

Factors affecting changes in lower extremity function and psychology of patient before and after anterior cruciate ligament reconstruction: a literature review

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ABSTRACT

Background: The Anterior Cruciate Ligament (ACL) is a type of ligament situated within the human knee joint, connecting the femur to the tibia. It plays a crucial role in maintaining joint stability and controlling the anterior movement of the tibia relative to the femur. ACL reconstruction is a surgical procedure to connect the ACL ligament to restore stability to knee function. In performing reconstruction, factors will affect the reconstruction results, one of which is the provision of rehabilitation, which will affect the patient's knee injury and osteoarthritis outcome score (KOOS). Another factor, kinesiophobia, can affect psychologically, so patients tend to feel afraid to move.

Objective: To determine whether factors affect lower extremity function and psychology before and after anterior cruciate ligament reconstruction (ACLR) surgery.

Methods: The study used a literature review design where the secondary data from published literature was reviewed and reported as the study topic. Literature searches were conducted online from PubMed and Google Scholar, using the keywords "ACL," "lower extremity function," "psychological," and "kinesiophobia" by combining the Boolean Operators "OR" and "AND."

Results: Based on the results of the journal review, it was found that there are factors that affect lower extremity function and psychology before and after reconstruction. Providing rehabilitation before and after ACLR and a low level of kinesiophobia can affect better reconstruction results.

Conclusion: Based on the review results, it might be concluded that several factors influence changes in lower extremity function and psychology. Factors such as the provision of pre and postoperative rehabilitation can affect the patient's lower extremity function. At the same time, factors such as kinesiophobia can affect the patient's psychology so that it has an impact on the ability to carry out daily activities.

Keywords: ACL, anterior cruciate ligament reconstruction, kinesiophobia, lower limb function, psychological.

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Background

Worldwide, among young adults, injuries to the anterior cruciate ligament (ACL) are quite common.¹ The anterior cruciate ligament (ACL) was one of the ligaments found in the knee joint. This ligament has a significant role in maintaining knee stability so that the tibia is not shifted forward.² The ACL has the potential to be injured, which is characterized by a rupture that causes the patient to lose the stability of the knee function. It can cause joint instability. Recently, there have been many cases of ACL injuries, more

than 200,000 cases per year.² The most common ACL injury is a non-contact injury with more than 70% of cases, which is caused by rapid deceleration of the lower extremity accompanied by a muscular contraction of the quadriceps and a change in direction or hyperextended knee landing.^{2,3} Contact injuries are less common and have only been reported in 28% of cases.² After the injury, the patient will undergo a physical and supporting examination, which will be used as a consideration for reconstruction and to determine the technique suitable for the patient's condition.

Anterior cruciate ligament reconstruction (ACLR) is performed by replacing the ACL ligament using tendon tissue to restore functional stability of the knee.¹ ACLR is a joint orthopedic surgery with more than 400,000 procedures completed annually in the United States.⁴ ACLR aims to restore knee function to return to previous activities, prevent further injury, and improve quality of life for an extended period.^{3,5} Treating an ACL injury with reconstruction requires a lot of consideration, so it is not uncommon for patients to choose to delay ACLR. Reconstruction performed 3-6 weeks after injury is referred to as acute or early reconstruction, where early reconstruction will have better clinical outcomes and stability.⁶ Whereas delayed ACLR is usually performed 6-11 months from injury.⁶ Some studies recommend early ACLR as delaying reconstruction may increase the chance of chondral and meniscus injury and may lead to loss of muscle strength.⁶ Delaying ACLR can be due to conservative management. Still, this method is not recommended for patients with high sports activity, so surgery must be performed, especially in athletes who still want to be active.³

The occurrence of an ACL injury can lead to decreased lower extremity function. Impaired limb function is characterized by dynamic knee instability and pain, limited range of motion, quadriceps strength deficits, decreased functional performance, neuromuscular dysfunction, and biomechanical maladaptations that can lead to inferior outcomes and increased risk for a second injury.⁷ In addition, an ACL injury can also impact one's psychological health due to the fear of re-injury and activity limitations due to functional impairment.⁸ In a study on return to sport, patients did not return to sport because they lacked confidence in their knees.⁹ So psychological readiness is also the most essential thing to be able to restart activities before injury. Psychological interventions during rehabilitation can improve patients' readiness to return to sports or pre-injury activities.¹⁰

