Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Medicine and Health Sciences
Department of Circulation and Medical Imaging

Ole Erik Furuberg

Associations between a post treatment test battery score for lower extremity disorders and patient satisfaction and relapse rate after nine months

Master's thesis in Clinical Health Science, Pain and Palliative Care MKLIHEL
Supervisor: Proffessor Håvard Østerås
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Kunnskap for en bedre verden

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Abstract

Introduction

Musculoskeletal disorders often require rehabilitation. Inadequate rehabilitation may lead to unachieved desired function and possible relapse of disorders. To evaluate rehabilitation, a feasible test battery including both subjective and objective tests can be helpful. The aim of this study was to assess whether higher scores of a test battery performed on the last day of a rehabilitation period for patients with lower extremity disorders were associated with higher relapse rates and lower satisfaction 6-12 months later.

Method

A prospective cohort study was conducted among patients with lower extremity disorders. Patients were tested with a test battery on the last day of a treatment series and the score classified them into risk-groups. A telephone interview was conducted 9 months later to assess relapse rate and satisfaction.

Results

Among responders (n = 154), 18% reported relapse. There was a significantly higher odds of relapse in the high-risk group compared to the low-risk group (OR = 3.24, 95% CI 1.00, 10.45). Among patients with an acute onset of disorders, there were significantly higher odds of relapse in the high-risk group compared to the low-risk group (OR = 46.04, 95% CI: 3.31, 632.61). The difference was not significant among patients with gradual onset of disorders. There was a statistically significant and fair correlation between a higher risk group and a lower patient satisfaction (r_s = -0.343, p<0.001). For patients with acute onset of disorders, the correlation was significant and fair (r_s = -0.466, p<0.001). For patients with gradual onset of disorders the correlation was not statistically significant (r_s = -0.219, p=0.051).

Conclusions

A high test battery score indicated a higher future relapse risk and lower patient satisfaction. Caution should be exercised in using the test battery to classify risks in the event of gradual onset of disorder.

Sammendrag

Introduksjon

Muskel- og skjelettplager krever ofte rehabilitering. Mangelfull rehabilitering kan føre til at ønsket funksjon ikke oppnås som igjen kan føre til økt fare for tilbakefall av plager. For å evaluere rehabilitering kan et gjennomførbart testbatteri som inkluderer både subjektive og objektive tester være nyttig. Målet med denne studien var å vurdere om høyere score på et testbatteri utført siste dag i en rehabiliteringsperiode for pasienter med plager i underekstremitetene var assosiert med høyere risiko for tilbakefall og lavere tilfredshet 6-12 måneder etter.

Metode

En prospektiv kohortstudie ble utført på pasienter med underekstremitetsplager. Pasientene ble testet med et testbatteri siste dag i en behandlingsserie og poengsummen klassifiserte dem i risikogrupper. De ble deretter kontaktet for et telefonintervju 9 måneder etter, og spurt om tilbakefall og tilfredshet.

Resultat

Blant respondentene (n = 154) rapporterte 18 % tilbakefall. Det var signifikant høyere odds for tilbakefall i høyrisikogruppen enn i lavrisikogruppen (OR = 3.24, 95 % KI 1.00, 10.45). Blant pasienter med akutt debut av lidelser var det signifikant høyere odds for tilbakefall i høyrisikogruppen enn i lavrisikogruppen (OR = 46.04, 95 % KI: 3.31, 632.61). Denne forskjellen var ikke signifikant blant pasienter med gradvis begynnende lidelser. Det var en statistisk signifikant og *fair* korrelasjon mellom en høyere risikogruppe og en lavere pasienttilfredshet (r_s = -0.343, $p<0.001$). For pasienter med akutt debut av plager var korrelasjonen statistisk signifikant og *fair* (r_s = -0.466, $p<0.001$). For pasienter med gradvis debut av lidelser var korrelasjonen ikke statistisk signifikant (r_s = -0.219, $p=0.051$).

Konklusjon

En høy testbatteriscore indikerte en høyere fremtidig tilbakefallsrisiko og lavere pasienttilfredshet. Det bør utvises forsiktighet ved bruk av testbatteriet for å risiko-klassifisere pasienter med gradvis debut av underekstremitetsplager.

Acknowledgements

First and foremost, I would like to thank my supervisors Håvard Østerås and Astrid Woodhouse for invaluable guidance and support during the process of the master's project. They have, in their busy schedules, responded to countless emails and phone calls. They have also acted as motivators and support when needed. I would also like to thank the physiotherapists at Rosenborgklinikken for their efforts in testing their patients with the test battery. Furthermore, I am grateful for the opportunity NTNU and Rosenborgklinikken have given me to combine work and study. Last but not least, I want to thank my daughter and my girlfriend for enduring my many hours concentrating in front of the computer.

Contents

Abbreviations

1RM	1 Repetition Maximum
ACL	Anterior Cruciate Ligament
FAOS	Foot and Ankle Outcome Score
HAGOS	Hip And Groin Outcome Score
IASP	International Association for the Study of Pain
KOOS	Knee Injury and Osteoarthritis Outcome Score
KOS	Knee Outcome Survey
LEFS	The Lower Extremity Functional Scale
LSI	Limb Symmetry Index
NRS	Numerical Rating Scale
NTNU	Norges teknisk-naturvitenskapelige universitet
PROMs	Patient-reported outcome measures
PROs	Patient-reported outcome
PSFS	Patient-specific function scale
RTS	Return to sports
SANE	Single Assessment Numeric Evaluation
VAS	Visual Analogue Scale
VRS	Verbal Rating Scale

1 Introduction

1.1 Rationale of the thesis

Within a month, 75-80% of the general population will experience musculoskeletal disorders, and the occurrence increases with age (1, 2). They are among the most frequent reasons for using both conventional and alternative health care services in Norway (3), and the most common medical cause of sick leave and disability benefits (1, 2). In 2020, health expenditure on physiotherapy, chiropractic treatment and other medical treatment was NOK 23.5 billion (4). Because of the ageing population, people in need of health care increases and the number of health workers per population are reduced. This means that health services must be streamlined (5). Rehabilitation is resource demanding and requirements for knowledge-based practice increases the need to document the usefulness of the rehabilitation process (6). Part of this is knowing when to end a treatment series. The social economy and the individual needs must be considered simultaneously. Overconsumption of services will not improve a patient's health and may also lead to more harm than good (7, 8). This has led to the global Choosing Wisely Campaign, where the intention is reducing overtreatment in the healthcare system (9). On the other hand, premature completion of rehabilitation may lead to the patient not reaching the desired function, which in turn may be associated with injury (10). In the UK in 2006 one in three of all musculoskeletal consultations in primary care were due to ailments of the lower extremities (11). Lower extremity disorders commonly lead to pain and functional loss (12, 13). More than 50% of the injuries in sports activity occur in the lower extremities (14), and there is convincing evidence for an increased probability of relapse, new injury or contralateral injury following the initial injury (14-20). This can be linked to loss of, and inadequate rehabilitation of, strength and neuromuscular control (10, 21). Other researchers suggest that factors existing before the first injury might also play a role (22).

With several aspects to consider, it may be challenging for a clinician to decide when the rehabilitation is completed. Documentation of the rehabilitation effect presupposes the use of mapping methods and instruments that consider the user's priority needs and goals (6). This can also provide necessary quantification for research (23). Previous studies have used different measurement methods to evaluate treatment outcomes or patient status (24-32). However, few have examined whether the measurement scores predict future relapse. The association between passing a return to sports (RTS) criteria test battery and relapse has mainly been assessed after ACL reconstruction, and the results are ambiguous (33-35). The populations in these studies were often selected groups of athletes between 20 and 30 years of age, and the transfer value to the general population might thus be low.

At an outpatient clinic in Trondheim, a test battery for lower extremities with a wide field of application has been developed (Appendix 1). The test battery is designed to indicate whether the treatment is completed and give an indication of risk for future relapse. In this study relapse covers both re-injury and relapse of disorders.

An inter-rater reliability study and a criterion-validity study in investigating whether the test battery results correlate to well-validated questionnaires for ankle, knee and hip are now being carried out at the clinic. No results are yet published.

An unpublished pilot study looking at the patients test battery score at the end of rehabilitation has been conducted. Of 137 patients, 56% got a score classified as low-risk, 20% as medium-risk, 23% as high-risk and 1% as very-high-risk. These results may indicate that many of the patients end the rehabilitation period with a high risk of relapse.

No follow-up study has so far been conducted in order to investigate whether the test battery can predict future status.

The aim of this study was to assess whether higher scores of the test battery performed at the end of treatment for lower extremity disorders were associated with higher relapse rates or lower self-reported satisfaction 6-12 months later.

Research questions were

"Will a high score of a test battery done at the end of treatment for lower extremity be associated with higher relapse rate 6-12 months later?"

"Will a high score of a test battery done at the end of treatment for lower extremity be associated with higher self-reported satisfaction 6-12 months later?"

The primary hypothesis was that higher scores of the test battery would be associated with higher relapse rates 6-12 months later. The secondary hypothesis was that higher scores of the test battery would be associated with lower self-reported satisfaction 6-12 months later.

This assignment consists of 2 parts:

Part 1:

The introduction is followed by a theoretical part, a supplementary description of the method, a short summary of results from the first research question and a full results section from the second question. The discussion part includes discussion of the results from the second research question and supplementary discussion of methodological challenges. Part 1 is rounded off with a discussion of the clinical relevance of the results from the study.

Part 2:

Part 2 is an article for publication in The Journal of Bodywork and Movement Therapies. The article contains a complete results section with accompanying tables and discussion of the results from the first research question. The article is written according to the journal's guidelines (appendix 2), but the font and reference style have been changed in this submission to match the NTNU template for increased readability.

2 Theory

2.1 Tests and measurement tools

To identify changes and evaluate progress in rehabilitation, standardized tests are useful (23). Tests for patient status should aim to be cost-effective, time-efficient, and easy to use, while giving a good indication of the patient's actual level of function, both self-perceived (subjective) and objective (23, 36, 37). The collection of tests and questions can be combined to a test battery (23). Test batteries are often used in rehabilitation after sports injuries, where many studies have looked at RTS after ACL injury (33-35, 38). Their findings are however ambiguous regarding the correlation between passing an RTP test and re-injury, indicating that more research is needed (33-35). The studies that have been done on such standardized tests have largely had a biomedical view and focus on specific acute injuries (34, 35, 39, 40).

