A Randomized, Controlled Study of a Rehabilitation Model to Improve Knee-Function Self-Efficacy With ACL Injury

Pia Thomeé, Peter Währborg, Mats Börjesson, Roland Thomeé, Bengt I. Eriksson, and Jon Karlsson

Context: The Knee Self-Efficacy Scale (K-SES) has good reliability, validity, and responsiveness for patients’ perceived knee-function self-efficacy during rehabilitation after an anterior cruciate ligament (ACL) injury. Preoperative knee-function self-efficacy has also been shown to have a predictive ability in terms of outcome 1 y after ACL reconstruction. Objective: To evaluate a new clinical rehabilitation model containing strategies to enhance knee-function self-efficacy. Design: A randomized, controlled study. Setting: Rehabilitation clinic and laboratory. Patients: 40 patients with ACL injuries. Intervention: All patients followed a standardized rehabilitation protocol. Patients in the experimental group were treated by 1 of 3 physiotherapists who had received specific training in a clinical rehabilitation model. These physiotherapists were also given their patients’ self-efficacy scores after the initial and 4-, 6-, and 12-mo follow-ups, whereas the 5 physiotherapists treating the patients in the control group were not given their patients’ self-efficacy scores. Main Outcome Measures: The K-SES, the Tegner Activity Scale, the Physical Activity Scale, the Knee Injury and Osteoarthritis Outcome Score, and the Multidimensional Health Locus of Control. Results: Twenty-four patients (12 in each group) completed all follow-ups. Current knee-function self-efficacy, knee symptoms in sports, and knee quality of life improved significantly (P = .05) in both groups during rehabilitation. Both groups had a significantly (P = .05) lower physical activity level at 12 mo than preinjury. No significant differences were found between groups. Conclusion: In this study there was no evidence that the clinical rehabilitation model with strategies to enhance self-efficacy resulted in a better outcome than the rehabilitation protocol used for the control group.

Keywords: physical activity, knee symptoms, locus of control

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A patient’s perceived self-efficacy is a factor of major importance for the rehabilitation outcome after sports-related injury.\(^1\) Strategies to enhance low self-efficacy or maintain high self-efficacy may be necessary to obtain a satisfactory outcome for a patient with an anterior cruciate ligament (ACL) injury.\(^4\)\(^5\) The way patients react emotionally to an ACL injury also appears to be closely connected to their rehabilitation behavior and clinical outcome, as well as their subjective well-being.\(^6\)\(^7\)

Self-efficacy refers to the way patients assess their capability to organize and execute courses of action required to attain designated types of performance.\(^8\) In other words, patients with an ACL injury set goals and anticipate the likely outcome to guide and motivate their efforts. Locke et al\(^9\) have suggested that people with high levels of self-efficacy select more difficult goals and also have greater commitment to those goals. People with high self-efficacy also choose to perform more challenging tasks.\(^10\) When setbacks occur, they recover more quickly and maintain their commitment to their goals.\(^10\) A recent study of patients’ rehabilitation behavior after an ACL reconstruction identified a group of patients who increased their effort and another group who “gave up”\(^11\) when faced with the demands of rehabilitation. Knee-function self-efficacy for patients with ACL injury has been shown to be characterized by factors such as the patients’ internal health locus of control and their assessment of knee-related function in sports and recreation.\(^5\)

Furthermore, preoperative knee-function self-efficacy has been shown to predict the outcome in terms of return to acceptable levels of physical activity, symptoms, and muscle function 1 year after ACL reconstruction.\(^3\)

A number of studies point to the importance of using a well-defined, guided rehabilitation protocol for a successful outcome after ACL surgery.\(^12\)\(^-\)\(^15\) No rehabilitation protocol has, however, been shown to succeed in generating acceptable levels of knee function for most patients after an ACL injury.\(^16\)\(^-\)\(^20\) To judge whether the outcome is acceptable, most ACL studies evaluate knee-joint-laxity restoration, knee function, and knee-muscle function. However, patients’ subjective assessment of their knee symptoms and knee function is also thought to have an important impact on outcome.\(^21\) Patients’ psychological profile, as well as the way they rate their knee-function capacity before surgery, has been shown to be useful in determining the return to preinjury activity level after an ACL reconstruction.\(^22\) For this reason, it may be important to consider patients’ attitude and cognitive behavior toward their ACL injury.

