Treatment of Knee Osteoarthritis in Primary Care

Needs, Influencing Factors, Outcome Prediction, and Implementation of Guidelines

PhD thesis

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Preface

This thesis was carried out at the Research Unit for Musculoskeletal Function and Physiotherapy at the Department of Sports Science and Clinical Biomechanics at the University of Southern Denmark, Odense, Denmark. The main supervisor was Professor Ewa M. Roos from the same research unit. Co-supervisor was Associate Professor and MD Jesper Lykkegaard from the Research Unit of General Practice at the Department of Public Health, University of Southern Denmark.

The thesis includes three different data-sets: two national ones from the Danish National Health Survey and the GLA:D® registry, and one from a local cohort collected from a Danish general practice. The locally collected data, was obtained as part of the European quality improvement project "Joint implementation of guidelines for osteoarthritis in Western Europe" (JIGSAW-E).

For the conduct of the JIGSAW-E project, the European Institute of Innovation and Technology (EIT) Health granted funding.

List of papers

I. **Baumbach L.**, Roos, E. M., Lykkegaard J., Thomsen K. S., Kristensen P. L., Christensen A. I., Thorlund J. B. (2020). Patients with osteoarthritis are least likely to receive lifestyle advice compared with patients with diabetes and hypertension: A national health survey study from Denmark. Osteoarthritis and Cartilage Open, 100067

II. **Baumbach L.**, List M., Grønne D. T., Skou S. T., Roos E. M. (2020). Individualized predictions of changes in knee pain, quality of life and walking speed following patient education and exercise therapy in patients with knee osteoarthritis – A prognostic model study. Osteoarthritis and Cartilage, 28(9), 1191-1201.

III. **Baumbach L.**, Ankerst D., Roos E. M., Nyberg L. A., Cottrell E., Lykkegaard J. Association between received treatments and satisfaction with care for patients with knee osteoarthritis seen in general practice in Denmark (submitted to the Scandinavian Journal of Primary Health Care on the 09/06/2020)

IV. **Baumbach L.**, Roos E. M., Ankerst D., Nyberg L. A., Cottrell E., Lykkegaard J. Effects of a multi-component intervention on the quality of care for knee osteoarthritis in a general practice in Denmark (in manuscript)

Thesis at a glance

	Assessment of needs (Paper I)	Prediction model development (Paper II)	Quantification of a factor influencing implementation (Paper III)	Evaluation an implementation (Paper IV)
Aim	To evaluate the proportion and associations of patients having OA, hypertension or diabetes alone or in combination and receiving advice on a) exercise and b) weight reduction	To predict individual changes in pain intensity, knee-related quality of life, and walking speed after two educational and 12 exercise therapy sessions in patients with knee OA	To investigate the association between received first-line or adjunctive treatment elements and satisfaction with knee-related care	To evaluate the effectiveness and sustainability of a multicomponent intervention on the care for patients with knee OA in a Danish general practice
Design	Cross-sectional study	Prognostic model study	Cross-sectional study	Longitudinal intervention study
Participants	71,717 participants aged ≥ 45 who have consulted their general practitioner during the previous 12 months of which 14,033 were obese	6,767 patients (and 2,863 validation patients) participating in the Danish patient education and exercise therapy program (GLA:D®)	131 patients aged ≥ 30 years who had at least one registered contact with their GP clinic in the previous six months due to knee OA	6 GPs of one Danish GP clinic, who provided knee OA-related care to 160 patients aged ≥ 30 years
Methods	Self-reported data from the Danish National Health Survey 2017 Outcome: Receipt of advice on a) exercise and b) weight reduction (if obese) Exposure: Seven patient groups with OA, hypertension and/or diabetes	Data from the GLA:D® registry Outcome: Changes in a) VAS measured pain intensity, b) KOOS quality of life score, c) walking speed (m/sec) from before to after the GLA:D® program 51 potential predictor variables obtained at baseline	Self-reported patient and electronic medical record data Outcome: Satisfaction with care ("satisfied" vs. "unsatisfied or neutral") Exposure: Receipt of nine treatment elements	Self-reported patient and electronic medical record data collected over two years in half year periods Intervention: Six primary interventions and three supportive follow-up interventions Outcome: Usage of newly introduced tools by the GPs and received treatment elements in patients with knee OA
Results	Patients with OA alone were least likely to receive exercise and weight-reduction advice. Patients with an additional disease were more likely to receive lifestyle advice. For all patient groups there was room for improving the delivery of lifestyle advice in general practice	Individualized predictions for changes after the GLA:D® program were not better at a clinically relevant level than average predictions	Providing information on first-line treatments to patients with knee OA ensures evidence-based high quality of care and was well accepted by the patients	A multicomponent intervention had only a transient effect over 6 months on the care provided to patients with knee OA in a GP clinic

GLA:D®: Good Life with osteoArthritis in Denmark, GP: General Practitioner, KOOS: Knee injury and Osteoarthritis Outcome Score, OA: Osteoarthritis, VAS: Visual Analog Scale

Scientific contributions

Paper I – Assessment of needs	
Study design	Linda Baumbach, Ewa M. Roos, Jesper Lykkegaard, Kristine S. Thomsen, Peter L. Kristensen, Anne I. Christensen, Jonas B. Thorlund
Data analysis and interpretation	Linda Baumbach, Ewa M. Roos, Jesper Lykkegaard, Kristine S. Thomsen, Peter L. Kristensen, Anne I. Christensen, Jonas B. Thorlund
Manuscript writing	Linda Baumbach
Manuscript revision	Linda Baumbach, Ewa M. Roos, Jesper Lykkegaard, Kristine S. Thomsen, Peter L. Kristensen, Anne I. Christensen, Jonas B. Thorlund
Paper II – Prediction model development	
Study design	Linda Baumbach, Markus List, Dorte T. Grønne, Søren T. Skou, Ewa M. Roos
Data analysis and interpretation	Linda Baumbach, Markus List, Dorte T. Grønne, Søren T. Skou, Ewa M. Roos
Manuscript writing	Linda Baumbach
Manuscript revision	Linda Baumbach, Markus List, Dorte T. Grønne, Søren T. Skou, Ewa M Roos
Paper III – Quantification of a factor influencing implementation	
Study design	Linda Baumbach, Ewa M. Roos, Donna Ankers, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard
Data analysis and interpretation	Linda Baumbach, Ewa M. Roos, Donna Ankers, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard
Manuscript writing	Linda Baumbach
Manuscript revision	Linda Baumbach, Donna Ankers, Ewa M. Roos, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard
Paper IV – Evaluation of an implementation	
Study design	Linda Baumbach, Ewa M. Roos, Donna Ankers, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard
Data analysis and interpretation	Linda Baumbach, Ewa M. Roos, Donna Ankers, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard
Manuscript writing	Linda Baumbach
Manuscript revision	Linda Baumbach, Ewa M. Roos, Donna Ankers, Lillemor A. Nyberg, Elizabeth Cottrell, Jesper Lykkegaard

Abbreviations

BMI	Body Mass Index
BPI	Bootstrapped Percentile Interval
CI	Confidence Interval
DNHS	Danish National Health Surveys
EMR	Electronic Medical Records
GLA:D®	Good Life with osteoArthritis in Denmark
GP	General Practitioner
JIGSAW-E	Joint Implementation of osteoarthritis guidelines across Western Europe
KOOS	Knee injury and Osteoarthritis Outcome Score
MRI	Magnetic Resonance Imaging
NICE	National Institute for health and Care Excellence
OA	Osteoarthritis
QoL	Quality of Life
SD	Standard Deviation
RMSE	Root Mean Squared Error
RR	Relative Risk
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
VAS	Visual Analog Scale
WHO	World Health Organization

Definition of terms

Adjunctive treatments	contain the receipt of any treatment which is recommended as second-line or third-line [1].
Exercise	comprises physical activities, which are done with the intention to maintain or improve physical fitness or health [2].
First-line treatments	consist of the three treatments: Patient education, Exercise and Weight reduction, which are recommended as initial treatments for patients with knee osteoarthritis [1,3-5].
Health education	according to the WHO is: "…any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes" [6].
Osteoarthritis	refers to symptomatic osteoarthritis.
Primary care	comprises medical treatments provided by local doctors or other health workers rather than specialist treatments at a hospital [7]. The recommended first-line treatments are thus provided in primary care.
Patient education	is defined as the process of influencing patient behavior and producing changes in knowledge, attitudes and skills necessary to maintain or improve health [8].
Elements of care	are provided by health professionals such as information or referrals to specialists. Several elements of care may build a treatment e.g. advising about exercise or referring to physiotherapy may be elements of the first-line treatment.

Introduction

The scope of the problem

The most common joint disease is osteoarthritis (OA), and its prevalence has doubled during the last 50 years [9-11]. The prevalence of OA increases with age. Above the age of 16 years, one out of five people self-reports they have OA. In the Danish population of people 75 years or older, it is every second person [12]. Further, OA is the second most common reason to consult the general practitioner (GP), also in Denmark [13-15]. The joints with the highest population impact are the knee and hip, as pain and stiffness in these weight-bearing joints often lead to reduced function and disability, which can cause sick leave, early retirement and expensive surgery [16-18]. Therefore, it is important to provide the optimal treatments to patients with OA. However, international studies indicate that the management of patients with OA in many healthcare systems is suboptimal [19-25].

Definition of knee osteoarthritis

Knee OA is a degenerative joint disease, which affects the knee joint and the surrounding structures [26]. However, there is no single definition of knee OA encompassing all circumstances [27]. Depending on the context, it is defined by structural pathologies or based on classification and diagnostic criteria and symptoms [16]. Structural pathologies are radiographically evaluated and graded by the Kellgren & Lawrence classification system from 0-4 (“no OA” to “severe OA”) [28]. The primary symptoms of knee OA are pain and stiffness. However, different diagnostic and classification criteria are recommended by different authorities [29]. Three of these are presented in Table 1.

Table 1. Overview of criteria recommended by authorities to clinically diagnose osteoarthritis

	The National Institute for Health and Care Excellence (NICE) of the UK [18]	American College of Rheumatology (ACR) [30]	The Danish knee osteoarthritis clinical guidelines [3]
Diagnostic criteria	- Activity related knee pain - ≥ 45 years - Morning stiffness no longer than 30 minutes or no-morning joint related stiffness	- Knee pain and one of the following three symptom combinations: 1) Crepitation, morning knee stiffness of 30 min or less, and aged 38 years or more 2) Crepitation, morning stiffness of longer than 30 min, and bony enlargement 3) No crepitation, but bony enlargement	- Knee complaints for ≥ 3 months plus at least three of the following symptoms: - Intermittent swelling - Crepitation - Stiffness/reduced mobility - ≥ 40 years old - Blood sample results do not indicate an inflammation or other rheumatic disease

Health education

According to the World Health Organization (WHO), health education aims at improving the health of individuals and communities. This is done by designing and combining learning experiences to increase knowledge or influence attitudes of health care providers and the public [6]. Bartholomew *et al.* specify: "The practice of health education involves three major program planning activities: Conducting a needs and capacity assessment, Developing and implementing a program, and Evaluating the program's effectiveness" [31]. In the needs and capacity assessment activity, existing literature and the status quo are assessed. Further, determinants are evaluated to identify barriers and enablers influencing the behavior and context that cause health and quality of life (QoL). For the second activity, Bartholomew and colleagues introduced the intervention mapping framework consisting of the following five steps: 1) proximal program objectives matrices, 2) theoretical methods and practical strategies, 3) program design, 4) adoption and implementation plan, 5) monitoring and evaluation plan [31]. Lastly, in the third activity of health education, when evaluating the program's effectiveness, it is important to include process measures and effect measures of outcomes. Effect measures indicate if a program improved the health of the patient; however, health is also influenced by many other factors than the received care. Therefore, to evaluate the quality of care, and to identify where changes are needed, process measures are easier to apply [32-34]. Process measures evaluate elements of provided and received care, and need to be associated with effect measures, such as reduced pain intensity. Health education is often addressed by multiple actors at the same time, which highlights the opportunity for parallel, iterative processes in the improvement of individual and community health.

Health education for patients with knee osteoarthritis

For patients with knee OA, several studies have identified and evaluated effective treatments [18,35-39]. The results of these studies are summarized in clinical guidelines, including grading the strength of the recommendation for a specific treatment [3,5,18,37,38,40,41]. In Denmark the grading goes from A - D (high to low). The strength is based on the type of underlying studies used for formulating the recommendation (Table 2). The aim of such clinical guidelines is to increase the application of evidence in clinical practice.

