professor Britt Elin Øiestad (opponent)
OsloMET, Oslo, Norway
Associate Professor Anne Møller (opponent)
University of Copenhagen, Copenhagen, Denmark

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ENGLISH SUMMARY

Low back pain (LBP) is a prevalent musculoskeletal pain condition among children and adolescents from the background population. In this group, LBP will often resolve within the first week of pain initiation. Also, this group of adolescents is characterised by low to moderate LBP intensity levels and a low proportion with functional limitations. Although previous research has investigated LBP in adolescents from the background population, less is known about care-seeking adolescents who consult for LBP in general practice.

Three studies with specific aims were undertaken to gain insight into adolescent patients who consult in general practice for LBP. The first study was designed as a prospective cohort study in which the aim was to identify the natural prognosis among care-seeking adolescents with LBP recruited from general practice. Another aim was to describe different trajectories of adolescent LBP and identify patient and parent-related factors that influenced the prognosis. Findings within this first study were based on prospective self-reported data collected through online questionnaires and data from electronic patient journals. This study had a follow-up time of 1 year from inclusion.

The second study was designed as a semi-structured interview-based study in which the aim was to investigate when and how care-seeking adolescents with LBP would interact with health care providers and which health literacy competencies and self-management strategies they would use to manage their LBP. For this purpose, a thematic analysis approach was used to analyse the audio-based research material to derive major themes and sub-themes.

The third study was designed as a single subject experimental study in which the aim was to investigate the short-term effect of an intervention to facilitate a self-management approach among care-seeking adolescent patients with LBP. The outcomes of interest were LBP intensity and function. It was further assessed if LBP-related worries and pain self-efficacy would mediate the effect of the intervention through cross-correlation lag zero analyses. Findings within the third study were based on prospective self-reported data collected through online questionnaires and a mobile application.

The findings from the first study indicate that care-seeking adolescents with LBP who consult in general practice present with moderate to high LBP intensity and LBP-related worries. Although both LBP intensity and LBP-related worries diminished after one year, most of the adolescent patients would continue to experience LBP and be worried about their LBP. Based on electronic patient journals, there was no indication of severe underlying pathology or radiculopathy at the time of the index consultation. One patient was found eligible for surgical intervention for specific pathology.

The findings from the second study indicate that the main trigger for seeking healthcare was LBP intensity or a sudden spike in LBP intensity. Most of the adolescent informants had self-managed their LBP with over-the-counter pain

medication through an extended period prior to consulting for their LBP. Most adolescents had an explicit desire to self-manage their LBP, but they also felt that they needed guidance from a health care provider to feel confident in self-managing their LBP. A frequent barrier to establishing productive partnerships between adolescent patients and their health care providers was problems with communication.

In the third study, findings suggest that it was possible to reduce LBP intensity and improve function in the short-term by facilitating a self-management approach among adolescent patients. Furthermore, LBP-related worries were positively cross-correlated with LBP intensity and pain self-efficacy was negatively cross-correlated with LBP intensity.

Although COVID-19 significantly hampered recruitment through the first study, and the third study was susceptible to missing data, the findings within this PhD thesis are among the first to investigate LBP intensity, LBP-related worries, LBP duration, functional limitations, and pain self-efficacy among care-seeking adolescents with LBP. The findings indicate that care-seeking adolescents from general practice may present with high LBP intensity, a high degree of LBP-related worries, functional limitations, and long durations of LBP compared to non-care-seeking adolescents with LBP. Future studies should investigate these factors in a large-scale observational study with care-seeking and non-care-seeking adolescents with LBP.

DANSK RESUME

Lænderygsmerter er en hyppig muskuloskeletal smertetilstand blandt børn og unge fra baggrundspopulationen. Hos mange unge vil smerten være aftaget indenfor den første uge. Disse unge er karakteriseret ved at rapportere lav til moderate smerteintensitet, og en lav grad af funktionelle begrænsninger. Selvom tidligere studier har beskæftiget sig med lænderygsmerter blandt unge fra baggrundspopulationen, så er der for nuværende meget lidt tilgængelig viden om unge, som opsøger behandling for deres lænderygsmerter i almen lægepraksis.

Denne afhandling omhandler de tre studier, som blev iværksat med henblik på at generere mere viden om de unge patienter med lænderygsmerter, som opsøger behandling i almen lægepraksis. Det første studie var et prospektivt kohorte studie, hvor formålet var at undersøge prognosen blandt unge med lænderygsmerter, som blev rekrutteret fra almen lægepraksis. Ydermere var formålet i studiet at beskrive forskellige forløb blandt de unge med lænderygsmerter, samt at identificere patient- og forælderrelaterede faktorer, som havde indflydelse på prognosen. Resultaterne fra dette første studie beror på prospektive selv-rapporterede data, som blev indsamlet via online spørgeskemaer, samt patientdata indhentet fra almen medicinske journaler. Studiet havde en opfølgningstid på 1 år fra inklusion.

Studie nummer to var designet som et semi-struktureret interview studie, hvor formålet var at undersøge hvornår og hvordan unge med lænderygsmerter interagerer med sundhedsprofessionelle, når de opsøger behandling. Ligeledes var formålet at undersøge, hvilke sundhedskompetencer og egen-håndterings strategier de unge anvendte for at tage hånd om deres lænderygsmerter. Til dette formål blev der anvendt tematisk analyse på det audio-baserede forskningsmateriale, med henblik på at tilvejebringe overordnede temaer samt sub-temaer.

Det tredje studie var designet som et enkelt-persons-eksperiment, hvor formålet var at undersøge den umiddelbare effekt af en intervention, som havde til hensigt at facilitere unge patienters egen-håndtering af lænderygsmerter. De definerede målepunkter var smerteintensitet og funktion. Studiet havde også til formål at undersøge om lænderygs-relaterede bekymringer og smerte-relateret tro på egne evner ville mediere effekten af interventionen. Resultater fra det tredje studie var baseret på prospektive selv-rapporterede data, som blev indsamlet via online spørgeskemaer og en mobil applikation.

Resultaterne fra det første studie indikerer at unge, som opsøger behandlinger for deres lænderygsmerter i almen lægepraksis, vil være plaget af moderat til høj smerteintensitet og en moderat til høj grad af lænderygs-relaterede bekymringer. På trods af at både smerteintensitet og bekymringer var reduceret efter et år, så havde de fleste unge forsat smerter, og de bekymrede sig fortsat om deres lænderygsmerter ved opfølgningen. Baseret på journaloplysningerne viste ingen af patienterne tegn på livstruende eller radikulære lænderygsmerter ved den indledende konsultation. En patient blev vurderet til at have gavn af kirurgisk behandling for en konkret patologi.

Resultaterne fra studie nummer to indikerede at den primære årsag til at opsøge en sundhedsprofessionel, var smerter relateret til lænderyggen eller en pludselig stigning i smerteintensiteten. De fleste af de unge havde prøvet at tage hånd om deres smerter ved at anvende smertestillende håndkøbsmedicin over en længere periode, inden de opsøgte behandling hos en sundhedsprofessionel. De fleste unge havde et eksplicit ønske om at egen-håndtere deres lænderygsmerter. Samtidig udtrykte de et behov for at blive guidet af en sundhedsprofessionel, for at føle sig selvsikker nok til at egen-håndtere smerterne. En hyppig barriere for at etablere et produktivt partnerskab mellem den unge og den sundhedsprofessionelle var problematisk kommunikation. Resultaterne fra det tredje studie indikerer, at det er muligt at reducere lænderygsrelateret smerteintensitet samt forbedre funktionen på kort sigt ved at facilitere unge patienters egen-håndtering af lænderygsmerter. Der blev fundet en positiv sammenhæng mellem smerteintensitet og lænderygs-relaterede bekymringer samt en negativ sammenhæng mellem smerteintensitet og smerte-relateret tro på egne evner.

På trods af at COVID-19 havde en negativ indflydelse på rekrutteringen af unge patienter til det første studie, og det tredje studie var påvirket af manglende data, så er studierne i denne afhandling blandt de første til at undersøge smerteintensitet, bekymringer, smertevarighed, funktion og smerte-relateret tro på egne evner blandt unge patienter, som opsøger behandling for lænderygsmerter. Resultaterne af studierne indikerer samlet set, at unge som opsøger behandling for lænderygsmerter i almen lægepraksis, oplever en høj grad af smerteintensitet, er meget bekymrede for deres smerter, er funktionelt begrænsede og har oplevet smerter i en længere periode, inden de opsøger behandling. På disse faktorer lader det til, at de unge patienter med lænderygsmerter differentierer sig fra unge med lænderygsmerter som ikke opsøger behandling. Hvorvidt de to grupper af unge med lænderygsmerter adskiller sig fra hinanden på disse faktorer, bør undersøges i fremtidige observationelle studier.

PREFACE

In 2013, I conducted my first research project as I was finalising my bachelor's degree in physiotherapy. After that experience, I was hooked, and I knew I had to pursue a master's degree. After two years in clinical practice, I was enrolled on the master's program for physiotherapy at the University of Southern Denmark in 2015. I instantly knew I was heading in the right direction, and I partook in all the research-related activities that were presented to me. In 2016, a new opportunity arose, as Professor Michael Skovdal Rathleff introduced me to the Research Unit for General Practice in Aalborg (today known as the Center for General Practice at Aalborg University). I was fortunate enough to conduct my master's project alongside great and knowledgeable people at the Research Unit, and during that process, I knew that I had to become a PhD student within that specific research environment. In 2017, after consulting the existing literature and through numerous discussions with my supervisors, I was able to present the first draft of my PhD on adolescent patients with low back pain who consult in general practice.

In 2018, I was successful in obtaining the necessary funding to initiate my PhD, and in the summer of 2019, I was enrolled as a PhD student at the Department of Health Science and Technology at Aalborg University. Knowing that I had a different clinical background, I did my utmost to engage with the people in and around general practice. I had several interviews with general practitioners, secretaries, physiotherapists, and younger medical doctors who wanted to become general practitioners. I familiarised myself with the general practice setting by visiting general practice clinics and reading the material published by both the Danish College of General Practice and The Danish Organization of General Practitioners. Lastly, I took a genuine interest in the group of patients that were to be the focus of my PhD. Through several interviews with adolescent patients with low back pain, I obtained knowledge of what mattered to these patients while battling their pain and functional limitations. Speaking with both clinicians and patients prior to undertaking my PhD was an immense eye-opener, and I would like to think that these initial steps provided a solid foundation for the research that I have been conducting for the previous four years.

With all the initial steps I took before initiating my PhD, I thought that I was well prepared for the path ahead. However, nothing could prepare me for the global COVID-19 pandemic, which took the world hostage for the main part of 2020 and 2021. The COVID-19 pandemic had an extensive impact on society and individual lives on both a global and a national level. The COVID-19 pandemic also had a substantial impact on my life, including my PhD. Personally, I consider the COVID-19 pandemic to be a force majeure. Nevertheless, I did everything that I could to generate relevant research of high quality despite the pandemic. It is my hope that the work presented in this thesis will aid general practitioners and other clinicians in managing adolescent patients with low back pain.

ACKNOWLEDGEMENT

This PhD thesis is dedicated to Dorte Drachmann. Dorte believed in me from day one, and I would not be where I am today without her. Dorte has contributed to the continuous development of the physiotherapy profession for many years, and I personally consider her to be a study of excellent leadership. Thank you.

I am immensely proud to present the work I have conducted during the previous four years. I would never have been able to get this far without the support of my supervisors. You have unlocked a potential in me that I didn't know existed, and you have taught me how to conduct research that lives up to the highest of standards. You have been my inspiration while I slowly but steadily developed into a supervisor and educator myself. Thank you for always being there for me on a day-to-day basis, especially at times when it mattered the most. I am grateful to have been given the opportunity to become a researcher and work with fellow researchers, clinicians, patients, stakeholders, administrative teams, and students. To have been a part of the research environment that you have provided is something that I will always treasure.

I would like to extend my gratitude to the funders (the Danish Association for Physiotherapy, the Foundation for General Practice in Denmark, and the Department for Research and Development at the University College of Northern Denmark) who believed in me, my team, and my project. Furthermore, I would like to thank all my external collaborators, including all the general practitioners who supported my endeavours. Also, I would like to thank the adolescent patients who took the time to engage in my projects. I am very grateful to you all.

I would like to extend a special thanks to my father, René Straszek, who taught me that it is human to make a mistake, but to keep making the same mistake is foolish. Also, a special thanks to my mother, Jeanette Nielsen, who taught me that I am great the way I am. I will spend the rest of my life teaching these same lessons to my children (and anyone else who needs them).

It was never written in the stars that I would undertake a PhD. When I was younger, I always thought that one should be extremely smart to be able to complete such a task. And now, when I am staring at the finish line, I am wondering if my younger self was wrong or if he was right.

At some point in time, I was obsessed with the thought of becoming a PhD student. At my wife's bachelorette party, her friends had asked me a series of questions, and they were eager to see if my wife would answer the same as I did. However, for the question "*What do you think Christian would like to become most in the world?*" I answered, "*A PhD student*". My wife (who knows me better than anyone) answered, "*The Green Power Ranger*".

TABLE OF CONTENTS

Chapter 1. Introduction.....	17
1.1. What is low back pain?	17
1.1.1. Clinical presentation and definition.	17
1.1.2. Diagnostic triage of adults with low back pain.	17
1.1.3. The impact of low back pain on adults and society.....	18
1.1.4. Risk factors for low back pain disability in adults.	19
1.1.5. Prognosis among care-seeking adult patients with low back pain.	19
1.2. What do we know about adolescent Low back pain? – A state of the art description.....	20
1.2.1. Research on adolescent low back pain prevalence in school settings. ...	20
1.2.2. The impact of low back pain on adolescents and the society.	21
1.2.3. Risk factors for low back pain in adolescents.	22
1.2.4. Prevention of adolescent low back pain.	23
1.3. Low back pain among care-seeking adolescents in general practice.....	24
1.3.1. A description of primary care general practice in Denmark.....	24
1.3.2. Is adolescent low back pain different from low back pain in adults?.....	25
1.3.3. Care-seeking behaviour – an introduction.....	26
1.3.4. Care-seeking behaviour among adolescents with low back pain.	27
1.3.5. Factors influencing care-seeking behaviour in adolescents with low back pain.....	28
1.3.6. Management of adolescent low back pain.....	29
1.3.7. Self-management and Health Literacy - an introduction.....	30
1.3.8. Current knowledge on interventions to facilitate self-management among patients with low back pain.....	32
Chapter 2. Knowledge gaps, aims, and study designs.....	33
2.1. A study of prognosis and trajectories of pain in care-seeking adolescents with low back pain from general practice – study 1.....	33
2.1.1. Knowledge gaps addressed in Study 1.	33
2.1.2. Aims of Study 1.	33
2.1.3. Design of Study 1 – A prospective cohort study.....	34

2.2. A study of health literacy competencies and self-management skills in care-seeking adolescents with low back pain from general practice – Study 2.....	34
2.2.1. Knowledge gaps addressed in Study 2.....	34
2.2.2. Aims of Study 2.....	35
2.2.3. Design of Study 2 – An interview-based qualitative study.....	35
2.3. A study on facilitating a self-management approach among care-seeking adolescents with low back pain.....	36
2.3.1. Knowledge gaps addressed in Study 3.....	36
2.3.2. Aims of Study 3.....	36
2.3.3. Design of Study 3 – A single subject experimental study.....	36
2.4. How the three studies are linked and how they supplement each other.....	38
Chapter 3. Study 1.....	41
3.1. Methods and materials.....	41
3.1.1. Study design.....	41
3.1.2. Pre-registration.....	41
3.1.3. Ethical considerations and additional approvals.....	41
3.1.4. Data protection and additional agreements.....	42
3.1.5. Stakeholder involvement.....	42
3.1.6. Recruitment of general practitioners.....	43
3.1.7. Recruitment of care-seeking adolescents with low back pain from general practice and their parents.....	43
3.1.8. Data collection strategy.....	46
3.1.9. Patient characteristics.....	47
3.1.10. Pain measures including primary outcome.....	47
3.1.11. Illness perception.....	47
3.1.12. Low back pain-related limitations and interference.....	48
3.1.13. Health-related quality of life.....	48
3.1.14. Sleep quantity.....	49
3.1.15. Physical activity levels.....	49
3.1.16. Analysis of demographic data.....	49
3.1.17. Latent class analysis.....	49
3.1.18. Deviation from protocol.....	50

3.2. Results.....	50
3.2.1. Patient characteristics.....	50
3.2.2. Primary outcome.....	51
3.2.3. Illness Perception.....	51
3.2.4. Additional pain measures.....	51
3.2.5. Low back pain-related limitations and interference.....	52
3.2.6. Health related quality of life.....	52
3.2.7. Physical activity levels.....	52
3.2.8. Data from electronic patient journals.....	52
3.3. Discussion.....	53
3.3.1. Summary of main findings.....	53
3.3.2. Comparison with previous research.....	53
3.3.3. Strengths and limitations.....	54
3.3.4. Perspectives on study implications and future research.....	56
3.4. Conclusion.....	57
Chapter 4. Study 2.....	58
4.1. Methods and materials.....	58
4.1.1. Study design.....	58
4.1.2. Ethical considerations and approvals.....	58
4.1.3. Sampling strategy.....	58
4.1.4. Context and setting.....	59
4.1.5. Researcher characteristics and reflexivity.....	59
4.1.6. Presentation of the thematic analysis approach.....	60
4.1.7. Development and structure of the interview guide.....	61
4.1.8. Trustworthiness and transparency.....	61
4.2. Findings.....	62
4.1. Synthesis and interpretation of thematic analysis.....	62
4.1.1. Utilizing resources and making decisions.....	64
4.1.2. Problem solving and taking action.....	64
4.1.3. Barriers to self-management and forming partnerships.....	65
4.2. Discussion.....	66

4.2.1. Summary of findings.....	66
4.2.2. Strengths and limitations.....	68
4.2.3. Comparison with existing literature.....	69
4.2.4. Future research perspectives.....	70
4.3. Conclusion.....	70
Chapter 5. study 3.....	72
5.1. Methods and materials.....	72
5.1.1. Study design.....	72
5.1.2. Ethical considerations and approvals.....	72
5.1.3. Setting and managing clinician.....	72
5.1.4. Description of phases.....	73
5.1.5. Randomization procedure.....	75
5.1.6. Eligibility criteria.....	75
5.1.7. Demographic data collected at inclusion.....	75
5.1.8. Primary outcomes for low back pain intensity and function.....	76
5.1.9. Pain self-efficacy.....	76
5.1.10. Pain interference.....	76
5.1.11. Illness perception.....	76
5.1.12. Physical activity levels.....	77
5.1.13. Health-related quality of life.....	77
5.1.14. Self-reported change in health status.....	77
5.1.15. Additional low back pain measures.....	77
5.1.16. Sleep quantity.....	78
5.1.17. Clinical commentaries from patients and therapeutic log.....	78
5.1.18. Proposed mediating factors.....	78
5.1.19. Description of intervention.....	78
5.1.20. Problem solving.....	79
5.1.21. Decision-making.....	79
5.1.22. Utilizing resources.....	79
5.1.23. Forming partnerships with health care providers.....	80
5.1.24. Taking action.....	80

5.1.25. Analysis of low back pain intensity.	80
5.1.26. Assessment of functional limitations.	81
5.1.27. Analysis of proposed mediating factors on low back pain intensity. ...	81
5.2. RESULTS	82
5.2.1. Patient characteristics.....	82
5.2.2. Visual analysis of low back pain intensity.	84
5.2.3. Level analysis.....	84
5.2.4. Trend analysis.	84
5.2.5. Analysis of immediate and latent effects.	84
5.2.6. Overlap analysis.	84
5.2.7. Change in self-reported health.	90
5.2.8. Functional limitations.....	91
5.2.9. Mediation analysis.	93
5.3. Discussion.	95
5.3.1. Summary of main findings.....	95
5.3.2. Comparison with previous research.	96
5.3.3. Strengths and limitations.....	97
5.3.4. Post hoc reflections.	99
5.4. Conclusion.	99
Chapter 6. General discussion and concluding remarks.	100
6.1. Overall considerations of findings.	100
6.2. Possible implications for managing adolescent low back pain in general practice.....	103
6.3. Overall consideration of selection bias.	105
6.4. Implications for future studies.....	106
Literature list.....	107

TABLE OF FIGURES

Figure 1: Flowchart for recruitment and follow-up in study 1. P. 45

Figure 2: Illustration of interaction between stakeholders in study 1. P. 46

Figure 3: Physical activity levels at baseline and 1-year follow-up. P. 52

Figure 4: Outline of major themes and sub-themes for Study 2. P. 62

Figure 5: Process of study 3. P. 74

Figure 6: Flowchart of study 3. P. 83

Figure 7: Levels analysis for study 3. P. 85-86

Figure 8: Trend analysis for study 3. P. 86-87

Figure 9: Analysis of immediate and latent effects for study 3. P. 88-89

Figure 10: Overlap analysis for study 3. P. 89-90

Figure 11: Limitations related to the activity of daily living among patients in study 3.
P. 92

Figure 12: Mediation analysis for study 3. P. 94-95

LIST OF PAPERS

This PhD thesis is comprised of the following three studies:

Study 1: Adolescent low back pain outcomes are less favourable than expected: a 1-year prospective cohort study.

Study 2: Competences to self-manage low back pain among care-seeking adolescents from general practice - A qualitative study.

Study 3: The short-term effect of an intervention to facilitate a self-management approach on pain intensity and functional limitations in adolescent patients with low back pain – a single subject experimental study.

ABBREVIATIONS

Avg: average

DaRD: Dansk Rygdatabase

EQ-5D-5L: Euroqol-5 dimensions-5 levels

HRQoL: Health-Related Quality of Life

LBP: Low Back Pain

LCA: Latent Class Analysis

Max: maximum

Min: minimum

NPRS: Numeric Pain Rating Scale

STRIBE: The Single-Case Reporting Guideline In BEhavioural Interventions Checklist

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology checklist

Q1: First quartile

Q3: third quartile

UK: United Kingdom

CHAPTER 1. INTRODUCTION.

In this chapter, I provide the reader with a state-of-the-art description of how low back pain presents in adults and adolescents from both the background population and clinical practice. This included descriptions and discussions on clinical presentation, diagnostics, risk factors, prognosis, and treatment. I also introduce the reader to the concepts of care-seeking behaviour, self-management, and health literacy. The purpose of this chapter is to provide the reader with an overview of the literature within the field and to introduce core concepts within the thesis.

1.1. WHAT IS LOW BACK PAIN?

1.1.1. CLINICAL PRESENTATION AND DEFINITION.

Low back pain (LBP) is characterised as a painful sensation in the area between the 12th thoracic vertebra and the gluteal fold (1). Previous literature has defined LBP as pain in the area below the costal margin and above the inferior of the gluteal fold with or without pain in the legs (2). Clinicians working with patients suffering from LBP are recommended by clinical guidelines to obtain a thorough medical history and undertake diagnostic triage to identify any underlying pathology of the pain (3). In this process, patients are categorised into 1 of 3 possible classifications, which are I) serious pathology, II) radicular pain or III) non-specific LBP (4).

1.1.2. DIAGNOSTIC TRIAGE OF ADULTS WITH LOW BACK PAIN.

Serious pathology, which may also be referred to as specific LBP, concerns identifiable, severe, underlying pathology for LBP (3,4). Such pathologies include fractures within the bony structure of the spine, cancer, rheumatological conditions (e.g., axial spondylarthritis) and cauda equina syndrome (4,5).

LBP with radiculopathy refers to compression of the nerve roots in the lumbar spine (6). One element that may cause this type of compression is the intervertebral discs (7). This phenomenon is known as lumbar disc herniation with radiculopathy and is defined as a localised displacement of the intervertebral disc material beyond the normal margins of the disc space, resulting in pain, weakness, or numbness in a myotomal or dermatomal distribution (7). This is commonly referred to as a disc bulge or disc protrusion (8). Thus, radiculopathy refers to the consequence of the nerve root compression (e.g., leg pain, numbness, or impaired voluntary muscle activation) and not the element that causes the compression. In patients with spinal stenosis, the spinal canal is narrowed by changes in the structures surrounding the nerves (i.e., discs, ligamentum flavum and facet joints) (9). This condition is a common cause of nerve root compression and related radiculopathy in patients over 65 years of age (9).

Although cancer and metastatic pain are categorised as serious pathology (4), primary cancer tumours may also lead to nerve root compression and radiculopathy in patients with no previous history of cancer (10).

The remaining category concerns patients suffering from non-specific LBP, which can be described as LBP without an identifiable pathoanatomical cause (5). In adults, non-specific LBP accounts for 90-95% of the care-seeking patients in primary healthcare (4,5,11). In contrast, serious pathology and LBP with radiculopathy are estimated to account for less than 1% and between 5-10% of patients in primary care, respectively (4). This uneven distribution of patients in the three categories underlines the fact that LBP is much more than biomechanical pain related to specific structures (6). This is further supported by findings from diagnostic imaging of disc degeneration, disc bulge and disc protrusion in asymptomatic individuals (8). Although the nociceptive input may be identifiable in some patients (e.g., with nerve root compression or fractures) but not in others (i.e., non-specific LBP), factors such as comorbidities, genetics, psychology, and social dynamics are known to contribute to the pain experience and functional limitations (6). As such, there is a variety of factors to consider when managing patients with LBP in clinical practice, as the impact of the pain is likely to differ between patients.

1.1.3. THE IMPACT OF LOW BACK PAIN ON ADULTS AND SOCIETY.

The burden of LBP on affected individuals and societies in the western part of the world has been widely documented in the adult population (6). The prevalence of LBP in adults has increased during the previous thirty years, and LBP is currently ranked the leading musculoskeletal-related cause of disability worldwide (12). LBP is common in the adult population, and although the mean prevalence is estimated to be 32.9%, most individuals are likely to experience LBP at some point during their lifetime (6). As the commonness of LBP in adults has been extensively documented (6,12), previous research has focused on investigating the impact of LBP on adult patients and estimating the societal burden of the condition.

High pain levels, functional limitation, and diminished Health-Related Quality of Life (HRQoL) are common characteristics of adult patients with LBP (11,13,14). The socioeconomic burden of LBP was previously estimated on a national level in different countries. In 2001, the estimated costs of LBP in Australia were 9 billion Australian dollars, whereas 1 billion accounted for direct healthcare costs (15). This illustrates that a substantial amount of the overall socioeconomic burden for LBP is related to indirect costs such as lost production and sick leave. Similar findings were reported in Sweden in 2005, where the authors estimated the indirect costs of LBP per patient to be substantially higher than the direct costs (16). In Denmark, both the direct cost and indirect cost of LBP have increased from 2015 to 2022 (17,18). In 2015, the direct cost of LBP was 1.8 million Danish crowns, while the indirect cost was 4.8 million Danish crowns (17). In 2022, the estimated extra direct and indirect costs were 7.1 million Danish crowns and 21 million Danish crowns, respectively (18). Even

though the estimates from Australia and Sweden are 20 years older than the most recent estimates from Denmark, the overall conclusion that the indirect cost surpasses the direct cost remains the same.

1.1.4. RISK FACTORS FOR LOW BACK PAIN DISABILITY IN ADULTS.

There are several risk factors associated with LBP disability in adults, including high LBP intensity, presence of leg pain, high Body Mass Index, smoking, and higher physical workloads (6). Psychological factors such as depression, catastrophising, and fear of movement due to pain are also associated with LBP disability in adults (6). As is the case with many musculoskeletal pain conditions, the prevalence of LBP increases with increasing age among adults between 30 and 70 years of age (19,20). One of the most consistent predictors for a new episode of LBP is a previous episode of LBP (21-23). The authors of one study from Australia found that the 1-year incidence of a recurrent episode of LBP was 33%. Furthermore, if the patients reported more than two previous episodes of LBP, they had increased odds of recurrent LBP (Odds Ratio = 3.18, 95% confidence interval [2.11-4.78]) compared to patients who reported less than two previous episodes (22).

1.1.5. PROGNOSIS AMONG CARE-SEEKING ADULT PATIENTS WITH LOW BACK PAIN.

Two older systematic reviews investigated the prognosis among adult patients with non-specific LBP (24,25). The findings indicate that most patients will experience a noteworthy decrease in LBP intensity and an increase in function within the initial six weeks from pain onset (24). Beyond six weeks, the reduction in LBP intensity and increase in function would be slow for up to 12 months, at which point the mean LBP intensity was found to be low (24). Patients with long-standing LBP (i.e., defined in that study as LBP for more than 12 weeks but less than 12 months) were also found to improve within the first six weeks. However, this group of patients were found to report continuous moderate LBP intensity and functional limitations after 12 months (24).

Looking beyond the first year from LBP onset, there seem to be further differences in the trajectory of pain among care-seeking adult patients. Investigators from the Primary Care Science Research Centre at Keel University (United Kingdom) applied longitudinal Latent Class Analysis (LCA) to investigate if care-seeking patients from general practice would have different trajectories in terms of LBP intensity (26,27). From 2001 to 2002, the investigators identified four distinct clusters based on LBP intensity scores collected over the course of 12 months among 342 patients (26). Patients from the largest cluster (36%) were characterised by reporting persistent mild pain, and patients in the second largest cluster (30%) were characterised as recovering due to continuous low LBP intensity scores (26). Patients in the two remaining clusters were characterised as having fluctuating pain (13%) that would oscillate

between moderate and high LBP intensity and severe chronic pain (21%) and who would report continuous high LBP intensity throughout the 12 months of data collection (26).

Seven years later, in the 2009-2010 period, the investigators followed up on 155 patients from the original cohort, and data were collected for an additional 12 months to conduct a new LCA (27). At this time, 3 of the original 4 clusters from 2006 (i.e., persistent mild pain (37%), fluctuating pain (11%), and severe chronic pain (21%)) were identified (27). The fourth cluster identified was characterised as having no or occasional pain (31%). For patients characterised with severe chronic LBP in 2001-2002, 74% (95% confidence interval [57%-92%]) stayed in their assigned cluster 7 years later (27). Of the 4 clusters initially identified, the trajectory of severe chronic LBP was found to be the most stable, and the cluster of patients with fluctuating pain was the most unstable, with 87% changing cluster (27). Approximately half (59%-56%) of patients in the 2 clusters with the mildest LBP intensity stayed in their originally assigned cluster, while the remaining half changed to the other mild cluster (27). These LCAs' analyses provide a more nuanced description of the pain trajectory and prognosis among care-seeking adult patients from general practice. Interestingly, these data suggest that most adult patients will continue to experience mild or occasional LBP, while as many as 1 in 5 may go on to experience persistent high LBP intensity even after seven years (27). These findings resonate with the notion that previous episodes of LBP were found to be a consistent predictor for new episodes of LBP (21,22). In summation, adult patients who experience LBP are likely to experience episodes of LBP throughout their lives. This leaves one wondering about the prevalence, trajectory, and prognosis of LBP among care-seeking adolescents from general practice.

1.2. WHAT DO WE KNOW ABOUT ADOLESCENT LOW BACK PAIN? – A STATE OF THE ART DESCRIPTION.

1.2.1. RESEARCH ON ADOLESCENT LOW BACK PAIN PREVALENCE IN SCHOOL SETTINGS.

It has been known for many years that LBP is common among adolescents recruited from school settings. Nearly 50 years ago, in 1984, Fairbank and colleagues took an interest in the area as they combined self-reported questionnaires about adolescent back pain with clinical examination (28). This early study revealed several interesting findings, the first being that more girls than boys reported back pain (28). From this study, we also saw the first tendency that back pain prevalence and onset would increase with increasing age (28). In relation, the earliest onset of back pain was reported by a person who was eight years of age. The prevalence of back pain was found to be higher in sports-active adolescents when compared to adolescents not engaged in sports. Finally, it was documented that 1 in every 10 of those with back pain had taken time off from school, and 1 in every five adolescents with back pain had seen a doctor (28).

Since 1984, the interest in conducting research within the area of adolescent LBP has increased, especially within school settings. More than ten cross-sectional studies (29-41) have documented that LBP is indeed prevalent in adolescent school children, with prevalence ranging from 10% (29) to 69% (37). Based on studies from Denmark, the mean prevalence is likely between 20%-30% among adolescent school children in Denmark (41-43). The difference in LBP prevalence between studies is likely due to the different questions used to assess LBP prevalence (e.g., Isolated LBP lasting one day (38) or LBP during the past three months (31)) and variation in age (e.g., 7-16 years of age (29) or 16-20 years of age (30)).

1.2.2. THE IMPACT OF LOW BACK PAIN ON ADOLESCENTS AND THE SOCIETY.

As stated previously, much research has been conducted to determine how LBP impacts adult patients and society. Based on cross-sectional studies, adolescents with LBP from the background population are characterised by low to moderate LBP intensity (35,44-46), a low proportion of individuals who report functional limitations (30,40), and small reductions in HLQoL (38). Furthermore, two cross-sectional studies and one prospective study found that the pain would resolve within seven days for 44%-78% of the affected adolescents (29,39,44). As such, adolescents with LBP from the background population seem, on average, to be affected less and for a shorter time period compared to adults. However, this does not necessarily mean that adolescent LBP does not have an impact on society.