Strategies to enhance self-efficacy are thought to be effective for diagnoses such as cardiac disease, whiplash-associated disorders, osteoarthritis, and persistent back pain.\(^23\)\(^-\)\(^26\) Strategies to enhance knee-function self-efficacy during rehabilitation have not, however, been evaluated for patients with an ACL injury. We hypothesized that it would be beneficial for a patient’s knee-function outcome after an ACL injury to use strategies to enhance low self-efficacy or maintain high self-efficacy during rehabilitation.

Therefore, the purpose of this randomized, controlled study was to compare the effects of 2 rehabilitation models on patients’ knee function 1 year after ACL injury. The experimental rehabilitation protocol included strategies to enhance knee-function self-efficacy, and a standard ACL rehabilitation protocol was used for comparison.
Methods

The Clinical Rehabilitation Model

For the purpose of this study, a clinical rehabilitation model was created with the aim of enhancing ACL-injured patients’ knee-function self-efficacy. The model is based on Bandura’s theories and on more than 25 years of clinical experience with patients with ACL injuries. The model (Figure 1) illustrates in 4 stages how the concept of self-efficacy can be implemented during rehabilitation to guide physiotherapists in enhancing patients’ knee-function self-efficacy. The stages overlap and can start again from stage 1 during the rehabilitation process when the patient is faced with new tasks and challenges. The goal is to gradually enhance self-efficacy, especially in patients with low knee-function self-efficacy. Patients with a high level of self-efficacy should be stimulated to maintain their strong knee-function self-efficacy.

Stage 1: Understanding. The physiotherapist strives to increase the patient’s understanding of the ACL injury, the extent of the rehabilitation, its content,

**Figure 1** — A clinical model illustrating in 4 stages how the concept of self-efficacy can be implemented during rehabilitation to guide physical therapists in reinforcing patients’ knee-function self-efficacy. The stages overlap and can start again from stage 1 during rehabilitation when the patient is faced with new tasks and challenges. The goal is to gradually strengthen self-efficacy, especially in patients with low knee-function self-efficacy. Patients with a high level of self-efficacy should be stimulated to maintain their strong knee-function self-efficacy.
and goals by giving information and demonstrating and allowing the patient to practice some challenging exercises. Personal goals should be set at this stage.

**Stage 2: Maturity.** The physiotherapist increases the patient’s understanding of the ACL injury by social persuasion and by increasing the variety of challenging exercises. The goal is to give the patient the opportunity to acquire mastery experience to gain maturity, that is, obtain a better understanding of the demands of the ACL rehabilitation.

**Stage 3: Persistence.** The physiotherapist guides the patient through an increasing variety and complexity of exercises. Furthermore, muscle-function tests should be included to give feedback to the patient and to evaluate how he or she is succeeding in rehabilitation. The patient should be reminded about personal goals to encourage persistence, that is, not to give up halfway through the rehabilitation but to continue with the exercises.

**Stage 4: Coping.** The physiotherapist encourages and gives support for a continuation with more demanding exercises outside the clinic. Furthermore, the physiotherapist reevaluates the rehabilitation with the patient and also the patient’s personal goals. For patients to be able to cope with their injury, it may be necessary to discuss more realistic goals or a new strategy for future physical activity.