Many factors will affect lower limb function and psychology both before and after ACLR surgery, namely the provision of combined rehabilitation, age, gender, preoperative pain level, *kinesiophobia*, body mass index, and duration of time to reconstruction. It was found that older patients had decreased muscle function and strength, lost flexibility, and experienced joint stiffness compared to younger patients.¹¹ Also, patients with a higher body mass index tend to have higher levels of fear and anxiety, which will affect the patient's psychology after surgery. In addition, gender can also have an effect; patients with male gender will have a higher international knee documentation committee (IKDC) score after surgery compared to female patients, but male patients have a higher rupture rate than female patients.^{12,13,14}

Based on the above background, the study was conducted with the aim of finding out more about the factors that influence lower extremity and psychological changes before and after ACL reconstruction surgery. In addition, this study is also essential to understand the results of surgery, as well as to improve the interventions provided. The

importance of this study in Indonesia is that it can provide specific information based on culture, environment, and medical care that affects the outcome of reconstruction and post-reconstruction recovery. The researcher hopes that the results of this study will be helpful for physiotherapy students and other readers to add insight and determine how to provide appropriate rehabilitation while still considering the above factors in patients both before and after ACLR surgery.

Methods

The research method used a literature review study in which the extracted the secondary data from research journals that have been published and obtained from various scientific journal databases on the internet related to factors that affect changes in lower extremity function and psychological before and after anterior cruciate ligament reconstruction. The search for literature articles was carried out online through searches on PubMed and Google Scholar using the keywords "ACL," "function," "psychological," "pre-operative," and "post-operative" by combining the boolean operators "or" and "and." Literature was selected based on inclusion and exclusion criteria. The inclusion criteria used in this literature review are 1) Literature was published from credible institutions and 2) The literature reviewed was published from the last ten years. The exclusion criteria in this literature review are: 1) Patients who did not perform ACLR, 2) Journals was published more than the last ten years. The literature used in the literature review has fulfilled the criteria set by the author.

Results

From the results of the literature that the author has found, five journals were relevant to the title of this research, which have been included in **Table 1**.

In Grindler et al.'s study, once obtained, the covariates used to evaluate the study were gender, age, months from injury to surgery, ACL grafting, cartilage injury in ACLR, and meniscus injury in ACLR.¹⁵ The rehabilitated group had a significantly higher preoperative KOOS; an additional analysis of the 2-year postoperative KOOS was performed with preoperative KOOS added as a covariate. Low or high preoperative scores were defined as scores below or above the preoperative median score (cutoff points: Pain: 77.78, symptoms: 75, activities of daily living (ADL): 91.18, Sports: 45, quality of life (QoL): 37.5).

In the study of Gulcan Harput et al, it was found that there was no significant time based on group interaction for body mass.¹⁶ Functional scores were found to be better in group 1, the group with smaller body mass, compared to group 2, the group with larger body mass. Body mass was more significant in group 2 compared to group 1 after surgery ($p < 0.001$). There was no difference in quadriceps strength between groups at one month after surgery ($p = 0.38$). Quadriceps strength was more significant in group 1 at three months ($p = 0.04$) and six months ($p < 0.001$) after surgery when compared to group 2. There were significant differences between the groups in *one-leg hop for distance*

test (OLHT) ($p=0.04$, $t=2.08$) and vertical jump (VJ) ($p=0.04$, $t=2.09$) and star excursion balance test posteromedial (SEBTPM) ($p=0.04$, $t=2.07$) and posterolateral (PL) ($p=0.04$, $t=2.06$) involved limb reach distances and IKDC scores ($p=0.04$, $t=2.09$).¹⁶

