

Interdisciplinary pain rehabilitation in primary care. A health economic perspective.

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To Nils, Elis, Ingrid & Ivar

“Let no one persuade you to cure the headache until he has first given you his soul to be cured. For this is the great error of our day in the treatment of the human body, that physicians separate the soul from the body. “

Hippocrates, 202 B.C

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Abstract

Background Chronic pain affects multiple aspects of life, including employment, functioning, interpersonal relationships, and overall quality of life. Approximately one-fifth of the European population experiences chronic pain. Yet, research and public policy have devoted limited attention to this condition, despite its substantial societal costs, including reduced productivity and high healthcare utilisation. The Interdisciplinary Pain Rehabilitation Programme (IPRP) is an evidence-based treatment provided in specialist care. However, it remains largely underutilised in primary care, where the majority of chronic pain patients are managed. Implementing the IPRP requires coordinated professional efforts and substantial initial resources, which can hinder its adoption. Current health-economic evaluations are limited, short-term, and inconclusive, casting doubt on the programme's long-term effectiveness.

Aims The overall aim of this thesis was to study the health economic implications of IPRPs in primary care from both a societal and healthcare provider perspective. Study I aimed to evaluate patient-reported outcomes and healthcare utilisation one year before and after a case manager-led IPRP. Study II aimed to analyse the cost-effectiveness of IPRP compared with care as usual. Study III aimed to analyse healthcare utilisation and costs one year before and after IPRP. Study IV aimed to examine whether participating in IPRP in primary or specialist care is associated with background variables, pain characteristics, quality of life, anxiety, and depression.

Methods Study I compared patient-reported outcomes and healthcare utilisation one year before and after assessment using non-parametric analyses, the Wilcoxon Signed Rank and Mann-Whitney U tests. Study II applied a cost-utility analysis to evaluate the cost-effectiveness of IPRPs compared with usual care in primary care. In Study III, healthcare utilisation and costs during the 1 year before and after IPRP were analysed by linking regional registry data to participants. Paired t-tests were used for comparative parametric analyses (Study III). The distribution of resources was compared one year before and one year after IPRP (Studies I and III). Study IV used logistic regression to identify factors associated with participation in IPRP in primary or specialist care.

Results In Study I, reduced healthcare utilisation after IPRP was associated with increased activity levels, improved health-related quality of life, and fewer general practitioner visits. Increased healthcare utilisation was associated with higher pain intensity and a lack of psychological support at baseline and greater use of specialist services. The cost-utility analysis carried out in Study II indicated that IPRP in primary care is cost-effective, particularly in the long term. In Study III, healthcare utilisation decreased by 16% and costs by 12% the year after IPRP. This was mainly due to fewer consultations with general practitioners and physiotherapists. Study VI showed that women, individuals with university education, and those with frequent general practitioner visits were more likely to participate IPRP in specialist care. Persistent pain and multiple pain sites also increased the likelihood of specialist referral. In contrast, obesity, high pain intensity, higher pain catastrophising, and better general health were associated with participation IPRP in primary care.

Conclusion IPRP enhances health-related quality of life and reduces sickness absence to an extent that supports its cost-effectiveness compared with usual care, especially in the long run. Reduced healthcare utilisation, especially visits to general practitioners and physiotherapists, generated cost savings and freed resources in the primary care centre. Early biopsychosocial intervention, including psychological support, may improve well-being and limit unnecessary healthcare use. Reorganising primary care resources could strengthen chronic pain management and support the broader implementation of IPRP. Socioeconomic factors appear to influence referral pathways, resulting in unequal access to healthcare and inefficient use of healthcare resources. Straightforward guidelines are needed to ensure that patients with lower rehabilitation needs receive treatment in primary care, while those with greater needs access specialist rehabilitation.

Sammanfattning på svenska

Långvarig smärta påverkar funktion, arbetsförmåga, relationer och välbefinnande för en femtedel av befolkningen. Den leder också till betydande samhällskostnader genom sjukskrivningar och hög vårdkonsumtion. Många patienter med långvarig smärta rapporterar missnöje med behandling och bemötande i vården. Interdisciplinära smärtrehabiliteringsprogram (IPRP) är en evidensbaserad behandling för långvarig smärta som är etablerad inom specialistvården och är ämnad för de mest komplexa patienterna. Trots att de flesta smärtpatienter behandlas i primärvården är tillgången till IPRP begränsad. En orsak kan vara att den baserar sig på ett mångprofessionellt omhändertagande, vilket är resurskrävande.

De hälsoekonomiska effekterna av IPRP i primärvården är outforskade. Vi vet inte heller om de rätta patienterna verkligen får komma till specialistvården. Det övergripande syftet med denna avhandling var att fördjupa förståelsen av de hälsoekonomiska konsekvenserna av interdisciplinära smärtrehabiliteringsprogram i primärvård ur både ett samhällsperspektiv och ett vårdgivarperspektiv. Studie I syftade till att utvärdera patientrapporterade variabler relaterade till smärta, psyko-emotionell funktion, coping, hälsorelaterad livskvalitet och arbetslivsfaktorer samt sjukvårdskonsumtion ett år efter IPRP. Studie II:s syfte var att analysera IPRPs kostnadseffektivitet jämfört med sedvanlig vård. Studie III syftade till att analysera sjukvårdskonsumtion och kostnader ett år före och ett år efter IPRP. Syftet i Studie IV var att med hjälp av regressionsanalys undersöka om deltagande i interdisciplinärt smärtrehabiliteringsprogram i primärvård eller specialistvård är associerat med bakgrundsvariabler, smärtkaraktistika, livskvalitet, ångest och depression.

Resultaten i Studie I visade att förändringar i vårdkonsumtion efter IPRP var associerade med patienternas coping-strategier vid ingången i programmet. Kostnads-nyttoanalysen i Studie II visade att IPRP i primärvården är kostnadseffektivt, framför allt på lång sikt. Studie III visade att IPRP leder till minskad vårdkonsumtion och kostnadsbesparingar, men det förutsätter en omfördelning av resurser. Slutligen visade Studie IV endast mindre skillnader i patientrapporterade utfallsmått vid baslinjen mellan patienter som deltog i IPRP i primärvård respektive specialistvård. Detta i sin tur tyder på att även

andra faktorer än klinisk komplexitet kan påverka fördelningen av patienter med långvarig smärta, trots nuvarande riktlinjer.

Sammanfattningsvis visar resultaten i denna avhandling att interdisciplinär smärtrehabilitering i primärvården kan vara kostnadseffektiv på längre sikt genom minskad sjukfrånvaro, förbättrad livskvalitet och lägre vårdkonsumtion. En tidig biopsykosocial ansats och tidigt psykologiskt stöd kan minska onödig vårdanvändning. Fördelningen mellan primär- och specialistvård verkar delvis styras av socioekonomiska faktorer vilket skapar risk för ojämlik vård. Tydligare riktlinjer och strukturerade bedömningar behövs för att säkerställa att patienter med lägre rehabiliteringsbehov behandlas i primärvården medan patienter med mer komplexa behov ska erbjudas vård i specialistvården.

List of studies

The thesis is based on the following studies, which will be referred to in the text by Roman numerals:

- I Eklund, K., Stålnacke, B.-M., Sundberg, A., Eklund, F. & Eklund, M. (2023). Introduction of a multimodal pain rehabilitation intervention in primary care: a pilot study. *Journal of Rehabilitation Medicine - Clinical Communications*, 6, <https://doi.org/10.2340/jrmcc.v6.3712>.
- II Eklund, K., Stålnacke, B.-M., Stenberg, G., Enthoven, P., Gerdle, B. & Sahlén, K.-G. (2021). A cost-utility analysis of multimodal pain rehabilitation in primary healthcare. *Scandinavian Journal of Pain*, 1, 48-58, <https://doi.org/10.1515/sjpain-2020-0050>.
- III Eklund, K., Stålnacke, B.-M., Enthoven, P., Zingmark, M. & Stenberg, G. (2025). Healthcare utilisation and resource distribution before and after interdisciplinary pain rehabilitation in primary care. *Scandinavian Journal of Pain*, 25(1), <https://doi.org/10.1515/sjpain-2025-0024>.
- IV Manuscript: Spinord, L., Eklund, K., Enthoven, P., Zingmark, M., Grimby Ekman, A., Stålnacke, B.-M., Stenberg, G. Associations between patient characteristics and participating in IPRP in specialist or primary care.

Abbreviations

MMRP	Multimodal pain rehabilitation programme, also referred to as IPRP
IPRP	Interdisciplinary pain rehabilitation programme, also referred to as MMRP
PROMs	Patient-reported outcome measures
ÖMPSQ	Örebro musculoskeletal pain screening questionnaire
EQ-5D	EuroQol five dimensions
EQ VAS	EuroQol Visual Analogue Scale
QALY	Quality adjusted life years
HRQoL	Health-related quality of life
ICER	Incremental cost-effectiveness ratio, equivalent to cost per gained QALY
SQRP	Swedish quality registry for pain rehabilitation
SQRP-PC	Swedish quality registry for pain rehabilitation for primary care
BMI	Body mass index
GDP	Gross domestic product

Thesis essentials

	STUDY I	STUDY II	STUDY III	STUDY IV
Study Design	Pilot study	Longitudinal prospective cohort study	Longitudinal prospective cohort study	Cross-sectional register study
Time Interval	2015 - 2018	2012 - 2015	2012 - 2015	2016 - 2020
Health Economic Evaluation	Cost description	Cost-effectiveness analysis	Cost description	Economic consideration
Health Economic Perspective	Healthcare provider perspective	Limited societal perspective	Healthcare provider perspective	NA
Study Population	36 participants Jakobstad, Finland	234 participants Region of Västerbotten and Östergötland, Sweden	146 participants Region of Västerbotten and Östergötland, Sweden	19,120 participants, 3985 from primary care and 15135 from specialist care. Country-wide, Sweden
Data Collection	Questionnaires, PROMS data Healthcare utilisation data and cost data from the regional registry	Questionnaires, PROMS data Cost data Sweden Statistics	Questionnaires, PROMS data Cost data SALAR Healthcare utilisation data from regional administrative registries	Questionnaires SQRP pain register data, PROMS data
Data Analysis	Descriptive and comparative statistics Pivot analysis Multiple regression analysis	Descriptive and comparative statistics	Descriptive and comparative statistics	Descriptive statistics Univariate and multivariable logistic regression analysis
My Contributions	Idea, design, data collection, analysis, and manuscript preparation	Idea, design, data collection, analysis, manuscript preparation	Idea, design, data collection, analysis, and manuscript preparation	Data collection, analysis, and manuscript preparation

Background

Chronic pain

Aetiology

The International Association of the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage” (1). The definition implies that pain is not merely a sensory perception but a subjective, complex experience unique to each of us (2).

Pain, in its acute form, has an intrinsic survival value, as it warns us of potential tissue damage and may prevent further injury. Acute pain is a symptom of tissue damage or an inflammatory process that typically resolves within days to weeks (3). Acute pain arises as a neuronal response involving specialist sensory receptors (nociceptors) in the tissue, which send signals through peripheral nerves to the spinal cord and up to the brain, where they are interpreted (4).

In 90 per cent of acute pain cases, the pain resolves within 3 months (5). Subsequently, the likelihood of spontaneous recovery declines markedly (6, 7). When pain persists for more than three months or beyond the expected healing time, it is referred to as chronic pain. Unlike acute pain, chronic pain confers no evolutionary advantage yet persists as a maladaptive signal, continuously imposing physiological stress on the body and mind (8).

Chronic pain occurs when the mechanisms that modulate nociceptive input, also known as pain modulation, no longer balance with the body’s regulatory capacity. This imbalance leads to decreased inhibition or increased facilitation of pain, resulting in heightened pain perception. Multiple factors influence the development of chronic pain, and each individual has a unique profile. A complex interplay of biomedical influences, psychosocial factors such as beliefs, attitudes, and personality traits, and behavioural factors, including contextual cues and responses from significant others, occurs within the brain to create each person’s distinct pain experience (2, 3). Historically, clinicians viewed chronic pain as a symptom of an underlying condition. However, with

the broader acceptance of the biopsychosocial model, researchers now view chronic pain as a distinct disease characterised by pathological changes in both the central and peripheral nervous systems (10, 11). This shift is fundamental because how we understand chronic pain influences its assessment and the factors clinicians consider when making a diagnosis (12).

