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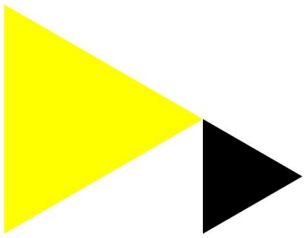

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Evaluation of treatment outcome using the Patient Specific Functional Scale in knee osteoarthritis patients undergoing multidisciplinary rehabilitation

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SUMMARY

Objective: First, to make an inventory of activity limitations commonly reported by knee osteoarthritis (OA) patients undergoing multidisciplinary rehabilitation. Second, to evaluate treatment outcome using the Patient Specific Functional Scale (PSFS) and compare it to the Western Ontario and McMasters Universities Osteoarthritis Index physical function subscale (WOMAC-pf).

Design: An observational study with assessments before and immediately after multidisciplinary rehabilitation. Five hundred and thirteen patients used the PSFS, a patient-reported tool to identify activity limitations and score the patient's ability to perform the activity on an 11-point Numeric Rating Scale (NRS), to report three activities in which they were limited. Frequencies and percentages of their highest-prioritized activity were calculated and categorized according to the International Classification of Functioning, Disability, and Health (ICF). Paired-samples T-tests were used to analyze the change in ability to perform the activities. Effect sizes of PSFS and WOMAC-pf were compared.

Results: Most patients indicated limitations in walking, walking up/down stairs, prolonged standing, and standing up from a chair. Following these common activities, 26 different activities were identified. The majority of these highest-prioritized activities fell under the first-level ICF category of Mobility. The ability to perform all activities significantly improved after treatment. Effect sizes ranged between 0.60 and 0.97 and were greater than the effect size of the WOMAC-pf (0.41).

Conclusion: Knee OA patients who undergo multidisciplinary rehabilitation exhibit improvements in performing daily activities. The PSFS is a valuable tool to evaluate patient-specific activity limitations and seems to capture improvements in activity limitations beyond the WOMAC-pf.

1. Introduction

Osteoarthritis (OA) is a common, degenerative, and debilitating disease, recognized as a top cause of disability in older adults [1]. Eighty percent of those with OA experience movement impairments and 25% cannot perform activities of daily life [2]. Of the joints frequently affected by this disease, OA in the hip and knee poses the greatest burden on the individual. These joints are large weight-bearing joints, which translates to a high degree of disability in terms of reduced mobility and limitations with activities of daily living, which is associated with a substantial and persistent reduction in physical functioning [3,4]. In the Netherlands, recommended conservative treatment for hip or knee OA is via a stepped-care approach, starting with a combination of patient education and medication, transitioning to exercise and diet therapy and medication, and ending with multidisciplinary rehabilitation when necessary [5].

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At the core of a multidisciplinary rehabilitation program is the patient's treatment goal, or what the patient seeks to achieve with the guidance of the health professionals. One recommended assessment tool, the Patient Specific Functional Scale (PSFS), can support the patient's treatment goal by identifying and prioritizing the patient's activity limitations [6]. The PSFS is a patient-specific tool in which a patient can indicate and prioritize several activity limitations as a result of the impairment, and can score the activities on an 11-point scale of performance [7]. The patient's treatment goal, the PSFS assessment, and the health professionals' further assessments of the patient are translated to more specified treatment goals through a shared decision-making process between the patient and clinician(s). The patient-specific treatment goals are then incorporated into an individualized multidisciplinary rehabilitation program.

As the PSFS is a patient-specific tool with good psychometric properties in patients with knee dysfunction and is directly related to goal-oriented multidisciplinary rehabilitation, it is a sound measurement tool to evaluate the effectiveness of multidisciplinary rehabilitation [8,9]. Despite this link, the effect of multidisciplinary rehabilitation on knee OA patients measured by the PSFS is unknown. The PSFS might also capture activity limitations not otherwise captured by disease-specific tools: it may therefore be a valuable tool to measure the effects of goal-oriented multidisciplinary rehabilitation. Although it is established that knee OA patients experience activity limitations, there is to date, no inventory of the most common patient-reported activity limitations that these patients face [10,11]. The International Classification of Functioning, Disability, and Health (ICF) can be used to universally describe such activities [12]. Research using the PSFS to evaluate exercise therapy as a part of multidisciplinary rehabilitation is mainly conducted after total knee arthroplasty [13,14]. Thus, studies using the PSFS as a primary outcome measure in knee OA patients following multidisciplinary rehabilitation are lacking.

Therefore, the first objective of this study was to make an inventory of the activity limitations that individuals with knee OA commonly face and prioritize as important to improve, and to categorize these activities according to broader taxonomic domains using the ICF. The second objective was to determine the outcome of patient-specific multidisciplinary rehabilitation on activity limitations as measured by the PSFS in patients with knee OA, and to compare these outcomes with the outcomes of the commonly-used Western Ontario and McMasters Universities Osteoarthritis Index physical function subscale (WOMAC-pf).

2. Methods

2.1. Study design

The study was an observational study, using measurements at baseline (T0) and immediately following completion of the multidisciplinary rehabilitation program (T1). Individual diagnosis and evaluation were the primary purpose of the measurements. In addition, data have been stored anonymously for evaluation of OA team care on a group level from 2009 to 2019. According to Dutch law, using data from routine health care for scientific purposes is permitted, as approved by the medical ethical committee of the Slotervaart hospital and Reade (U/2782/0851).