A report from 2021 based on data from the Danish Back Database (Dansk Rygdatabase – DaRD) revealed that approximately 20% of 30–60-year-olds who worked full time one year before receiving a back pain-related diagnosis were unable to maintain their degree of employment after consulting at the hospital (45). These findings remained unchanged two years later when the DaRD report of 2023 was made available (46). Therefore, musculoskeletal pain conditions such as LBP have a large socioeconomic impact. From a research perspective, it has also been of interest to investigate the impact adolescent LBP have on society. However, the indirect makers for societal impact needed to be adjusted as children and adolescents do not contribute to society (i.e., taxes based on full-time employment) to the same extent as adults.

As such, many studies have used a similar approach to that of Fairbank from 1984 (28) and have investigated if LBP was associated with school absenteeism and a decrease in physical activity and sports participation. In one study from 2004, the authors found that 7.8% (95% confidence interval [7.3-8.1]) of adolescents (10-16 years of age) had been absent from school due to LBP specifically (39). One study from 1992 (34) and another from 2001 produced similar findings (40). Even though these studies were conducted more than a decade apart, these findings suggest that approximately 8-10% of adolescents will be absent for one or more school days due to LBP (28,34,36,40). In Denmark, this may pose an issue from a societal point of

view, as all Danish children are bound by law (LBK nr 1887 af 01/10/2021) to undergo ten years of primary school (i.e., 0-9th grade).

In relation to school absenteeism, two cross-sectional studies also found an association between physical activity or sports participation and back pain (30,42). These findings suggest that LBP is more prevalent among adolescents who are highly engaged in physical activity or sports. However, a series of cross-sectional studies also found a high prevalence of LBP among adolescents who engage frequently in sedentary activities (i.e., screen time) (43,47-50). These mixed findings indicate that the association between physical activity and LBP among adolescents may be more complex than it is possible to investigate in a cross-sectional design. One study suggested that physical activity may be a risk factor for LBP among adults (51). Moreover, the authors found that both very high and very low levels of physical activity increased the risk of LBP when compared to moderate levels of physical activity (51). One prospective study revealed similar findings among school children aged 9-10, as both high and low levels of self-reported physical activity were associated with an increased risk of back pain (52). In contrast, moderate levels of physical activity seemed to decrease the risk of back pain (52). However, results from two prospective studies investigating the association between objectively measured physical activity and back pain indicate that it might be too early to determine if and how physical activity levels may be associated with back pain (53,54). This conclusion is similar to the one of an overview of systematic reviews concerning risk factors for back pain during adolescence (55).

1.2.3. RISK FACTORS FOR LOW BACK PAIN IN ADOLESCENTS.

Like physical activity, it remains inconclusive if age should be considered a risk factor for LBP in adolescents. One review found that 3 cohort studies reported age as a risk factor for adolescent LBP, while 1 cohort study found no association (56). In relation, findings from one systematic review found very low-quality evidence supporting the association between age and musculoskeletal pain in adolescents (57). Nevertheless, there is consistent evidence to suggest that LBP prevalence increases with increasing age through adolescence (40,44,58). Based on findings from an overview of systematic reviews, there seems to be consistent evidence that girls are more likely to report back pain compared to boys (55). In relation, two prospective cohort studies had contradicting findings regarding the association between sex and LBP among adolescent school children. One study found no significant association (59) while the other found a strong association between female sex and LBP (60). Although the prevalence of LBP is consistently found to be higher in girls compared to boys, there is a lack of evidence supporting sex as a consistent risk factor for LBP specifically. Even though there is some uncertainty regarding the association between adolescent LBP, age, and sex, previous research has aimed to investigate the impact of other potential risk factors in this age group. School bag weight, chair design, muscle strength, hypermobility, posture, and alignment are all factors which, at some points, were thought to influence the development of LBP in adolescence. However, there is

a general lack of evidence to support that any of these factors should be considered as a risk factor for adolescent LBP (61-64).

As with adults and emerging adults, the most consistent individual risk factor for adolescent LBP is one or more previous episodes of LBP (60,65). As such, there are grounds to believe that adolescents with LBP will experience new episodes throughout their teen years. This notion was, to some extent, confirmed by Hébert and colleagues, who identified 5 clusters of adolescent school children with spinal pain through LCA. In alignment with previous findings, most of the 1556 adolescents in the study had no spinal pain (49.8%) or spinal pain rarely (27.9%) (66). However, two clusters were found to have spinal pain rarely (14.5%), and spinal pain at moderate intensity (6.5%) and both these clusters were characterised by a notable increase in weeks with spinal pain with increasing age (66). Similar trajectories were previously identified through LCA (67). These findings suggest that adolescents with LBP will indeed experience more LBP throughout their teen years. However, as data on neck pain, back pain and LBP was pooled in this study, the generalizability of the results to a population of adolescents with isolated LBP is hampered.

Besides these individual risk factors, previous literature points to a series of environmental factors that may influence the development of LBP in adolescents. One systematic review and meta-analysis found that the offspring of adults with long-standing musculoskeletal disorders from the general population had 1.6 greater odds of reporting musculoskeletal disorders themselves (68). These findings were supported by a recent systematic review and meta-analysis in which the authors found moderate quality evidence that children from families with a history of musculoskeletal disorders had 2.04 greater odds of reporting musculoskeletal disorders themselves (69). In a subgroup analysis, the investigators found moderate quality evidence that children with parents or siblings with a history of back pain had 1.98 greater odds of reporting spinal pain themselves (69). Although most of these findings are based on cross-sectional studies, there is some evidence to suggest that environmental factors, including family history, play a role in the development of LBP in adolescents (64,68,69).

1.2.4. PREVENTION OF ADOLESCENT LOW BACK PAIN.

Previous research within the field of back pain in children and adolescents aimed to implement “Back Schools” in primary school settings with the overall aim of preventing new episodes of back pain (70,71). The content within different back school initiatives has varied, although many addressed themes such as “correct” posture while seated, “correct” packing and lifting of backpacks, spinal anatomy and physiology, and information regarding risk factors for back pain (72). Although the included students significantly improved their general knowledge of back pain, none of these attempts were successful in preventing new episodes of back pain (70,71). The absence of effect from these previous attempts to reduce back pain prevalence is

likely related to two main issues. Firstly, we know from the literature that one or more previous episodes of LBP are the most consistent risk factor for a new episode of LBP in adolescents (60,65). Moreover, previous research has documented that LBP prevalence increases with increasing age in adolescents (40,44,58). As more than 20-30% of Danish adolescents will experience LBP at some point (41-43) it seems somewhat unrealistic to reduce the number of new episodes of LBP in adolescents. Secondly, from our current understanding of common musculoskeletal pain conditions, including LBP, we know that these types of pain conditions are affected by more than mere biomechanics. Factors related to beliefs about pain, pain self-efficacy, functional and social limitations and context also impact LBP experiences in adolescents (73). Therefore, focusing on spinal anatomy and biomechanics without addressing psychological, social, and contextual factors is unlikely to result in a positive long-term effect on LBP prevalence. Currently, there is consistent evidence documenting a lack of effective strategies to prevent LBP in both adults and adolescents (74).

1.3. LOW BACK PAIN AMONG CARE-SEEKING ADOLESCENTS IN GENERAL PRACTICE.

1.3.1. A DESCRIPTION OF PRIMARY CARE GENERAL PRACTICE IN DENMARK.

In 2012, Kjeld Møller Pedersen and colleagues published a paper which thoroughly described the general practice setting in Denmark (75). Although this is an older paper, it still provides an accurate description of the current general practice setting. General practitioners in Denmark are gatekeepers to the Danish healthcare system, including secondary healthcare (75). Due to a strong welfare state, every Danish resident has free and direct access to a general practitioner. As such, all Danes can be listed with a general practitioner (75). Although this is still true, recent reports from the Danish Organization of General Practitioners (Praktiserende lægeres Organisation – PLO) show a current shortage of general practitioners in all five regions of Denmark (76). A general practitioner in Denmark will, on average, have 1.561 individual patients listed with them. A general practitioner is allowed to close their list for new patients if it reaches 1.600 individual patients (75). The report from PLO shows that as many as 66% of the Danish general practice clinics are unable to take additional patients (i.e., the lists of general practitioners are closed for new patients) (76). The report also shows that the number of patients listed with each general practitioner in the clinics with closed access is between 1.654 (Southern Region of Denmark) and more than 1.700 (Northern Region of Denmark and Region Zealand) (76). As such, these numbers indicate a continuous challenge with providing sufficient coverage of general practitioners for the Danes.

The general practitioners serve as gatekeepers for the Danish healthcare system during normal working hours (8.00 AM to 16:00 PM). During this time, it is possible to consult a general practitioner with a prior appointment. If an individual is severely hurt, it is possible to call 112 for immediate rescue services. This is equivalent to 911 in the United States. In cases of minor injuries which do require specialist treatment in the secondary healthcare sector, patients need to consult their general practitioner in person or over the phone to get a referral. If the need for secondary healthcare services arises outside normal work hours, patients need to contact an out-of-hours phone service, which can then refer the patient to secondary healthcare services (75). Besides managing patients and referring them to secondary healthcare services, it is also possible for the general practitioner to refer patients to a range of primary healthcare services such as primary care physiotherapy, chiropractic, and psychology.

All Danish patients who receive healthcare in general practice will have the content of their consultations recorded and stored with a unique identification code (i.e., Det Centrale Person Register; CPR number) (77). This code consists of 10 numbers, with the first 6 being the date of birth (day, month, year). The last four numbers are generated at random. However, the last number of individuals born as females will be an even number and vice versa for males (77). The CPR-number system makes it possible to conduct a vast amount of register-based research in Denmark, as it is possible to link data from different databases and healthcare services (77).

The International Classification of Primary Care – 2nd edition (ICPC-2) (81) system is widely used by Danish general practitioners to index consultation topics. The system is based on I) a letter system from A-Z and II) colour codes. For example, if a patient consults for symptoms or complaints regarding the lower back, the general practitioner will index the consultation with the L03 code. The letter refers to the overall location of the complaint. The letter L refers to complaints in the musculoskeletal system. Furthermore, L03 is coloured green, which means that this is a symptom-related diagnosis. In contrast, the L75 code is for patients diagnosed with a fractured femur. This code is also located within the musculoskeletal system. However, the code is red, which means the diagnosis is based on an identifiable injury within the musculoskeletal system. The L71 code (cancer in the musculoskeletal system) is coloured blue and relates to neoplastic diseases (78). In summation, by combining the CPR numbers with the ICPC-2 codes, it is possible to collect data for specific reasons for consulting (e.g., low back pain) in individual patients.

1.3.2. IS ADOLESCENT LOW BACK PAIN DIFFERENT FROM LOW BACK PAIN IN ADULTS?

In 1989, Turner and colleagues published a cross-sectional study on their investigation into LBP-related diagnosis among children younger than 15 years of age who presented to the orthopaedic department at the Royal Manchester Children's Hospital between 1978 and 1984 (79). The investigators found a specific underlying pathology

for 50% of the 61 children who consulted during the period, while the remaining 50% were characterised as having non-specific LBP (79). In the group with identifiable pathology, four were found to have a tumour, and 5 had an infection. As such, 9/32 (28%) with an identifiable pathology had a potentially life-threatening diagnosis. Even when taking the time and secondary care setting into account, these findings suggest an extremely high prevalence of severe pathology in care-seeking adolescents. Although previously published literature states that LBP in individuals under the age of 20 should be considered a sign of severe pathology (2,80), there is currently no evidence to support this statement (64,73).

Since the study by Tuner and colleagues in 1989, only little research has been conducted regarding the prevalence and incidence of severe LBP-related pathology in care-seeking adolescents. One study from the United States found that adolescents accounted for 0.5% (25.130 patients) of those who had consulted for back pain at one of 45 included hospitals over the course of 4.5 years (81). Of these adolescent patients, 0.4% (88 patients) were diagnosed with a severe underlying pathology, with the most common being fractures (81). Even though these findings are from a secondary care setting, it seems reasonable to assume that the prevalence of severe pathology in the lower back among care-seeking adolescent patients from primary care may correspond to that of adult patients. Currently, there is no evidence to suggest that diagnostic triage of care-seeking adolescents with LBP from primary care should be conducted any differently from the approach described for adult LBP patients (3,4,64,73).

1.3.3. CARE-SEEKING BEHAVIOUR – AN INTRODUCTION.

Care-seeking behaviour was previously defined in the literature as “...*any action undertaken by individuals who perceive themselves to have a health problem or to be ill for the purpose of finding an appropriate remedy*” (82). As such, care-seeking behaviour concerns both the time at which an individual seeks care, which health care provider individuals engage with, and how or if care-seeking is maintained (83). Based on previous research in adults, care-seeking behaviour is highly individualised and influenced by factors such as age, gender, financial means, perceived health status and illness, context, social culture, and availability of healthcare services (82,83). Therefore, the action of seeking care for health problems can likely not be considered generic for all patients, irrespective of age and condition. Going through the published literature, it is evident that the concept of care-seeking behaviour among adolescents with LBP, or musculoskeletal pain in general, seems to have been investigated solely from a quantitative perspective. As such, there is some available knowledge on how frequently adolescents with LBP consult a health care provider for their pain (please see section 1.3.4 - Care-seeking behaviour among adolescents with low back pain). Previous studies have also uncovered some of the factors which influence care-seeking behaviour in adolescents with LBP (please see section 1.3.5 - Factor influencing care-seeking behaviour in adolescents with low back pain). In contrast, there is a distinct lack of qualitative studies investigating the concept of care-seeking behaviour in this specific group of young patients.

1.3.4. CARE-SEEKING BEHAVIOUR AMONG ADOLESCENTS WITH LOW BACK PAIN.

In this thesis, care-seeking adolescents are defined as young individuals who seek care with a health care provider. Although LBP is common among adolescents, previous research has shown a large variation in the percentage of adolescents who will go to consult a health care provider for LBP. Two older cross-sectional studies found that between 6.5% and 25.3% would consult a general practitioner due to LBP (39,40). Furthermore, one study from Italy reported that as many as 76% had consulted a health care provider with 44% consulting a general practitioner (35). In a prospective cohort study from Denmark, the investigators found that approximately 8% of adolescents between ages 9 and 13 would consult a health care provider due to back pain (58). At age 15, the group of care-seeking adolescents had increased to 30-40%. Moreover, 90% of those who had sought care at age 13 also sought care at age 15 (58). Similar results were found in a recent study from Sweden, which aimed to investigate consultation patterns among care-seeking children, adolescents, and young adults in primary and secondary care (84).

Currently, there is little knowledge regarding the care-seeking behaviour of adolescents with LBP from general practice. Some of the most recent data was published by investigators from the Primary Care Science Research Centre at Keel University. These studies are largely based on retrospective data collected through the Consultations in Primary Care Archive (CiPCA) database. This database is an ongoing primary care medical record database which contains anonymised data of all consultations between patients and health care providers from 12 general practice clinics in North Staffordshire in the United Kingdom (85,86). Through the Read Code system, it is possible to identify consultations concerning musculoskeletal disorders (87). From this approach, Tan and colleagues found that back pain was a relatively infrequent reason to consult a general practitioner in patients under the age of 9, whereas it became the most common reason to consult for any musculoskeletal disorder in the 14-17-year-olds (86). The standardised annual consultation prevalence per 10.000 registered persons between 3 and 17 years of age for LBP specifically was 49 in both female and male patients (86). Investigators from the same research group at Keel University also sought to collect cross-sectional data on adolescent musculoskeletal pain from general practice. Although the strategy for collecting data was found to be feasible, only a small sample size of 27 adolescent patients was reached (88). In 2022, Pourbordbari and colleagues also attempted to collect cross-sectional data from general practice on activity limiting musculoskeletal pain conditions in care-seeking adolescents. The investigators found that back pain was the third most common reason for adolescents to consult a general practitioner, only surpassed by pain in the knees and ankles (89). These data correspond with the most common pain locations found in Danish adolescents from the background population (42). A recent study aimed to investigate care-seeking behaviour among adolescents consulting for musculoskeletal pain conditions in general practice. The study included routinely collected data from the CiPCA database for patients aged 7-15 who consulted for musculoskeletal pain between 2003 and 2010 (90). The investigators

found that the annual consultation rate for these types of conditions increased with age. This was also the case for back pain specifically (90). Although the underlying data for this study was collected prospectively, they were managed as retrospective register data (90). As such, there is a continuous lack of prospective studies investigating prognosis, trajectories, pain intensity and functional limitations among care-seeking adolescents with LBP from general practice.

1.3.5. FACTORS INFLUENCING CARE-SEEKING BEHAVIOUR IN ADOLESCENTS WITH LOW BACK PAIN.

As stated previously, there is evidence to suggest that both individual and environmental factors may influence the development of LBP in adolescents (64,68,69). This may also be true in relation to care-seeking behaviour in adolescent patients with LBP. In relation to individual factors, one study among Finnish adolescents found that girls had significantly more primary health care contacts compared to boys (91). Furthermore, multiple symptoms of internalising (i.e., anxiety, depression, withdrawal, and somatic complaints) and externalising (i.e., delinquent or aggressive behaviour) problems were associated with increased primary health care contacts in both girls and boys (91). There is also some evidence to suggest that worries may play a role in the care-seeking of patients. A recent study among care-seeking adolescents with musculoskeletal disorders from Danish general practice found that 1 in every three felt anxious or worried at the time of consulting a general practitioner. Importantly, these results do not concern specific worries about LBP and should not be interpreted as such. However, in a qualitative interview-based study among children and adolescents with back pain, worries related specifically to back pain were expressed by some of the informants (92). The worries were related to the notion of not being able to keep up with peers and going on to have functional limitations, as was the case for their parents (92). Interestingly, worries and fears about the future were found to be a major theme among adult patients with LBP in a large meta-ethnographic study of qualitative research (93). As such, LBP-related worries may be present in care-seeking adolescents. However, currently, there is a lack of knowledge about how prevalent these worries are, what adolescent patients are worried about, and how LBP-related worries may change with time.

Two older studies from the United States (94,95) and one study from the United Kingdom (96) investigated individual and environmental factors which were thought to influence care-seeking behaviour in children and adolescents. In the study by Janicke and colleagues from 2001, the investigators found that the child's pain, the number of retrospective visits, and the presence of acute recurring illness significantly influenced the number of consultations the children would have over the course of 2 years (95). The investigators also found that the mother's worries about the child's health significantly influenced the number of consultations during the 2-year period (95). In the study by Janicke from 2003, the investigators found that the care-seeking behaviour of the parents would influence the number of consultations for the children (94). Similar results were found in the study by Little and colleagues from 2001, where higher consultation rates in the parents would predict consultation rates in the children

(96). In summation, there is evidence to suggest that both individual and environmental factors may influence care-seeking behaviour in adolescents, although there is a lack of studies investigating these factors specifically within care-seeking adolescents with LBP from general practice.

1.3.6. MANAGEMENT OF ADOLESCENT LOW BACK PAIN.

At present, little research has been conducted on the management of adolescent LBP in clinical practice. A systematic review from 2014 investigating the effect of conservative management strategies for adolescent LBP included four randomised controlled trials, of which only one study recruited care-seeking adolescents (97). In this one study, care-seeking adolescents between 12 and 18 years of age from physiotherapy clinics were randomised to receive either individual physiotherapy, back education and self-training or back education and self-training only for 12 weeks (98). The authors found an overall reduction in pain and an increase in function, although the majority of patients in both groups continued to have intermittent LBP after the 12-week period (98). Although most studies investigating the effect of exercise on adolescent LBP recruited participants outside clinical practice, there is some evidence to suggest that exercise may reduce back pain on a group level (55).

There have also been previous attempts to investigate the effect of spinal manipulation among adolescents with acute LBP. In a study from 2015, Selhorst and colleagues randomised adolescents 13-17 years of age to either spinal manipulation and exercise or sham spinal manipulation and exercise (99). All patients were prescribed eight consultations. The authors found no statistically significant difference between the two groups six months after the intervention, although both groups had significantly improved in terms of LBP intensity and function (99). These findings further suggest that exercise may be effective in reducing LBP intensity and improving function. However, it is important to recognise that the mean LBP intensity scores in both groups were approximately 3 at baseline measures with an 11-point Numeric Pain Rating Scale (NPRS), and the patients were recruited in the acute phase (mean pain duration 47 days, standard deviation 22 days) (99). Therefore, much of the improvement is likely due to regression to the mean (100-102). In a similar randomised study from 2018, the authors also found improvement in terms of LBP intensity and function among adolescents with long-standing LBP who received either 12 weeks of spinal manipulation and exercise or exercise alone (103). Although there was a larger improvement in the group who received spinal manipulation and exercise, there was no clinically relevant difference between the two management strategies after one year (103). Furthermore, improvements in both groups were relatively small throughout. This may be due to the patients having experienced pain for an extended period of time (median pain duration of 104 weeks). In relation, previous studies were unsuccessful in reducing pain intensity in adult patients with long-standing LBP. This is despite a significant improvement in function across the trials (1,104,105). As such, LBP duration may impact treatment effects in terms of pain intensity in patients.

Currently, there is limited evidence indicating that one specific management strategy is more effective than another to reduce LBP intensity and improve function among care-seeking adolescents with LBP. Although exercise may have shown promising results in previous studies, the effects were small overall, especially in adolescents with long-standing pain. However, taking into consideration that the majority of adolescent patients with one or more episodes of LBP are likely to continue to experience episodes of LBP throughout their lives and the fact that severe pathology is uncommon in this age group, there is a rationale to explore if an intervention to facilitate a self-management approach may affect LBP intensity and function among care-seeking adolescent patients with LBP.

1.3.7. SELF-MANAGEMENT AND HEALTH LITERACY - AN INTRODUCTION.

The perception of self-management within this PhD thesis is based on the work by Dr Kate Lorig of Stanford University, who, alongside her colleague, Dr Halstad Holman, outlined the concept of self-management in their paper from 2003 (106). In this paper, the authors argue that self-management for most individuals is a lifelong process regardless of health status. As such, self-management concerns the act of maintaining good health on a day-to-day basis (106). Importantly, Lorig and Holman argue that “*One cannot not manage*” (106). This notion is likely reflected in clinical practice as different individuals will have different self-management strategies. Even though these different strategies may vary greatly, they all reflect an attempt to self-manage. In their paper from 2003, Lorig and Holman define five key skills for successful self-management, which are 1) Problem solving, 2) Decision-making, 3) Utilizing resources, 4) Forming partnerships with healthcare providers, and 5) Taking action (106).

In this PhD thesis, the concept of health literacy is believed to be closely related to self-management as it reflects an individual’s capacity to interact with the complex demands of maintaining and promoting good health in modern society (107). Health literacy was defined by the World Health Organization as “*the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health*” (108). Therefore, health literacy encompasses a wide range of individual competencies such as navigating the healthcare system, finding, and appraising reliable health information, and actively engaging with health care providers (108). As such self-management may be considered the actions taken to maintain one’s health, whereas healthy literacy may be thought of as the individual competencies that makes the management of one’s health possible. From this notion, it is evident that the concepts of self-management and health literacy are intertwined and, to some extent, may influence each other.

Below, I provide the reader with a brief introduction to each of these five key skills for successful self-management, as outlined by Lorig and Holman (106). I also describe how the specific health literacy competencies of navigating within the

healthcare system, engaging with health care providers, and obtaining information are thought to influence specific self-management skills among care-seeking adolescents with LBP within this PhD.

Problem solving: The essential notion of self-management is that it is grounded in a unique, individual health-related problem which requires a problem-based approach to overcome (106). To be able to apply a problem-based approach, one needs to be able to first identify and define the problem, generate one or more solutions, implement one or more of these solutions and eventually evaluate if the solutions were helpful in overcoming the given problem (106). As such, a problem-based approach can be thought of as a circular process during which different solutions for a given health-related problem are identified, implemented, evaluated, and potentially maintained.

Decision-making: Deciding on which solution should be applied to counter a given health-related problem first and foremost requires an adequate amount of information. This information should then be used to make short-term changes on a day-to-day basis to reflect any response related to the problem at hand (106). Having the ability to obtain and process relevant information regarding general health or a specific condition is also considered essential in terms of health literacy competencies (109). Furthermore, deciding on an appropriate solution is closely related to care-seeking behaviour. In this process, individuals are required to assess their own health and subsequently decide if they can overcome the problem by themselves or if aid from a health care provider is required (106).

Utilizing resources: Individuals may use a variety of resources to overcome a health-related problem. This may include everything from internet-based resources, information from libraries, knowledge obtained through friends, and experiences described by family members (106). Being able to utilize social resources from friends and family was also found to be an important ability in terms of health literacy (109). In this thesis, social support is thought to be of great importance for care-seeking adolescents with LBP, as these young patients may have limited experience with managing pain conditions. This limited experience may also be reflected in the ability of adolescent patients to navigate the healthcare system. Being able to identify and decide which health care provider to engage with is also a vital ability to possess from a health literacy perspective (109). Therefore, being able to navigate the Danish healthcare system was thought to be important for the adolescent patients within this thesis, as these young patients were thought to have limited personal experience in this area.

Forming partnerships with health care providers: Lorig and Holman argue that many patients must be able to form strong clinical alliances with health care providers to successfully self-manage their health (106). Such partnership between the patient and the health care provider should foster discussions on health matters, which would subsequently lay the foundation for patients to make informed decisions about their health (106). Based on this key skill, it is evident that self-management is not

necessarily something patients do on their own. On the contrary, having the ability to actively engage with health care providers was also identified as a vital element to maintaining good health from a health literacy perspective (109). Due to their potential limited experience with engaging with health care providers, it was believed that this key skill would be of significance among adolescent patients with LBP.

Taking action: To be able to take action is a skill closely linked to the patient's level of self-efficacy, which reflects how confident an individual is that he or she can accomplish a given task (106). Developing high levels of self-efficacy is especially relevant in the process where the aim is to change behaviour. For patients with low levels of self-efficacy, it is vital to ignite a positive spiral in which patients are successful in completing specific and meaningful tasks, which in turn will boost their self-efficacy. Therefore, these tasks should be tailored to each individual patient with the overall aim of boosting confidence and self-efficacy so that the patient may be motivated to change behaviour.

1.3.8. CURRENT KNOWLEDGE ON INTERVENTIONS TO FACILITATE SELF-MANAGEMENT AMONG PATIENTS WITH LOW BACK PAIN.

In their masterclass paper from 2021, Dr.s Alice Kongsted, Inge Ris, Per Kjaer, and Jan Hartvigsen outlined ten key points for clinicians regarding self-management of LBP (110). The authors argue that self-management of LBP will be a lifelong process for most of the affected individuals due to the high rate of recurrent LBP episodes (110). Furthermore, the authors highlight that traditional biomechanical explanations for LBP do not correlate well with LBP intensity ratings or functional limitations (110). Instead, the authors encourage clinicians to take an interest in self-management: *“Clinicians should care about self-management because most people with LBP continuously manage their condition and should be able to do it well”* (110).

At present, there is evidence to suggest that self-management interventions are effective for managing chronic LBP in adult patients. A systematic review and meta-analysis of 13 randomised controlled trials found that self-management intervention had a moderate and significant effect on reducing LBP intensity for up to one-year post-intervention (111). The study further shows that self-management intervention had a small to moderate effect on disability among patients with chronic LBP (111). It was not possible to identify any studies investigating the effect of a self-management intervention specifically for care-seeking adolescent patients with LBP.

CHAPTER 2. KNOWLEDGE GAPS, AIMS, AND STUDY DESIGNS

In this chapter, I provide the reader with a description of the specific knowledge gaps that I aimed to address during my PhD. For these knowledge gaps, I also provide the study aims of the three studies that were conducted as part of this PhD. I will, in addition, provide the reader with a brief presentation of the three study designs. This is meant to inform the reader of the specific study designs and the methodological considerations related to each of the three studies. At the end of the chapter, I provide the reader with a description of how the three studies supplement each other to accumulate new knowledge within the field of adolescent low back pain.

2.1. A STUDY OF PROGNOSIS AND TRAJECTORIES OF PAIN IN CARE-SEEKING ADOLESCENTS WITH LOW BACK PAIN FROM GENERAL PRACTICE – STUDY 1.

2.1.1. KNOWLEDGE GAPS ADDRESSED IN STUDY 1.

As described in the introduction, the prevalence and impact of LBP have been extensively investigated in adolescents from school settings (29-41). In contrast, there is a lack of prospective studies investigating the prognosis and trajectories of pain among care-seeking adolescents who consult their general practitioner. Therefore, no prospective data regarding LBP intensity, symptom worries and functional limitations among care-seeking adolescents exists. Furthermore, based on cross-sectional data, there is evidence to suggest that both individual and parent-related factors may play a role in the development (64,68,69) and potentially the prognosis among care-seeking adolescents with LBP. However, no prospective studies have investigated if specific factors related to the young patients or their parents may influence the prognosis among care-seeking adolescents from general practice.

2.1.2. AIMS OF STUDY 1.

In the first study, we aimed to investigate the prognosis and trajectories of pain among care-seeking adolescents with LBP after they had consulted their general practitioner. A subsequent aim was to investigate if a series of individual and/or parent-related factors would influence the prognosis among adolescent patients.

The aims of study 1 were I) to identify the natural prognosis of LBP among care-seeking adolescents in general practice, II) to describe the different trajectories of adolescent LBP by performing a latent class analysis on longitudinal data, and III) to identify patient and parent-related factors which influence prognosis.

2.1.3. DESIGN OF STUDY 1 – A PROSPECTIVE COHORT STUDY.

The first study of this PhD was designed as a prospective cohort study. In this study, self-reported data was collected through online questionnaires. Additional data related to the index consultation of each adolescent patient was collected from individual general practice clinics. Along with cross-sectional studies and case-control studies, prospective cohort studies are among the most widely used designs within the field of epidemiology (112). The purpose of a prospective cohort study is often to investigate the association between exposures and outcomes within clearly defined study populations (112). This was also the case with the first study of this PhD, as we aimed to investigate if a series of individual and parent-related factors (exposure variables) could potentially impact prognosis (outcome) in care-seeking adolescents with LBP from general practice. A similar prospective cohort design was previously used to assess if recurrent LBP episodes could be predicted among care-seeking adults (22). Based on repeated follow-up measures collected during the course of one year, we further sought to identify different pain trajectories among the included adolescents. Such use of the prospective cohort study design was previously applied to investigate pain trajectories in care-seeking adults (26) and adolescents from the general population (67).

The initial plan was to include participants in parallel cohorts, with the primary cohort consisting of children and adolescents who consult their general practitioner for LBP. One parent of each child included in the primary cohort was supposed to be invited to participate in the secondary cohort; however, due to unforeseen circumstances involving the COVID-19 pandemic, it was not possible to establish either cohort as planned. These circumstances had a significant impact on the planned analyses related to both the possible exposure/outcome association and the analyses related to pain trajectories. Please see Chapter 3 for a detailed outline of Study 1 and the related deviations from the study that was originally planned.

2.2. A STUDY OF HEALTH LITERACY COMPETENCIES AND SELF-MANAGEMENT SKILLS IN CARE-SEEKING ADOLESCENTS WITH LOW BACK PAIN FROM GENERAL PRACTICE – STUDY 2.

2.2.1. KNOWLEDGE GAPS ADDRESSED IN STUDY 2.

As outlined in the introduction, some quantitative studies have investigated care-seeking behaviour in adolescents with LBP. These studies both assessed consultation rates (86) and factors associated with seeking care in children and adolescents (94,95). However, at present it was not possible to identify any previous study investigating care-seeking behaviour among adolescents with LBP from a qualitative point of view. As such, it is currently unknown how adolescents with LBP interact with the

healthcare system and specific health care providers when seeking care. Furthermore, which health literacy competencies and self-management skills these young individuals apply in their pursuit of a solution remain to be uncovered.

2.2.2. AIMS OF STUDY 2.

In the second study, we aimed to investigate when care-seeking adolescents with LBP interact with health care providers and how the patients and the health care providers interact with each other based on the patient's point of view. Further, we wanted to investigate which health literacy competencies and strategies the adolescents used to self-manage their LBP on their own, with their family and with health care providers.

The primary research questions for study 2 were to investigate when and how care-seeking adolescents with LBP interact with health care providers and which health literacy competencies and strategies they use to self-manage their LBP.

2.2.3. DESIGN OF STUDY 2 – AN INTERVIEW-BASED QUALITATIVE STUDY.

The second study of this PhD was designed as an interview-based qualitative study. All research material for this study was collected through semi-structured single-person interviews and stored as audio files. The semi-structured interview is a well-established and recognised qualitative research approach for collecting responses from individual informants or groups of individuals through a series of open-ended questions posed by an interviewer (113). The semi-structured interview is widely used within a variety of scientific fields, such as primary healthcare research, nursing, sociology, and psychology (113-115). Furthermore, this form of interview was found applicable for interviewing both adults and adolescents (92,116). The semi-structured interview has been refined over the course of decades and can be used and adapted to suit various qualitative approaches, including phenomenology, hermeneutics, and grounded theory (117-119). Through the semi-structured interview, it is possible to gain in-depth insights into the life of an individual or a group of individuals (113). During the analysis of the collected research material, we used the 6-step thematic analysis approach as described by Braun and Clarke (120). This approach has been widely used to analyse semi-structured research material, and it currently has more than 79.000 cross-references (121).