Chronic pain arises when the mechanisms that modulate nociceptive input, also referred to as pain modulation, no longer maintain equilibrium with the body's regulatory capacity. The imbalance leads to reduced inhibition or increased facilitation of pain, resulting in amplified pain perception. Multiple factors shape the development of chronic pain, and each exhibits a distinct profile. A mosaic of biomedical influences, psychosocial factors such as beliefs, attitudes, personality traits, and behavioural elements, including contextual cues, and responses by significant others, interact within the brain to form each person's unique pain experience (2, 3). Clinicians have previously viewed chronic pain as a symptom of an underlying condition. As the biopsychosocial model has gained broader recognition, researchers have begun to regard chronic pain as a distinct disease marked by pathological alterations in both the central and peripheral nervous systems (10, 11, 13). This shift is of foremost importance, as the conceptualisation of chronic pain shapes its evaluation and guides the factors clinicians consider when establishing a diagnosis (12).

Chronic pain can arise in any body system, such as the nervous, musculoskeletal, or gastrointestinal systems. It may affect any body region, including the face, lower back, neck, upper limbs, thorax, abdomen, pelvis, or urogenital area. It can also involve multiple regions simultaneously, as seen in widespread pain (14). A limited number of studies have focused on the health economic aspects of chronic pain.

The impact on the individual

Approximately 20 per cent of individuals in Sweden experience moderate to severe chronic pain (15). Comparable prevalence has been reported internationally (8). American estimates report that chronic pain affects more people than the combined prevalence of diabetes, heart disease, and cancer (16).

The impact of chronic pain varies across individuals (8). Women generally exhibit a higher prevalence than men (2, 17). Socioeconomic factors further influence both the development and persistence of chronic pain (8). Prevalence also increases with age (2).

Chronic pain exerts a substantial adverse effect on multiple aspects of an individual's life and functioning. Chronic pain restricts the ability to perform activities, participate in daily life, and maintain employment due to impairments in body functions (18). Limitations in daily activities additionally affect personal relationships, financial stability, and psychosocial well-being (19). Consequently, individuals with chronic pain face an elevated risk of developing anxiety, depression and sleep disturbance (20). Chronic pain is one of the main contributors to years lived with disability, which is reflected in the markedly reduced health-related quality of life observed in this population compared with the general population (21-23).

The biopsychosocial model

The biopsychosocial concept was coined in 1977 by the psychiatrist George L. Engel (24). He argued that understanding and effectively treating a medical condition requires consideration not only of biological factors but also of the patient and the context in which they live and function. At this time, the reductionist biomedical philosophy dominated, asserting that disease could be explained solely in terms of measurable biological variables. In contrast, the biopsychosocial model emphasises that a comprehensive assessment must account for biological, psychological, and social factors to understand the determinants of a condition and identify appropriate interventions (25). This model provides a valuable framework for examining the dynamic interactions among these factors in the onset and persistence of chronic pain. Further, the pain experience is perceived to be influenced not only by individual factors within the biological domain, the psychological domain and the social domain but also by the interactions among these domains (2) (Figure 1). The biopsychosocial model offers clinicians and patients a comprehensive framework for understanding and effectively treating chronic pain (2, 20).

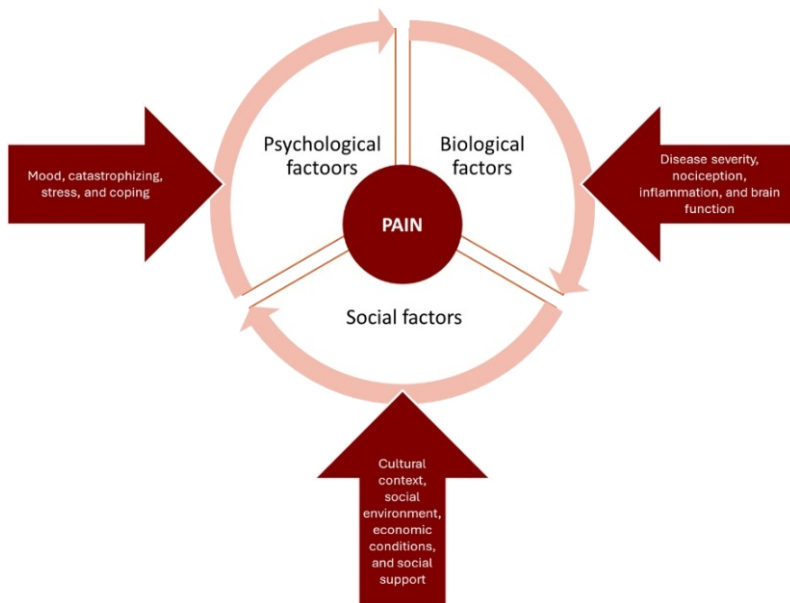


Figure 1. The biopsychosocial model with a pain perspective, derived from Fillingim's (2017) Biopsychosocial model of pain.

Chronic pain management

As the understanding of chronic pain has expanded beyond the biomedical perspective to include psychological and sociocultural dimensions, the management of chronic pain has evolved considerably. It is now generally recognised that the individual experience shaped by biological, psychological, and social factors, as suggested by the biopsychosocial model, should guide assessment and management of chronic pain (2).

Pain assessment

The first step in effective pain management is a comprehensive pain assessment grounded in the biopsychosocial model. Such an assessment is essential for understanding the factors that influence pain and its impact on the patient (26). As pain is a subjective experience and tissue damage or inflammation is not always detectable, clinicians must rely on the patient's report of pain in the absence of evidence to the contrary (13, 27). The

assessment should combine a detailed medical evaluation and patient history with a clinical interview, complemented by standardised self-report instruments to measure pain intensity, functional abilities, beliefs and expectations, and emotional distress (12). This process enables classification of the underlying pain mechanism and the assignment of a diagnosis, providing a foundation for targeted treatment and rehabilitation (25). The International Classification of Functioning, Disability and Health (ICF), a classification tool used in healthcare, supports a biopsychosocial assessment by evaluating function, activity, and participation, while accounting for personal and environmental factors (28, 29).

Interdisciplinary pain rehabilitation

Interdisciplinary pain rehabilitation is an evidence-based treatment regarded as the gold standard in the management of chronic pain (30). Evidence-based medicine applies the most appropriate evidence, combining scientific research and clinical expertise to guide decisions (31). The primary goal of interdisciplinary pain rehabilitation is to enhance daily functioning, emotional well-being, and quality of life, and to support return to work, rather than focusing solely on pain reduction (32). In Sweden, the concepts multimodal and interdisciplinary pain rehabilitation have been used interchangeably, reflecting the field's evolving terminology.

When the healthcare system offers an interdisciplinary pain rehabilitation programme (IPRP), the patient has tried various unimodal treatments with no improvement in their condition (33). According to Swedish guidelines (34), healthcare should offer IPRPs to patients with intermittent or continuous pain lasting more than three months that significantly interferes with daily activities. Patients with less complex pain conditions can be appropriately managed in primary care, whereas more complicated cases are referred to specialist care. The severity of negative psychological factors determines the complexity of chronic pain, the presence of comorbidities such as inflammatory, metabolic, or cardiovascular conditions, and the intensity of pain (35). For instance, a patient with minimal harmful psychological components, no comorbidities, and moderate pain intensity is, according to guidelines, suitable for IPRP in primary care.

IPRP combines cognitive-behavioural therapy-based interventions, physical exercise, and patient education, focusing on coping and pain management

(35). An interdisciplinary team delivers IPRP through group sessions or a combination of group and individual activities over a limited time period. IPRP teams include a range of healthcare professionals, including general practitioners, physiotherapists, occupational therapists, social workers, and psychologists. The patient is part of the team, and their goals and participation are essential for achieving the specified goals (36).

Systematic reviews and meta-analyses show that interdisciplinary pain rehabilitation programmes lead to sustained improvements in physical, emotional, and social functioning among patients with chronic pain. Nevertheless, studies included are primarily delivered in specialist care, while only a small proportion take place in primary care settings (4.6%) (37, 38). IPRP is more effective than care as usual or no treatment in reducing pain, disability, and sickness absence (39, 40). In specialist care, IPRP has demonstrated cost-effectiveness (41, 42), while health economic evaluations of IPRP in primary care are more limited. Nonetheless, existing evidence suggests that IPRP outperforms usual care in improving disability and pain outcomes, while also generating cost savings and demonstrating cost-effectiveness (43-45). Furthermore, improvements achieved through IPRP have been reported to persist at long-term follow-up (37).

The Swedish Quality Registry of Pain

Considerable variability exists in the selection, content, and dosage of IPRP, which complicates the evaluation of its outcomes and effectiveness (36, 46). Nevertheless, because IPRP is a resource-intensive intervention in terms of both professional input and time, systematic follow-up is essential. In Sweden, the national Swedish Quality Registry of Pain (SQRP) has monitored IPRPs since 1998. A primary care version of the registry (SQRP-PC), containing fewer variables, was introduced in 2015 (47). The registries aim to monitor, develop, and improve the quality of pain care, and they provide a foundation for comprehensive research.

The registries collect data from comprehensive patient questionnaires, including patient-reported outcome measures (PROMs) completed at baseline, upon completion of rehabilitation, and at 1-year follow-up. These PROMs use standardised and validated instruments (described in more detail in the Methods section) to capture demographic, educational, psychological, and pain-related characteristics, as well as physical disability and satisfaction with

life and work. Participation in the SQRP is optional and is undertaken by specialist care units and primary care centres themselves.

Other treatment options

Recent systematic reviews and guidelines identify other effective treatments for chronic pain. Non-pharmacological interventions, particularly exercise therapy and psychosocial interventions such as cognitive behavioural therapy, have demonstrated efficacy in improving pain and function. Pharmacological treatments, including non-opioid medications such as nonsteroidal anti-inflammatory drugs, certain antidepressants, and anticonvulsants, are recommended for specific conditions (48, 49). Opioids, however, should be reserved for select cases and administered under strict monitoring due to safety risks (48).

Chronic pain management in the Swedish healthcare system

Sweden is a welfare state characterised by high life expectancy and low rates of preventable mortality. All residents have access to universal healthcare at a largely subsidised cost. Nevertheless, the Swedish healthcare system faces several challenges, including an ageing population, rapidly rising costs, and a workforce shortage (31, 50). The system is primarily tax-funded (86%) and accounts for approximately 11.2 per cent of Swedish gross domestic product (GDP), exceeding the European average (51).

National guidelines for chronic pain treatment were first introduced in 1994 by an expert group appointed by the Swedish National Board of Health and Welfare (52). The report emphasised organisational structures, evidence-based interventions, and appropriate resource allocation. To promote and permanently implement evidence-based IPRP with particular emphasis on primary care, the Swedish government launched the Rehabilitation warranty in 2009 (53).

Following the dismantling of the Rehabilitation Guarantee, a renewed assessment of chronic pain management in Sweden was undertaken. A national report (54) described chronic pain services as fragmented and poorly coordinated across primary and specialist care. The report, which

incorporated input from clinicians, regional authorities and patients, identified a need for clear objectives, a shared knowledge base, adequate professional competence, collaboration across care levels and continuous training in chronic pain management. Patients and patient organisations also emphasised substantial national inequalities in the delivery of chronic pain care, identifying this as a significant concern (54, 55).

To address the shortcomings and recommendations outlined in the 2016 national report (54), a National Action Group was tasked with developing a generic chronic pain treatment structure spanning primary and specialist care, known as the P3C pathway. The pathway promotes a consistent person-centred approach that strengthens patient empowerment and supports equitable care. It highlights early and timely interventions, coordinated collaboration across patients, practitioners, and care levels, self-management, and the use of evidence-based and experience-based knowledge (56).

The role of primary and specialist care

The Swedish healthcare system is decentralised, with primary and specialist care financed, organised, and provided by the regions (50). By law, primary care must offer non-hospital-based outpatient services without restrictions on disease, age, or patient group (57, 58). Its primary responsibilities include health promotion, disease prevention, and rehabilitation within general medicine (50).