Table 2. Overview of the grading system for the strength and evidence of recommendations in clinical guidelines in descending order

Type of publication	Evidence	Strength
Meta-analysis Randomized control trial	Ia Ib	A
Control trials without randomization Cohort studies	II	B
Case-control-study Descriptive studies	III	C
Expert committee reports	IV	D

Recommended first-line treatment

International clinical guidelines agree on a step-wise treatment approach for managing knee OA [1,3-5,18,37-42] (Figure 1 from Roos and Juhl 2012 [1]). The recommended first-line treatments are patient education (strength B), exercise (strength A) and if indicated, weight reduction (strength A) [3]. These treatments are also defined as core treatments [18], which may be combined with adjunctive treatments such as pain-killers and passive treatments, if needed [18,43]. Only if the combination of the first-line and adjunctive treatments were introduced to the patient and failed to reach the desired improvements, surgery should be considered [1,18,43]. The first-line treatments lead to pain reduction, increased QoL, and improved function [43-46], which are important outcomes for patients with knee OA [4,47]. This step-wise treatment approach for patients with knee OA is also recommended in Denmark, according to the national clinical guidelines released in 2012 [3].

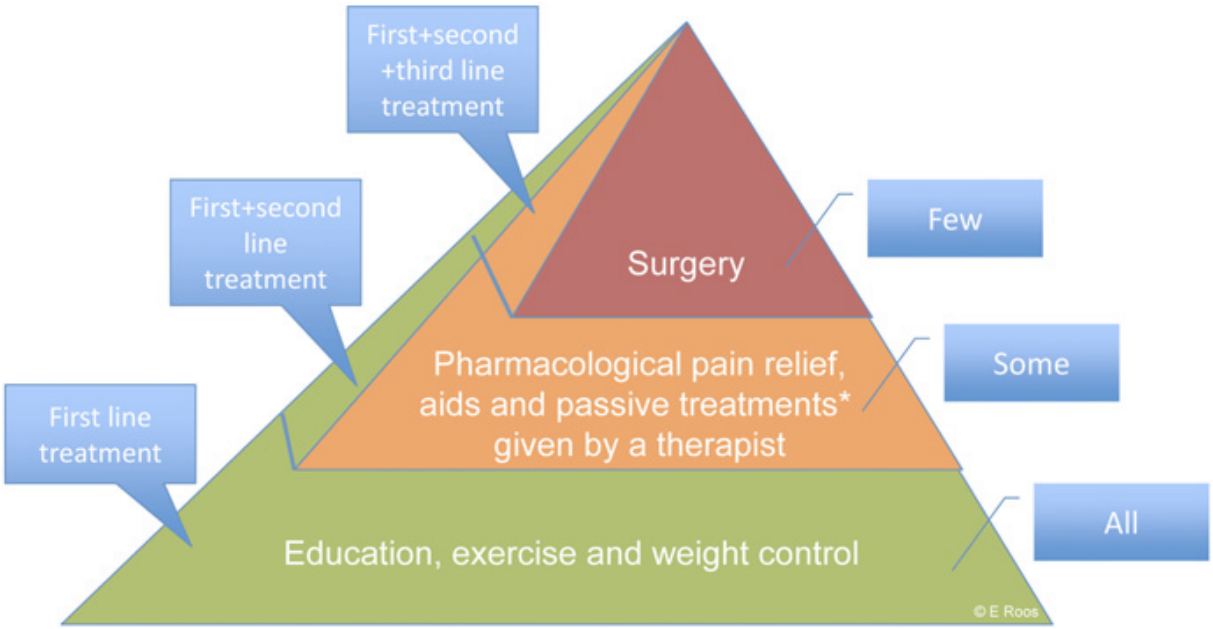

Figure 1. Step-wise treatment approach for managing patients with knee osteoarthritis from Roos and Juhl 2012.

The Good Life with osteoArthritis in Denmark (GLA:D®) program

Patients should receive the recommended first-line treatment in primary care. However, studies indicate that most patients with knee OA seen in primary care are initially treated with adjunctive treatments, or with treatments that lack evidence regarding their effectiveness [19,24,25,48,49]. To support the receipt of the recommended, evidence-based, first-line treatments from physiotherapists in patients with knee OA, GLA:D® was initiated in 2013. GLAD® consists of three parts: 1) courses for physiotherapists in delivering clinical guideline-based care, 2) a standardized patient education and exercise program, and 3) the GLAD® registry, a data repository for results evaluation. The annual reports from GLA:D® highlight that after the initial treatments involving education and exercise, patients in clinical practice report fewer symptoms [46]. This is a health education success, as it confirms that the first-line treatments are effective in research and clinical settings.

Osteoarthritis treatment in Danish general practices

In Denmark, GPs have a key function, as they are the first contact for patients entering the health care system. They have a gatekeeper function and refer patients to a specialist if needed. Therefore, it is part of their duty to ensure the provision of knee OA first-line treatment elements, such as information on exercise, and if needed on weight reduction, but also to refer to physiotherapy if indicated. However, as in many other countries, the first-line treatments for patients with knee OA are underutilized in Denmark according to a European study [20]. This

study included 49 Danish patients, of which 8 (17%) received information on lifestyle changes [20]. Due to the small sample size, generalization of the findings might be questioned, and the status quo of received first-line treatment elements in patients with knee OA across Denmark remains uncertain.

Barriers and enablers influencing implementation in primary care

A systematic review of reviews identified four sources of barriers and enablers for clinical guideline implementation, which should be considered: the external context, the organization, the professionals and the interventions [50] (see Figure 2, adopted from [50]). It is acknowledged that barriers and enablers can be subject to change, which means that barriers can become enablers or vice versa [50]. Further, a 'fit' between the intervention and the specific external, organizational, and professional context is important for a successful implementation [50].

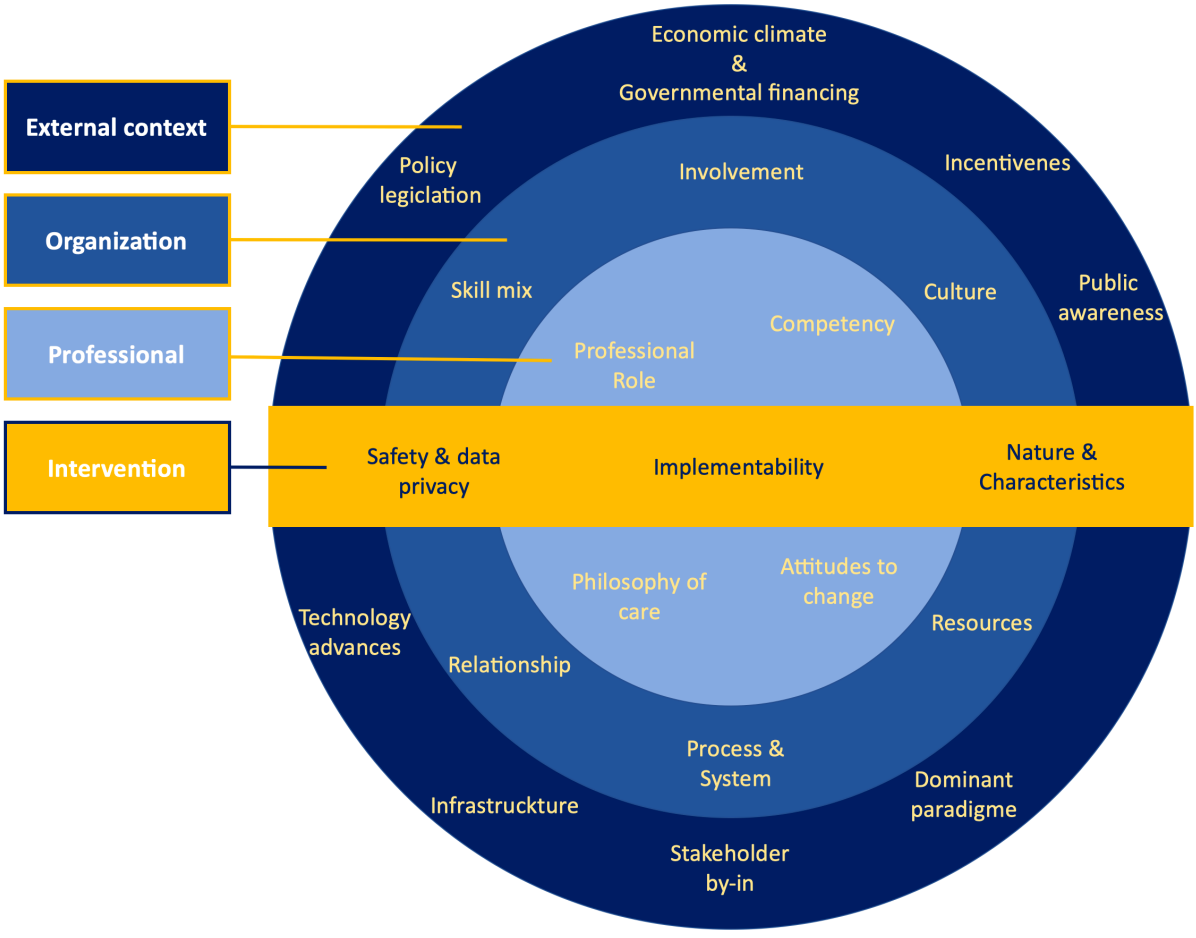

Figure 2. Barriers and enablers that influence implementations, adopted from Lau et al. 2016.

Examples of existing professional barriers to delivering the recommended first-line treatments for patients with knee OA are assumptions made by GPs that patients prefer adjunctive

treatments over first-line treatments [51], and that GPs are concerned about their relationship with the patient when addressing required lifestyle changes such as weight reduction and exercise [52,53]. Also, GPs feel a lack of expertise to provide such first-line treatments [52,54].

An organizational barrier experienced by GPs is the lack of consultation time [52]. In this regard, it is also unknown how additional diseases, requiring lifestyle changes as well as initial treatment, affect the chance of receiving advice on common first-line treatments.

External sources facilitating implementation are technologies [50,55]. Examples of such technologies are computational tools, which can support the diagnosis or treatment decision process. Such decision tools may increase GPs' confidence in providing information on first-line treatments. In the development of such tools, it is important to include a validation and comparison with the state-of-the-art, as well as evaluating the usability and effectiveness in a clinical setting [56-59]. Currently, there is only one model predicting treatment success based on exercise interventions in patients with OA with applicability to clinical practice [60]. It was built using only 101 cases and combines exercise with the adjunctive passive treatment of manual therapy. Furthermore, the prediction model was not validated externally, and is thus not ready for implementation into clinical practice.

International primary care quality improvement project

The implementation of knee OA first-line treatments requires improvements in many countries [20]. Therefore, a British team of researchers started the Management of Osteoarthritis In Consultation Study (MOSAICS) in 2011 [61]. The primary aim of the study was to determine the clinical and cost effectiveness of a model OA consultation, which implements core recommendations from the National Institute for Health and Care Excellence (NICE) OA guidelines in primary care. Furthermore, the impact, feasibility and acceptability of this model consultation was evaluated to develop and evaluate a training package for GPs for the management of OA. Lastly, the feasibility of 'quality markers' for OA management using a new consultation template for documentation was evaluated. Due to its success in the provision of information on first-line treatments, the study was upscaled to "Joint Implementation of osteoarthritis guidelines across Western Europe" (JIGSAW-E) [62]. The aim of JIGSAW-E was the implementation of an approach to improve the quality of care and to support self-management of OA in primary care. The JIGSAW-E approach includes four innovations: 1) an OA guidebook written by patients and health professionals, 2) a model consultation, 3) training

for health professionals delivering the care, and 4) quality indicator recording and measurement tools [63]. To ensure a successful implementation, which has the potential to increase the quality of care in other Western countries, these innovations need to be adapted to the specific national health care contexts.

Aim of the thesis

The overall aim of this PhD thesis was to explore the current usage and ways of improving usage of first-line treatments for patients with knee OA in general practice.

Specific aims

Paper I: To investigate the proportions and associations between having OA, hypertension or diabetes alone or in combination with receiving exercise advice, and (if obese) weight reduction advice, from the GP, and to evaluate if there was a change in received advice in patients with OA from 2013 to 2017.

We hypothesized that patients with more than one disease requiring lifestyle changes are more likely to receive lifestyle advice from their GP and that this practice would increase from 2013 to 2017 for patients with OA.