2.3. A STUDY ON FACILITATING A SELF-MANAGEMENT APPROACH AMONG CARE-SEEKING ADOLESCENTS WITH LOW BACK PAIN.

2.3.1. KNOWLEDGE GAPS ADDRESSED IN STUDY 3.

As demonstrated in the introduction, the most consistent risk factor for a new episode of LBP in both adult and adolescent patients is one or more previous episodes of LBP (60,65,66). As such, there is evidence to suggest that individuals who experience LBP will continue to experience episodes of LBP during their lives. There is currently little evidence to support the effectiveness of exercise or spinal manipulation on LBP and function among adolescent patients recruited from clinical practice (44,97,103). However, as adolescent patients with LBP are likely to experience continuous episodes of LBP during their lives, there is a rationale to investigate the effectiveness of interventions aimed at facilitating a self-management approach among care-seeking adolescents with LBP so they may be confident in managing their pain on their own or in collaboration with family, friends, or health care providers. This notion is supported by previous studies displaying small to moderate effects of self-management intervention on LBP intensity and disability among adult patients with long-standing LBP (111).

2.3.2. AIMS OF STUDY 3.

The aim of study 3 was to investigate the short-term effect of an intervention to facilitate self-management among adolescent LBP patients assessed by LBP intensity and functional limitations in a single subject experimental study. We further aimed to investigate if LBP-related worries and pain self-efficacy would mediate the effect of the intervention.

We hypothesised that the intervention would decrease LBP intensity and improve function on a patient level in the short-term. We further hypothesised that LBP-related worries and pain self-efficacy would mediate the effect of the intervention on a patient level in the short-term.

2.3.3. DESIGN OF STUDY 3 – A SINGLE SUBJECT EXPERIMENTAL STUDY.

The third study of this PhD was designed as a single subject experimental study. In this study, all data was collected through self-reported questionnaires, which were administered both through e-mail and a mobile application. The single subject experimental study is a well-established research method that is widely used within the field of medicine and psychology (112). Single subject experimental studies are also referred to as “N=1 studies” (122) as they are used to investigate the impact of treatments on a patient level (123). As such, single subject experimental studies were previously used to study treatment effects among patients with insomnia,

osteoarthritis, and anxiety (122).

Currently, the randomised controlled trial design is recognised as the gold standard for investigating the benefit of a given treatment protocol (124). However, as the findings of randomised controlled trials are based on group means, the applicability of the findings on an individual patient level is likely limited (125). As such, it has previously been argued that frequent individual assessments are required to assess the impact of a given treatment on individual patients (123). It was further argued that findings from single subject experimental studies are especially desirable in the early stages of treatment development as these allow for the identification of individual patients who benefit from the treatment (123).

Some would probably argue that single subject experimental studies are another description of trials commonly known as pilot studies. Although findings from single subject experimental studies may be used to inform randomised controlled trials, this is not the main purpose of these studies. In contrast, the main purpose of pilot studies is primarily to assess the elements within a given study protocol, estimate recruitment rates, and calculate sample sizes (126). One important distinction between pilot studies and single subject experimental studies is that while the findings from a pilot study are meant to inform a subsequent study (126), the findings from a single subject experimental study are primarily meant to inform clinical practice (122,123,127) while informing large group-based studies are a subsequent and optional purpose.

While it is important to distinguish between pilot studies and single subject experimental studies, it is further important to distinguish between randomised controlled trials and single subject experimental studies (127). This is especially true when considering the randomisation procedure and the assignment to intervention. Participants in group-based randomised controlled trials are randomised to two or more interventions in order to assess the treatment effect between interventions (128). In single subject experimental studies, the randomisation procedure is concerned with the process of assigning participants across two or more conditions rather than across two or more experimental groups (127). For the single subject experimental study in this PhD, the adolescent patients underwent a baseline phase (phase A) of 8-14 days from inclusion. The specific time at which each patient would commence the intervention phase (phase B) was assigned to them at random. As such, the baseline phase would last a minimum of 8 days and a maximum of 14 days, pending the randomisation. With this approach, it was possible to assess the immediate individual effect of the intervention irrespective of which time each adolescent patient initiated the intervention phase.

One additional characteristic of single subject experimental studies is the high frequency of data collection. In these types of studies, data are often collected daily or weekly (129). As such, single subject experimental designs will often generate high-density data over time when compared to randomised controlled trials that may collect data months apart.

One final factor to consider is the discrepancy between the statistical approaches used in single subject experimental studies and the group-based randomised controlled trials. For single subject experimental studies, it is uncommon to provide aggregated baseline or follow-up data on the study population (130). This is in line with the overall methodological approach of assessing data on an individual patient level. In contrast, aggregated baseline and/or follow-up data are usually available for group-based randomised controlled trials, for instance, in the form of a table containing descriptive data for the study population (131). When assessing between-group differences in intervention studies, it is possible to apply statistical models to test pre-specified or explorative hypotheses. The student's t-test and the analysis of variance are both common statistical models to assess mean differences between independent groups (132). Further, Person's correlations are commonly used to assess if there is a simple linear association between two variables (132). It is common in randomised controlled trials to study the association between an exposure variable and an outcome variable of interest (e.g., the association between a given intervention and a related outcome). However, such relationships may be mediated by a third factor, thus rendering the traditional exposure/outcome relationship too simplistic (133). For this statistical issue, it is possible to conduct a mediation analysis. In contrast to the statistical approach outlined for the randomised controlled trial, much of the data in single subject experimental studies will be assessed with a combination of simple statistical models and visual interpretation (134,135). Furthermore, it is also possible to conduct a mediation analysis within a single subject experimental study, just as is the case for the randomised controlled trials. Nevertheless, it is important to remember that mediation analyses from randomised controlled trials are applied to group-based data while mediation analyses within single subject experimental studies are applied to individual patient data (133-135). Therefore, one needs to distinguish between these two types of mediation analyses as they are, in fact, different from each other.

2.4. HOW THE THREE STUDIES ARE LINKED AND HOW THEY SUPPLEMENT EACH OTHER.

The Sequence of prevention model, as presented by Dr. Willem van Mechelen, was designed as a framework to reduce injuries in sports (136). The framework consists of 4 steps, which may be repeated in a sequence. In step 1, the extent of the injury problem should be established in relation to incidence and severity. In step 2, the aetiology and mechanisms of the injury should be investigated. In step 3, a preventive measure should be introduced. This preventive strategy is then subsequently evaluated in terms of effectiveness by repeating step 1 (136). Although the Sequence of prevention model was designed specifically to prevent sports-related injuries, I found that the overall framework provided a solid foundation for investigating LBP among care-seeking adolescents from general practice.

When this PhD was initiated, the primary aim was to generate new knowledge related to care-seeking adolescents with LBP from general practice from both an epidemiological and qualitative point of view. As such, we aimed to establish two

parallel cohorts, which included both care-seeking adolescents with LBP from general practice and their parents. From the primary cohort of adolescent patients, it would be possible to investigate the extent of pain related to the lower back based on prospective data, which aligns with step 1 of the Sequence of prevention model (136).

As outlined in Chapter 1, there is no evidence to suggest that severe pathology or radiculopathy is more common in adolescent patients as compared to adult patients (please see section 1.3.2. - Is adolescent low back pain different from low back pain in adults?). Therefore, it is reasonable to assume the majority of care-seeking adolescents will present with non-specific LBP. As non-specific LBP is characterised by not having a pathoanatomical origin (5), it may, however, be difficult to identify any underlying aetiology or specific mechanism for this type of pain. The main focus was, therefore, to investigate if a series of individual and parent-related factors would impact prognosis among the adolescents one year after consulting their general practitioner. We further aimed to identify different pain trajectories within the group of care-seeking adolescents. In line with step 2 of the Sequence of prevention model (136), we did collect data related to the index consultation of each patient included in study 1 of the PhD. This was to investigate if the general practitioners would suspect any underlying pathology at the time of consultation.

To supplement these quantitative findings, we further aimed to investigate when and how adolescents with LBP would interact with the healthcare system and with health care providers in their pursuit of a remedy. It was believed that a combination of prospective data and findings from qualitative interviews would provide a better understanding of the care-seeking behaviour among adolescents with LBP from general practice.

However, as the world was introduced to the COVID-19 pandemic just as study 1 was initiated, the prospective cohort study could not be completed as planned. Nevertheless, it was possible to include 13 adolescent patients with LBP from general practice, and these patients provided some interesting prospective data, especially regarding LBP intensity and LBP-related worries over the course of the study. It was also possible to identify some interesting points regarding health literacy competencies and self-management strategies from the adolescent informants who participated in the second study of this PhD. Based on step 3 of the Sequence of prevention model, it should theoretically be possible to introduce a preventive strategy to reduce the burden of adolescent LBP based on the findings from studies 1 and 2 (136). However, based on empirical findings, we know that the prevalence of LBP increases with increasing age and that a previous episode of LBP is a consistent risk factor for a new episode of LBP among adolescents (66). Furthermore, there is currently no evidence to support any preventive measure for either adult or adolescent LBP (74).

Based on these previous findings, there were no rational for introducing a new preventive strategy in a third study within this PhD. Instead, it seemed more appropriate to investigate if it was possible to facilitate a self-management approach among care-seeking adolescents with LBP in a small experimental study. As such, the primary purpose of study 3 in this PhD was not to provide adolescent patients with a cure for their LBP but rather to give them tools to manage their LBP on their own or in collaboration with parents, friends, or health care providers.

In summation, this PhD was largely based on steps 1 and 2 of the Sequence of prevention model. It was, to some extent, possible to accomplish the initial goal, which was to gain insight into the group care-seeking adolescent patients with LBP from general practice. And with the inclusion of the single subject experimental study, it was possible to provide new insight from both an epidemiological, qualitative, and management perspective.

CHAPTER 3. STUDY 1.

In this chapter, I provide the reader with a detailed description of the methodological considerations for the first study of the PhD. Furthermore, I present the results of the study, which are subsequently discussed along with the methods. At the end of the chapter, I provide a brief conclusion for the study.

3.1. METHODS AND MATERIALS.

3.1.1. STUDY DESIGN.

The first study in this PhD was designed as a prospective parallel-design cohort study based on relevant items from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (137). In the study, we planned to obtain data through I) self-reported email-based questionnaires and II) register data from general practice journals and biweekly text messages. The primary cohort was planned to include care-seeking adolescent patients with LBP. In a parallel secondary cohort, we planned to include one parent for each of the included adolescents. A STROBE checklist for the current study can be found in Appendix A.

3.1.2. PRE-REGISTRATION.

The study was pre-registered at Clinicaltrials.gov before the first adolescent patient was enrolled [Trial registration: NCT04148144].

3.1.3. ETHICAL CONSIDERATIONS AND ADDITIONAL APPROVALS.

The study followed the principles of the Helsinki Declaration. Prior to undertaking the study, ethical approval was sought from the local Ethical Committee in the Northern Denmark Region Committee ((Niels Bohrs Vej 30, 9220 Aalborg East, Denmark. The Region of Northern Denmark). The Committee replied that approval was not necessary. Observational studies, such as the current one, do not fall within the legal boundaries of the Ethical Committee in Denmark, and thus, approval from such committee is often not required prior to initiation (LBK nr 1338 af 01/01/2020). Written informed consent to participate in the study was obtained from all patients and from parents or legal guardians for any adolescent patient below the age of 15. Written informed consent to participate in the secondary cohort was obtained from the parents and/or legal guardians themselves.

Research projects conducted within Danish general practice, which involve more than five general practice capacities (i.e., more than five full-time general practitioners),

are required to seek approval from The Committee of Multipractice Studies, which is an independent committee organised under the Danish College for General Practice. The Committee consist of general practitioners who will go through incoming applications. The Committee will either I) recommend general practitioners to participate, II) not recommend general practitioners to participate or III) provide no recommendation. The Committee evaluated the current study prior to initiation and deemed the study appropriate for general practice. As such, the Committee recommended Danish general practitioners to partake in the study.

3.1.4. DATA PROTECTION AND ADDITIONAL AGREEMENTS.

Collection, storage, and working with patient data were conducted in accordance with the European General Data Protection Regulation of Maj 25th 2018. Written informed consent to handle data was obtained from all patients and from parents or legal guardians for any patient below the age of 15. Written informed consent to handle data for participants in the secondary cohort was obtained from the parents and/or legal guardians themselves. Data handling agreements and collaboration agreements were obtained from all participating general practice clinics.

3.1.5. STAKEHOLDER INVOLVEMENT.

The study's aims and methodology were informed through collaboration and discussions with adolescent patients with LBP and their parents, general practitioners, clinical staff, physiotherapists, and expert researchers within the field of LBP.

Adolescent patients, who at the time were undergoing a treatment course for LBP, were interviewed at the site where they received the treatment. These initial interviews were conducted to provide insight into the thoughts that the patients would have towards their LBP and what challenges they would encounter in their daily lives due to their LBP. Parents of adolescents with LBP were also interviewed to obtain knowledge of the experience of being a parent to a young individual in pain. One general practitioner, a general practitioner in training, and a secretary working within a general practice clinic were interviewed to gain insight into the clinical setting of general practice and what was important to consider as a researcher within this specific setting. To gain more insight into what characterised adolescent patients with LBP who were referred from general practice to primary care physiotherapy, a series of interviews was conducted among four physiotherapists with a special interest in adolescent LBP. Finally, this specific study was discussed multiple times with both Danish and foreign expert researchers within the field of adolescent LBP.

The interviews and discussions were conducted during normal working hours, and all informants were made aware that the insight gained was used to inform subsequent scientific studies within the field of adolescent LBP. All interviews were conducted in 2017 as preparation prior to undertaking the current PhD. The information gained during the interviews and discussions aided in the process of forming the aims and

selecting the study designs for study 1 and study 2 within this PhD. Det information also influenced the choice of outcomes for study 1.

3.1.6. RECRUITMENT OF GENERAL PRACTITIONERS.

Recruitment of general practitioners for the study was undertaken with different approaches. First, general practice clinics in the Northern Region of Denmark were identified through web-based searches. The clinics were then contacted by phone. In this process, the researcher would wait in line with the other individuals calling at the time. The phone was most often answered by a front desk secretary who would ask for written study information to be forwarded via e-mail. After 1-2 weeks, the clinics were contacted again and asked to participate in the study. The success rate of this approach was poor, and thus, there was a shift in the method used to recruit clinics. Instead, the clinics were visited in person and were given an envelope containing two documents. The first document was a very short description of the study, and the second document was an information sheet with facts about back pain and brief, anonymous quotes from adolescents with LBP. These quotes were acquired through stakeholder interviews. Further, the researcher would provide a small box of chocolate for the general practitioners and clinical staff to share. Moreover, the researcher would ask the front desk secretary to give the envelope to a specific general practitioner within the clinic. This approach had a higher success rate compared to the initial approach. It was initially estimated that 50 general practice clinics should be contacted and invited to take part in the study. This estimate was based on the time and resources available within the project and the estimated number of adolescent patients that needed to be recruited (please see section 3.1.7. – Recruitment of care-seeking adolescents with low back pain from general practice and their parents). In accordance with the convention for Danish general practice (138), participating general practitioners were financially compensated for their time and contribution to the study with a standard fee of approximately 19 euros. This amount corresponded with the fee for a standard 10-minute consultation in Danish general practice.

3.1.7. RECRUITMENT OF CARE-SEEKING ADOLESCENTS WITH LOW BACK PAIN FROM GENERAL PRACTICE AND THEIR PARENTS.

To increase the external validity and ensure adequate diversity in the study population, it was estimated that approximately 400 children and adolescents between 8 and 19 years of age should be recruited from 50 Danish general practice clinics. This estimate was based on previously published data indicating that 2.700 adolescents between the ages of 10 and 19 would consult a general practitioner due to LBP in Denmark on a yearly basis (139). The initial intent was to recruit general practice clinics and patients from the Northern Region of Denmark; however, due to acquiring additional external funding, the recruitment could be widened to include the whole of Denmark. As such, a study population of 400 would provide data on

15% of the care-seeking population available. Furthermore, we aimed to recruit general practice clinics and patients from both rural and urban areas.

Adolescent patients were eligible for inclusion in the primary cohort if they were between 8 and 19 years of age and if they consulted their general practitioner because of LBP. Adolescents who consulted for other conditions but who experienced concurrent LBP were also eligible for inclusion. The general practitioners and clinical staff were provided with a small, laminated card which had a brief description of the study on one side and the two inclusion criteria (i.e., age between 8-19 and experiencing LBP) on the other side (please see Appendix B). The current study was conducted concurrently with a similar study on care-seeking adolescent patients with knee pain in general practice. Therefore, knee pain is also included on the laminated card displayed in Appendix B. To heighten the feasibility of the study, there was no elaborate description of the area, which was considered the lower back area, although this has been used in previous studies (1,2). As such, it was up to the general practitioner and clinical staff to determine if the adolescent patients had pain in an area corresponding to the lower back.

Parents recruited for the secondary parallel cohort were required to be parents or legal guardians of the included adolescents. Both adolescents and parents were required to understand written and spoken Danish to be included in the study. Eligible adolescent patients and parents were excluded from participation if they did not provide written informed consent.

Adolescent patients who fulfilled the eligibility criteria were invited by the clinical staff to participate in the study. The clinical staff provided the adolescents with a tablet containing the baseline questionnaire. All adolescent patients who completed the baseline questionnaire were given a movie ticket. Consent to follow-up with the adolescent patients and their parents on a yearly basis was obtained at the 1-year follow-up. A flowchart illustrating the recruitment process and time for follow-up is outlined in Figure 1.

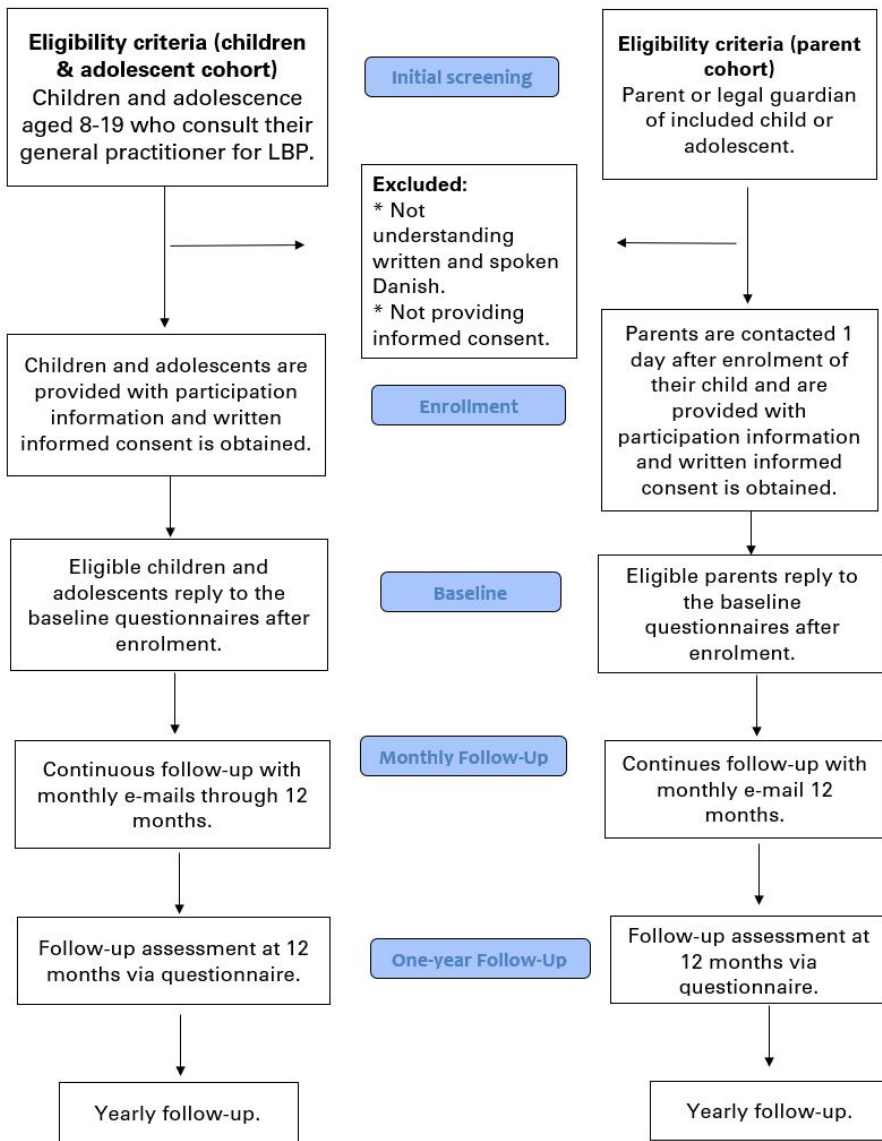
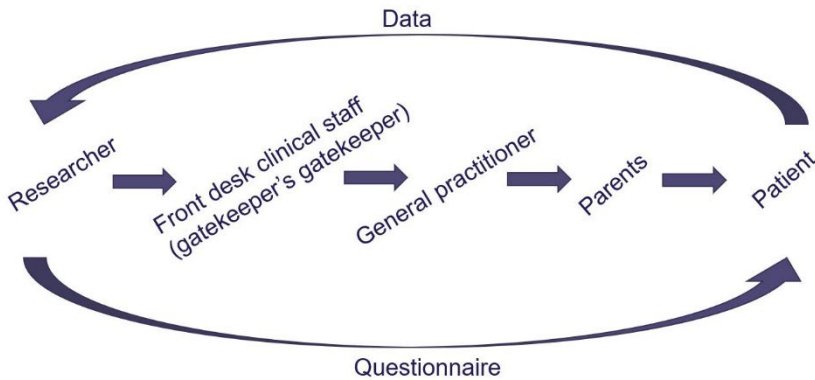


Figure 1: Flowchart for recruitment and follow-up in study 1.

3.1.8. DATA COLLECTION STRATEGY.

Collecting data from adolescent patients with LBP from general practice proved challenging in several different ways. Firstly, contact should be established with front desk clinical staff before it is possible to discuss participation with one or more owners of the clinic (i.e., one of the general practitioners). As general practitioners are gatekeepers to the health care system in Denmark, the front desk staff may be thought of as “the gatekeeper’s gatekeeper”. Subsequently, most eligible patients under the age of 18 were thought to be accompanied by a parent or legal guardian who would have to give permission for the adolescent to participate in the study. Finally, the adolescent patient could be included in the project. Figure 2 is meant as a visual illustration of the interaction between the stakeholders in the study.

Figure 2: Illustration of interaction between stakeholders in study 1.



To ensure a high degree of participation among general practitioners and adolescents, the general practitioners were presented with several different options for data collection in their clinic. This adaptable recruitment process was previously found to be effective and feasible as the authors of one study were able to recruit 100 adolescent patients with musculoskeletal pain from a Danish general practice setting over the course of 10 months (89). Self-reported data was obtained through online questionnaires, preferably on the day of the index consultation (baseline). At baseline, the adolescents answered an online questionnaire via a tablet. The questionnaire was developed and distributed through REDCap™. If requested by the general practitioner or the patients, a paper version of the questionnaire was available. The parents of the included adolescents were contacted one day after the inclusion of their child and were invited to take part in the parallel cohort. Baseline questionnaires for the parents were distributed via e-mail. The parents were asked to complete a follow-up questionnaire after one year. To investigate the natural prognosis of LBP, adolescents or their parents (adolescents < 18 years of age) would receive a monthly e-mail regarding their

child's LBP and related limitations during the previous week. Online questionnaires have previously been used to collect data on back pain among adolescents (44).

At the time of inclusion, written informed consent was obtained from each patient to retrieve information from the index consultation. This information was retrieved manually from electronic patient journals at the individual general practice clinics. From these patient journals, it was possible to collect information on the reason for consultation, data regarding diagnosis and referrals for additional healthcare services. The data from electronic patient journals were identified with the individual CPR numbers, which were combined with individual dates for inclusion.

3.1.9. PATIENT CHARACTERISTICS.

The following baseline characteristics were collected among the adolescent patients at the time of inclusion: name, CPR number, phone number, e-mail, age, gender, weight, height, and smoking status.

Baseline characteristics of the parents and legal guardians from the parallel cohort included name, phone number, e-mail, age, gender, postal code, educational level, employment status, civil status, and smoking status.

3.1.10. PAIN MEASURES INCLUDING PRIMARY OUTCOME.

For adolescents, the worst pain during the week prior to consulting the general practitioner was assessed with the 100mm visual analogue scale (0 mm = no pain, 100 mm = worst possible pain). This pain measure was considered the primary outcome of the study. The frequency of LBP was assessed on a 5-point rank scale (daily, several times per week, weekly, monthly, rarely). Adolescent patients were also asked if they experienced pain in other parts of the body, which affected their participation in usual daily activities (yes/no). If the participants answered "yes", they were asked to note at which body site they experienced their additional pain. The current use of pain medicine to manage LBP was also investigated with a single question, with the response options being yes/no. These pain measures were used in a previous study among adolescents with musculoskeletal pain (43,140). Parents from the parallel cohort were asked if they had experienced LBP within the week prior to being enrolled in the study (yes/no).

3.1.11. ILLNESS PERCEPTION.

To investigate individual illness perception of LBP, each adolescent patient was asked, "Are you worried about your back pain"? The response options were based on a 10-point rank scale, with one being equal to "not worried at all", whereas ten was equal to "very worried". This question was adapted and modified from item-nr. Six within the Brief Illness Perception Scale (141). Illness perception among parents and legal guardians within the parallel cohort was also assessed with a single question: "Are you worried about your child's back pain"? This question had the same response

options as described for the illness perception among adolescent patients. In the analysis of data, this question served as a proxy for LBP-related worries.

3.1.12. LOW BACK PAIN-RELATED LIMITATIONS AND INTERFERENCE.

To investigate LBP-related interference with usual activities during the day, the included adolescent patients were asked a single question; “Please check the box which best describes how your back pain affects your usual activities through a normal day (e.g., going to school, participate in sport, be with friends and family)”. This question had the following response options: I have no problems doing my usual activities, I have slight problems doing my usual activities, I have moderate problems doing my usual activities, I have severe problems doing my usual activities, or I have extreme problems doing my usual activities. This question was modified from the usual activity domain within the Euroqol-5 dimensions-5 levels (EQ-5D-5L) questionnaire (142). To assess if LBP had influenced school attendance, the adolescent patients were asked the question, “Have you missed one or more school or workdays during the last month because of your back pain”? To this question, the response options were; “yes”, “no”, or “I don’t go to school or have a job”. To assess if the child’ LBP influence the parent’s work life, parents were asked if they, a close friend, or a family member had taken any time off from work during the past week due to the child’ LBP.

3.1.13. HEALTH-RELATED QUALITY OF LIFE.

To assess HRQoL among the adolescent patients, they were asked two questions. The first question was, “Have you felt satisfied with your life?” The response options for this question were not at all, slightly, moderately, very, and extremely. The second question was, “Have you felt under pressure?” The response options for this question were never, seldom, quite often, very often, and always. These questions were adapted from the emotion and psychological well-being domains within the KIDSCREEN 52 questionnaire (143).

The full EQ-5D-5L was used to assess HRQoL among the parents included in the parallel cohort. The EQ-5D-5L is a generic questionnaire-based instrument for assessing health in people over the age of 15 (142). The questionnaire defines health in 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has five response categories ranging from no problems to extreme problems. In addition, the overall health on the day of completing the EQ-5D-5L questionnaire was assessed by a 100 mm visual analogue scale (142).

3.1.14. SLEEP QUANTITY.

Sleep quantity was assessed in both adolescents and parents with the question, “How many hours do you sleep on average during the night”? Furthermore, the parents were asked how many hours they believed their child slept during an average night.

3.1.15. PHYSICAL ACTIVITY LEVELS.

Physical activity level was assessed by a single question; “How often do you usually exercise at a level where you get shortness of breath or sweaty?”. This question had seven response options (never, less than once a month, 1-2 times per month, one time per week, 2-3 times per week, 4-6 times per week or every day). This approach was used previously to assess physical activity in patients (144).

3.1.16. ANALYSIS OF DEMOGRAPHIC DATA.

A descriptive analysis of the baseline characteristics was performed. Continuous data was presented with mean and standard deviation or median and the first to third quartiles depending on distribution and unless otherwise specified. Categorical data was presented with absolute and/or relative values. Data was analysed using Microsoft Excel for Microsoft 360, PC version 2022 and STATA version 17, StataCorp LLC, Texas, USA.

3.1.17. LATENT CLASS ANALYSIS.

We planned to investigate the natural prognosis and individual LBP trajectory among the included patients (i.e., aims I and II for the current study) via Latent Class Analysis. Previous studies have used Latent Class Analysis to group patients with LBP into distinct clusters relating to LBP trajectories (26,145). Experts within the field of LBP and LCA proposed in 2016 that future studies should aim to confirm if the four established LBP clusters (i.e., no or occasional pain, persistent mild pain, fluctuating pain and persistent severe pain) could be found not only in other cohorts focused on musculoskeletal pain but also within an adolescent population, as the knowledge in this area was scarce (146). As such, the LCA for the current study would be performed in accordance with previously described methods (26,27,146). The main variable for the analysis would be the LBP intensity of the worst pain experienced during the previous week. These LBP intensity scores would be trichotomised into no pain (pain intensity less than 1), mild-moderate pain and high pain (pain intensity of 5 or more). Longitudinal LCA would be used to allocate participants into clusters based on the trajectory of their LBP intensity scores over the course of 12 months. In these types of analysis, each participant would be allocated to the cluster that best matches their individual pain profile based on individual probabilities of belonging to one of the specific clusters identified. At present, there is no clear rule to determine the best cluster match (146). Therefore, the clusters for the current study would be

made by applying statistics in combination with clinical interpretation of the identified clusters.

We further aim to investigate if individual and parent-related LBP factors would influence LBP prognosis among adolescent patients (i.e., aim III of the current study) using regression analysis. This was planned as a longitudinal analysis of the exposure-outcome relationships within and between the primary and secondary cohorts. However, due to severe challenges in terms of recruitment, both of the above analyses were never thoroughly developed nor executed along with a statistician as initially intended.

3.1.18. DEVIATION FROM PROTOCOL.

Due to the COVID-19 pandemic and national lockdown, it was not possible to conduct the study as intended. From March 11th, 2020, Denmark was under national lockdown, which restricted mobility in the public space and in the health care system, including general practice (147,148). Many of these restrictions continued for a large part of 2021. As described above, the initial plan was to include up to 400 adolescent patients, which was thought to be feasible due to the tailored recruitment strategy, the large support experienced within the general practice community and the time available for recruitment. By recruiting between 200 and 400 adolescent patients, it would have been possible to investigate the natural course and/or fluctuation in LBP intensity through LCAs, as done previously among adult patients (26). However, due to the national lockdowns and subsequent restrictions on consultation in general practice, it proved very hard to include adolescent patients during the study period. This had a vast impact on the sample size.

The initial plan also included a parallel cohort consisting of one parent of each adolescent patient. The purpose was to assess if there was any prospective association between parent-related factors, individual patient factors, and LBP prognosis one year after the initial consultation. However, the COVID-19 pandemic severely hampered the recruitment of parents for the parallel cohort. Consequently, the parallel cohort was never established, and no data regarding parents or legal guardians are presented in the result section for the current study.

3.2. RESULTS.

3.2.1. PATIENT CHARACTERISTICS.

Sixty-nine general practitioners and general practice trainees from 19 clinics agreed to aid in the recruitment process. The 19 clinics were located in Region North, Middle and South of Denmark. Due to the COVID-19 pandemic, it was not possible to recruit general practitioners from the two remaining Danish regions. Patients for the study were recruited from 7 of the 19 clinics that participated in the study. From October 18th, 2019, to August 20th, 2021, 13 patients (median age 15 and range 8-17) responded to the baseline questionnaire (46% females). At the 1-year follow-up, data

was available for 12 patients. Demographic data from baseline and follow-up are presented in Table 1.

Table 1: Patient characteristics in Study 1.

Variables	Baseline (n=13)	1-year-follow-up (n=12)
Age, median (min-max)	15 (8-17)	
Gender, n females (%)	6 (46%)	
Height cm, median (Q1-Q3)	176 (160-183)	
Body weight, kg, median (Q1-Q3)	60 (51-69)	
Smoking status, n yes (%)	1 (8%)	
School or work absenteeism, n yes (%)	1 (8%)	
Use of pain medication for LBP, n yes (%)	3 (23%)	1 (8%)
Average hours of sleep/night, median (Q1-Q3)	8 (7-8)	7 (6-8)

Min: minimum; Max: maximum; Q1-Q3: First (Q1) and third (Q3) quartiles; kg: kilogram.

3.2.2. PRIMARY OUTCOME.

The median worst pain during the previous week at baseline was 60mm (Q1-Q3, 50-75) and 23mm (Q1-Q3, 20-41) at follow-up. The median change from baseline to follow-up was -30mm (Q1-Q3, (-55) - (-25)). One patient reported no LBP at the 1-year follow-up.

3.2.3. ILLNESS PERCEPTION.

Median levels of symptom worry at baseline was 6 (Q1-Q3, 5-8). The median score was reduced to 4 (Q1-Q3, 2-4) at the time of follow-up. One patient reported no LBP-related worries at the 1-year follow-up.

3.2.4. ADDITIONAL PAIN MEASURES.

At baseline, 84% of patients experienced LBP every day or several times per week. Five of the 13 patients (38%) reported having pain at additional pain sites at baseline, with the most common site being the knee. Of the 12 patients who responded to the questionnaire at the 1-year follow-up, only one patient reported no pain symptoms.

3.2.5. LOW BACK PAIN-RELATED LIMITATIONS AND INTERFERENCE.

At baseline, all 13 patients reported that they were functionally limited in their usual activities due to LBP, with 7 out of 13 (53%) being severely or moderately limited. Four patients (33%) reported no functional limitations at the 1-year follow-up.