In Theunissen et al.'s study, it was found that based on multivariable regression analysis, there was a positive correlation between four predictor variables (prolonged injury-to-surgery time, high preoperative pain level, male gender, and low body mass index) and high levels of *kinesiophobia* at three months postoperatively ($R^2 = 0.384$, $p = 0.02$).¹⁷ The prevalence of *kinesiophobia* was seen from preoperatively, three months postoperatively, and 12 months postoperatively in patients undergoing ACLR. The strongest correlation was seen with *injury-to-surgery time* (ITST) ($R^2 = 0.20$, $\beta = 0.85$, $p < 0.01$). The regression coefficient of 0.85 indicates that a delay of 1 month without surgery correlates with an increase of 0.85 points on the *Tampa Scale of Kinesiophobia* (TSK). Preoperative pain level was identified as the second strongest predictor of postoperative *kinesiophobia* ($R^2 = 0.11$, $\beta = -0.13$, $p < 0.01$). Univariable linear regression analysis on a subset of patients who completed TSK preoperatively and three months postoperatively revealed preoperative *kinesiophobia* as a strong predictor of postoperative *kinesiophobia* ($R^2 = 0.35$, $\beta = 0.62$, $p < 0.01$).¹⁷

In Stephanie et al.'s study, it was found that treatment with exercise therapy alone was a prognostic factor for fewer knee symptoms compared to early reconstruction plus exercise medicine (regression coefficient 10.1, 95% CI 2.3 to 17.9).¹⁸ Base meniscus lesions were associated with worse sports/recreational function (-14.4, 95% CI -27.6 to -1.3), and osteochondral lesions were associated with worse QoL (-12.3, 95% CI -24.3 to -0.4) after early reconstruction plus exercise therapy. In the same group, undergoing additional non-ACL surgery and a worse baseline KOOS score were prognostic for worse outcomes on all KOOS subscales. After delayed reconstruction, initial meniscus damage was a prognostic factor for pain (14.3, 95% CI 0.7 to 27.9).¹⁸

In Shunsuke et al.'s study, the proportion of patients whose scores did not change positively from pre-ACLR to 6 months post-ACLR was higher for the TSK (38%) and ACL-RSI (38.0%) scores than the IKDC score (6.3%).¹⁹ Furthermore, the percentage change in the IKDC score was not associated with changes in the TSK and ACL-RSI scores. The ACL-RSI score increased significantly from pre-ACLR to 6 months post-ACLR. IKDC results: pre-op, mean, \pm standard deviation, 68,5 \pm 10,1; post-op, 82,1 \pm 10,2. TSK: pre-op, standard deviation, 26,0 \pm 3,6; post-op, 23,6 \pm 4,4. ACL-RSI: pre-op, represent \pm standard deviation, 58,1 \pm 17,9; post-op, 64,4 \pm 17,6.¹⁹

Discussions

Patients with ACL injuries before and after reconstruction will have different extremity and psychological functions. Generally, after someone has reconstruction, several things cause changes. Several factors

may play a role, such as the provision of rehabilitation before and after reconstruction, delayed ACLR, BMI, *kinesiophobia*, gender, and age.

Providing rehabilitation before and after ACLR will show better patient-reported outcomes preoperatively and two years postoperatively compared to patients receiving usual care.¹⁵ The provision of rehabilitation before and after ACLR also has a vital role to play in improving lower limb function, where it is said that patients who receive rehabilitation before and after ACLR will have a higher KOOS score compared to patients who only perform reconstruction without providing rehabilitation.¹⁵ This is because successful rehabilitation after ACLR can be optimized when muscle strength and range of motion deficits are reduced.¹⁵ Subjective knee function in one study showed significant positive changes after ACLR and rehabilitation.^{19,20} Another journal also said that providing rehabilitation before surgery for five weeks with monitoring can significantly restore knee joint function. So, it can be concluded that doing rehabilitation immediately after injury and after ACLR is essential and can provide significant benefits in the postoperative period.^{21,22}