Paper II: To provide validated algorithms predicting expected individualized changes immediately after patient education and exercise therapy for patients with knee OA and compare them to predictions of average changes.

We hypothesized that, individual predictions are more precise than average prediction of expected changes following patient education and exercise therapy in patients with knee OA.

Paper III: To investigate the association between receiving different elements of care and satisfaction with knee-related care at a GP clinic.

We hypothesized that, patients with OA receiving lifestyle advice are less satisfied with their received knee related treatment than those who did not received the advice.

Paper IV: To Implement multi-component interventions at a GP clinic and to evaluate the sustainable effectiveness of these interventions, which were supported by activities to maintain changes, for the management of patients with knee OA.

We hypothesized that the quality of delivered care sustainably improved after a multicomponent intervention.

Methods

The specific aims of the thesis, in light of the health education process for improving the treatment of patients with knee OA in primary care, are illustrated in Figure 3. Each of the papers in the thesis is categorized into the three main activities of the health education process. Paper I evaluates if and to what extend changes in the provision of first-line treatment recommendations from the general practitioners in Denmark are needed. Paper III points as well at the needs and capacity assessment, and it is evaluating a factor which might influence the provision of first-line treatments, and should thus be respected when developing and implementing programs aiming at increasing the provision of first-line treatments. In paper II, an algorithm to support motivating patients for the first-line treatments and the shared-decision making process was developed. Finally, in paper IV, a developed and tested program from the UK was adopted to the Danish context and implemented as well as evaluated.

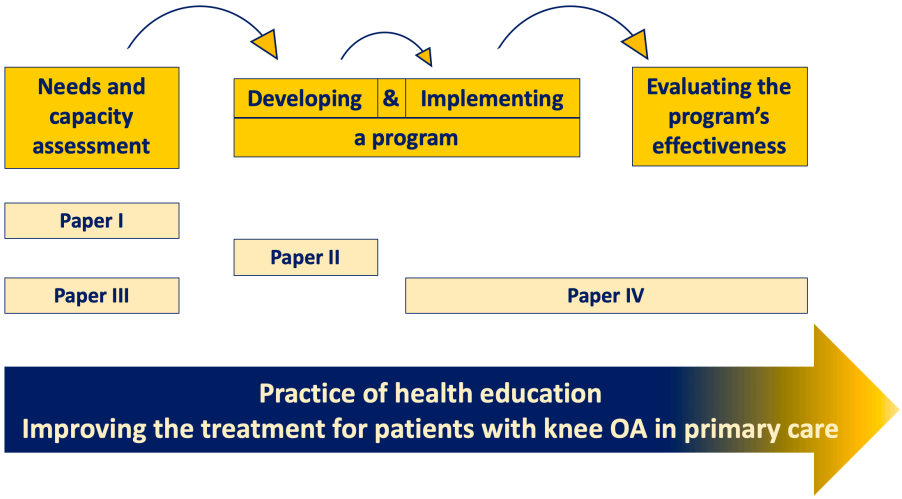

Figure 3. Overview of included papers in this thesis, as part of the health education in knee osteoarthritis first-line treatments.

An overview of the data collection periods of the three data sets included in the thesis is presented in Figure 4. Papers I and II used existing data from the Danish National Health Survey (DNHS) and the national GLAD® registry, respectively. Papers III and IV utilized Danish data collected as part of the JIGSAW-E research project in a local cohort. This research project was designed as a Danish pilot study to test a culturally adopted implementational program for

sustainable effectiveness, and to build a Danish GP champion clinic which could support the wider implementation.

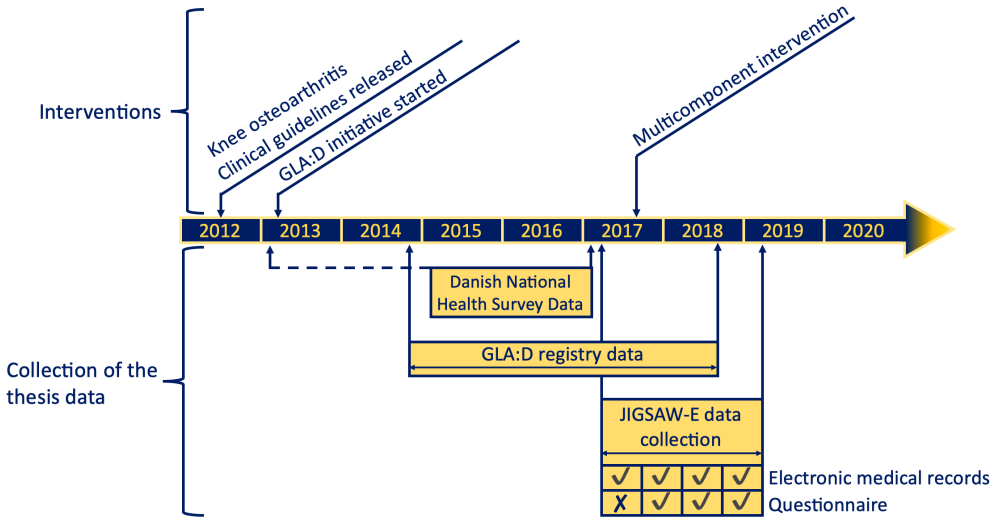

Figure 4. Data collection for the thesis in light of interventions addressing patients with knee osteoarthritis.

Registration and Ethics

For Paper I, data were provided after application to the DNHS. No further registrations were needed. The patients from the remaining two data sources, GLAD® and JIGSAW-E, gave informed consent to use their data for research. Both projects were approved by the Danish Data Protection Agency (cases SDU, 10,084 and SDU, 10,267, respectively) and for both projects, the respective ethics committees of the Regions of Northern and Southern Denmark decided that their approval was not required.

Table 3. Participant inclusion criteria and osteoarthritis definition for the four papers

Inclusion criteria	Paper I – Danish National Health Survey data	Paper II – GLA:D® registry data	Papers III and IV – data from one Danish GP clinic
Age	≥ 45	✗	≥ 30
Presence of osteoarthritis *Defined as:*	✗ *Self-reported present or prior OA in combination with symptoms in the extremities or joints during the last 14 days*	✓ *Patients were considered to have OA, since they participated in the GLA:D® program, which has the inclusion criterion of having had contact with the health care system due to problems in their hip or knee, which were not due to another problem such as tumor, inflammatory disease, sequelae hip fracture, or more severe symptoms from fibromyalgia or generalized pain [46]*	✓ *A listed diagnosis code of the ICPC-2-R during the study period at the GP clinic of either:* *- (L90) knee OA* *- (L91) OA + knee mentioned in free text* *- (L15) knee complaints recurring ≥ 3 months without an acute event or other explanation*
Complete data	✓	✓	✗
Time of data collection	February 2017 and February 2013	Baseline data registered between: 9. October 2014 and the 31. August 2017 for model building and between 1. September2017 and 31. August 2018 for model validation	For Paper III: September 2017 until February 2019 For Paper IV: March 2017 until February 2019
Additional inclusion criteria	Self-reported to have seen their GP in the previous 12 months.	Participated in the GLA:D® program and indicating the knee as the principal joint of complaint	A primary or secondary listed diagnosis code of the ICPC-2-R during the time of the data collection at the GP clinic of either: - (L90) knee OA - (L91) OA + knee mentioned in free text - (L15) knee complaints recurring ≥ 3 months without an acute event or other explanation. For Paper II: Information on the outcome was available For Paper IV: Patients with a replaced knee were excluded

GLAD®: Good Life with osteoArthritis in Denmark, ICPC-2-R: International Classification of Primary Care, OA: Osteoarthritis, ✗: Not an Inclusion criterion, ✓: An inclusion criterion

Table 4. Overview of the outcome (O), exposure/predictor (E), and characteristic (C) variables in the four papers. The number of variables to obtain the information is given in parentheses.

Information	Paper I	Paper II	Paper III	Paper IV
Age	C	E	C	C
Sex	C	E	C	C
BMI	C	E	-	C
Number of comorbidities	-	-	-	C
OA	E	-	C	C
Hypertension	E	E	-	C
Diabetes	E	E	-	-
Cancer	-	E	-	C
Digestive disease	-	E	-	C
Sensory disease	-	-	-	C
Cardiovascular disease	-	E	-	C
Hypercholesterolemia disease	-	-	-	C
Musculoskeletal-disease	-	E	-	C
Neurological disease	-	E	-	C
Psychological disease	-	E	-	C
Pulmonary disease	-	E	-	C
Skin disease	-	-	-	C
Endocrine disease	-	-	-	C
Urinary and Genital disease	-	-	-	C
Other disease	-	E (n=3)	-	-
Presence of previous knee surgery/replacement	-	E (n=2)	C	C
Wants or waiting for surgery	-	E (n=2)	-	-
Radiographic signs of OA	-	E	-	-
Presence of pain	-	E (n=7)	-	-
Duration of symptoms	-	E	-	-
Knee-related quality of life	-	E	C	C
ASES other symptom score	-	E	-	-
EQ-5D score	-	E	-	-
SF12 score mental and physical component	-	E (n=2)	-	-
General health situation	-	E	-	-
Level of physical activity	C	E (n=2)	-	-
Walking difficulty	-	E	-	-
Use of helping aid for walking	-	E	-	-
Anxious about physical activity	-	E	-	-
Smoking	-	E	-	-
Sick leave during the last year	-	E	-	-
Educational level	C	E	-	-
Working status	-	E	-	-
Born in Denmark	-	E	-	-
Danish citizen	-	E	-	-
Living situation	-	E	-	-
Reason and number of consultations	-	E	C	C (n= 4)
(Usage of) maximal step-up test	-	-	-	O
(Usage of) 30-second chair stand test	-	E	-	O
40m Fast Paced Walking Test	-	E	-	-
Usage of documentational tool	-	-	-	O
Received information on osteoarthritis	-	-	E	O
Received information on treatment options	-	-	E	O
Received information on managing osteoarthritis	-	-	E	O
Received information/advice on exercise	O	-	E	O
Received advice on weight reduction	O	-	E	O
Received information on relationship between weight and osteoarthritis	-	-	E	O
Received information on when the next review of the joint should happen	-	-	E	O
Received pain medication	-	E	E	O
Referred to physical therapy due to knee OA	-	-	E	O
Treatment received at the physiotherapist	-	E	-	-
Referred to orthopedic specialist	-	-	E	O
Referred to rheumatological specialist	-	-	E	O
Referred to imaging	-	-	E (n=2)	O (n=2)
Satisfaction with knee-related care	-	-	O	-
Change in pain intensity (-100 – 100; worse – better)	-	O	-	-
Change in knee-related QoL (-100 – 100; worse – better)	-	O	-	-
Change in walking speed m/seconds	-	O	-	-

(BMI = Body Mass Index, n= number of variables, OA = osteoarthritis, QoL = Quality of Life)

Paper I – Assessment of needs based on Danish National Health Survey data

For the primary aim of Paper I, a cross-sectional study design was used, meaning observational data from the DNHS were evaluated at one point in time.

Data source and participants

Since 2010, the DNHS has been conducted every 3 to 4 years and aims at monitoring the health of the Danish population. Each time, a random sample of Danish residents is selected from a list of all personal unique identification numbers (which are mandatory for Danish residents) and invited to participate in the survey. Data from 2017 were used to calculate proportions and associations. To evaluate the change over time in advice received, data from 2013 were also utilized.

In Paper I, only participants aged at least 45 years, who had consulted a GP within the last twelve months, were included (Table 3).

Variables

The two process measure outcome variables of interest were the exercise and weight reduction advice received. Participants responded to the questions: “Did your GP during the last 12 months advise you to a) exercise, and b) reduce weight?” with either “yes”, “no”, or “I do not remember” as response options. The outcome was dichotomized into “yes” vs. “no” or “I do not remember”.

The exposure variables investigated were the presence of OA, hypertension, and diabetes alone or in combination. All diseases were self-reported based on the question, “Do you currently have, or have you previously had, *the respective disease*?” The response options were dichotomized into “Yes, I have it now” or “Yes, I have previously had it” vs. “No”. Additionally, to be classified as a patient with OA, the participants needed to report a typical OA symptom during the last 14 days. The question asked was, “Have you, during the last 14 days, been bothered by pain or discomfort in the arms, hands, legs, knees, hips or joints, and if so, have you been bothered a little or a lot?”. Patients who answered: “Yes, a lot” or “Yes, a little” were considered to have OA symptoms, while participants who answered “No”, were not considered to have symptoms, and thus not categorized as having OA. The additional criteria for the OA definition was used to reduce the false positive rate in categorised patients with OA.