2.1.1 Physical performance tests

Physical performance tests measuring strength or coordination are easy to administer, not time-consuming, and usually do not require much expertise or equipment (41). Traditionally, outcomes in orthopedics have focused on clinician-based physical objective measurements, and range of motion (ROM) and strength measures are often included (42). ROM can be measured by a goniometer, but smartphone applications are also found reliable and valid (43). Limb side differences are normally minimal, and opposite sides of the body are used as an indicator of normal extremity ROM (44, 45).

Quadriceps strength is related to function, re-injury and return to sports after ACL surgery (46, 47). In the general population knee extensor muscle weakness is found to be associated with increased risk of developing knee osteoarthritis (48). One repetition maximum (1RM) is considered gold standard for testing muscle strength (49). A systematic review article concluded that 1RM test has good to very good test-retest reliability regardless of training experience, muscle group, gender and age of the person being tested (50). As a cut-off value, Limb Symmetry Index (LSI) score of >90% is most often used (51). This refers to affected limb having a physical performance of > 90% of non-affected limb (52, 53). 1RM tests are often included in a test battery. A detailed analysis of the results of a test battery showed that muscle strength, and not hop test performance, was associated with re-injury after ACL reconstruction (47).

Hop distance symmetry is also commonly used as a criterion for RTS after ACL reconstruction (54). Hop tests give an indication of dynamic knee stability (55). They are shown as reliable and valid functional measures, but preferably in a combination of four hop tests: one hop for distance, 6 meters hop on time, three hop over line for distance and three hop for distance (56). Three hop for distance is found to be a practical function test with good reliability (57) giving a good indication of strength and power (58). However, limb asymmetry in a test consisting of only one hop for distance can be masked due to change in biomechanics in the hop performance (54). Kotsifaki et al (2022) suggests including a vertical hop test (59). His team found both biomechanical deficits and differences in limb symmetry in vertical hop tests, despite symmetry in

horizontal functional performance and strength tests (54, 59). LSI of >90% is also commonly set as cut off in hop tests (51, 60).

LSI of >90% in both strength and distance is recommended as a cut-off point (38), although one can argue that there is no justification for that exact number (34). LSI may overestimate knee function because of reduced training and sports participation after the injury, leading to bilateral loss of function (52, 53).

2.1.2 Load consistency

A consistent high training load has a protective effect against injury, as well-developed physical qualities protect against injury (61, 62). There is convincing evidence that many training protocols aiming to improve strength and neuromuscular control done over a period reduces injury rate in team sports (63, 64). There is also evidence that under-training may increase injury risk (61). For running injuries, there is moderate quality evidence that lower running volume is a risk factor for injury (15). People respond better to relatively small increases in training load, and load must be applied in a moderate and progressive manner (62). Training load spikes above 4-week average (chronic load), increases the risk for injury, and therefore the acute - chronic workload ratio should be considered before RTS (65).

2.1.3 Self-reported outcomes

Recently there has been a shift towards self-reported outcomes as these may help target patient-important improvements (42).

Patient-reported outcomes (PROs) are patient responses without interpretation by anyone else, and patient-reported outcome measures (PROMs) are tools to measure PROs (66). PROMs can provide information about the patient's perception of the condition either physically, mentally, or within quality of life (25). Various PROMs are commonly used to evaluate rehabilitation for a wide range of patients with lower extremity disorders (24). The Lysholm Knee Score was developed in the 80's for patients who have had ligament surgery in the knee, it is still widely used and still valid (26). The Lower Extremity Functional Scale (LEFS) (67), the Knee Outcome Survey (KOS) (31), the Knee Injury and Osteoarthritis Outcome Score (KOOS) (27) which also is adapted to the hip and groin in the Hip And Groin Outcome Score (HAGOS) (28) and ankle/foot in the Foot and Ankle Outcome Score (FAOS) (29) are all well-validated questionnaires. Many of these contain a lot of questions and are demanding for a patient to complete (31). Furthermore, great demands are made on therapists to have an overview of and familiarize themselves with the use of each individual tool.

The Single Assessment Numeric Evaluation (SANE) is a single-element PROM aimed at assessing patients' level of perceived function (30). The patient indicates the current status of their injured body part on a continuous scale from 0–100 (24). A study showed a good correlation between the SANE and passing of the RTP test after ACL reconstruction (68). A systematic review article found SANE useful for assessing the experience of the condition in female participants with knee injuries and in military patients with ankle sprains (24). One study found good correlation between KOS and SANE in patients with patellofemoral pain (31). Another study saw a statistically significant, but weak, correlation between Lysholm Knee Score and SANE in knee

replacement patients (30). A review article found moderate correlation between shoulder, knee, and ankle-specific SANE and longer PROMs (69).

Patient-specific function scale (PSFS) allows the patient to identify and score self-chosen activity problems (32). It is widely used in Norway, and can be used by many different patient groups (70), including patients with knee pain (32).

2.1.4 Pain

Pain is defined as "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" by the International Association for the Study of Pain (IASP) (71). In their work of revising the definition of pain they note that pain is not the same as nociception and it cannot be inferred solely from activity in sensory neurons. They also note that pain is learned through life, it is always a personal experience and that a person's report of pain should be respected. It is influenced by varying degrees by biological, psychological, and social factors (71). This emphasizes that pain must be measured subjectively (72). Some researchers claim that when the therapist asks the patient questions there is a risk of bias. Thus, it may be preferable to let the patient self-report on a form that includes a Visual Analog Scale (VAS) (73). However, a systematic review found Numeric Rating Scale (NRS 11) applicable and recommended in most settings, and that a verbal version of it, VNRS 11, can be used (72). Pain lasting for more than 3 months is defined by IASP as chronic (74). Chronic pain is affecting 20-30 % of the adult population (75, 76). After new onset of chronic pain, the prognosis is fairly good, but becomes poorer as pain persists (77). "Absence of pain" is often used as one criterion for RTP (78), however, that might not be an achievable goal for patients with longstanding pain. Therefore, for patients experiencing chronic pain, focusing on coping strategies might be more helpful than aiming for total absence (79).

2.1.5 Psychological resources

An increasing body of evidence shows that the patients' psychological resources affect treatment results (80). Factors such as fear-avoidance, self-efficacy and optimism are shown as predictors of outcome after ACL reconstruction (81-83). Self-efficacy refers to the confidence to carry out the courses of action necessary to accomplish desired goals (84). Self-efficacy is a prognostic factor for the outcome of rehabilitation for people with long-term pain (85). It is linked to rehabilitation adherence and results in musculoskeletal disorders (80). By participating in exercise programs, people with chronic hip and knee pain improve the management of ailments and gain better self-efficacy (12). High degree of self-efficacy is associated with better goal achievement, physical function, physical activity, and quality of life in people with rheumatoid arthritis (86). Suitable questions can give an indication of self-efficacy, and several different forms have been created for different areas of use (80). Studies suggest that appropriate psychological coping strategies are associated with a higher rate of return to sports after injury (87, 88). A high incidence of psychosocial strains and insecurity has been found in people who are to return to sports after injury, including fears of injury and concerns about whether they are well enough trained (89). These factors must therefore be addressed in rehabilitation (87), and appear in an evaluation of whether the patient has completed the course of treatment (38). Several questionnaires have been created to

measure health-related quality of life and psychological status of the general population (90).

2.2 Reliability and validity

For a test battery to be useful in both clinical and research settings, sufficient validity and reliability is needed (91, 92). When administering a test or an outcome measure the results must be an accurate reflection of reality, and validity and reliability provide useful insight (93). The distinction between reliability and validity is essential: a measure can be reliable but not valid (provide a consistent measure of an unintended attribute). For a test to be valid, it needs to be reliable (91). Combined, a valid and reliable test informs the clinician that it can be used to guide clinical decisions (91).

Validity is the degree to which the measure reflects the construct that was intended to measure rather than something else (93). This means how well the measurement represents the true value of the variable of interest. There are four main types of validity: face, construct, content, and criterion-related validity (91, 92). Face validity refers to whether a test appears to test what it is intended to. Construct validity refers to whether a test measures the concept that it is intended to. Content validity refers to whether a test is fully representative of what it aims to measure, that it is representative of all aspects of the construct. Criterion validity refers to whether the results correspond to a different test of the same thing, whether the test results compare to the results of a well-established gold standard (91, 92).

The Reliability of a test refers to the consistency or reproducibility of data (93). There are several types of reliability, including test-retest reliability, inter-observer reliability and intra-observer reliability (91). Test-retest reliability means that the results will be similar when the same test is repeated to the same sample at a different point in time. Inter-observer reliability refers to the agreement between different raters when applying the same test to the same patient. Intra-observer reliability refers to the stability of data recorded by one tester using the same test across two or more trials (91, 92).

3 Method

The study was set up as a prospective cohort study. At an outpatient clinic in Trondheim, patients with lower extremity disorders who agreed to participate were tested with a test battery (Appendix 1 & 3) on the last day in a treatment series. Patients who met the inclusion criteria were contacted for a telephone interview (Appendix 4) 9 (range 6-14) months later. A full methods section is found in the article.

The data used in this master thesis is a part of a larger project with the aim of evaluating and validating the test battery. Information from the test battery scheme, the patient record, and the two first questions in the telephone interview were used as data material in the thesis. The first as an outcome for results to the article, the second question was: Considering the ailments, you were attending at a physiotherapist for, how satisfied are you with today's function? (1) Very satisfied, (2) satisfied, (3) neither satisfied nor dissatisfied, (4) dissatisfied, (5) very dissatisfied.

3.1 Predictors

Predictor variable, or independent variable, is a variable that is presumed to cause, explain or influence the dependent variable (91). In this study the predictor variable was the risk group allocation: "low", "medium", "high" or "very high" classified from the test battery score. No patients classified as "very high" risk, so this group was left out of the analysis.

3.2 Outcomes

The outcome measure, or the dependent variable, is a response variable that is assumed to depend on the independent variable (91). The outcome measures in this study were the first two questions in the telephone interview. First, a dichotomous variable yes/no on patient self-reported re-injury or relapse of the ailments. Second, a five-response category Likert scale (94) on patient self-reported satisfaction with function at the time of the telephone interview.

3.3 Confounders

A confounding variable is a factor that contaminates the effect between independent and dependent variable (95). It is associated with the independent variable, affects the outcome variables and not a causal link between independent variable and outcome. If a confounding factor is not adjusted for, the crude odds ratio may be under- or overestimated (91). Stratification is a method for adjusting for possible confounders and checking adjusted odds ratio with crude odds ratio. If there is no discrepancy, it indicates no confounding (95). In the logistic regression age and gender were adjusted for by adding them as covariates, as both may influence injuries and disorders (16, 96-98).

Gender was used as a dichotomous variable and age in groups (years: 18-24, 25-34, 35-44, 45-54, 55-100).

