

The relationship of physical exercise frequency and type of rehabilitation on knee function and readiness to return to sports after ACL reconstruction: A Literature Review

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ABSTRACT

Background: ACL injury is a common injury in the young adult population. The annual incidence of ACL injuries in the general population reaches 68.6 per 100,000 people. ACL injuries can be caused by physical contact or non-contact. Management of patients with ACL injuries can include non-operative and surgical approaches. ACL tears cause anatomical and physiological disorders and require a long healing process.

Objective: This study aimed to determine the relationship between the frequency of physical exercise and the type of rehabilitation on knee function and readiness to return to sports in patients after ACL reconstruction.

Methods: This study was a narrative review, which used secondary data in the form of research journals obtained from various scientific journal database sources on the internet. A search for literature articles was carried out online via PubMed and Google Scholar sites using the keywords "ACL Reconstruction," "Physical Exercise," "Rehabilitation," "Knee Function," and "Physical Readiness".

Results: The five reviewed literature showed a possible relationship between the frequency of physical exercise on knee function and readiness to return to sports after an ACL injury caused by increased physical activity carried out for seven days. There was a significant difference between home-based rehabilitation and supervised rehabilitation on knee function after one year of rehabilitation. Supervised rehabilitation showed a significant improvement in knee function compared to home-based rehabilitation.

Conclusion: There was a possible relationship between the form of rehabilitation on knee function and readiness to return to sports after ACL reconstruction, and a possible relationship between the frequency of physical exercise or the patient's physical activity and knee function, and can minimize the presence of kinesiophobia.

Keywords: ACL reconstruction, frequency of physical exercise, knee function, readiness to return to sport, type of rehabilitation.

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Introduction

An anterior cruciate ligament (ACL) is a ligament that plays an important role in the knee joint. The ACL consists of two different bundles whose names are adapted to their position concerning the tibia: the anterior-medial (AM) bundle and the posterior-lateral (PL) bundle.¹ The ACL stabilizes the knee by limiting translation of the anterior tibialis and limiting rotational forces in the tibiofemoral joint.² ACL injuries are among the common injuries in the young adult population.^{3,4} The annual incidence of ACL injuries in the general population reaches 68.6 per 100,000 people.^{2,5} Management of patients with ACL injuries can include non-

invasive approaches and surgery.⁶ ACL reconstruction is an ACL tissue graft operation that is used to restore stability and function to the knee joint, allowing the patient to return to their pre-ACL injury level of activity and prevent the occurrence of knee osteoarthritis in the future.⁷ ACL tears cause anatomical and physiological disorders and require a long healing.⁸ Knee pain symptoms, limited recreation, and quality of life (QoL) often occur more than five years after an ACL injury.⁹

According to the type of cognitive behavior related to fear of movement and repetitive injury, the patient's

opinion related to this fear can influence how active the patient is physically. Indirectly, the patient becomes afraid to move and anticipates movement, causing a decrease in physical activity.¹⁰ Individuals with a history of ACL injury spend less time doing physical activity and have fewer daily steps than healthy individuals.^{11,12} This physical inactivity can increase the risk of muscle atrophy. The risk of muscle atrophy cannot be avoided because there are no countermeasures such as exercise, nutrition, or pharmacological intervention. Therefore, it is recommended to carry out physical activity to maintain skeletal muscle, which includes muscle mass, muscle strength, and energy.¹³ Carrying out activities and leisure physical activity is considered an important domain of public health interventions and has been associated with the risk of cardiovascular disease and depressive symptoms.¹⁰

Regardless of surgical or non-surgical management, both procedures usually require a long rehabilitation.^{14,15} The rehabilitation approach includes special physiotherapy physical exercises, which generally cost much less than the surgical approach.⁶ With progressive rehabilitation measures using physical therapy in stages and according to the patient's condition, functional disorders can be overcome, functional stability can be achieved, and the patient can return to sports safely.^{16,17} The initial goal of rehabilitation after an ACL injury is to eliminate swelling and pain. Joints, restoring joint range of motion and movement patterns in basic movements such as walking refers to rehabilitation with exercise therapy. This exercise therapy includes components such as resistance training, neuromuscular training, high-level dynamic functional tasks, and sport-specific training.¹⁸ Strength and plyometric plus balance exercises are among the most effective ACL injury programs.¹⁹