2.2. Patients

Patients included were from the Amsterdam OA (AMS-OA) cohort, which consisted of individuals with hip and/or knee OA who were referred to Reade, outpatient center for Rehabilitation and Rheumatology in Amsterdam, the Netherlands [15–17]. Patients in this cohort did not have rheumatoid arthritis or inflammatory arthritis and did not undergo joint arthroplasty. Patients within the AMS-OA cohort who were included in this study were those diagnosed with knee OA by a physician or according to American College of Rheumatology (ACR) criteria and underwent exercise therapy as a part of Reade's multidisciplinary rehabilitation program. For the first objective of this study, patients with complete pre-treatment PSFS measurements from 2009 to 2019 were included. Reade began collecting follow-up PSFS data in 2013: patients included for the second objective were therefore those who underwent treatment starting in 2013 and had pre- and post-treatment PSFS measurements.

2.3. Intervention

The included patients underwent a multidisciplinary rehabilitation program that was tailored to the specific treatment goals of each patient. Exercise therapy, a central component of the program, was conducted at Reade with a qualified physiotherapist under the coordination of a rehabilitation physician. The exercise therapy programs were based on the activities identified in the PSFS and adapted to each patient to determine the frequency, intensity, and duration of exercise. Patients attended one 60-min session or two 30-min sessions per week and were prescribed at-home exercises initially conducted on a daily basis and later progressed to higher intensity exercises 2–4 times per week. When indicated, a rheumatologist, podiatrist, occupational therapist, social worker, and/or psychologist were consulted for additional interventions. The overall rehabilitation program aimed at decreasing pain, decreasing limitations in activities, improving quality of life, and reducing the overall burden of disease on the patient.

2.4. Measurements

2.4.1. Descriptive measures

Patients were assessed according to an examination protocol to collect demographic, clinical, radiographic, biomechanical, and psychosocial factors relating to the disease. The following descriptives were collected: age, sex, Body Mass Index (BMI), OA severity (Kellgren & Lawrence score, K/L), number of comorbidities (Cumulative Illness Rating Scale, CIRS), average left and right upper leg peak muscle strength (isokinetic dynamometry), self-reported physical functioning (subscale of Western-Ontario and McMaster Universities Osteoarthritis Index, WOMAC), average knee pain within the previous week (Numeric Pain Rating Scale, NPRS), and level of anxiety and/or depression (Hospital Anxiety and Depression Scale, HADS).

2.4.2. Primary outcome measure

The PSFS is a self-reported tool used to describe a patient's activity limitations. Patients were provided with a Dutch PSFS which included a list of 30 activities adapted from Beurskens et al. and were asked to indicate all activities that he or she was limited in performing within the previous week [18,19]. Patients were also able to indicate any additional activities in the "other" section. The patient prioritized their three most important activity limitations; the most important was defined in this study as $PSFS_1$, the second as $PSFS_2$, and the third as $PSFS_3$. The patient then rated these activities on a numeric rating scale (NRS) ranging from 0 to 10, where 0 indicates no limitations in performing the activity and 10 indicates that performing the activity is impossible (NRS performance). In a population with knee dysfunction, the minimal detectable change (MDC) for NRS is 2.5 points per activity, and 1.5 points for the average of the three prioritized activities ($PSFS_{average}$) when analyzing the data in a group-based context [9].

2.4.3. Secondary outcome measure

The Dutch WOMAC-pf (17 items), a valid and reliable tool, was used to assess activity limitations related to OA of the lower limb [20,21]. Each item is answered on a Likert scale of 0–4, with a total subscale score ranging from 0 to 68. The raw score is standardized with the following equation: [(68 - raw score) *100]/68. Higher scores indicate more activity limitations. Missing items were imputed with the corrected item mean [22]. The minimal detectable change (MDC), or the smallest change detected by a measuring tool that is related to a noticeable change not due to measurement error for all WOMAC sections in knee OA

patients after 2 months is 14.1 points (on a scale of 0–100) [23]. The minimal clinically important difference (MCID) for the WOMAC-pf is an 11.25 point change from the baseline score [24].

2.5. Statistical analysis

All analyses were performed using SPSS, version 24 (SPSS Inc, Chicago, IL). Means, standard deviations, frequencies and percentages were calculated to describe the population.

For the first objective, the frequencies and percentages of each patient's highest prioritized activity limitation ($PSFS_1$) from the PSFS questionnaire were calculated and categorized according to the ICF in order to cluster similar activities for analysis. The frequencies and percentages of the ICF activity categories were calculated.

For the second objective, the change in performance of the PSFS activities (as measured by an 11-point NRS) following rehabilitation was analyzed in two ways. First, after checking the normality of the data and establishing it was normally distributed, paired-samples T-tests were used to analyze the change in difficulty of the three prioritized activities individually and averaged together ($PSFS_1$, $PSFS_2$, $PSFS_3$, and $PSFS_{average}$). Second, paired-samples T-tests were used to analyze the change in difficulty of the most frequently-reported specific activities. In each instance, effect sizes were calculated using the equation for standardized mean difference between pre- and post-treatment. The magnitude of effect sizes was designated according to the guidelines proposed by Cohen [25]. The magnitude of the effect size of $PSFS_1$ was additionally compared to the effect size of the WOMAC-pf.