In the analysis, the following characteristics of the patients were considered as confounding variables: Age, Sex, Body Mass Index (BMI), Educational level, and Level of physical activity. BMI was included as confounding variable in the analysis on weight reduction as we assumed that even in the included obese participants there will be an association between BMI and the reception of advice. The specific questions asked for all confounding variables may be found in Paper I.

Statistics

To evaluate the proportions of patients receiving advice on exercise and weight loss, and associations with three diseases, the included participants were grouped into seven patient groups and one reference group. In the patient groups, the participants had OA, hypertension or diabetes alone or in any combination. In the reference group, patients had none of the three investigated diseases. Two logistic regressions were performed to quantify the association, via odds ratios, of the diseases and the receipt of advice. One regression was performed for the receipt of exercise advice and another one for the receipt of weight reduction advice. In the analysis on weight reduction advice only, participants with a BMI of at least 30 were included, to ensure that advice was indicated. Both analyses were performed crudely and also with adjustments for age, sex, BMI, educational level, and level of physical activity. In addition, statistical weights, which were supplied by the DNHS were included. They account for differences in characteristics between responders and non-responders to the DNHS, by utilizing national registry data.

To evaluate the change in exercise and weight reduction advice received by patients with OA (alone or in combination with either of the two other diseases) from 2013 to 2017, Chi^2 tests were applied with statistical significance levels of $p < 0.05$.

Paper II – Prediction model development based on GLA:D® registry data

This was a prognostic model study with a longitudinal design. Thus, repeated observations of the same variables were obtained at different points in time.

Data source and participants

The GLA:D® registry was utilized as the data source. It stores data collected before, immediately after and 12 months after a standardized physiotherapist-delivered patient education and exercise therapy program for patients with hip and knee OA (the GLA:D® program). The program includes two educational and 12 exercise therapy sessions (60 min, twice a week for 6 weeks). The registry data includes two functional tests, and variables describing the treatment setting, characteristics of the patients and patient-reported outcome measures. Data collected between October 2014 and August 2017 were utilized for model building. Data collected between September 2017 and August 2018 were used to validate the models. Patients included in this paper had knee OA and participated in the GLA:D® program (Table 3)

. All these patients had contact with the health care system due to their symptoms in the knee joint. However, patients with other reasons for these symptoms such as a tumor, an inflammatory joint disease, or sequelae after hip fracture were excluded. Furthermore, patients were excluded from the GLA:D® program if other symptoms were more pronounced than the OA problems, such as chronic, generalized pain, or fibromyalgia.

Variables

The effect measure outcomes of interest in this paper were the changes from before to after the GLA:D® program in pain intensity measured on a Visual Analog Scale (VAS) (0-100; best to worst), knee-related QoL measured on the Knee injury and Osteoarthritis Outcome Score (KOOS QoL score) (0-100; worst to best) and walking speed measured in m/sec with the 40m Fast-Paced Walking Test. As potential predictor variables, all obtained variables from the GLAD® registry collected at baseline before the intervention of the GLA:D® program, which provide information on patient characteristics, functional level, and habits were included (n=51) (Figure 4). The specific questions asked may be found in the appendix of Paper II.

Statistics

An overview of the paper including the methods can be found in (Figure 5).

In the first analysis step, random forest regression was used to identify the most important predictor variables per outcome, with each potential predictor variable assigned a normalized importance score between 0 and 100, based on the variable importance, which was calculated by the root mean squared error (RMSE) from the out-of-bag sample. The elbow technique was subsequently applied to select the variables to be included in the models [64]. For model-building, tenfold cross-validation was included and the default settings of the caret package for random forest regression were applied, i.e. in each regression, 500 decision trees were built. The performance of the models was evaluated with the R^2, which reflects the amount of explained variance, and the RMSE, which reflects the accuracy of the models. The models were further validated with independent data collected later in time (temporal validation) and compared with the currently used method of providing average improvements. For comparing the prediction of average improvement with individualized predictions, the absolute mean differences between individual predictions and the true changes, and average predictions and the true changes, were evaluated and compared.

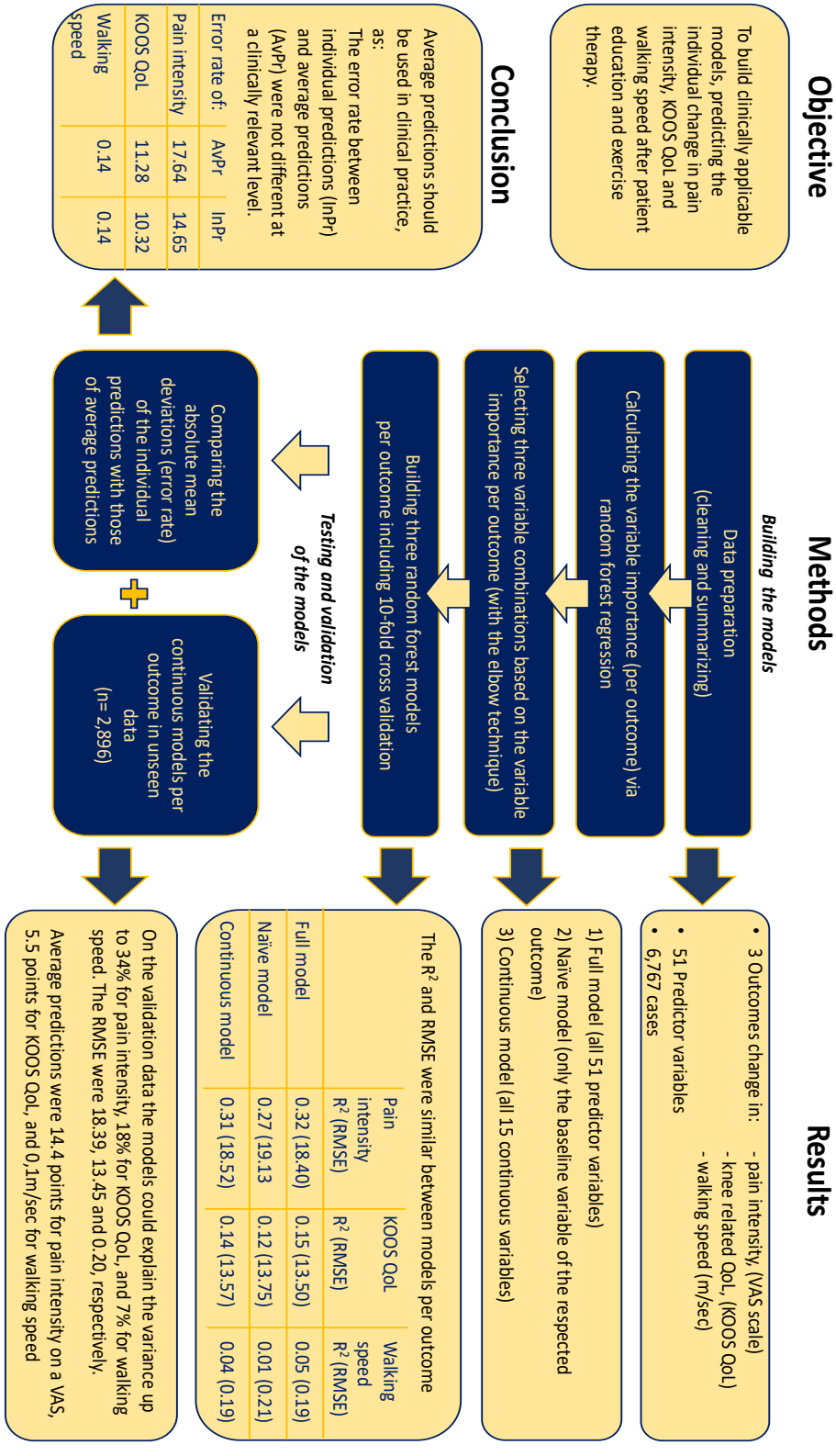

Figure 5. Overview of the GLA:D® prediction model

AvPr: Average predictions, InPr: Individual prediction, KOOS: Knee injury and Osteoarthritis Outcome Score, QoL: Quality of life, RMSE: Root Mean Squared Error, VAS: Visual Analog Scale

Paper III – Quantification of a factor influencing implementation based on JIGSAW-E data

Paper III utilized the Danish JIGSAW-E project data in a cross-sectional study design.

Setting, data source and participants

The data for the JIGSAW-E project were collected in a Danish GP clinic, whose GPs volunteered to participate and create a champion clinic, if the implementation were successful. Furthermore, the GP clinic was selected due to its interest in research and because it uses the International Classification of Primary Care (ICPC-2-R) for diagnosis coding in combination with free text notes for documenting consultations. The data of this project covers information from a patient questionnaire including questions from the OsteoArthritis Quality Indicator questionnaire (OA-IQ) [65], which was combined with electronic medical records (EMRs). The inclusion period of the data in this paper covers the time from September 2017 until February 2019 (Figure 4). The questionnaire was sent out three times, each covering the previous half-year period, including a reminder if patients did not respond after 2 weeks. Data from patients who answered multiple times were included only once, with their first response. In Table 3, the inclusion criteria for the patients and the used OA definition is presented.

Variables

An overview of all included variables is presented in Table 4.

The effect measure outcome, satisfaction with knee-related care, was measured on a Likert scale (very satisfied, satisfied, neutral, unsatisfied, very unsatisfied) and obtained via a questionnaire. The question asked was: “How satisfied are you with the treatments you received at the GP clinic concerning your knee problems?”. The answers were dichotomized into “satisfied” vs. “neutral or unsatisfied”.

The exposure variables of interest were the receipt of first-line treatment elements mainly obtained from the questionnaire and receipt of adjunctive treatment elements obtained from the EMR. As part of the questionnaire, patients answered the following OA-IQ questions:

- “Have you been given information about OA?”
- “Have you been given information about different treatment options?”
- “Have you been given any advice on how you might help yourself to manage or deal with your OA?”

- "Have you been given information or advice about physical activity and exercise to help you with your joint pain?"
- "Have you been given information on the relationship between weight and OA?"
- "Have you discussed and agreed with your GP when you will have a review of your joint pain and treatment?"
- "Have you been advised to lose weight?".

The answer options were: "Yes", "No", and "I do not remember" for all but the last question, where the answer options were: "Yes", "No", and "I am not overweight". The answers were dichotomized into "Yes" vs. "No" or "I do not remember". However, for the last question, patients who stated that they were not overweight were excluded from the analysis.

From the EMR, information on pain-killer prescriptions, and referrals to physiotherapist, orthopaedic surgeon, rheumatologist, X-ray, and MRI were obtained for the respective half-year period of inclusion. They were coded as either "received" or "not received". "Received" was coded if either a referral note or a feedback note from the related specialist regarding the knee was available in the EMR during the respective period.

Characteristics of the patients were also obtained from the EMR (age, sex, number of EMR-recorded knee-related contacts with the health care system during the last half year) and the questionnaire (knee-related quality of life evaluated by the subscale of the Knee injury and Osteoarthritis Outcome Score (KOOS), presence of a total knee replacement).

Statistics

First, statistically significant ($p < 0.05$) differences between the characteristics of satisfied and unsatisfied patients were evaluated via Chi^2, Fisher's exact, and ANOVA tests, as appropriate. Then, relative risks (RR) and 95% bootstrap percentile intervals for treatment elements with a sufficient number of at least 10 cases per outcome and satisfaction with knee-related care were calculated [66]. The 95% bootstrapped percentile intervals were used instead of confidence intervals, as the bootstrapping reduces the influence of potential outliers on the results, which is especially needed for studies (like this one) with a small sample. The identified statistically significant elements of care were subsequently tested regarding their independence in Chi^2 tests. Lastly, a sensitivity analysis for statistically significant elements of care was performed comparing only very satisfied and satisfied patients with unsatisfied and very unsatisfied patients, i.e. neutral satisfied patients were excluded.

Paper IV – Evaluation of an implementation based on JIGSAW-E data

For Paper IV, the Danish JIGSAW-E data were utilized in a longitudinal study design.

Data source, participants and intervention

The inclusion criteria are given in Table 3. In contrast to the first JIGSAW-E paper, patients were included multiple times if they answered the questionnaire for several time periods, to avoid a selection bias. Details of the study setting and data collection can be found in the chapter "Setting, data source and participants" in the section describing the methodology of Paper III above. For Paper IV, EMR data were additionally collected from March 2017 until August 2017. In August 2017, a multi-component primary intervention for the GP clinic staff was introduced and discussed. In total, data were collected for four half-year periods: one before and three after the primary intervention. In addition to the primary intervention, three supportive follow-up interventions were initiated after the primary intervention, and one researcher (LB) visited the GP clinic every half year at least twice for data collection.