After experiencing an ACL injury, knee function decreases due to instability of the knee joint, swelling, pain, reduced range of motion of the joint, reduced muscle function, and changes in movement patterns.¹⁸ Most people's knee with an ACL injury will never be felt as before the injury.⁹ Return to sport (RTS) status is a valuable indicator of clinical success. It can describe physical, psychological, and social conditions and motivate patients to return to their pre-injury lifestyle.²⁰ Reduced knee function is linked to a psychological dread of re-injury and decreased muscle power.²¹

Many individuals do not return to sport, adopt a physically inactive lifestyle, and fear experiencing re-injury.⁹ Physical and psychological factors both influence patients to return to sports.^{22,23} Psychological factors that influence the recovery of the pre-injury knee condition include cognitive responses such as perception behavior and affective responses such as mood, which are also related to the individual's response to the experience of injury, rehabilitation, and surgery as well as RTS status.²⁴

Based on the introduction above, this research aims to discover more about the relationship between frequency of physical exercise and type of rehabilitation on knee function and readiness to return to sports after ACL reconstruction.

Methods

This research used a literature review method. The preparation of this research used secondary data in the form of research journals obtained from various scientific journal database sources on the internet relating to the relationship between frequency of physical exercise and type of rehabilitation on knee function and readiness to return to sports after ACL reconstruction. A literature search was carried out online using PubMed and Google Scholar sites using the keywords "ACL Reconstruction," "Physical Exercise," "Rehabilitation," "Knee Function," and "Physical Readiness". At the online literature search stage, five pieces of literature were selected according to the predetermined inclusion and exclusion criteria. The inclusion criteria for this research were: 1) Literature published by a credible institution and 2) Literature published no more than the last ten years. The exclusion criteria in this study were: 1) Patients who did not experience an ACL injury, 2) Literature published more than the last ten years.

Results

Based on the results of the literature search, five pieces of literature were obtained related to the research title, which has been written in Table 1. Norte et al.'s research results stated that the TSK-17 test showed a low correlation between Godin, IKDC, triple hop distance, and crossover hop distance. When entered into a multiple regression model, more downward crossover hop distance ($R^2 = 0.109$, $\beta = 3.237$, $p = .004$) and KOOS ADL ($R^2 = 0.189$, $\beta = -.307$, $p < .001$) explained less kinesiophobia. Greater in the total cohort. The Godin leisure-time exercise value in this study showed $p < 0.001$.¹⁰

In research conducted by Rhim et al., the results stated that the supervised rehabilitation (SR) type of rehabilitation showed a significant improvement in knee function compared to home-based rehabilitation (HBR). In both groups, Lysholm values increased gradually over six months and one year (SR; 44.3 ± 8.7 , 71.3 ± 7.0 , and 87.3 ± 5.8 , $p < 0.001$; HBR; 46.3 ± 17.4 , 66.3 ± 16.8 , 75.6 ± 15.1 , $p < 0.001$). However, after undergoing rehabilitation for one year, the SR group showed higher Lysholm values than those Lysholm values in the HBR group (SR; 87.3 ± 5.8 vs. 75.6 ± 15.1 , $p = 0.016$).²⁵

Research conducted by Grevnerts et al. stated that the main reasons for choosing non-ACLR treatment were high activity demands and knee instability. Patients in the non-ACLR group were older and had lower pre-injury activity levels compared with patients in the ACLR acute phase ($p = 0.031$ and $p = 0.01$) and subacute phase ($p < 0.01$ and $p < 0.02$). There were no differences in age or pre-injury activity level between the non-ACLR and the acute phase ACLR group. There was no difference in patients reporting knee instability at baseline, four weeks, or three months after injury.²⁶

In research conducted by Yuliana and Kushartanti, it was stated that psychological readiness to return to sports after an ACL injury using the ACL-RSI questionnaire with a

Table 1. Summary of articles relevant to the physical exercise frequency and type of rehabilitation on knee function and readiness to return to sports after ACL reconstruction