**Study Population and Recruitment**

During a 6-month period, 40 patients age 16 to 55 years seeking acute medical care for a recently (1–2 wk) injured knee during sports activity were included in the study. All the patients were diagnosed as having an acute ACL injury based on a clinical examination performed by an experienced orthopedic surgeon. The patients had to be able to read and understand the Swedish language. None of the included patients had been treated for the ACL injury before entering the study, and the intention was to rehabilitate the knee with the goal of satisfactory knee function without surgery. Twenty patients were randomized into an experimental group and 20 patients into a control group. For randomization, the patients were asked to draw 1 of 40 envelopes (20 experimental and 20 controls).

The human research ethics committee of the Faculty of Medicine, Göteborg University, approved the study. Written informed consent was obtained, and patients’ rights were protected.

**The Intervention**

All the patients received rehabilitation training according to a standardized rehabilitation protocol (described in the Appendix), and all the patients were rehabilitated at the same sports-medicine clinic. Patients in the experimental group were treated by 1 of 3 physiotherapists who had received specific training in the clinical rehabilitation model (Figure 1). The specific training consisted of two 1-hour sessions on the self-efficacy concept and on the clinical rehabilitation model. The sessions were followed by several discussions. The clinical rehabilitation model used by the physiotherapists in the experimental group was not available for the physiotherapists in the control group. The physiotherapists treating the patients in the experimental group were given their patients’ self-efficacy scores after the initial and 4-, 6-,
and 12-month visits to the laboratory, whereas the 5 physiotherapists treating the patients in the control group were not given their patients’ self-efficacy scores.

**Main Outcome Measures**

**Self-Efficacy.** The Knee Self-Efficacy Scale (K-SES) was used to determine perceived knee-function self-efficacy. The K-SES has been reported to be a valid and reliable self-administered instrument with good responsiveness for patients with an ACL injury.

**Physical Activity.** Patients assessed their present physical activity level using the Tegner Activity Scale (Tegner scale). The Tegner scale is used for grading work and sports activities and was modified in 2000, when new sports such as floorball and snowboarding were added to the scale. The modified version of the Tegner scale was used in this study with the permission of the authors (Dr. Yelverton Tegner, personal communication).

Patients assessed their present level of intensity and frequency of participation in physical activity using the Physical Activity Scale (PAS), originating from a validated score for middle-aged and former athletes. The PAS was constructed by an expert group of experienced physiotherapists and orthopedic surgeons, which ensured good face validity of the scale. On the PAS, patients made their own assessment of how vigorously and frequently they participated in physical activity.

The PAS and the Tegner scale were used to assess both the patients’ preinjury physical activity and their present physical activity on each visit to the laboratory.

**Symptoms.** The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to assess patients’ knee function, symptoms, and associated knee problems. The KOOS is a self-administered, valid, and reliable instrument for patients with knee injuries and has good responsiveness for patients with ACL injuries. The subscores of knee-related sports and recreational activities (KOOS_SPORT) and knee-related quality of life (KOOS_QOL) were used.

**Locus of Control.** The Multidimensional Health Locus of Control (MHLC) is a valid and reliable measurement of people’s belief that their health is or is not determined by their behavior. Internal health locus of control refers to the belief that one’s outcome is directly related to one’s own behavior. External health locus of control refers to the belief that one’s outcome after injury or surgery is under the control of powerful others, and health locus of control by chance refers to the belief that one’s outcome is determined by fate, luck, or chance.

**Data Collection**

After the randomization procedure on the first visit to the laboratory, all patients were asked to complete forms on demographics. They also completed the K-SES, the Tegner scale for physical activity level before their injury and at the present time, and the PAS for the intensity and frequency of their participation in physical activity before their injury and at the present time. The MHLC was also completed at this time to measure patients’ belief in their health locus of control. A first visit to the rehabilitation clinic was arranged within a week of the visit to the laboratory.
The second visit to the laboratory was 4 months after the injury. At this time, all patients were asked to complete the K-SES, the Tegner scale, the PAS, and the KOOS.\textsuperscript{31} The third visit to the laboratory was 6 months after the injury. At this time, the K-SES, the Tegner scale, and the PAS at the current time were completed by the patients. The fourth visit to the laboratory was 12 months after the injury. At this time, all patients had finished their rehabilitation at the clinic. The K-SES, the Tegner scale, and the PAS at the present time were completed at this final follow-up, together with the KOOS and the MHLC.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, version 14.0 for Windows). Standard procedures were used for descriptive statistics.