Primary care serves as the main access point for patients with chronic pain, while only 0.5–2% receive treatment in specialist care (15). It plays a critical role in early identification and assessment of newly developed chronic pain, which requires providers to understand the condition's complexity (59). Ideally, primary care can prevent chronic pain by providing early intervention and continuous patient contact (60). However, many general practitioners and other providers report difficulties and discomfort in managing chronic pain (61-63). Limited pain training and insufficient understanding of its complexity often hinder recognition of the need for a biopsychosocial approach (13, 64, 65). Most patients remain in primary care, and referrals to specialist care are low, reflecting barriers and inequalities in access (66, 67). Swedish reports further highlight restricted and unequal access to specialist pain interventions and long waiting times (68).

Specialist care provides advanced somatic and psychiatric services in both outpatient and inpatient settings. In Sweden, chronic pain management at this level is typically delivered in interdisciplinary clinics affiliated with regional or university hospitals. Specialist care addresses the most complex and resource-intensive cases, usually following referrals from primary care. Teams typically include professionals from several disciplines, including physicians, nurses, physiotherapists, psychologists, social workers, and occupational therapists. When needed, anaesthesiologists, clinical pharmacologists, neurologists, neurosurgeons, orthopaedists, and psychiatrists are available (60). A key distinction from primary care is that specialist care generally involves professionals with formal training in pain management, whereas such expertise is uncommon in primary care.

Chronic pain management in the Finnish healthcare system

Learning from healthcare delivery in other countries can strengthen national systems. Although each country has its own structures, the Nordic region shares principles of universalism, equitable access and strong public trust, which enable meaningful comparisons and knowledge exchange (69). Sweden is recognised for its interdisciplinary rehabilitation for chronic pain, supported by a long clinical tradition and the advanced Swedish Quality Registry for Pain Rehabilitation (38). Experiences from the Rehabilitation Guarantee in Swedish primary care have also informed the development of interdisciplinary pain rehabilitation in Finland.

The Finnish system is largely publicly funded and covers all residents, but unlike Sweden, privately provided and funded healthcare plays a larger role (70). Private services include primary care, dental care, speciality care, child welfare, and occupational healthcare. Employers are legally required to provide preventive occupational healthcare, which may also include general practitioner services. Consequently, employed individuals often enjoy better access to ambulatory care—free of charge and with shorter waiting times—since these services are typically purchased from the private sector (70). Healthcare expenditure is similar to Sweden's, at 10.5% of GDP (71)

Since the 2023 administrative reform, the Finnish healthcare system has been organised into 21 self-governing well-being service counties, funded by the

government and responsible for both primary and specialist care (70). Before the reform, the system was more decentralised and resembled the Swedish model.

Chronic pain affects approximately 19% of the Finnish population. (72, 73). Around 40% of primary care visits involve pain, and half of these cases concern musculoskeletal conditions (74). Chronic pain management in Finnish primary care has traditionally relied on unimodal rehabilitation, primarily involving the general practitioner and physiotherapist, with less frequent participation from occupational therapists and psychologists. Several project-based initiatives have introduced interdisciplinary outpatient pain rehabilitation programmes in both primary and specialist care. Additional efforts have aimed to strengthen chronic disease management in primary care through the Chronic Care Model (75, 76).

Health economic evaluation

Public health advancements over the past centuries have increased life expectancy and expanded the ageing population. Developments in healthcare technologies and interventions have simultaneously created economic constraints and made clinical decision-making more complex. (31). Maximising the use of limited resources requires identifying treatment strategies that consider not only clinical effectiveness but also resource utilisation, unit costs, and health-related quality of life over time (77). Health economic evaluation is a systematic approach to comparing healthcare interventions based on costs and outcomes (77, 78). Its main goal is to guide decision-makers towards interventions that offer the greatest value for the resources spent. Cost-effectiveness analysis plays a well-established role in this process (79). It underpins the ethical basis for Swedish healthcare prioritisation, which is founded on three principles: the human dignity principle, the needs principle, and the cost-effectiveness principle (80)

A cost description or analysis can be used when insufficient data prevent a complete economic evaluation. It is regarded as a partial economic evaluation and, alone, is not sufficient to support a decision, but it can provide substantial evidence for decision-making (77).

Health economic evaluations are conducted from different perspectives depending on the context, including stakeholder perspectives, data and resource availability, and the intended use of the analysis (81). The choice of perspective determines which costs and outcomes are considered and is essential, as favourable outcomes from one perspective may not be as appealing from another. Evaluations can be performed from the perspective of the individual patient, healthcare provider, government, etc. A societal perspective is broader, encompassing all costs relevant to society, thus integrating all perspectives (77).

The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) were developed to ensure that health economic evaluations are identifiable, interpretable, and useful for decision-making. CHEERS provides a checklist with item-specific recommendations, which were applied as thoroughly as possible in this thesis (82).

Measuring health

Measuring health plays a crucial role in public accountability by informing decision-makers about major health concerns and the effectiveness of medical care. It also influences social goals and drives reform. Historically, health measurement relied on population-level statistical data (83). These objective indicators evaluate health status at the individual or population levels (84). As living conditions and public health improved, the concept of health shifted from mere survival to maintaining well-being and, ultimately, to a holistic view of health and well-being aligned with the biopsychosocial model (83). This shift led to the development of subjective indicators, where individuals report their health and its impact on daily life—commonly known as patient-reported outcome measures (PROMs) (84). PROMs capture quality-of-life aspects that traditional clinical outcomes may miss, making them valuable in economic evaluations (77). Despite potential biases, partly addressed through validity studies, subjective indicators remain vital for policy development because objective measures alone cannot provide complete insight (77). In chronic or life-threatening conditions, treatment must be assessed by its capacity to deliver a life worth living in social, psychological, and physical terms (83).

The cost burden of chronic pain

Annual costs of chronic pain are estimated to account for 3–10 per cent of gross domestic product, excluding losses related to reduced quality of life and

informal care (13, 85-87). In Sweden, the societal costs of chronic pain of at least moderate severity were estimated at 87.5 billion SEK in 2003, based on a major European survey by Breivik and colleagues (15, 88). The Swedish Medical Products Agency, using the same study, estimated that the equivalent costs would be 149 billion SEK in 2022 (89). These figures include direct costs such as healthcare utilisation and medication, as well as indirect costs related to productivity loss from sickness absence, reduced work capacity, and disability pensions (15, 90). Productivity loss is often calculated using the human capital approach, which values lost output as the total cost of employing an individual, including wages and employer contributions (77). Additional indirect costs—such as caregiving, transportation, and other out-of-pocket expenses—are more challenging to quantify. Beyond direct and indirect expenses, chronic pain imposes significant intangible burdens—including emotional distress, social role disruption, and identity loss—that sharply reduce quality of life for patients, and their families, yet remain difficult to quantify within traditional economic evaluations (91).

Health-related quality of life

Health-related quality of life (HRQoL) reflects perceived well-being related to health and its effect on different areas of life, making it narrower than overall quality of life (83). HRQoL is valuable in health economic evaluations because it captures benefits beyond clinical outcomes (92). The health status instrument EuroQol EQ-5D is commonly used to measure HRQoL by summarising health status into a single index (EQ-5D index) or a utility weight based on five dimensions—mobility, self-care, usual activities, pain/discomfort, and anxiety/depression—each rated at three severity levels (93). The EQ-5D index or utility weight is derived from population preferences using valuation methods such as time trade-off, standard gamble, rating scale, or discrete choice (94). For example, the time trade-off asks respondents to choose between living longer in a less desirable state or shorter in full health (83). EQ-5D also includes a visual analogue scale (EQ VAS), where individuals rate their health from 0 to 100 (93). Instruments such as the EQ-5D generate utility weights that are commonly used to compare health-economic benefits across interventions (83, 84).

Cost-utility analysis

Cost-utility analysis is a type of cost-effectiveness analysis that compares the cost of an intervention with the health benefit it provides, often measured in

quality-adjusted life years (QALYs). One QALY equals one year in perfect health and is calculated by multiplying a health-related quality of life weight, e.g., EQ-5D index, by one year of life (77, 78). For example, living three years in perfect health equals three QALYs, while living three years with 50 per cent quality of life equals 1.5 QALYs. A QALY gain indicates the difference in total QALYs accumulated across different health states and time periods, representing the societal cost of gaining one year in perfect health. The strength of QALYs lies in their ability to combine improvements in quality of life with the duration of those improvements, providing a comprehensive measure of benefit (84) (Figure 2). Cost-utility analysis produces an incremental cost-effectiveness ratio (ICER) (Figure 3). ICER enables comparisons across treatments and disease areas, aiding resource-allocation decisions in healthcare (77).

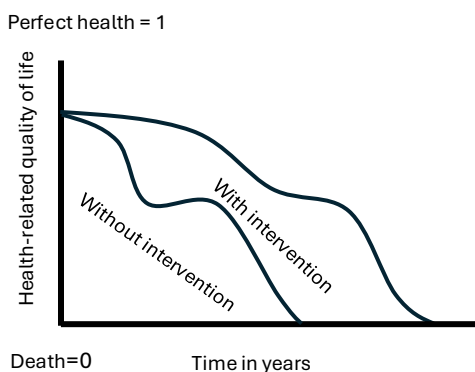


Figure 2. Illustration of how the QALY measures the combination of quality and quantity of life.

$$\text{ICER} = \frac{\text{COST}_{\text{new}} - \text{COST}_{\text{care as usual}}}{\text{QALY}_{\text{new}} - \text{QALY}_{\text{care as usual}}}$$

Figure 3. Formula ICER or cost by QALY gained

Cost-effectiveness threshold

To interpret and apply ICERs in healthcare decision-making, they must be evaluated against a benchmark that indicates whether a treatment's cost is justified by its health outcomes, typically expressed as a QALY gain (95). This benchmark, known as the cost-effectiveness threshold, reflects the maximum amount a society is willing to spend for a health benefit, such as one QALY. Several methods are available to determine this threshold; in this thesis, the

marginal productivity approach is utilised. This method defines the threshold as the opportunity cost of health generated by the least cost-effective intervention displaced by the new intervention (95). In a healthcare system operating under a fixed budget, an intervention with a cost per QALY below this threshold is deemed theoretically acceptable (96). A group of Swedish experts has estimated a cost-effectiveness threshold for Swedish settings based on an estimate by the National Institute for Health and Care Excellence (NICE) (95). The estimated cost per QALY gained in Sweden ranges from €15,974 to €19,734.

Extrapolation of costs

Extrapolation estimates the long-term costs and benefits of an intervention by utilising evidence from previous research within the same field. The method relies on assumed treatment effects and provides a way to address uncertainty about expected costs and outcomes when assessing cost-effectiveness. Economic evaluations commonly use extrapolation when analysing interventions for long-term conditions such as depression, diabetes, and cardiovascular disease, where benefits accrue over extended periods (77).

Healthcare utilisation

Chronic pain is consistently associated with markedly higher healthcare utilisation (90, 97, 98). Research has shown that patients with chronic pain, especially those with high pain-related disability and restrictions in daily activities, have up to two- to fivefold higher odds of seeking care compared to individuals without pain (90, 99-101). The complex nature of chronic pain, together with difficulties in recognising and communicating its consequences, often drives repeated care-seeking behaviour while also contributing to delays in timely medical diagnosis and appropriate treatment (61, 102, 103).

Chronic pain accounts for about 10% of primary care visits (74, 104), and roughly 7% of Swedish adults seek ongoing care for chronic pain (54). A study from French-speaking Belgium indicated that patients with chronic pain may account for 33-50% of all patient contacts in general practice (105). Despite frequent healthcare seeking, around 40% of patients with moderate to severe pain report receiving inadequate care (15). Research has shown that healthcare utilisation remains high over the long term when chronic pain is poorly managed, as shown in a 21-year follow-up, emphasising the need for early

identification to improve chronic pain management and reduce resource strain (99).

Healthcare utilisation and resource allocation are interconnected and influence efficiency and equity of the healthcare system (106, 107). Patterns of healthcare utilisation can help identify unmet needs and service provision gaps, thereby informing resource-allocation decisions. Unmet needs have been associated with increased healthcare utilisation (106). Chronic conditions, socioeconomic and gender inequalities have also been associated with unmet healthcare needs (106, 108). For example, in a Finnish study, women, unemployed persons, and persons born abroad reported higher unmet needs (106). Healthcare utilisation is also related to resource availability at care facilities (109). Care facilities often operate with limited human resources, including general practitioners, nurses, and therapists. Analysis of utilisation patterns can therefore guide facilities in allocating healthcare resources more effectively (109). Research indicates that current resource allocation relies on historical utilisation patterns and ad hoc decision-making, which calls for a more detailed assessment of actual healthcare needs to support more effective and equitable prioritisation of existing limited resources (106, 110).