3. Results

3.1. Patient selection

Between 2009 and April 2019, 563 patients of the AMS-OA cohort (in total N = 1050 at the moment of the study) with knee OA underwent multidisciplinary rehabilitation guided by the multidisciplinary OA team at Reade. The other 487 patients in the AMS-OA cohort either underwent multidisciplinary rehabilitation with a diagnosis other than knee OA or underwent treatment as part of a randomized controlled exercise trial. Of the 563 patients who underwent OA team rehabilitation, 50 patients were missing crucial data and were therefore excluded for analysis. Five

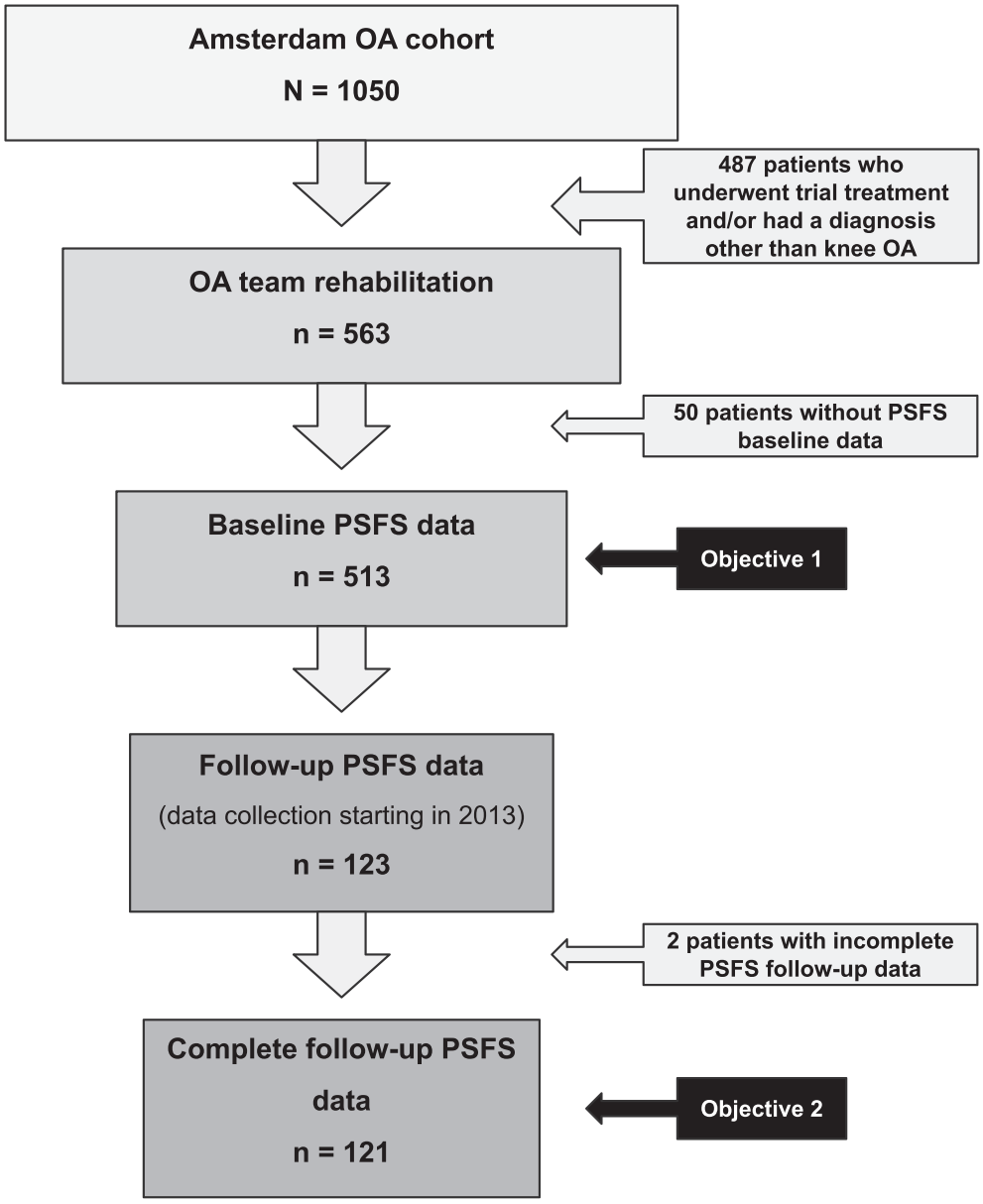

Fig. 1. Patient selection.

hundred and thirteen patients had complete PSFS data at baseline: this subpopulation was analyzed for objective one. One hundred and twenty-three patients underwent treatment since follow-up PSFS data started to be collected in 2013, and 121 patients had complete PSFS data at baseline and follow-up: this subpopulation was analyzed for objective two (see Fig. 1).

Baseline characteristics of both samples are displayed in Table 1. The subpopulation with T0 PSFS data (n = 513) is listed in the first column, and the subpopulation with follow-up PSFS data (n = 121) after the multidisciplinary rehabilitation is listed in the second column. The subpopulation with T0 PSFS data (n = 513) and the subpopulation with both T0 and T1 PSFS data exhibited comparable baseline characteristics.

3.2. Frequencies and categorization of activities: Objective 1

The activity limitation that patients reported in the PSFS questionnaire and prioritized as most important was categorized into groups according to the first and second levels of the ICF (see Table 2). The frequencies of the most important activities were calculated and are displayed in Fig. 2 according to both first and second levels of the ICF (see Fig. 2).

Table 1
Baseline characteristics for two subpopulations: patients that identified activity limitations at T0 (n = 513), and patients that rated the activity limitations at T0 & T1 (n = 121).