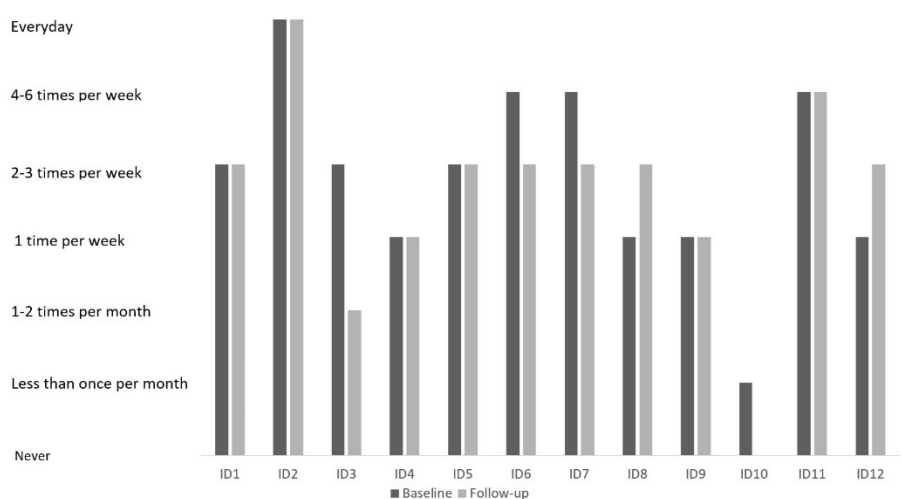
3.2.6. HEALTH RELATED QUALITY OF LIFE.

In relation to psychological well-being, 7 of the 13 patients (53%) stated that they were much or very much satisfied with their life at baseline. Furthermore, 5 of the 13 patients (38%) reported that they always or very often felt under pressure.

3.2.7. PHYSICAL ACTIVITY LEVELS.

Figure 3 illustrates physical activity levels for the 12 patients for whom data was available at baseline and follow-up. Physical activity levels were unchanged from baseline to follow-up for six patients. Four patients had reduced their physical activity levels, while the two remaining patients had increased their physical activity levels.

Figure 3: Physical activity levels at baseline and 1-year follow-up.



3.2.8. DATA FROM ELECTRONIC PATIENT JOURNALS.

Journal notes from the index consultation were available for 11 of the 13 patients at the 1-year follow-up. For two patients, the content of the index consultation concerned other medical issues than LBP. As such, these notes were not obtained for the current

study.

Two patients were referred to diagnostic imaging under suspicion of Scheuermann's disease and significant, operable scoliosis. These were both confirmed by imaging. Of the remaining nine patients, two were presenting with scoliosis, two had pain potentially related to their muscles, and five had no diagnostic label. However, in these four cases, it was not concluded if muscles or scoliosis were the underlying cause of the patient's LBP. Five patients were referred to a physiotherapist. For two of these patients, the general practitioner specified that the intervention should involve exercises. No specifications were noted for the remaining three patients referred for physiotherapy. Lastly, one general practitioner provided a patient with strengthening home-based exercises.

3.3. DISCUSSION.

3.3.1. SUMMARY OF MAIN FINDINGS.

Over the course of 1 year, LBP intensity and symptom worries diminished from high and moderate levels at the baseline to moderate and low levels at follow-up. Only one patient reported no LBP or LBP-related worries at follow-up. At baseline, more than 80% of the patients experienced LBP every day or several times per week, and all patients were functionally limited by their LBP at the baseline consultation. At the 1-year follow-up, only 4 of the 12 available patients experienced no functional limitations. Data from electronic patient journals revealed that none of the patients were suspected to have underlying life-threatening pathology. Only one patient was found to be eligible for surgical intervention for scoliosis. No underlying cause of LBP was assigned to the remaining adolescent patients.

3.3.2. COMPARISON WITH PREVIOUS RESEARCH.

In a recent cross-sectional study from Denmark, the authors found that activity limiting back pain was the third most common reason for adolescent patients (age 8-19) to consult their general practitioner (89). In this study, back pain was only surpassed by pain in the knee or ankle/feet (89), which corresponds to the most common pain sites among adolescents from the Danish background population (42). This distribution of pain sites further aligns with data from the UK (86). In the current study, adolescent patients experienced moderate to high pain intensity and LBP-related worries in the week prior to consulting their general practitioner. All patients stated that they were functionally limited by their LBP at baseline. This aligns with findings from the cross-sectional study from Denmark, in which the authors had similar findings in terms of pain intensity, functional limitations, and worries (89).

The proportion of adolescents who continued to experience LBP was higher compared to a recent systematic review, which found that 32-38% of adolescents with LBP would continue to experience pain 1-3 years from baseline (149). This difference in prognosis may be explained by the fact that most of the adolescents included in the

systematic review were recruited from community-based settings and not a clinical setting as in the current study. One important finding was that LBP was not resolved completely despite the fact that these were young individuals. As such, these findings indicate that LBP is not completely self-limiting among care-seeking adolescents from general practice.

LBP duration was not assessed in the current study. Nevertheless, it would be highly interesting to investigate LBP duration among this care-seeking group of adolescents as they may have experienced LBP for an extended period of time prior to consulting a health care provider. Research on adults with LBP has shown that a combination of a previous history of LBP, high LBP intensity, psychological distress (e.g., catastrophising, believing something to be far worse than it actually is) and concurrent leg pain are associated with ongoing LBP (6) As the patients in this study initially presented with moderate to high LBP intensity and LBP related worries, these factors may also be contributing factors for ongoing LBP in adolescent patients.

3.3.3. STRENGTHS AND LIMITATIONS.

A major strength of the current study is the linking of self-reported prospective data with data obtained from electronic patient journals. This approach made it possible to assess the 1-year prognosis among care-seeking adolescent patients with LBP from general practice and combine these data with findings from the general practitioners and subsequent healthcare services in the primary and secondary sectors.

One additional strength of the study was that the recruitment strategy, study aims, and study design were developed alongside general practitioners, clinical staff, physiotherapists, patients, parents and researchers within the field of LBP. This ensured that it was feasible to implement and fit the recruitment strategy to the individual general practice clinic, thus avoiding compromising the daily clinical routine.

Despite some major strengths, the current study also has some limitations. Firstly, over the course of nearly two years, it was only possible to include a total of 13 adolescent patients in the primary cohort. Further, it was not possible to establish a parallel cohort of patients during that same timeframe. In a similar study, the authors included 14 adolescent patients with back pain over the course of 10 months from 17 general practice clinics (89). The recruitment process of the current study lasted for nearly twice as long, and patients were recruited from 19 general practice clinics. This suggests that the inclusion of patients was hampered significantly in the current study compared to the study by Pourbordbari and colleagues, in which data was collected between October 2018 and August 2019.

The most probable explanation for this discrepancy is the COVID-19 pandemic and the related national lockdowns, which likely had a significant impact on the recruitment of patients and the retention of general practitioners. This explanation is further supported by the fact that 6 of the 13 adolescents from the study were included during January and February of 2020. From this point, there would be more than six months until the next patient was included and an additional three months before

reaching a total sample of 10 adolescent patients in 2020. This aligns with the fact that Denmark was put into national lockdown on March 11th, 2020 (148). Two booster campaigns were undertaken between lockdowns, which included visiting general practice clinics to generate awareness and interest for the study. However, during each lockdown, the general practitioners had to prioritise the ever-changing nature of their clinical practice. Consequently, research activities were put on hold.

An additional perspective regarding the slow recruitment is related to the national restrictions on consulting a general practitioner in Denmark during the COVID-19 pandemic. As such, there were likely fewer adolescent patients consulting for LBP during the recruitment period. This would, in turn, provide fewer adolescent patients eligible for inclusion. This hypothesis is strengthened by a recent questionnaire-based study among general practitioners in Ireland (150). The study showed a significant decrease in face-to-face consultations and a significant increase in telemedical consultations. Despite the increase in telemedical consultations, the overall number of face-to-face consultations was significantly reduced during the COVID-19 pandemic (148,150).

An alternative explanation for the slow recruitment rate, which does not involve the COVID-19 pandemic, is related to the notion that the number of eligible adolescent patients consulting in general practice may have been overestimated. As there is currently very little data regarding consultation rates of adolescents with LBP from general practice, this alternative explanation cannot be discarded as such. However, based on available register data from 2013, more than 3.000 adolescents between 5-19 years of age consulted for LBP in general practice (139). Although the number of care-seeking adults with LBP is much higher, these epidemiological data suggest that adolescents with LBP do seek care in general practice (139). However, this source does not specify if these types of young patients are more commonly seen in some geographical areas compared to others. Even though we were aided by general practitioners from both rural and urban areas located within 3 of the 5 Danish Regions, it is possible that we were unable to involve the clinics with the highest consultation rates for this specific type of young patient.

Secondly, one methodological limitation to be considered is that we did not collect data on the number of eligible adolescents who declined to participate in the study. As such, we are unable to provide a detailed description of the recruitment rate for the study. It is well known that the recruitment of patients can be a costly, recourse demanding, and challenging process (151). In relation, we found similar methodological limitations regarding recruitment rates in previous attempts to recruit adults (152) and adolescents from the Danish general practice setting (89). Although this may be a common limitation within these types of studies, we acknowledge that future attempts to conduct similar studies should strive to collect data on both ineligible patients and eligible patients who accept or decline to participate to provide a thorough description of recruitment rates.

Thirdly, it is possible that the current study may be prone to selection bias, as this is a common type of bias within prospective cohort studies (153). Self-selection bias is considered a threat to the internal validity of such studies. This type of selection bias

can potentially lead to discrepancies in clinical characteristics between eligible patients who volunteer to participate in a study and eligible patients who do not volunteer to participate (154). Considering the lack of data on eligible patients who declined to participate in the study, there may be a theoretical possibility of self-selection bias within the current study. In relation, the small sample size may, to some extent, hamper the overall generalizability to the study population. Thus, these data should be interpreted with some caution.

Lastly, we prioritised a short initial questionnaire to be answered in the clinics by the adolescent patients, and this decision may likely impact the validity of the study findings (155). Nevertheless, it was a priority to use standardised questions from previously validated questionnaires or questions used in prior studies among patients with musculoskeletal pain conditions. As such, we did our utmost to balance methodological rigour with the time restraints in this specific clinical setting.

3.3.4. PERSPECTIVES ON STUDY IMPLICATIONS AND FUTURE RESEARCH.

Based on the findings from the current study, there seems to be evidence to suggest that the adolescents who seek care for LBP in general practice may differ from the non-care-seeking adolescents with LBP. This may especially be true in terms of LBP intensity and functional limitations. While adolescents with LBP from the background population may be characterised by low to moderate LBP intensity (35,156-158) and only a small proportion displaying functional limitations (30,40), the patients from the current study displayed moderate to high LBP intensity at inclusion. Furthermore, all included patients in the current study experienced functional limitations. Similar results were found in a previous study investigating factors associated with healthcare use among adolescents from the background population (159). From the current study, there is further evidence to suggest that care-seeking adolescents may present with high LBP-related worries at the time of consulting in general practice. However, due to the design of this study, it was not possible to determine to which extent LBP-related worries would be present in non-care-seeking adolescents with LBP. This could be explored in future epidemiological studies among care-seeking and non-care-seeking adolescents with LBP.

One consideration regarding future epidemiological studies among care-seeking adolescents from general practice concerns the choice of study design. Based on the current study and the study by Pourbordbari and colleagues (89), the recruitment rate of care-seeking adolescents with LBP may be considered slow as opposed to care-seeking adolescents with pain in the knee or the ankles. As such, recruiting through a prospective cohort design may not be the most optimal strategy. An alternative strategy would be to collect retrospective data on consultation rates directly from the general practice clinics. In accordance with Danish Law (LBK nr. 903 af 26/08/2019), it is possible to obtain routinely collected data from clinical practice for statistical research purposes without consent from individual patients. However, one needs to get permission from the local ethical committee before undertaking such a study. By

providing individual clinics with the age span of interest (i.e., patients between 8-19 years of age), the year of years of interest, and relevant IPC2 codes (i.e., L02 and L03) (160), it would be possible to collect data on consultation rates. It would further be possible to collect demographic data regarding age, sex, and subsequent referrals for diagnostic imaging or treatment modalities within the primary and secondary care setting. With this approach, it would also be possible to collect data of relevance from the parents of these care-seeking adolescents. Despite this retrospective study would also have methodological limitations, it could provide a suitable alternative to that of the prospective cohort study to investigate if some individual and parental factors may influence prognosis. This is despite the fact that follow-up data would probably be limited. Furthermore, such a retrospective study would likely be insufficient in identifying different pain trajectories due to the potential lack of frequent follow-up. One additional alternative to the prospective cohort study would be to conduct a case series, although such studies often deal with small samples of patients when compared to prospective and retrospective cohort studies (160).

3.4. CONCLUSION.

Most of the care-seeking adolescents with LBP in the current study continued to experience low to moderate LBP and LBP-related worries one year after their initial consultation in general practice. Data from electronic patient journals revealed that only one patient had a condition which was potentially suitable for surgical intervention. There is a need for additional prospective studies investigating prognosis and pain trajectories among care-seeking adolescents from general practice. Studies with more frequent follow-ups could provide important knowledge about the natural course and fluctuation in LBP within this young group of patients.

CHAPTER 4. STUDY 2.

In this chapter, I provide the reader with a detailed description of the methodological considerations for the second study of the PhD. I further present the findings of the study, which are subsequently discussed along with the methods. A brief conclusion for the study is provided at the end of the chapter. Importantly, this study was published prior to submitting the thesis.

4.1. METHODS AND MATERIALS.

4.1.1. STUDY DESIGN.

The current interview-based study was conducted at the Center for General Practice at Aalborg University. Reporting of the study follows the approach outlined by O'Brien et al. (161).

4.1.2. ETHICAL CONSIDERATIONS AND APPROVALS.

All adolescent informants in the study received oral and written information about the purpose of the study prior to participating. Written informed consent was obtained from all adolescent informants prior to undertaking the interviews. For interview studies among adolescents from Denmark between 15 and 18 years of age, there was no requirement for obtaining written informed consent from parents/legal guardians prior to undertaking the study (162). However, researchers were required to inform parents/legal guardians about the project in which their children participated. Therefore, for all adolescent informants under the age of 18, parents/legal guardians were forwarded written information about the study (162). These guidelines are outlined by the Danish Data Protection Agency, and the approach was further verified by the local Ethics Committee. In Denmark, interview studies are exempt from obtaining approval from an ethics committee as this type of research does not fall within the legal boundaries of the regional ethics committees (LBK nr 1338 of 01/09/2020). Nevertheless, the Ethics Committee in the Northern Region of Denmark (Niels Bohrs Vej 30, 9220 Aalborg East, Denmark) was informed about the study approach outlined above and replied that no ethical approval was required (journal number: 2023-000206) (162). The study was conducted in accordance with the Declaration of Helsinki (163).

4.1.3. SAMPLING STRATEGY.

Adolescent informants were sampled through general practice clinics, physiotherapy clinics, sports clubs, and social media. Eligible adolescent informants were required to fulfil three criteria to be deemed eligible for participation in the study (162). The

informants had to I) be between 15 and 19 years of age, II) have experienced constant or fluctuating activity limiting LBP within the previous 12 months from inclusion, and III) have had previous contact with a health care provider due to LBP (e.g., general practitioner, physiotherapist, chiropractor) within the previous 12 months from inclusion (162). All potential adolescent informants were screened over the phone for eligibility by the author of this PhD. This was done to ensure that the included informants fulfilled the eligibility criteria prior to enrolment in the study (162).

4.1.4. CONTEXT AND SETTING.

Due to a combination of national COVID-19 guidelines and convenience, all interviews were conducted via Microsoft Teams for Microsoft 365 or over the phone. This approach made it possible to sample informants from all of Denmark, as there were no restrictions in terms of transportation. All adolescents were interviewed once, and the duration of the interviews was 20-41 minutes (162). The interviewer sat in an uninterrupted office during the interviews. The adolescent informants joined the interview from a remote location of their choosing. The interviews were audio recorded via two Dictaphones, and notes regarding communication behaviours (e.g., eye-rolling, sighs, tone of voice or specific gestures) were noted during the interviews. The adolescent informants did not receive a copy of their transcribed interview prior to analysis (162).

4.1.5. RESEARCHER CHARACTERISTICS AND REFLEXIVITY.

The author of this PhD thesis was the interviewer in the current study, and he conducted all interviews. The interviewer was a trained physiotherapist with two years of clinical experience managing musculoskeletal pain complaints in both younger and older patients referred to rehabilitation in the municipality (162). He held a master's degree in physiotherapy and had conducted a wide range of survey-based and experimental studies among adolescents and young adults with musculoskeletal pain during his research career (43,140,164,165). At the time of the study, the interviewer had some prior experience with interview-based research, although the current study was his first major project within the qualitative research paradigm (162). While conducting the study, the interviewer was employed as a PhD student at Aalborg University investigating factors associated with long-standing LBP among care-seeking adolescents in Danish general practice. There was neither a personal nor a professional relationship between the interviewer and the adolescent informants prior to undertaking the interviews (162). The adolescent informants were informed about the objective of the study prior to enrolment. In addition, they were informed about the interviewer's background and special interest in the topic (162).

4.1.6. PRESENTATION OF THE THEMATIC ANALYSIS APPROACH.

For the current study, the primary research questions were to investigate when and how care-seeking adolescents with LBP interact with health care providers and which health literacy competencies and strategies they use to self-manage their LBP (162). For this purpose, the 6-step model for thematic analysis described by Braun and Clarke was applied (120,166). This analysis approach is compatible with constructivism as an epistemological standpoint in which meaning and/or knowledge is produced through dialogue (120,167).

In the **first step** of this approach, the researcher would get familiar with the research material through listening and re-listening to the audio-based recordings and transcription of the material into written text (120,162). In the **second step**, initial codes were generated (120,162). In the current study, these codes were derived from the specific study aims. Specific themes and sub-themes were generated through the **third step** based on patterns identified within the initial codes (120,162). The themes were then reviewed and validated from the research material during the **fourth step** (120,162). During the **fifth step**, the themes were defined and specified further before the findings were reported in **step six** (120,162).

The transcription process was based on a predetermined guide. In this process, the words spoken by the interviewer and the adolescent informants were fully transcribed ad verbatim from the audio-based recordings (162). During extended breaks in the interview (e.g., due to reflection), punctuation (“...”) was noted. Further, sound words such as “eh” or “hmm” repetitions and double initiation of sentences were not transcribed (162). NVivo 12 Pro for Windows 64 was used during transcription and data analysis (162). To ensure anonymity among both the adolescent informants and the health care providers discussed in the interviews, highly specialised health care providers (e.g., orthopaedic surgeon or rheumatologist) or treatment modalities (e.g., surgical procedure or pharmacological intervention) are presented as “specialist” and “specialised treatments” (162).

The 6-stage model for thematic analysis allows for both a semantic (i.e., surface meaning, the “what”) and a latent analysis (i.e., the search for deeper understanding, the “why”) of the research material (120,166). The semantic analysis in this study was descriptive in nature and was used to assess which circumstances made the adolescent informants seek care for their LBP, what type of treatment they received and which health literacy competencies they used while engaging with the health care providers (162). The latent analysis was applied to investigate the deeper layers of care-seeking behaviour, especially in terms of how the mechanisms and motivations behind the different self-management strategies interacted with each other (162). It should be stated explicitly that the interviewer worked under the assumption that an intervention for adolescent LBP, to some extent, should include components to develop sufficient self-management strategies and enhance patient health literacy competencies (162). As such, the literature regarding self-management and health literacy was used to

develop the interview guide (please see section 4.1.7. - Development and structure of the interview guide). Nevertheless, the interviewer was aware that care-seeking adolescents with LBP could find that additional components should be a part of the intervention as well (162). Furthermore, the initial coding for the analysis was based on explicit statements from the research material and was not deliberately generated and fitted into a pre-specified structure based on the theoretical framework (162).

4.1.7. DEVELOPMENT AND STRUCTURE OF THE INTERVIEW GUIDE.

The interview guide was composed of 3 phases. In the first phase, the adolescent informants were encouraged to introduce themselves and their initial interest in participating in the study and describe the clinical course related to their LBP (162). This phase was thought of as an opportunity for the adolescent informants to become comfortable talking about their clinical course (162). The second phase of the interview guide was based on key elements from health literacy literature (i.e., navigating the health care system, finding and engaging with health care providers, and obtaining and processing information) and self-management literature (i.e., forming partnerships with health care providers, taking action, and utilizing resources) (106,107). At the end of the second phase, the adolescent informants were asked to reflect on what they thought would be the most effective management strategies for their LBP and what they thought to be essential to know when managing adolescent LBP as a health care provider (162). In the third and final phase, the adolescent informants were asked if they wished to speak of other matters related to their LBP which had not been covered during the interview and if they were surprised about some of the things discussed during the interview. The interview guide did not change throughout the study (162). The interview guide is available within the thesis in English (Appendix C) and in Danish (Appendix D).

4.1.8. TRUSTWORTHINESS AND TRANSPARENCY.

Before undertaking the full thematic analysis, the preliminary findings were discussed between the PhD student and the main supervisor after the 6th interview had been transcribed and coded (162). Based on this discussion, the remaining four interviews were transcribed and coded. Afterwards, the main supervisor went through 25% of the coding to verify the findings supporting the major themes and sub-themes (162). Due to logistics, the findings were discussed within the author group via email correspondence until a consensus was reached (162). Saturation was reached after the 8th interview as no new themes or sub-themes arose during the remaining two interviews (162).

4.2. FINDINGS.

Ten adolescent informants were recruited for the current study from November 17th, 2021, to June 29th, 2022. At the time of inclusion, the following characteristics were obtained from the adolescents: age, gender, duration of LBP, LBP intensity (average during the previous week, worst during the previous week and current LBP intensity) assessed with on the NPRS, and family history of LBP (parents or siblings – yes/no) (162). Four adolescents were recruited from primary care physiotherapy and medical clinics, three adolescents were recruited from sports clubs, and three adolescents were recruited through social media posts (162). One semi-structured interview (median duration 34.5 minutes, range 20-41 minutes) was conducted with each of the ten adolescents (162). Characteristics of the adolescent informants are presented in Table 2. Nine of the adolescent informants consulted a general practitioner during their course with LBP (162). The most common approach in general practice was a brief physical examination followed by a referral for diagnostic imaging or physiotherapy (162). Eight adolescent informants consulted one or more physiotherapists during their course, with the most common treatment modalities being exercise therapy and manual therapy (162). Five adolescent informants consulted a chiropractor, the most common treatment provided being spinal manipulation and massage (162).

4.1. SYNTHESIS AND INTERPRETATION OF THEMATIC ANALYSIS.

Three major themes emerged from the 6-step thematic analysis. These were Self-management, Pain & Function, and Communication (162). Each major theme covered 3-8 sub-themes which are outlined in Figure 4.

The findings from the descriptive semantic analysis can be found in Appendix E, along with sample quotes and the interpretation of the interviewer. The semantic analysis contains the surface analysis of all identified themes and sub-themes from the thematic analysis (162). The latent analysis can be found in the below sections.

Figure 4: Outline of major themes and sub-themes for study 2 (162).

Major Theme 1: Self-management	Major Theme 2: Pain and function	Major Theme 3: Communication
<p>• Sub-themes</p> <ul style="list-style-type: none"> • When to seek care • Trigger for seeking health care • Expectations • Navigating the health care system • Pain medicine • Load management • Retention to treatment • Help to self-manage 	<p>• Sub-themes</p> <ul style="list-style-type: none"> • Pain as a limiting factor • Explanation for pain • Diagnostic uncertainty 	<p>• Sub-themes</p> <ul style="list-style-type: none"> • Difficulties understanding and being understood • Not being taken seriously • Help to take the next step

Table 2: Characteristics of adolescent informants in Study 2 (162).

Pseudonym	Age	Sex	Duration of LBP	LBP intensity*			Pain onset	Family history of LBP
				Avg	Worst	Current		
Kathrine	18	Female	1.5 years	6	8	4	Insidious	Yes
Sarah	17	Female	3 years	6	6	4	Insidious	No
Emma	18	Female	5 years	6	9	4	Traumatic	Yes
Hellen	16	Female	2-3 years	7	8	4	Insidious	Yes
Amanda	18	Female	2.5 years	5	8	0	Insidious	No
Beatrice	16	Female	3 years	0.5	3	0	Insidious	Yes
Diane	16	Female	2.5 years	6	7	4	Insidious	No
Tommy	16	Male	10 months	3	7	2	Insidious	No
Oliver	16	Male	9 months	0	2	0	Insidious	Yes
Ingrid	15	Female	2 years	7	9	4	Traumatic	No

* LBP intensity was measured on a 11-point numeric pain rating scale (0 = no pain & 10 = worst imaginable pain). LBP intensity was assessed as average (avg) LBP during last week, worst LBP during last week and current LBP.

4.1.1. UTILIZING RESOURCES AND MAKING DECISIONS.

For most of the adolescent informants, over-the-counter pain medicine was a common and often first attempt to self-manage LBP. Even though many used over-the-counter pain medicine repeatedly and for longer periods of time, the effect was often minor or insufficient overall (162). Among sports-active adolescents, over-the-counter pain medicine was frequently used to make it through a training session or participate in a competition (162). This may reflect a lack of knowledge about the appropriate use of over-the-counter pain medicine and insufficient awareness of alternative self-management strategies (162).

The main trigger for seeking healthcare was pain or a sudden increase in LBP intensity. Functional limitations were often experienced along with pain, although these limitations were not reported as the main trigger for seeking healthcare (162). Most of the adolescent informants decided to seek care in collaboration with their parents. Many sought care with a general practitioner or another health care provider based on guidance from either parents or peers (162). Their expectations before going to the general practitioner varied. Some had high expectations in terms of extensive examination, diagnostics workup and treatment, while others only consulted to get referred to another health care provider (e.g., physiotherapist or chiropractor) (162).

Most of the adolescent informants were aware that the general practitioner should most often be consulted initially due to their role as gatekeepers to secondary healthcare and additional primary healthcare (162). However, at times when the general practitioner was not available (e.g., bank holidays), they explored alternative strategies. Emma, age 18, elaborated on such a scenario:

[You chose to go to the emergency department; why was that?]. *“It was because it was a Sunday, and I knew that I could not stand it (the pain) until I was able to get in touch with my general practitioner, so I had to figure out something and get some pain medicine or something”*. [Was it the right time to go to the emergency department you think?]. *“I think so. I had been waiting for a while, and I had taken the pain medicine I already had”*.

This is one of the various examples displaying the adolescents’ ability to navigate the (Danish) healthcare system based on prior knowledge (162).

4.1.2. PROBLEM SOLVING AND TAKING ACTION

For many adolescent informants, the overall purpose of seeking healthcare was to be provided with strategies that could reduce their LBP intensity and subsequently lead to recovery of function (162). The desire among the adolescent informants to self-manage their LBP was frequently expressed during the interviews. Amanda, age 18, shared her thoughts on this matter during her interview:

[Did you miss anything during the course of your treatment for back pain?]. *“I actually think that could be something like having a health professional that you were connected to and whom you had the possibility of calling or emailing and say “I am actually a little worried because it (the pain) is moving down in my legs” and then there would actually be someone who replied. To just know that you had a health professional that could answer your questions or help when you were insecure”.*

Just like Amanda, many of the adolescent informants stated that they wanted help to self-manage their LBP in the form of guidance from a health care provider, to feel fully confident in managing their own LBP (162). As such, none of the adolescent informants seemed to have any intention of being dependent on a specific health care provider or a specific treatment (162). In summation, the adolescents consulted a health care provider for guidance and to get strategies to manage their LBP which they could experiment with on their own. When in doubt or when they had no success with the provided strategies, they would seek care again for either assurance that what they were doing was right or to get new strategies that they could try to manage their LBP (162).

4.1.3. BARRIERS TO SELF-MANAGEMENT AND FORMING PARTNERSHIPS.

Sufficient and productive communication is essential for partnerships between adolescents and health care providers to be successful. However, most of the adolescent informants were explicit about experiencing difficulties understanding what health care providers told them, especially in relation to the cause of their LBP (162). The adolescent informants would often report being provided with an overwhelming amount of information, which was made even harder to comprehend due to the use of long and difficult words (162). Also, the adolescent informants expressed concern about not being understood by the health care providers. This was often related to a sense of not knowing what to say and what information to give the health care providers during consultations (162). Based on these findings, it seems that the adolescent informants were aware that they, to some extent, played a role in the problems they would experience while trying to communicate with their health care provider.

An additional contributing factor to these problems with communication was when the adolescent informants did not feel they were being taken seriously by their health care provider (162). Diane, age 16, elaborated on her experience with consulting her general practitioner:

[Was there any health professional that you would say you had a poor relation with during your course with back pain?]. *“My general practitioner. I do not feel that it was the right way to deal with it. When you come several times and says that your back hurts it is not without reason... There is a reason that I keep coming and say it hurts and that it does not get better... He did not really understand that... it is like, just because you are a child, then the pain is not so bad”.*

Like Diane, many of the adolescent informants had the feeling that their health care provider would express scepticism towards their LBP intensity (162). In extreme cases, they felt that the health care provider did not believe that the LBP was as intense as the adolescents described it (162). As such, problems with communicating and distrust could hamper a mutually beneficial partnership between adolescents with LBP and health care providers. For some adolescents, these barriers lead to feeling abandoned as the adolescent did not know how to move forward in terms of managing their LBP (162). Many of the adolescent informants felt that they, at some point in their course with LBP, reached a standstill as their current health care providers were not able to help them further (162). Consequently, some felt lost as they were not provided with help to take the next step in terms of treatment modalities or guidance to seek other health care providers (162).

4.2. DISCUSSION.

4.2.1. SUMMARY OF FINDINGS.

The findings from the thematic analysis suggest that adolescents consulting health care providers for LBP experience multiple barriers to establishing meaningful and productive partnerships, which could otherwise aid them in self-managing their LBP (162). The adolescent informants sought care due to LBP or an increase in LBP intensity. Often, an initial failed attempt to self-manage their LBP would prompt the consultation. The adolescent informants collaborated with their parents and peers prior to consulting a health care provider especially if they themselves had limited or no prior experience with the healthcare system (162). These findings suggest that adolescents with LBP can use the resources available to them (i.e., support and advice from parents and peers) and apply these resources to take action (i.e., seek care) (162). This is important as utilizing resources and taking action are both core skills in self-management (106). Having access to and applying resources in the form of social support is further an essential ability from a health literacy perspective (109). This is also true in regards to obtaining, appraising, and applying information related to once health (109).

From the semantic analysis, we derived that most of the adolescent informants were given a solely biomechanical explanation for their pain (162). These findings resonate with a recent scoping review in which the authors found that interventions in previous non-surgical and non-pharmacological experimental studies in adolescents with recurrent or persistent LBP were based on outdated biomechanical models for persistent LBP (168). Importantly, all the adolescent informants were functionally limited by their LBP. This would, in some, lead to a sensation of “feeling old”, “irritated”, or even “*frustrated*” (162). As such, these adolescents displayed signs of being affected on a psychological level, which is also known to influence LBP in adolescents (169).

Since the renowned psychiatrist George Engel published his paper on the bio-psycho-social approach to disease management in 1977, it has been widely recognised that the experience of pain is not only related to biomechanics but also to psychological and social aspects (170,171). Findings from previous research suggest that psychological factors related to negative beliefs about LBP and a high degree of internalising (anxious/depressed and withdrawn) and externalising (aggression and rule-breaking) behaviour are associated with back pain in adolescents (73,169). There is further evidence to suggest that social factors such as family history of LBP, socioeconomic status, and stressful life events may play an important role in the development of adolescent LBP (169). These findings underpin the notion that adolescent LBP is most likely related to more than pure biomechanics. At present, little is known regarding factors which may affect treatment outcomes among adolescents with LBP. Based on findings among adults with LBP, it seems that catastrophic thoughts about what LBP means are linked to greater disability and suboptimal treatment response (172). These findings further support the notion that both the development and treatment response among adolescents with LBP are likely influenced by a combination of biomechanical, psychological, and social factors. Therefore, providing adolescent LBP patients with a purely biomechanical explanation for their pain does not align with the principles of a bio-psycho-social treatment approach.

In some cases, adolescents found the biomechanical explanation to be unsatisfactory, which in turn could lead to the feeling of diagnostic uncertainty (162). Even though many of the active adolescents were provided with a load management strategy (i.e., reduction in training volume), they would most often point to an active component (e.g., specific exercises or manual therapy) as the main contributor to their pain reduction (162). This underlines the importance of providing accurate information to avoid misbeliefs regarding mechanisms for pain and pain relief.

From the latent analysis, we found that most of the adolescent informants had an explicit desire to self-manage their LBP, but many expressed a need for guidance and validation from a health care provider to feel confident in self-managing their LBP (162). Although self-management, to some extent, implies that patients should manage their conditions on their own, this is, in fact, not the case. Rather, patients and health care providers should form partnerships in which patients develop their skills in providing accurate and precise information about their pain experience for the health care provider to act on (106). Being able to engage with health care providers is also important in terms of health literacy (109). Establishing a strong therapeutic alliance or partnership with health care providers has previously been described as a central component in managing adolescent LBP (106). Problems with communicating and the feeling of not being taken seriously were found to be significant barriers to establishing a partnership between the adolescent informants and health care providers, which in turn would hamper the adolescents in self-managing their LBP (162).