Rationale

The Declaration of Montreal by the International Association for the Study of Pain affirms that “access to pain management is a fundamental human right” (111). Despite this commitment, many patients with chronic pain report dissatisfaction with their treatment and describe feeling overlooked within the healthcare system (15, 19). The Interdisciplinary Pain Rehabilitation Programme (IPRP) is an evidence-based treatment established in specialist care. However, the treatment is largely underused in primary care settings, where most patients with chronic pain are treated (64). Consequently, chronic pain management often relies on unimodal approaches, such as physiotherapy or pharmacological treatment, that yield limited or unsustainable effects and, in severe cases, increase social and occupational exclusion and delay functional recovery (15, 112, 113).

One potential obstacle to the underutilisation of IPRP in primary care is that it relies on interdisciplinary care, which requires substantial resources. Another barrier is the lack of evidence regarding the effectiveness, resource needs, and cost implications of IPRP in primary care (114, 115). Demonstrating the long-term benefits of IPRP is essential to justify its adoption in primary care.

IPRP is a resource-intensive intervention and, according to current Swedish guidelines, should be offered to patients who exhibit the most complex clinical presentations (35). Complexity in chronic pain manifests in various ways across individuals, making the selection of suitable candidates for IPRP challenging (116). However, it remains unclear whether patients participating in IPRP in specialist care differ from those in programmes delivered in primary care. Clarifying which patients require rehabilitation in specialist care versus primary care can improve resource allocation across the healthcare system and increase access to evidence-based treatment for patients with chronic pain. Over time, more precise allocation may also decrease healthcare utilisation and sickness absence, leading to broader socio-economic benefits.

Aim

The overall aim of this thesis was to study the health economic implications of interdisciplinary pain rehabilitation programmes (IPRP) in primary care from both a societal and healthcare provider perspective.

More specifically, the aims were to analyse:

- The impact of IPRP on healthcare utilisation and resource allocation in the primary care centre before and after IPRP (Studies I and III)
- Healthcare utilisation costs before and after IPRP (Studies I and III)
- Cost-effectiveness of IPRP compared to care as usual and its long-term implications (Study II)
- The distribution of patients participating in IPRP between primary and specialist care (Study IV)

Methods

Research design

The research presented in this thesis draws on a pilot study (Study I), data collected in a prospective longitudinal survey (Studies II and III), and a cross-sectional register study (Study IV). All studies were conducted in clinical settings that allowed for real-world observations and yielded results that can be fully applied in clinical practice.

The pilot study (Study I) was conducted at a primary care centre on the west coast of Finland. The longitudinal prospective studies (Studies II-IV) and the register study (Study IV) were conducted within Swedish healthcare. The longitudinal prospective studies included primary care centres in one southern and one northern region of Sweden (Studies II-IV). The register study (Study IV) involved both Swedish primary and specialist care. Patient-reported outcome measures (PROMs), sociodemographic information, healthcare utilisation, and cost data were examined before and after IPRP (Studies I-IV). The cost-effectiveness of IPRP was assessed through a cost-utility analysis, and the results were extrapolated to estimate long-term benefits (Study II). Survey data and national health register data were linked to analyse healthcare utilisation and costs among patients with chronic pain in the pilot study and in one of the longitudinal prospective studies (Studies I and III).

Participants

All participants in Studies I–IV were aged 18 to 65 years and were consecutively referred to IPRP from primary care by a general practitioner, physiotherapist, or occupational therapist. Participants in Study IV who received care within specialist services were initially referred from primary care and subsequently accepted for specialist care. Studies II and III included some of the same participants. Complementary ethical approval was obtained to conduct Study III. At the time of the application, not all 1-year follow-up questionnaires had been submitted and registered, which explains the lower number of participants in Study III.

The inclusion criteria for all studies included disabling chronic pain lasting more than three months, no need for further medical assessment, sufficient proficiency in the national language, and agreement not to undergo parallel treatments. Language proficiency requirements specified Swedish in Studies II–IV and either Finnish or Swedish in Study I. In Study I, conducted at a Finnish primary care centre, the inclusion criteria differed slightly. Eligibility for Study I also required a score above 50 on the Örebro Musculoskeletal Pain Screening Questionnaire (ÖMPSQ)(117) and a lack of access to occupational health care. All patients who met these inclusion criteria, provided written informed consent, and completed questionnaires at baseline and 1-year follow-up were included in the studies.

Settings

Study I was conducted in a bilingual primary care centre in Jakobstad, a small town on Finland's west coast with approximately 20,000 residents. The centre is located adjacent to the regional rehabilitation facility, whose specialists were trained at Umeå University Hospital and were familiar with Sweden's emerging efforts to integrate interdisciplinary pain rehabilitation into primary care within the Rehabilitation warranty. Study I aimed to apply lessons from Swedish primary care and, in a broader sense, may be seen as a feasibility study. The project was conducted through consensus and collaboration between Umeå University and Jakobstad Hospital.

Studies II and III were carried out in primary care centres in the Swedish regions of Västerbotten and Östergötland during the Rehabilitation warranty with government funding.

In Study IV, register data were collected from primary care centres and specialist units across Sweden, all of which reported to SQRP and SQRP-PC.

Interdisciplinary pain rehabilitation programme

The IPRPs in the thesis varied slightly. However, all IPRPs shared the common feature that healthcare providers at the primary care centre referred patients to the IPRP team, which assessed and selected suitable patients for rehabilitation. An individualised rehabilitation plan was generally implemented to support the rehabilitation process. A distinctive aspect of

Study I was the systematic use of the ÖMPSQ, which predicts long-term disability and failure to return to work (117). The ÖMPSQ was systematically administered at the initial point of care-seeking in Study I but was not required for entry into IPRP in Studies II-IV. Additionally, a key feature of the IPRP process in study I was the role of the case manager, who acted as the central coordinator, maintaining communication with the patient and tailoring the individual programme. The core IPRP team in Study I consisted of the primary care physician, physiotherapist, and a case manager, with access to consultation from other professionals, if necessary, including a specialist in physical medicine and rehabilitation from the regional rehabilitation facility. Unlike most IPRPs, the programme in Study I was not limited by a timeframe and could continue beyond the 1-year follow-up.

The content and duration of the IPRP studied in Studies II-IV varied depending on the resources available at the primary care centre. Programme length ranged from six to ten weeks, with 1.5 to 3.5 hours per week. The team composition varied according to available resources and patient needs but always included at least one physiotherapist and one occupational therapist, as well as at least one team member familiar with cognitive behavioural therapy. Additionally, a general practitioner, a nurse, a psychologist, and/or a social worker contributed as team members or consultants (63). Many participants received preventive sickness benefits to allow time off work for participation.

Study IV explored the use of IPRP in both primary and secondary care. The main difference between IPRPs in these settings is the availability of specialist expertise and resources, which are significantly greater in specialist care. Data on the precise content, intensity, and professional composition of IPRPs in Study IV were unavailable because no standardised method exists for collecting these data, and neither SQRP nor SQRP-PC includes such details (36).

Data collection

PROMs and descriptive data (Study I-IV)

Baseline data in all studies were collected using comprehensive questionnaires. In Studies I-III, the questionnaires were adapted from the SQRP to fit primary care conditions. The data collected in Studies I and III later served as the basis for the primary care version, SQRP-PC. In Study IV, data were retrieved from the SQRP and the SQRP-PC. The variables in the

questionnaires included background information such as descriptive or sociodemographic data (sex, age, country of origin, housing situation, education level, employment, and income), along with patient-reported outcome measures (PROMs) related to pain, physical and emotional functioning, coping, HRQoL, life and work satisfaction, work-related factors, and sickness absence. The questionnaires were completed at baseline and at 1-year follow-up in all studies. Most of the instruments listed in the questionnaires (Table 1) were selected in accordance with the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) core outcome domains for the treatment of patients with chronic pain (118) and the Validation and Application of a patient-relevant core set of outcome domains to assess multimodal pain therapy (VAPIAN) (119) (Kaiser et al., 2018).

The patient reported illness absence in the questionnaires, using the percentages specified by the Swedish Social Insurance Agency (25%, 50%, 75%, or 100%).

Table 1. Instruments of the questionnaire.

PROMS Instruments	Description
Pain duration	Number of years at baseline since pain onset
Numeric pain rating scale (NPRS)	Measuring Pain intensity last week and Current pain intensity in an 11-point Likert scale: 0=no pain, 10=extreme pain.
Hospital anxiety and depression scale (HADS)	The HADS comprises 14 items evenly divided between anxiety (HAD-A) and depression (HAD-D). Subscale scores range from 0 to 21. A score of 11 or higher is the cut-off for a possible clinically significant disorder (120).
Chronic pain acceptance questionnaire (CPAQ)	The CPAQ is a 20-item scale measuring activity engagement (score range: 0–66) and pain willingness (score range: 0–54). All items are rated on a scale from 0 (never true) to 6 (always true) (121).

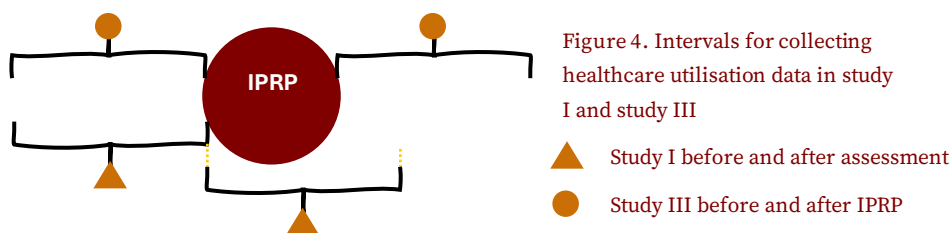
Pain catastrophizing scale (PCS)	<p>Thirteen questions evaluate the extent to which patients experience thoughts and feelings such as rumination, magnification, and helplessness during pain. Each question offers four possible responses (0 (not at all), 1 (to a slight degree), 2 (to a moderate degree), 3 (to a great degree), 4 (all the time)). The questionnaire provides a total score ranging from 0 to 52, along with three subscale scores: Rumination (0–16), Magnification (0–12), and Helplessness (0–18) (122).</p>
Functional rating index (FRI)	<p>The FRI consists of 10 items that measure pain and function in daily activities. Eight items refer to activities of daily living, and two refer to two different attributes of pain. Each item has five possible response points: 0 = no pain or complete ability to function, to 4 = worst possible pain and inability to perform this function. The points are totalled and translated into percentages of the maximum points, with 0% = no disability (123).</p>
European quality of life instrument (EQ5D-3L)	<p>The EQ5D-3L instrument is utilised to assess health-related quality of life (HRQoL) and comprises the EQ-5D index and the EQ-VAS. The EQ-5D evaluates five areas—mobility, self-care, activities, pain, and mental health—on a three-tier scale. Scores are combined into an index from –0.594 to 1, with 1 being optimal health. Additionally, the EQ-VAS show self-rated health from 0 (worst) to 100 (best) (124).</p>
Life satisfaction questionnaire (LISAT-11)	<p>The LISAT-11 captures the patient’s estimations of satisfaction with “life as a whole” (LISAT-life) and with ten specific areas, e.g., satisfaction with the professional/employment situation (LISAT-vocation). Each item has six possible answers: (1) very dissatisfying; (2) dissatisfying; (3) fairly dissatisfying; (4) fairly satisfying; (5) satisfying; and (6) very satisfying. In this study, LISAT-Life and LISAT-vocation were used (125).</p>
Self-reported work ability index (WAI)	<p>The WAI includes a single-item question, “Current work ability compared with lifetime best”, with a possible score of 0–10 (126).</p>

Health economic data

Healthcare utilisation – Study I and III

Studies I and III described and analysed healthcare utilisation before and after participation in IPRPs. The analyses drew on data from linked regional and local medical registers. Healthcare utilisation refers to the total number of recorded healthcare contacts, including in-person visits, telephone contacts, and administrative activities. These contacts involved physicians, including general practitioners and specialists, as well as nurses in primary and specialist care, psychologists, physiotherapists, occupational therapists, and social workers.