Variable	Value (n = 513)	Value (n = 121)
Age[a] (years)	61.08 ± 10.21	60.67 ± 10.20
Sex[b] (female)	367 (71.5%)	94 (77.7%)
BMI[a] (kg/m^2)	30.40 ± 6.17	32.08 ± 6.00
Treatment duration (weeks)	30.17 ± 14.70	32.06 ± 14.10
Missing	378 (73.7%)	0 (0.0%)
Knee OA[b] (ACR-criteria diagnosis)		
Unilateral knee	89 (17.3%)	21 (17.4%)
Bilateral knee	283 (55.2%)	73 (60.3%)
Missing	141 (27.5%)	27 (22.3%)
Radiographic severity Knee R[b]		
K/L grade 0-1	163 (31.7%)	39 (32.2%)
K/L grade 2	90 (17.5%)	8 (6.6%)
K/L grade 3	46 (9.0%)	6 (5.0%)
K/L grade 4	31 (6.0%)	4 (3.3%)
Missing	183 (35.7%)	64 (52.9%)
Radiographic severity Knee L[b]		
K/L grade 0-1	168 (32.7%)	43 (35.6%)
K/L grade 2	89 (17.3%)	7 (5.8%)
K/L grade 3	44 (8.6%)	3 (2.5%)
K/L grade 4	27 (5.3%)	4 (3.3%)
Missing	171 (33.3%)	64 (52.9%)
# Comorbidities[b] (CIRS-score ≥2)		
0	98 (19.1%)	6 (5.0%)
1	126 (24.6%)	37 (30.6%)
≥2	126 (24.6%)	30 (24.8%)
Missing	163 (31.8%)	48 (39.7%)
Upper leg muscle strength[a] (Nm/kg)		
Flexion	0.72 ± 0.72	0.72 ± 1.00
Extension	1.01 ± 0.81	0.97 ± 1.05
Missing	4 (0.8%)	1 (0.8%)
WOMAC PFS at baseline[a]	47.24 ± 21.65	52.02 ± 21.66
Missing	46 (9.0%)	13 (10.7%)
NPRS- Knees[a]	5.85 ± 2.14	6.24 ± 2.08
Missing	74 (14.4%)	18 (14.9%)
HADS[a]		
Anxiety	7.29 ± 4.19	7.79 ± 3.63
Depression	3.72 ± 3.54	4.02 ± 3.14
Missing	74 (14.4%)	17 (14.0%)

SD = Standard Deviation; BMI = body mass index; K/L = Kellgren/Lawrence; CIRS = Cumulative Illness Rating Score; WOMAC PFS = Western Ontario and McMaster Universities Osteoarthritis Index Physical Functioning Subscale; NPRS = Numeric Pain Rating Scale; HADS = Hospital Anxiety Depression Score.
[a] Mean ± SD.
[b] Frequency (%).

Table 2
ICF first level and second level activity categorization [12].

ICF First Level	ICF Second Level	Corresponding PSFS Activity
Mobility (*Chapter 4*)	Changing body positions (*d410*)	Getting out of bed, standing up from a chair, sitting in a chair, getting in/out of a car, bending over while standing, bending and twisting back, picking an object up from the ground, standing from the floor, squat to stand, kneel to stand
	Maintaining body positions (*d415*)	Lying in bed, prolonged sitting, standing, prolonged standing, prolonged bending, maintaining a squat position, maintaining a kneeling position
	Transferring oneself (*d420*)	Rolling over in bed
	Lifting and carrying objects (*d430*)	Carrying an object, lifting an object
	Walking (*d450*)	Walking, walking after prolonged sitting
	Moving around (*d455*)	Running, walking up/down stairs
	Moving around in different locations (*d460*)	Walking in house, walking inside
	Driving (*d475*)	Driving an automobile, biking
	Using transportation (*d470*)	Using public motorized transportation
Self-care (*Chapter 5*)	Dressing (*d540*)	Putting on clothes
Domestic life (*Chapter 6*)	Household tasks, other specified and unspecified (*d649*)	Light housework, heavy housework, domestic tasks
	Caring for household objects (*d650*)	Taking care of plants outdoors
Interpersonal interactions & relationships (*Chapter 7*)	Intimate relationships (*d770*)	Sexual activities
Major life areas (*Chapter 8*)	Remunerative employment (*d850*)	Executing work
Community, social, & civic life (*Chapter 9*)	Recreation and leisure (*d920*)	Socializing/going out, performing hobbies, performing sports, vacationing, playing with children, arts and culture
	Religion and spirituality (*d930*)	Praying multiple times per day

The four most frequently prioritized activities identified by the PSFS were: walking (162/513, 31.6%), walking up and down stairs (68/513, 13.3%), prolonged standing (37/513, 7.2%) and standing up from a chair (36/513, 7.0%). Following the four most commonly listed activities, 26 different activities were identified that comprised the remaining 210/513, 41.0% of the population.

The majority of the activity limitations identified were classified under the ICF first level of Mobility (454/513, 88.5%). The four most frequently listed types of activity limitations when organized by ICF second level categories were activities involving: walking (163/513, 31.8%), maintaining body positions (90/513, 17.5%), changing body positions (80/513, 15.6%), and moving around (78/513, 15.2%). Following the four most frequently listed second-level categories, 12 other categories were included that accounted for the remaining 102/513, 19.9% of the population.