Delaying ACLR and managing ACL rupture with exercise therapy has a positive association as the provision of exercise therapy instead of early reconstruction may change prognostic factors for 5-year outcomes in a more positive direction.¹⁸ Poorer KOOS scores, sport/recreation, and QoL scores after ACL rupture may benefit from starting exercise therapy before considering ACLR. Starting exercise therapy will enable acute signs of injury to subside before considering ACLR, which is beneficial to long-term outcomes.¹⁸ However, some journals suggest that there is no clinical difference in terms of range of motion or functional outcomes between early ACLR and delayed ACLR with rehabilitation. Patients with early reconstruction will have comparable knee function after one year but will have a higher rate of *re-rupture* or contralateral rupture.²³

The higher BMI had lower normalized quadriceps strength gains, poorer jumping and balance performance, and lower IKDC scores compared to individuals with normal BMI after ACLR.¹⁶ Patients with higher BMI had a longer functional recovery rate than patients with normal BMI. This is due to excessive pressure on the knee, which causes degenerative changes that will affect knee function.¹⁶ In addition, compression due to high BMI can also increase the risk of injury. Another journal states that patients who have a BMI of more than 25 kg/m² will have an increased risk of ACL revision after primary reconstruction.²⁴

Factors associated with psychological changes in patients, such as *kinesiophobia*, were also found.^{17,19} The prevalence of *kinesiophobia* decreased during postoperative rehabilitation, but high *kinesiophobia* was still present in most patients after ACLR.¹⁷ Experiencing more difficulty in performing daily physical activities due to *kinesiophobia* will be related to a more negative psychological response where patients feel pain, so they avoid active movements that will cause repeated injuries.¹⁷ In Shunsuke et al.'s study, the

Table 1. Five articles on lower limb functions and psychological readiness before and after anterior cruciate ligament reconstruction

Author	Title	Methods	Results
H. Grindem, PT, PhD, LP. Granan, MD, PhD, MA. Risberg, PT, PhD, L. Engebretsen, MD, PhD, L. Snyder-Mackler, PT, ScD, SCS, ATC, FAPTA, and I. Eitzen, PT, PhD. (2015) ¹⁵	How does a combined pre-operative and post-operative rehabilitation program influence the outcome of ACL reconstruction two years after surgery? A comparison between patients in the Delaware-Oslo ACL Cohort and the Norwegian Knee Ligament Registry	Study design: cohort study. Total sample size: 370 people. Independent variables: a. pre-op + post-op intervention; b. post-op intervention. Dependent variable: KOOS value after two years of operation. Statistical tests: <i>chi-square test</i> , <i>Mann-Whitney test</i> , and <i>t-test</i> . Measurement tools: KOOS Validity: Cronbach alpha 0.84-0.97. With the confirmation of testing hypothesis: 86%. ²⁶	<i>There is a relationship between the provision of pre-operative and post-operative combined rehabilitation p<0.001</i> <i>KOOS Pain: pre-op, \hat{a} = 11.5 (95% CI= 8.0-15.0); post-op, \hat{a} = 7.6 (95% CI= 4.4-10.9).</i> <i>KOOS symptoms: pre-op, \hat{a} = 9.5 (95% CI= 5.8-13.1); post-op, \hat{a} = 11.9 (95% CI= 8.0-15.8).</i> <i>KOOS ADL: pre-op, \hat{a} = 10.0 (95% CI= 6.5-13.3); post-op, \hat{a} = 5.5 (95% CI= 2.8-8.3).</i> <i>KOOS sports: pre-op, \hat{a} = 24.6 (95% CI= 19.0-30.2); post-op, \hat{a} = 17.7 (95% CI= 12.1-23.2).</i> <i>KOOS QoL: pre-op, \hat{a} = 13.8 (95% CI= 9.9-17.8); post-op, \hat{a} = 10.8 (95% CI= 5.9-15.7).</i>
Adam VanZile, Malcolm Driessen, Patrick Grabowski, Hanni Cowley, Thomas Almonroeder (2022)	Deficits in Dynamic Balance and Hop Performance Following ACL Reconstruction Are Not Dependent on Meniscal Injury History	Study design: <i>Cross-sectional</i> . Sample size: 34 athletes Dependent variable: <i>dynamic balance</i> and <i>hop performance</i> measured by YBT and SLHT Independent variables: absence of a history of concomitant meniscus injury and type of surgical intervention Statistical test: YBT and SLHT	YBT; anterior [F(2, 31) = 0.26; p = 0.05]. 0.77], posteromedial [F(2, 31) = 0.86; p = 0.43], or posterolateral [F(2, 31) = 0.41; p = 0.67]. SLHT: [F(2, 31) = 0.04; p = 0.96] or <i>triple hop test distances</i> [F(2, 31) = 0.03; p = 0.97].
Gulcan Harput, PT, PhD, Hande Guney-Deniz, PT, PhD, Hamza Ozer, MD, Gul Baltaci, PT, PhD, and Carl Mattacola, PhD, ATC (2020) ¹⁶	Higher Body Mass Index Adversely Affects Knee Function After Anterior Cruciate Ligament Reconstruction in Individuals Who Are Recreationally Active BMI	Study design: prospective, controlled study. Total sample size: 91 people. Independent variables: a. BMI between 18.5-24.9 kg/m ² ; b. BMI >24.9 kg/m ² . Dependent variable: IKDC score. Statistical tests: <i>Kolmogorov-Smirnov test</i> and <i>Student's t-test</i> . Measurement tool: IKDC Validity: Cronbach alpha 0.90. With confirmation of the testing hypothesis: 100%. ²⁷	Group 2: <i>p</i> = 0.92; group 1: <i>p</i> = 0.001. Group 2 body mass > group 1: <i>p</i> < 0.001 Muscle strength: <i>p</i> = 0.003 Functional results: OLHT (<i>p</i> = 0.04, <i>t</i> = 2.08); VJ (<i>p</i> = 0.04, <i>t</i> = 2.09); SEBTPM (<i>p</i> = 0.04, <i>t</i> = 2.07); PL (<i>p</i> = 0.04, <i>t</i> = 2.06); IKDC (<i>p</i> = 0.04, <i>t</i> = 2.09). IKDC value of group 1 = 84.39 ± 12.81; group 2 = 76.97 ± 13.51