Authors	Titles	Variables	Results
Grant E. Norte, Haley Solaas, Susan A. Lintasa, John Goetschius, Lindsay V. Slater, Joseph M. Hart (2019)	The relationship between kinesiophobia and clinical outcomes after ACL reconstruction differs by self-reported physical activity engagement.	Study design: cross-sectional Number of samples: 77 people Independent variables: a. post-op kinesiophobia, b. post-op objective lower extremity function, c. post-op subjective function. Dependent variables: IKDC, TSK-17, KOOS, & Godin Leisure Time- Exercise values Statistical test: <i>Chi-squared</i> test, <i>Mann-Whitney U</i> test, and <i>Spearman</i> correlations.	IKDC: p -value=.252, β =-.191, mean \pm SD = 81.6 \pm 11.5 TSK-17: p -value=.030, mean \pm SD= 32.9 \pm 6.0 KOOS pain: p -value=.196, mean \pm SD= 91.4 \pm 9.2 KOOS symptoms: p -value=.272, mean \pm SD = 83.8 \pm 13.1 KOOS activities of daily living : p -value =.983, β =-.307, mean \pm SD = 96.5 \pm 8.3 KOOS sports and recreation: p -value = .057, mean \pm SD = 81.5 \pm 16.8 KOOS QoL: p -value = .24, mean \pm SD = 66.7 \pm 20.7 Godin LeisureTime-Exercise : p -value = <.001, mean \pm SD = 72.7 \pm 34.9
Hye Chang Rhim, Jin Hyuck Lee, Seo Jun Lee, Jin Sung Jeon, Geun Kim, Kwang Yeol Lee, and Ki-Mo Jang (2020)	Supervised Rehabilitation May Lead to Better Outcomes than Home-Based Rehabilitation Up to 1 Year after Anterior Cruciate Ligament Reconstruction	Design studies:prospective observational Number of samples: 26 people Independent variable: knee function for six months - 1 year in the SR & HBR Group Variable bound: value questionnaire Statistical tests: SPSS & <i>Shapiro-Wilk</i> test	Lysholm 6 months SR: p <0.001, Lysholm score = 71.3 \pm 7.0 Lysholm 6 months HBR: p <0.001, Lysholm score= 66.3 \pm 16.8 Lysholm 1 year SR: p =0.016, Lysholm score = 87.3 \pm 5.8
Hanna Tigerstrand Grevnerts, PT, PhD, Sofi Sonesson, PT, PhD, Hakan Gauffin, MD, PhD, Clare L. Ardern, PT, PhD, Anders Stalman, MD, PhD, and Joanna Kvist, PT, PhD (2021)	Decision-Making for Treatment After ACL Injury From an Orthopedic Surgeon and Patient Perspective	Study design: prospective cohort Number of samples: 216 people Independent variable: knee instability Dependent variable: parametric tests & non-parametric tests Statistical tests: SPSS, <i>chi-Square</i> test, and <i>Mann-Whitney U</i> test	Non-ACLR patients had lower pre-injury activity levels compared with acute-phase patients (p <0.01) Non-ACLR patients had lower pre-injury activity levels compared to sub-acute phase patients (p < 0.02)

Ela Yuliana and Wara
Kushartanti
(2020)

Knee function and psychological
readiness after ACL injury,
operative and non-operative
treatment

Study design: a cross-sectional survey
Number of samples: 30 people
Independent variables: a. functional knee,
b. psychological readiness
Dependent variable: IKDC 2000 score and ACL-RSI
Statistical test: descriptive statistics

ACL-RSI: Sig. 0.713, $p > 0.05$
IKDC 2000: Sig. 0.110, $p > 0.05$

Shelby E. Baez, Matthew C.
Hoch, Johanna M. Hoch (2019)

Psychological factors are
associated with a return to pre-
injury levels of sport and physical
activity after
ACL reconstruction

Study design: cross-sectional
Number of samples: 40 people
Independent variable: ACLR patients
Dependent variable: RTS results (yes/no)
Statistical tests: SPSS software, *Chi*-square, and *t*-test

Non-RTS patients = 25 people
Significant difference between RTS and non-RTS
patients ($p=0.00$), $\beta = -1689.7$ (-3032.6 to -346.7)

ACLR, anterior cruciate ligament reconstruction; IKDC, international knee documentation committee; TSK-17, the Tampa scale of kinesiophobia-17; KOOS, knee injury, and osteoarthritis outcome score; ACL-RSI, the ACL return to sport after injury; RTS, return to sport; SPSS, statistical package for the social sciences.