To estimate healthcare utilisation costs, detailed resource use was linked to individual social security numbers, which were then connected to regional and local medical registries. Data were retrieved for two observation periods: the one-year interval before and the one-year interval after participation in IPRP. One-year intervals were selected because patient-reported outcome measure data covered the same time frames. In study III, the analysis excluded healthcare utilisation during IPRP because participation in the programme typically results in a temporary increase in service use through active management of chronic pain. The programme lasted approximately three months on average. Consequently, the second observation period began three months after programme initiation and extended for one year. This design differed slightly from that used in study I, in which the healthcare utilisation data covered the 1-year before and after the assessment (Figure 4).



In the Study 1, cost and usage data were gathered from the Hospital District of Southwest Finland and the Department of Social and Health Care in Jakobstad. The cost calculations were based on the actual time healthcare professionals spent on each case. In study III, cost data were obtained from the Swedish Association of Local Authorities and Regions as unit costs.

Cost-utility analysis - Study II

A cost-utility analysis was performed in study II from a partial societal perspective, including intervention costs and productivity losses due to sickness absence and disability pension. A complete societal perspective would include all relevant costs, such as primary care, hospital care, emergency care, pharmaceuticals, medical supplies, and out-of-pocket payments. Study II, however, excluded costs related to hospital and emergency contacts, pharmaceuticals, medical supplies, and out-of-pocket expenses.

Because detailed information on the dosage or content of each intervention was unavailable and no expenditure records for the IPRPs existed, the programme cost was set equal to the financial compensation that primary care centres received through the Rehabilitation warranty in 2014: 25,000 SEK per patient for each completed IPRP (127).

Productivity loss costs were estimated using the human capital approach described in Section 1.5.2. Accordingly, productivity loss was calculated by applying the mean salary across all included occupational categories, along with the standard employer social security contribution of 31.42 % (128). Under this approach, the average annual salary represents the yearly productivity loss for an individual on full-time sickness absence. Costs were not discounted because the follow-up period was limited to one year.

Self-reported sickness absence was measured using the graded absence levels implemented by the Swedish Social Insurance Agency, corresponding to 25%, 50%, 75%, or 100% absence. The analysis excluded costs related to sickness benefits because, from a societal perspective, such transfers amount to a redistribution of income rather than a loss of overall societal resources.

Data analysis

Descriptive variables and PROMs

Background data and PROMs were analysed using comparative statistics in all studies. Parametric variables were analysed using a paired t-test comparing baseline and 1-year follow-up. Non-parametric analyses were performed using the Wilcoxon Signed Rank Test and the Mann-Whitney U analysis. Missing values were not imputed.

For comparison between primary and specialist care in Study IV, the Chi-square test (2x2 table), the Mann-Whitney U test (2x3, 2x4, and 2x5 tables), and the student's t-test for continuous variables were used. Between-group effect size was reported with Phi (2x2 table), or Cramer's V in categorical variables, and 95% confidence intervals were calculated using bootstrapping. All analyses were conducted in IBM SPSS using a significance level of $p < 0.05$ (two-tailed) and 95% confidence intervals (CI).

Cohen's effect size was calculated using an online psychometric calculator (129). Effect sizes for continuous variables (Study IV) were determined with Student's t-test. Absolute effect sizes of 0.0-0.2 were interpreted as non-significant, 0.2-0.49 as small, 0.5-0.79 as medium, and 0.8 and above as broadly significant (130).

In study IV, factors associated with having received IPRP in primary care or specialist care (dependent variable) were identified as follows. Multivariable logistic regression was conducted using variables that were statistically significant ($p < 0.05$) in the univariate analysis to develop a model for receiving IPRP in primary or specialist care. Variables with a Spearman rank correlation >0.5 were arbitrarily excluded from the multivariable logistic regression to prevent multicollinearity.

In the logistic regression analysis, variables with an OR and 95% CI above 1 indicated higher odds of participating in IPRP in specialist care. In comparison, variables with an OR and 95% CI below 1 indicated higher odds of participating in IPRP in primary care.

Healthcare utilisation – Study I and III

Evaluating healthcare utilisation, the number of healthcare contacts was analysed. Healthcare utilisation was specified per caregiver category to detect possible changes in resource distribution after IPRP.

In Study I, the total number of visits and telephone contacts at baseline and at the 1-year follow-up were compared using the non-parametric Wilcoxon signed-rank test and the Mann-Whitney U test. The analysis included all participants and separate subgroups defined by whether participants increased or decreased their healthcare contacts by at least 1 contact. A decrease was

regarded as a favourable outcome. The analyses detailed healthcare contacts by professional category.

In Study III, the total number of visits, telephone contacts, and administrative items during the one year before and after the IPRP were compared using a paired t-test analysis for the entire cohort. In-person visits were also compared for the same time intervals by caregiver category.

A CI of 95% with a level of significance $p < 0.05$ was used in all analyses. No imputation was carried out for missing values.

Healthcare utilisation data was combined with patient data to determine the total healthcare use and costs for the cohorts in Studies I and III. These were then compared across the entire cohort and within each caregiver category for the one year before the IPRP and the one year after.

The cost descriptions adopt a healthcare provider perspective, in which the primary care provider, and by extension the region in Sweden and the municipality in Finland, are responsible for primary care.

Cost-utility analysis – Study II

In Study II, a cost-utility analysis was performed by dividing the total cost of the IPRP and the total cost of usual care by the difference in the EQ-5D index from baseline to the 1-year follow-up. The analysis produced the QALY gain (ICER), which was then compared with an established cost-effectiveness threshold to assess the IPRP's cost-effectiveness.

In Study II, a pragmatic clinical design made it infeasible to establish a conventional control group. Torrance (1997) notes that in such situations, the appropriate comparator can be the expected course of events in the absence of the evaluated intervention (131). Recent research in comparable contexts has also shown that constructing an objection-free control group is nearly impossible due to ethical, economic, and practical constraints (132). Consequently, baseline data served as the comparative alternative representing the scenario in which participants continued to receive care as usual. This approach assumed that their overall health state, including the mean EQ-5D index and work status, would remain unchanged without participation in the IPRP, which aligns with the group's long average pain duration of nearly ten

years. Care as usual consisted of standard primary care treatment, such as pharmacological management or unimodal interventions provided by individual professionals, including physiotherapists and psychologists.

Extrapolation of costs

The extrapolation in Study II relied on hypothetical long-term effects on sickness absence and HRQoL. Estimates for these outcomes were obtained from earlier long-term Swedish studies. A discount rate of 3.5 per cent was applied (77). Two extrapolation scenarios were developed. The first assumed that the HRQoL improvement observed at follow-up persisted throughout the five-year period. The second assumed that this improvement declined by half.

Ethical considerations

All studies included in this thesis were conducted in accordance with the principles of the Declaration of Helsinki (133). Study I was approved by the Ethics Committee of the Hospital District of Western Finland (Dnr: 20.12.2016 §537). Studies II-III (Dnr-2017-438-32M, supplement Dnr-2013-192-31M) were approved by the Regional Ethical Review Board in Umeå. In study IV (Dnr-2023-07900-02), register data were used with the authorities responsible for the registries' approval.

Written informed consent was obtained from all participants before inclusion after oral and written information. Patients were informed of their right to withdraw from the study at any time, without further explanation. Contact information was provided in case questions arose.

To protect participant integrity, all extracted personal data was depersonalised and coded during data entry so that no individual could be identified. All analyses were carried out at the group level, thereby ensuring that individual data remained unidentifiable. All data was handled with strict care and confidentiality in accordance with the Personal Data Act and, subsequently, the General Data Protection Regulation, which came into effect in May 2018.

The datasets generated and/or analysed in this study are not publicly available as the Ethical Review Board has not approved the public availability of these data.

Results

Study I

In total, 29 of 36 participants at baseline completed the 1-year follow-up. Healthcare utilisation in the cohort increased from an average of 13 visits to 18 visits (Figure 5). Total healthcare costs rose by 46%, from €1,631 to €2,998.

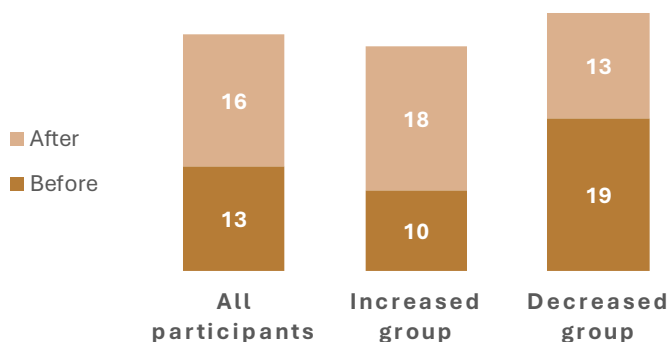


Figure 5. The average number of healthcare visits 1-year before and after.

To detect trends in healthcare service use, participants were divided into two subgroups based on whether they increased (Increase group) or decreased (Decrease group) their healthcare utilisation with one or more visits after IPRP. Within-group analysis showed that the Increase group had reduced pain intensity at follow-up ($p=0.013$, ES=0.54). The Increase group, in turn, significantly improved their overall health (EQ VAS) ($p = 0.041$, ES 0.58) and were more prone to engage in activity despite pain ($p = 0.024$, ES 0.63). Both subgroups reported enhanced self-reported work ability at follow-up (Decrease vs Increase group, $p = 0.020$, ES 0.31 vs $p = 0.014$, ES 0.58). Between-group (Table 2) comparative analysis showed that the Increase group presented with more pain ($p = 0.050$, ES 0.64) and depression ($p = 0.034$, ES 0.77) at baseline. At follow-up, the only significant difference between the two subgroups was that those with decreased utilisation were more willing to experience pain ($p = 0.037$, ES 0.94).

Within-group analysis (Figure 6) showed that Decreased group increased their use of specialist physicians ($p = 0.001$), rehabilitation personnel ($p = 0.050$), and specialists in physical and rehabilitation medicine ($p = 0.012$) in the year after IPRP. Conversely, Increased group reduced their use of general practitioners ($p = 0.014$).

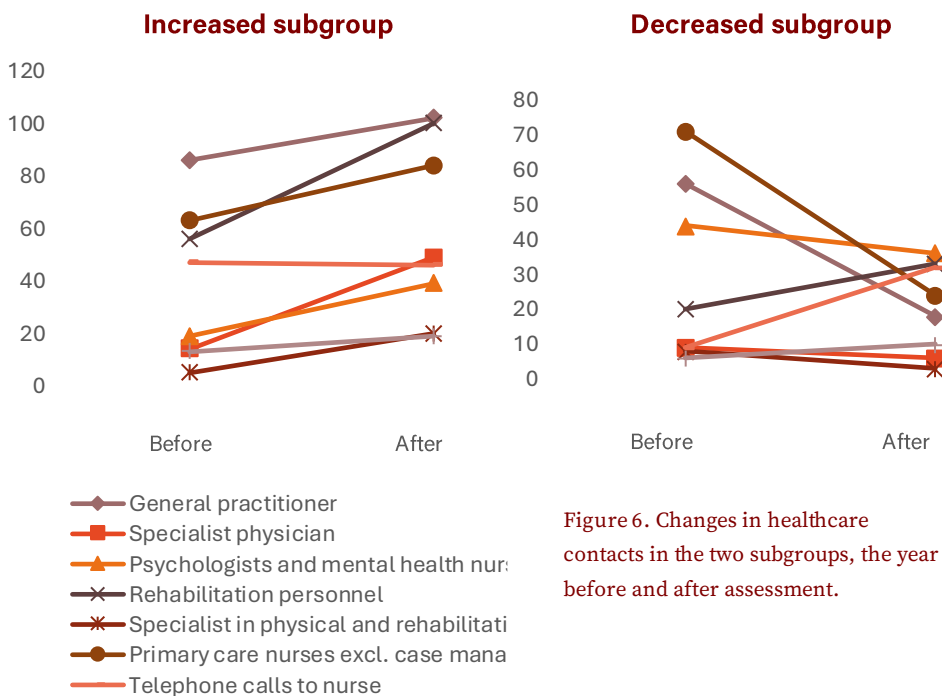


Figure 6. Changes in healthcare contacts in the two subgroups, the year before and after assessment.