3.3. Change in PSFS post-treatment: Objective 2

After completion of treatment, which consisted of two or more disciplines for 87.5% of this population, there was a statistically significant improvement in performance (NRS) of each activity at a 95% confidence

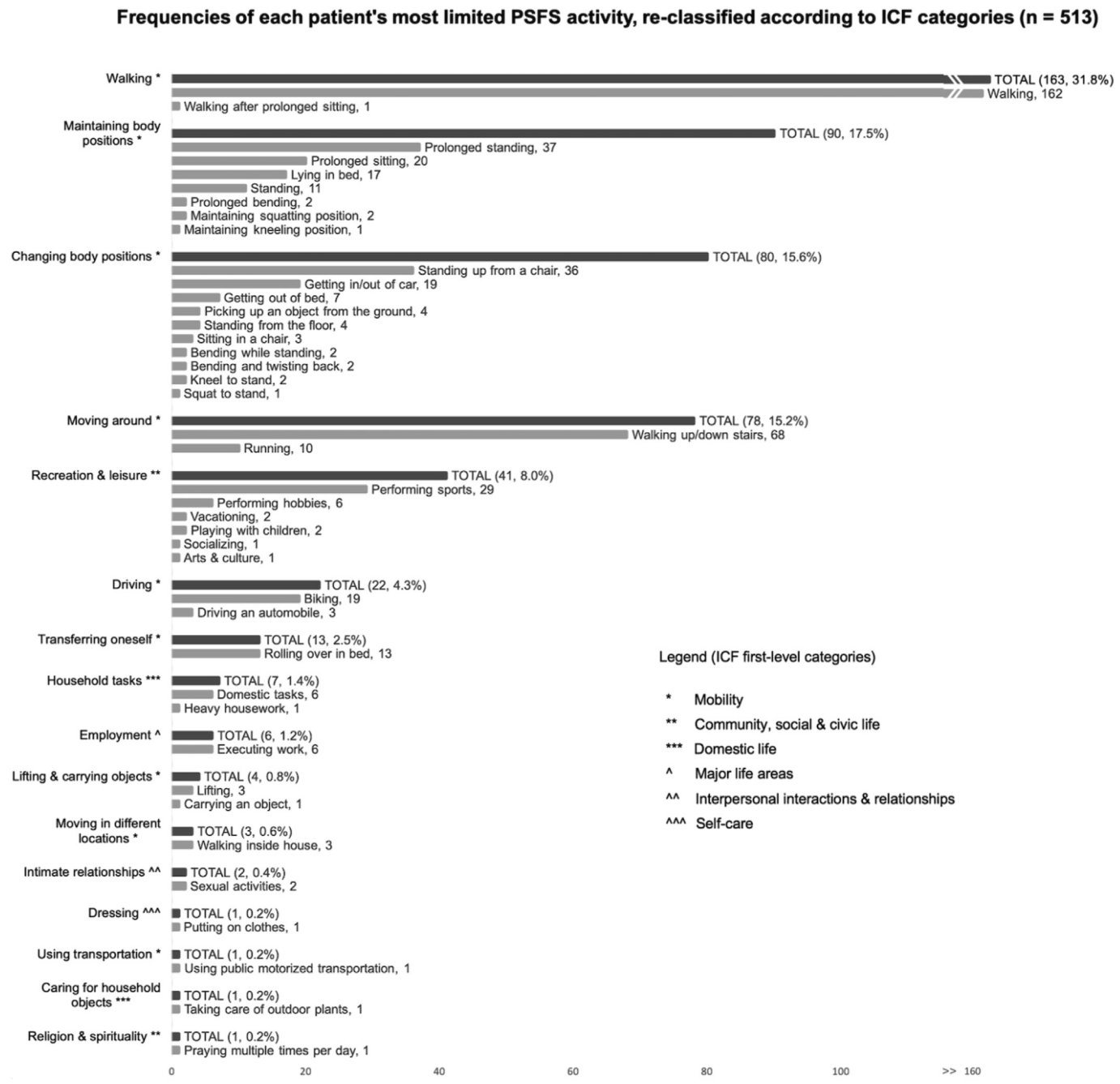

Fig. 2. The frequencies of the highest-prioritized activity limitations ($PSFS_1$), arranged by the second-level classification of the ICF taxonomy. The total frequency and percentage of the ICF category is displayed in the total bar. The specific activities in each ICF category and their frequencies are displayed underneath.

interval: $PSFS_1$ ($d = 0.82$, large effect size), $PSFS_2$ ($d = 0.97$, large effect size), $PSFS_3$ ($d = 0.73$, medium-large effect size), and the average of the activities $PSFS_{average}$ ($d = 1.02$, large effect size). There was a statistically significant improvement in performance (NRS) of the following most frequently indicated specific activities, listed in either $PSFS_1$, $PSFS_2$, or $PSFS_3$: walking (PSFS walking, $d = 0.82$, large effect size) and walking up or down the stairs (PSFS stairs, $d = 0.83$, large effect size) (see Table 3).

WOMAC-pf scores (n = 102) significantly decreased from before treatment to after treatment, indicating a decrease in activity limitations. The mean difference in WOMAC-pf scores was 8.65 with a 95% confidence interval ranging from 5.39 to 11.91. The magnitude of the treatment effect was small-medium ($d = 0.41$).

4. Discussion

The first objective of this study was to make an inventory of patient-specific prioritized activity limitations identified by the PSFS by knee OA patients, and to categorize these activity limitations according to the ICF. It was shown that, most broadly on the first level of the ICF, the most common limitations were mobility limitations (454/513, 88.5%). More specifically on the second level of the ICF, the most common limitations were in performing types of activities that involved walking, maintaining body positions, changing body positions, and moving around: 80.1% of the population indicated limitations in these types of activities. The actual PSFS activities most commonly listed were walking, walking up

Table 3
Outcomes pre-treatment (T0) and post-treatment (T1), and corresponding effect sizes (*d*).