4.2.2. STRENGTHS AND LIMITATIONS.

This study was partially conducted during the COVID-19 pandemic, and therefore, all interviews were undertaken online through Microsoft Teams or through telephone calls (162). This approach made it possible to interview adolescents from all over Denmark, as transportation or COVID-19 restrictions were no barriers to participating. However, the online format may have influenced the interview process due to the lack of physical presence between the adolescent informants and the interviewer (162). Seen from a different perspective, the online format gave the adolescent informants the possibility to participate from a remote location of their choosing without the pressure of visiting an unfamiliar location or having to invite a foreign person (the interviewer) into their homes. Instead, the adolescent informants could interact with the interviewer at a distance through the computer or phone (162). A major strength is the inclusion of adolescents who had recent contact with a health care provider and functional limitations as this made it possible to gain insight into the health literacy competencies and self-management skills among care-seeking adolescents with LBP (162).

One possible limitation of the study relates to the interview guide. Although the interview guide was developed through extensive sparring within the research group, it did not undergo a formal pilot test prior to undertaking the study. Nevertheless, the interviewer experienced that all the adolescent informants responded to each question in an informative and relevant manner. Therefore, no changes were made to the interview guide throughout the study.

Another potential limitation of the current study is the possibility of selection bias. As was the case with Study 1, the current study may be susceptible to self-selection bias (154). Furthermore, most of the adolescent informants in the current study were supported by their parents in their endeavour to resolve their LBP. This is evident from the findings of the current study, especially regarding the sub-theme related to how the adolescent informants would navigate the healthcare system. Therefore, it could be speculated that the adolescent informants in the current study may differ from both care-seeking and non-care-seeking adolescents who are not supported by their parents in their pursuit of a solution.

Some discrepancy may indeed be found among the adolescent informants from the current study and adolescents with LBP who would likely benefit from consulting a health care provider, but who were not encouraged or supported by their parents to do so. It could be hypothesised that such adolescents would more often be encouraged by their parents to apply a “wait and see” approach when compared to the care-seeking adolescents from the current study.

One important consideration is that health care providers in Denmark by law (LBK nr 903 af 26/08/2019) are required to include parents or legal guardians of patients between the ages of 15 and 18 years of age in the process of deciding on a specific treatment for a given condition. Therefore, most of the adolescents who consult in clinical practice and who go on to receive treatment will, to some extent, be supported by their parents. As such, it seems less likely that the care-seeking adolescent

informants from the current study would differ significantly from other care-seeking adolescents with LBP.

4.2.3. COMPARISON WITH EXISTING LITERATURE

Previous studies among adolescents with both LBP and musculoskeletal pain, in general, found that higher pain intensity and functional limitations were common denominators among adolescents who sought healthcare (89,159,173). However, from these findings, it was not possible to derive if high pain intensity or functional limitations, or the combinations of the two, should be considered the main trigger for seeking care. Although all adolescent informants from the current study were functionally limited by their LBP at the time of consultation, most of the adolescent informants pointed to their LBP intensity as the main trigger for seeking healthcare and not their functional limitations. As such, these findings may provide an indication as to why some adolescents with LBP seek care, and some do not.

Prior to seeking care, many of the adolescent informants used over-the-counter pain medicine as a first step to self-manage their LBP, although this approach had only short-lasting or no effect (162). Over-the-counter pain medicine was used frequently and for long periods, especially among sport-active adolescents, which aligns with the findings in a recent systematic review on the use of over-the-counter pain medicine in this age group (174). With problem solving being one of the five core skills of self-management (106) our findings indicate that care-seeking adolescents with LBP need alternative strategies when trying to self-management (162).

This is important as a general desire among the adolescents to self-manage their condition with guidance from a health care provider was uncovered (162). However, our findings indicate that problems with communicating and the feeling of not being taken seriously among the adolescent informants may have severely hampered the possibility of forming productive partnerships (162). The adolescent informants point to this as especially problematic in situations where their treatment courses were discontinued without being advised on a possible next step. In these situations, the adolescents felt that the health care providers gave up on them despite their young age (162). This reaction from the adolescents indicates that they did not have the required information to make a decision for their future treatment course on their own. This is problematic as both being able to make a decision and forming partnerships with health care providers are vital components when self-managing a condition (106).

Communication barriers between adolescent patients and health care providers have previously been highlighted however, here the problem often relates to the adolescents' underdeveloped abilities to communicate, make informed decisions, and assess potential threats (175). From a health literacy perspective, this suggests that adolescent patients do not have the required competencies to engage with health care providers when trying to manage health-related issues (109). As some of the adolescent informants from the current study found it difficult to know which information should be given to the health care providers during consultations, this

notion cannot be discarded as such. Nevertheless, this standpoint is somewhat fixed and offers no solution. Moreso, this standpoint insinuates that the problems with communication between the health care providers and adolescent patients primarily lie with the young patient and not the health care provider. However, as adolescent patients often have no prerequisites for understanding the complex terminology of health and medicine at a professional level, this notion is likely counterproductive while managing illness and conditions among adolescent patients (162).

In a recent viewpoint by Pate and colleagues, the authors highlight the importance of not assessing adolescent LBP patients as adult patients (176). The authors especially encourage health care providers to prioritise listening to the adolescents' narrative and to ask open-ended questions such as "*Tell me about why you have come to see me today?*" (176). With health care providers recognising the need for an individually tailored approach to assessing adolescents with LBP, communication between the two parties may likely improve (175,176).

4.2.4. FUTURE RESEARCH PERSPECTIVES.

Based on the findings from the current study, there seems to be a rationale to further explore how health care providers can support adolescents in self-managing their LBP (162). Most of the adolescents in the current study had an explicit desire to self-manage their LBP, but they also expressed a need for continuous counselling and guidance from a health care provider (162). As such, it may be possible for primary care general practitioners, chiropractors, or physiotherapists to assume the roles of health care consultants when supporting care-seeking adolescents with LBP (162). This approach may, in addition, facilitate the adolescent to become an active part of the management process. Furthermore, the adolescents from the current study displayed sufficient abilities to navigate the Danish healthcare system, especially in collaboration with family members (i.e., parents) (162). As utilizing the resources among the parents positively influenced the process of navigating the healthcare system, future studies should explore how and if parental resources may positively influence the self-management process of care-seeking adolescents with LBP (162).

4.3. CONCLUSION

The findings from the current study indicate that adolescent informants with LBP display various health literacy competencies, which partly enable them to navigate the health care system in collaboration with their parents in order to seek care. However, the adolescents lacked alternative self-management strategies, as initial attempts to self-manage with over-the-counter pain medicine would often be ineffective. Most adolescents were explicit about their desire to self-manage their LBP, but they needed guidance from a health care provider in order to be confident in self-managing their LBP. One of the most common barriers to engaging in a partnership with a health care provider was problems with communicating and the feeling of not being taken seriously. Health care providers should strive to tailor the assessment of adolescents

with LBP to optimise communication. Further, health care providers should assist adolescents in self-manage their pain and provide guidance when needed.

CHAPTER 5. STUDY 3.

In this chapter, I provide the reader with a detailed overview of the methods and results of the third study within this PhD thesis. The results and methods related to this study specifically are discussed and reflected upon. Lastly, a conclusion for the study is provided at the end of the chapter.

5.1. METHODS AND MATERIALS.

5.1.1. STUDY DESIGN.

This single case experimental study was based on the The Single-Case Reporting Guideline In BEhavioural Interventions (SCRIBE) 2016 Checklist (130). The study was preregistered on clinicaltrials.gov prior to the enrolment of the first patient [Trials registration: NCT05553444]. The study was conducted at the Center for General Practice at Aalborg University.

5.1.2. ETHICAL CONSIDERATIONS AND APPROVALS.

Ethical approval was sought from the regional ethics committee prior to undertaking the study. However, the Ethics Committee in the Northern Region of Denmark (Niels Bohrs Vej 30, 9220 Aalborg East, Denmark) responded that no approval was necessary for the current study. The Ethics committee based their decision on the intervention consisting of standard physiotherapy and advice related to lifestyle. Written informed consent was obtained from all adolescent patients prior to participating in the study. For patients younger than 18 years of age, written informed consent was obtained from parents and/or legal guardians.

5.1.3. SETTING AND MANAGING CLINICIAN.

Adolescent patients were recruited from general practice clinics, primary care physiotherapy clinics, primary care rheumatologists and social media. The intervention was delivered in a clinical setting. The provider of the intervention (the PhD-student: CLS) was a trained physiotherapist with two years of clinical experience. CLS had previously worked with a variety of patients across different age groups and musculoskeletal pain conditions. CLS had, both as a clinician and a researcher, completed a series of courses specifically concerning patients with chronic and complex musculoskeletal pain conditions. At the time of the study, CLS undertook his PhD at Aalborg University, where his main research focus was on LBP among care-seeking adolescents from general practice. After recruitment, patients attended an initial session with CLS, where written and oral information about the study was provided. A full medical history of each adolescent patient was also obtained at this time.

5.1.4. DESCRIPTION OF PHASES.

The procedure was based on the A - B - A'/B' design and was inspired by the methods described by JP Caneiro et al. in 2019 (177).

In this study, **phase A** served as a baseline to establish fluctuations in LBP intensity, LBP-related worries, pain self-efficacy and function prior to initiating the treatment. The initiation of phase A was based on convenience, and the specific time for the initial session depended on when the adolescent patients were available. As such, the initiation of phase A was non-concurrent, as described by Michiels and Onghena (127). During phase A, self-reported data was collected every day for a minimum of 8 days and a maximum of 14 days. Including data from the initial session, 9-15 data points would be available following phase A. The time for initiating phase B was assigned to each participant at random. As such, phase A would be a minimum of 8 days and up to 14 days or more, depending on both randomisation and logistical issues (public holidays and weekends). At the end of the initial session, patients were informed about the date for the first consultation of phase B.

During **phase B**, CLS would facilitate the intervention based on the initial session, LBP intensity and LBP-related worries during phase A and the patient's goals. During phase B, the patients could attend a 1-hour weekly session for up to 6 weeks. To reflect clinical practice, the frequency and duration of these sessions were agreed upon with each individual patient. If the patients found that they had reached an acceptable symptom state (please see section 5.1.14. - Self-reported change in health status) before the 6th session, phase B was terminated, and phase A' was initiated. During the first week of phase B, self-reported data was collected daily. In the remaining weeks of phase B, the patients were followed up weekly. Depending on the frequency of the session, up to 12 data points could be available following phase B.

During **phase A'**, the patients were followed weekly for 12 weeks. During phase A', the patients would not receive any study-related treatment. After phase A', 12 data points would be available.

Phase B' contained 3 x 1-hour criterion-based booster sessions, which were delivered over three consecutive weeks. Phase B' was initiated if patients experienced both LBP intensity and functional limitations equal or greater than those at baseline, for a minimum of two sequential weeks during phase A'. Neither CLS nor the patients were blinded to randomisation nor treatment after the initial session. As data was obtained by CLS through self-reported online questionnaires, there was no blinding of the assessor either. Figure 5 illustrates the process of the study and how the phases are linked.

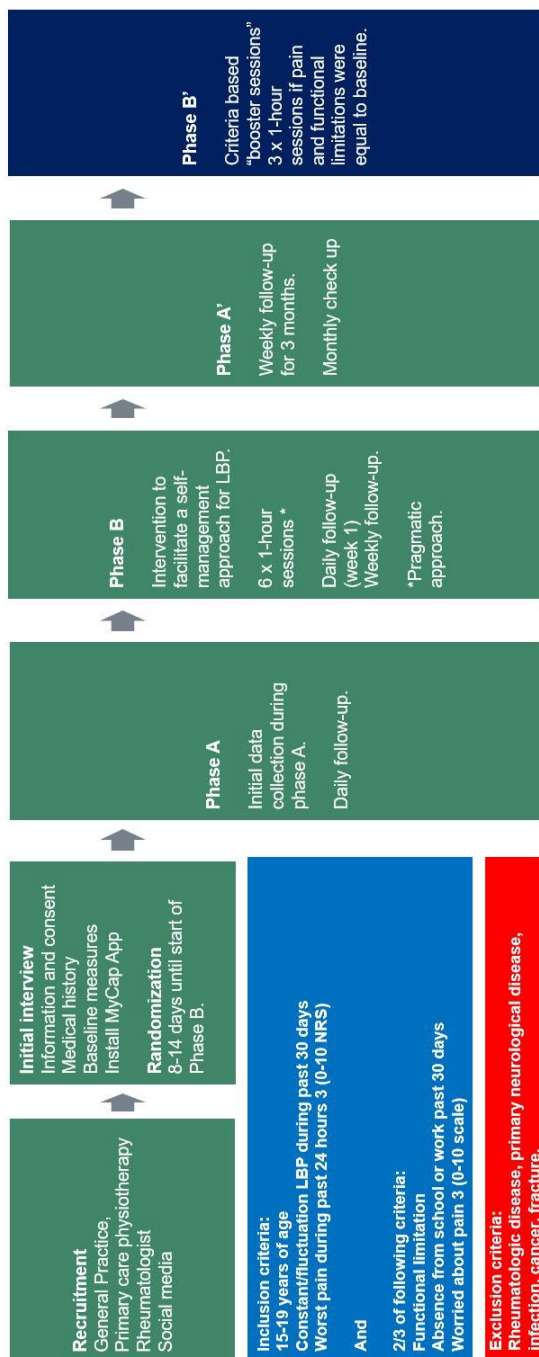


Figure 5: Process of study 3.

5.1.5. RANDOMIZATION PROCEDURE.

In this study, adolescent patients were randomly allocated to initiate phase B between 8 and 14 days after enrolment. This provided the opportunity to investigate if the patients experienced a positive effect in terms of LBP intensity, LBP-related worries, and functional limitation after phase B was initiated, independent of the time at which the intervention was introduced (127). The randomisation procedure and the concealment of allocation were conducted by a researcher who was not related to the study. The randomisation sequence was concealed in sequentially numbered, opaque, and sealed envelopes. The envelope for each patient was opened at the end of the initial session prior to undertaking phase A.

5.1.6. ELIGIBILITY CRITERIA.

At the time of study initiation, the aim was to include six adolescent patients with LBP. This number of patients was based on previous single subject experimental studies among adult patients with LBP (177,178). Eligible patients were required to be 15-19 years of age and experience consistent or fluctuating axial LBP (located between T12 and the gluteal fold) for more than 30 days with the worst pain intensity during the past 24 hours equal to or more than three on the 11-point NPRS. Eligible patients were also required to meet at least two of the following three criteria. I) Experience functional limitations in one or more daily activities (e.g., sports participation, sitting or lifting), based on scoring eight or below on the 0-10 Patient Specific Functional Scale (PSFS) (179), II) being absent from work and/or school for one or more days during the past 30 days due to LBP, and III) being worried about their LBP based on scoring three or higher on a 0-10 scale when asked “Are you worried about your back pain” (please see section 5.1.11. - Illness perception). Eligible patients were allowed to experience pain at other body sites in concurrence with pain in the lower back. Further, patients were required to speak and understand Danish. Patients were excluded if they were diagnosed with rheumatic arthritis or a primary neurological disorder (e.g., multiple sclerosis), had a severe underlying pathology such as infection, cancer or fracture or showed clinical symptoms of cauda equina.

5.1.7. DEMOGRAPHIC DATA COLLECTED AT INCLUSION.

At the time of inclusion, data regarding name, phone number, email address, age, sex, height and weight was collected for each patient. A list of collected data and corresponding time points for the study can be found in Appendix F.

5.1.8. PRIMARY OUTCOMES FOR LOW BACK PAIN INTENSITY AND FUNCTION.

The 11-point NPRS (0 equals no pain and 10 equals worst possible pain) was used to assess the worst pain during the past 24 hours at inclusion and at the end of phases B and A'. To investigate functional limitations related to LBP, included patients were asked to respond to the PSFS at inclusion and at the end of phases B and A'. In this questionnaire, the patients would identify one to three activities that they found themselves limited in accomplishing. These activities were rated from a 0 (unable to perform activity) to 10 (able to perform activity at pre-injury level) (179). The primary outcome for each patient was the activity with the lowest score on the PSFS. If two or more activities had equally low scores, the patient would determine which activity should be the primary outcome for function. The primary assessment points for both the PSFS and the NPRS were at the end of phases B and A'.

5.1.9. PAIN SELF-EFFICACY.

Self-efficacy was assessed with the 2-item short form of the Pain Self-Efficacy Questionnaire (PSEQ) (180). This questionnaire was based on two items evaluating to which degree the patients felt confident in engaging in different tasks despite the pain being present. Each question had a corresponding 7-point rank scale ranging from 0 (not confident at all) to 6 (very confident).

5.1.10. PAIN INTERFERENCE.

A single question was used to investigate LBP interference during usual activities throughout phases A, B and A'. "Please check the box which best describes how your back pain affects your usual activities through a normal day (e.g., go to school, participate in sports, be with friends and family)". The question had five response options ranging from "I have no problems doing my usual activities" to "I have extreme problems doing my usual activities". This question was modified from the usual activity domain within the EQ-5D-5L questionnaire (142). Data on LBP interference was collected throughout phases A, B and A'.

5.1.11. ILLNESS PERCEPTION.

To investigate illness perception of LBP, the patients were asked, "Are you worried about your back pain"? The response options were on an 11-point scale, with 0 being equal to "not worried at all," whereas ten was equal to "very worried". This question was a modification of item number 6 in the Brief Illness Perception Scale (141). This question was used in the data analysis as a proxy for LBP-related worries.

5.1.12. PHYSICAL ACTIVITY LEVELS.

Physical activity level was assessed by a single question; “How often do you usually exercise at a level where you get short of breath or sweat?”. This question had seven response options (never, less than once a month, 1-2 times per month, one time per week, 2-3 times per week, 4-6 times per week or every day). Data on physical activity levels was collected at the time of inclusion.

5.1.13. HEALTH-RELATED QUALITY OF LIFE.

Two questions from the KIDSSCREEN 52 were used to assess HRQoL among adolescent patients (143). The first question was from the psychological wellbeing dimension: “Have you felt satisfied with your life?”. The response options for this question were not at all, slightly, moderately, very and extremely. The second question was from the moods and emotions dimension: “Have you felt under pressure?”. The response options for this question were never, seldom, quite often, very often, always. Data related to HRQoL was collected at the time of inclusion.

5.1.14. SELF-REPORTED CHANGE IN HEALTH STATUS.

The Global Rating of Change Scale (GROC) was used to assess self-reported improvement (181). The GORC was based on a single question: “How do you experience your LBP now compared to before you initiated the treatment?”. For this study, we used the 7-point Likert scale ranging from “much improved” to “much worse”, which was used previously (182). Further, we used the Patient Acceptable Symptom State (PASS) questionnaire to assess if patients reached a self-evaluated satisfactory result of the treatment. This did not necessarily correspond to the patients being pain-free or completely recovered, as some patients could still have achieved a satisfying result despite having pain symptoms. This approach was used previously among patients to assess self-reported improvement and satisfaction with treatment (183).

5.1.15. ADDITIONAL LOW BACK PAIN MEASURES.

The frequency of LBP was assessed on a 5-point rank scale (daily, several times per week, weekly, several times per week, rarely). Adolescent patients were asked if they experienced pain in other parts of the body, which affected their participation in usual daily activities. The response options for this were “yes” or “no”. In addition, the patients were asked if they currently use pain medicine to manage their LBP (yes/no response). Lastly, patients were asked how long they had experienced LBP. These data were collected at the time of inclusion.

5.1.16. SLEEP QUANTITY.

In this study, sleep quantity was assessed with a single question. “How many hours do you sleep on average during the night”? This question was used to assess sleep quantity among adolescents in a previous study (43). Data on sleep quantity was collected at the time of inclusion.

5.1.17. CLINICAL COMMENTARIES FROM PATIENTS AND THERAPEUTIC LOG.

Throughout phases B and A, patients were encouraged to report any relevant events in the comment box, which was forwarded along with the app-based questionnaire. The patients were instructed to include a commentary to accompany their LBP intensity scores if they found it appropriate and meaningful. In accordance with Danish Law, CLS kept a therapeutic log for each individual patient throughout their participation in the study.

5.1.18. PROPOSED MEDIATING FACTORS.

It is common in research to study the association between an exposure variable and an outcome variable of interest (e.g., the association between exposure X and outcome Y). However, such relationships may be mediated by a third factor, thus rendering the traditional X and Y association too simplistic (133). A mediating factor (Z) is statistically defined as a factor which changes because of a given intervention ($X \rightarrow Z$) and which subsequently correlates with the outcome of interest ($Z \rightarrow Y$) (184). In this study, we proposed two factors that could potentially mediate the effect of the intervention on LBP intensity within each patient. These factors were 1) LBP-related worries and 2) pain self-efficacy. These factors were chosen based on findings from the first study within this PhD and the findings by Caneiro et al. from 2019 (177).

5.1.19. DESCRIPTION OF INTERVENTION.

The intervention was based on the five key skills for successful self-management outlined by Lorig et al. (106). These were 1) Problem solving, 2) Decision-making, 3) Utilizing resources, 4) Forming partnerships with health care providers, and 5) Taking action (106). At the initiation of each individual treatment course, it was not assumed that each patient would lack all five skills. As such, the intervention was tailored to each patient based on the initial assessment and continuous clinical reasoning during the treatment course.

In this study, the concept of health literacy was believed to be closely related to self-management as it reflects an individual’s capacity to interact with the complex demands of maintaining and promoting good health in modern society (107).

Health literacy was defined by the World Health Organization as “*the cognitive and social skills which determine the motivation and ability of individuals to gain access*

to, understand and use information in ways which promote and maintain good health" (108). Therefore, health literacy encompasses a wide range of individual competencies such as navigating the healthcare system, finding, and appraising reliable health information, and actively engaging with health care providers (108).

5.1.20. PROBLEM SOLVING.

The fundamental notion of self-management is that it is problem-based and thus anchored in a unique, individual problem for each adolescent patient (106). To acquire this specific skill, patients were taught how to think in a problem-solving manner. This meant identifying and defining a problem, generating solutions, implementing one or more solutions and subsequently evaluating the impact of these solutions. It was anticipated that all included patients would benefit from developing this specific skill as it provides a fundamental base for developing adequate self-management strategies.

5.1.21. DECISION-MAKING.

To acquire this skill, patients would need to learn when they have adequate information to make short-term changes on a daily basis as a response to changes in their condition (106). Having the ability to obtain, process and apply relevant information regarding general health or a specific condition is also considered essential in terms of health literacy (109). In developing this skill, two points were especially emphasised to the patients. Firstly, the adolescent patients were made aware that they would sometimes encounter statements or knowledge that would challenge their own beliefs. Therefore, patients were encouraged to be open-minded to process information which could be difficult to believe at first. Secondly, the patients were taught to self-assess. This assisted the patients in differentiating between the decision to seek care with a health care provider during pain flares and the decision to take a day or two off and return gradually to normal daily living on their own.

5.1.22. UTILIZING RESOURCES.

As clinicians are often knowledgeable about general care pathways due to their occupation, clinicians may at times forget that most patients are not as well-informed on this matter. Therefore, patients were informed about the structure of the Danish healthcare system, and they were taught how to navigate this system to make them capable of determining which type of health care provider they would need to consult at a given time. Being able to identify and decide which health care provider to engage with is a vital ability to possess from a health literacy perspective (109). Being able to utilize resources also involves retrieving information from different available sources such as the internet, the library, peers, and family members (106). Being able to utilize social resources from friends and family was also found to be an important ability in terms of health literacy (109). Therefore, being able to navigate the Danish

healthcare system and utilize available social support was believed to be especially important for adolescent patients in this study.

5.1.23. FORMING PARTNERSHIPS WITH HEALTH CARE PROVIDERS.

To successfully self-manage, many patients must be able to form strong clinical alliances with health care providers and be able to discuss and make informed decisions about their condition in collaboration with clinicians (106). Also, having the ability to actively engage with health care providers was identified as a vital element to maintaining good health from a health literacy perspective (109). Therefore, in this study, patients were free to engage with health care providers who were not affiliated with the study. The experience and outcome of the encounters with different health care providers were discussed throughout the treatment course. This approach was believed to be the most optimal approach for adolescent patients to gain experience and subsequently reflect on these experiences. To underpin the importance of establishing productive partnerships with health care providers, all adolescent patients and their parents/legal guardians were provided with a direct phone number to CLS and informed that they were allowed to reach out through text messages or phone calls if they had any questions related to their treatment course or LBP in general. As such, each adolescent patient had a way to contact a health care provider with a special interest in LBP if necessary.

5.1.24. TAKING ACTION.

The ability to take action is closely related to how confident individuals are that they can accomplish a given task (106). Having a sufficient level of self-efficacy is especially relevant in the process of changing behaviour to overcome health problems. For patients who displayed low levels of self-efficacy in this study, it was important to facilitate a process in which the patients were successful in completing specific and meaningful tasks, which, in turn, would boost their self-efficacy. In this study, these takes were tailored to each individual patient with the overall aim of boosting confidence and self-efficacy so that the patient became motivated to change behaviour and subsequently manage their LBP.

5.1.25. ANALYSIS OF LOW BACK PAIN INTENSITY.

A visual analysis was applied to determine if the intervention influenced LBP intensity. Although there is no formal consensus on how to analyse data from single subject experimental studies, we used the widely recognised steps posed by Kratochwill et al. in 2010 (135). The analyses were conducted in four steps.

The first step was a level analysis in which the stability of data within a phase was assessed. For this purpose, a line composed of the mean score within each phase was calculated and added for visual inspection.

The second step was a trend analysis in which the slope of the best-fitting straight line for the data within each phase was composed and added for visual interpretation. This line was composed by the Microsoft Excel™ software.

The third step was an analysis of immediate and latent effects. To investigate the immediate effect of the intervention we compared the last three data points from phase A with the first three data points from phase B. To assess the latent effect of the intervention, we compared the last three data points from phase B to the last three data points of phase A'.

In the fourth step, we conducted an overlap analysis in which we assessed the number of overlapping data points between the phases. For this analysis, we included a line which represented the lowest LBP intensity score in phase A (i.e., the “low A-line”). To determine whether there was a systematic change in LBP intensity during phase B, a minimum of 9 of the 12 data points from this phase should be located below the low A line (134).

5.1.26. ASSESSMENT OF FUNCTIONAL LIMITATIONS.

To assess change in functional limitations, the individual patient scores from the PSFS were presented descriptively for baseline and at the end of phases B and A' respectively. At some time points, the patients were unable to provide a specific number for the PSFS as they either had not performed the specific activity for a while or they felt more confident in describing their current status with words instead of numbers. Therefore, PSFS scores are supplemented with verbal statements from the patients. Data regarding functional limitations in relation to usual activities are presented descriptively with individual graphs.

5.1.27. ANALYSIS OF PROPOSED MEDIATING FACTORS ON LOW BACK PAIN INTENSITY.

The analysis of mediation was conducted in two steps. In **the first step**, data related to LBP intensity scores, LBP-related worries and PSEQ scores was plotted in two graphs. The first graph contained data on LBP intensity and LBP-related worries as these were assessed on similar 11-point scales ranging from 0 to 10. The second graph held data on the PSEQ scores, which were scored on a 7-point scale ranging from 0-6. These graphs were visually assessed for mediation of LBP-related worries and PSEQ scores in relation to LBP intensity across phases A, B, and A'.

In **the second step**, we applied a cross-correlation lag zero analysis as used in the study by Caneiro et al. from 2019 (177). This type of analysis assesses the temporal association between LBP intensity, LBP-related worries and PSEQ scores through a series of cross-lag correlation analyses, which are adjusted for autocorrelation (129). In single subject experimental study, frequent data from a few individuals are obtained over the study period. As such, within subject data points are not considered to be independent of each other which is often an a-prior assumption for conducting parametric and non-parametric statistical analyses (129). For instance, the pain

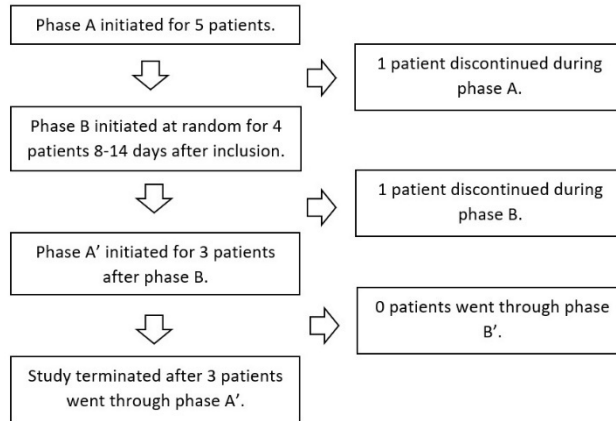
intensity rating of a patient obtained in the morning is likely predictive of the pain intensity rating obtained in the afternoon or even the day after for that same patient (129). Therefore, autocorrelation can be thought of as a series of observations in which one data point fully or partially depends on one or more of the previous observations. In short, future data points can, to some extent, be explained by previous ones (129). Using the free Simulation Modeling Analysis software (177) it was possible to calculate the cross-correlation between the proposed mediating factors and LBP intensity for each individual patient while adjusting for autocorrelation. A cross-correlation coefficient at lag zero was interpreted as statistically significant with a corresponding p-value below 0.05. Cross-correlation coefficients were reported as Spearman's rho.

5.2. RESULTS

5.2.1. PATIENT CHARACTERISTICS

From August 30th, 2022, to June 22nd, 2023, 5 female adolescent patients between 15-19 years of age initially entered the study. The LBP duration of the five patients ranged from 6 months to 2,5 years. One patient discontinued during phase A due to circumstances unrelated to the study. Thus, this patient did not receive the intervention and was excluded. One additional patient discontinued during phase B as she found the intervention to be ineffective. Therefore, complete data for phases A, B and A' was available for three patients. Figure 6 illustrates the patient flow during the study, and baseline characteristics of the three patients who underwent all three phases are found in Table 3. None of the three patients fulfilled the criteria for initiating the booster sessions in phase B' (please find a description of these criteria in section 5.1.4 – Description of phases). As none of the patients was enrolled in phase B', no data was collected for this specific phase.

Three patients (P1-P3) attended a 1-hour baseline session in person before randomisation and one additional 1-hour session at the initiation of phase B. During phase B, each patient had 1 or 2 sessions in person of 45 minutes to 1 hour duration and between 3-5 follow-up sessions over the telephone or Microsoft Teams lasting between 15-45 minutes. The online format was made available as most of the patients had lengthy travel times. There were some missing data for all three patients during all 3 phases. Some of the missing data was due to technical issues (e.g., the questionnaire was made unavailable for the patient if it was not answered within 24 hours after receiving it); however, most of the missing data was due to the patients forgetting to answer the questionnaires altogether. Data collection points for P1-P3 are accounted for in Appendix G.

Figure 6: Flowchart of study 3.**Table 3:** Baseline characteristics of patients in study 3.

	P1	P2	P3
Pain onset	Light trauma	Non-traumatic	Non-traumatic
Use of pain medicine for LBP	No	No	Yes
Hours of sleep	6	8	6
Usual physical activity	2-3 times per week	2-3 times per week	4-6 times per week
Missed school or work due to LBP	Yes	No	No
Additional pain sites	No	No	Yes
Pain frequency	Several times per week	Several times per week	Several times per week
Satisfied with life	Very	Very	Very much
Feeling under pressure	Seldom	Very often	Very often

5.2.2. VISUAL ANALYSIS OF LOW BACK PAIN INTENSITY.

5.2.3. LEVEL ANALYSIS.

Figure 7 illustrates the level analysis for P1-P3. For P1, there was a decrease in LBP intensity from phase A to phase B, while there was no difference in LBP intensity for P2 and P3 between these two phases. For P1, LBP intensity increased slightly during phase A' towards the level seen in phase A. For P2 and P3, LBP intensity was similar across all three phases. For all three patients, there was considerable variation in the LBP intensity data across the data points and phases.

5.2.4. TREND ANALYSIS.

Figure 8 illustrates the trend analysis for P1-P3. For P1, the slope of the trend line decreased from phase A to phase B. In phase A' the slope of the trend line increased, although not to the same degree as in phase A. For P2, the slope of the trend line increased during phase A compared to phase B; however, during phase A' the slope decreased and moved towards the slope seen in phase A. For P3, the slope of the trend line increased during phase B compared to phase A, thus reaching a steady state around five on the NPRS.

5.2.5. ANALYSIS OF IMMEDIATE AND LATENT EFFECTS.

Figure 9 illustrates the analysis of immediate and latent effects for P1-P3. For P1, the intervention seemed to have an immediate effect on LBP intensity, and the effect was stable during phase B. Although LBP intensity was lower at the end of phase A' compared to phase A, the latent effect was smaller for P1 as there was a slight increase in LBP intensity at the end of phase A' compared to the end of phase B. For P2, there was no immediate effect of the intervention when assessing the last three data points of phase A and the first three data points of phase B, respectively. However, there was a small latent effect with LBP intensity stabilising around 3-4 on the NPRS at the end of phase A'. For P3, there was neither an immediate nor a latent effect of the intervention in terms of LBP intensity.

5.2.6. OVERLAP ANALYSIS.

Figure 10 illustrates the overlap analysis for P1-P3. For P1, there was a decrease in LBP intensity as all data points in phase B were located below the low A-line. For both P2 and P3, no systematic decrease in LBP intensity was found during phase B.

