ISSN: 2347-6567

International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

IJAMSCR |Vol. 14 | Issue 4| Oct - Dec 2026

www.ijamscr.com

DOI : https://doi.org/10.61096/ijamscr.v14.iss4.2026.1660-1668

Comparative Study on Effectiveness of Intermittent Blood Flow Restriction Training VS Hip Strengthening Exercises for Patients with Patellofemoral Pain Syndrome

Lavanya C[1], Dr. Athira M[2], Dr. P. Bright Alwin Victor[3]

[1]BPT, [2]Assistant Professor, [3]Principal,

Revathi Institute of Physiotherapy and Research, Avinashi, Tirupur, India.
(Affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai)

Corresponding Author: Dr. P. Bright Alwin Victor, MPT, PhD
Email: alwin0729@gmail.com

Published on: 20-10-2026
Published by: Futuristic Publications
2026| All rights reserved.

Creative Commons Attribution 4.0 International License.

Abstract:

Background: Patellofemoral pain syndrome is one of the most common musculoskeletal conditions affecting the knee, particularly among adolescents, young adults, and physically active individuals. It is characterized by diffuse anterior knee pain that is aggravated by activities such as stair climbing, squatting, running, prolonged sitting, and kneeling.

Objective: The purpose of this study was to determine the effectiveness of intermittent blood flow restriction training compared with hip abductor, external rotator, and extensor muscle strengthening exercises in patients with Patellofemoral pain syndrome.

Methods: A randomized controlled trial was conducted among 20 patients with Patellofemoral pain syndrome. The participants were randomly allocated into two groups: Group A received hip abductor, external rotator, and extensor muscle strengthening exercises, while Group B received intermittent blood flow restriction training. Both groups received treatment three sessions per week for six weeks. Pre- and post-intervention assessments were performed using the Anterior Knee Pain Scale (AKPS) and Numerical Pain Rating Scale (NPRS) to assess functional ability and pain intensity. Results:

Comparison of the pre- and post-intervention mean values of the Anterior Knee Pain Scale and Numerical Pain Rating Scale demonstrated improvement in both groups. However, Group A showed a greater improvement in functional ability and a greater reduction in pain compared with Group B

Conclusion: The conclusion of this study was the Both hip strengthening exercises and intermittent blood flow restriction training were effective in improving functional ability and reducing pain in individuals with Patellofemoral pain syndrome. However, the findings of this study indicate that hip abductor, external rotator, and extensor muscle strengthening exercises produced greater improvements than intermittent blood flow restriction training over the eight-week intervention period.

Keywords: Patellofemoral pain syndrome, anterior knee pain scale, numerical pain rating scale, hip strengthening and intermittent blood flow restriction training.

Introduction

Patellofemoral pain syndrome is one of the most common musculoskeletal conditions affecting the knee and is a frequent cause of anterior knee pain. It is characterized by pain around or behind the patella that is typically aggravated by activities involving loading of the patellofemoral joint with the knee in a flexed position, such as squatting, stair climbing, running, jumping, and prolonged sitting. Patellofemoral pain syndrome commonly affects adolescents, young adults, athletes, and physically active individuals, with a higher prevalence reported among females. Various biomechanical and neuromuscular factors, including altered lower-limb alignment, hip muscle weakness, and changes in movement patterns, may contribute to the development and persistence of symptoms.

Patellofemoral pain syndrome is considered a multifactorial condition associated with a combination of mechanical, biomechanical, and neuromuscular factors. Contributing factors may include repetitive loading or overuse, altered patellar tracking, weakness of the hip and knee musculature, reduced neuromuscular control, and altered lower-limb biomechanics. These factors may increase mechanical stress on the patellofemoral joint and surrounding structures, resulting in pain and functional limitations. Common clinical manifestations include anterior knee pain during activities such as stair climbing, squatting, kneeling, running, and prolonged sitting, sometimes referred to as the "theatre sign." Some individuals may also experience crepitus, tenderness around the patella, and difficulty performing functional or sporting activities.

The Patellofemoral joint is formed by the articulation between the posterior surface of the patella and the trochlear groove of the femur. Normal function of the quadriceps and hip musculature plays an important role in maintaining optimal lower-limb alignment and controlling movement of the Patellofemoral joint. Weakness of the hip abductors, external rotators, and extensors may contribute to altered femoral and pelvic movement during weight-bearing activities. This may subsequently influence patellar mechanics and increase stress on the Patellofemoral joint. Quadriceps weakness may also affect knee stability and functional performance.

The diagnosis of patellofemoral pain syndrome is primarily based on a detailed history and clinical examination. Assessment generally includes evaluation of pain, muscle strength, range of motion, lower-limb alignment, movement patterns, and functional activities. Clinical tests such as the Clarke's test, patellar apprehension test, eccentric step test, and single-leg squat test may be used as part of the clinical assessment. Imaging investigations are generally considered when symptoms are atypical, persistent, or when other structural or intra-articular pathologies are suspected.