Outcome Measure	T0	T1	Mean Change	95% CI	*p* value	Effect Size (*d*)
$PSFS_1$[a] NRS (n = 121)	6.84 ± 1.68	4.98 ± 2.71	1.87 ± 2.77	[1.37, 2.37	<0.001[b]	0.82
$PSFS_2$[a] NRS (n = 120)	7.19 ± 1.75	5.08 ± 2.52	2.11 ± 2.70	[1.62, 2.60]	<0.001[b]	0.97
$PSFS_3$[a] NRS (n = 118)	7.14 ± 1.85	5.38 ± 2.89	1.76 ± 2.79	[1.25, 2.27]	<0.001[b]	0.73
$PSFS_{average}$[a] NRS (n = 117)	7.03 ± 1.34	5.18 ± 2.19	1.84 ± 2.16	[1.45, 2.24]	<0.001[b]	1.02
PSFS walking[a] NRS (n = 74)	6.85 ± 1.80	4.81 ± 3.01	2.04 ± 3.12	[1.31, 2.77]	<0.001[b]	0.82
PSFS stairs[a] NRS (n = 74)	7.08 ± 1.79	5.27 ± 2.52	1.81 ± 4.46	[1.24, 2.38]	<0.001[b]	0.83
WOMAC-pf[a] (n = 102)	51.60 ± 21.28	42.95 ± 21.37	8.65 ± 16.58	[5.39, 11.91]	<0.001[b]	0.41

SD = standard deviation; PSFS = Patient Specific Functional Scale; NRS = Numeric Rating Scale; ICF = International Classification of Functioning, Disability, and Health; WOMAC-pf = Western Ontario and McMaster Universities Osteoarthritis Index Physical Function Subscale.

[a] Mean ± SD.

[b] Significant at 95% confidence interval ($p < 0.001$).

and down stairs, prolonged standing, and standing up from a chair: 59% of the population indicated these limitations as being their most important activity limitation. The remaining 41% of the population identified 26 different activity limitations as their most important limitation to improve with multidisciplinary rehabilitation. Thus, the inventory showed that the majority of OA patients experienced limitations with walking, but many patients also experienced specific activity limitations that were reported with smaller frequencies. The large spread of activity frequency indicates that activity limitations are indeed patient-specific. In order for rehabilitation professionals to successfully identify these specific activity limitations which ultimately shape rehabilitation goals and planning, a patient-reported tool such as the PSFS is recommended.

The second objective of this study was to evaluate the effect of tailor-made multidisciplinary rehabilitation on patient-specific prioritized activity limitations as measured by the PSFS in patients with knee OA. Individually tailored multidisciplinary rehabilitation improved patients' functional ability according to the change in NRS of each PSFS activity with medium-large and large effect sizes. Although the three PSFS activities did not improve individually by the MDC (2.5 points on the NRS), the average of the activities did improve by the MDC (1.5 points on the NRS). When activity limitations were measured by WOMAC-pf, improvements after multidisciplinary rehabilitation were smaller (small-medium effect sizes). WOMAC-pf may not be able to detect differences in activity limitations as precisely as the PSFS since WOMAC-pf is comprised of predetermined items. These items may include activity limitations not treated in the individualized multidisciplinary rehabilitation program, and more importantly, these items may not incorporate the patient's main activity limitation [13]. Additionally, most patients had one or more comorbidities: disease-specific tools may be less appropriate for such patients [26]. The PSFS can more specifically measure a patient's limitations in activities as it gives the patient freedom to identify their unique activity limitations and measure them in a systematic way. The PSFS is further emphasized as a recommended tool as it possesses good psychometric properties in various populations and validity when showing group-level change comparisons [8,27].

When interpreting the rehabilitation outcomes, it is important to consider the specific patient population being analyzed. The patients who underwent multidisciplinary rehabilitation had clinical complexities, such as the presence of comorbidity, or unsuccessful treatment in primary care. Over the 10-year span analyzed in this study, the complexity of patients has increased, but the rehabilitation program has been consistently centered around exercise therapy with treatment from additional health professionals when indicated. This complex, heterogeneous group of OA patients, who require treatment from multiple disciplines and often have comorbidities, is not representative of the larger OA population, and may have influenced the magnitude of the treatment results. Although research indicates that patients with musculoskeletal disorders often improve by the MDC on the PSFS after completing a primary care rehabilitation program in primary care, this may not extend to secondary care treatment of complex patients with a degenerative disease [28].

Patient progress can be evaluated according to different domains including physical outcomes, patient perceptions, and patient goals. Although progress has typically been evaluated by means of physical outcomes, increasing emphasis is being placed on patient goal-setting [25,29]. The process of shared decision making translates patient goals into measurable treatment goals. Recent research has optimized patient involvement in goal setting by using an adapted version of the PSFS [28]. Tools such as these are valuable as they aid in goal setting and measure goal attainment. It is important to measure progress not just in terms of disease-specific outcomes but also in terms of goal attainment, particularly for those with chronic conditions and/or comorbidity, especially as healthcare shifts towards value-based health care [25].

As the study shows that walking, walking up and down stairs, prolonged standing, and standing up from a chair are common activity limitations reported by patients with knee OA in need of multidisciplinary rehabilitation, rehabilitation professionals and future research can focus specifically on the most effective ways to target and improve these activities. It is also important to note that alongside these common activity limitations, is a wide variety of alternative limitations, albeit with lesser frequencies. Rehabilitation healthcare providers must also place emphasis on finding effective ways to target these unique activity limitations in order to improve outcomes for all activity limitations.