Figure 7: Levels analysis for study 3.

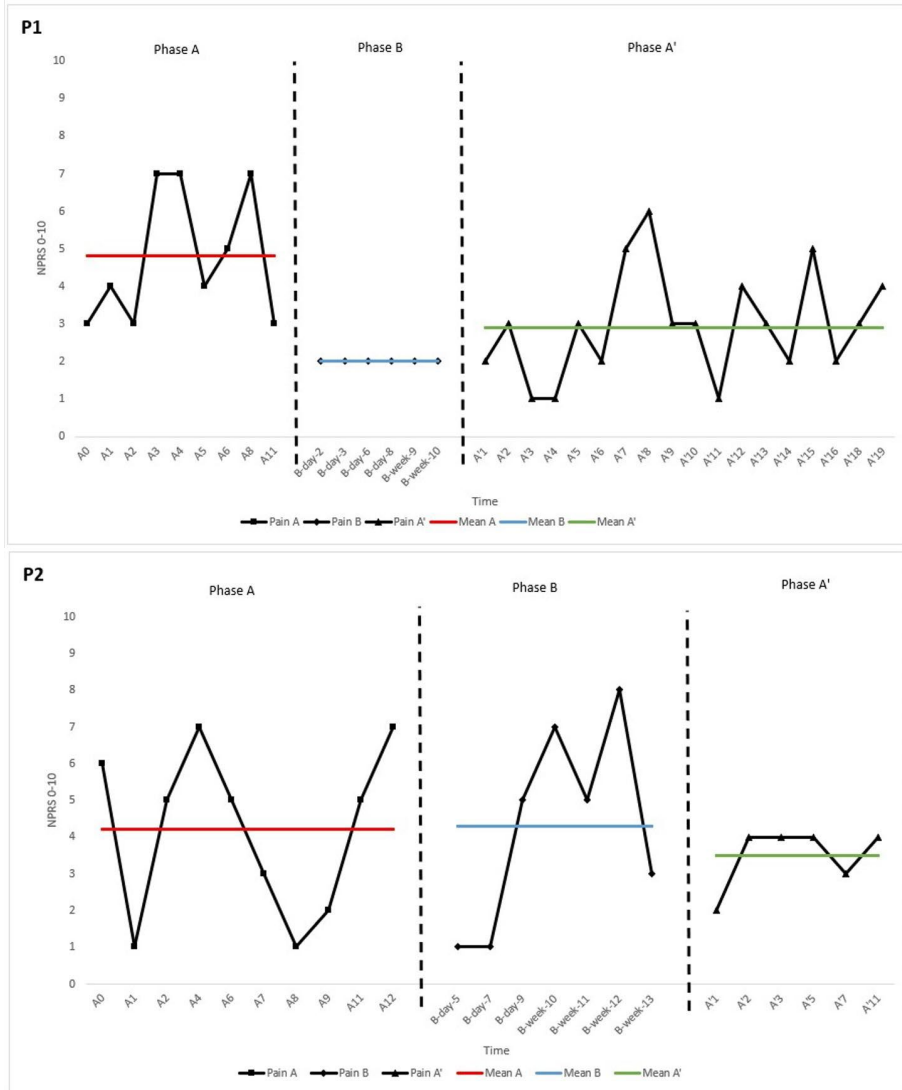


Figure 7: Continued

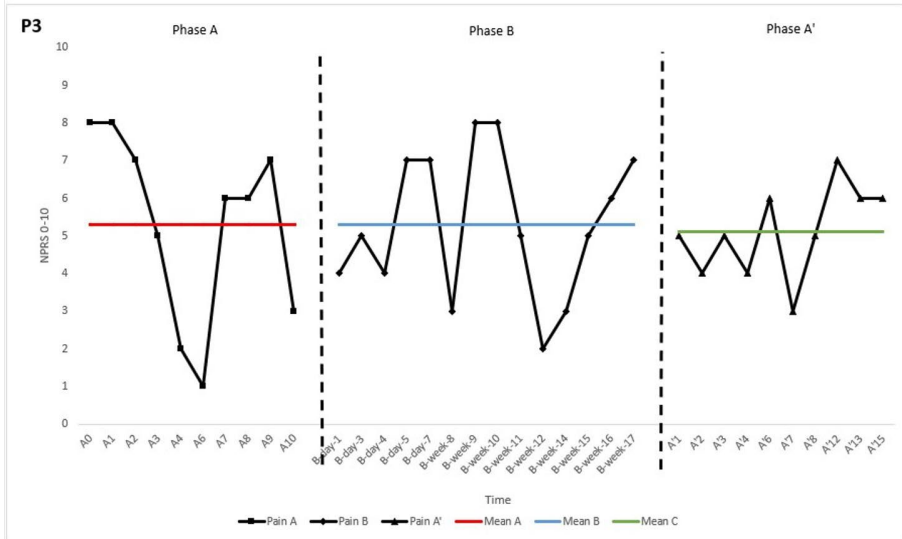


Figure 8: Trend analysis for study 3.

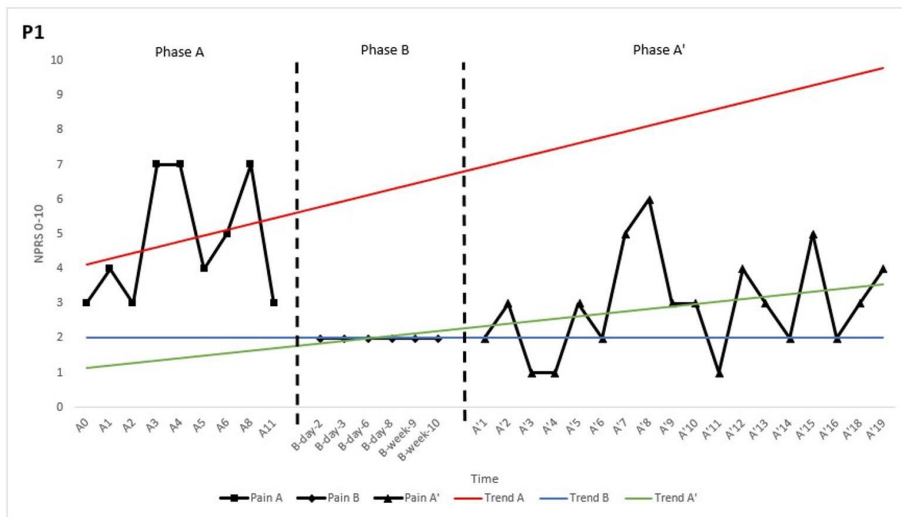


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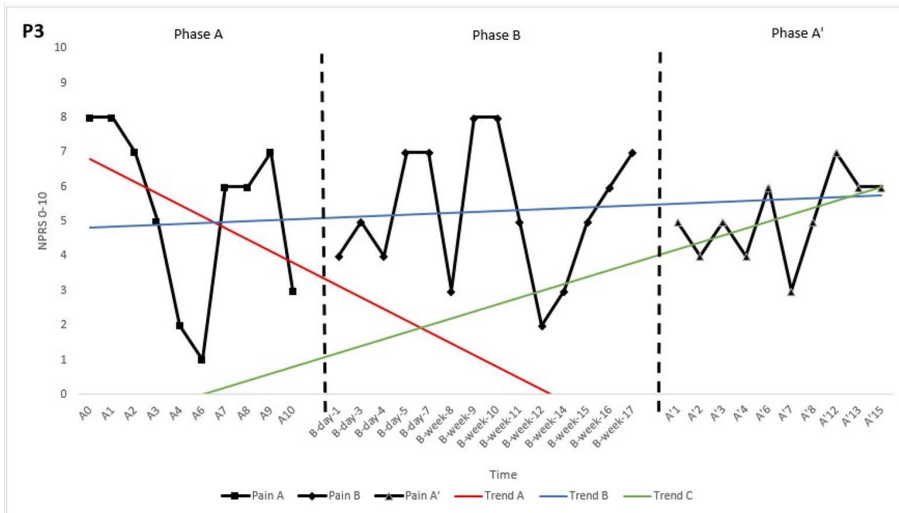
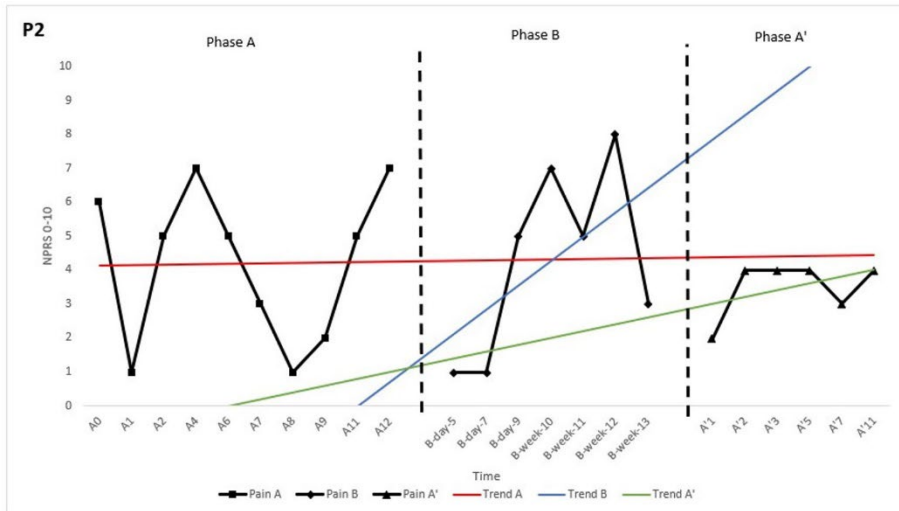


Figure 9: Analysis of immediate and latent effects for study 3.

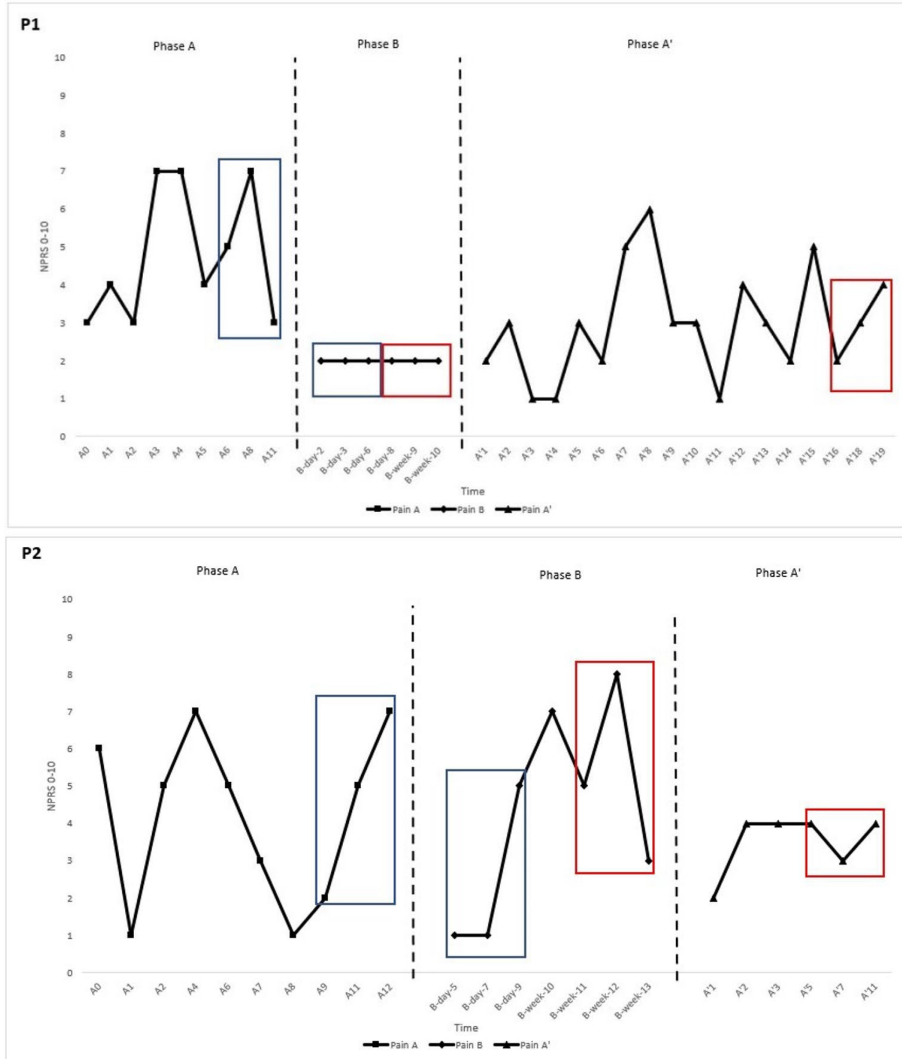


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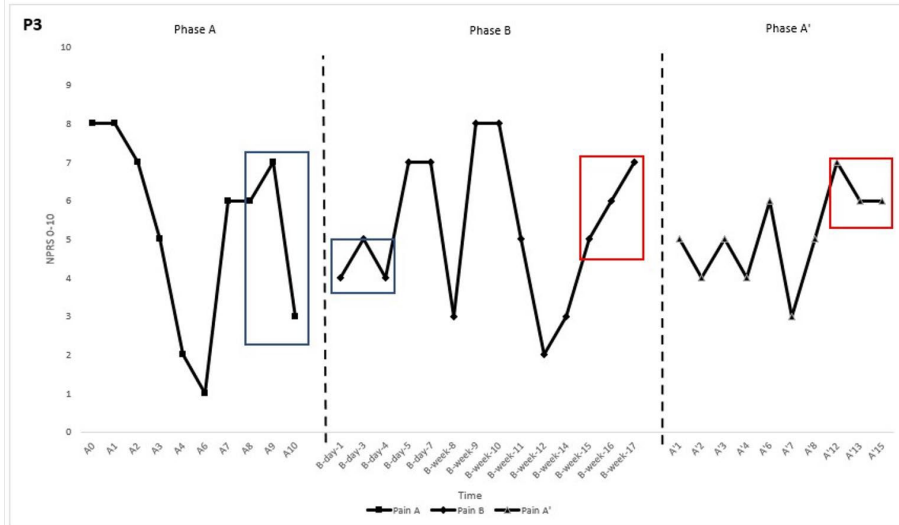


Figure 10: Overlap analysis for study 3.

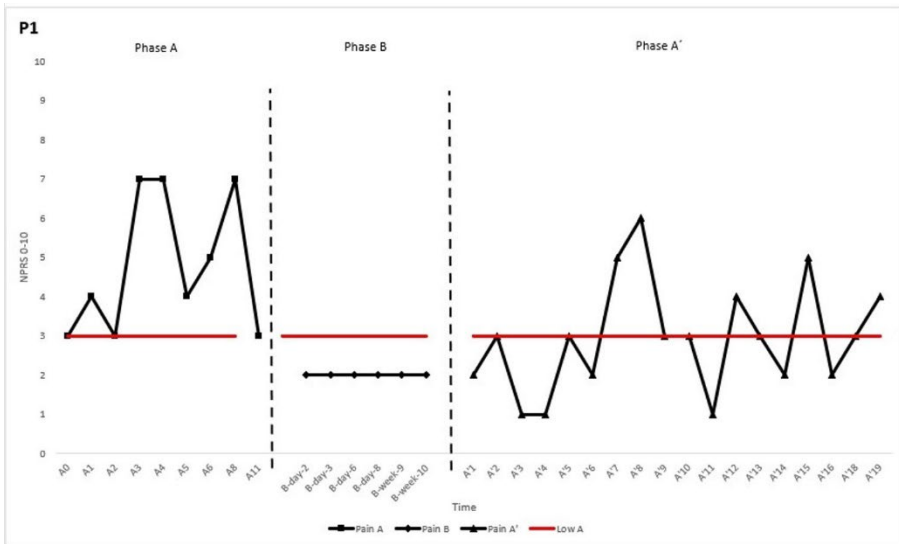
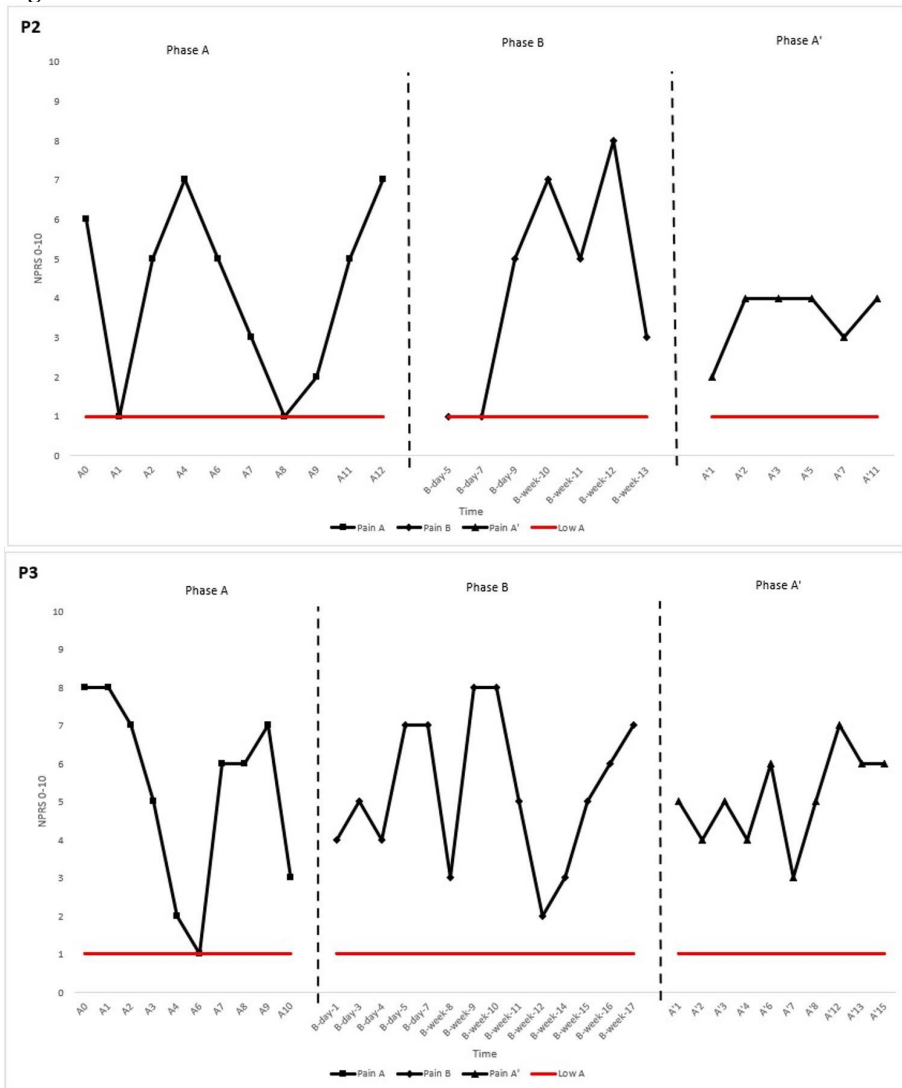


Figure 10: Continued.



5.2.7. CHANGE IN SELF-REPORTED HEALTH.

Assessed with the GROG at the end of phase B, P1 reported her LBP status to be “much better” after the treatment compared to before, and P2 reported her LBP status to be “a little better”. P3 reported that her LBP status was unchanged at the end of phase B. Assessed with the PASS, none of the patients found that they were in no more need of treatment during phase B.

5.2.8. FUNCTIONAL LIMITATIONS.

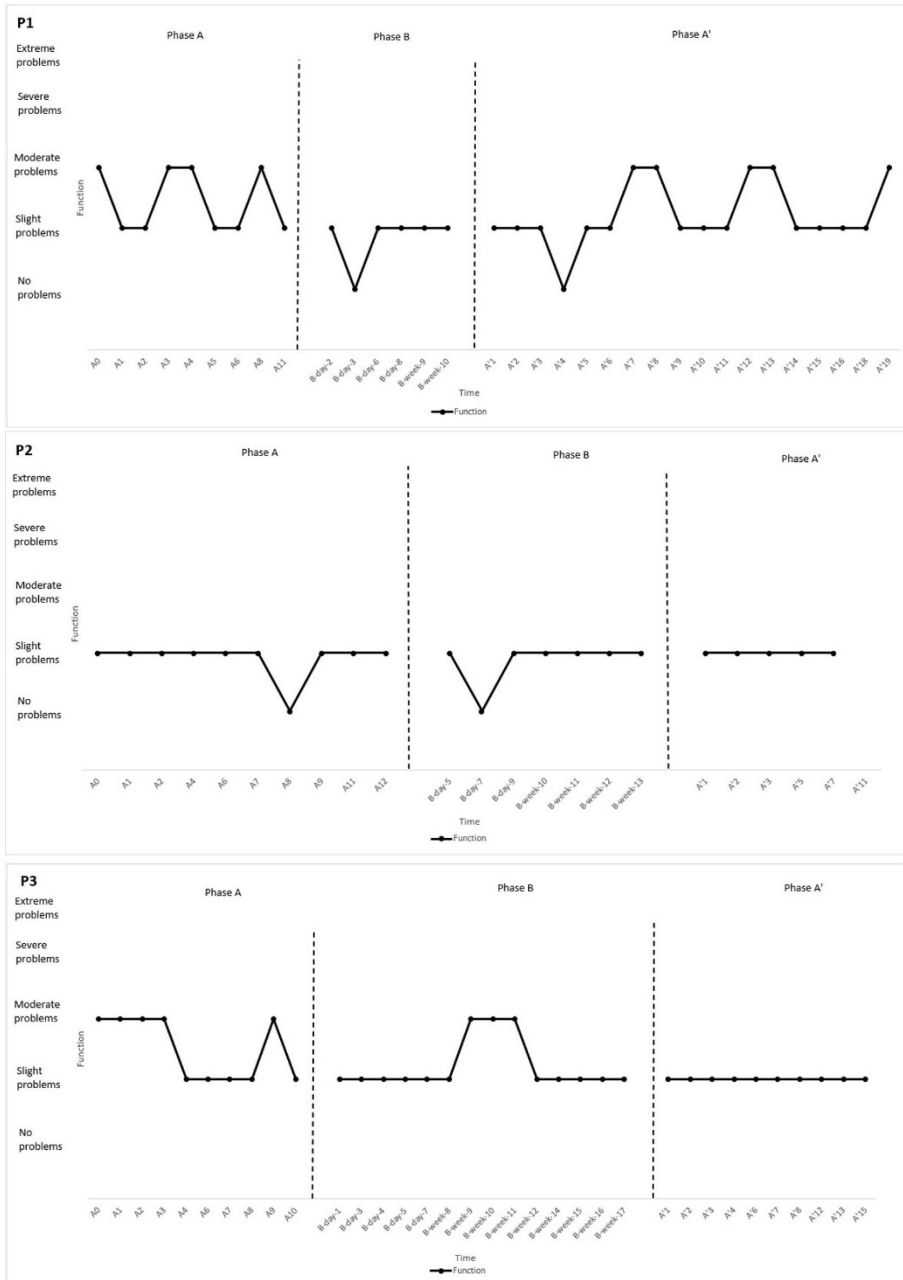
The individual scores from the PSFS are presented in Table 4. Over the course of the 3 phases, all three patients experienced improvement related to the individual activities specified in the PSFS. P1 had the smallest change. However, this patient was able to do the specified activity (walking on a hard surface) without pain at the end of phase A' whereas this activity was painful at baseline. The two remaining patients reported vast improvement for on (P3) or both activities (P2) specified in the PSFS.

In relation, the variability in functional limitations related to usual activities was found to be small (ranging from “no problems” to “moderate problems” across the 3 phases for all three patients (please see Figure 11).

Table 4: Functional limitations assessed with Patient Specific Functional Scale.

Function/time-point	Baseline	End of phase B	End of phase A'
P1			
Heavy lifting	10 (with pain)	10 (less pain)	No longer relevant
Walking on a hard surface	6 (with pain)	8 (less pain)	9 (without pain)
P2			
Walking long distances	2	Have not tried it in a while.	9
Exercising	3	3	8
P3			
Sitting for long periods	6	Less pain than before	Not problematic at the time
Driving	3	Less pain than before	7

Figure 11: Limitations related to the activity of daily living among patients in study 3.



5.2.9. MEDIATION ANALYSIS.

Based on the visual interpretation of the graphs in Figure 12, there seemed to be a clear pattern for P1 and P2. For these patients, PSEQ scores diminished as LBP intensity and LBP-related worries increased and vice versa. For P3, there was a concurrent increase and decrease in LBP intensity and LBP-related worries, which were similar to the patterns for P1 and P2. However, as P3 had continuously high PSEQ scores throughout all 3 phases, no distinct association between PSEQ scores and LBP intensity was observed.

Based on the findings from cross-correlation lag zero analysis, there was a positive correlation between LBP intensity and LBP-related worries for all three patients. These cross-correlation was found to be statistically significant for all three patients. For P1 and P2, there was a negative correlation between PSEQ scores and LBP intensity. These cross-correlations were, in addition, found to be statistically significant for the question related to work. For the question related to lifestyle, the cross-correlation was only found to be statistically significant for P1. It was not possible to calculate the cross-correlation coefficient between LBP intensity and PSEQ scores for P3 due to the continuous high PSEQ scores reported by this patient (Table 5).

As part of the treatment course, all patients were asked about what in particular would worry them in relation to their LBP. All patients replied that their main concerns were about the future aspects of their LBP. This included worries about the future duration of their LBP and whether their pain would persist. They also expressed concerns towards whether their LBP would continue to interfere in terms of function and if the pain would hamper school and/or work life.

Table 5: Cross-correlation at lag zero. Illustrating the level of association (ρ) between each proposed mediating factor and LBP intensity and the related p-values.

Variable	P1		P2		P3	
	ρ	p-value	ρ	p-value	ρ	p-value
LBP related worries	0.66	0.001	0.38	0.044	0.35	0.048
Pain self-efficacy short form score						
Work	-0.65	0.001	-0.40	0.034	-	-
Lifestyle	-0.69	0.001	-0.23	0.154	-	-

Figure 12: Mediation analysis for study 3.

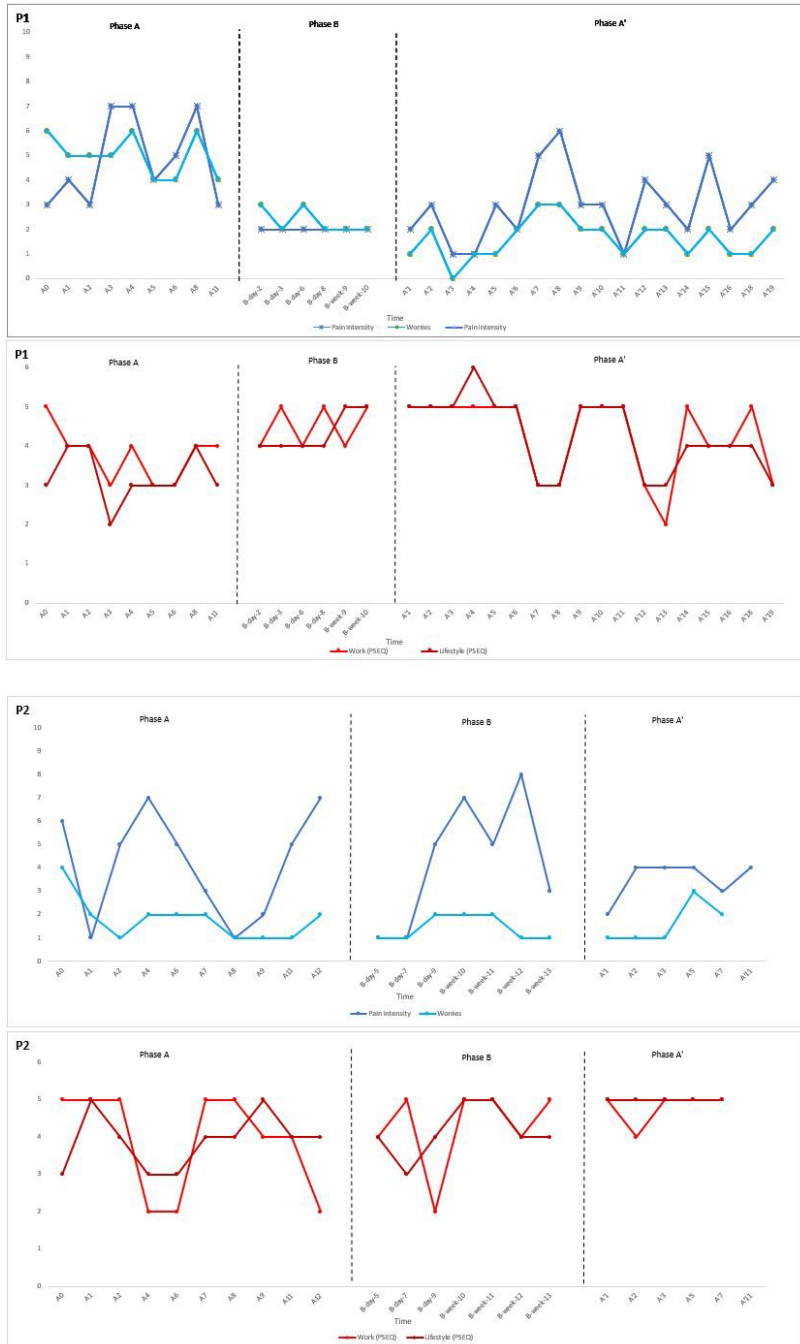
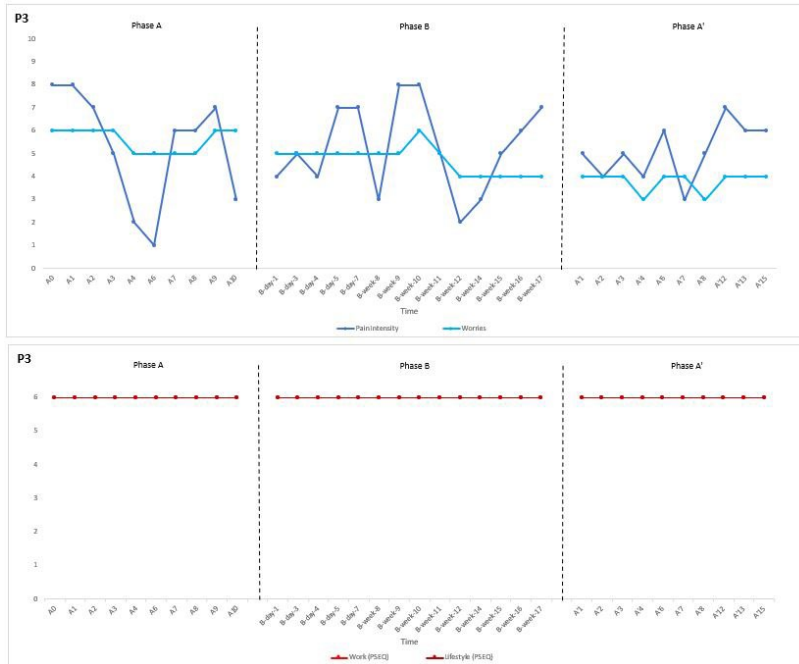


Figure 12: Continued.



5.3. DISCUSSION.

5.3.1. SUMMARY OF MAIN FINDINGS.

To the best of our knowledge, this is the first study to investigate the short-term effect of an intervention to facilitate a self-management approach among adolescent patients with LBP in a single subject experimental design. From the visual analysis of the LBP intensity data, we found that LBP intensity decreased within 1 of the three patients. All three patients reported improvement in terms of function at the end of phase A' based on individual PSFS scores.

Based on both the visual interpretation and cross-correlation lag zero analyses of the proposed mediating factors, we found a positive cross-correlation between LBP intensity and LBP-related worries and a negative cross-correlation between LBP intensity and PSEQ scores. All cross-correlation coefficients between LBP intensity and LBP-related worries were found to be statistically significant.

5.3.2. COMPARISON WITH PREVIOUS RESEARCH.

As was the case within the first study of this PhD thesis, adolescent patients within the current study displayed a high degree of LBP intensity and LBP-related worries at baseline. In a recent study among care-seeking adolescents with musculoskeletal pain, the authors found that 1/3 of the adolescent patients were worried and or anxious at the time of consulting their general practitioner (89). Although interesting, these findings did not reveal what the adolescent patients were worried or anxious about. However, through continuous dialogue with the adolescent patients in the current study, the patients would disclose that much of their LBP-related worries concerned their future lives. As such, the adolescent patients expressed concerns towards the prolonged nature of their LBP and whether the pain would ever go away. If the LBP would persist, the adolescent patients would worry if the pain would influence their functional capacity, future education, and career possibilities. In relation to this, Costa and colleagues conducted a recent qualitative study in which they investigated how adult patients with LBP would navigate the uncertainty within LBP care (185). One of the four main findings of the study was that adult patients worried about what would happen to them over time in terms of healthcare access and their ability to engage and socialise with others (185). Altogether, this illustrates that worries about the future are present in both adult and adolescent patients with LBP. Notably, the specific circumstances of which the two groups worry may differ between adult and adolescent patients.

In a systematic review from 2019, the authors investigated baseline factors which were associated with poor prognosis among adolescent patients with musculoskeletal pain (149). The authors found that LBP could persist for more than six years for 40% of those initially affected (149). The authors also reported that a long duration of LBP and more functional limitations were associated with poorer prognosis in this age group (149). In the current study, the adolescent patients displayed specific functional limitations assessed with the PSFS. However, the patients did not report extensive pain interference in terms of daily living activities, as illustrated in Figure 11. These findings indicate that the association between functional limitations and prognosis in adolescent patients with LBP may, to some extent, depend on the experience of being especially limited during specific functions of high importance for the individual patients.

