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RESEARCH ARTICLE

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Evaluation of an educational course for primary care physiotherapists on comorbidity-adapted exercise therapy in knee osteoarthritis: an observational study

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Abstract

Objective: The objectives of the present study were to: (1) evaluate the effect of an educational course on competence (knowledge and clinical reasoning) of primary care physical therapists (PTs) in treating patients with knee osteoarthritis (KOA) and comorbidity according to the developed strategy; and (2) identify facilitators and barriers for usage.

Method: The present research was an observational study with a pretest-posttest design using mixed methods. PTs were offered a postgraduate course consisting of e-learning and two workshops (blended education) on the application of a strategy for exercise prescription in patients with KOA and comorbidity. Competences were measured by questionnaire on knowledge (administered before and 2 weeks after the course), and a patient vignette to measure clinical reasoning (administered before the course and after a 6 month period of treating patients). Facilitators and barriers for using the strategy were assessed by a questionnaire and semi-structured interviews.

Results: Thirty-four PTs were included. Competence (knowledge and clinical reasoning) improved significantly ($p < 0.01$). Fourteen out of 34 PTs had actually treated patients with KOA and comorbidity, during a 6-month period. The strategy was found to be feasible in daily practice. The main barriers included the limited number of (self-) referrals of patients, limited number of reimbursed treatment sessions by insurance companies and a suboptimal collaboration with (referring) physicians.

Conclusion: A blended course on exercise therapy for patients with KOA and comorbidity seems to improve PTs' competence through increasing knowledge and clinical reasoning skills. Identified barriers should be solved before large-scale implementation of exercise therapy can take place in these complex patients.

KEYWORDS

blended education, comorbidity, exercise therapy, knee osteoarthritis, primary care

1 | INTRODUCTION

Exercise therapy is an effective intervention in patients with knee osteoarthritis (OA) (Fransen et al., 2015), but its application may be limited in patients with severe comorbidity. Sixty-eight to 85% of patients with knee OA suffer from comorbidity (e.g. cardiovascular diseases, diabetes or obesity) (Caporali et al., 2005; Juhakoski, Tenhonen, Anttonen, Kauppinen, & Arokoski, 2008; Kadam, Jordan, & Croft, 2004; Tuominen et al., 2007; van Dijk et al., 2008) and, frequently, more than one comorbid disease is present (van Dijk et al., 2008). Exercise therapy for patients with knee OA consists of exercise for lower-limb muscle strengthening, aerobic capacity, and training of daily activities like walking, stair climbing, and transfers (e.g. rising from a chair, getting into and out of a car) (Brosseau et al., 2017a,b; Fernandes et al., 2013; Fransen et al., 2015). Comorbidity may limit the exercise tolerance, depending on the type, number and severity of the comorbid disease(s) (de Rooij et al., 2013). For example, in patients with knee OA and chronic heart failure (HF), breathlessness and fatigue disproportional to the level of exertion should be avoided because of the risk of cardiac decompensation (Coats, 2001). Therefore, we have recently developed and evaluated a strategy to adapt knee OA exercises to the comorbid disease in patients with knee OA and severe comorbidity (de Rooij et al., 2014; de Rooij et al., 2017). Targeted comorbidities were coronary disease, heart failure, type 2 diabetes, chronic obstructive pulmonary disease, and obesity. The results of a randomized controlled trial evaluating the exercise strategy, conducted in a specialized rehabilitation centre, showed that tailored exercise therapy greatly improved physical functioning (effect size = 0.9), reduced pain (effect size = 0.8) and was safe for patients with knee OA and (severe) comorbidity (de Rooij et al., 2017).

Because knee OA in combination with comorbidity is highly prevalent, treatment of these patients cannot only take place in specialized centres. Implementation of a standardized strategy for exercise therapy in patients with knee OA and comorbidity in primary care is therefore warranted. However, in the Netherlands physiotherapists (PTs) often have expertise related to a particular cluster of diseases (e.g. musculoskeletal diseases) while expertise on the comorbid disease (e.g. diabetes or cardiovascular disease) may not have been sufficiently developed. Current guidelines are often developed for patients with only one disease (e.g. exercise guideline for knee OA (Fernandes et al., 2013; Kampshoff et al., 2018) or cardiac rehabilitation (Achttien et al., 2011) and PTs have to design a customized treatment plan based on separated guidelines for patients with knee OA and comorbidity. Furthermore, a secondary care setting differs from a primary care setting. In comparison to physiotherapists in specialized rehabilitation centres (secondary care setting) in the Netherlands, PTs in primary care often have less time available per patient and receive a lower number of reimbursed treatment sessions. For these reasons, the previously developed strategy needed to be adapted to primary care and it was necessary to educate the PTs in applying the strategy. An educational course was developed and evaluated aiming to increase specific knowledge of the comorbid diseases and the clinical reasoning skills of PTs. In addition, perceived barriers and facilitators for using the strategy in primary care were identified, to evaluate whether this strategy was feasible in primary care. The aims of the present study were therefore to: (1) evaluate the effect of an education course on the competence (knowledge and clinical reasoning) of primary care PTs in treating patients with knee OA and comorbidity according to the developed strategies; and (2) identify facilitators and barriers for use of this strategy in primary care.