<p>W. W. E. S. Theunissen, M. C. van der Steen, W. Y. Liu, R. P. A. Janssen (2020)¹⁷</p>	<p>Timing of anterior cruciate ligament reconstruction and preoperative pain are essential predictors of postoperative kinesiophobia</p>	<p>Study design: retrospective study. Total sample size: 102 people. Independent variables: a. duration of time to surgery; b. pain level. Dependent variable: kinesiophobia score after surgery. Statistical tests: Unpaired <i>t-test</i>, <i>Chi-square</i> test, and <i>Kolmogorov-Smirnov test</i>. Measurement tool: TSK Validity: TSK: Cronbach alpha 0.76.²⁸</p>	<p>Correlation of ITST with kinesiophobia ($R^2 = 0.20$, $\beta = 0.85$, $p < 0.01$). Correlation of preoperative pain level with postoperative kinesiophobia ($R^2 = 0.11$, $\beta = -0.13$, $p < 0.01$). TSK pre-op and 3 months post-op with pre-op kinesiophobia ($R^2 = 0.35$, $\beta = 0.62$, $p < 0.01$). Table 1. Five articles on lower limb functions and psychological readiness before and after anterior cruciate ligament reconstruction</p>
<p>Stephanie R Filbay, Ewa M Roos, Richard B Frobell, Frank Roemer, Jonas Ranstam, L Stefan Lohmander (2017)¹⁸</p>	<p>Delaying ACL reconstruction and treating with exercise therapy alone may alter prognostic factors for 5-year outcome: an exploratory analysis of the KANON trial.</p>	<p>Study design: KANON trial, Prospective RCT. Total sample size: 118 people. Independent variables: a. early reconstruction + exercise therapy; b. late reconstruction + exercise therapy; c. exercise therapy only. Dependent variable: KOOS value after five years of operation. Using data from the KANON trial. Validity: Cronbach alpha 0.84-0.97. With the confirmation of testing hypothesis: 86%.²⁶</p>	<p>Exercise therapy alone: OR= 10.1 (95% CI= 2.3-17). KOOS sport/recreation $\hat{a} = -14.4$ (95% CI= -27.6-(-1.3)). KOOS QoL early reconstruction+exercise therapy $\hat{a} = -12.3$ (95% CI= -24.3-0.4) Delayed reconstruction+exercise therapy $\hat{a} = 14.3$ (95% CI= 0.7-27.9)</p>
<p>Shunsuke Ohji ,Junya Aizawa, Kenji Hirohata, Takehiro Ohmi, Sho Mitomo, Hideyuki Koga and Kazuyoshi Yagishita (2022)¹⁹</p>	<p>Changes in subjective knee function and psychological status from preoperation to 6 months post anterior cruciate ligament surgery reconstruction.</p>	<p>Study design: longitudinal observational Total sample size: 32 people Independent variables: a. changes in knee function pre-op+post-op; b. changes in psychological status pre-op+post-op. Dependent variable: IKDC, TSK, and ACL-RSI values Statistical tests: a priori samples were performed with G* Power software. Measurement tools: IKDC, TSK, ACL-RSI IKDC validity: Cronbach alpha 0.90. With confirmation of the testing hypothesis: 100%.²⁷ Validity: TSK: Cronbach alpha 0.76.²⁸ Validity of ACL-RSI: Cronbach alpha 0.96.²⁹</p>	<p>Cohen's d value IKDC-SKF= 1.38; TSK= 0.39; ACL-RSI= 0.34. IKDC-SKF: pre-op, mean±standard deviation, 68.5± 10.1; post-op, 82.1± 10.2. TSK: pre-op, mean± standard deviation, 26.0± 3.6; post-op, 23.6± 4.4. ACL-RSI: pre-op, mean± standard deviation, 58.1± 17.9; post-op, 64.4± 17.6</p>