3.4 Effect modifier

Effect modification is present if the strength of an association between two variables is influenced by another variable that differs between subgroups in the population (99). In the logistic regression the variable "onset of disorders (acute or gradual)" had these properties. In this study the onset of disorders was classified as acute if the patient record described "a trauma resulting from a specific and identifiable event" (100) as direct cause for the treatment. Other disorders were classified as gradual.

3.5 Statistical analysis

The collected data were manually plotted into Microsoft Excel (2010, Version: 14.0.7268.5000). Then the data was transferred to IBM SPSS Statistics (Version 26 for Microsoft Windows), where the statistical analyses were done.

To assess whether the risk group had a significant effect on the risk of relapse, a logistical regression analysis was conducted. The relationship is expressed as an odds ratio. Descriptive statistics showed tendencies towards a linear relationship, indicating that a regression analysis was appropriate. Assumptions that need to be met for logistic regression are the outcome variable needs to be binary, linearity of continuous independent variables and log-odds, no strongly influential outliers, absence of multicollinearity, independence of observations and sufficiently large sample size (101). In this data the dependent variable (outcome) was binary, relapse yes or no. By performing the Box-Tidwell transformation and using the transformed variables to test the assumption of linearity in the logit, it was found that the continuous variable "age" was not linearly related to the log-odds. Age groups were created, so that the variable became ordinal. No outliers were found in the data and all data points were included in the analysis. By performing linear regression, collinearity diagnosis, collinearity statistics tolerance was >0.1 (exact value 0.9), indicating no multicollinearity. No predictor was measured twice. By using Bivariate Correlation and including all the independent variables, it was found that none of them had a correlation coefficient that was higher than 0.7 or lower than -0.7, meaning the assumption of independence of observations was not violated. With a sample size of 154 and 3 predictor variables, the assumption of sufficiently large sample size was met.

To assess whether the risk group had a significant effect on patient self-reported satisfaction, Spearman's rank order correlation was used. Spearman's correlation coefficient measures the strength and direction of a monotonic association (102). The assumptions for Spearman's correlation are that the variables are ordinal; the variables represent paired observations and there is a monotonic relation between the two variables. These assumptions were met. The terms for correlation strength vary in the literature, and absolute limit values should be used with caution (103). In this study, the correlation is referred to as "low" at rho = 0.1-2.9, "fair" at rho = 3.0-5.9 (104).

A significance level was set at a p-value < 0.05

4 Results

4.1 Relapse

A study flowchart, the descriptive statistics and the results on relapse are presented in the article. The main result was that there was a significantly higher odds of relapse in the high-risk group vs the low-risk group (OR = 3.24, 95% CI 1.00, 10.45) when adjusted for age and gender (Figure 1). Among patients with acute onset of disorders, there was a significantly higher odds of relapse in the high-risk group than in the low-risk group (OR = 46.04, 95% CI: 3.31, 632.61). That difference was not significant among patients with gradual onset of disorders (OR = 0.72, 95% CI: 0.14, 3.63) (Figure 2).

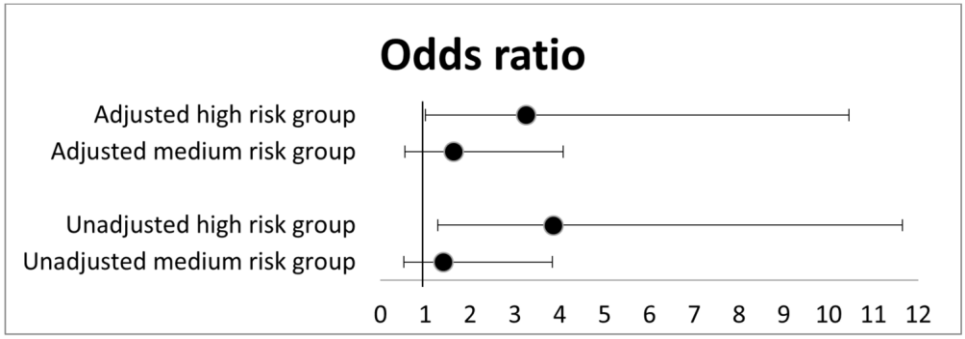

Figure 1. Relapse odds ratio in the high- and medium risk group. The low-risk group is reference.

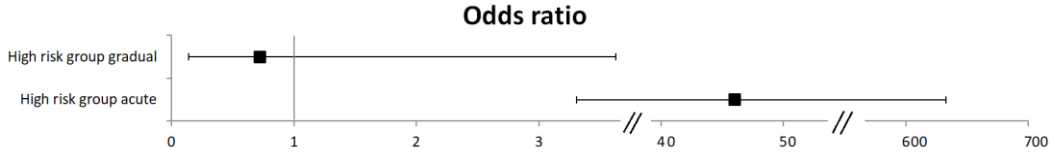

Figure 2. The Odds ratio within the high-risk group, grouped by patients with acute onset of disorders and patients with gradual onset of disorders. The low-risk group is reference.

4.2 Self-reported satisfaction

Of patients that responded to the telephone interview (n = 154) 51% reported very satisfied, 29% was satisfied, 15% neither satisfied nor dissatisfied and 5% was dissatisfied or very dissatisfied. The characteristics grouped by the satisfaction level are displayed in table 1.

Table 1. Patient self-reported satisfaction and characteristics of cases 9 (range 6-14) months after completion of rehabilitation and tested with the test battery.

Total: n=154	Very satisfied n=78	Satisfied n=45	Neither n=23	Dissatisfied/ very dissatisfied* n=8
Age, median (quartiles)	27 (12, 47)	29 (23, 40)	30 (25, 41)	29 (25, 37)
Gender				
Men	40 (49.4)	27 (33.3)	10 (12.3)	4 (4.9)
Women	38 (52.1)	18 (24.7)	13 (17.8)	3 (4.1)
Onset of disorders				
Acute	42 (56.7)	18 (24.3)	11 (14.8)	3 (4.1)
Gradual	36 (45.0)	27 (33.7)	12 (15.0)	5 (6.3)
Treatment				
Surgery	44 (53.0)	21 (25.3)	11 (13.3)	6 (7.2)
Conservative	34 (47.9)	24 (33.84)	12 (16.9)	1 (1.4)
Disorder site				
Hip	2 (25.0)	4 (50.0)	2 (25.0)	0 (0)
Knee	55 (51.4)	32 (29.9)	15 (14.0)	5 (4.7)
Ankle	21 (53.4)	9 (23.1)	6 (15.4)	3 (7.7)

Count (% within row group) unless otherwise stated.
** Only one patient reported very dissatisfied, therefore dissatisfied and very dissatisfied are merged.*

An association was found between a higher risk group and a lower patient satisfaction (Figure 3). In the low-risk group 64% reported being very satisfied compared to 38% in the medium-risk group and 6% in the high-risk group. Very satisfied and satisfied combined included 84% of the patients in the low-risk group compared to 79% in the medium-risk group and 61% in the high-risk group. In the low-risk group 12% of patients reported neither satisfied nor dissatisfied, and 4% reported to be dissatisfied or very dissatisfied. In the medium-risk group 16% reported neither satisfied nor dissatisfied, and 5% answered dissatisfied or very dissatisfied. In the high-risk group 28% reported neither satisfied nor dissatisfied and 11% were dissatisfied or very dissatisfied.

There was a statistically significant and fair correlation between a higher risk-group and a lower patient satisfaction (r_s = -0.343, p<0.001).

Among patients with an acute onset of disorders, the correlation between a higher risk group and lower patient satisfaction was found to be statistically significant and fair (r_s = -0.466, p<0.001).
Among patients with gradual onset of disorders, this correlation was not significant (r_s = -0.219, p=0.051).

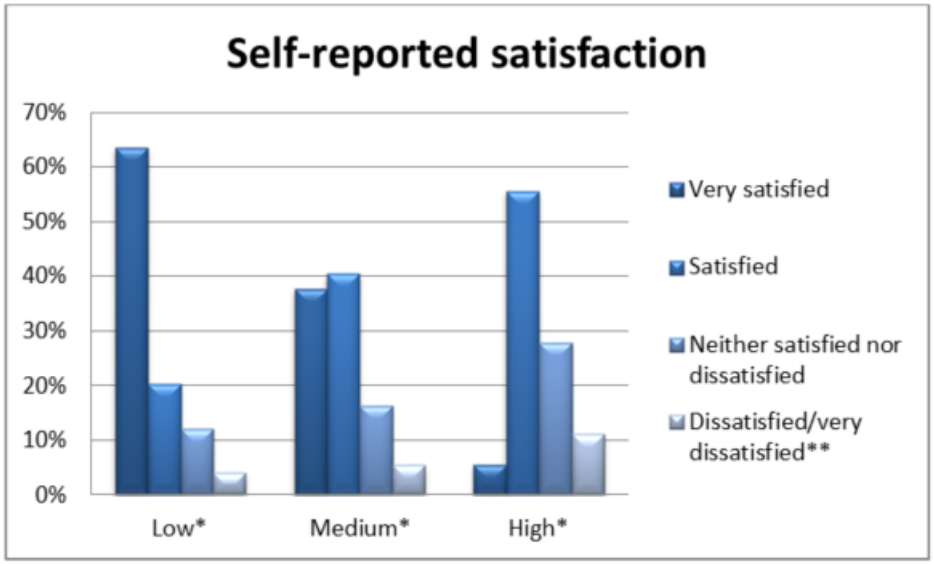

Figure 3. Patient satisfaction within risk group classified from test battery score, 9 (range 6-14) months after completion of rehabilitation and tested with the test battery.
**Risk group classified from test battery score.*
***Only one patient reported very dissatisfied, therefore dissatisfied and very dissatisfied are merged.*

5 Discussion

The main findings of the current study are discussed in the article. In this section there is a short discussion of the second research question followed by a discussion of methodology.

5.1 Self-reported satisfaction

The present study showed that there was a significant association between a higher risk group and lower patient satisfaction 9 months later. The correlation was fair (104), and statistically significant.

This corresponds with the result for research question one, where the high-risk had a significantly higher odds of relapse than the low-risk group. One can argue that this is two sides of the same coin, relapse leads to less satisfaction. Overall, the patients reported a high satisfaction, and there were small differences between groups. A systematic review by Hush et al (2011) found that patients were highly satisfied with musculoskeletal physical therapy. They also found that the treatment outcome was infrequently and inconsistently associated with patient satisfaction (105). In addition, telephone respondents may prefer extreme response categories and report better health status (106). The fact that a representative from the clinic conducted the telephone interview may have pushed responders to overestimate their satisfaction or avoid negative response.