2 | METHODS

2.1 | Study design

This study is a mixed methods study that used both an observational pre-posttest component combined with semi-structured interviews. The study was conducted among PTs working in primary care who took part in a postgraduate blended educational course. After following the course, PTs treated patients with knee OA and comorbidity during a 6-month period. We evaluated basic knowledge levels (factual knowledge and comprehension) of practitioners about managing patients with knee OA and comorbidities by a multiple choice test before (T0) and 2 weeks after the course (T1) (Stanny, 2016). We also tested more advanced knowledge levels (application and analysis, i.e. clinical reasoning skills) prior to the course (T0) and after a 6-month period of practical application of the strategy (T2). Course satisfaction was assessed directly after the course with a questionnaire. Facilitators and barriers for using the strategy were evaluated by a questionnaire at T2. In addition, semi-structured interviews were performed with a random selection of PTs at T2, to gain more in-depth understanding of facilitators and barriers. The study was performed from July 2016 to September 2017. The study protocol was approved by the Medical Ethical Review Board of the Reade/Slotervaart Hospital, Amsterdam, the Netherlands (number P1659).

2.2 | Participants

Physical therapists who were a member of a network for rheumatic diseases and PTs from regional subdivisions of the Royal Dutch Society for Physical Therapy (KNGF) in the Netherlands (North-Holland and Mid-Holland) were invited to participate via an invitation email or an online newsletter, respectively. If interested, the participant eligibility was assessed by telephone screening by the researcher (MROO). Inclusion criteria were: (1) the PT was specialized in OA treatment or had the intention to specialize in this topic; (2) the PT was expected to treat, on a monthly basis, at least one new knee OA patient with comorbidity (i.e. cardiac disease, diabetes type 2, COPD or obesity; if this was not the case, the PT had to be willing to actively recruit patients from general practitioners (GPs) in the area or from the orthopaedic department of the surrounding

hospitals; (3) availability of an exercise facility; (4) instruments to measure clinical parameters e.g. blood pressure, heart frequency, pulse oximetry; and (5) availability of safety facilities (i.e. presence of an automated external defibrillator).

2.2.1 | Treatment strategy for knee OA and comorbidity

The strategy, as developed in a secondary care setting, consists of diagnostic and intervention phases and supports the PT in making clinical decisions and designing a customized treatment plan. The specific options for adaptations to the diagnostic phase and intervention phase are listed in the protocol, as described previously (de Rooij et al., 2014; de Rooij et al., 2017). In the randomized controlled trial in which the strategy was evaluated patients received a 20-week individualized (tailored) knee OA exercise program, with two sessions of 30 to 60 min a week under supervision of a PT.

For primary care, the protocol was adapted by shortening the diagnostic phase from 60 min to 45 min. In addition, the number of treatment sessions and duration of the session was open to the PTs choice (instead of a set period of 20 weeks, two times a week, which was used in the RCT), depending on the patient-specific goals and the number of reimbursed treatment sessions of each individual patient.

2.3 | Educational course for PTs

The blended learning course was developed by an expert PT/researcher (MROO) in collaboration with an educational instructional designer and teachers from the Amsterdam University of Applied sciences. The expert PT has >15 years of experience in treating patients with knee OA, is an expert in the development of comorbidity-related adaptations and is experienced in teaching health professionals. Each workshop was led by the expert PT and performed with the help of five PT teachers who were familiar with the treatment of patients with knee OA and comorbidity and the developed strategy. The teachers received oral and written instructions on how to guide the participants in the process of clinical reasoning. The blended educational course consisted of five e-learning lectures and two interactive workshops. The content of the educational course was based on the previously developed and tested strategy (de Rooij et al., 2017). The content and the topics that were educated in the e-learning lectures and workshops are summarized in table 1.

After following the e-learning lectures and the two workshops, PTs treated patients with knee OA and comorbidity, during a 6-month period. Target comorbidities were coronary disease, heart failure, type 2 diabetes, COPD or obesity. During the intake the PT checked whether the patient fulfilled the clinical criteria of the American College of Rheumatology for knee OA (Altman et al., 1986). The Cumulative Illness Rating Scale (CIRS) was used to measure comorbidity (Hudon Fortin, & Vanasse, 2005; Hudon, Fortin, & Soubhi, 2007). Patients had to score a severity score ≥ 2 for the comorbidity on the CIRS, indicating that the comorbidity has an impact on daily activities and the patient was receiving regular care for the comorbidity.