Several limitations exist in this study. As mentioned, the complex group of OA patients within the secondary care center is not representative of the larger OA population and therefore limits the generalizability of the results to similar populations. A second limitation is regarding the specifics of the activity limitations, which were not analyzed. In order to group activities, aspects of the activity which may have made it more patient-specific were omitted. For example, many patients identified having a limitation in walking, however the distance which one could walk until the onset of the problem may vary greatly between patients. The ability of the PSFS to capture this patient-specific detail is one of the benefits of the tool. In addition, patients were presented with a list of activities that might be affected by their OA. Although the list was comprehensive and patients had the opportunity to provide their unique activity in the "other" section, this pre-defined list can create a bias towards selecting one of the provided activities. Furthermore, when the activity limitations were analyzed based on priority ($PSFS_1$, $PSFS_2$, $PSFS_3$, or $PSFS_{average}$), the change in performance was analyzed across a wide range of different activities, making it difficult to interpret the change at the group level. The responsiveness of the PSFS for those with knee OA needs to be established in future research, as the most similar patient population in which the responsiveness of the PSFS is established is those undergoing total knee arthroplasty [13]. Another limitation is the population size of patients with follow-up PSFS data. This limitation was present because follow-up PSFS data were not collected at Reade until 2013. Additionally, some variables were incomplete as the data were collected in a clinical setting over a span of 10 years. Although some data were missing, the data collected in this setting is valuable as it evaluates patients' change in activity limitations as a result of clinical care as opposed to being conducted in a trial setting.

5. Conclusion

Patients with knee OA undergoing multidisciplinary rehabilitation experience activity limitations which most commonly hinder their lives in terms of walking, walking up and down stairs, prolonged standing, and standing up from a chair, although many patients experience limitations in performing more unique activities. These specific limitations are important to identify before treatment as they can be used to structure patient-specific treatment programs, used to set the goals of rehabilitation, and used to evaluate goal attainment. Multidisciplinary rehabilitation significantly reduces these activity limitations in highly complex patients and the improvements are clinically relevant when the activities are averaged together. The PSFS is a valuable tool as it identifies specific activity limitations and captures improvements of these limitations; therefore, it is advisable to use the PSFS in addition to other commonly used patient-reported tools, such as WOMAC, in multidisciplinary rehabilitation OA settings.

Author contributions

All authors contributed to the conception and design of the study, the critical revision of the study for important intellectual content, and the final approval for submission. The following authors contributed to the following aspects:

Conception and design: Moore, Corning, van der Esch, Roorda, Dekker, Groot, Wijbenga, Lems, van der Leeden.

Analysis and interpretation of the data: Moore, Corning, van der Esch, Roorda, Groot, Lems, van der Leeden.

Drafting of the article: Moore, Corning, van der Esch, van der Leeden.

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Provision of study *materials or patients*: Roorda, Groot.

Statistical expertise: Moore, Corning, van der Esch, Roorda, Dekker, Groot, Wijbenga, Lems, van der Leeden.

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Declaration of competing interest

The authors declare that they have no competing interests.

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References

[1] American College of Rheumatology, Osteoarthritis, 2018. Available at: https://www.rheumatology.org/I-Am-A/Patient-Caregiver/Diseases-Conditions/Osteoarthritis. (Accessed 22 July 2018).

[2] World Health Organization, Chronic rheumatic conditions, 2018. Available at: http://www.who.int/chp/topics/rheumatic/en/. (Accessed 22 July 2018).

[3] A. Litwic, M. Edwards, E. Dennison, C. Cooper, Epidemiology and burden of osteoarthritis, Br. Med. Bull. (105) (2013) 185–199, https://doi.org/10.1093/bmb/lds038.

[4] C. Jinks, K. Jordan, P. Croft, Osteoarthritis as a public health problem: the impact of developing knee pain on physical function in adults living in the community: (KNEST 3), Rheumatology 46 (5) (2007) 877–881, https://doi.org/10.1093/rheumatology/kem013.

[5] A. Smink, C. van den Ende, T. Vliet Vlieland, B. Swierstra, J. Kortland, J. Bijlsma, et al., Beating osteoARThritis: development of a stepped care strategy to optimize utilization of timing of non-surgical treatment modalities for patients with hip or knee osteoarthritis, Clin. Rheumatol. 30 (2011) 1623–1629, https://doi.org/10.1007/s10067-011-1835-x.

[6] W. Peter, M. Jansen, E. Hurkmans, H. Bloo, J. Dekker, R. Dilling, et al., Physiotherapy in hip and knee osteoarthritis: development of a practice guideline concerning initial assessment, treatment and evaluation, Acta Reumatol Port 36 (3) (2011) 268–281.

[7] P. Stratford, C. Gill, M. Westaway, J. Binkley, Assessing disability and change on individual patients: a report of a patient specific measure, CPA 47 (4) (1995) 258–263, https://doi.org/10.3138/ptc.47.4.258.

[8] K. Horn, S. Jennings, G. Richardson, D. Vliet, C. Hefford, J. Abbott, The patient-specific functional scale: psychometrics, clinimetrics, and application as a clinical outcome measure, J. Orthop. Sports Phys. Ther. 42 (1) (2012) 30–42, https://doi.org/10.2519/jospt.2012.3727.

[9] A. Chatman, S. Hyams, J. Neel, J. Binkley, P. Stratford, A. Schomberg, et al., The patient-specific functional scale: measurement properties in patients with knee dysfunction, Phys. Ther. 77 (8) (1997) 820–829, https://doi.org/10.1093/ptj/77.8.820.