ACL-RSI, anterior cruciate ligament return to sport after injury scale; β , beta; BMI, body mass index; IKDC, international knee documentation committee; ITST, injury-to-surgery time; KOOS, knee injury, and osteoarthritis outcome score; OLHT, one-leg hop for distance test; OR, odds ratio; PL, posterolateral; QoL, quality of life; SEBTPM, star excursion balance test posteromedial; TSK, Tampa scale of kinesiophobia; VJ, vertical jump.

psychological state of some participants did not change positively before ACLR until six months after ACLR.¹⁹ Based on these results, it may be necessary to evaluate not only knee function but also the psychological state of each patient before surgery and observe the changes. A previous study also said that patients with ACL injuries who underwent preoperative structured rehabilitation to improve quadriceps muscle strength and other functions would have significantly decreased TSK scores after rehabilitation.¹⁹

Another factor is gender. Journals discussing this matter show no significant difference between patients' KOOS and IKDC scores. Differences were only seen in KOOS *sport* and QoL scores, but these differences did not reach clinical importance.^{13,14} Christopher Kuenze et al.'s study reported that men showed better IKDC and KOOS *pain* scores than women. Still, the journal concluded that men and women had similar levels of knee function, fear of movement, and readiness to return to sport.²⁵

There is also the age factor, where one journal said there was no statistically significant difference in ACLR results based on age. Younger patients are more likely to have poor psychological well-being due to high expectations for recovery, which can lead to disappointment if the results are not satisfactory.^{11,12} It is said that young patients are a risk factor for contralateral injury as they are more likely to return to high-risk activities.¹¹ A reduced risk of contralateral ACL injury is found in older patients as they are less physically demanding and have higher satisfaction with their knee function.¹¹ So, it can be concluded that the prognosis of ACL reconstruction is not always dependent on age.

In this research, the author realizes that several things are weaknesses and obstacles of this research. The barriers in this research include the author having difficulty in finding journals that match the research title. Besides that, the author also experienced problems in accessing several journals that had been found. However, this can be handled to complete this research on time.

Conclusion

Based on the literature collected, the results of the above studies indicate that there are factors that will affect lower limb function and psychology. The provision of pre and postoperative reconstruction is said to improve knee function, delayed reconstruction can have positive or negative changes in limb function, high BMI can also affect knee function, and higher levels of *kinesiophobia* will affect psychological readiness to return to previous activities. Other factors, such as age and gender, did not significantly affect post-ACLR. Based on the research that the authors have done, the authors provide several suggestions, namely that future researchers can look for other factors that might affect the results of ACLR, and future researchers can apply this research framework in other studies.