TABLE 1 Characteristics of the participating physiotherapists (PTs) (n = 34)

Main objective
• To teach the PTs to adapt regular knee OA exercise therapy to the comorbid disease to ensure safety and to optimize training intensity of exercise for the patient.
Study load
• E-learning lectures: seven-hours study load
• Two workshops: each three-hours study load
Topics of the e-learning lectures
• Pathophysiology of knee OA
• Content of regular exercise therapy in knee OA
• Pathophysiology of the comorbid disease (coronary disease, heart failure, diabetes type 2, COPD, obesity)
• Adaptations to diagnostics due to the comorbid disease (history taking, physical examination)
• Influence of medication (for the comorbid disease) on exercise tolerance
• Interpretation of exercise testing in patients with cardiac disease or COPD
• Safety aspects of exercise therapy related to the comorbid disease
• Timing and performance of monitoring the comorbid disease during treatment
• Clinical decision making on when to consult a medical specialist due to signs or symptoms of the comorbid disease
Interactive workshops
• PTs were challenged to apply the content of the online modules to casuistic examples (e.g. a patient with knee OA and diabetes or coronary disease) in order to improve clinical reasoning and to practice the use of the developed strategy.

OA osteoarthritis, COPD Chronic Obstructive Pulmonary Disease

2.4 | Assessments

The primary outcome measure for the educational course evaluation was the competence of PTs to apply the comorbidity-adapted exercise in patients with knee OA and comorbidity. Competence was defined as (1) knowledge of knee OA and comorbidities (cardiac diseases, diabetes type 2, COPD and obesity) and the (2) skills for clinical reasoning to adapt the knee OA exercise program.

2.4.1 | Competence of physiotherapists

Knowledge was tested by a multiple-choice questionnaire which was based on the content of the e-learning topics (see table 1). This

questionnaire comprised 60 multiple-choice (three answer options) questions, which required approximately 60 min of PTs time. Blooms' taxonomy was used to formulate questions on various levels from factual knowledge up to comprehension levels (Stanny, 2016). A correct answer yielded one point with a total range score of 0–60, with a higher score indicating more knowledge.

For measuring clinical reasoning skills, a vignette of a patient with knee OA and comorbidity (diabetes type 2 and coronary disease) was described with nine open questions mainly based on the application – analysis level of knowledge (Stanny, 2016). Vignettes are a valid way to measure clinical reasoning skills by PTs (van Dulmen et al., 2014). The questions focused on clinical decision making in diagnostics and treatment and contained the following topics: history taking and physical examination of the comorbid disease, interpretation of test results, and adaptations of the OA exercise therapy during treatment. For each question a maximum of five points could be achieved (total range score of 0–45, with higher scores indicating a higher level of skills for clinical reasoning). A standard checklist of predefined answer options was used to assess the output. Two reviewers assessed the answers independently (MROO and MTER). In case of differences in scores, mutual agreement was achieved by discussion.

2.4.2 | Satisfaction with the educational course

Course satisfaction was assessed by a questionnaire directly after the second workshop. We used an adapted version of the questionnaire of Peter et al., who evaluated course satisfaction in PTs following a course to increase adherence to a Dutch physiotherapy practice guideline for hip and knee OA (Peter et al., 2015). The adapted questionnaire included five questions all rated on a 0–10-point scale (with higher score indicates more satisfaction): (1) How do you rate the quality of the overall educational course? (2) How do you rate the content of the e-learning? (3) How do you rate the content of the workshops? (4) How do you rate the gained obtained knowledge of comorbidity? (5) Do you expect that the content of the educational course is applicable in your daily practice?

2.4.3 | Facilitators and barriers for using the strategy

Facilitators and barriers for implementation of the developed strategy in primary care were assessed by questionnaire (see appendix 2). We used an adapted version of the questionnaire of van der Wees et al. who identified perceived barriers for implementing the Dutch physiotherapy COPD clinical practice guideline (van der Wees et al., 2013). The adapted questionnaire comprised 27 items on facilitators and barriers in using the strategy. Each item was scored on a 5-point Likert scale, ranging from 0 (totally agree) to four (totally disagree). In addition, to gain more in-depth understanding semi-structured interviews on facilitators and barriers for using the strategy in primary care were conducted by telephone by the first author among 10 randomly chosen PTs. A topic guide to structure the interview (see appendix 1) was formulated in consultation with members of the project group (MLEE and JDEK). The topic guide was refined based on answers given by therapists to the questionnaire of facilitators and barriers for using the strategy in primary care. A reliable depiction of the experiences of the PTs was achieved by verifying with the individual PT whether the remarks were interpreted correctly by giving a summary at the end of the interview.

2.4.4 | Characteristics of PTs and evaluation of referrals

The following characteristics of PTs were gathered: age, sex, work setting, years of work experience as PT and previous participation in educational courses concerning rheumatic and musculoskeletal conditions (yes/no) or comorbidity specific courses (e.g. cardiac rehabilitation). In addition, the participating PTs were asked to register which physician referred the patients with knee OA and comorbidity.