The analysis was done for each of the subgroups, and there was no major difference between genders or surgery/not surgery. However, if the analysis was performed separately for patients with acute onset of disorders and patients with gradual onset of disorders, the results suggest that there is a difference. There was a statistically significant and fair correlation between risk group and satisfaction among patients with acute disorders but not significant among patients with gradual onset disorders. This corresponds with the results on relapse, giving even more arguments for further research for assessing which patients the test battery is suitable for.

5.2 Design

This study was designed as a prospective cohort study. This design is appropriate to assess whether potential risk factors are associated with an outcome, but both selection bias and confounding are threats to the results (91, 107). Prospective cohort studies minimize recall bias, it is possible to estimate population at risk, but it is not possible to infer causation, only association (108).

5.3 Selection

A strength in this study was the high response rate in the telephone interview (97%). A high response rate increases internal validity (93). The five non-responders did not differ in baseline characteristics from those who answered and were left out of the statistics.

All patients who met the inclusion criteria were meant to be invited to participate in the study. There was unfortunately no record of eligibility. Some patients may have ended treatment without completing the test battery, for a variety of reasons. This is a potential selection bias, which means that there is a risk that the study sample may not be representative for the desired population (91, 107).

The test battery was designed for all patients with lower extremity disorders, leading to a heterogeneous group of patients. This increases the risk of confounding, which creates uncertainty as to whether the data are representative for a particular group (107). The baseline characteristics showed an equal distribution between gender, treatment method and acute or gradual onset of disorders. However, there were too few patients with hip or ankle injuries to perform certain group analysis. There was a predominance of patients at a relatively young age. This may reflect the clinic's sporting profile, but might be a weakness as to whether the data can be used for all patients with lower extremity disorders and thus a threat to external validity (92).

5.4 Measures

Exposure status (risk group allocation) was determined at inclusion of the study. Neither the therapist nor the patient had knowledge of the outcome (future relapse and satisfaction) when scoring the test battery. The telephone interview was also conducted without the researcher knowing the risk group allocation, which minimized bias.

The predictor value was the risk group allocation scored from the test battery. The aim of this study was not to evaluate the contents of the test battery. However, the tests included in the test battery, the scoring system and the classification in risk groups greatly affected this study. A sum score with multidimensional constructs results in lost information regarding each separate construct (109). Another weighing of items in the test battery may have yielded different outcomes, and a study considering this would be interesting.

A ceiling effect in the test battery can mask that patients have not reached desired level of rehabilitation. Floor and ceiling effects can affect the responsiveness of a test instrument, as no further improvements can be detected by the test instrument (23). In this study, there was not significant difference in the odds of relapse in the low-risk group and the medium risk-group, suggesting no ceiling effect. However, only a few patients were in the high-risk group, and nobody were allocated in the very high-risk group. Furthermore, only a few patients reported relapse. As seen in the large confidence intervals in the results, the uncertainty in the analysis is therefore high. A solution for this would have been to include more patients, and could be included in future studies.

For outcome measures, a telephone interview was chosen. Other standardized tests, or validated questionnaires, such as KOOS (27), HAGOS (28), or FAOS (29) may have been preferable. On the other hand, this would have been a greater burden for the patients. Ethics and response rates were considered when decisions on using a telephone interview

were made. Compared to mailed questionnaires, telephone interviews result in a higher response rate (106). However, it is important to be aware that content in the questions, the way the questions are asked and by whom the questions are asked may affect the outcome (91). The method effect may be as large as the effect under investigation (106). To minimize this, the questions and the implementation of the telephone interview were thoroughly evaluated before data collection. Also, all patients received the same interview, making this effect equal across both risk-groups and outcomes.

For relapse, a simple yes/no outcome was chosen. The question was about relapse, and not a new injury. Research also shows that a previous injury of any type may increase the risks of a range of lower limb subsequent injuries (17, 34). Further studies might also consider assessing this.

For some patients, it can be difficult to determine if they have a relapse of disorders, as they may not be completely symptom-free at the end of treatment. Many patients have long-term ailments, and long-term pain ailments often persist (77). In order to have a scale answer alternative, a question about patient satisfaction with the validated Likert scale (91, 94) answer options were chosen. In retrospect, another scale, such as VAS (110) might have been chosen. The experience was that it was both time consuming and hard to avoid biases when the question was read to the patients. The response style, extreme or mild, is a threat to Likert scale (111, 112), and telephone respondents may prefer extreme response categories and report better health status (106). It has been found that in written questionnaires VAS items were less vulnerable to bias, avoided ceiling effect better, and the time needed to complete the questionnaire was 28% shorter than the Likert-scaled questionnaire (110). VAS is not feasible over telephone, but Chatterji et al (2017) found similar results for patient completed VAS and a 0-100 scale over the telephone for people awaiting hip or knee arthroplasty (113).

5.5 Analysis

Logistic regression analysis was chosen to assess the association between risk groups and relapse. This method is used for dichotomous outcomes and allows adjustments for possible confounders. Confounders "age" and "gender" were used, as previous research has shown that both may influence injuries and disorders (16, 96-98). Age could not be used as a continuous variable in logistic regression when analyses showed that it was not linear associated with the log-odds. This was solved by using age groups as categorical data. There was however a possibility that other confounders might affect the results. BMI, activity level and type of activity might also affect lower extremity injuries (16, 97, 98). This data could not be collected from patient records and was therefore not included. In this study we also had data about the disorder site (hip, knee, or ankle), but not enough to make subgroup analyses. When checking for change-in-estimate, neither "disorder site", "treatment method" (surgery/conservative) nor "onset of disorders" (acute/gradual) changed the result of the logistic regression by more than 10%, giving an indication that they should not be included as confounders (95). These factors were therefore not included in the adjusted analysis. However, when the analysis was done separately in patients with acute onset of disorders and patients with gradual onset of disorders, a major difference was found. This suggests effect modification and that these results should be presented separately (99). However, in both groups few with high-risk scores reported relapse. Therefore the confidence intervals are wide, and they overlap slightly, so these findings must be interpreted with caution.

To assess the association between the test battery and patient satisfaction the intention was to conduct an ordinal regression. This was not possible as the test of parallel lines was significant, indicating that the assumption of proportional odds was violated. Therefore, the results of patient satisfaction were presented descriptive, and the significance and strength of the association was tested with Spearman's rank order correlation.

6 Clinical relevance and future studies

The results from this study showed an association between a higher test battery score and both higher relapse rate and lower satisfaction 9 months later. This provides information regarding the usefulness of the test battery to assess whether the rehabilitation series is complete. It is beneficial to help patients until they reach a test battery score lower than classified as high-risk. There was no significant difference in odds of relapse between the low-risk and the medium-risk. This indicates that it might be ok to end rehabilitation while the patent still has a medium-risk score. Only small adjustments in the weighting of the items in the test battery will affect this result, and further studies should assess the scoring system.

The results in this study indicate that the test battery is associated with relapse and future satisfaction for patients with acute onset of disorders, but possibly not for those with gradual onset. This might be taken into consideration in clinical use, but further research is needed to assess this. There were too few patients with hip and ankle disorders to do subgroup analyses. This emphasizes the need for further studies that can assess whether the test battery can predict relapse or future satisfaction for subgroups of patients.

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Associations between a post treatment test battery score for lower extremity disorders and relapse rate after nine months

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Abstract

Introduction

Musculoskeletal disorders often require rehabilitation. Inadequate rehabilitation may lead to unachieved desired function and possible relapse of disorders. To evaluate rehabilitation, a feasible test battery including both subjective and objective tests can be helpful. The aim of this study was to assess whether higher scores of a test battery performed on the last day of a rehabilitation period for patients with lower extremity disorders were associated with higher relapse rates 6-12 months later.

Method

A prospective cohort study was conducted among patients with lower extremity disorders. Patients were tested with a test battery on the last day of a treatment series and the score classified them into risk-groups. A telephone interview was conducted 9 months later to assess relapse rate.

Results

Among responders (n = 154), 18% reported relapse. There was a significantly higher odds of relapse in the high-risk group vs the low-risk group (OR = 3.24, 95% CI 1.00, 10.45). There was not significant difference in odds of relapse between low-risk and medium-risk. Among patients with acute onset of disorders, there were a significantly higher odds of relapse in the high-risk group vs the low-risk group (OR = 46.04, 95% CI: 3.31, 632.61). The difference was not significant among patients with gradual onset of disorders.

Conclusion

The test battery score classified as high-risk indicated a higher future relapse risk than a score classified as low-risk. Caution should be exercised in using the test battery to classify risks in the event of gradual onset of disorders.

1 Introduction

Musculoskeletal disorders have a considerable impact on health services in Norway, and are the most common medical cause of sick leave and disability benefits (1, 2). The occurrence increases with age (3), and because of the aging population, there is an increased need to streamline health services (4). Disorders in the lower extremities are a common health problem leading to pain and function loss (5, 6). More than 50% of the injuries in sports activity occur on the lower extremities (7). After injury or disorder in the lower extremities, there is convincing evidence for an increased probability of re-injury, new injury or contralateral injury (7-13). Previous injury combined with inadequate rehabilitation is a risk factor for re-injury of the same type and location (10, 14). Premature termination of rehabilitation may lead to the patient not reaching the desired level of function (15). Overuse of health services will, however, not improve a patient's health, and may instead lead to more harm than good (16). Documentation of the rehabilitation effect presupposes the use of mapping methods and instruments that take care of the user's priority needs and goals (17). Various Patient Reported Outcome Measures (PROM) are commonly used for subjective patient status (18). Common standardized tests with objective measures are mostly designed for rehabilitation after sports injuries, many designed for deciding when to return to sports (RTS) after ACL reconstruction (19). Few studies have investigated the association between test scores of physical performance tests and risk of re-injury or relapse of disorders (19-25). A mapping tool for patient status must be standardized, cost-effective, time-efficient, and easy to use in clinical practice, while giving good indication of the patient's actual level of function, both self-perceived (subjective) and by objective tests (17, 26). Physical performance tests which measure strength or coordination are easy to administer, are not time-consuming, and usually do not require much expertise or equipment (24). Suitable questions can give an indication of self-efficacy, and several different forms have been created for different areas of use (27). A test battery with a combination of a few simple tests and questions, that are applicable for the general population to carry out, may be useful in clinical everyday life. At an outpatient clinic in Trondheim, such a test battery has been developed in order to indicate whether treatment is completed and to give an indication of risk for future relapse. In this study relapse covers both re-injury and relapse of disorders. The aim of this study was to assess whether higher scores of a test battery performed on the last day of a rehabilitation period for lower extremity disorders were associated with higher relapse rates in patients with lower extremity disorders 6-12 months later. The primary hypothesis was that higher sum scores of the test battery score will be associated with higher relapse rates 6-12 months later.