To the best of our knowledge, this study is one of few attempts to collect high-density data among care-seeking adolescent patients with LBP. Previous group-based experimental studies in similar populations assessed LBP intensity 2 to 6 months apart (99,103) and not on a daily and weekly basis as in the current study. As such, it is challenging to compare these findings with existing literature. Nevertheless, the vast fluctuation in both LBP intensity and LBP related worries found among the patients in the current study is interesting to consider in relation to what may characterises care-seeking adolescent with LBP. Furthermore, it is worth discussing if the care-seeking adolescent may differ from those who experience LBP but do not consult a health care provider.

Previous research among adolescents with LBP from the background population found that this group, in general, would report low to moderate LBP intensity (35,156-158). This is interesting, as most of the adolescents included in studies 1, 2, and 3 of the current thesis reported moderate to high LBP intensity at the time of consultation. As such, care-seeking adolescents may, in general, display a higher degree of LBP intensity compared to adolescents who do not consult a health care provider for LBP. In relation, one previous study found that worries about the child's health among their mothers would significantly influence the number of consultations among the children during a 2-year period (95). Although it is unknown if the children in that study were worried themselves, the results from both studies 1 and 3 within this PhD thesis indicate that a high degree of LBP-related worries may be a specific trade among the care-seeking adolescents with LBP. However, before such conclusions can be reached, future studies should strive to assess LBP intensity and LBP-related worries in a cohort of both care-seeking and non-care-seeking adolescents with LBP.

5.3.3. STRENGTHS AND LIMITATIONS.

One strength of the current study is that the time of initiating phase B was randomised, as this provided the opportunity to assess the immediate effect of the intervention irrespective of time for each adolescent patient. Although current checklists for developing single subject experimental studies explicitly state that the procedure of randomisation should be accounted for (130,186), Michiels and Onghena point to this as a common shortcoming in the reporting of set studies (127).

To further strengthen the randomisation of phase B, all patients should have initiated phase A concurrently. However, this was not possible for the current study.

This study has some limitations. Firstly, there was a substantial amount of missing data for all three patients, especially during phases B and A'. There was a continuous effort to remind the adolescent patients to answer the questionnaires on the MyCap™ app. This included text message reminders and phone calls from the primary investigator. Unfortunately, this effector seemed to have little effect as the patients would continuously forget to answer the questionnaires. Only a few pieces of data were missing due to technical issues (e.g., issues with the phone or the app). One possible explanation for the missing data could be that the frequent data collection approach within the study (i.e., daily and weekly) was overwhelming for the adolescent patients. However, as it took 1-2 minutes to answer the daily and weekly questionnaires through the MyCap™ app, this explanation seems unlikely. An alternative explanation is that the notification to complete the questionnaires was overlooked due to multiple notifications from other applications such as Instagram, Facebook, Snapchat, etc. Moreover, if the patients waited to reply to the weekly questionnaires for more than 24 hours after they were first notified by the MyCap™ app, they would be unable to reply as the questionnaire would be inaccessible. In such cases, the patients would have to wait one week to reply to the next questionnaire. Although the application-based questionnaires were tested extensively by the author of this PhD thesis, a more formalised pilot test with additional participants would likely have uncovered such issues beforehand.

Secondly, we expected to have 12 data points through phase B to include in the visual overlap analysis. To determine a systematic change in LBP intensity, 9 of these 12 points should fall below the low A-line. This strategy was based on previous recommendations for similar types of analyses (134). As such, this analysis may be compromised by missing data through phase B. Nevertheless, the remaining elements of the visual analysis (i.e., levels analysis, trend analysis, and analysis of immediate and latent effects) support the current interpretation of the overlap analysis.

Thirdly, the study may be susceptible to selection bias. In this study, we wanted to include adolescent patients who had LBP for long durations (i.e., months or years), and they were required to experience functional limitations due to their pain. Furthermore, we expected that the patients, to some extent, would worry about their LBP. From these criteria, it can be assumed that the patients included in the current study were highly selected, considering the high proportion of adolescents with LBP. Furthermore, all patients under the age of 18 were accompanied by their parents. This behaviour likely reflects a high degree of parental support among the included adolescent patients. However, considering that LBP will likely resolve within seven days for 44%-78% of affected adolescents from the background population (29,39,44), it was our intention to include care-seeking adolescent patients with long-standing and limiting LBP in the current study, as the pain was unlikely to resolve by itself within these specific individuals. This notion is supported by findings from study 1 within this thesis as it showed most of the included adolescents would continue to experience low to moderate LBP intensity 1-year after consulting their general practitioner. Demographic data from Study 2 also display that care-seeking adolescents with LBP may experience pain for several years (162). Although the patients in the current study may be highly selected, it seems reasonable to direct an intervention towards these specific individuals to aid them in self-managing their LBP.

Lastly, due to the frequent collection of data, our priority was to develop a brief questionnaire to be answered by the patients through the MyCAP™ App. Although we used similar questions to assess LBP intensity and worries related to LBP in Study 1, we are not aware of any study that has validated these questions in an adolescent population. The Pain Self-efficacy questionnaire short form was derived from the original 10-item Self-efficacy questionnaire and is comprised of 2 items (i.e., item 5 and item 9) from the original questionnaire (180). In one study, the short-form version of the Pain Self-efficacy questionnaire underwent psychometric evaluation, and the authors found that the new 2-item version was valid and reliable for assessing pain self-efficacy in patients with chronic pain. Furthermore, the authors argue that the short-form version of the Pain Self-efficacy questionnaire is suitable for both research and clinical work (180). However, to the best of our knowledge, this questionnaire has yet to be validated in an adolescent population. This should be taken into consideration when interpreting the results. To assess individual limitations in relation to function, we used the Pain Specific Functional Scale. The PSFS was previously found to be suitable for assessing individual functional limitations among patients in

clinical practice, but it is seldom used in research as data from different patients cannot be pooled (179,187). Nevertheless, the PSFS seems too suitable for single subject experimental studies as these are based on individual patient analyses and not group-based analyses (122,123). Importantly, it has previously been stated that the usefulness of the PSFS in adolescent populations should be investigated further due to the lack of published literature in this area (187). This notion is supported by findings from the current study. It is evident from the data in Table 4 that the PSFS may be a suboptimal measure of functional limitations in adolescent patients with LBP, as some of the patients were more comfortable with providing a verbal statement related to their current functional limitations rather than a number from 0-10. Overall, it is likely that the choice of measures may have impacted the validity of the study findings. Therefore, the findings should be interpreted with this in mind.

5.3.4. POST HOC REFLECTIONS.

In the current study, I (CLS) had the roles of both lead investigator and clinician. Although I had a few years of clinical experience and extensive insight into the literature regarding adolescent LBP, I found the study to be very challenging in terms of combining my obligations as a father, husband, clinician, teacher, supervisor, and PhD student. Returning to clinical work and seeing adolescent patients after five years in research was not without difficulties. Sitting in front of patients as their main clinician required a substantial amount of thought and consideration. Although I did my utmost to live up to the role of an “expert” clinician within the field, I sometimes struggled with the feeling of not being able to fulfil the role to my own standards and expectations.

5.4. CONCLUSION.

The findings of the current study indicate that it is possible to decrease LBP intensity and improve function in the short-term among adolescent LBP patients through an intervention aimed at facilitating a self-management approach. Furthermore, findings from the mediation analysis suggest a positive cross-correlation between LBP intensity and LBP-related worries and a negative cross-correlation between LBP intensity and pain self-efficacy within the three patients. The findings, however, should be interpreted with caution due to missing data during all three phases. Future studies should further investigate LBP intensity and functional limitations in relation to LBP-related worries and pain self-efficacy.

CHAPTER 6. GENERAL DISCUSSION AND CONCLUDING REMARKS.

In this final chapter, I will provide the reader with my overall considerations as to how the knowledge gained through this PhD may contribute to the field of adolescent low back pain. Furthermore, I will discuss and relate the findings of this PhD specifically to the general practice setting. As all three studies within this PhD have few participants overall, I also discuss the possibility of selection bias. Lastly, I will give a brief argument of what knowledge is currently lacking in this field and what future studies should focus on.

6.1. OVERALL CONSIDERATIONS OF FINDINGS.

The studies within this PhD thesis are among the first to focus on care-seeking adolescents with LBP, especially within the general practice setting. Furthermore, these studies are among the first to prospectively investigate factors such as LBP intensity, LBP-related worries, LBP duration, pain self-efficacy and functional limitations within a care-seeking population of adolescents with LBP.

The age span within Study 1 was substantially larger than in Study 2 and Study 3. In study 1, we aimed to investigate prognosis and pain trajectories within a wide range of adolescent patients with LBP. Both older and newer research has demonstrated that patients younger than ten years of age may consult for back pain in primary care (28,86,188). Therefore, we chose to set the minimum age limit to 8 years of age in Study 1. We further chose to set the maximum age limit to 19 years of age in this study, as this corresponds to the crossing from adolescence to young adulthood. In Study 2 and Study 3, the age span used to include informants and patients was smaller than in Study 1. In both studies 2 and 3, the age span was 15-19 years of age. The decision to include older individuals in these studies was partially based on the age of the patients included in study 1 (median age of 15) and partially on previous studies showing that LBP becomes especially prevalent among adolescents in their mid-teens (86,139). Furthermore, we believed that the age span of 15-19 would heighten the possibility of recruiting a homogeneous sample of informants and patients.

In study 1, LBP pain duration was not assessed. However, the high degree of LBP intensity and LBP-related worries among the patients sparked an interest in investigating LBP duration in the two subsequent studies. LBP duration was found to be especially interesting as the patients in study 1 were quite young (i.e., median age of 15 and range between 8-17). In studies 2 and 3, we found that many of the adolescent patients had experienced LBP for several years despite their young age. (Please see Table 2 and section 5.2.1 for information on LBP duration in study 3). Interestingly, LBP intensity was found to be high despite the young age of the patients in Studies 1 and 3 and the adolescent informants in Study 2. These findings may

indicate that although LBP intensity will diminish after one year among care-seeking adolescent patients, as displayed in study 1, some will likely move on to experience continuous LBP at high intensity for years based on the demographic data from studies 2 and 3.

In relation, only one patient from study 1 was found to have an underlying pathology, which would likely improve from surgery at the time of the index consultation. For the remaining patients, there was no suspicion of severe pathology, nor LBP-related radiculopathy noted in the electronic journal entry related to the index consultations. Although these findings should be interpreted with caution, they also need to be discussed with the previous literature on identifiable pathology among adolescents with LBP. As stated in the introduction, one study from the United States with data from 45 different hospitals found that less than 100 adolescent patients were diagnosed with a severe underlying pathology over the course of 4.5 years (81). Although these data are not directly transferable to that of the Danish general practice setting, there is currently no evidence to suggest that the occurrence of severe pathology among adolescents with LBP consulting in general practice should be considered to be especially high (64,73). Also, based on previous literature, it seems that the prevalence of LBP-related radiculopathy (e.g., disc herniations) is also low within this age group (189). As such, it may be hypothesised that some adolescent patients will continue to experience LBP after consulting their general practitioner despite no identifiable underlying pathology. In terms of diagnostic triage, the findings within this PhD thesis do not indicate that the occurrence of serious, underlying pathology among care-seeking adolescents should be considered to be different from that of non-care-seeking adolescents when taking the published literature into account. However, the findings within this PhD thesis may indicate that care-seeking adolescents and non-care-seeking adolescents with LBP differ in other aspects.

Findings from previous studies indicate that adolescents with LBP from the background population are characterised by low to moderate LBP intensity (35,156-158) and with a low proportion of individuals with functional limitations (30,40). Moreover, there is evidence to suggest that the pain would resolve within seven days for 44%-78% of these adolescents (29,39,44). This is interesting, as the majority of adolescents included in this PhD thesis were characterised by moderate to high LBP intensity, a high degree of functional limitation and long durations of LBP. Although there is currently no evidence to support that the occurrence of serious, identifiable pathology should differ between care-seeking and non-care-seeking adolescents with LBP, findings from the current PhD thesis indicate that these two groups may differ in terms of LBP intensity, degree of functional limitations and LBP duration. To the best of my knowledge, no previous studies have investigated LBP-related worries in a large sample of non-care-seeking adolescents with LBP. However, based on findings from this PhD thesis, there is now some evidence to suggest that the degree of LBP-related worries may be high among care-seeking adolescents with LBP. Nevertheless, if these two groups are, in fact, different from each other, at what point do some of

the non-care-seeking adolescents with LBP transition into care-seeking adolescents in general practice?

The findings from study 2 within this PhD thesis may offer some of the answers to this specific question. In this study, we uncovered that many of the adolescent informants had initially attempted to self-manage their LBP with over-the-counter pain medication for an extended period of time prior to consulting their general practitioner. Despite their efforts, most of the adolescent informants in Study 2 experienced limited or no effect from this approach (162). Moreso, the adolescent informants stated that the main trigger for seeking care with a health care provider was LBP intensity or a sudden increase in LBP intensity. These findings can, to some extent, explain why some of the non-care-seeking adolescents with LBP will go on to become care-seeking adolescents. This notion also aligns with findings from study 1, in which LBP intensity was found to be moderate to high at the time of consultation. As a sudden spike in LBP intensity was found to be the main trigger for seeking care in study 2 (162), this may also explain the high degree of LBP-related worries among the patients in study 1 at the time of consultation. This may especially be true among the patients who did not experience a significant pain reduction despite prolonged use of pain medication.

One of the most interesting findings from Study 3 was the vast fluctuation in LBP intensity, LBP-related worries and pain self-efficacy over the course of time. Interestingly, LBP intensity and LBP-related worries were found to be positively cross-correlated and thus moved concurrently in the same direction within the three patients. These cross-correlations were, in addition, found to be statistically significant in all three included patients. Also, the findings from study 3 indicate that pain self-efficacy was negatively cross-correlated with LBP intensity, as these two variables would move in opposite directions at lag zero. This is highly interesting, as it may indicate a relationship between these three factors. However, the findings from study 3 do not offer solid data as to how these factors are intertwined. Nevertheless, it may be possible to derive a theoretical hypothesis.

As stated previously, the main trigger for seeking healthcare among the informants in Study 2 was LBP intensity or a sudden spike in LBP intensity (162). This was despite the fact that the patients in all three studies experienced concurrent functional limitations. As such, it may be hypothesised that the relationship between LBP intensity, LBP-related worries, and pain self-efficacy may begin with the LBP itself. The LBP or increase in LBP intensity may subsequently lead to an increase in LBP-related worries, especially among adolescent patients who have used pain medication and thus expected a pain reduction and not an increase in their LBP. Lastly, the concurrent increase in LBP intensity and LBP-related worries may then impact pain self-efficacy in some adolescent patients.

One potentially important aspect of adolescent LBP addressed in this PhD thesis was LBP-related worries among adolescents. From both cross-sectional data (89) and qualitative interview data (92) there was previous evidence to suggest that some adolescents would worry about their LBP. In study 3 of this PhD thesis, LBP-related

worries were addressed continuously among the patients during the course of treatment. In this study, the adolescent patients would express worries regarding their future in terms of functional limitations, education, and occupation. Especially worries about the future and functional limitations were also expressed among adolescent informants in a previous qualitative interview study (92). Although the patients' worries in Study 3 were addressed extensively during their individual courses, a high degree of LBP-related worries prevailed among the patients.

6.2. POSSIBLE IMPLICATIONS FOR MANAGING ADOLESCENT LOW BACK PAIN IN GENERAL PRACTICE.

As discussed throughout, the studies within the present PhD thesis have some methodological limitations. Therefore, the findings have been interpreted with caution. Nevertheless, I do believe several of the enclosed findings to be novel and of relevance to the general practice setting. Therefore, I have sought to outline some of the possible implications these findings may have regarding the management of adolescent LBP in general practice.

Firstly, based on findings from study 2 and study 3, it is likely that care-seeking adolescents with LBP who consult their general practitioner have experienced their pain for a prolonged period of time. During this period, many of the adolescent patients will have tried to self-manage their LBP with over-the-counter pain medication with little or no effect. In such cases, it may be advisable to acknowledge that the patients have tried to manage their LBP prior to consulting. From the perspective of the general practitioner, this may also be a sign that adolescent patients lack alternative self-management strategies to pain medication.

Secondly, from all three studies, it seems that adolescent patients with LBP are knowledgeable about the role of the general practitioner within the Danish healthcare system. Therefore, they also seem to be aware that initially consulting a general practitioner would be an optimal strategy in their endeavours to overcome their LBP. This was especially true if the adolescent patients utilized social resources from their parents or peers in order to navigate the Danish healthcare system. From a clinician's point of view, it may again be advisable to acknowledge that the adolescent patients were able to find their way into general practice to seek care for their LBP despite their young age and likely limited experience with the Danish healthcare system.

Thirdly, from studies 1 and 3, there is evidence to suggest that the adolescents who do seek care for LBP in general practice may differ from the non-care-seeking adolescents with LBP. These differences are likely not related to any serious, identifiable pathology but more in terms of LBP intensity and LBP-related worries. Findings from the current PhD thesis indicate that care-seeking adolescents with LBP from general practice may display higher LBP intensity compared to their non-care-seeking peers. Furthermore, care-seeking adolescents may present with high LBP-related worries at the time of consulting in general practice. This notion is based on the findings from studies 1 and 2, which suggest that the main trigger for seeking

healthcare in this group of adolescent patients was LBP intensity or a sudden spike in LBP intensity (162). Furthermore, based on findings from Study 3, an increase in LBP intensity and LBP-related worries may decrease pain self-efficacy in these young patients. As such, it seems advisable to acknowledge that care-seeking adolescent patients presenting with LBP are, in fact, in pain, that they likely worry extensively about their pain, and that they most likely lack strategies to self-manage their pain. Based on findings from study 2, these aspects seem important to consider as a clinician, as many of the adolescent informants would experience some distrust from their health care provider in terms of LBP severity (162). This feeling of not being taken seriously would, in turn, discourage the adolescents in their pursuit of an effective management strategy for their LBP. This was also true for adolescents who experienced difficulties understanding what the general practitioner or other health care providers would tell them during the consultation (162). These difficulties were often related to the use of long and difficult words from the field of medicine. Importantly, many of the adolescent informants were aware that they themselves found it difficult to know how to relay their message to a health care provider in the most optimal way (162). From the adolescents' point of view, there seemed to be several barriers to productive communication with their health care providers. These barriers may have severely compromised the possibilities for establishing mutually beneficial partnerships between adolescent patients and their health care providers.

Lastly, none of the adolescent informants from Study 2 expressed any desire to be dependent on a health care provider nor engage frequently with the healthcare system. On the contrary, these adolescents expressed an explicit desire to self-manage their LBP, and they were open to trying different strategies to reduce their LBP (163). (162). However, to feel confident in self-managing their LBP, the adolescent informants from study 2 expressed a need for continuous guidance from a health care provider during their process of self-managing (162). As such, the adolescents felt that they sometimes would require guidance and sparing at times of doubt. This could be at times when the adolescents were unsure if they performed their exercise correctly or when they sought inspiration for new management strategies to try out. From study 3, it seems that a self-management approach can lead to a reduction in LBP intensity and improved function in the short-term among adolescents with LBP. As described previously, one key element of successful self-management is the ability to establish meaningful partnerships with one or more health care providers. For many care-seeking adolescents, their general practitioner will be the first “partner” they encounter in their pursuit to reduce LBP. This means that the general practitioners are not necessarily required to provide a solution for the pain but rather present a range of self-management opportunities for the adolescent patients to explore on their own or in collaboration with parents and/or peers. Unless the general practitioner has a strong clinical suspicion towards an identifiable (and maybe even severe) underlying pathology, these patients may be less likely to benefit from being referred to secondary healthcare. Rather, there is a rationale for managing these adolescent patients within the primary healthcare setting. Depending on the patient, their LBP intensity and their level of LBP-related worries, these patients may improve by seeking guidance and

care from their general practitioner, a psychologist, a chiropractor, or a physiotherapist in the primary care setting.

6.3. OVERALL CONSIDERATION OF SELECTION BIAS.

As described in the introduction, the main focus of this PhD was to generate new knowledge on care-seeking adolescents with LBP from general practice. As discussed throughout the thesis, these specific adolescents may be highly selected as they do not necessarily represent all adolescents who experience LBP. This is evident from previous research showing mixed estimates of care-seeking behaviour among adolescents with LBP. From these studies, it seems that seeking care with a general practitioner specifically may vary greatly in terms of age and country (35,39,40,58,84).

As discussed previously, it is possible that study 1 of this PhD may be susceptible to selection bias as no data regarding eligible patients who declined to participate in the study were collected. From an epidemiological point of view, the small sample size may also, to some extent, hamper the overall generalizability of the findings to the population of care-seeking adolescents from general practice. As disclosed earlier in the thesis, the data from Study 1 should be interpreted with the notion of possible selection bias in mind.

Selection bias was also discussed extensively for study 2, which was designed as an interview-based qualitative study. As such, it was debated if the adolescent informants included in the study were different from non-care-seeking adolescents with LBP and care-seeking adolescents with LBP who experienced less social support from their parents. One important aspect of this discussion concerned the Danish Law requiring health care providers to include parents or legal guardians of patients between the ages of 15 and 18 years of age in the process of deciding on a specific treatment for a given condition (LBK nr 903 af 26/08/2019). From this notion, it seems less likely that the care-seeking adolescent informants from Study 2 should be considered different from other care-seeking adolescents with LBP. In terms of methodology, it is also important to recognise that the notion of “adequate sample size” should be assessed differently between epidemiological studies and qualitative interview studies. Whereas a large sample size is important in terms of generalizability within prospective cohort studies (112) other factors may be used to determine the adequate sample size within qualitative interview studies. In their paper from 2016, Malterud and colleagues argue that sample sizes and the level of information power within qualitative interview studies are closely linked to the dimensions of 5 distinct items (190). These items are 1) the aim of the study (broad vs narrow), 2) the specificity of the study sample (dense vs sparse), 3) whether or not the study is based on prior theory (applied vs none), 4) the strength of the dialogue (strong vs weak), and 5) how the analysis is conducted (within cases vs. across cases) (190). Regarding study 2 within this thesis, it could be argued that the aim of the study was narrow, the specificity of the study sample was dense, the study was based on prior theory related to self-management and health literacy, and the dialogue within most of the interviews was considered strong. This may indicate that the study sample held a high degree of information power. However,

as the thematic analysis was conducted across all cases, this strategy may have reduced the information power of the sample within the study.

Lastly, the possibility of selection bias within Study 3 was also discussed previously in the thesis. To be eligible for inclusion in Study 3, the adolescent patients were required to have experienced fluctuating or constant LBP for more than 30 days. They were also required to have experienced functional limitations due to their LBP to be eligible for participation. Previous research shows that LBP will likely resolve within seven days from initiation for 44%-78% of affected adolescents from the background population (29,39,44). Furthermore, there is evidence to suggest that only a low proportion of adolescents with LBP from the general population report functional limitations (30,40). As such, the adolescent patients in Study 3 may differ in terms of LBP duration and functional limitations compared to adolescents with LBP from the background population. However, based on findings from both study 1 and study 2 within this thesis, it seems that care-seeking adolescents with LBP may be characterised by long pain duration and functional limitations. This indicates that the adolescent patients in Study 3, to some extent, may display similar characteristics as other care-seeking adolescents with LBP. Nevertheless, the results of Study 3 should be interpreted and generalised within the boundaries of the described patient characteristics and clinical setting (130).

6.4. IMPLICATIONS FOR FUTURE STUDIES.

Due to unforeseen factors, such as the COVID-19 pandemic, it was not possible to investigate the association between individual patient and parent-related factors on prognosis within care-seeking adolescents with LBP from general practice. Neither was it possible to assess different LBP trajectories through LCAs. Nevertheless, I believe that the rationale for conducting large-scale observational studies with this specific aim remains. Importantly, there are alternative study designs available, such as retrospective register studies. In such a study, it would be possible to collect patient data directly from general practice clinics via the ICPC-2 coding system (please see a detailed description of this alternative study design under section 3.3.4 - Perspectives on study implications and future research, in chapter 3). Furthermore, I believe that the findings from this PhD thesis may offer some insight into what individual patient factors may be especially important to consider in future studies. These include LBP intensity, LBP-related worries, pain self-efficacy and functional limitations.

Furthermore, it would be highly interesting if future studies were to investigate if and how care-seeking adolescents with LBP may differ from non-care-seeking adolescents with LBP in terms of identifiable underlying pathology, LBP intensity, LBP-related worries, functional limitation, and pain self-efficacy. Although findings from the current PhD thesis may indicate that there are differences between non-care-seeking and care-seeking adolescents with LBP, large-scale studies investigating this notion with validated assessment tools are needed before such a conclusion can be reached.

LITERATURE LIST

- (1) O'Keeffe M, O'Sullivan P, Purtill H, Bargary N, O'Sullivan K. Cognitive functional therapy compared with a group-based exercise and education intervention for chronic low back pain: a multicentre randomised controlled trial (RCT). *Br J Sports Med* 2020 Jul;54(13):782-789.
- (2) van Tulder M, Becker A, Bekkering T, Breen A, del Real MTG, Hutchinson A, et al. Chapter 3. European guidelines for the management of acute nonspecific low back pain in primary care. *Eur Spine J* 2006 Mar;15 Suppl 2(Suppl 2):169.
- (3) Oliveira CB, Maher CG, Pinto RZ, Traeger AC, Lin CC, Chenot J, et al. Clinical practice guidelines for the management of non-specific low back pain in primary care: an updated overview. *Eur Spine J* 2018 11;27(11):2791-2803.
- (4) Traeger A, Buchbinder R, Harris I, Maher C. Diagnosis and management of low-back pain in primary care. *CMAJ* 2017 Nov 13;189(45):E1386-E1395.
- (5) Maher C, Underwood M, Buchbinder R. Non-specific low back pain. *Lancet* 2017 Feb 18;389(10070):736-747.
- (6) Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. *Lancet* 2018 06 09;;391(10137):2356-2367.
- (7) Kreiner DS, Hwang SW, Easa JE, Resnick DK, Baisden JL, Bess S, et al. An evidence-based clinical guideline for the diagnosis and treatment of lumbar disc herniation with radiculopathy. *Spine J* 2014 Jan;14(1):180-191.
- (8) Brinjikji W, Luetmer PH, Comstock B, Bresnahan BW, Chen LE, Deyo RA, et al. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. *AJNR Am J Neuroradiol* 2015 Apr;36(4):811-816.
- (9) Lurie J, Tomkins-Lane C. Management of lumbar spinal stenosis. *BMJ* 2016 Jan 4;352:h6234.
- (10) Kunwald M, Straszek CL, Bjarkam CR, Ettrup MS, Skajaa T, Thomsen JL, et al. Intradural Extramedullary Ewing Sarcoma in an Adolescent Female. *Adolesc Health Med Ther* 2022 Feb 15;13:39-43.
- (11) Vlaeyen JWS, Maher CG, Wiech K, Van Zundert J, Meloto CB, Diatchenko L, et al. Low back pain. *Nature Reviews Disease Primers* 2018;4(1):52.

- (12) GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2020 Oct 17;396(10258):1204-1222.
- (13) Konstantinou K, Dunn KM, Ogollah R, Vogel S, Hay EM, ATLAS study research team. Characteristics of patients with low back and leg pain seeking treatment in primary care: baseline results from the ATLAS cohort study. *BMC Musculoskelet Disord* 2015 Nov 4;16:332-8.
- (14) Oliveira CB, Hamilton M, Traeger A, Buchbinder R, Richards B, Rogan E, et al. Do Patients with Acute Low Back Pain in Emergency Departments Have More Severe Symptoms than Those in General Practice? A Systematic Review with Meta-Analysis. *Pain Med* 2022 Apr 8;23(4):614-624.
- (15) Walker BF, Muller R, Grant WD. Low back pain in Australian adults: the economic burden. *Asia Pac J Public Health* 2003;15(2):79-87.
- (16) Ekman M, Jönhagen S, Hunsche E, Jönsson L. Burden of illness of chronic low back pain in Sweden: a cross-sectional, retrospective study in primary care setting. *Spine (Phila Pa 1976)* 2005 Aug 1;30(15):1777-1785.
- (17) Flachs EM, Eriksen L, Koch MB, Ryd JT, Dibba E, Skov-Ettrup L, et al. Sygdomsbyrden i Danmark – sygdomme. Statens Institut for Folkesundhed, Syddansk Universitet. 2015.
- (18) Mairey I, Rosenkilde S, Klitgaard MB, Thygesen LC. Sygdomsbyrden i Danmark – sygdomme. Statens Institut for Folkesundhed, Syddansk Universitet. 2022.
- (19) Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum* 2012 Jun;64(6):2028-2037.
- (20) Safiri S, Kolahi A, Cross M, Hill C, Smith E, Carson-Chahhoud K, et al. Prevalence, Deaths, and Disability-Adjusted Life Years Due to Musculoskeletal Disorders for 195 Countries and Territories 1990-2017. *Arthritis Rheumatol* 2021 Apr;73(4):702-714.
- (21) da Silva T, Mills K, Brown BT, Herbert RD, Maher CG, Hancock MJ. Risk of Recurrence of Low Back Pain: A Systematic Review. *J Orthop Sports Phys Ther* 2017 May;47(5):305-313.
- (22) Machado GC, Maher CG, Ferreira PH, Latimer J, Koes BW, Steffens D, et al. Can Recurrence After an Acute Episode of Low Back Pain Be Predicted? *Phys Ther* 2017 Sep 1;97(9):889-895.

- (23) Øiestad BE, Hilde G, Tveter AT, Peat GG, Thomas MJ, Dunn KM, et al. Risk factors for episodes of back pain in emerging adults. A systematic review. *Eur J Pain* 2020 Jan;24(1):19-38.
- (24) da C Menezes Costa L, Maher CG, Hancock MJ, McAuley JH, Herbert RD, Costa LOP. The prognosis of acute and persistent low-back pain: a meta-analysis. *CMAJ* 2012 Aug 7;184(11):613.
- (25) Itz CJ, Geurts JW, van Kleef M, Nelemans P. Clinical course of non-specific low back pain: a systematic review of prospective cohort studies set in primary care. *Eur J Pain* 2013 Jan;17(1):5-15.
- (26) Dunn KM, Jordan K, Croft PR. Characterizing the course of low back pain: a latent class analysis. *Am J Epidemiol* 2006 Apr 15;163(8):754-761.
- (27) Dunn KM, Campbell P, Jordan KP. Long-term trajectories of back pain: cohort study with 7-year follow-up. *BMJ Open* 2013 Dec 11;3(12):e003838-003838.
- (28) Fairbank JC, Pynsent PB, Van Poortvliet JA, Phillips H. Influence of anthropometric factors and joint laxity in the incidence of adolescent back pain. *Spine (Phila Pa 1976)* 1984;9(5):461-464.
- (29) Taimela S, Kujala UM, Salminen JJ, Viljanen T. The prevalence of low back pain among children and adolescents. A nationwide, cohort-based questionnaire survey in Finland. *Spine (Phila Pa 1976)* 1997 May 15;22(10):1132-1136.
- (30) Sundell C, Bergström E, Larsén K. Low back pain and associated disability in Swedish adolescents. *Scand J Med Sci Sports* 2019 Mar;29(3):393-399.
- (31) Skoffler B, Foldspang A. Physical activity and low-back pain in schoolchildren. *Eur Spine J* 2008 Mar;17(3):373-379.
- (32) Silva, Mônica R O G C M, Badaró AFV, Dall'Agnol MM. Low back pain in adolescent and associated factors: A cross sectional study with schoolchildren. *Braz J Phys Ther* 2014;18(5):402-409.
- (33) Salminen JJ, Pentti J, Terho P. Low back pain and disability in 14-year-old schoolchildren. *Acta Paediatr* 1992 Dec;81(12):1035-1039.
- (34) Olsen TL, Anderson RL, Dearwater SR, Kriska AM, Cauley JA, Aaron DJ, et al. The epidemiology of low back pain in an adolescent population. *Am J Public Health* 1992 Apr;82(4):606-608.
- (35) Masiero S, Carraro E, Celia A, Sarto D, Ermani M. Prevalence of nonspecific low back pain in schoolchildren aged between 13 and 15 years. *Acta Paediatr* 2008 Feb;97(2):212-216.