2.5 | Data analysis

Descriptive statistics for baseline characteristics of the PTs, and the outcome of knowledge and clinical reasoning and satisfaction with the course were tabulated as mean (SD), or percentages, as appropriate. All outcome measures were normally distributed. A paired-sample *t*-test was used to analyze the mean difference in knowledge (between baseline (T0) and 2 weeks post-education (T1)) and clinical reasoning skills (between baseline (T0) and 6 months post-education (T2)). Barriers and facilitators for implementation of the strategy were tabulated using descriptive statistics. Subsequently, the notes that were taken during the semi-structured interviews with the PTs were summarized. The a priori power calculation was based on an expected within-group effect size (ES) of 0.5. This effect was found in a study of Peter et al. (2013), measuring adherence to a Dutch physiotherapy practice guideline for hip and knee OA after an educational course for PTs. Assuming the same ES of 0.5, the estimated minimum number of participants in our study was 34, using competence of PTs as the primary outcome (alpha 0.05; power 0.80).

3 | RESULTS

3.1 | Participants

Out of 53 potential participants 34 PTs met the inclusion criteria and were willing to participate in the study (see Figure 1). Baseline characteristics of the participating PTs are presented in Table 2. Fourteen out of 34 PTs treated one or more patients with knee OA and comorbidity according to the strategy. Patients were referred by GPs, orthopaedic surgeons or by self-referral.

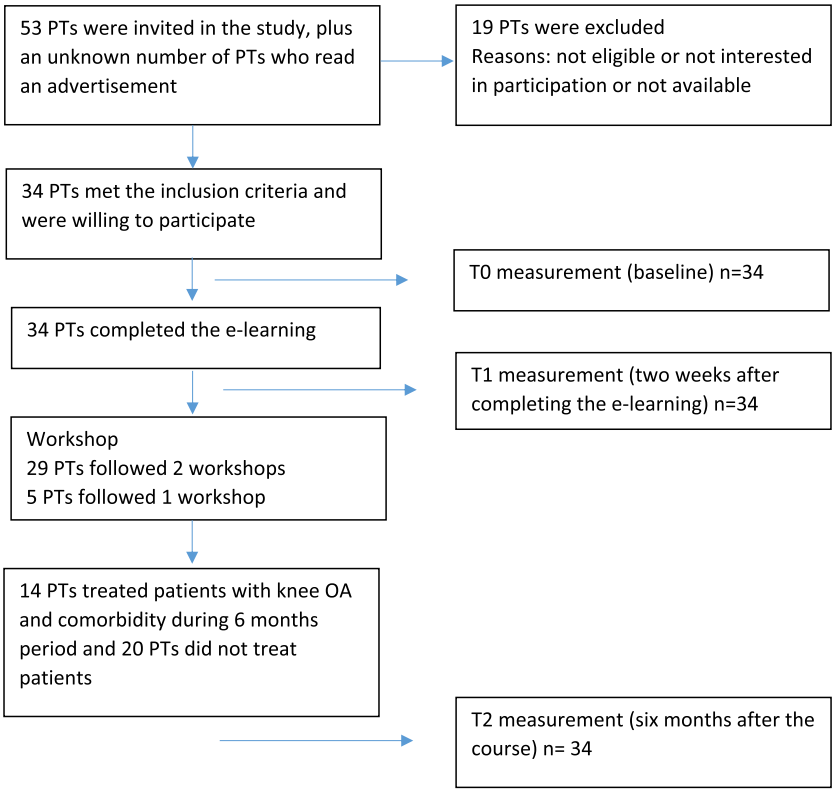

FIGURE 1 Flowchart
OA osteoarthritis, PT physiotherapist [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Characteristics of the participating physiotherapists (PTs) (*n* = 34)

Demographics	
Age (years), mean ± SD	43.7 ± 11.1
Sex (female), n (%)	23 (68)
Working experience as PT, n (%)	
0–5 years	6 (18)
6–10 years	5 (15)
11–15 years	2 (6)
>15 years	21 (62)
Member of a network of rheumatic diseases, yes n (%)	12 (35)
Working experience in OA treatment, n (%)	
0–5 years	9 (27)
6–10 years	5 (15)
11–15 years	4 (12)
>15 years	16 (47)
Work experience in treatment of patients with knee OA and comorbidity, yes *n (%)*	23 (68)
Accredited education in OA treatment, yes n (%)	17 (50)
Specialization in comorbidity, n (%)	
Cardiovascular diseases/rehabilitation	5 (15)
Pulmonary disease/rehabilitation	7 (21)
Diabetes	3 (9)
Geriatrics	2 (6)
Other (e.g. cancer, oedema therapy)	15 (44)

3.2 | Competence physiotherapists

Statistically significant improvements were found for the total group (n = 34), both for knowledge levels between baseline (T0) (mean = 38.65 SD 4.58) and T1 (mean = 43.09 SD 5.69) ($p < 0.01$), and for clinical reasoning baseline (mean = 23.50 SD 6.37) and T2 (mean = 30.25 SD 6.53) ($p < 0.01$).