2 Method

2.1 Design

A prospective cohort study was conducted. The study was approved by the Regional Committee for Medical and Health Research Ethics, Central Norway, (REK Central), with case no. 2019/1061, and was conducted in accordance with the Declaration of Helsinki for Research in Humans. All patients included gave their written consent to participate after receiving written and oral information about the study.

2.2 Procedures

At an outpatient clinic in Trondheim, Norway, patients with lower extremity disorders who agreed to participate were tested with a test battery (Appendix 1 & 3) on the last day of treatment in a treatment series. Patients who met the inclusion criteria data were contacted for a telephone interview (Appendix 4) on average 9 (range 6-14) months later. The first question in the telephone interview, asking about re-injury or relapse of the disorders, was used as an outcome.

2.3 Selection

Inclusion criteria were patients over the age of 18 years who had finished rehabilitation with a physiotherapist for unilateral or bilateral lower extremity injury or disorder and with a complete test battery score at baseline. Exclusion criteria were patients considered by the treating physiotherapist unable to complete the test battery or patients who for linguistic reasons unable to answer the questions. A power analysis was not performed, but it was estimated that 150 people could be recruited in the inclusion period, and that it would meet the sample size criteria for the logistic regression (28).

2.4 Measures

The patients completed the test battery under the supervision of the treating physiotherapist. All 17 physiotherapists had access to the measurement protocol and received thorough training in the execution. The test battery was developed at the clinic, using both evidence and clinical reasoning. It was designed for postoperative and non-surgery patients with injuries or disorders in the foot/ankle, knee, and hip. It consisted of six variables: strength, coordination, range of motion (ROM), self-efficacy, pain, and activity level. Strength was measured with 1RM, the gold standard for testing muscle strength (29). Coordination was measured with 3 hops for distance, as it can provide information about strength and power and has good reliability (30, 31). Side difference of > 90% was used as cut-off in strength

and hop-test, as recommended in RTP after ACL reconstruction (9, 32-34). ROM was tested with a goniometer against opposite leg, which is common practice (35, 36) and a cut-off of 15° side difference was used. Each of these three functional tests were given 0 points if within cut-off, and 10 points if outside cut-off. For self-efficacy, five items were taken from valid and reliable self-efficacy questionnaires: the Norwegian version of the Tampa scale (37), Knee Self-Efficacy Scale (38) and a quality-of-life outcome measure questionnaire (39). Each of these five claims was scored 5 if the patient agreed and 0 if the patient disagreed. Absence of pain was used as criterion, as often used for RTP (40). Report of pain was scored 10 points, and absence 0 points. Activity level refers to acute – chronic workload. Training load spikes above 4-week average (chronic load) increases the risk of injury, therefore acute - chronic workload is recommended considered before RTS (41). The patient was asked if the training load was within the normal/desired amount and intensity continuously for the last four weeks, if yes 0 points, and no 25 points. The patient was also asked if relapse during the last 3 months of rehabilitation had occurred, if yes 10 points and no 0 points. The sum score classifies the patient into low- (0-20 points), medium- (21-44 points), high- (45-70 points), or very high-risk of relapse (71-100 points). This was used as a predictor in the analysis. As there were no patients in the very high-risk group, it was left out of the analysis. Questions in the telephone interview were first prepared by the test battery developers, then reviewed and revised by those responsible for this project. The telephone interview was conducted by the first author of this article, who also worked as physiotherapist at the clinic. Five pilot interviews were done while another person on the project was listening, with an evaluation afterwards. No major problems were identified, and the data was included in the study. Used as outcome measure in this article, was the question: have you experienced re-injury or relapse of the disorders since the end of treatment? Yes/ No.

Variables collected from patient records were gender, age, disorder site (hip, knee, or foot/ankle), treatment method (surgery or conservative), and onset of disorders (acute or gradual). In this study the onset of disorders was classified as acute if the patient record described "a trauma resulting from a specific and identifiable event" (42) as direct cause for the treatment. Other disorders were classified as gradual.

2.5 Statistical analysis

The collected data were manually plotted into Microsoft Excel (2010, Version: 14.0). Then the data was transferred to IBM SPSS Statistics (Version 26 for Microsoft Windows), where the statistical analyses were done. To assess whether the risk group had a significant effect on the risk of relapse, a logistical regression analysis was conducted. The relationship is expressed as an odds ratio. A significance level was set at a p-value < 0.05.

3 Results

A flow chart of patients in the study is displayed in Figure 1. Five dropouts are left out of the statistical analysis. Their characteristics did not differ from those who responded. This left 154 patients with complete data (97% response rate).

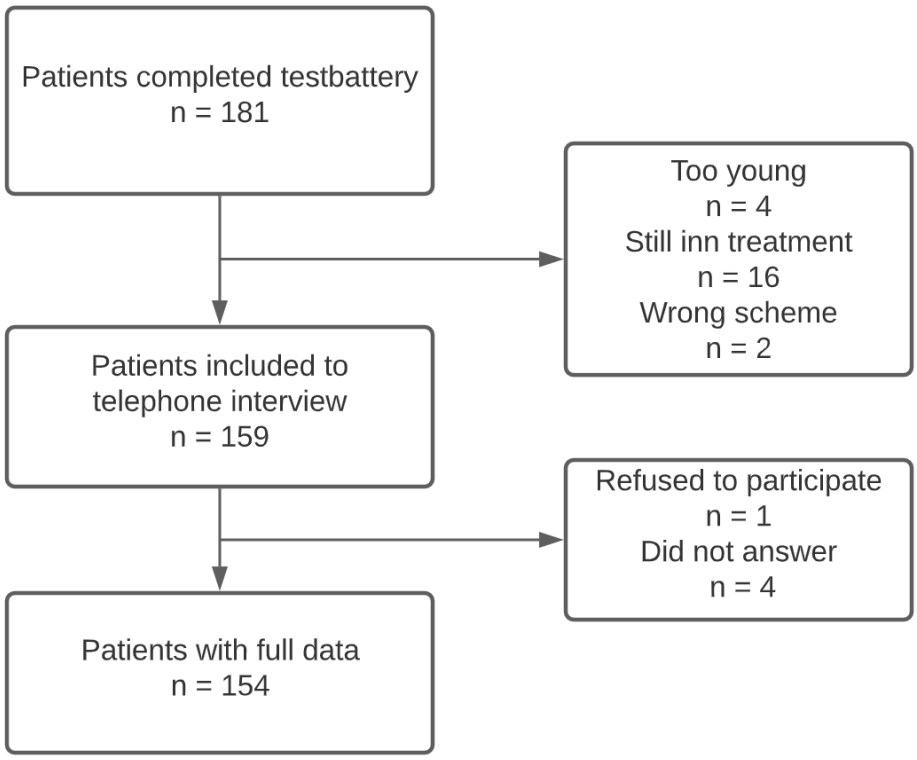

Figure 1. Study flow chart presenting inclusion to telephone interview.

Baseline characteristics are displayed in Table 1. Of the patients with full data, 64% got a test battery score that classified them into the low-risk group, 24% into the medium-risk group and 12% into the high-risk group. No patients were classified into the very high-risk group.

Table 1
Baseline characteristics of patients, and stratified into risk group*

	Total n=154	**Low*** n=99	**Medium*** n=37	**High*** n=18
Age, median (quartiles)	28.5 (22-42)	28 (22-42)	36 (23.5-46)	28 (24.5-34)
Gender				
Men	81 (52.6)	51 (63.0)	19 (23.5)	11 (13.6)
Women	73 (47.4)	48 (65.8)	18 (24.7)	7 (9.6)
Onset of disorder				
Acute	74 (48.1)	53 (71.6)	15 (20.3)	6 (8.1)
Gradual	80 (51.9)	46 (57.5)	22 (27.5)	12 (15.0)
Treatment				
Surgery	83 (53.9)	55 (66.3)	18 (21.7)	10 (12.0)
Conservative	71 (46.1)	44 (62.0)	19 (26.8)	8 (11.3)
Disorder site				
Hip	8 (5.2)	6 (75.0)	2 (25.0)	0 (0)
Knee	107 (69.5)	69 (64.5)	25 (23.4)	13 (12.1)
Ankle	39 (25.3)	28 (61.5)	10 (25.6)	5 (12.8)

Count (%), unless otherwise stated.
In columns low, medium, and high, percentages are within row group
* *Risk group classified form total score of the test-battery.*

Of the included sample (n = 154), 18% participants reported relapse of their disorders. Table 2 displays characteristics grouped by relapse/not relapse. Of patients with a test battery score classified as the high-risk group, 39% reported relapse, in the medium risk-group 19% reported relapse and in the low-risk group 14% reported relapse (Figure 2). Results from binary logistic regression are displayed in Table 3. When adjusted for age and gender, there was a significantly higher odds of relapse in the high-risk group than in the low-risk group (OR = 3.24, 95% CI 1.00, 10.45). No significant difference was found between the medium-risk group and the low-risk group (OR = 1.62, 95% CI 0.55, 4.81).

Table 2
Relapse and characteristics of cases, 9 (range 6-14) months after completion of rehabilitation and tested with the test battery.