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Conflict of interest

The author states there is no potential conflict of interest in connection with the research, authorship and/or publication of this article.

Author contributions

NNRP conducted a literature search, and prepared and edited the paper; IPGSA conceptualized the research design, conducted a literature search, and prepared and edited the paper, and AAGESU and IKYF also conducted a literature search and reviewed the text

Ethical consideration

This review study used published articles that are accessible. Thus, this study did not require any informed consent or ethical consideration

References

1. Adhitya IPGS, Manuaba IBAP, Suprawesta L, Mauludina YS, Marufa SA. Patient characteristics of non-operative anterior cruciate ligament injury associated with poor knee functions on activities of daily living: A cross-sectional study. *Bali Med J.* 2020;9(3):608–13.
2. Gusma KC. Survei Penyebab Terjadinya Cedera Anterior Cruciate Ligament (Acl) Pada Komunitas Acl Indonesia Cabang Jateng Diy. *Unnes Journal of Sport Sciences.* 2022;6(2):0
3. Monk AP, Davies LJ, Hopewell S, Harris K, Beard DJ, Price AJ. Surgical versus conservative interventions for treating anterior cruciate ligament injuries. *The Cochrane database of systematic reviews.* 2016;4(4):1-30
4. Larose G, Leiter J, Peeler J, McRae S, Stranges G, Rollins M, et al. Quality of life during the wait for ruptured anterior cruciate ligament reconstruction: a randomized controlled trial. *Canadian Journal of Surgery.* 2022;65(2):269-274.
5. Zavitri LK. Rehabilitasi Pasca Operasi Cedera Anterior Cruciate Ligament (ACL). *Unram Medical Journal.* 2022;11(3):1101-1106.
6. Kresna IPD, Hernugrahanto KD, Wardhani RIL, Utomo DN. Comparison of Functional Outcome After Early and Delayed Anterior Cruciate Ligament Reconstruction: A Systematic Review. *Qanun Medika.* 2022;6(2):141-163.
7. Logerstedt D, Di Stasi S, Grindem H, Lynch A, Eitzen I, Engebretsen L, et al. Self-Reported Knee Function Can Identify Athletes Who Fail Return-to-Activity Criteria up to 1 Year After Anterior Cruciate Ligament Reconstruction: A Delaware–Oslo ACL Cohort Study. *Journal of Orthopaedic & Sports Physical Therapy.* 2014;44(12):914-923.
8. Yuliana, E, Kushartanti, DW. Fungsional lutut dan kesiapan psikologis pasca cedera ACL penanganan operatif dan non-operatif Knee functional and psychological readiness of post ACL injury in operative and non-operative treatment. *Jurnal Penelitian Pembelajaran.* 2022;6(3):561-574.
9. Adhitya IPGS, Wibawa A, Ngurah IG, Aryana W, Adrian M, Rachman P, et al. Physiotherapy Rehabilitation Management on Phase I of Post Operative Anterior Cruciate Ligament Reconstruction : A Case Report. 2022;16(2):132–9.
10. Herman, M, Rosella Komalasari, D. Penatalaksanaan Fisioterapi Post Operative Anterior Cruciate Ligament: Studi Kasus. *PhysioHS.* 2020;4(1):31-35.
11. Kim KT, Kim HJ, Lee HI, Park YJ, Kang DG, Yoo JI, Moon, DK, Cho SH, Hwang SC. A comparison of results after anterior cruciate ligament reconstruction in over 40 and under 40 years of age: A meta-analysis. In *Knee Surgery and Related Research.* 2018;30(2):95-106.
12. Cristiani R, Forssblad M, Edman G, Eriksson K, Stålmán A. Age, time from injury to surgery and hop performance after primary ACLR affect the risk of contralateral ACLR. In *Knee Surgery, Sports Traumatology, Arthroscopy.* 2022;30(5):1828-1835.
13. Mok AC, Fancher AJ, Vopat, ML, Baker J, Tarakemeh A, Mullen S, Schroepel JP, Templeton K, Mulcahey MK, Vopat BG. Sex-Specific