3.3 | Course satisfaction

Overall, the participants were satisfied with the educational course (7.9 points (SD 0.9) (n = 33)). The content of the e-learning modules was rated 8.2 points (SD 0.7) (n = 33) and the content of the workshops 7.6 points (SD 0.9) (n = 33). Increase in knowledge of comorbidity was rated at 6.8 points (SD 1.4) (n = 33) and expected applicability for daily clinical practice at 7.1 points (SD 1.0) (n = 31).

3.4 | Facilitators and barriers for using the strategy in primary care

In Table 3, the main facilitators and barriers for implementing the strategy to adapt exercise therapy to comorbid diseases in primary care are summarized using the implementation framework of Grol et al., 2003. According to Grol and Grimshaw (2003), implementation strategies

TABLE 3 Main facilitators and barriers for implementing the protocol on the exercise strategy in primary care (n = 14)

Facilitators	(Strongly) Disagree (%)	Neither agree nor disagree (%)	(Strongly) Agree (%)
Design, content and feasibility			
The protocol is feasible in daily clinical practice	0	14	86
The protocol supports me in clinical reasoning	9	7	93
The protocol is supporting the improvement of my knowledge regarding knee OA exercise therapy and comorbidity	0	7	93
The protocol is supportive in which comorbidity-related symptoms I need to monitor before, during and after treatment	0	14	86
Working with the protocol invites me to discuss more with experts in the field of comorbidity	14	36	50
Change in working method			
Have changed my working method	15	7	79
Applicability			
The protocol is applicable to OA patients with comorbidity that I see in my clinical practice	7	7	86
Barriers			
Design, content and feasibility			
In my daily clinical practice I can integrate working according to the protocol well	7	29	64
Knowledge and skills			
I have sufficient knowledge about knee OA exercise therapy and comorbidity to apply the protocol in daily clinical practice	14	14	71
I have sufficient skills to apply the protocol in daily practice	21	14	64
Applicability			
I treat enough patients with knee OA and comorbidity to apply the protocol	57	14	29
The number of treatments that the patient receives from insurance company is a barrier in using the protocol	7	43	50
Social environment			
The general practitioners or other physicians are collaborative regarding the application of the protocol in daily clinical practice	79	21	0

OA osteoarthritis

should be aimed at the level of the professional (e.g. education), the organization (e.g. adaptation of work processes), the context (e.g., adequate funding) or the patient (e.g. patient information). The percentages of facilitators and barriers are presented for PTs who actually treated patients with knee OA and comorbidity according to the strategy during the project (n = 14). We combined the responses 'strongly disagree' and 'disagree' as well as 'strongly agree' and 'agree'. See appendix 2 for full listing of the responses to each item of the questionnaire and distribution among all response categories for all PTs (n = 34) and for who actually treated patients with knee OA and comorbidity according to the strategy during the project (n = 14).

With regard to facilitators, the majority of PTs stated that the strategy was feasible in daily practice (86%), improved knowledge regarding knee OA exercise therapy and comorbidity (93%) and was supportive in clinical reasoning (93%). Eighty-six percent of the PTs responded that the strategy was applicable to OA patients with comorbidities which they treat in daily clinical practice and 79% mentioned that they had changed their working method in treating patients with knee OA and comorbidity.

The main barriers to applying the strategy in primary care were related to the limited number of referrals or self-referrals of patients with knee OA and comorbidity to PTs (57%), limited number of reimbursed treatment sessions by insurance companies (50%) and a suboptimal collaboration with (referring) physicians (79%). The results of the semi-structured interviews supported the results from the questionnaires. Data saturation was achieved after eight out of 10 semi-structured interviews (data saturation was defined as when the researcher begins to hear the same comments again and again (Grady, 1998)). The interviews lasted 30 min on average. In the interviews, PTs indicated that a suboptimal collaboration with general practitioners and physicians resulted in a lower number of referred patients with comorbidity. In addition, PTs indicated that a lack of referral or self-referral of patients was due to the fact that referring physicians (e.g. orthopaedic surgeons) or patients do not always believe in or may lack knowledge about the effectiveness of exercise therapy. A summary of answers given by the PTs in the semi-structured interviews is presented in appendix 1.

4 | DISCUSSION

This study showed that a blended course on exercise therapy for knee OA patients with comorbidity seems to be effective in improving PTs' competence in treating complex knee OA patients with comorbidity in primary care. The main barriers to applying the strategy in primary care were related to the limited number of (self-) referrals of patients with knee OA and comorbidity to PTs, limited number of reimbursed treatment sessions by insurance companies and a suboptimal collaboration with (referring) physicians. These results can be helpful to improve treatment in primary care for patients with knee OA and comorbidity.