The primary interventions

In August 2017 during a three-hour meeting at the GP clinic with the majority of the staff (four GPs, two GP trainees, one nurse, two bio-analysts, two secretaries, and one practice manager), five of the six primary interventions were presented, and discussions regarding if and how they should be implemented took place:

1) An OA leaflet devised by OA patients for patients, which was adopted from the JIGSAW-E guidebook,

2) An education program for health professionals on the clinical knee OA guidelines, which was culturally adopted from the JIGSAW-E training for Danish health professionals delivering the care,

3) Two functional tests to monitor the functions of patients with knee OA, the 30-sec chair stand test and the maximal step-up test, as recommended in the literature [42,67],

4) A live model consultation, conducted by the researcher/GP with a volunteer patient with knee OA (Adopted from the JIGSAW-E model consultation), and

5) An EMR phrase aiding the consultation and documentation in providing guideline-recommended care, which popped-up in the documentational system when a specific button

combination was pressed during the documentation of a consultation (culturally adopted form JIGSAW-E).

These five primary interventions were presented to the staff of the GP clinic by a professor focusing on prevention and treatment of joint injury and OA (ER), a PhD-student (LB), and an associate professor with experience in research in general practice (JL). The associate professor was also a practicing GP.

The sixth primary intervention targeted patients with knee OA at the clinic and was conducted by the three above-mentioned researchers and the GP clinic staff. Written material on the JIGSAW-E project for the GP clinic webpage and waiting room was prepared and implemented.

The supportive follow-up interventions

The first supportive follow-up intervention was in September 2017 at an open GP clinic day on men's health for the patients registered at the clinic. One researcher involved in the project (LB) supported the staff of the clinic and provided the OA leaflet and information on the functional tests. The second supportive follow-up intervention was a joint publication by the researchers and two GPs of the clinic, which was prepared and released in May 2018 in a Danish general practitioner journal (Månedsskrift for Almen Praksis). The final supportive follow-up intervention was a feedback session on the GPs' performance in providing knee OA first-line treatments, which was delivered in October 2018 during a regular lunch break. The second and third follow-up intervention were initiated after observing the limited use of the written material during the data collection.

Variables

The effect measure outcomes of interest were the receipt of 16 treatment elements obtained from the EMR and questionnaire, presented in Table 5. The usage of the two functional tests and the EMR phrase aiding the consultation and documentation were evaluated based on notes in the EMR. The exact questions and coding for the remaining outcomes are described in the section describing the methodology in Paper III. The characteristics included in Paper IV can be found in Table 4.

Table 5. Outcome measures of Paper IV obtained from electronic medical records and the osteoarthritis quality indicator questionnaire

Electronic medical record data		OA-Quality indicator questionnaire data
Received prescriptions/referrals for/to: - Pain-killers - Physiotherapy - Orthopedic surgeon - Rheumatologist - X-ray - MRI	**Usage of:** - 30-second chair stand test - Maximal step-up test - The EMR phrase aiding the consultation and documentation	**Received information on:** - OA - Treatment options for OA - Management of OA - Physical activity and exercise - Reducing weight when overweight - The relationship between weight and OA - When the next review at the GP clinic should take place

GP: General Practitioner, MRI: Magnetic Resonance Imaging, OA: Osteoarthritis

Statistics

The knee-related treatment elements received by patients with knee OA in the GP clinic were evaluated before and after the primary multi-component intervention. The data were split into four half-year periods to evaluate statistically significant differences and changes ($p < 0.05$) in the delivered treatment elements over the course of two years using the ANOVA, Chi^2 or Fisher's exact tests, depending on the type of specific characteristic and outcome variable.

Results

The main characteristics of the included participants from the different data sources are presented in Table 6. As all patients involved in Paper III were included in Paper IV (n=131/160), only the characteristics of the patients from Paper IV are presented.

Table 6. Characteristics of patients included in the four papers

Variable(s)	Paper I – Needs assessment	Paper II – Outcome prediction	Paper III &IV – Quantifying a factor influencing patients' satisfaction and implementing clinical guidelines
	71,717 Danish citizens, aged ≥ 45 years, having seen their GP during the last 12 months	6,767 patients with knee OA participating in the GLA:D® program	160 patients with knee OA from one Danish GP clinic, aged ≥ 30 years
Age, mean (SD)	62.11 (10.59)	64.55 (9.41)	62.50 (13.20)
Sex female, n (%)	37,757 (52.7)	4,891 (72.3)	89 (55,6%)
BMI, mean (SD)	26.57 (4.79)	28.55 (5.20)	29.53 (9.34)
KOOS quality of life score (from 0-100, worst to best), mean (SD)	-	54.83 (14.64)	48.36 (20.29)

BMI: Body Mass Index, GLA:D®: Good Life with osteoArthritis in Denmark, GP: General Practitioner, KOOS: Knee injury and Osteoarthritis Outcome Score, n: Number, SD: Standard deviation

Paper I - Assessment of needs

In 2017, of the 312,349 Danish citizens invited to participate, 183,372 (58.7%) responded to the DNHS. Of those, 71,717 were 45 years or older, who reported that they had had contact with their GP during the previous 12 months. Fourteen thousand and thirty-three of these patients were obese and thus, in addition to the analysis of the receipt of exercise advice, the receipt of weight reduction advice was included in the analysis. Table 7 provides an overview of the characteristics of participants with OA, hypertension, or diabetes (alone or in any combination) and the reference group included in the analyses of exercise and weight reduction advice.

Table 7. Overview of the characteristics in the reference and patient groups

Characteristics of participants included in the analyses on exercise advice								
Total (n= 71,717)	**Reference group (n= 29,269)**	**OA (alone) (n=11,024)**	**Hypertension (alone) (n=15,400)**	**Diabetes (alone) (n=1,200)**	**OA and hypertension (n=9,222)**	**OA and diabetes (n=562)**	**Hypertension and diabetes (n=2,899)**	**OA, diabetes, hypertension (n=2,141)**
Age, mean (SD)	58.4 (10.0)	62.6 (10.0)	64.1 (10.3)	62.7 (10.6)	67.2 (10.0)	65.1 (10.0)	65.5 (9.6)	68.0 (9.3)
Female, n (%)	15,643 (53.4)	6,967 (63.2)	7,100 (46.1)	484(40.3)	5,332 (57.8)	287 (51.1)	947 (32.7)	997 (46.6)
BMI, mean (SD)	25.4(4.2)	26.2 (4.5)	26.9 (4.6)	27.3 (4.8)	28.1 (5.2)	29.2 (5.3)	29.4 (5.5)	30.9 (6.0)
Characteristics of participants included in the analyses on weight reduction advice								
Total (n= 14,033)	**Reference group (n= 3,384)**	**OA (alone) (n=1,877)**	**Hypertension (alone) (n=3,261)**	**Diabetes (alone) (n=2,89)**	**OA and hypertension (n=2,786)**	**OA and diabetes (n=210)**	**Hypertension and diabetes (n=1,146)**	**OA, diabetes, hypertension (n=1,080)**
Age, mean (SD)	55.9 (9.0)	60.0 (9.4)	60.6 (9.5)	60.0 (10.1)	64.3 (9.4)	62.5 (9.3)	62.7 (9.3)	65.9 (8.8)
Female, n (%)	1,787 (52.8)	1,169 (62.3)	1,394 (42.7)	127(43.9)	1,552 (55.7)	111 (52.9)	373 (32.5)	509 (47.1)
BMI, mean (SD)	33.4 (3.9)	33.6 (3.8)	33.5 (3.9)	34.0 (3.6)	34.2 (4.2)	34.6 (4.3)	34.6 (4.3)	35.5 (4.8)

BMI: Body Mass Index, n: Number of included patients, OA: Osteoarthritis

The proportions of, and associations between, patient groups and receiving exercise and weight reduction advice are presented in Figure 6 and Figure 7. Patients with OA alone were least likely to receive exercise and weight reduction advice (13%, OR 1.4, 95% CI 1.3 to 1.5 and 27%, OR 1.6, 95% CI 1.4 to 1.8, respectively) among all the patient groups. Among patients with one disease only, those with diabetes were most likely to receive advice (32%, OR 4.2, 95% CI

3.7 to 4.7, and 55%, OR 5.4, 95% CI 4.2 to 7.0, respectively). Every additional disease increased the odds of receiving exercise advice as well as weight reduction advice. However, patients with OA were not the main driver of this increase, as the addition of OA as the third disease to hypertension and diabetes neither increased the odds of receiving exercise advice nor in receiving weight reduction advice.

The secondary analysis conducted in Paper I revealed no increase in the proportion of patients with OA receiving advice from 2013 to 2017 (independent of comorbidities) either for exercise advice (20% - 21%, p =0.038) or for weight reduction advice (43% - 40%, p <0.001).

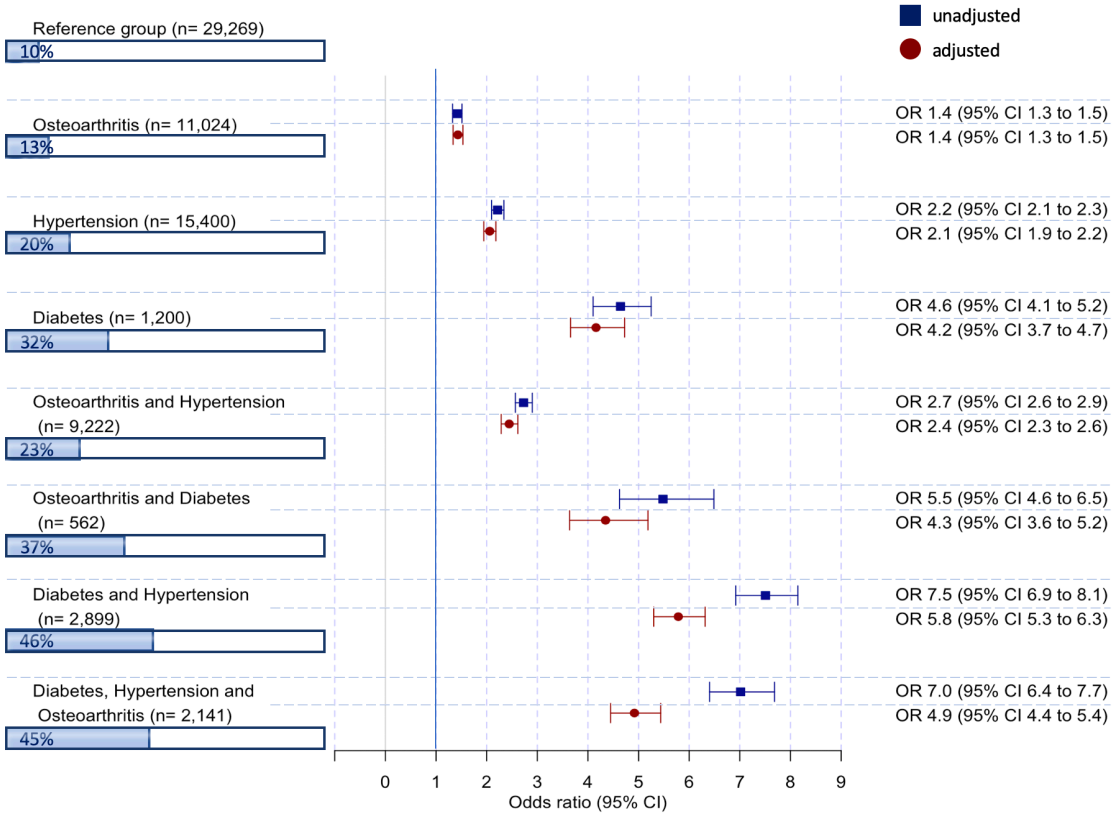

Figure 6. Proportions and odds ratios of patient groups compared with participants having none of the three investigated diseases (osteoarthritis, hypertension and diabetes) and receiving exercise advice

CI: Confidence Interval, OR: Odds Ratio, adjusted for: Age, Sex, Body Mass Index, Level of physical activity and Educational level