- Outcomes After Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-analysis. In *Orthopaedic Journal of Sports Medicine*. 2022;10(2):1-10.
14. Ryan J, Magnussen RA, Cox CL, Hurbank JG, Flanigan DC, Kaeding CC. ACL reconstruction: Do outcomes differ by sex? A Systematic Review. In *Journal of Bone and Joint Surgery*. 2014;96(6):p 507-512.
 15. Grindem H, Granan LP, Risberg MA, Engebretsen L, Snyder-Mackler L, Eitzen I. How does a combined preoperative and postoperative rehabilitation programme influence the outcome of ACL reconstruction 2 years after surgery? A comparison between patients in the Delaware-Oslo ACL Cohort and the Norwegian National Knee Ligament Registry. *British Journal of Sports Medicine*. 2015; 49(6):385-389.
 16. Harput G, Guney-Deniz H, Ozer H, Baltaci G, Mattacola C. Higher Body Mass Index Adversely Affects Knee Function After Anterior Cruciate Ligament Reconstruction in Individuals Who Are Recreationally Active. *Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine*. 2020;30(6):e194-e200.
 17. Theunissen WWES, van der Steen MC, Liu WY, Janssen RPA. Timing of anterior cruciate ligament reconstruction and preoperative pain are important predictors for postoperative kinesiophobia. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2020;49(9):2551-2562.
 18. Filbay SR, Roos EM, Frobell RB, Roemer F, Ranstam J, Lohmander LS. Delaying ACL reconstruction and treating with exercise therapy alone may alter prognostic factors for 5-year outcome: An exploratory analysis of the Kanon trial. *British Journal of Sports Medicine*. 2017;(22):1622-1629.
 19. Ohji S, Aizawa J, Hirohata K, Ohmi T, Mitomo S, Koga H, Yagishita K. Changes in subjective knee function and psychological status from preoperation to 6 months post anterior cruciate ligament reconstruction. *Journal of Experimental Orthopaedics*. 2022;9(1):114
 20. de Oliveir, F L, Roy JS, Pappas E. ACL injury, physical activity, and overweight/obesity: a vicious cycle? In *Knee Surgery, Sports Traumatology, Arthroscopy*. 2020;28(3):667-669.
 21. Gu, EW, Cross AG, Hessburg L, Koolmees D, Bernstein DN, Elhage KG, Moutzourous V, Makhni EC. The Presence of Preoperative Depression Symptoms Does Not Hinder Recovery After Anterior Cruciate Ligament Reconstruction. *Orthopaedic Journal of Sports Medicine*. 2021; 9(1):1-6
 22. Ficek K, Gołaś A, Pietraszewski P, Strózik M, Krzysztofik M. The Effects of a Combined Pre- and Post-Operative Anterior Cruciate Ligament Reconstruction Rehabilitation Program on Lower Extremity Muscle Imbalance. *Applied Sciences (Switzerland)*. 2022;12(15):7411.
 23. Manandhar RR, Chandrashekhar K, Kumaraswamy V, Sahanand S, Rajan D. Functional outcome of an early anterior cruciate ligament reconstruction in comparison to delayed: Are we waiting in vain? *Journal of Clinical Orthopaedics and Trauma*. 2018;9(2):163-166.
 24. Snaebjörnsson T, Svantesson E, Sundemo D, Westin O, Sansone M, Engebretsen L, Hamrin-Senorski E. Young age and high BMI are predictors of early revision surgery after primary anterior cruciate ligament reconstruction: a cohort study from the Swedish and Norwegian knee ligament registries based on 30,747 patients. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2019;27(11):3583-3591.
 25. Kuenze C, Bell DR, Grindstaff TL, Lisee CM, Birchmeier T, Triplett A, Pietrosimone B. A comparison of psychological readiness and patient-reported function between sexes after anterior cruciate ligament reconstruction. *Journal of Athletic Training*. 2021;56(2):164-169