We found statistically significant improvements on knowledge and clinical reasoning skills of PTs in complex knee OA patients. Moreover, if we interpret the knowledge level by using a criterion based absolute cut off score (van der Vleuten etal., 2010) (≥ 40 correct answers for multiple choice, calculated by a score 50% above the chance of guessing), then 44% of PTs would have passed the knowledge test at baseline, compared to 71% directly after the course. For clinical reasoning skills 38% of PTs would have passed the test (≥25 points) at baseline, compared to 80% after following the course. These results are in line with two systematic reviews evaluating the effectiveness of blended education in health professionals (Liu et al., 2016; Rowe, Frantz, & Bozalek, 2012).

The main barrier for integrating the strategy in daily practice was the low number of treated patients with knee OA and comorbidity during the study. PTs indicated that non-referral of patients with knee OA and comorbidity was related to a lack of knowledge or belief in the effectiveness of exercise therapy in patients with knee OA and comorbidity by referring physicians and patients. Our results are in line with previous studies that reported an underuse of non-surgical treatment options in patients with knee OA (Brand et al., 2014; Hoogeboom et al., 2012; Smink et al., 2014; Snijders et al., 2011). In addition, Hofstede et al found similar barriers for referral to non-surgical treatment for OA patients in orthopaedic practice (Hofstede et al., 2016). Egerton et al. described in a systematic review similar barriers to the management of osteoarthritis in primary care GPs: GPs tend to trivialize the problem and believe OA to be inevitable and lower priority than other health conditions which may lead to under management of the condition; a lack of knowledge regarding OA guidelines; clinicians' perceptions about the disease, patient adherence and the treatment effectiveness may all lead to variable practice at odds with the recommendations (Egerton, Diamond, Buchbinder, Bennell, & Slade, 2017).

Another important barrier was the limited reimbursement of treatment sessions by health insurance companies. PTs indicated that often more treatments were necessary to properly treat complex patients with comorbidity (in the Netherlands patients with osteoarthritis receive on average 17 treatment sessions (sd 21.2) (Leemrijse et al. 2016)). For example, an extended intake procedure was required to adequately identify comorbidity-related restrictions or contraindications for exercise therapy. In addition, it took more time to build up a training program due to the low exercise tolerance of these patients. For patients with knee OA and comorbidity exercise therapy is an important treatment option. Comorbidity-adapted exercise therapy is found to be highly effective in reducing knee pain and improving physical functioning in these patients (de Rooij et al., 2017).

A strength of this study is that we developed an effective interactive educational course for PTs on exercise therapy for knee OA patients with comorbidity and evaluated barriers and facilitators for using the protocol in primary care. The protocol was originally developed and tested in a secondary care setting and facilitators and barriers can differ between settings. In this study several barriers for using the protocol in primary care were identified. Insight into barriers and facilitators is essential to optimize the use of the protocol in primary care. For larger scale implementation these barriers should be solved first.

This study also has some limitations. First, we performed an observational study to evaluate the effect of the educational course

on competence of PTs in primary care. To compare the level of competence of PTs who followed an educational course with PTs who did not follow an educational course a randomized controlled trial should be performed. Second, we did not evaluate the effect of the treatment on the patient level, since this was not within the scope of this study. Future studies should also study the effect of exercise therapy on pain and function in patients with knee OA and comorbidity provided by trained PTs who are working in primary care. Third, qualitative data was used to gain more in-depth information on the answers that PTs gave in the questionnaire about facilitators and barriers for using the strategy in primary care. However, there was no peer review in this part of the data analysis process which could be considered as a limitation. Fourth, we used a multiple-choice test and patient vignettes to assess PTs' competence levels. Even though patient vignettes are a valid way to measure PTs' clinical reasoning skills (van Dulmen et al., 2014), the gold standard to assess true competence would be to observe PTs in practice.

Our findings have several implications for clinical practice. First, it seems that PTs have to treat patients with knee OA and comorbidity regularly to properly transfer the gained knowledge and skills into clinical practice and to integrate the strategy in daily practice. This suggests that concentration of patients by reference to specialized and experienced PTs can be helpful and may ensure safe and effective treatment of patients with knee OA and comorbidity. Second, changing the attitude and beliefs of referring physicians (including general practitioners, orthopaedic surgeons and other healthcare providers) and patients with regard to the effect of exercise therapy in patients with knee OA and comorbidity is an important condition to successfully implement the strategy in primary care. Although direct evidence is lacking, our first impression is that a closer collaboration between general practitioners, physicians and PTs, for example in an OA network, may stimulate communication between healthcare providers and support them in making agreements on criteria for referral, for example, regarding triage of patients to primary or secondary care (e.g. rehabilitation centre or orthopaedic surgeon). Third, health insurance companies should increase the number of reimbursed treatment sessions in patients with knee OA and comorbidity to treat these patients properly.