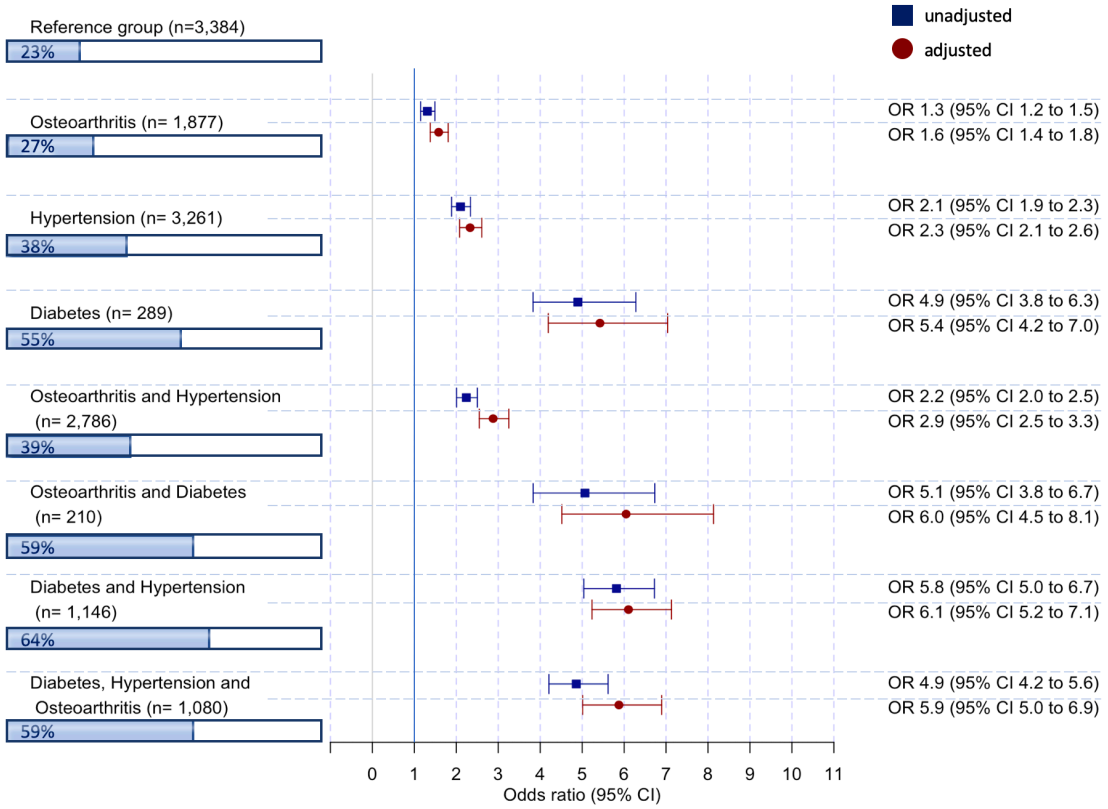

Figure 7. Proportions and odds ratios of patient groups compared with participants having none of the three investigated diseases (osteoarthritis, hypertension and diabetes) and receiving weight reduction advice

CI: Confidence Interval, OR: Odds Ratio, adjusted for: Age, Sex, Body Mass Index, Level of physical activity and Educational level

Paper II - Prediction model development

A total of 14,824 patients met the inclusion criteria for building the prediction models. For validating the models, 2,896 patients were involved. Of the 14,824, 17 % (n=2,594) were lost to follow up and did not provide any data after the intervention. These patients are contained in the 6,261 patients, who were excluded due to missing data in one or more of the outcome variables of interest. Additionally, 1,796 patients were excluded due to missing values in the baseline variables, 1,665 of those due to technical problems with the registry, as one variable was not collected during half a year. In total, 6,767 patients were included for building the prediction models.

An overview of the results of Paper II can be found in Figure 5. Using the validation data, the three continuous models, each including the fifteen most important variables (all continuous variables) explained 34%, 18%, and 7% of the variance in pain intensity, knee-related QoL, and walking speed, respectively. The individualized predictions had on average an error rate of 14.65 points on a VAS scale, 10.32 points on the KOOS QoL score and 0.14m/sec for walking speed, in the validation data. Adding or subtracting as appropriate the average improvements of 14.5 VAS pain intensity points, 5.5 KOOS QoL points, and 0.1m/sec walking speed to/from the baseline values, the average error rates of these 'average predictions' were 17.64, 11.28, and 0.14 in the validation data, respectively. Thus, the differences between the individualized and average prediction error rates did not reach clinical relevance of approximately 20mm for the VAS change score, 8-10 points for the KOOS score, and 0.1m/sec for walking speed [68-70]. Therefore, clinicians can simply continue to provide patients with the easiest to apply patient education and exercise therapy which result in average improvements, as a means to motivate them to receive first-line treatments.

Paper III - Quantification of a factor influencing implementation

In January 2018, the study's GP clinic site had 6,240 listed patients, of whom 4,174 were 30 years or older (51% female). In the inclusion period between September 2017 and February 2019, 242 listed patients with knee OA had contact with the GP clinic. Of those, 136 (56%) gave informed consent to participate in the research project and provided information by completing the questionnaire. Patients who were invited and answered the questionnaire more than once (n=26) were included using only their first response. Of the 136 included patients, five were excluded due to missing information on the outcome. Of the remaining 131, 18 were very satisfied, 50 were satisfied, 40 were neither-nor "satisfied", seven were unsatisfied, and seven were very unsatisfied with their received knee-related care. Thus, in total 77 (59%) of the included patients were satisfied and 54 (41%) were unsatisfied or neutral. The evaluation of the patient characteristics revealed no statistically significant differences between satisfied and unsatisfied or neutral patients. Four treatment elements were excluded due to the number of cases per outcome being too small: 1) receiving advice to lose weight, 2) receiving information on when the next review should happen, 3) referral to a rheumatological specialist, and 4) referral for Magnetic Resonance Imaging (MRI). Therefore, the associations between receipt of nine out of 13 treatment elements and satisfaction with care were evaluated. The related proportions and RRs of being satisfied are presented in Table 8. The receipt of three first-line treatment elements revealed a positive association with satisfaction with knee-related care: information on OA treatment options, information on physical activity and exercise, and information on the relationship between weight and OA (all $p < 0.05$). An ad hoc power calculation for the reception of information on physical activity and exercise, as well as for the information on the relationship between weight and OA revealed a power of 66% to detect the difference of 21 percentage points between the satisfied and unsatisfied (or neutral) patient groups. For the reception of information on treatment options, the power was 70% to detect the difference of 22 percentage points. For the remaining six treatment elements, no conclusive association was found. The three statistically significant treatment elements were highly dependent ($p<0.001$). Thus, if a patient received one of the three forms of advice, the patient was much more likely to also receive another form of advice, compared with patients who did not receive any initial advice. In the sensitivity analysis, excluding patients who were neutral regarding their satisfaction with knee-related care, two of the three statistically significant elements of care stayed significant: information on physical activity and exercise, (RR

1.22, 95% BPI 1.01 to 1.58), and information on the relationship between weight and OA (RR 1.29, 95% BPI 1.12 to 1.54).

Table 8. Proportions of and associations between the receipt of treatment elements and satisfaction with knee-related care

Treatment elements	Satisfied patients (n=77) n (%)	Unsatisfied or neutral patients (n=54) n (%)	Relative Risk (95% BPI)
Obtained from the quality indicator questionnaire – Patient education on…			
Information on OA [++]			
- Yes	25 (69)	11 (31)	
- No	51 (55)	42 (45)	1.27 (0.92 to 1.70)
Information on OA treatment options [++]			
- Yes	40 (71)	16 (29)	
- No	35 (48)	38 (52)	1.49 (1.11 to 2.00) *
Information on managing OA [++++]			
- Yes	26 (66)	13 (34)	
- No	49 (56)	39 (44)	1.20 (0.89 to 1.59)
Information on physical activity and exercise [+]			
- Yes	50 (67)	24 (33)	
- No	26 (46)	30 (54)	1.46 (1.08 to 2.11) *
Information on the relationship between weight and OA [++++++]			
- Yes	33 (73)	12 (27)	
- No	39 (48)	41 (52)	1.50 (1.13 to 2.03) *
Obtained from the electronic medical records regarding Prescriptions and referrals for/to…			
Pain killers[++]			
- Yes	45 (55)	36 (45)	
- No	31 (65)	17 (35)	0.86 (0.65 to 1.15)
Referral to physiotherapy			
- Yes	31 (55)	25 (45)	
- No	46 (61)	29 (39)	0.90 (0.66 to 1.23)
Referral to orthopedic specialist			
- Yes	20 (61)	13 (39)	
- No	57 (58)	41 (42)	1.04 (0.73 to 1.43)
Referral to X-ray [+]			
- Yes	24 (62)	15 (38)	
- No	53 (58)	38 (42)	1.06 (0.77 to 1.40)

BPI: Bootstrapped percentile interval, OA: Osteoarthritis, *: Statistically significant, [+]: Indicates the number of missing values

Paper IV – Evaluation of an implementation

During the four half years of the inclusion period of the second JIGSAW-E paper, from February 2017 to February 2019, 309 listed patients with knee OA had contact with the GP clinic. Of those, 169 (55%) agreed to participate in the study, but nine were excluded as they reported having at least one replaced knee, which meant it was unlikely that they were still in need of first-line treatment. Therefore, 160 patients were included. Of those, 27 had contact with the GP clinic during two time periods, and 6 during three time periods. This led to an inclusion of 199 data sets, 54 for the time period before the primary interventions, and of 54, 45, and 46, for the first, second, and third time period after the primary interventions, respectively. Differences in patient characteristics between the different time periods were observed for sex ($p=0.024$) and in prior presence of knee-related diagnosed coding for knee OA ($p=0.005$).

The difference in percentages of received treatment elements is illustrated in Figure 8. To protect the anonymity of the patients, treatment elements which were received by five or less patients are presented with the percentage of five cases (9%, 9%, 11% and 11% for the time periods respectively). After the primary interventions, the newly introduced functional tests ($p<0.001$), and documentation support ($p<0.001$) were used for half a year by the GPs. Furthermore, during this first time period, the referral rate to orthopedic surgeons dropped from about 30% to 17% ($p=0.049$), and a statistically significant difference was observed in prescriptions for pain-killers ($p=0.008$), mainly driven by a decrease in paracetamol prescriptions in the first time period after the primary interventions ($p=0.001$). The activities of the study did not maintain these changes. Increases to higher values than seen prior to the primary interventions were observed for the second and third time periods. After the primary interventions, the receipt of information on first-line treatment elements remained stable at 50% and lower, but advice on physical activity and exercise was provided in up to 65% of the cases.

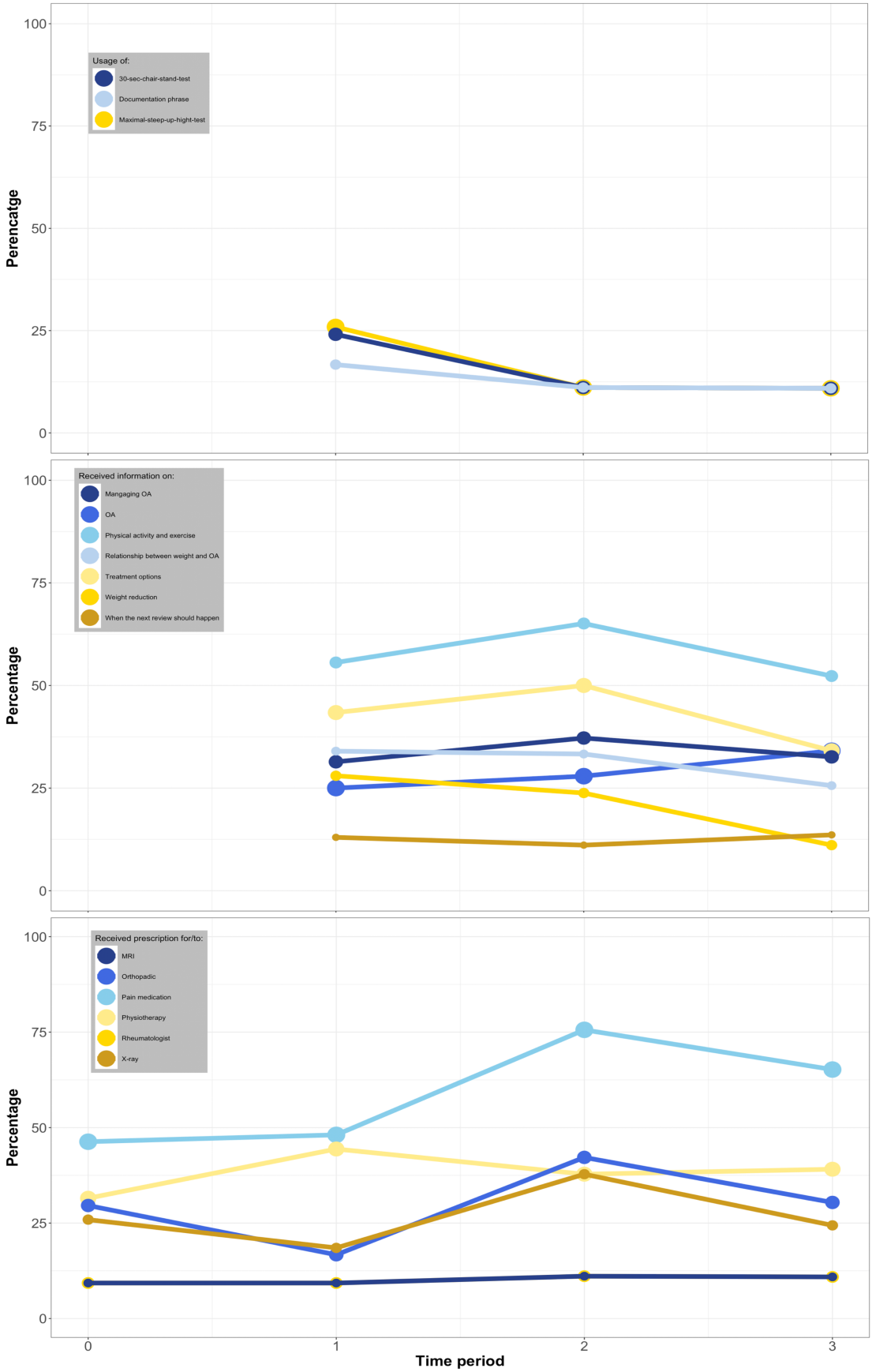

Figure 8. Percentage of patients who received an element of care for the different time periods