score obtained was $p > 0.05$ and knee functional skills using the IKDC 2000 questionnaire with a score of $p > 0.05$ between subjects through operative and non-operative treatment have not revealed any significant differences.⁵

Research conducted by Baez et al. stated that psychological factors, especially fear related to injury and self-efficacy, were linked more significantly to functional outcomes with a return to sports status and the level of physical activity undertaken. Of these, 25 people (62%) did not return to exercise, and another 29 did not achieve an average of 10,000 steps per day. There was no significant difference between the RTS and non-RTS groups for current physical activity levels on the Tegner results ($p = 0.00$).²

Discussion

After experiencing an ACL injury, many patients do not return to physical activity and adopt a lifestyle with decreased physical activity. They are afraid of re-injury after an ACL injury. Carrying out rehabilitation measures after an ACL injury can restore physical activity levels and daily life activities. Rehabilitation through exercise therapy can also reduce the swelling and joint pain commonly felt by ACL injury patients. Repair can help improve a person's psychological response, but the fear of re-injury (kinesiophobia) can increase and can become a prominent emotion when returning to sport.²⁷

It was reported by Norte et al. that patients who were less physically active showed greater kinesiophobia and lower overall health than patients who were more physically active, which was supported by a combination of several factors such as intense physical activity involvement, kinesiophobia high levels of, as well as poor overall health perceptions related to whether or not the patient returns to sports.¹⁰ The type of rehabilitation management chosen by the patient, both HBR and SR, can improve the patient's knee function. However, research by Rhim et al. stated that there was a significant improvement in the knee function of patients in the SR group, as seen from the results of the Lysholm questionnaire scores after one year of rehabilitation. With the quite large difference in Lysholm values between the HBR and SR groups, it is stated that knee function in the SR group is better than in the HBR group.²⁵ ACLR and the decision of whether or not they return to sports. In this case, the physiotherapist is referred to as the main provider of rehabilitation management who is considered a motivator and guide in delivering evidence-based care to facilitate the patient's return to sports. The physiotherapist has the most valuable task when determining the return to the sport because he can facilitate appropriate discussions with other multidisciplinary team members, which can also demonstrate the physiotherapist's role as a provider in the rehabilitation period.²⁸

The main reason for undertaking ACL reconstruction (ACLR) is the patient's desire to return to highly demanding activities. Research by Hanna Tigerstrand Grevnerts et al. found that patients with lower activity levels and older age

chose not to undergo ACLR. In contrast, patients with higher activity and younger generations chose to undergo ACLR. After carrying out the ACLR procedure, his knee function returned to close to the normal function of 90%. However, there was still a decrease in quality of life related to knee function after five years of carrying out the ACLR procedure. With this, it can be stated that there have been no significant differences between ACLR and non-ACLR patients related to knee function.²⁵ Supported by research conducted by Yuliana and Kushartanti, which summarizes that there are no significant differences related to knee function and readiness to return to sports in patients. ACLR and non-ACLR. In patients with ACLR and non-ACLR interventions who had similar or higher levels of activity compared to before the injury, it was found that the IKDC 2000 score and ACL-RSI score were higher, but in patients who had lower physical activity than before the injury. Higher ACL-RSI scores evidence psychological responses related to willingness to return to exercise are higher, and vice versa.⁵

In this research, the author found several things that were obstacles and weaknesses of this research. Obstacles and disadvantages in this research include the limited number of journals that discuss the frequency of physical exercise after ACLR and the difficulty of accessing several relevant journals. However, these obstacles and weaknesses can be overcome properly to complete this research on time. It is hoped that this research will be useful for students and physiotherapists so that they can broaden their knowledge and determine the frequency of physical exercise and the type of rehabilitation that suits the patient's condition.

Conclusion

Based on the reviewed literature found that there was a relationship between the frequency of physical exercise on knee function and readiness to return to sports after ACL reconstruction, and there was a significant difference between home-based rehabilitation and supervised rehabilitation on knee function and readiness to return to sports after ACL reconstruction.

Conflict of interest

There are no conflicts of interest in this study.

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Ethical consideration

The researchers conducted a literature review on the subject. There was no need for ethical approval because the study just evaluated existing data and did not involve human subjects or collect new data.

Author contribution

NKAKD and IPGSA conceptualized the research design, conducted a literature search, also prepared and edited the paper; IP conducted a literature search and reviewed the paper.

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