In conclusion, a blended course on exercise therapy for patients with knee OA and comorbidity seems to improve PTs' competence through increasing knowledge and clinical reasoning skills. Identified barriers should be solved, before larger scale implementation of exercise therapy can take place in these complex patients.

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ETHICAL APPROVAL

The study protocol was approved by the Medical Ethical Review Board of the Reade/Slotervaart Hospital, Amsterdam, the Netherlands (number P1659).

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CONFLICT OF INTEREST

There are no conflicts of interest.

AUTHOR CONTRIBUTIONS

All authors were involved drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Ms de Rooij had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study conception and design. de Rooij, van der Leeden, van der Esch, Lems, Meesters, Roorda, Peter, Terbraak, Vliet Vlieland, Dekker. Acquisition of data. de Rooij. Analysis and interpretation of data. de Rooij, van der Leeden, van der Esch, Lems, Roorda, Terbraak, Vredeveld, Dekker.

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APPENDIX 1

Summary of PTs answers in the semi-structured interview

Topic	Summary of PTs answers
Was the intake procedure feasible (in time, difficulty, implementable)?	- The intake procedure is feasible and implementable, but it is important to extend the intake phase to at least to 45 min (30 min intake is regular in the Netherlands). - The more you apply the strategy in daily practice, the easier it is to integrate the strategy in your daily working method
Did the strategy help you in your clinical decision-making process during diagnostics and treatment phase? Is so, in what way?	- By using the strategy you gain more insight into the exercise tolerance of the patient and you have more background knowledge to make clinical decisions. However, the total amount of knee OA patients with comorbidity was lower than expected which hampered the expansion of required knowledge and skills. To familiarize yourself with the strategy, you have to apply it regularly.
Did you encounter any obstacles when providing the treatment?	- The number of treatment sessions the patients receive from insurance companies restricted the application of the strategy. - Patients with knee OA and comorbidity are not always motivated to perform exercises. - Requesting medical information about patients from specialists takes a lot of time. - Physicians are not always collaborating in discussing medical conditions of patients
Do you have any suggestions to improve the number of referred patients?	- Inform GPs, orthopaedic surgeons and other referrers better about the benefits of exercise therapy in patients with knee OA and comorbidity. - Inform patients with knee OA and comorbidity better about the benefits of exercise therapy - Optimize collaboration with orthopaedic surgeons and other health care providers - inform patients with knee OA and comorbidity better about the benefits of exercise therapy - in complex patients insurance companies should reimburse more treatment sessions because it takes more time to build up a training program - Extend the study duration so PTs have more time to treat patients according to the strategy
Do you have any suggestions for improvements to implement the strategy?	- It is useful to plan a follow up/refreshment training to repeat and discuss the content of the course/protocol and its practical application - shortening the protocol would increase user-friendliness

APPENDIX 2

Full questionnaire and detailed responses for identifying barriers and facilitators for implementing the protocol on the exercise strategy of the total group (*n* = 34), and PTs who actually treated patients with knee OA and comorbidity (*n* = 14)