[10] M. Pisters, C. Veenhof, G. van Dijk, M. Heymans, J. Twisk, J. Dekker, The course of limitations in activities over 5 years in patients with knee and hip osteoarthritis with moderate functional limitations: risk factors for future functional decline, Osteoarthritis Cartilage 20 (6) (2012) 503–510, https://doi.org/10.1016/j.joca.2012.02.002.

[11] K. Covinsky, K. Lindquist, D. Dunlop, T. Gill, E. Yelin, Effect of arthritis in middle age on older-age functioning, J. Am. Geriatr. Soc. 56 (1) (2008) 23–28, https://doi.org/10.1111/j.1532-5415.2007.01511.x.

[12] World Health Organization, International Classification of Functioning, Disability and Health: ICF, WHO, Geneva, 2001.

[13] D. Berghmans, A. Lenssen, L. van Rhijn, R. de Bie, The patient-specific functional scale: its reliability and responsiveness in patients undergoing a total knee arthroplasty, J. Orthop. Sports Phys. Ther. 45 (7) (2015) 550–556, https://doi.org/10.2519/jospt.2015.5825.

[14] P. Stratford, D. Kennedy, A. Wainwright, Assessing the patient-specific functional scale's ability to detect early recovery following total knee arthroplasty, Phys. Ther. 94 (6) (2014) 838–844, https://doi.org/10.2522/ptj.20130399.

[15] M. van der Esch, J. Knoop, M. van der Leeden, L. Roorda, W. Lems, D. Knol, et al., Clinical phenotypes in patients with knee osteoarthritis: a study in the Amsterdam osteoarthritis cohort, Osteoarthritis Cartilage 23 (4) (2015) 544–549, https://doi.org/10.1016/j.joca.2015.01.006.

[16] L. Edelaar, J. van Dieën, M. van der Esch, L. Roorda, J. Dekker, W. Lems, et al., Nonlinear relationship between isokinetic muscle strength and activity limitations in patients with knee osteoarthritis: results of the Amsterdam-Osteoarthritis cohort, J. Rehabil. Med. 49 (7) (2017) 598–605, https://doi.org/10.2340/16501977-2252.

[17] J. Knoop, J. van Tunen, M. van der Esch, L. Roorda, J. Dekker, M. van der Leeden, et al., Analgesic use in patients with knee and/or hip osteoarthritis referred to an outpatient center: a cross-sectional study within the Amsterdam Osteoarthritis Cohort, Rheumatol. Int. 37 (10) (2017) 1747–1755, https://doi.org/10.1007/s00296-017-3785-3.

[18] A. Schreuders, A. Videler, Patiënt specifieke functionele schaal: de Dutch language version (PSFS - DLV), Nederlands Tijdschrift voor Handtherapie 17 (2) (2008) 12–14.

[19] A. Beurskens, H. de Vet, A. Köke, E. Lindeman, G. van der Heijden, W. Regtop, et al., A patient-specific approach for measuring functional status in low back pain, J. Manip. Physiol. Ther. 22 (3) (1999) 144–148, https://doi.org/10.1016/s0161-4754(99)70127-2.

[20] N. Bellamy, W. Buchanan, C. Goldsmith, J. Campbell, L. Stitt, Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee, J. Rheumatol. 15 (12) (1988) 1833–1840.

[21] L. Roorda, C. Jones, M. Waltz, G. Lankhorst, L. Bouter, J. van der Eijken, et al., Satisfactory cross cultural equivalence of the Dutch WOMAC in patients with hip osteoarthritis waiting for arthroplasty, Ann. Rheum. Dis. 63 (1) (2004) 36–42, https://doi.org/10.1136/ard.2002.001784.

[22] M. Huisman, Imputation of missing item responses: some simple techniques, Qual Quant 34 (2000) 331–351.

[23] V. Williams, S. Piva, J. Irrgang, C. Crossley, G.K. Fitzgerald, Comparison of reliability and responsiveness of patient-reported clinical outcome measures in knee osteoarthritis rehabilitation, J. Orthop. Sports Phys. Ther. 42 (8) (2012) 716–723, https://doi.org/10.2519/jospt.2012.4038.

[24] F. Angst, T. Benz, S. Lehmann, A. Aeschlimann, J. Angst, Multidimensional minimal clinically important differences in knee osteoarthritis after comprehensive rehabilitation: a prospective evaluation from the Bad Zurzach Osteoarthritis Study, RMD Open 4 (2) (2018), e000685, https://doi.org/10.1136/rmdopen-2018-000685.

[25] J. Cohen, Statistical Power Analysis for the Behavioral Sciences, second ed., Lawrence Erlbaum, Hillsdale, 1988.

[26] D. Reuben, M. Tinetti, Goal-oriented patient care- an alternative health outcomes paradigm, N. Engl. J. Med. 366 (9) (2012) 777–779, https://doi.org/10.1056/NEJMp1113631.
[27] J. Abbott, J. Schmitt, The Patient-Specific Functional Scale was valid for group-level change comparisons and between-group discrimination, J. Clin. Epidemiol. 67 (6) (2014) 681–688, https://doi.org/10.1016/j.jclinepi.2013.11.002.
[28] P. Nicholas, C. Hefford, S. Tumilty, The use of the Patient-Specific Functional Scale to measure rehabilitative progress in a physiotherapy setting, J. Man. Manip. Ther. 20 (3) (2012) 147–152, https://doi.org/10.1179/2042618612Y.0000000006.
[29] A. Stevens, A. Köke, T. van der Weijden, A. Beurskens, Ready for goal setting? Process evaluation of a patient-specific goal-setting method in physiotherapy, BMC Health Serv. Res. 17 (1) (2017) 618, https://doi.org/10.1186/s12913-017-2557-9.