Discussion

Main findings

Regarding the current usage of first-line treatments in general practices, this thesis found that, in Denmark, less than half of the patients with knee OA received advice on exercise (21%) and on weight reduction (40%), and no increase was observed from 2013 to 2017. However, an additional disease (hypertension or diabetes) increased the odds of patients with OA receiving common first-line treatment recommendations (Paper I). Furthermore, in paper III, it was highlighted that if patients with knee OA receive disease-related educational treatment elements, they were more satisfied with their received care than those who did not receive the educational treatment elements.

Regarding ways to improve the usage of first-line treatments, it was found, that individualized predictions of the outcomes of patient education and exercise are possible, but did not have a clinically relevant reduced error rate over predictions using average outcomes (Paper II). Furthermore, the effect of a multi-component intervention lasted only six months and the provision of educational first-line treatment elements remained stable but low at 50% or less cases, except for the provision of information on physical activity and exercise (which increased to 65%) (Paper IV).

General discussion

In summary, this PhD thesis has contributed to unraveling insights regarding the health educational process on first-line treatments of knee OA in general practices. The overall contribution will be discussed in the context of the health education framework underpinning this thesis (see Figure 3, page 20).

Several previous studies address the first health educational activity, namely “needs and capacity assessment”, by evaluating the received care in patients with osteoarthritis. These studies highlight, that there is room for improving the usage of first-line treatments in several countries [20,24,25,71]. The results of this thesis are well in line with the previous literature, i.e. patients with osteoarthritis do not receive sufficient advice on exercise and weight reduction in Denmark. The current situation is further assessed by qualitative studies aiming at

identifying barriers and enablers for the usage of first-line treatments [52,53]. These studies conclude that GPs are concerned regarding the patient-practitioner relationship when addressing lifestyle changes and in addition, they feel a lack of time and expertise to provide the recommended lifestyle advice [52,53]. However, qualitative studies assessing the patient perspective are contradicting to the GPs' initial assumption, as patients express their willingness to change their lifestyle if indicated [72,73]. Our findings support that patients with knee OA well accept the reception of educational first-line treatment elements (Paper III).

The second health educational activity, namely "developing and implementing a program", has previously been addressed in different ways [61,74]. For developing an implementational program it is important to respect and identify enablers and barriers [50,55]. One such identified enabler are computational tools, which can support clinicians in diagnosis and treatment decisions [50,55]. Such tools need to be developed and tested for their effectiveness in clinical settings, prior to wider implementation. A prototype of such a tool, which predicts individualized changes following patient education and exercise, was developed as part of this thesis (Paper IV). However, as the predications were not clinically relevant better than the currently used average predictions, this tool requires further development prior to be applied in a clinical setting.

The third and final health educational activity, namely "evaluating the program's effectiveness", is addressed by the "MOSAIC" and "SAMBA" studies [61,74]. Both of these studies report an increase in the usage of first-line treatments over a half-year time following the implementation, but conclude that there is still room for improvement [75,76]. In this thesis, similar findings of partially improved delivery of care over a 6-months period following an implementation were observed. However, here the positive effects in the study of this thesis faded away after the first half year, which was not evaluated and reported in the "MOSAIC" and "SAMBA" studies [75,76].

Interpretation of the results

Assessment of needs

A European study from 2015 with a small Danish sample indicated that patients with knee OA in Denmark do not receive sufficient advice on exercise and weight reduction as recommended

in national clinical guidelines [3,20]. This observation was confirmed in Paper I based on the DNHS data from 2017, which revealed that less than half of the patients with knee OA received exercise and weight reduction advice. Furthermore, this thesis confirmed the hypothesis that having an additional disease requiring the same lifestyle changes as first-line treatment increases the chance of receiving respective advice (Paper I). The finding and the observation that patients with knee OA were least likely to receive advice on exercise and weight reduction in Denmark could possibly be explained by a lack of GP-specific OA guidelines, which already exist for hypertension and diabetes (https://www.dsam.dk/). This lack would also explain the novel finding that it was not OA, but diabetes and hypertension that triggered patients with more than one disease receiving advice. Nonetheless, it should be noted that from the current study, it remains unknown how often and why the patients consulted their GP and received advice. It is only known that the participants consulted their GP within the last year, as this was an inclusion criterion. The second hypothesis of paper I, that the proportion of patients with OA who received advice is increasing, was rejected despite the release of the Danish clinical guidelines for knee OA in 2012 (ref).

Prediction model development

Existing studies indicate that GPs feel they have a lack of consultation time and expertise to inform patients about lifestyle changes [52]. To provide clinicians with a supporting computational tool predicting expected individualized changes after patient education and exercise therapy, new algorithms were developed. Existing computational tools lack validation and are not designed for clinical practice, as they partially rely on measurements not available in clinical settings [60,77]. In addition, they do not use data from clinical settings, which reduces generalization of the computational tool [60,77]. However, the hypothesis that individual predictions would perform better than predictions from average values was rejected as the validation of the new individualized prognostic models did not have a clinically relevant lower error rate than providing average predictions (Paper II). For better individualized predictions, additional data influencing the outcomes of OA are probably needed. This may include genomic, social and psychological data [78-80].

Quantification of a factor influencing implementation

Existing studies highlight that clinicians are concerned about the relationship they have with their patient when addressing recommended lifestyle changes [52,53,81]. Some clinicians also

expect that patients are not interested in changing their lifestyle, despite having a lifestyle disease [73]. However, the receipt of information about physical activity and exercise and about the influence of weight on OA were positively associated with patients' satisfaction with knee-related care (Paper III). This finding lead to rejecting the hypothesis that the provision of first-line treatments disappoints the patients. The finding, however, aligns with that of an Australian hypertension study, which highlights that patients were willing to change their lifestyle if required [73]. However, due to the small study sample, these findings of Paper III should be confirmed in a larger and independent population.

Evaluation of an implementation

A European quality improvement project included interventions, which were implemented in the UK and which led to an increase in educating about first-line treatments in general practice for the time of that study (six months after implementation) [82]. After cultural adoption and implementation, the interventions also improved the care for patients with knee OA in one GP clinic in Denmark for 6 months (Paper IV). This finding is in line with the results from the Norwegian "SAMBA-model" studies, which also report an increase in the uptake of first-line treatments six-month after an intervention [76,83]. However, the improvements in this study were not sustained, and long-term data from the UK and Norwegian studies are not yet available. One reason might have been the occurrence of a major restructuring exercise in the clinic [84] where one of the initiating GPs of the clinic retired and two GP trainees were replaced. Another reason might have been the external context, which did not support the interventions. First, GP-specific guidelines for OA management were not available in Denmark which, if they had been available, might have increased the quality of care provided as they did for hypertension and diabetes, the patients with these diseases were more likely to receive the relevant advice (Paper I). Furthermore, in contrast to the Norwegian study, only the staff of the GP clinic was included and no physiotherapists. An inclusion of the physiotherapist might be an enabler of the external context, and should be considered for future studies. A potential professional barrier which could have been better addressed are concerns from GPs regarding their patient-practitioner relationship when addressing required lifestyle changes. In summary, the intervention seemed to fit in this organization, but barriers in the external and professional context probably hindered a sustainable change.

Health education in first-line treatments

This thesis confirmed the findings of a previous study, that first-line treatments are not commonly received by patients with knee OA from Danish GPs. Furthermore, it highlights that the currently available average improvements may be used to inform patients about expected changes from patient education and exercise therapy, and that despite the GPs' concerns, information on exercise and the influence of weight on OA were accepted by patients with knee OA. Lastly, for sustainable improvements in the provision of first-line treatments, probably a better fit between the intervention as well as external and professional context is required.

Methodological considerations

In light of the health educational process, the starting time of my separate studies may have been suboptimal. Ideally, the findings from paper II and III would have been incorporated in paper IV. However, due to the limited time of three years to complete the PhD project in Denmark, the practical work on paper IV started before the results of papers II and III was available. However, as the results indicate, different activities and iteration cycles of the health educational process may even independently serve the overall aim of this process, i.e. to improve the usage of first-line treatments of patients with OA in general practices. In addition, the same data set could be used to address different activities of the same health education process (see papers III and IV).

Osteoarthritis definition

OA is diagnosed in different ways in clinical practice and research [3,29,30]. In clinical practice, the diagnosis depends on the context, while orthopedic surgeons tend to diagnose OA based on x-rays, and GPs diagnose OA clinically based on criteria, using tools readily available to them. In research, the information available may influence the definition, depending on where and how the used data were obtained. OA may be self-reported, based on diagnostic criteria, radiographic imaging, or any combination of these. In general, self-reported disease status has its limitations [85-88] and is therefore a source of bias in the related, presented studies [86]. In this thesis, all patients considered to have OA had clinical symptoms. In Papers I and II, a carefully defined but pragmatic OA definition was chosen based on the information available. The data available for Paper I enabled an OA definition in line with the diagnostic criteria from the NICE guidelines of being at least 45 years and of having symptoms in the extremities or

joints. In addition, these patients self-reported to have OA. In Paper II, patients who were eligible and participated in the GLA:D® program for hip and knee OA were considered to have OA. For all these patients, it was confirmed that no other serious reason was the origin of the symptoms, for which they contacted the health care system. In Papers III and IV, the opportunity to also include patients aged at least 30 years at an early OA stage was chosen, as first-line treatments are also very important at this stage. In these studies, both patients with an OA diagnosis from the GP, where the criteria for this diagnosis were unknown, and patients with chronic knee pain have been included. These patients might not consider themselves to have OA; however, athletes with a knee injury during their childhood and adolescence comprise a subgroup of patients with OA at an early age [89,90]. Nonetheless, the GPs of the clinic were concerned about coding an ICPC-2-R OA diagnosis in the patient record system at an early age, as they feared that some patients might face negative effects from their additional private health insurance as a consequence. Therefore, patients also consulting the GP clinic, who were coded with chronic knee pain without a recent adequate trauma or other reason, were considered in Papers III and IV to have knee OA.

A change in the OA definition used in the papers could affect the results. In Paper I, a strict diagnosis of OA was chosen. Some patients who reported having OA, but no symptoms during the last 2 weeks, were thus not considered to have OA. However, if the symptom criteria had not been included, more patients would probably not have received the advice, as this would have decreased the probability that they consulted their GP due to OA symptoms. In Paper II, it would have been possible to only include patients with self-reported signs of knee OA diagnosed by x-ray. However, this would probably not have changed the results as only a minority (4%) of the patients reported an absence of radiographic OA signs. Furthermore, the presence of radiographic OA signs was included as a potential predictor variable but found not to be significant. In Papers III and IV, patients who might not have considered themselves as having OA were included. These patients might not have primarily requested care for their knee OA, and therefore, they might be less likely to have received knee OA treatment. However, the clinicians of the clinic were educated in guideline-recommended care, and the main aim of this project was to evaluate their treatment behavior. Therefore, they should have recommended the receipt of first-line treatments in these patients as well.