Total, n=154	Relapse n=28	Not relapse n=126
Age, median (quartiles)	28 (25, 31)	29 (22, 45)
Gender		
Men	12 (14.8)	69 (85.2)
Women	16 (21.9)	57 (78.1)
Onset of disorders		
Acute	12 (16.2)	62 (83.8)
Gradual	16 (20.0)	64 (80.0)
Treatment		
Surgery	14 (16.9)	69 (83.1)
Conservative	14 (19.7)	57 (80.3)
Disorder site		
Hip	1 (12.5)	7 (87.5)
Knee	20 (18.7)	87 (81.3)
Ankle	7 (17.9)	32 (82.1)
Risk-group*		
Low*	14 (14.1)	85 (85.6)
Medium*	7 (18.9)	30 (81.1)
High*	7 (38.9)	11 (61.1)

Count (% within row group) unless otherwise stated.
** Risk group classified form total score of the test-battery.*

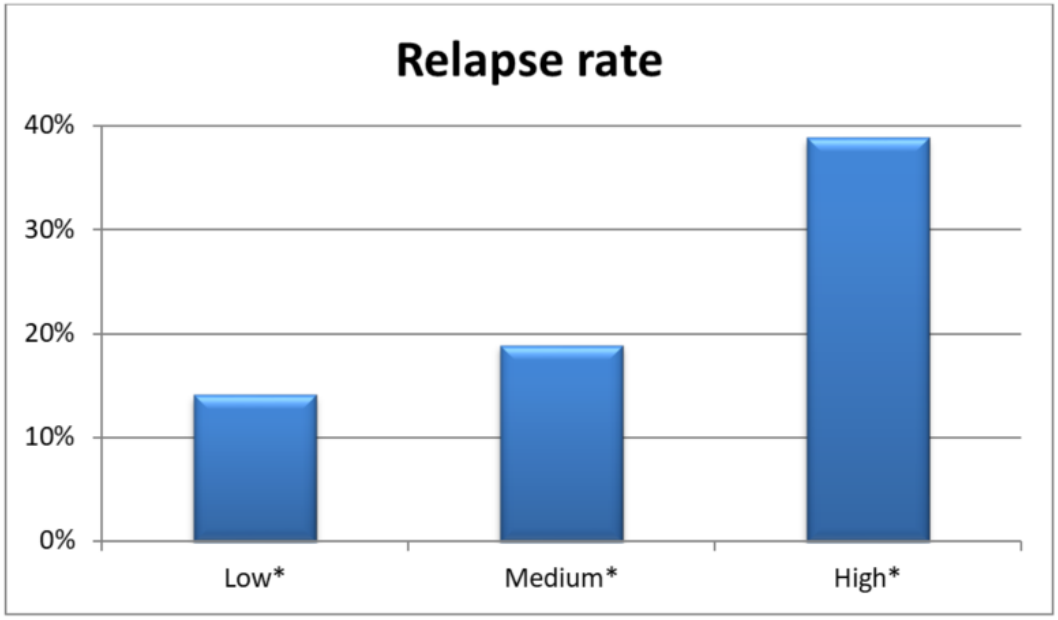

Figure 2. Relapse rate grouped by risk group, 9 (range 6-14) months after completion of rehabilitation and tested with the test battery.
**Low, medium, and high refers to the risk group classified from the test battery score.*

Table 3.
Risk group associated with relapse from the test battery. Unadjusted and adjusted logistic regression.

	Unadjusted		Adjusted**	
	OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
Risk group				
Low*				
Medium	1.42 (0.52, 3.84)	0.494	1.62 (0.55, 4.81)	0.382
High	3.86 (1.28, 11.65)	0.016	3.24 (1.00***, 10.45)	0.049

* Ref category
***Adjusted for gender and age (years: 18-24, 25-34, 35-44, 45-54, 55-100).*
****Exact value 1.003*

Figure 3 illustrates reported relapse grouped by onset of disorders, acute or gradual. Among patients with acute onset (n = 74), 12 patients (16%) reported relapse. Within the high-risk group 4 of 6 reported relapse and in the low-risk group 5 of 48 reported relapse. Adjusted for age and gender, there was a significantly higher odds for relapse in the high-risk group than in the low-risk group (OR =

46.04, 95% CI: 3.31, 632.61). Among patients with gradual onset of disorders (n = 80), 16 patients (20%) reported relapse. Within the high-risk group 3 of 12 reported relapse, and within the low-risk group 9 of 46 reported relapse. Adjusted for age and gender, there was not a significant difference in odds of relapse in the high-risk group than the low-risk group, odds (OR = 0.72, 95% CI: 0.14, 3.63).

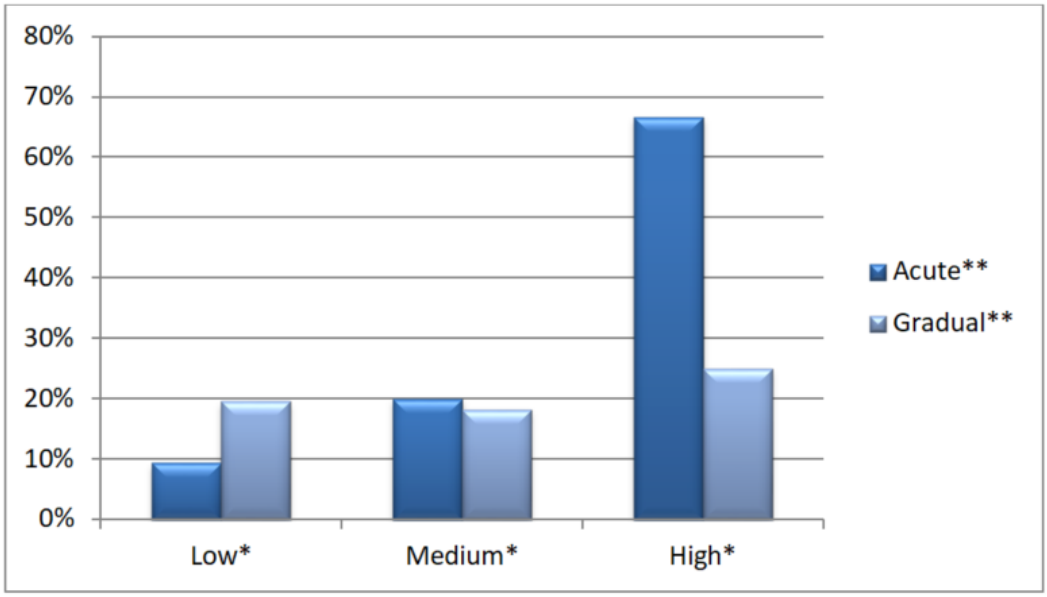

Figure 3. Relapse grouped by risk group, among patients with acute onset of disorders and patients with gradual onset of disorders.
**Low, medium, and high refers to the risk group classified from the test battery score.*
***Acute and gradual refers to onset of disorders, before treatment.*

4 Discussion

The present study showed that patients with a score on the test battery classified as high-risk had a significantly higher odds of reporting relapse 9 months after, compared to patients with a low-risk score (OR = 3.24, 95% CI 1.00, 10.45). This was an important finding, as it provides information regarding the usefulness of the test battery to assess whether the rehabilitation series is complete. Premature ending of rehabilitation can lead to a patient not reaching desired function, resulting in a higher risk of relapse (15). As Lübecke (2018) pointed out, both current status and long term outcomes must be taken into account when assessing outcome measures (26). Informing the patient that a high-risk score will be associated with a higher risk of relapse, they can be better educated, which in turn can contribute to increased rehabilitation compliance. (43). There was, however, no significant difference in odds of relapse between the low-risk and the medium-risk (OR = 1.62, 95% CI 0.55, 4.81). This finding might indicate that it is not necessary to continue rehabilitation beyond the stage where the patient scores according to medium risk. This probably means a shorter rehabilitation period, and without increased risk of relapse, that is in line with the global Choosing Wisely Campaign where the intention is to reduce overtreatment (44). Overuse of healthcare is a problem on a social and individual level (16, 45).

If the association between test battery score and relapse of disorders represent a true causal association, it can help RTS decisions both for athletes and recreational sports. Helping patients decide when they can return to the desired level of activity, without a substantial risk of injury, is part of the job as a physiotherapist (46). Preventing injury is not only for athletes, but becoming a public health priority (47). The association between passing an RTS-criteria test battery and relapse has mainly been investigated for ACL injuries (19, 21, 22), and the results are ambiguous. In a systematic review and meta-analysis, Webster and Hewett (2019) found that passing RTS test batteries did not significantly reduce the risk for further knee injuries in general or ACL injuries specifically. Another systematic review by Ashigbi et al (2020) found, however, that passing a RTS test was associated with reduced re-injury rates. Direct comparison to the present study is problematic due to differences in methodology and sample. Three systematic reviews found no standardized, reliable, and validated RTP test after hip arthroscopy (48), Achilles tendon rupture (49), hamstrings strain (23). In two systematic reviews, Hegedus et al (2015) found limited evidence supporting correlation between injury and clinician-friendly lower extremity physical performance tests and lower extremity injuries (24, 25). In a systematic review by Vereijken et al (2020), they recomended more high-quality prospective cohort studies including athletes with any type of lower extremity injury to assess relation between function performance and RTS (50).

A total of 154 patients completed the study, and the goal of at least 150 participants was achieved. However, few patients were in the high-risk group and few reported relapse, which resulted in wide confidence intervals for the odds ratio, limiting the accuracy of the association between the test battery and relapse. The inclusion criteria was all patients with lower extremity disorders, but to assess

whether the test battery predicts relapse for all, subgroup analysis should be performed. The baseline characteristics show an equal distribution between gender, treatment method and acute or gradual onset of disorders. Too few patients with hip or ankle injuries were included to perform group analysis. There were also a predominance of young patients. This may reflect the clinic's sporting profile, but might be a weakness as to whether the data can be used for patients with lower extremity disorders in general. No difference in either test battery score or relapse rate were found between patients with or without surgery. Research shows that many conditions improve with conservative treatment. Even after Achilles rupture, ACL-injury, or degenerative meniscal tear the difference in long-term outcomes are insignificant (51-54). When checking for change-in-estimate, acute or gradual onset of disorders did not influence the change the logistic regression results more than 10%, which is an indication that it was not a confounder (55). However, when the analysis was done separately for these two patient groups, there was a major difference, suggesting effect modification (56). It must be taken into consideration that in both groups a small number of patients in the high-risk group reported relapse which resulted in wide and slightly overlapping confidence intervals for the odds ratio, so these findings must be interpreted with caution. This might nevertheless indicate that the test battery predicts relapse only for patients with acute onset of disorders, and that further research is needed to assess this. Most of the RTP tests discussed earlier are used for acute injuries. Many chronic conditions persists, and treatment may relieve pain and improve function, but often not completely alleviate symptoms, such as in osteoarthritis (5, 57) or anterior knee pain in young adults (6). It is also unlikely that people with chronic pain conditions can get rid of the ailments completely (58). For this reason it may also be difficult for the individuals to decide whether they should report relapse.