Power analysis before the study revealed that 40 patients (20 in each group) would be sufficient to detect a difference between groups of approximately 15 points on KOOS\textsubscript{SPORT} with a power of 90\%, a 5\% significance level, and a standard deviation of 15.

The Mann–Whitney $U$ test was used to evaluate the differences between the groups, and the Wilcoxon signed-rank test was used to study differences within groups. All the significance tests were 2-tailed and conducted at the 5\% significance level.

Results

In total, the study finally comprised 24 patients, 12 in the study group and 12 in the control group. Three of the 40 patients were excluded from the study; 2 were subsequently diagnosed as having a posterior cruciate ligament injury, and 1 was diagnosed as not having a complete tear of the ACL. Thirty-seven patients, 18 women and 19 men, with a mean age of 30 years (range 16–53) remained in the study. No differences were found between the experimental group ($n = 18$) and the control group ($n = 19$) in terms of age, gender distribution, or physical activity level before injury. Three patients in the experimental group and 6 in the control group underwent an ACL reconstruction during the first year after injury and were consequently excluded from the study. Four of the remaining 28 patients chose not to participate or were unavailable for the 12-month follow-up. As a result, 24 patients, 12 in each group, were evaluated at the 12-month follow-up. All the results presented at the initial visit and 4-, 6-, and 12-month follow-ups therefore only relate to these 24 patients.

No significant differences were found between groups at the first visit or at the 12-month follow-up in terms of the outcome measures (Table 1).

Patients’ self-efficacy at present (K-SES\textsubscript{PRESENT}) increased significantly from the first visit to the 12-month follow-up in the experimental group ($P = .005$) and in the control group ($P = .003$; Figure 2, Table 1). No significant change was detected in either group in terms of patients’ future self-efficacy (K-SES\textsubscript{FUTURE}; Figure 3, Table 1).
Table 1  Outcome Measures, Mean (SD), Range

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group</th>
<th>Control Group</th>
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<tbody>
<tr>
<td></td>
<td>Preinjury</td>
<td>Recently injured</td>
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<tr>
<td>Self-efficacy</td>
<td></td>
<td></td>
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<tr>
<td>K-SES&lt;sub&gt;PRESENT&lt;/sub&gt;</td>
<td>2.9* (2.7)</td>
<td>7.5 (2.4)</td>
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<tr>
<td></td>
<td>0.3–9.3</td>
<td>3.3–9.8</td>
</tr>
<tr>
<td>K-SES&lt;sub&gt;FUTURE&lt;/sub&gt;</td>
<td>6.1 (1.4)</td>
<td>5.0 (2.8)</td>
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<tr>
<td></td>
<td>3.3–7.7</td>
<td>0–9</td>
</tr>
<tr>
<td>Physical activity</td>
<td></td>
<td></td>
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<tr>
<td>Tegner</td>
<td>6.8* (1.6)</td>
<td>3.9 (2.2)</td>
</tr>
<tr>
<td></td>
<td>3–9</td>
<td>1–7</td>
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<tr>
<td>PAS</td>
<td>2.9 (0.8)</td>
<td>2.4 (0.5)</td>
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<tr>
<td></td>
<td>2–4</td>
<td>2–3</td>
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<tr>
<td>Knee symptoms and knee quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOOS&lt;sub&gt;SPORT&lt;/sub&gt;</td>
<td>50.4* (19.8)</td>
<td>72.1 (18.8)</td>
</tr>
<tr>
<td></td>
<td>15–85</td>
<td>40–95</td>
</tr>
<tr>
<td>KOOS&lt;sub&gt;QOL&lt;/sub&gt;</td>
<td>50.5* (12.6)</td>
<td>64.1 (19.1)</td>
</tr>
<tr>
<td></td>
<td>25–69</td>
<td>38–100</td>
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<tr>
<td>Locus of control</td>
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<tr>
<td>internal locus</td>
<td>4.3 (0.8)</td>
<td>3.9 (0.7)</td>
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<tr>
<td></td>
<td>3.3–5.7</td>
<td>2.3–5.0</td>
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<tr>
<td>external locus</td>
<td>2.8 (0.6)</td>
<td>2.6 (0.8)</td>
</tr>
<tr>
<td></td>
<td>1.7–3.5</td>
<td>1.3–4.2</td>
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<tr>
<td>locus by chance</td>
<td>2.2 (0.8)</td>
<td>2.1 (0.7)</td>
</tr>
<tr>
<td></td>
<td>1.2–3.8</td>
<td>1–3.3</td>
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Abbreviations: K-SES, Knee Self-Efficacy Scale; Tegner, Tegner Activity Scale; PAS, Physical Activity Scale; KOOS<sub>SPORT</sub>, Knee Injury and Osteoarthritis Outcome Score, knee-related sports and recreational activities; KOOS<sub>QOL</sub>, Knee Injury and Osteoarthritis Outcome Score, knee-related quality of life.