Item	Strongly Disagree *n* (%)		Disagree *n* (%)		Neither Agree nor disagree *n* (%)		Agree *n* (%)		Strongly Agree *n* (%)	
Design, content, feasibility	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**
The protocol is feasible in daily clinical practice.	0	0	4 (11.8)	0	7 (20.6)	2 (14.3)	21 (61.8)	10 (71.4)	2 (5.9)	2 (14.3)
In my daily clinical practice I can integrate working according to the protocol well.	1 (2.9)	0	9 (26.5)	1 (7.1)	9. (26.5)	4 (28.6)	13 (38.2)	7 (50)	2 (5.9)	2 (14.3)
The protocol supports me in clinical reasoning.	0	0	3 (8.8)	0	5 (14.7)	1 (7.1)	21 (61.8)	9 (64.3)	5 (14.7)	4 (28.6)
The protocol gives the opportunity to make your own decisions regarding history taking, physical examination, and treatment.	0	0	0	0	5 (14.7)	1 (7.1)	26 (76.5)	11 (78.6)	3 (8.8)	2 (14.3)
Some contents of the protocol are incorrect.	5 (14.7)	1 (7.1)	17 (50)	7 (50)	11 (32.4)	6 (42.9)	1 (2.9)	0	0	0
The lay out of the protocol facilitates its usage in daily practice.	0	0	6 (17.6)	1 (7.1)	21 (61.8)	10 (71.4)	7 (20.6)	3 (21.4)	0	0
In my daily clinical practice, I work with sufficient equipment (including blood pressure meter, saturation meter) to properly apply the protocol.	1 (2.9)	0	0	0	0	0	16 (47.1)	4 (28.6)	17 (50.0)	10 (71.4)
The protocol is supporting the improvement of my knowledge regarding knee OA exercise therapy and comorbidity.	0	0	1 (2.9)	0	2 (5.9)	1 (7.1)	21 (61.8)	7 (50)	10 (29.4)	6 (42.9)
The recommendations over adapting the diagnostic phase (history taking and physical examination) in the protocol are clear and understandable.	0	0	3 (8.8)	0	9 (26.5)	4 (28.6)	19 (55.9)	8 (57.1)	3 (8.8)	2 (14.3)
The recommendations over adapting the OA exercise therapy in the protocol are clear and understandable.	0	0	1 (2.9)	0	10 (29,4)	5 (35.7)	20 (58.8)	8 (57.1)	3 (8.8)	1 (7.1)
The protocol is supportive in which comorbidity-related symptoms I need to monitor before, during and after treatment.	0	0	2 (5.9)	0	4 (11.8)	2 (14.3)	26 (76.5)	10 (71.4)	2 (5.9)	2(14.3)
Working with the protocol invites me to discuss more with experts in the field of the comorbidity.	1 (2.9)	0	7 (20.6)	2(14.3)	8 (23.5)	5 (35.7)	17 (50)	7(50)	1 (2.9)	0
I treat enough patients with knee OA and comorbidity to apply the protocol.	9 (26.5)	1 (7.1)	14 (41.2)	7 (50)	4 (11.8)	2 (14.3)	5 (14.7)	3 (21.4)	2 (5.9)	1 (7.1)
Change in working method										
In general, I feel resistance towards working according to protocols.	8 (23.5)	0	20 (58.8)	10(71.4)	5 (14.7)	4 (28.6)	0	0	1 (2.9)	0
The protocol fits well with my working methods of daily clinical practice.	1 (2.9)	0	4 (11.8)	2 (14.3)	16 (47.1)	4 (28.6)	12 (35.3)	7 (50)	1 (2.9)	1 (7.1)
I have changed my working method.	1 (2.9)	1 (7.1)	5 (14.7)	1 (7.1)	8 (23.5)	1 (7.1)	17 (50)	9 (64.3)	3 (8.8)	2 (14.3)
Knowledge and skills										
I have sufficient knowledge about knee OA exercise therapy and comorbidity to	2 (5.9)	0	10 (29.4)	2 (14.3)	6 (17.6)	2 (14.3)	15 (44.1)	10 (71.4)	1 (2.9)	0

(Continues)

Item	Strongly Disagree *n* (%)		Disagree *n* (%)		Neither Agree nor disagree *n* (%)		Agree *n* (%)		Strongly Agree *n* (%)	
Design, content, feasibility	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**	***n* = 34**	***n* = 14**
apply the protocol in daily clinical practice.										
I have sufficient skills to apply the protocol in daily clinical practice.	1 (2.9)	0	10 (29.4)	3 (21.4)	8 (23.5)	2 (14.3)	14 (41.2)	8 (57.1)	1 (2.9)	1 (7.1)
I read the protocol sufficiently to remember any of its contents.	2 (5.9)	1 (7.1)	9 (26.5)	(14.3)	11 (32.4)	5 (35.7)	12 (35.3)	6 (42.9)	0	0
Applicability										
The number of treatments that the patient receives from their insurance company is a barrier in using the protocol.	0	0	4 (11.8)	1 (7.1)	9 (26.5)	6 (42.9)	16 (47.1)	6 (42.9)	5 (42.7)	1 (7.1)
Working according to the protocol is too time-consuming.	1 (2.9)	0	2 (5.9)	2(14.3)	15 (44.1)	7 (50)	11 (32.4)	3 (21.4)	5 (14.7)	2 (14.3)
Working according to the protocol should be financially rewarded.	1 (2.9)	0	3 (8.8)	2 (14.3)	11 (32.4)	8 (57.1)	16 (47.1)	3 (21.4)	3 (8.8)	1 (7.1)
The protocol is applicable to OA patients with comorbidity that I see in my clinical practice.	1 (2.9)	0	6 (17.6)	1 (7.1)	9 (26.5)	1 (7.1)	17 (50)	12 (85.7)	1 (2.9)	0
Social environment										
The patients are cooperative in applying the protocol in daily clinical practice.	2 (5.9)	0	3 (8.8)	1 (7.1)	20 (58.8)	5 (35.7)	9 (26.5)	8 (57.1)	0	0
My colleagues in physiotherapy are cooperative in applying the protocol in daily clinical practice.	2 (5.9)	0	3 (8.8)	2 (14.3)	25 (73.5)	11 (78.6)	4 (11.8)	1 (7.1)	0	0
The management of my practice is collaborative regarding the application of the protocol in daily clinical practice.	2 (5.9)	0	2 (5.9)	2 (14.3)	25 (73.5)	10 (71.4)	5 (14.7)	2 (14.3)	0	0
The general practitioners or other physicians are collaborative regarding the application of the protocol in daily clinical practice.	5 (14.7)	3 (21.4)	17 (50)	8 (57.1)	11 (32.4)	3 (21.4)	1 (2.9)	0	0	0

OA osteoarthritis