The RTP tests discussed above mainly contain objective measures. The test battery used in our study also included subjective measures of pain, psychological factors, and activity consistency, which is a strength of the test battery. Many studies have used different patient-reported outcome measures (PROMs) to evaluate treatment outcomes or patient status (59). Having a good overview of all PROMs is challenging, and Kyte et al (2015) emphasizes that therapists are insecure about their use and when to use which. The idea behind the test battery is that it should be one, easily administered, tool with a combination of items covering necessary factors to assess rehabilitation status after lower extremity disorders. Functional aspects, such as strength, flexibility or neuromuscular control have shown to be affected by injuries (15). In the test battery coordination was measured with 3 hops for distance. This test is found to provide information about strength and power and has good reliability (30, 31). A combination of hop distance symmetry is commonly used as a criterion for RTS after ACL reconstruction, but can be masked due to changed biomechanics in the hop (60). Kotsifaki et al (2022) suggests using a vertical hop test. They found both biomechanical deficits and differences in limb symmetry in vertical hop, despite symmetry in horizontal functional performance and strength tests (60, 61). Muscle strength was measured with 1RM, the gold standard (29). It has a good to very good test-retest reliability regardless of training experience, muscle group, gender and age of the person being tested (62). Detailed analysis of another test battery showed that strength was associated with

re-injury and not hop test after ACL reconstruction (63). LSI of >90% in both strength and distance is recommended as a cut-off point (20), although it can be argued that there is no justification for that exact number (21). LSI may overestimate function because of bilateral function loss (64, 65). The evidence showing that patients' psychological resources affect treatment results is increasing (27). Research has shown a connection between psychological aspects and return to sports (66), adherence to rehabilitation (27) and is a prognostic factor for long term pain (67). These factors must therefore be addressed in rehabilitation (66), and thus, be a part of a treatment evaluation (20). Suitable questions can give an indication of self-efficacy, and several different forms have been created for different areas of use (27). In this test battery, a variety of claims were taken from valid and reliable self-efficacy questionnaires: the Norwegian version of the Tampa scale (37), Knee Self-Efficacy Scale (38) and a quality-of-life outcome measure questionnaire (39). The combination used here is however not previously validated. Absence of pain was used as criterion, as often used for RTS (40). This might not be an achievable goal for patients with longstanding pain, as longstanding pain usually persists (58). Inconsistency in activity level has been given a high score in the battery. People respond better to small increases in training load, and load must be applied in a moderate and progressive manner (68). Training load spikes above 4-week average (chronic load), increases the risk for injury, and therefore the acute - chronic workload ratio should be considered before RTS (41).

Limitations

Due to the corona pandemic, activity levels may have been affected in some patients. Insufficient activity level gave 25 points on the test battery, and that alone classified into the medium risk group. Also, patients inability to compete during the pandemic may have impacted the relapse rate. There is a general agreement among researchers that injury incidence is greater during competition (14). A potential limitation of the test battery was the use of a sum score. A sum score with multidimensional constructs results in lost information regarding each separate construct (18). Further research for adjusting the scoring system should be done. Another limitation of the study was using a telephone interview to assess relapse rate. It might have been better to have patients to perform a standardized test or possibly a validated questionnaire. This might have resulted in lower response rate and was therefore opted out. Patients in this study were asked for relapse or re-injury. There is convincing evidence in the literature that previous injury combined with inadequate rehabilitation is a risk factor for relapse of the same type and location (14). Research, however, also shows that a previous injury of any type may increase the risk of a range of lower limb subsequent injuries (10, 21). This should be considered in later studies. A strength of the study was the high response rate (97%). However, there was unfortunately no record of eligibility, and selection bias may well have been masked due to the selection of recruitment done by the physiotherapists. The generalizability to a wide range of patients might be limited due to the predominance of people at a relatively young age and few patients with hip and ankle injuries.

5 Conclusion

Patients with a test battery score classified as high-risk had a significantly higher odds of reporting relapse than patients with a low-risk score. There was no significant difference in odds of relapse between the low-risk goup and the medium-risk group. The results indicated that this applies to patients with acute onset of disorders, but possibly not for those with gradual onset. This emphasizes the need for further studies that can assess whether the test battery can predict relapse for subgroups of patients.

6 Clinical Relevance

- To assess whether the rehabilitation series is finished the test battery is useful, as a score classified as high-risk is associated with significantly higher relapse rate.
- It is beneficial to continue rehabilitation until patients reach a test battery score lower than classified as high-risk.
- The results in this study indicate that a high-risk score on the test battery is associated with higher future relapse for patients with acute onset of disorders, but possibly not for those with gradual onset. This might be taken into consideration in clinical use, but further research is needed to assess this.

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Appendix

Appendix 1: Test battery lower extremities

Appendix 2: Author info for The Journal of Bodywork and Movement Therapies

Appendix 3: Test protocol for the test battery

Appendix 4: Telephone interview

Appendix 1: Test battery lower extremities

Rosenborgklinikken Fysioterapi AS

ROSENBORGKLINIKKEN FYSIOTERAPI

Testbatteri, underekstremitet

Et klinisk testbatteri for smertetilstander og funksjonsnedsettelser i underekstremitetene

Dato for test: ..... ProMed pasient-ID: .....

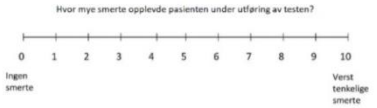
Affisert ekstremitet (sett kryss): Høyre Venstre Bilateralt

1. Styrke (10 poeng)

1RM, beinpress / kneekstensjon / tåhev i beinpressapparat (unilateral test, stryk over uaktuelle testøvelse).

- Sidelikhet (<10% sideforskjell) – 0 poeng
- Ikke sidelikhet (>10% sideforskjell) – 10 poeng
- 1RM ikke gjennomførbart grunnet smerte / frykt for provokasjon av symptomer / manglende funksjonsnivå – 5 poeng

Høyre (kg) ..... Venstre (kg) ..... (ikke en del av poengberegningen)

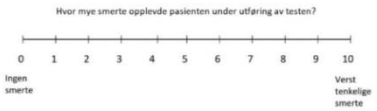


2. Koordinasjon (10 poeng)

Tre hink for distanse (beste av tre forsøk), stillestående start.

- Sidelikhet (<10% sideforskjell) – 0 poeng
- Ikke sidelikhet (>10% sideforskjell) – 10 poeng
- Hinketest ikke gjennomførbart grunnet smerte / frykt for provokasjon av symptomer / manglende funksjonsnivå – 5 poeng

Høyre (m) ..... Venstre (m) ..... (ikke en del av poengberegningen)



3. **Bevegelsesutslag (10 poeng)**

Aktiv ekstensjon (sittende)

Høyre (grader) .....Venstre (grader) ..... Tolkning: grenseverdier for avvik asymmetri over 15°.

4. Tiltro til egen mestring (25 poeng)

- Be pasienten ta stilling til følgende påstander (5 poeng per påstand pasienten er **enig** i).

Jeg frykter for å skade meg dersom jeg trener	ENIG / UENIG
Jeg vet **ikke** hvordan jeg skal trene og behandle meg selv i tiden fremover	ENIG / UENIG
Personer som opplever smerter som min skal **ikke** trene/være fysisk aktive	ENIG / UENIG
Jeg stoler **ikke** på begge beina mine like mye	ENIG / UENIG
Jeg føler meg **ikke** klar for å returnere til mitt ønskede/vanlige aktivitetsnivå	ENIG / UENIG

5. Smerte (10 poeng)

Hvor mye smerte har pasienten hatt i snitt siste døgn? Skala 0-10 (NRS):……

Hvor mye smerte har pasienten hatt ved utførelse av:……..…….(type aktivitet)?

Skala 0-10 (NRS):……

Side **1** av **2**

6. Aktivitetsnivå (35 poeng)

- Har pasienten trent med ønsket/normal treningsmengde og -intensitet sammenhengende de siste fire uker? JA = 0 poeng / NEI = 25 poeng
- Har pasienten opplevd vesentlig forverring/re-skade ila. de tre siste måneder av rehabiliteringen? JA = 10 poeng / NEI = 0 poeng

Score

Score i sum: ..... av 100 poeng.

Tolkning av score:

Grønn (0 til 20 poeng) – liten risiko for tilbakefall / ny skade / forverring
Gul (21 til 44 poeng) – moderat risiko for tilbakefall / ny skade / forverring
Oransje (45 til 70 poeng) – høy risiko for tilbakefall / ny skade / forverring
Rød (71 til 100 poeng) – høy risiko for tilbakefall / ny skade / forverring

Appendix 2: Author info for The Journal of Bodywork and Movement Therapies

Article for *The Journal of Bodywork and Movement Therapies*

https://www.bodyworkmovementtherapies.com/content/authorinfo

Your article should be double spaced with a margin of at least 3cm.

Papers should be set out as follows, with each section beginning on a separate sheet: title page, abstract, text, acknowledgements, references, tables, and captions to illustrations.

You should give a maximum of four degrees/qualifications for each author and the current relevant appointment.

The abstract should be structured and no more than 250 words in length. It should follow the appropriate structure for your study type (eg. Randomized Controlled Trial; Systematic Review, etc) as laid out in the scientific reporting guidelines on https://www.equator-network.org/ . If in doubt, use the generic structure: Introduction; Method; Results; Discussion; Conclusion.

Contact details for submission

Text

Headings should be appropriate to the nature of the paper. The use of headings enhances readability. Three categories of headings should be used:
•major ones should be typed in capital letters in the center of the page and underlined
•secondary ones should be typed in lower case (with an initial capital letter) in the left hand margin and underlined
•minor ones typed in lower case and italicized

Do not use 'he', 'his', etc. where the sex of the person is unknown; say 'the patient', etc. Avoid inelegant alternatives such as 'he/she'. Avoid sexist language.

Avoid the use of first person ('I' statements) and second person ('you' statements). Third person, objective reporting is appropriate. In the case of reporting an opinion statement or one that cannot be referenced, the rare use of 'In the author's opinion?' or 'In the author's experience?.' might be appropriate. If in doubt, ask the editor or associate editor for assistance.

Acronyms used within the text are spelled out at the first location of usage and used as the acronym thereafter. For example, 'The location of a central trigger point (CTrP) is central to a taut fiber. The CTrP is palpated by.....'

Single quotation are used to express a quote marks (Matthews (1989) suggests, 'The best type of?') while double quotation marks are used for a quote within a quote or to emphasize a word within a quote.

Promotion of self, seminars or products is inappropriate. Reference to a particular product as it applies to the discussion, particularly where valid research of the product or comparison of products is concerned, can be included as long as a non-promotional manner is used.

Structure

We expect authors to follow the scientific reporting guidelines for their study type, as found on https://www.equator-network.org/ . Editors and reviewers will look for evidence of their use in submitted manuscripts. This will affect editorial decisions.

All full-length submissions should include a final section entitled "Clinical Relevance". This should contain between 2-5 bullet points highlighting the immediate usefulness and/or implications of the study's findings for clinicians. Submissions that omit this feature will be returned for correction.

Illustrations

The journal is fully illustrated throughout. Please give consideration at an early stage of writing your paper to the illustrations which will enhance and develop the text. It is the author's responsibility to provide all the illustrations for the paper. However, following discussion with the Editor, Journal of Bodywork & Movement Therapies may undertake (at no expense to the author) redrawing from supplied references figures. Additionally Journal of Bodywork & Movement Therapies has access, at no cost to the author, to illustrations appearing elsewhere in Elsevier imprint books and journals. Full source files should be supplied at submission. Label each figure with a figure number corresponding to the order it appears within the article (i.e., Figure 1, Figure 2). Ensure that each illustration is cited within the text ('see Figure 1') and that a caption is provided.