*Significant ($P < .05$) difference between recently injured (or 4 months) and 12 months.
Figure 2 — Median, 5th, 25th, 75th, and 95th percentiles of patients’ perceived present knee-function self-efficacy (K-SES_{PRESENT}) when recently injured and at 4-, 6-, and 12-month follow-up. A significantly ($P \leq .05$) higher level of self-efficacy was seen in both groups at 4, 6, and 12 months than when recently injured.

Figure 3 — Median, 5th, 25th, 75th, and 95th percentiles and outliers (white circles) of patients’ perceived self-efficacy of future knee function (K-SES_{FUTURE}) when recently injured and at 4-, 6-, and 12-month follow-up. No significant differences in self-efficacy were seen between follow-ups in any of the groups.
Both groups, the experimental group \((P = .009)\) and the control group \((P = .04)\), had a significantly lower physical activity level \((\text{Tegner}_\text{PRESENT})\) at the 12-month follow-up than preinjury (Table 1). The level for physical intensity and frequency \((\text{PAS}_\text{PRESENT})\) in the control group, but not in the experimental group, was significantly lower \((P = .02)\) at 12 months than preinjury (Table 1). A significant increase \((P = .05)\) was detected for both groups on \(\text{KOOS}_\text{sport}\) and \(\text{KOOS}_\text{QOL}\) between the 4- and 12-month follow-ups (Table 1). No significant change in locus of control was detected in either group between the first visit and the 12-month follow-up, except for a significantly lower internal locus of control \((P = .03)\) in the control group (Table 1).

**Discussion**

The principal finding in the current study was that there was no significant difference between the patients in the experimental group and the control group. These results failed to support our research hypothesis that strategies to improve self-efficacy during rehabilitation would be beneficial for patients’ knee function.