- (36) Masiero S, Sarto F, Cattelan M, Sarto D, Del Felice A, Agostini F, et al. Lifetime Prevalence of Nonspecific Low Back Pain in Adolescents: A Cross-sectional Epidemiologic Survey. *Am J Phys Med Rehabil* 2021 Dec 1;100(12):1170-1175.
- (37) Balagué F, Skovron ML, Nordin M, Dutoit G, Pol LR, Waldburger M. Low back pain in schoolchildren. A study of familial and psychological factors. *Spine (Phila Pa 1976)* 1995 Jun 1;20(11):1265-1270.
- (38) Balagué F, Ferrer M, Rajmil L, Pont Acuña A, Pellisé F, Cedraschi C. Assessing the association between low back pain, quality of life, and life events as reported by schoolchildren in a population-based study. *Eur J Pediatr* 2012 Mar;171(3):507-514.
- (39) Jones MA, Stratton G, Reilly T, Unnithan VB. A school-based survey of recurrent non-specific low-back pain prevalence and consequences in children. *Health Educ Res* 2004 Jun;19(3):284-289.
- (40) Wedderkopp N, Leboeuf-Yde C, Andersen LB, Froberg K, Hansen HS. Back pain reporting pattern in a Danish population-based sample of children and adolescents. *Spine (Phila Pa 1976)* 2001 Sep 1;26(17):1879-1883.
- (41) Fuglkjær S, Vach W, Hartvigsen J, Dissing KB, Junge T, Hestbæk L. Musculoskeletal pain distribution in 1,000 Danish schoolchildren aged 8-16 years. *Chiropr Man Therap* 2020 08 04;28(1):45.
- (42) Rathleff MS, Roos EM, Olesen JL, Rasmussen S. High prevalence of daily and multi-site pain--a cross-sectional population-based study among 3000 Danish adolescents. *BMC Pediatr* 2013 Nov 19;13:191.
- (43) Lindberg L, Nielsen SB, Damgaard M, Sloth OR, Rathleff MS, Straszek CL. Musculoskeletal pain is common in competitive gaming: a cross-sectional study among Danish esports athletes. *BMJ Open Sport & Exercise Medicine* 2020 /08/01;6(1):000799.
- (44) Dissing KB, Hestbæk L, Hartvigsen J, Williams C, Kamper S, Boyle E, et al. Spinal pain in Danish school children - how often and how long? The CHAMPS Study-DK. *BMC Musculoskelet Disord* 2017 Mar 27;18(1):67-5.
- (45) RKKP's Videncenter. Dansk Rygdatabase
- DaRD Årsrapport 2020
- opgørelsesperiode fra 1. juli 2019 til 30. juni 2020. 2021.
- (46) RKKP's Videncenter. Dansk Rygdatabase
- DaRD Årsrapport 2021
- opgørelsesperiode fra 1. juli 2020
til og med 30. juni 2021. 2022.

- (47) Brindova D, Veselska ZD, Klein D, Hamrik Z, Sigmundova D, van Dijk JP, et al. Is the association between screen-based behaviour and health complaints among adolescents moderated by physical activity? *Int J Public Health* 2015 -02;60(2):139-145.
- (48) Minghelli B. Musculoskeletal spine pain in adolescents: Epidemiology of non-specific neck and low back pain and risk factors. *J Orthop Sci* 2020 -09;25(5):776-780.
- (49) Lemes ÍR, Oliveira CB, Silva GCR, Pinto RZ, Tebar WR, Christofaro DG. Association of sedentary behavior and early engagement in physical activity with low back pain in adolescents: a cross-sectional epidemiological study. *Eur Spine J* 2022 -01;31(1):152-158.
- (50) Hakala PT, Rimpelä AH, Saarni LA, Salminen JJ. Frequent computer-related activities increase the risk of neck-shoulder and low back pain in adolescents. *Eur J Public Health* 2006 Oct;16(5):536-541.
- (51) Heneweer H, Vanhees L, Picavet HSJ. Physical activity and low back pain: a U-shaped relation? *Pain* 2009 May;143(1-2):21-25.
- (52) Franz C, Møller NC, Korsholm L, Jespersen E, Hebert JJ, Wedderkopp N. Physical activity is prospectively associated with spinal pain in children (CHAMPS Study-DK). *Sci Rep* 2017 Sep 14;7(1):11598-4.
- (53) Aartun E, Hartvigsen J, Boyle E, Hestbaek L. No associations between objectively measured physical activity and spinal pain in 11-15-year-old Danes. *Eur J Pain* 2016 -03;20(3):447-457.
- (54) Aartun E, Boyle E, Hartvigsen J, Ferreira PH, Maher CG, Ferreira ML, et al. The most physically active Danish adolescents are at increased risk for developing spinal pain: a two-year prospective cohort study. *BMJ Open Sport Exerc Med* 2016;2(1):e000097.
- (55) Kamper SJ, Yamato TP, Williams CM. The prevalence, risk factors, prognosis and treatment for back pain in children and adolescents: An overview of systematic reviews. *Best Pract Res Clin Rheumatol* 2016 12;30(6):1021-1036.
- (56) Beynon AM, Hebert JJ, Lebouef-Yde C, Walker BF. Potential risk factors and triggers for back pain in children and young adults. A scoping review, part I: incident and episodic back pain. *Chiropr Man Therap* 2019 Nov 19;27:58-9. eCollection 2019.
- (57) Huguet A, Tougas ME, Hayden J, McGrath PJ, Stinson JN, Chambers CT. Systematic review with meta-analysis of childhood and adolescent risk and prognostic factors for musculoskeletal pain. *Pain* 2016 Dec;157(12):2640-2656.

- (58) Kjaer P, Wedderkopp N, Korsholm L, Leboeuf-Yde C. Prevalence and tracking of back pain from childhood to adolescence. *BMC Musculoskelet Disord* 2011 May 16;12:98-98.
- (59) Jones GT, Macfarlane GJ. Predicting persistent low back pain in schoolchildren: a prospective cohort study. *Arthritis Rheum* 2009 Oct 15;61(10):1359-1366.
- (60) Smith A, Beales D, O'Sullivan P, Bear N, Straker L. Low Back Pain With Impact at 17 Years of Age Is Predicted by Early Adolescent Risk Factors From Multiple Domains: Analysis of the Western Australian Pregnancy Cohort (Raine) Study. *J Orthop Sports Phys Ther* 2017 Oct;47(10):752-762.
- (61) O'Sullivan PB, Caneiro JP, O'Sullivan K, Lin I, Bunzli S, Wernli K, et al. Back to basics: 10 facts every person should know about back pain. *Br J Sports Med* 2020 Jun;54(12):698-699.
- (62) Palsson TS, Andreucci A, Straszek CL, Rathleff MS, Hoegh M. Reducing the Weight of Spinal Pain in Children and Adolescents. *Children* 2021;8(12).
- (63) Yamato TP, Maher CG, Traeger AC, Williams CM, Kamper SJ. Do schoolbags cause back pain in children and adolescents? A systematic review. *Br J Sports Med* 2018 Oct;52(19):1241-1245.
- (64) O'Sullivan K, O'Keefe M, Forster BB, Qamar SR, van der Westhuizen A, O'Sullivan PB. Managing low back pain in active adolescents. *Best Pract Res Clin Rheumatol* 2019 Feb;33(1):102-121.
- (65) Henriot-Jéhel C, Lemire J, Teulier C, Bussièrès A, Lardon A. Factors associated with back pain in children aged 6 to 12 years of age, an eight months prospective study. *Sci Rep* 2022 Jan 12;12(1):603-7.
- (66) Hébert JJ, Beynon AM, Jones BL, Wang C, Shrier I, Hartvigsen J, et al. Spinal pain in childhood: prevalence, trajectories, and diagnoses in children 6 to 17 years of age. *Eur J Pediatr* 2022 Apr;181(4):1727-1736.
- (67) Dunn KM, Jordan KP, Mancl L, Drangsholt MT, Le Resche L. Trajectories of pain in adolescents: a prospective cohort study. *Pain* 2011 Jan;152(1):66-73.
- (68) Higgins KS, Birnie KA, Chambers CT, Wilson AC, Caes L, Clark AJ, et al. Offspring of parents with chronic pain: a systematic review and meta-analysis of pain, health, psychological, and family outcomes. *Pain* 2015 Nov;156(11):2256-2266.
- (69) Dario AB, Kamper SJ, O'Keefe M, Zadro J, Lee H, Wolfenden L, et al. Family history of pain and risk of musculoskeletal pain in children and adolescents: a systematic review and meta-analysis. *Pain* 2019 11;160(11):2430-2439.

- (70) Dullien S, Grifka J, Jansen P. Cluster-randomized, controlled evaluation of a teacher led multi factorial school based back education program for 10 to 12-year old children. *BMC Pediatr* 2018 Sep 26;18(1):312-y.
- (71) Dolphens M, Cagnie B, Danneels L, De Clercq D, De Bourdeaudhuij I, Cardon G. Long-term effectiveness of a back education programme in elementary schoolchildren: an 8-year follow-up study. *Eur Spine J* 2011 Dec;20(12):2134-2142.
- (72) Steele EJ, Dawson AP, Hiller JE. School-based interventions for spinal pain: a systematic review. *Spine (Phila Pa 1976)* 2006 Jan 15;31(2):226-233.
- (73) O'Sullivan P, Smith A, Beales D, Straker L. Understanding Adolescent Low Back Pain From a Multidimensional Perspective: Implications for Management. *J Orthop Sports Phys Ther* 2017 Oct;47(10):741-751.
- (74) Foster NE, Anema JR, Cherkin D, Chou R, Cohen SP, Gross DP, et al. Prevention and treatment of low back pain: evidence, challenges, and promising directions. *Lancet* 2018 06 09;391(10137):2368-2383.
- (75) Pedersen KM, Andersen JS, Søndergaard J. General practice and primary health care in Denmark. *J Am Board Fam Med* 2012 -03;25 Suppl 1:34.
- (76) Praktiserende Lægeres Organisation. Andelen af praksis med lukket for tilgang stiger markant. 2023 January.
- (77) Mainz J, Hess MH, Johnsen SP. The Danish unique personal identifier and the Danish Civil Registration System as a tool for research and quality improvement. *Int J Qual Health Care* 2019 Nov 30;31(9):717-720.
- (78) Soler J, Okkes I, Wood M, Lamberts H. The coming of age of ICPC: celebrating the 21st birthday of the International Classification of Primary Care. *Fam Pract* 2008 Aug;25(4):312-317.
- (79) Turner PG, Green JH, Galasko CS. Back pain in childhood. *Spine (Phila Pa 1976)* 1989 Aug;14(8):812-814.
- (80) Annertz M, Dr M, funktion Vbo, universitetssjukhus S, Åke L, Emeritus P, et al. Ländryggströntgen ger falsk säkerhet och ringa nytta för patienten. 2017 -11-14T16:00:00+00:00.
- (81) Zhou AZ, Marin JR, Hickey RW, Lam SK, Ramgopal S. Serious diagnoses at revisits in children discharged from the emergency department with back pain. *Acad Emerg Med* 2021 Nov;28(11):1299-1307.
- (82) Olenja J. Health seeking behaviour in context. *East Afr Med J* 2003 Feb;80(2):61-62.

- (83) Anagaw TF, Melaku Mazengia E, Bogale EK, Talie Fenta E, Eshetu HB, Kebede N, et al. Health-seeking behavior among non-communicable disease patients globally, systematic review and meta-analysis. *SAGE Open Med* 2023 Dec 6;11:20503121231215236.
- (84) Bondesson E, Olofsson T, Caverius U, Schelin MEC, Jöud A. Consultation prevalence among children, adolescents and young adults with pain conditions: A description of age- and gender differences. *Eur J Pain* 2020 Mar;24(3):649-658.
- (85) Jordan K, Clarke AM, Symmons DPM, Fleming D, Porcheret M, Kadam UT, et al. Measuring disease prevalence: a comparison of musculoskeletal disease using four general practice consultation databases. *Br J Gen Pract* 2007 Jan;57(534):7-14.
- (86) Tan A, Strauss VY, Protheroe J, Dunn KM. Epidemiology of paediatric presentations with musculoskeletal problems in primary care. *BMC Musculoskelet Disord* 2018 02 06;19(1):40.
- (87) Jordan KP, Kadam UT, Hayward R, Porcheret M, Young C, Croft P. Annual consultation prevalence of regional musculoskeletal problems in primary care: an observational study. *BMC Musculoskelet Disord* 2010 Jul 2;11:144-144.
- (88) Michaleff ZA, Campbell P, Hay AD, Warburton L, Dunn KM. Child and adolescent musculoskeletal pain (CAM-Pain) feasibility study: testing a method of identifying, recruiting and collecting data from children and adolescents who consult about a musculoskeletal condition in UK general practice. *BMJ Open* 2018 Jun 14;8(6):e021116-021116.
- (89) Pourbordbari N, Jensen MB, Olesen JL, Holden S, Rathleff MS. Bio-psychosocial characteristics and impact of musculoskeletal pain in one hundred children and adolescents consulting general practice. *BMC Prim Care* 2022 Jan 25;23(1):20-8.
- (90) Prathivadi Bhayankaram N, Lacey RJ, Barnett LA, Jordan KP, Dunn KM. Musculoskeletal consultations from childhood to adulthood: a longitudinal study. *J Public Health (Oxf)* 2020 Nov 23;42(4):e428-e434.
- (91) Kekkonen VK, Kivimäki P, Valtonen H, Tolmunen T, Lehto SM, Hintikka J, et al. Psychosocial problems in adolescents associated with frequent health care use. *Fam Pract* 2015 Jun;32(3):305-310.
- (92) Lauridsen HH, Stolpe AB, Myburgh C, Hestbæk L. What are important consequences in children with non-specific spinal pain? A qualitative study of Danish children aged 9-12 years. *BMJ Open* 2020 Oct 20;10(10):e037315-037315.
- (93) MacNeela P, Doyle C, O'Gorman D, Ruane N, McGuire BE. Experiences of chronic low back pain: a meta-ethnography of qualitative research. *Health Psychol Rev* 2015;9(1):63-82.

(94) Janicke DM, Finney JW. Children's primary health care services: social-cognitive factors related to utilization. *J Pediatr Psychol* 2003 Dec;28(8):547-557.

(95) Janicke DM, Finney JW, Riley AW. Children's health care use: a prospective investigation of factors related to care-seeking. *Med Care* 2001 Sep;39(9):990-1001.

(96) Little P, Somerville J, Williamson I, Warner G, Moore M, Wiles R, et al. Family influences in a cross-sectional survey of higher child attendance. *Br J Gen Pract* 2001 Dec;51(473):977-81, 984.

(97) Michaleff ZA, Kamper SJ, Maher CG, Evans R, Broderick C, Henschke N. Low back pain in children and adolescents: a systematic review and meta-analysis evaluating the effectiveness of conservative interventions. *Eur Spine J* 2014 Oct;23(10):2046-2058.

(98) Ahlqwist A, Hagman M, Kjellby-Wendt G, Beckung E. Physical therapy treatment of back complaints on children and adolescents. *Spine (Phila Pa 1976)* 2008 Sep 15;33(20):721.

(99) Selhorst M, Selhorst B. Lumbar manipulation and exercise for the treatment of acute low back pain in adolescents: a randomized controlled trial. *J Man Manip Ther* 2015 Sep;23(4):226-233.

(100) Barnett AG, van der Pols JC, Dobson AJ. Regression to the mean: what it is and how to deal with it. *Int J Epidemiol* 2005 Feb;34(1):215-220.

(101) Morton V, Torgerson DJ. Effect of regression to the mean on decision making in health care. *BMJ* 2003 May 17;326(7398):1083-1084.

(102) Croft P, Altman DG, Deeks JJ, Dunn KM, Hay AD, Hemingway H, et al. The science of clinical practice: disease diagnosis or patient prognosis? Evidence about "what is likely to happen" should shape clinical practice. *BMC Med* 2015 Jan 30;13:20-4.

(103) Evans R, Haas M, Schulz C, Leininger B, Hanson L, Bronfort G. Spinal manipulation and exercise for low back pain in adolescents: a randomized trial. *Pain* 2018 Jul;159(7):1297-1307.

(104) Vibe Fersum K, Smith A, Kvåle A, Skouen JS, O'Sullivan P. Cognitive functional therapy in patients with non-specific chronic low back pain-a randomized controlled trial 3-year follow-up. *Eur J Pain* 2019 Sep;23(8):1416-1424.

(105) Vibe Fersum K, O'Sullivan P, Skouen JS, Smith A, Kvåle A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: a randomized controlled trial. *Eur J Pain* 2013 Jul;17(6):916-928.

- (106) Lorig KR, Holman H. Self-management education: history, definition, outcomes, and mechanisms. *Ann Behav Med* 2003 -08;26(1):1-7.
- (107) Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health* 2012 Jan 25;12:80-80.
- (108) Maindal HT, Kayser L, Norgaard O, Bo A, Elsworth GR, Osborne RH. Cultural adaptation and validation of the Health Literacy Questionnaire (HLQ): robust nine-dimension Danish language confirmatory factor model. *Springerplus* 2016 Aug 2;5(1):1232-9. eCollection 2016.
- (109) Osborne RH, Batterham RW, Elsworth GR, Hawkins M, Buchbinder R. The grounded psychometric development and initial validation of the Health Literacy Questionnaire (HLQ). *BMC Public Health* 2013 Jul 16;13:658-658.
- (110) Kongsted A, Ris I, Kjaer P, Hartvigsen J. Self-management at the core of back pain care: 10 key points for clinicians. *Braz J Phys Ther* 2021;25(4):396-406.
- (111) Du S, Hu L, Dong J, Xu G, Chen X, Jin S, et al. Self-management program for chronic low back pain: A systematic review and meta-analysis. *Patient Educ Couns* 2017 Jan;100(1):37-49.
- (112) Belbasis L, Bellou V. Introduction to Epidemiological Studies. *Methods Mol Biol* 2018;1793:1-6.
- (113) Diccico-Bloom B, Crabtree BF. The qualitative research interview. *Med Educ* 2006 Apr;40(4):314-321.
- (114) Darlow B, Dean S, Perry M, Mathieson F, Baxter GD, Dowell A. Easy to Harm, Hard to Heal: Patient Views About the Back. *Spine (Phila Pa 1976)* 2015 Jun 1;40(11):842-850.
- (115) DeJonckheere M, Vaughn LM. Semistructured interviewing in primary care research: a balance of relationship and rigour. *Fam Med Community Health* 2019 Mar 8;7(2):e000057-000057. eCollection 2019.
- (116) Synnott A, O'Keeffe M, Bunzli S, Dankaerts W, O'Sullivan P, O'Sullivan K. Physiotherapists may stigmatise or feel unprepared to treat people with low back pain and psychosocial factors that influence recovery: a systematic review. *J Physiother* 2015 Apr;61(2):68-76.
- (117) Bevan M. A Method of Phenomenological Interviewing. *Qual Health Res* 2014;24:136-144.

- (118) Paterson M, Higgs J. Using Hermeneutics as a Qualitative Research Approach in Professional Practice. *The Qualitative Report* 2005;10.
- (119) Ramalho R, Adams P, Huggard P, Hoare K. Literature Review and Constructivist Grounded Theory Methodology. *FQS* 2015;16(3).
- (120) Braun V, Clarke V. Using thematic analysis in psychology. *null* 2006;3(2):77-101.
- (121) Braun V, Clarke V. Using thematic analysis in psychology. 2006; Available at: <https://www.tandfonline.com/doi/abs/10.1191/1478088706qp0630a>. Accessed Jan 12, 2024.
- (122) Punja S, Bukutu C, Shamseer L, Sampson M, Hartling L, Urichuk L, et al. N-of-1 trials are a tapestry of heterogeneity. *J Clin Epidemiol* 2016 Aug;76:47-56.
- (123) Hayes SC, Long DM, Levin ME, Follette WC. Treatment development: can we find a better way? *Clin Psychol Rev* 2013 Nov;33(7):870-882.
- (124) McCracken LM. Personalized pain management: Is it time for process-based therapy for particular people with chronic pain? *Eur J Pain* 2023 Oct;27(9):1044-1055.
- (125) Fisher AJ, Medaglia JD, Jeronimus BF. Lack of group-to-individual generalizability is a threat to human subjects research. *Proc Natl Acad Sci U S A* 2018 Jul 3;115(27):E6106-E6115.
- (126) Arain M, Campbell MJ, Cooper CL, Lancaster GA. What is a pilot or feasibility study? A review of current practice and editorial policy. *BMC Med Res Methodol* 2010 Jul 16;10:67-67.
- (127) Michiels B, Onghena P. Randomized single-case AB phase designs: Prospects and pitfalls. *Behav Res Methods* 2019 Dec;51(6):2454-2476.
- (128) Kamper SJ. Randomization: Linking Evidence to Practice. *J Orthop Sports Phys Ther* 2018 Sep;48(9):730-731.
- (129) Borckardt JJ, Nash MR, Murphy MD, Moore M, Shaw D, O'Neil P. Clinical practice as natural laboratory for psychotherapy research: A guide to case-based time-series analysis. *Am Psychol* 2008;63(2):77-95.
- (130) Tate RL, Perdices M, Rosenkoetter U, Shadish W, Vohra S, Barlow DH, et al. The Single-Case Reporting Guideline In BEhavioural Interventions (SCRIBE) 2016 Statement. *Phys Ther* 2016 Jul;96(7):e1-e10.

(131) Schulz KF, Altman DG, Moher D, the CG. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *BMC Medicine* 2010;8(1):18.

(132) Portney LG, Watkins MP. *Foundations of Clinical Research: Applications to Practice*. : Pearson; 2014.

(133) MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annu Rev Psychol* 2007;58:593-614.

(134) Swoboda CM, Kratochwill TR, Levin JR. Conservative dual-criterion method for single-case research: A guide for visual analysis of AB, ABAB, and multiple-baseline designs (WCER Working Paper No. 2010-13). 2010.

(135) Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M & Shadish, W. R. *Single-case designs technical documentation*. 2010.

(136) van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med* 1992 Aug;14(2):82-99.

(137) von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008 Apr;61(4):344-349.

(138) Dansk Selskab for Almen Medicin. Dansk Selskab for Almen Medicin. 2023; Available at: <https://www.dsam.dk/forskning/multipraksisudvalget/>.

(139) Hunsbår S. *Almen medicin*. 1st ed.: Munksgaard Danmark; 2014.

(140) Rathleff MS, Holden S, Straszek CL, Olesen JL, Jensen MB, Roos EM. Five-year prognosis and impact of adolescent knee pain: a prospective population-based cohort study of 504 adolescents in Denmark. *BMJ Open* 2019 May 28;9(5):e024113-024113.

(141) Broadbent E, Petrie KJ, Main J, Weinman J. The brief illness perception questionnaire. *J Psychosom Res* 2006 Jun;60(6):631-637.

(142) Herdman M, Gudex C, Lloyd A, Janssen M, Kind P, Parkin D, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res* 2011 Dec;20(10):1727-1736.

(143) Ravens-Sieberer U, Gosch A, Rajmil L, Erhart M, Bruil J, Duer W, et al. KIDSCREEN-52 quality-of-life measure for children and adolescents. *Expert Rev Pharmacoecon Outcomes Res* 2005 Jun;5(3):353-364.

(144) Skou ST, Bricca A, Roos EM. The impact of physical activity level on the short- and long-term pain relief from supervised exercise therapy and education: a study of 12,796 Danish patients with knee osteoarthritis. *Osteoarthritis Cartilage* 2018 Nov;26(11):1474-1478.

(145) Kongsted A, Hestbæk L, Kent P. How can latent trajectories of back pain be translated into defined subgroups? *BMC Musculoskelet Disord* 2017 Jul 3;18(1):285-8.

(146) Kongsted A, Kent P, Axen I, Downie AS, Dunn KM. What have we learned from ten years of trajectory research in low back pain? *BMC Musculoskelet Disord* 2016 May 21;17:220-2.

(147) Hansen JP, van Sas TQB, Fløjstrup M, Brabrand M, Hvolby A. The effect of the March 2020 COVID-19 lockdown on national psychiatric contacts in Denmark: An interrupted time series analysis. *Brain Behav* 2021 Aug;11(8):e2264.

(148) Huibers L, Bech BH, Kirk UB, Kallestrup P, Vestergaard CH, Christensen MB. Contacts in general practice during the COVID-19 pandemic: a register-based study. *Br J Gen Pract* 2022 Oct 27;72(724):e799-e808.

(149) Pourbordbari N, Riis A, Jensen MB, Olesen JL, Rathleff MS. Poor prognosis of child and adolescent musculoskeletal pain: a systematic literature review. *BMJ Open* 2019 -07-18;9(7):e024921.

(150) Robyn Homeniuk, Claire Collins. How COVID-19 has affected general practice consultations and income: general practitioner cross-sectional population survey evidence from Ireland. *BMJ Open* 2021;11(4):e044685.

(151) Kamper SJ. Sampling: Linking Evidence to Practice. *J Orthop Sports Phys Ther* 2020 Dec;50(12):725-726.

(152) Schiøttz-Christensen B, Nielsen GL, Hansen VK, Schødt T, Sørensen HT, Olesen F. Long-term prognosis of acute low back pain in patients seen in general practice: a 1-year prospective follow-up study. *Fam Pract* 1999 Jun;16(3):223-232.

(153) Lu H, Cole SR, Howe CJ, Westreich D. Toward a Clearer Definition of Selection Bias When Estimating Causal Effects. *Epidemiology* 2022 Sep 1;33(5):699-706.

(154) Tripepi G, Jager KJ, Dekker FW, Zoccali C. Selection bias and information bias in clinical research. *Nephron Clin Pract* 2010;115(2):94.

- (155) Poolman RW, Swiontkowski MF, Fairbank JCT, Schemitsch EH, Sprague S, de Vet HCW. Outcome instruments: rationale for their use. *J Bone Joint Surg Am* 2009 May;91 Suppl 3(Suppl 3):41-49.
- (156) Lunde L, Koch M, Hanvold TN, Wærsted M, Veiersted KB. Low back pain and physical activity--A 6.5 year follow-up among young adults in their transition from school to working life. *BMC Public Health* 2015 Nov 12;15:1115-2.
- (157) Aartun E, Hartvigsen J, Wedderkopp N, Hestbaek L. Spinal pain in adolescents: prevalence, incidence, and course: a school-based two-year prospective cohort study in 1,300 Danes aged 11-13. *BMC Musculoskelet Disord* 2014 May 29;15:187.
- (158) Junge T, Wedderkopp N, Boyle E, Kjaer P. The natural course of low back pain from childhood to young adulthood - a systematic review. *Chiropr Man Therap* 2019 Mar 20;27:10-x. eCollection 2019.
- (159) Tiira AH, Paananen MV, Taimela SP, Zitting PJ, Järvelin MR, Karppinen JI. Determinants of adolescent health care use for low back pain. *Eur J Pain* 2012 Nov;16(10):1467-1476.
- (160) Kooistra B, Dijkman B, Einhorn TA, Bhandari M. How to design a good case series. *J Bone Joint Surg Am* 2009 May;91 Suppl 3:21-26.
- (161) O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for Reporting Qualitative Research: A Synthesis of Recommendations. *Academic Medicine* 2014;89(9).
- (162) Straszek CL, Skrubbeltrang LS, O'Sullivan K, Thomsen JL, Rathleff MS. Competences to self-manage low back pain among care-seeking adolescents from general practice - a qualitative study. *BMC Primary Care* 2023;24(1):252.
- (163) World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 2013 Nov 27;310(20):2191-2194.
- (164) Straszek CL, Rathleff MS, Graven-Nielsen T, Petersen KK, Roos EM, Holden S. Exercise-induced hypoalgesia in young adult females with long-standing patellofemoral pain - A randomized crossover study. *Eur J Pain* 2019 Nov;23(10):1780-1789.
- (165) Hansen FS, Lyngs M, Lauridsen MDH, Straszek CL. IS ESPORTS ASSOCIATED WITH INCREASED HEALTH RISKS? A CROSS-SECTIONAL COMPARISON OF MUSCULOSKELETAL PAIN PREVALENCE AMONG YOUNG DANISH ESPORTS PLAYERS AND HANDBALL PLAYERS. *medRxiv* 2022:2022.09.19.22279922.

(166) Braun V, Clarke V. Reflecting on reflexive thematic analysis. *null* 2019;11(4):589-597.

(167) Peck B, Mummery J. Hermeneutic Constructivism: An Ontology for Qualitative Research. *Qual Health Res* 2018 Feb;28(3):389-407.

(168) Hauber SD, Robinson K, Kirby E, Kamper S, Lennox NN, O'Sullivan K. Describing the nonsurgical, nonpharmacological interventions offered to adolescents with persistent back pain in randomized trials: A scoping review. *Eur J Pain* 2022 Dec 31.

(169) O'Sullivan K, O'Keefe M, Forster BB, Qamar SR, van der Westhuizen A, O'Sullivan PB. Managing low back pain in active adolescents. *Best Pract Res Clin Rheumatol* 2019 Feb;33(1):102-121.

(170) Engel GL. The need for a new medical model: a challenge for biomedicine. *Science* 1977 Apr 8;196(4286):129-136.

(171) Dahl TH. International classification of functioning, disability and health: an introduction and discussion of its potential impact on rehabilitation services and research. *J Rehabil Med* 2002 Sep;34(5):201-204.

(172) Sullivan MJ, Thorn B, Haythornthwaite JA, Keefe F, Martin M, Bradley LA, et al. Theoretical perspectives on the relation between catastrophizing and pain. *Clin J Pain* 2001 Mar;17(1):52-64.

(173) Masiero S, Carraro E, Sarto D, Bonaldo L, Ferraro C. Healthcare service use in adolescents with non-specific musculoskeletal pain. *Acta Paediatr* 2010 Aug;99(8):1224-1228.

(174) Al-Janabi N, Olesen AE, Straszek CL, Guldhammer C, Rathleff MS, Andreucci A. Pain medication use for musculoskeletal pain among children and adolescents: a systematic review. *Scand J Pain* 2021 -10-26;21(4):653-670.

(175) White B, Viner RM. Improving communication with adolescents. *Arch Dis Child Educ Pract Ed* 2012 -06;97(3):93-97.

(176) Pate JW, Joslin R, Hurtubise K, Anderson DB. Assessing a child or adolescent with low back pain is different to assessing an adult with low back pain. *J Paediatr Child Health* 2022 -04;58(4):566-571.

(177) Caneiro JP, Smith A, Linton SJ, Moseley GL, O'Sullivan P. How does change unfold? an evaluation of the process of change in four people with chronic low back pain and high pain-related fear managed with Cognitive Functional Therapy: A replicated single-case experimental design study. *Behav Res Ther* 2019 Jun;117:28-39.

(178) Edwin de Raaij EJ, Harriet Wittink H, Francois Maissan JF, Jos Twisk J, Raymond Ostelo RWJG. Illness perceptions; exploring mediators and/or moderators in disabling persistent low back pain. Multiple baseline single-case experimental design. *BMC Musculoskeletal Disorders* 2022;23(1):140.

(179) Stratford P, Gill C, Westaway M, Binkley J. Assessing Disability and Change on Individual Patients: A Report of a Patient Specific Measure. *Physiotherapy Canada* 1995;47(4):258-263.

(180) Nicholas MK, McGuire BE, Asghari A. A 2-item short form of the Pain Self-efficacy Questionnaire: development and psychometric evaluation of PSEQ-2. *J Pain* 2015 Feb;16(2):153-163.

(181) Kamper SJ, Maher CG, Mackay G. Global rating of change scales: a review of strengths and weaknesses and considerations for design. *J Man Manip Ther* 2009;17(3):163-170.

(182) Riel H, Jensen MB, Olesen JL, Vicenzino B, Rathleff MS. Self-dosed and pre-determined progressive heavy-slow resistance training have similar effects in people with plantar fasciopathy: a randomised trial. *J Physiother* 2019 Jul;65(3):144-151.

(183) Riel H, Vicenzino B, Olesen JL, Jensen MB, Ehlers LH, Rathleff MS. Corticosteroid injection plus exercise versus exercise, beyond advice and a heel cup for patients with plantar fasciopathy: protocol for a randomised clinical superiority trial (the FIX-Heel trial). *Trials* 2020 Jan 2;21(1):5-0.

(184) Lee H, Mansell G, McAuley JH, Kamper SJ, Hübscher M, Moseley GL, et al. Causal mechanisms in the clinical course and treatment of back pain. *Best Pract Res Clin Rheumatol* 2016 Dec;30(6):1074-1083.

(185) Costa N, Butler P, Dillon M, Mescouto K, Olson R, Forbes R, et al. "I felt uncertain about my whole future"-a qualitative investigation of people's experiences of navigating uncertainty when seeking care for their low back pain. *Pain* 2023 Jul 20.

(186) Porcino AJ, Shamseer L, Chan A, Kravitz RL, Orkin A, Punja S, et al. SPIRIT extension and elaboration for n-of-1 trials: SPENT 2019 checklist. *BMJ* 2020 Feb 27;368:m122.

(187) Pathak A, Sharma S. Clinimetrics: The Patient-Specific Functional Scale. *Journal of Physiotherapy* 2023;69(2):126.

(188) Pedersen JR, Hartvigsen J, Hoegh M, Thorlund JB. Self-reported characteristics of people seeking primary care physiotherapy in Denmark: A cross-sectional study. *Physiother Res Int* 2024 Jan;29(1):e2068.

(189) Ozgen S, Konya D, Toktas OZ, Dagecinar A, Ozek MM. Lumbar disc herniation in adolescence. *Pediatr Neurosurg* 2007;43(2):77-81.

(190) Malterud K, Siersma VD, Guassora AD. Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qual Health Res* 2016 Nov;26(13):1753-1760.

APPENDICE

Appendix A. STROBE checklist for Study 1.	125
Appendix B. Card for inclusion of patients in study 1.	127
Appendix C. Interview guide for Study 2 [English].	128
Appendix D. Interview guide for Study 2 [Danish].	134
Appendix E. Semantic analysis for Study 2.	147
Appendix F. List of collected data and time points for Study 3.	155
Appendix G. Data collection points for study 3.	158
Appendix H. Manuscript for Study 1.	165
Appendix I. Manuscript for Study 3.	183
Appendix J. Published paper of Study 2.	221