Reference style

The accuracy of references is the responsibility of the author. This includes not only the correct contextual use of the material, but also the citation itself. In the text your reference should state the author's surname and the year of publication (Smith 1989); if there are two authors you should give both surnames (Smith & Black 1989). When a source has more than two authors, give the name of the first author followed by 'et al'. (Smith et al 1989). No commas are used between the name and date. It is important to verify the correct and full title, the full authorship, and all other reference details with the original source (book, journal, etc.,) or through a service, such as Medline or ScienceDirect.

A list of all references in your manuscript should be typed in alphabetical order, double spaced on a separate sheet of paper. Each reference to a paper needs to include the author's surname and initials, year of publication, full title of the paper, full name of the journal, volume number and first and last page numbers. The names of multiple authors are separated by a comma with each appearing as

surname followed by initials. The date is placed after the author's name(s), not at the end of the citation.

Here are examples:
Cleary C, Fox JP 1994 Menopausal symptoms: an osteopathic investigation. Complementary Therapies in Medicine 2: 181-156

References to books should be in a slightly different form:
Chaitow L 1996 Muscle Energy Techniques. Churchill Livingstone, Edinburgh
Hicks CM 1995 Research for Physiotherapists. Churchill Livingstone, Edinburgh
When citing a paper that has a digital object identifier (doi) please use the following style:
Liebenson C 2000 Sensory motor training. Journal of Bodywork and Movement Therapies 4: 21-27. https://doi.org/10.1054/jbmt.2000.0206

References to Datasets: [dataset] Oguro, M., Imahiro, S., Saito, S., Nakashizuka, T., 2015. Mortality data for Japanese oak wilt disease and surrounding forest compositions. Mendeley Data, v1. https://doi.org/10.17632/xwj98nb39r.1.

Appendix 3: Test protocol for the test battery

All tests are performed at the clinic by the treating physiotherapist. The participant completes warm-up with global aerobic activity 10-15 min before the start of the test.

1 strength (one repetition maximum, 1RM) in 1 of 3 different maximum strength tests are performed: knee extension, leg press or toe lift in leg press machine. Witch test is chosen by the relevant therapist based on what is most appropriate for the current ailment. The participant warms up with 1-3 sets in the relevant exercise before the test starts. The load is gradually increased, and the participant performs the movement once on each leg before increasing the weight. Pause 1-3 min between each set. 1RM should be achieved after 3-6 attempts. The heaviest weight a participant can lift is registered as 1RM. 1RM is registered for both sides.

Side inequality (10% side difference) gives 10 points.
1RM not feasible due to pain / fear of provocation of symptoms / lack of functional level gives 5 points.
Partiality (below 10% side difference) gives 0 points.

2 Coordination: Three hop for distance (best of three attempts on each leg), stationary start on one leg. The participant gets 1-3 attempts to get acquainted with the exercise. There are 3 continuous hops without stopping. The participant must stand steady at the last landing. If the participant fails to keep his balance in the last landing, the attempt is rejected.

Side inequality (10% side difference) gives 10 points.
1RM not feasible due to pain / fear of provocation of symptoms / lack of functional level gives 5 points.
Partiality (below 10% side difference) gives 0 points.

3 Range of motion: Interpretation: limit values for deviation asymmetry above 15°. The therapist chooses one of three tests: active knee extension while sitting, active plantar flexion ankle while sitting, and active flexion hip while supine. Measured against the opposite side with a protractor.
Side inequality (15° side difference) gives 10 points.

4 Self efficacy: The patient is asked to comment on the claims below.
"I fear injury if I exercise"

"I do NOT know how to train and treat myself in the future"
"People who experience pain like mine should NOT exercise / be physically active"
"I do NOT trust both my legs as much"
"I do NOT feel ready to return to my desired / regular activity level."

5 points are given per statement the patient agrees with.

5 Pain: «How much pain has the patient had on average in the last 24 hours on a scale from 0-10 (NRS). »

«How much pain has the patient had when performing ..... (Type of activity) on a scale from 0-10 (NRS).
ALL indications of pain on one or both points give a score of 10 points in total.

6 Activity level: Two questions are asked to explore the participants' level of activity:

"Has the patient trained with the desired / normal amount of training and intensity continuously for the last four weeks?"
Yes gives 0 points. No gives 25 points.
"Has the patient experienced significant deterioration / re-injury in the last three months of rehabilitation?"
Yes gives 10 points. No gives 0 points.

Total score

In total, it is possible to get a score of 100 points.
- Score Green (0 to 20 points) - small risk of relapse / new injury / deterioration.
- Score Yellow (21 to 44 points) - moderate risk of relapse / new injury / deterioration.
- Score Orange (45 to 70 points) - high risk of relapse / new injury / deterioration.
- Score Red (71 to 100 points) - high risk of relapse / new injury / deterioration

Appendix 4: Telephone interview

The interview started with an introduction:

"Hi! My name is "nn.". I am contacting you since you agreed to be called a few months after you completed the test battery at the clinic. I wonder if you have 3 minutes to answer how you are now. First, I would like to inform you that this telephone interview is confidential, and your answers will only be used anonymously at group level, so it is not possible to identify you in the publication."

If the patient agreed, the interview continued with the following questions:

1: Have you experienced re-injury or relapse of the disorders since the end of treatment?
(1) Yes/ (2) No

2: Considering the ailments you were a physiotherapist for, how satisfied are you with today's function?
(1) Very satisfied, (2) satisfied, (3) neither satisfied nor dissatisfied, (4) dissatisfied, (5) very dissatisfied

3: Did you continue with training or exercises for current ailments in the recommended intensity and amount after you have completed your rehabilitation?
(1) Strongly agree, (2) agree, (3) neither agree nor disagree, (4) disagree, (5) strongly disagree

4: Have you been training with the desired amount and intensity continuously for the last four weeks?
(1) Strongly agree, (2) agree, (3) neither agree nor disagree, (4) disagree, (5) strongly disagree

5. I fear injury if I exercise **(5) Agree/ (0) Disagree**

6. I do not know how to train and treat myself in the future: **(5) Agree/ (0) Disagree**

7. People who experience pain like mine should not exercise / be physically active: **(5) Agree/ (0) Disagree**

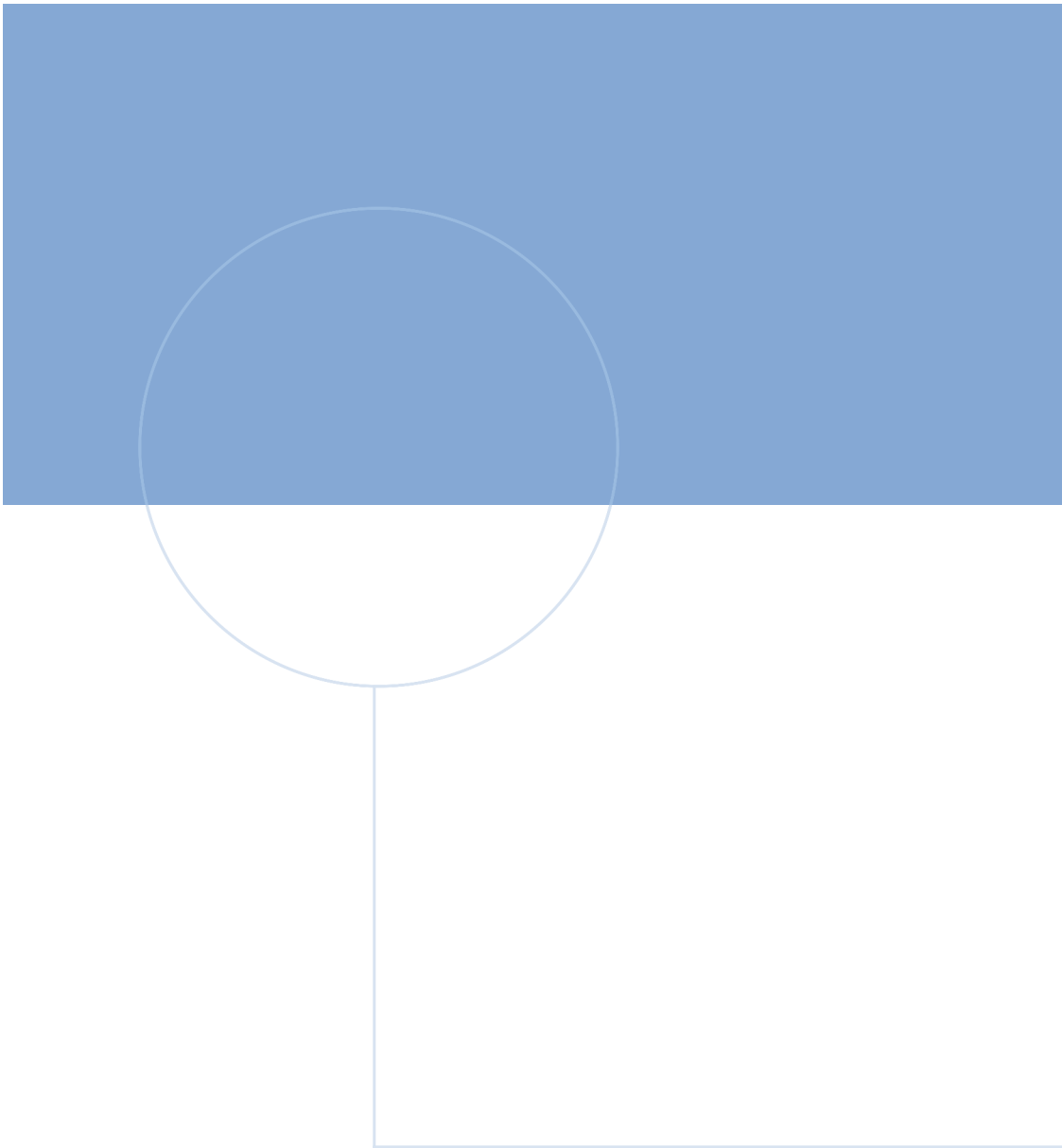
8. I do not trust both my legs as much: **(5) Agree/ (0) Disagree**

9. I do not feel ready to return to my desired / regular activity level: **(5) Agree/ (0) Disagree**

10. Pain:

How much pain have you experienced on average in the last 24 hours? Scale 0-10.
How much pain have you experienced when performing ..... (type of activity) Scale 0-10

The interview ends with asking the participant if he/she has any questions, as well as thanking them for participation.



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