Measuring patients’ knee-function self-efficacy is a new approach, making it potentially easier to understand and treat patients with an ACL injury. Recognition of the people who require help with their perception of knee-function self-efficacy may be important, and the \(\text{K-SES}\) can be useful for this purpose.\(^\text{27}\) In the current study, we chose to study the 2 factors of knee-function self-efficacy separately, \(\text{K-SES}_\text{PRESENT}\) and \(\text{K-SES}_\text{FUTURE}\). In our previous study of a larger population of patients with ACL injuries, the 2 \(\text{K-SES}\) factors were presented together as 1 score and were shown to improve significantly during rehabilitation.\(^\text{28}\) The determinants of \(\text{K-SES}_\text{PRESENT}\) and \(\text{K-SES}_\text{FUTURE}\) are somewhat different in that internal locus of control plays an important part in determining present but not future knee-function self-efficacy.\(^\text{5}\) Patients with a high level of present knee-function self-efficacy believe that their outcome after injury is to a large degree related to their individual behavior; in other words, they have a stronger internal locus of control than patients with low self-efficacy.\(^\text{5}\) In the current study, present self-efficacy improved significantly in both groups, but internal locus of control decreased in both groups during rehabilitation, with a significant decrease seen in the control group only. Patients with ACL injuries have been shown to have fewer perceived functional limitations when they believe that their health status is directly related to their own behavior, that is, controlled by internal locus.\(^\text{33}\) The importance of this maintenance of internal locus of control for ACL patients’ future knee function or for the patients’ opportunity to undergo a successful ACL reconstruction is interesting, but it calls for further study.

In the current study, no significant changes were detected during the rehabilitation for \(\text{K-SES}_\text{FUTURE}\), as was the case for \(\text{K-SES}_\text{PRESENT}\). Perceived \(\text{K-SES}_\text{FUTURE}\) thus appears to be more stable and not as easily influenced during rehabilitation as \(\text{K-SES}_\text{PRESENT}\). Self-efficacy is considered a *state*, that is, the way a person interprets a situation at a given moment in time. It is considered possible to influence and change a person’s psychological state. It therefore is reasonable to believe that using strategies to enhance knee-function self-efficacy in patients with ACL injury during rehabilitation may improve the outcome of rehabilitation. Even though knee-function self-efficacy is regarded as a state, there might also be some element of *trait* involved, that is, a personality characteristic, especially in perceived
K-SES_{FUTURE}. In addition, a person’s psychological trait is considered much more difficult to influence and change.

K-SES_{FUTURE} has also been shown to be a significant predictor of preoperative knee symptoms, knee quality of life, and physical functioning in patients who undergo ACL reconstruction. However, K-SES_{PRESENT} was preoperatively a significant predictor of patients’ returning to physical intensity and frequency (PAS) 1 year after ACL reconstruction. In the current study of patients who did not undergo surgery, a significant reduction was demonstrated for the control group but not for the experimental group in their physical activity intensity and frequency. There was also a tendency for higher K-SES_{PRESENT} in the experimental group, but no significant difference was observed compared with the control group.

All the test instruments were self-administered in the current study. Each patient had the opportunity to assess his or her knee symptoms and function, as well as how he or she felt about returning to physical activity and sports, with minimal influence from other people. At the group level, the patients did not return to their preinjury physical activity level. They did, however, consider themselves to have fewer symptoms and good knee function. This is in accordance with other studies, in which patients have undergone seemingly successful rehabilitation with or without ACL reconstruction but are unable or unwilling to return to their previous level of physical activity for different reasons, such as low previous or desired activity level, external health locus of control, and low perceived physical function, as well as insufficient mental planning. Heijne et al11 studied rehabilitation expectations in patients 1 year after ACL reconstruction and concluded that many patients became frustrated and had a tendency to give up on their rehabilitation because the effort that was needed was much greater than they had anticipated. However, Heijne et al11 also concluded that many patients increased their rehabilitation effort when they realized what was needed to return to physical activity. Bandura10 suggested that, when negative discrepancies are experienced between aspirations and actual achievement level, performers with high self-efficacy will increase their level of effort and persistence, whereas low-self-efficacy performers will give up.10 In other words, strong self-efficacy may be important for success, and enhancing self-efficacy in patients with low self-efficacy may therefore possibly increase the number of patients that will succeed with their rehabilitation.

The aim of the current study was to implement strategies to enhance knee-function self-efficacy, using a clinical rehabilitation goal-oriented model (Figure 1), to help patients with low knee-function self-efficacy and support patients with high knee-function self-efficacy. No differences were detected between the experimental and the control group for the outcome measures used in the current study.