Between-subgroups analysis showed that the Increased group benefited from psychologists and mental health nurse services ($p = 0.005$) and visited the primary care nurse ($p = 0.046$) more frequently than the Decreased group during the year before IPRP. The Decreased group had significantly more visits to both the general practitioner ($p = 0.033$) and the specialist physician ($p = 0.015$) in the year after assessment, compared with Increased group.

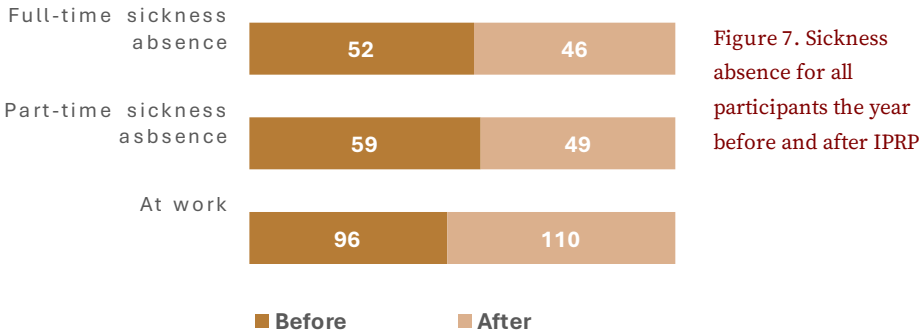
The total costs of healthcare utilisation rose by 46% for all participants in the year after IPRP, including costs attributable to IPRP. The average cost per

participant was €1,631 one year before the team assessment and €2,998 one year after.

Study II

The cost-utility analysis in Study II yielded an ICER of €18,704 per quality-adjusted life year, suggesting that the IPRP is cost-effective at a threshold of €19,734.

The participants' health-related quality of life improved significantly at follow-up, as indicated by the EQ-5D index ($p < 0.001$) and the EQ-VAS ($p < 0.001$). Among the participants, sickness absence declined by 15% after IPRP (Figure 7).



The extrapolation of costs based on return-to-work indicated that the total cumulative discounted value of the IPRPs reached approximately €1 million after 5 years (Figure 8). If the reduction in sickness absence persisted for an additional 10 months beyond the 1-year follow-up, cost savings from reduced production losses would offset the intervention costs for all participants, marking the break-even point shown in Figure 6. Beyond this point, the intervention would generate net economic gains for society. If HRQoL effects persisted at the same level observed at the 1-year follow-up, the extrapolation suggested that the incremental cost-utility ratio would decrease sharply from €18,704 to €3,517 five years after the IPRP. If HRQoL declined by 50%, the ICER would decrease to €4,729.

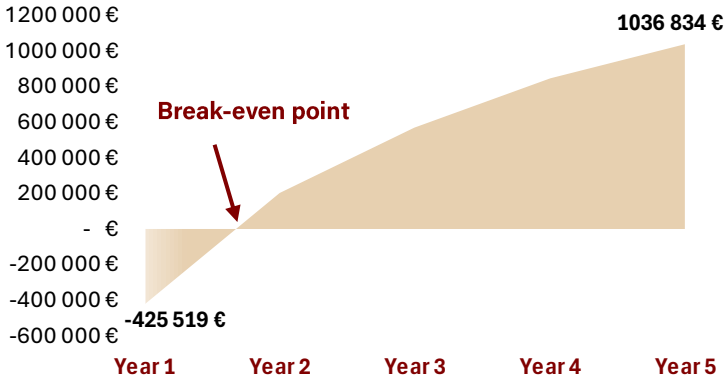


Figure 8. Cumulative cost savings and break-even point where cost for IPRP are balanced by cost savings.

Study III

Healthcare contacts among the 146 participants in the cohort declined by 16% during the year after the IPRP ($p = 0.013$) (Figure 9). Participants averaged 19 in-person visits in the year before the IPRP and 16 visits in the following year, representing a 15% reduction ($p = 0.055$). Visits to general practitioners and physiotherapists decreased most notably, by 23% ($p < 0.001$) and 31% ($p = 0.048$), respectively. Conversely, visits to primary care nurses rose by 6% ($p = 0.779$), to occupational therapists by 5% ($p = 0.818$), and to psychologists or social workers by 10% ($p = 0.630$).

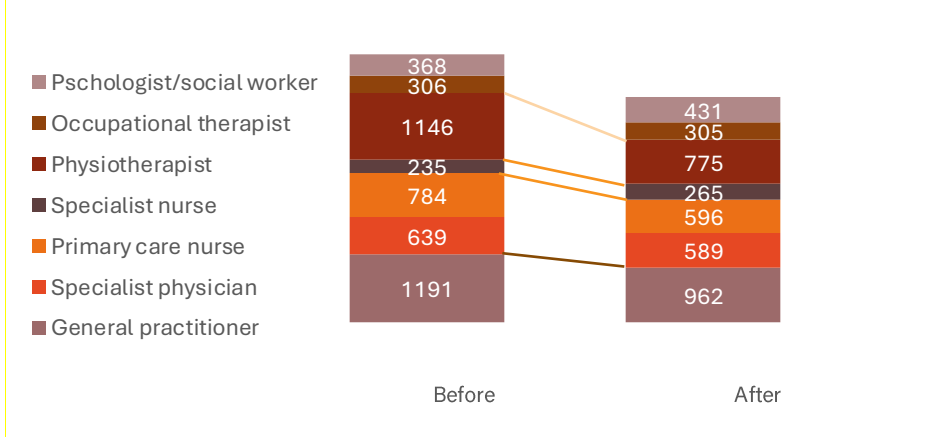


Figure 9. Contacts with healthcare providers 1-year before and after IPRP

The cost savings from reduced healthcare utilisation amounted to €434 per participant, representing a 12% reduction. The average annual healthcare cost per patient with chronic pain was €3,561 before IPRP and €3,128 afterwards. The most substantial savings, 93%, originated from fewer visits to GPs and physiotherapists.

Study IV

A total of 19,120 participants from the SQRP were included in the study, of whom 3,985 participated IPRP in primary care and 15,135 in specialist care. The comparative analysis of PROMs (Table 3) between primary care and specialist care showed that participants who participated IPRP in specialist care had significantly higher levels of pain intensity, catastrophising, and depression ($p < 0.001$) compared to those treated in primary care. However, the effect sizes were minimal (<0.2). IPRP participants in primary care appeared to have better health status, higher EQ-5D index and EQ VAS scores, and reported better work ability than those who IPRP participants in specialist care ($p < 0.001$, $ES > 0.2$).

The multivariable logistic regression analysis (Figure 10) revealed that being a woman (OR 1.228 (CI 95%) [1.108 - 1.360]), having a university education (OR 1.275 (1.167 - 1.394)), and consulting a doctor four or more times in the past 12 months (OR 1.506 (1.384 - 1.639)) increased the likelihood of participating in rehabilitation in specialist care. Furthermore, the pain variables—persistent pain (OR 1.340 [1.214 - 1.478]) and having a higher number of pain sites (OR 1.010 [1.004 - 1.015])—indicated increased odds of engaging in rehabilitation in specialist care.

Obesity (OR 0.866 [0.792 - 0.947]), higher pain catastrophising (OR 0.996 [0.991 - 1.000]), greater pain intensity in the past week (OR .714 [0.607 - 0.838]), and better general health (EQ VAS and EQ-5D index) (OR 0.993 [0.991 - 0.996]) were associated with increased odds of participating in rehabilitation in primary care. Additionally, higher work ability (WAI) (OR 0.979 [0.962 - 0.996]) was linked to a greater likelihood of engaging in IPRP in primary care.

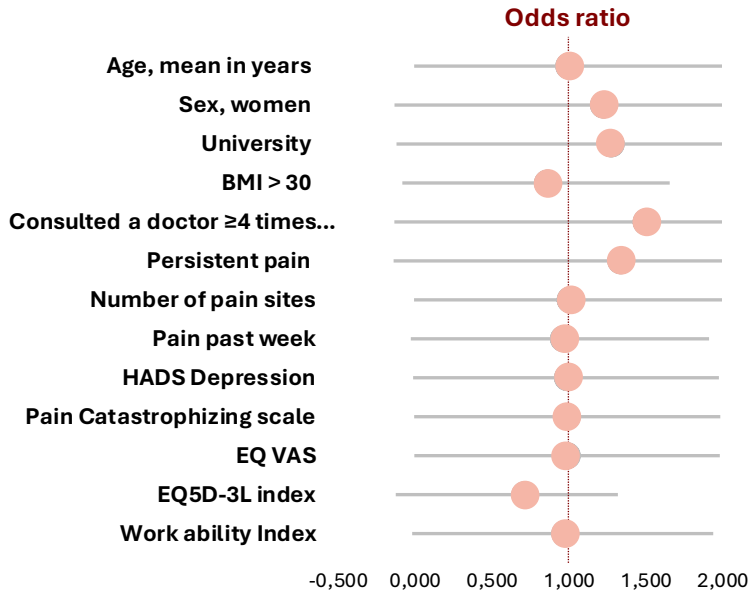


Figure 10. Results from multivariable logistic regression OR for participating in IPRP in primary or specialist care. OR and 95% CI above 1 indicated higher odds of participating in IPRP in specialist

Discussion

Main findings

The overall aim of this thesis was to analyse the economic implications of interdisciplinary pain rehabilitation programmes (IPRP) in primary care from a societal and healthcare provider perspective. Study I indicated that changes in healthcare utilisation after IPRP were associated with patients' pain coping strategies at baseline. In Study II, IPRP was shown to be cost-effective compared with care as usual, particularly when five-year cost savings were considered. Study III demonstrated reduced healthcare utilisation and sickness absence following IPRP participation, resulting in substantial cost and resource savings. In addition, findings from Studies I and III indicated a need to redirect resources from general practitioners and physiotherapists to psychologists, social workers, occupational therapists, and nurses (Studies I and III). Finally, Study IV revealed only minor differences in baseline PROMs between patients participating in IPRP in primary versus specialist care, suggesting that factors other than clinical complexity may influence the allocation of patients with chronic pain, despite current guideline recommendations.

Cost-effectiveness of IPRP in primary care

The findings of Study II demonstrate that IPRP improves health-related quality of life and reduces sickness absence to an extent that supports its cost-effectiveness compared with continued care as usual for patients with chronic pain. These results are broadly consistent with the few economic evaluations previously conducted in primary care (43, 45, 134). A comparison between the studies, however, is not meaningful, as they differ considerably in design, perspective, and cost components. The economic evaluations, however, show a trend: biopsychosocial and interdisciplinary interventions tend to produce significant health gains and cost savings at favourable cost ratios.

The cost-utility analysis in Study II showed that IPRP meets the cost-effectiveness threshold set by the Swedish standard of €19,734 per QALY gained. In theory, this indicates that IPRP is suitable for public funding, which

provides valuable information for decision-makers when prioritising limited resources. However, using cost-effectiveness analyses at the primary care level presents specific interpretative challenges. As noted earlier, it is difficult to compare the cost-effectiveness of other interventions because of the heterogeneity of the evaluations. Additionally, the cost per gained QALY (ICER) is rarely used when prioritising treatment options in Swedish healthcare today (78). Therefore, it is more useful to consider the outcomes that contributed to IPRP's cost-effectiveness. For example, Study III's findings show that sickness absence declined by 15% after participation in IPRP. This reduction reflects decreased productivity losses and significant cost savings. Previous studies have reported similar reductions in sickness absence following interdisciplinary pain rehabilitation (127, 130-132). The decrease furthermore aligns with IPRP's core societal aim and the objective of the Rehabilitation warranty.

Another finding related to sickness absence was that cohorts in Studies I-III demonstrated significant improvement in self-reported work ability. This improvement suggests that participants strengthened their belief in their capacity to return to work after completing IPRP. Belief in returning to work or remaining in employment has been identified as a significant predictor of actual vocational outcomes in the rehabilitation of individuals with chronic pain in Sweden (135). Consequently, the gains observed in work ability may signal future vocational benefits.