Influence factors in different study designs

Data analyses in various study designs are challenged by factors that influence the outcomes differently [91]. In association studies, these factors are called exposures, which influence the outcome evaluated, and confounding variables, which influence the exposure and the outcome [92,93]. In prediction studies, they are called predictor variables, and in implementation studies they are called barriers and enablers.

In all studies, the first challenge is to identify all relevant factors. One then tries to address them by quantifying their influence, at least in association and prediction studies.

In Paper I, the influence of OA on receiving exercise and weight reduction advice is quantified in crude and adjusted models. The changes in estimates between both models highlight the importance of including confounding variables in the analysis. In this paper, adjustments for all potential confounding variables were done as this is scientifically accepted [94]. Nonetheless, even in such large, national cohorts, there is a risk of unidentified factors influencing the results. In the current study, the time since the last visit might have influenced the recall ability of the patient [95]. Information on the time since the last visit was, however, not available and could not be considered in the analyses.

In addition, the more confounding variables that are adjusted for, the lower the power of the study and the broader the confidence intervals will be.

In Paper III, differences between satisfied and unsatisfied patients were investigated in a 'small' study sample (n=131), without adjustments. Specifically note that it was not considered from whom patients received the information, which could be an influencing factor. Hence, the findings of this study should be confirmed in a larger study.

In the prediction model study (Paper II), 51 predictor variables were included. Individualized predictions had a lower error rate than average predictions, but it was not clinically relevant, which suggests that predictor variables were missing. This could include, for example, biological factors like inflammation of the synovium, genetic information, for example on the genes TGFB1, FGF18, CTSK and IL11, and detailed psychological data on depression, which are all suggested factors in research to influence OA and its procession [78,79,96-98].

In the implementation paper (Paper IV), some barriers of the professionals and the external context, such as concerns from the GPs regarding the provision of first-line treatments

recommendations, and the collaboration with other health care professionals seemed to be inadequately addressed. This might be the reason for no sustainable change in the management of patients with knee OA. This is supported by studies showing that multiple interventions are more successful than a single intervention [82].

Quality of the care provided

To evaluate the quality of care, quality indicators for the treatment of patients with knee OA, which are process measures, may be used [65]. In Papers I and IV, information regarding the receipt of first-line treatment elements, which are quality indicators, were assessed based on self-reported data. However, the quality of the information provided remains unknown. In this regard, the use of positive or negative words can influence, for example, pain experiences [99]. To secure a minimum of quality of care, it is advisable to provide written information as well as to use documentation tools or prediction tools [55].

Outcome measures

Depending on the aim of a project, different outcome measures of the effect or the process are recommended [32-34]. Effect measures are of interest to patients and politicians, as they inform about expected changes and options to save money. Process measures are of interest to health professionals and institutions [32-34]. They allow an easier evaluation of the performance of an individual institution. Evaluating an institution based on effect measures is challenging, as changes and outcomes depend on multiple factors, which are often unknown. Therefore, effect measures may only be partly influenced by the performance of an institution [32,33]. Factors that cannot be influenced by an institution comprise especially the external context, such as the care received at previous or subsequent institutions. Thus, especially in association studies with effect measures as outcomes, confounding variables are an issue. Therefore, it is recommended to use process measures to evaluate the quality of care provided by an institution [32,33].

In this thesis, outcome measures of the process (Papers I & IV) and the effect (Papers II & III) were included. While information on the quality of care was collected via process measures, the effectiveness of received treatments was evaluated via effect measures. In general, it is important that a process measure is associated with an effect measure, as only then can the process measure be potentially important for improving health [32,33]. However, for the process measures of received information on first-line treatments that we used, there is limited

information on their association with effect measures. Paper III highlights an association between the process measure of receiving first-line treatment elements and the effect measure of satisfaction with knee-related care. Doubts about an association with other effect measures are supported by the findings from the JIGSAW-E project in the UK that reported the observed increase in quality of care did not substantially improve the pain and disability measured on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) in patients with OA [75,82]. However, additional effect measures such as health care costs were not evaluated, and their association remains uncertain. Furthermore, this observation is not surprising, as the receipt of advice or information does not necessarily lead to behavioral changes such as exercising and reducing weight, which actually have a positive effect on patients' pain and function [46]. Not following the advice might be an individual patient's decision and should therefore be respected. Still, the provision of the advice is indicated as it is one element of the recommended first-line treatments, and informing patients has the potential to change the patient's mind and increase their satisfaction (Paper III).

Strength and limitations

The overall strength of this thesis is the combination of different methods and tools to support data-driven health education in first-line treatments for patients with knee OA in general practice. The available data from the GLA:D® registry and the DNHS comprise large samples, which strengthen the generalization of the findings. The data obtained as part of the JIGSAW-E project in Denmark on the other hand is a much smaller sample, but very rich in detail, which is useful for designing larger studies to confirm the findings the JIGSAW-E studies. Consequently, the findings from this study should not be extrapolated to general practice in general.

The major limitation of Papers I and III, which report associations, is the lack of a capacity to demonstrate causality [100]. Due to the cross-sectional study design, it remains uncertain if patients first developed OA or hypertension or diabetes and were subsequently advised on lifestyle changes, or the other way around (Paper I), and also, if patients first received the respective elements of care or instead, were first satisfied (Paper III).

The major limitation in the prognostic model (Paper II) and intervention study (Paper IV) is the lack of a control group. This lack results in an uncertainty regarding the reason for the observed changes. It remains unknown if they occurred due to the GLA:D® program (Paper II) and the interventions (Paper IV) or if other non-investigated factors influenced them.

Perspectives

The results of this thesis indicated that there is still room for improving GPs' understanding and practice of the role of health education in first-line treatments for patients with OA in general practice.

The results from the DNHS study (Paper I) suggest it would be valuable to perform a follow-up comparison in the future, as the DNHS data are obtained every 3 to 4 years. Thus, after a potential national intervention, such as a release of GP-specific guidelines for the management of OA, changes due to the intervention could be estimated with future DNHS data.

A follow up to Paper II regarding the individualized predictions could be to evaluate whose outcomes can successfully be predicted and why. Then, the patients with 'predictable outcomes' could be compared with patients with 'unpredictable' changes to evaluate if these patients indicate useful subgroups. Another opportunity would be to combine the self-reported, and functional test data from the GLA:D® registry with biological or psychological data. Lastly, a tool providing GPs with an overview of the expected average changes could be developed and tested for its effectiveness in supporting clinicians by providing information on first-line treatments.

The findings from Paper III on satisfaction with knee-related care should be validated in a larger, independent study.

A final step of the JIGSAW-E project should be the presentation of the project results to the staff of the GP clinic, with a subsequent discussion to identify additional barriers and enablers experienced by the clinicians in the implementation of the introduced interventions. This knowledge could then be considered in planning future interventions.

Conclusions

To increase the use of recommended first-line treatment elements - information about exercise and weight reduction for patients with knee OA in general practice - GPs should be informed that the provision of information on lifestyle changes is accepted by knee OA patients and positively associated with their satisfaction with care. Furthermore, as individualized outcome predictions did not have a clinically relevant lower error rate, GPs should be informed of the expected average improvements from patient education and exercise therapy. This would increase their provision of evidence-based information and help motivate their patients to accept recommended first-line treatments. Furthermore, short-term (six-month) improvements in the management of knee OA care in the GP clinic can be achieved by a multicomponent educational intervention.

Overall, this thesis highlights specific areas, where there is room for improving the process and content of health education in first-line treatment for patients with knee OA in general medical practices.

Summary

Introduction: Knee osteoarthritis (OA) is a common disease with increasing prevalence and burden for the population. Clinical guidelines recommend patient education, exercise, and weight reduction as first-line treatments, but they remain underutilized in many Western countries.

Methods: To improve the usage of the recommended first-line treatments, four measures were applied. First, the receipt of first-line treatment in the form of lifestyle advice given by the general practitioner (GP) in Denmark was evaluated in patients with knee OA and compared with that given for hypertension and diabetes (alone and in any combination). Second, algorithms predicting individualized outcomes of patient education and exercise were developed and validated to support shared decision-making during GP consultations. Third, the perceived professional barrier of GPs being concerned about harming the relationship they have with their patients when providing lifestyle advice was quantified by evaluating the association between received treatment elements and patient satisfaction. Fourth, internationally successful and tested interventions to improve the management of patients with knee OA at GP clinics were culturally adopted and implemented in one Danish GP clinic to study the sustainable effectiveness of these interventions.

Results: In Denmark, less than half the patients with knee OA received lifestyle advice. They were least likely to receive this advice when compared with patients suffering from hypertension or diabetes. Individualised outcome predictions were better than average estimations, but the improvements were not clinically relevant. The receipt of information on first-line treatments was positively associated with the patients' satisfaction with their knee-related care. Lastly, the culturally adopted intervention to improve the quality of care for patients with knee OA at a GP clinic in Denmark had only a six-month lasting effect.

Conclusions: There is room for improving the quality of care given to patients with knee OA by GPs in Denmark by following the clinical guidelines of recommended first-line treatments. This may be achieved by assuring GPs that the average improvements in patient education and exercise may be used to motivate patients to adopt lifestyle changes. They may also be assured that patients' satisfaction increases with the receipt of lifestyle advice. Lastly, future implementation studies using culturally adopted interventions, should take into account

potential specific barriers of the individual clinics - including those in the professional and external context - to reach robust conclusions regarding their ability to support sustainable improvements.

Dansk resume (Danish summary)

Introduktion: Knæartrose (KA) er en hyppigt forekommende sygdom med stor udbredelse, hvilket er en byrde for befolkningen. Kliniske retningslinjer anbefaler som førstelinjebehandling patientuddannelse, træning og vægttab for overvægtige. Imidlertid er der mange vestlige lande, hvor disse behandlingsformer ikke bliver anvendt tilstrækkeligt.

Metode: For at forbedre brugen af de anbefalede førstelinjebehandlinger blev der gennemført fire forskningsprojekter. I det første blev det undersøgt, hvor mange af patienterne med artose, der fik råd om livsstilsforandringer som førstelinjebehandling af alment praktiserende læger (AL) i Danmark. Resultatet blev sammenlignet med patientgrupper med enten forhøjet blodtryk, diabetes eller enhver kombination af de tre sygdomme. I det andet forskningsprojektblev der udviklet og valideret en algoritme til prædiktion af forandringer hos patienter med KA efter patientuddannelse og træning til at støtte op om beslutningsprocessen ved lægekonsultationer. I det tredje projektblev det gennem en kvantificering af sammenhæng mellem livsstilsrådgivning og patienttilfredshed undersøgt, om ALs bekymringer i forhold til at give råd om livsstil er berettigede. Associationer mellem den modtagede behandling og patienternes tilfredshed blev beregnet. I det fjerde projekt blev succesfuld interventioner fra England, som har øget behandlingskvaliteten hos patienter med KA, kulturelt tilpasset, implementeret og evalueret i en almen dansk lægepraksis.

Resultat: I Danmark fik mindre end halvdelen af patienterne med artrose råd om livsstil og sammenlignet med patienterne med forhøjet blodtryk og diabetes var det mindst sandsynligt, at de fik råd. De individualiserede prædiktioner af forandringer efter patientuddannelse og træning var bedre end gennemsnitsforudsigelserne, men forskellene var ikke klinisk relevante. Modtagelse af information om førstelinjebehandling var positivt associeret med patienternes tilfredshed med knærelateret behandling. Endelig havde de kulturelt adopterede inventioner for at forbedre behandlingen hos patienter med KA i en dansk lægepraksis effekt med en varighed på seks måneder.

Konklusion: Der er mulighed for at forbedre behandlingskvaliteten for patienterne med KA ved AL i Danmark ved at følge de kliniske retningslinjers anbefalinger for førstelinjebehandling. Dette kan opnås ved at informere om, at de gennemsnitlige værdier kan anvendestil at motivere patienterne til patientuddannelse og træning og at de kan øge patienternes

tilfredshed ved at give dem råd om livsstil. Slutteligt skal de eksisterende barrierer, der hersker i de individuelle lægepraksisser, blandt personale, og i den eksterne kontekst i højere grad inddrages i kommende studier, som bruger kulturelt tilpassede interventioner, for at sikre resultaternes validitet i forhold til en vedvarende effekt.

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