One major difference between treatment groups was that the physiotherapists in the experimental group were given feedback on their patients’ K-SES scores after each visit to the laboratory, as well as prestudy training in the rehabilitation model. The study was designed in such a way that, if any differences between groups were detected, they would not be because of environmental differences. However, one limitation with the current study design was the possible contamination between groups, as well as between therapists, diluting the potential effect of the feedback given on the patients’ K-SES scores and the prestudy education of the physiotherapists in the experimental group. All the patients in the current study received rehabilitation at the same clinic with the same environment and resources for exercises.
To summarize, knee-function self-efficacy, as well as subjective satisfaction with knee symptoms and function, increased in both groups, as seen in the improved scores on the KOOS\textsuperscript{SPORT}. In the current study we also found that the control group had a significantly lower level of physical intensity and frequency at the 12-month follow-up than preinjury. Furthermore, the control group had a significantly lower internal locus of control at the 12-month follow-up than at the initial evaluation. However, because there were no significant between-groups differences for either physical activity or internal locus of control at either time point, and because similar trends were seen in the experimental group, these decreases cannot be clearly attributed to the treatment. It cannot be excluded in the current study that both types I and II errors occurred. The limitations of a small sample size and possible contamination between groups limit the possibility to draw more definite conclusions. The study has raised several new hypotheses to be evaluated in the future.

**Conclusion**

It can be concluded from the current study that there was no evidence that the clinical rehabilitation model with strategies to enhance self-efficacy led to a better outcome than the rehabilitation protocol used for the control group.

**Acknowledgments**

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**References**

Improving Knee-Function Self-Efficacy


Appendix: Rehabilitation Protocol

The rehabilitation protocol used at the Sportrehab Sports Medicine Clinic is criterion based and functionally oriented. The rehabilitation protocol was used for all the patients in the study. The various exercises were adjusted by the physical therapist for each individual specifically and then gradually guided through the rehabilitation program.

Phase 1—Lasts ~1–2 Weeks
- Patient status: Post-ACL injury
- Goal: Reduce knee-joint swelling
- Gait without crutches as soon as possible
- Quadriceps/Hamstring control
- Restore full knee extension
- Knee flexion to 90° or more
- Treatment program: Daily home exercises with range-of-motion exercises and gait control

Phase 2—Lasts ~4–6 Weeks
- Patient status: Reduced symptoms of knee-joint swelling and pain
- Goal: Full range of motion, normal gait pattern, increased motor control
- Return to work with light strain on the knee
- Treatment program: Exercises for daily rehabilitation
  Range-of-motion training, bicycling allowed when 110° knee flexion is achieved
  Functional training, gait exercises forward, backward, and sideways
Coordination and balance exercises
Pool exercises
Pain-free functional strength training, static and dynamic, open- and closed-chain exercises

**Phase 3—Lasts ~8–16 Weeks**
- Patient status: Further reduced symptoms and increased knee-joint tolerance
- Goal: Return to work with heavy strain on the knee and light recreational sports
- Treatment program: Exercise program for all the different qualities, 3 to 5 d/wk
  - Gradually increase strength training in open and closed chain
  - Increase functional training such as jogging, jumping, and sportlike exercises
  - Gradually increase outdoor activities such as cycling and running as a complement to rehabilitation for more general conditioning of the body

**Phase 4—Lasts ~3–6 Months**
- Patient status: Minimal symptoms and increased knee-joint tolerance to a gradually higher intensity of training
- Goal: Gradual return to sports activities
- Increase strength and stamina as tolerated
- Treatment program: Exercise program that gradually becomes more sports specific
  - Continue to increase strength training and activities for more general conditioning of the body
  - Continue to increase outdoor activities such as cycling, running, skiing, etc
  - Increase activities including cutting, twisting, and hopping for a gradual return to desired sports activity