Besides the decrease in sickness absence after IPRP, the improvements in HRQoL were the other main contributor to the cost-effectiveness seen in Study III. As HRQoL reflects an individual's overall perceived health status across physical, psychological, and social domains, such improvements have important clinical implications for the individual participant and, in the long run, potentially reduce the social and individual burden of chronic pain (124, 136). The cohorts in Studies II-IV demonstrated markedly lower HRQoL than the general Swedish population. At baseline, their EQ-5D index ranged from 0.27 to 0.34, which is substantially lower than reported indices of 0.78 - 0.86 and 0.88 - 0.93 in the highest and lowest socio-economic groups, respectively (137, 138). HRQoL in these cohorts is low and compares unfavourably with levels reported in other chronic conditions. Burström et al. (2001) also reported average EQ-5D index values of 0.60 in diabetes, 0.38 in depression, 0.71 in hypertension, 0.60 in ischaemic heart disease, 0.44 in stroke, 0.64 in asthma,

and 0.55 in low back pain (138). These comparisons highlight the substantial burden experienced by individuals with chronic pain and underscore the severity of their reduced quality of life. In contrast, the Finnish cohort in Study I exhibited nearly twice the baseline HRQoL (0.59–0.66). The levels in Study I are also consistent with European studies of chronic pain in the general population (87, 139).

The pronounced difference in HRQoL at baseline between Studies II–IV and Study I may reflect a greater severity of pain and disability among individuals referred to IPRP, where the inclusion criteria may have been more stringent. However, patient selection during the rehabilitation warranty period was not determined solely by clinical need. Financial incentives and limited training in chronic pain assessment have been reported as contributing factors influencing referral decisions (63). These observations illustrate the heterogeneity that characterises chronic pain populations and reinforce the need for transparent, evidence-based, and clinically grounded selection procedures in rehabilitation programmes (140).

Long-term perspective

The extrapolation carried out in Study II showed that the cost per QALY gained, or the cost for one year of perfect health, would fall to one quarter to one fifth of the original estimate if the observed improvements in health-related quality of life persisted over five years or declined by fifty per cent during that period. This is supported by a five-year follow-up paper by Westman and colleagues (141). To date, an equivalent follow-up period has not been established. Long-term follow-up with shorter follow-ups, however, demonstrate that positive outcomes after IPRP can last for many years after programme completion, indicating that the intervention has enduring effects on functioning and quality of life (37, 142, 143). A recent systematic review reported improvements in HRQoL after IPRP in 86% of the 30 studies with a minimum follow-up of 12 months. The review covered both primary and specialist care and demonstrated sustained long-term improvements in overall health (144). This is further underscored by evidence demonstrating how IPRP enhances patients' coping abilities and self-efficacy, which are key mechanisms for maintaining improvement over time (145-147).

The extrapolations in Study II further indicated that if the reduction in sickness absence continued beyond the first year, the programme costs for all participants would be fully counterbalanced by savings from reduced productivity loss. These findings align with previous research in primary care, which has documented positive effects of IPRP on sickness absence, although the evidence remains limited (132, 147). In one study, sickness absence days decreased significantly for up to two years after programme completion, suggesting that improvements can be sustained over extended periods (132). While earlier studies highlight statistical reductions in sickness absence, Study II demonstrates that even modest decreases can yield significant economic gains when translated into reduced productivity loss.

Healthcare utilisation and cost savings

Study III showed a 16% decrease in healthcare utilisation following IPRP. This finding aligns with earlier evidence indicating that IPRP delivered in primary care settings reduces subsequent healthcare use (40, 86, 145, 148, 149).

Reduced healthcare utilisation generated cost savings of €63,286 or €434 per participant. When extrapolated to a national level the economic impact increase substantially. If applied to all individuals with moderate to severe chronic pain in Sweden this group represents 18 per cent of the population or 10.6 million individuals according to Breivik and colleagues (15). IPRP could therefore yield annual savings of approximately € 830 million (150). This amount corresponds to 0.012% of Sweden's gross domestic product in 2024 (151). Evidence indicates that reductions in healthcare utilisation persist for extended periods after interdisciplinary rehabilitation (152). These findings suggest durable reductions in healthcare use like those observed in Study II. Emilson and colleagues (99) further emphasised the importance of early intervention by demonstrating that healthcare utilisation may persist for up to 21 years in patients who do not receive effective treatment.

Cost savings in healthcare utilisation also affect cost-effectiveness, as shown in earlier economic evaluations of IPRPs (134, 153). This suggests that the decrease in healthcare utilisation observed in Study III would further contribute to a lower cost per gained year in full health if it had been included in the cost-utility analysis of Study II.

The findings on healthcare utilisation in Study I did not align with the results presented in Study III. One probable explanation is that healthcare utilisation in Study I was assessed both before and after the baseline, and IPRP resources were included in the utilisation data. Consequently, healthcare use and related costs rose, mainly due to increased visits to specialist doctors. This pattern suggests that several patients entering the IPRP during the pilot phase had not undergone a complete diagnostic assessment prior to enrolment, which may have limited their ability to benefit fully from the rehabilitation (152).

This limitation is understandable given that Study I was a pilot conducted at a single primary care centre, where the organisational structures and procedures surrounding the implementation of IPRP were less elaborated and structured than those in the Swedish primary care centres where IPRP was implemented. That said, other challenges in the selection and assessment of patients referred to IPRP were also observed in Studies I and III (63). These are important considerations when implementing IPRP in primary care settings.

Resource distribution before and after IPRP

Findings from Study III, and to some extent also from Study I, show that IPRP reduces visits to physiotherapists and general practitioners. Similar results were reported in the only comparable study on this topic, which found that the number of pain-related general practitioner appointments decreased by 40% after a pain management programme (145). Relieving physiotherapists and general practitioners of some of the workload associated with a patient group often regarded as particularly challenging offers benefits for both professional groups. This relief is also vital for primary care services more broadly, as their responsibilities continue to expand while available resources have not increased at the same pace (58). Furthermore, the share of general practitioners in Sweden is among the lowest in Europe (14%), reflecting the current shortage of general practitioners (58, 154). Fewer consultations would likely ease pressure on general practitioner services and, in turn, reduce waiting times.

Unlike the decline in visits to physiotherapists and general practitioners, Study III noted a slight increase in visits to psychologists, social workers, primary care nurses, and occupational therapists. These findings suggest that implementing IPRP in a primary care centre requires redistributing clinical work from physiotherapists and general practitioners to psychologists, social

workers, nurses, and occupational therapists. Additionally, in Study I, we observed tendencies indicating that the case manager, as a coordinator of the rehabilitation process, could ease the workload of other healthcare providers, especially the general practitioner. The case manager served as a continuous point of contact for participants in the IPRP in Study 1, and this role positively influenced healthcare utilisation in the population. This aligns with earlier research showing that case management is associated with greater adherence to treatment guidelines and higher patient satisfaction, thereby reducing healthcare utilisation and costs for patients with long-term conditions (147). Thus, the reallocations mandated by IPRP encourage more efficient use of healthcare resources because tasks previously performed by general practitioners are shifted to other providers with lower costs.

Factors associated with healthcare utilisation

In Study I, we analysed patient-reported outcomes alongside healthcare utilisation. In contrast to the results in Study III, Study I showed increased utilisation of healthcare services. Participants were divided into subgroups based on whether they increased or decreased their utilisation to identify distinct care-seeking patterns.

The subgroup analysis in Study I revealed that participants who increased their utilisation continued to seek care across different provider categories after the assessment. Those who reduced their utilisation displayed fewer contacts with all providers except rehabilitation personnel, fewer telephone contacts with the general practitioner and the nurse, and fewer contacts with the case manager. Participants who reduced their healthcare utilisation relied more on telephone consultations and the case manager than on in-person visits and appointments with the physician. This pattern indicates increased capacity for self-management. They also utilised psychosocial support more before IPRP. This is demonstrated by improvements in activity engagement, self-rated health, and pain acceptance following IPRP. This supports the idea that this subgroup possessed more advanced coping skills, (121).

In Study I, the subgroup that increased its healthcare use, in turn, reported higher levels of pain and depression at baseline, which can be interpreted as weaker coping skills. This aligns with research showing that perceived ill health, primarily pain and psychological distress, drives healthcare-seeking behaviour (155, 156). Similarly, previous research has shown that limited

coping strategies are associated with high healthcare utilisation (90). The healthcare-seeking patterns observed in Study I therefore indicate that coping skills at IPRP entry influenced subsequent utilisation. Correspondingly, the decrease in healthcare use in Study III may reflect improved coping strategies developed during IPRP, consistent with findings that enhanced coping ability and a shift towards a biopsychosocial approach reduce healthcare utilisation among individuals with chronic pain (157). Thus, analysing healthcare utilisation over time can help determine which treatment components and intensities provide the most significant benefit for specific patient subgroups.

IPRP in primary and specialist care

IPRPs are typically provided in primary and secondary care, with specialist care reserved for patients with the most complex conditions. Results from Study IV indicated that differences in baseline characteristics between patients who participated in IPRPs in primary care and specialist care were small. Instead of following established guidelines, socio-economic factors seemed to influence the allocation of patients to specialists or primary care providers.

Socioeconomic disparities

Female gender, a university or college degree, higher self-reported annual physician visits and body mass index below 30 showed increased odds of participation in an interdisciplinary pain rehabilitation programme within specialist care in Study IV. Inequality in assessment and access to specialist pain rehabilitation has previously been reported to be related to social factors such as gender, socio-economic status, and diagnosis (158, 159). Studies have shown that gender-stereotyped norms and socio-cultural assumptions among healthcare providers influence pain assessment and can shape rehabilitation, including assumptions that multimodal rehabilitation is more suitable for women than for men (55, 160, 161). Research has also shown that higher educational levels and similarities with the general practitioner are associated with referrals to specialist care (161). Socio-economic disparities do not occur only among patients with chronic pain, since evidence from the Swedish healthcare system shows that patients with lower educational attainment report reduced person-centredness and lower overall satisfaction with healthcare (50).

The finding in Study IV that body mass index below 30 increases the odds of receiving IPRP in specialist care indicates unequal access for patients with obesity. This contradicts the SKR guidelines, which classify obesity as a comorbidity requiring rehabilitation in IPRPs (35). Habitus, such as appearance, fitness, and weight, has been reported to influence specialist pain rehabilitation assessment negatively (162). Research has established a link between chronic pain and obesity, noting that obesity raises the risk of developing chronic pain (163). Lower BMI is also associated with a lower prevalence of high-impact chronic pain (164). Despite this, weight reduction is generally not prioritised within IPRPs (165).

Selection of patients for IPRP in primary versus specialist care

Findings in Study IV indicate that primary care providers care for patients with complexities similar to those encountered in specialist care. Although having persistent pain and a higher number of pain sites increased the odds of participating in IPRP within specialised care, the findings showed that patients who received IPRP in primary care reported higher pain intensity. Similar results have been reported in an American study (166). Given the broad mandate of primary care, its responsibility for most patients with chronic pain and the limited specialist training in chronic pain management among primary care professionals, these findings indicate an imbalance in the provision of chronic pain management in Sweden. Wang and Jia (2020) warn that disparities in the availability and quality of healthcare resources between specialist care and primary care settings may lead to inefficient use of resources. The selection guidelines require revision so that patients with lower rehabilitation needs remain in primary care, while those with greater needs receive rehabilitation in specialist care. Resource allocation across care levels also warrants review to support approaches that reduce the gap between primary and specialist care.

Differentiating between complex and very complex chronic pain and choosing the appropriate level of care is neither clear nor straightforward (167, 168). Reports indicated that the Rehabilitation guarantee did not offer healthcare practitioners clear guidelines or standardised measures for assessing patients with chronic pain, leading to disparities in patient selection that depended on the referring physician and/or the clinic (53, 169). It is probable that these shortcomings persist to some extent. The assessment and selection process occurs at two levels: in primary care, where clinicians determine if a referral to

specialist services is necessary; and in specialist care, where referred patients are further evaluated and either admitted to IPRP or returned to primary care. This structure indicates that issues in patient allocation are likely to occur at both stages. Difficulties in selecting patients in primary care may arise from insufficient training in pain assessment, leading to the wrong patients being referred or to patients not being referred at all (168). Short consultation times and limited resources in primary care also impede accurate assessment (113). Patients with complex pain conditions might be referred to specialist care, yet the interprofessional team's assessment may determine that IPRP is not the most suitable option. This decision could be influenced by various factors, such as the programme being too demanding for the patient or the patient's health status preventing active involvement in group-based activities. The complexity underscores the need for thorough collaboration between primary and specialist care, which has repeatedly been reported as inadequate (54, 61).

Although the findings in this thesis suggest that the IPRP in primary care may be cost-effective, it remains a resource-intensive intervention, particularly in its initial phase. Therefore, it should be prioritised for patients with the greatest need. Previous research has shown that not all patients benefit from the IPRP (59, 170). Other studies indicate that structured pain assessment alone can help some patients manage their pain (171, 172). Moreover, research estimates that around 40% of individuals with chronic pain do not seek care, highlighting opportunities for self-management approaches (38, 173). Tailoring chronic pain treatment to be more patient-centred would thus benefit both patients and society (56, 112). The launch of the treatment structure for adults with chronic pain spanning from primary to specialist care in 2022 by the Nation Action Group is a promising step towards addressing the gap between the care levels and increasing access to early and timely evidence-based chronic pain treatment in Swedish health care (174).

Methodological considerations

The main strength of this thesis lies in its contribution to the largely underexplored health economic effects of interdisciplinary pain rehabilitation programmes (IPRP) in primary care. Another strength is that the outcomes of IPRP are examined in real-world clinical settings with regular primary healthcare staff, increasing relevance for healthcare providers and making the results more accessible and easier to implement in primary care centres.

Additionally, when analysing healthcare utilisation, regional administrative registers were used, which is a strength because most healthcare utilisation studies rely on self-reported data, which is susceptible to recall bias. Furthermore, healthcare utilisation data used in most economic evaluations are generally limited to a few professionals. In our studies, in contrast, we included the most important healthcare providers in the interdisciplinary team, providing a broader view of the organisational resources involved in working with IPRP. Study IV included a large study population, thereby increasing its generalisability, which is a strength of this thesis. However, there are specific methodological considerations that must be addressed in this thesis.

Data collection

Background data and variables concerning pain, physical and emotional functioning, coping, HRQoL, life and work satisfaction, work-related factors, and sickness absence were collected through self-report in all studies. The reliance on self-ratings via PROMs introduces methodological limitations, as these measures depend on patients' subjective evaluations, which may lead to response bias and limit the precision of the assessed outcomes. However, the instruments included in the questionnaires reporting on PROMs have been widely used and validated.

All studies in this thesis were pragmatic clinical studies, and establishing a control group was not feasible. Achieving a completely objective control group is nearly impossible to attain ethically, economically, and practically in clinical practice (38, 132). The absence of a control group may be viewed as a methodological limitation in Studies II-IV, as it prevents a clear distinction between treatment effects and natural variation in symptoms. However, the participants' average pain duration was around 9 years, which makes it less likely that this is the case.

EQ-5D with three levels was used in this thesis, as it was the instrument available at the time the data were collected. This may be considered a limitation since they are not as sensitive to detecting changes as the EQ-5D with five levels, which is available and recommended today (94, 175, 176).

Finally, the somewhat outdated data used in this thesis may be perceived as limiting the accuracy in the present context. However, chronic pain continues

to be a widespread societal issue, and the findings would likely be similar today.

Limitations in the economic evaluations

Systematic shortcomings in economic evaluations in the field of chronic pain have been reported for over two decades, including concerns about heterogeneity and the inadequate use of economic methodology (37, 68, 177, 178). To address these methodological challenges, we endeavoured to adhere to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS)(82) Checklist for conducting economic evaluations in Studies I-III, as far as possible. We also aimed for transparency by providing calculations in tables, ensuring they are reproducible and that it is clear how the results have been derived.

The adoption of a partial societal perspective in the cost-utility analysis in Study II was necessitated by the lack of detailed information on costs and content of the individual programmes. A complete societal perspective requires the inclusion of all costs, no matter who incurred them (77). Cost data was not collected alongside other baseline data in the longitudinal retrospective cohort study which data was analysed in Studies II and III. Because the data could not be credibly retroactively retrieved, we chose not to include other costs in the cost-utility analysis in Study I. Nevertheless, the costs did not differ between the two alternatives. Drummond and colleagues (77) argue that analysts may exclude costs common to both options because such costs do not influence the choice between alternatives. Another limitation in the cost-utility analysis in Study II concerns the intervention's cost. The analysis lacked detailed information on the exact dosage and content of each IPRP. As a result, the cost estimates relied on government financial compensation to the primary care centre rather than on measured resource inputs. The absence of a control group or alternative intervention also represents a limitation in Study II. The cost-utility analysis, therefore, compared baseline data from participants in the IPRP with follow-up outcomes in the same cohort. This approach treated usual care as unchanged over time. These limitations restrict the cost-utility analysis and its outcomes, reducing their usefulness for decision-making.

The healthcare utilisation analyses in Studies I and III also presents specific limitations. Healthcare utilisation costs evaluated were not specific to chronic

pain but reflected all healthcare contacts recorded during the measured periods. This may be considered a limitation, as the data may capture healthcare use associated with conditions other than chronic pain. Our patient consent restricted access to diagnosis-related information, which prevented us from identifying the clinical reason for each visit. However, the use of healthcare utilisation data linked solely to chronic pain would also risk excluding relevant contacts, as the complexity of pain makes it difficult to determine whether a visit arises from pain or from conditions that interact with or contribute to pain. Another cost-related limitation was the considerable variation in cost information obtained across the regions in Study III. For example, visits to orthoptists, speech therapists, audiologists, assistant nurses, hearing care technicians, and orthopaedic technologists were not counted since they were not compatible with both datasets of the regions in Study III. Data about emergency ward visits and hospitalisations were not available. Patient consent requirements and the entry into force of the General Data Protection Regulation (GDPR) in May 2018 further limited the collection of cost data, as it restricted access to detailed data on healthcare use, such as time of or reason for contact (179).

Overall, gathering medical and cost data was a significant challenge in this thesis due to confusing sources, fragmented data, and security regulations, e.g. the introduction of GDPR. Moreover, there is no standardised, systematic, or conventional approach to auditing and comparing the health economic effects of treatments within Swedish healthcare, particularly in the field of chronic pain management.

The use of extrapolation emphasises a limitation of the cost-utility analysis, as long-term outcomes were not directly observed. However, since the IPRP aims for sustained behavioural and functional change, extrapolation is unavoidable, as benefits are expected to continue beyond the clinical trial. Otherwise, cost-effectiveness may be systematically underestimated (77, 180). Similar extrapolations of costs and benefits have been conducted in a recent (68) to project future outcomes, where other options are lacking.

Due to the lack of studies to compare with and the existing ones being considerably heterogeneous, when it comes to health economic perspectives, costs included, reporting of costs and healthcare utilisation, it was not possible to make meaningful comparisons of ICER, which may also be seen as a limitation.

The use of cost-effectiveness thresholds is not problem-free and is associated with substantial theoretical, empirical, and normative challenges. There are two principal methods for estimating the cost-effectiveness threshold: a normative approach reflecting the population's willingness to pay for health, and a marginal productivity approach that represents the health foregone when replacing existing treatments with the new intervention (95). For complex interventions with long-term and cross-sector effects, fixed thresholds can oversimplify value assessment and obscure uncertainty and distributional effects. Furthermore, they may fail to represent true affordability or local resource constraints. Therefore, context-specific approaches are advocated instead of static thresholds (181, 182). The purpose of using a cost-effectiveness threshold in Study III, was to put the results of the cost-utility analysis in perspective with existing methods of determining cost-effectiveness. The cost-effectiveness threshold alone cannot resolve healthcare priority setting, but it may support policy decision-making (183).

The cost descriptions of Study I and Study III were not directly comparable as the costs included differed. The cost description of healthcare utilisation in Study I included costs for diagnostic and interventional procedures, such as radiographic examinations, surgical interventions, and hospital admissions. Study III did not include these costs.

Generalisability

The significant dropout in Studies II and III reduces the generalisability of the results by limiting the representativeness of the final samples. Their cross-national design, however, partially counteracts this, as the data includes patients from both the northern and southern regions of Sweden. Dropout rates align with those reported in other studies using the SQRP (152, 184). The dropout pattern in Studies II and III may reflect inadequate reporting protocols, as IPRP had been introduced only recently in primary care at the time of data collection.

The limited number of participants in Study I means the findings should be interpreted with caution, as their wider applicability is limited. To address this, the effect sizes were also provided. These indicate a potentially relevant effect. However, a larger sample size is needed for more reliable conclusions.

The large sample size in Study IV, by contrast, enhances methodological robustness through increased statistical power and better generalisability of the findings to a wider range of clinical populations. Since the thesis was carried out in Sweden and Finland, its external validity is most relevant to similar healthcare systems.

Conclusions

This thesis demonstrates that implementing an interdisciplinary pain rehabilitation programme (IPRP) in primary care provides various health-economic benefits for the primary care centre, the individual, and society. The findings suggest that IPRP enhances health-related quality of life and reduces sickness absence to an extent that supports its cost-effectiveness compared with usual care. Further investigation into the long-term health-economic impacts of IPRP in primary care could reinforce the argument for its adoption, despite the significant initial investment. Over time, such implementation would improve access to evidence-based pain management and facilitate earlier detection and intervention for individuals at risk of developing chronic pain.

IPRP decrease healthcare utilisation, leading to cost savings and freeing up resources within the primary care centre. As the biomedical model shifts towards the biopsychosocial approach, the primary roles of general practitioners and physiotherapists become less prominent. This change involves reallocating workforce resources to other professionals on the interdisciplinary team, such as occupational therapists, psychologists, social workers, and nurses, whose roles are becoming increasingly important. Implementing IPRP in primary care benefits not only patients with chronic pain but also enhances teamwork and person-centred care more broadly at the primary care centre, supporting the ongoing movement within the Swedish health and social care system towards high-quality, accessible, community-based care.

The selection of patients for IPRP in primary and specialist care in Sweden appears to be influenced by socioeconomic factors rather than by adherence to existing guidelines. A biased selection of patients leads to unequal treatment of chronic pain patients and to an ineffective use of limited healthcare resources. Given the imbalance in the distribution of chronic pain patients, the allocation of limited healthcare resources warrants careful consideration.

Clinical implications and future research

Primary care provides a cost-effective setting for interdisciplinary pain rehabilitation as it allows early identification and treatment of individuals at risk of developing chronic pain. Additionally, IPRP delivered in primary care reduces reliance on more expensive specialist services, thus contributing to a more efficient use of healthcare resources. Since IPRP is largely underutilised in primary care, the findings of this thesis have several clinical implications.

- IPRP should be prioritised in primary care to improve access to evidence-based pain management across all healthcare levels.
- Healthcare providers in primary care, especially those delivering IPRP, should receive comprehensive training in chronic pain and biopsychosocial informed care.
- Historically, translating evidence into practice has been slow due to the cumbersome administrative system. To increase the number of primary care centres offering IPRP, there is a need for bold, creative approaches to working, reorganising, and mobilising existing resources.
- Innovative funding could be allocated to individual primary care centres for local pilot projects that aim to implement IPRPs
- There is a need to clarify existing national guidelines for the assessment and selection of chronic pain patients for IPRP and assist healthcare providers in applying them consistently.
- A seamless collaboration and knowledge sharing between primary and specialist care providers is warranted, as it could ensure that referrals are correctly sent from primary care and accepted in specialist care.
- There is a need to raise awareness and discuss how socio-economic factors impact the selection of patients for IPRP.
- We must increase knowledge and awareness of long-term pain and its consequences for the individual and society in order to influence decision makers

Based on the findings of this thesis, future research should address the following areas:

- Long-term clinical trials using observed outcome data should test and confirm the findings of this thesis and should include appropriate control groups.

- Researchers should develop standardised outcome measures for economic evaluations of IPRPs in order to reduce methodological heterogeneity across economic evaluations.
- Future research should examine how health care services can reallocate personnel towards IPRP and should analyse practical implementation strategies within primary care centres.
- Studies should identify effective mechanisms to support collaboration around IPRPs between primary care and specialist care.
- Comparative analyses should evaluate outcomes of IPRP in primary and specialist care to promote efficient use of limited health care resources.
- Research should assess strategies that ensure equal and transparent patient selection for IPRPs across primary and specialist care settings.

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