The management of Patellofemoral pain syndrome is generally individualized according to the patient's symptoms, contributing factors, and functional limitations. Conservative management may include patient education, activity modification, therapeutic exercise, pain management, patellar taping, manual therapy, gait and movement retraining, and progressive strengthening exercises. Exercise-based rehabilitation, particularly interventions targeting the hip and knee musculature, is commonly used to improve muscle strength, neuromuscular control, movement patterns, and functional performance.

The outcome measures used in the present study were the Anterior Knee Pain Scale (AKPS) and the Numerical Pain Rating Scale (NPRS). The AKPS is used to assess functional limitations associated with anterior knee pain, with higher scores indicating better functional status. The NPRS is used to quantify the intensity of pain experienced by the participant, with lower scores indicating reduced pain intensity. These outcome measures were used to evaluate changes in functional ability and pain before and after the intervention.

Methods:

Study design and participants

A comparative study was conducted on 20 Individuals with knee pain Among with patellofemoral pain syndrome patients. Participants Were selected based on inclusion and Exclusion criteria and were randomly Assigned into two groups. Group A Received hip strengthening exercises while group B received intermittent blood flow restrictions training for a total of 8 weeks. Ethical Clearance Number: (IEC-RIPT/DT/21/0519).

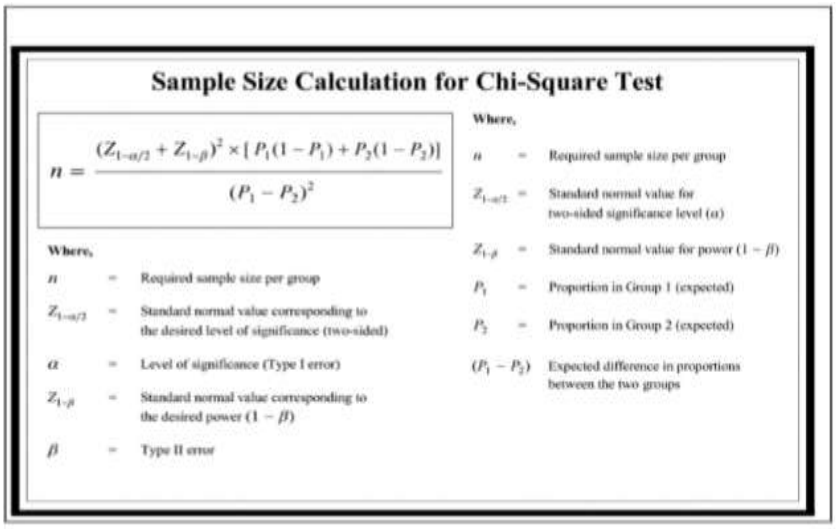


Fig. 1 Chi square test for sample size calculation

Inclusion Criteria

Participants aged 18–40 years with a clinical diagnosis of Patellofemoral Pain Syndrome (PFPS) presenting with anterior knee pain were included in the study. Participants were required to have experienced symptoms for a minimum duration of 4–6 weeks or longer. They were required to report pain during at least two functional activities, including prolonged sitting or kneeling, squatting, running, stair climbing, or jumping/hopping. Participants with a pain intensity of more than 3/10 on the Numeric Pain Rating Scale (NPRS) during a provocative functional activity were included. Participants who were able to understand the study instructions and participate in the prescribed intervention were considered eligible.

Exclusion Criteria

Participants with a previous history of knee surgery, including arthroscopy or ligament reconstruction, were excluded. Individuals with concurrent knee pathologies, such as ligament or meniscal injuries, osteoarthritis, patellar instability, or previous patellar dislocation, were also excluded. Participants with neurological or cardiovascular disorders, including those with resting blood pressure greater than 140/90 mmHg, were excluded due to potential limitations or risks associated with exercise participation. Individuals with a body mass index (BMI) greater than 30 kg/m² were excluded because increased body mass may influence patellofemoral joint loading, pain, functional performance, and exercise tolerance. Participants with a history of recurrent patellar instability or dislocation and those unable to safely perform or complete the prescribed intervention were also excluded.

Intervention

Group A: Hip Muscle Strengthening Exercise Program

Participants performed hip abductor, external rotator, and extensor strengthening exercises 3 sessions/week on non-consecutive days for 8 weeks. Each session lasted 30–40 minutes, with 3 sets of 8–12 repetitions and 30–60 seconds rest between sets. The exercise program included:

Glute bridge,Lateral band walk,Single-leg squat,Clamshell exercise,Side-lying hip abduction

Exercises were performed under therapist supervision with progression based on participant tolerance.

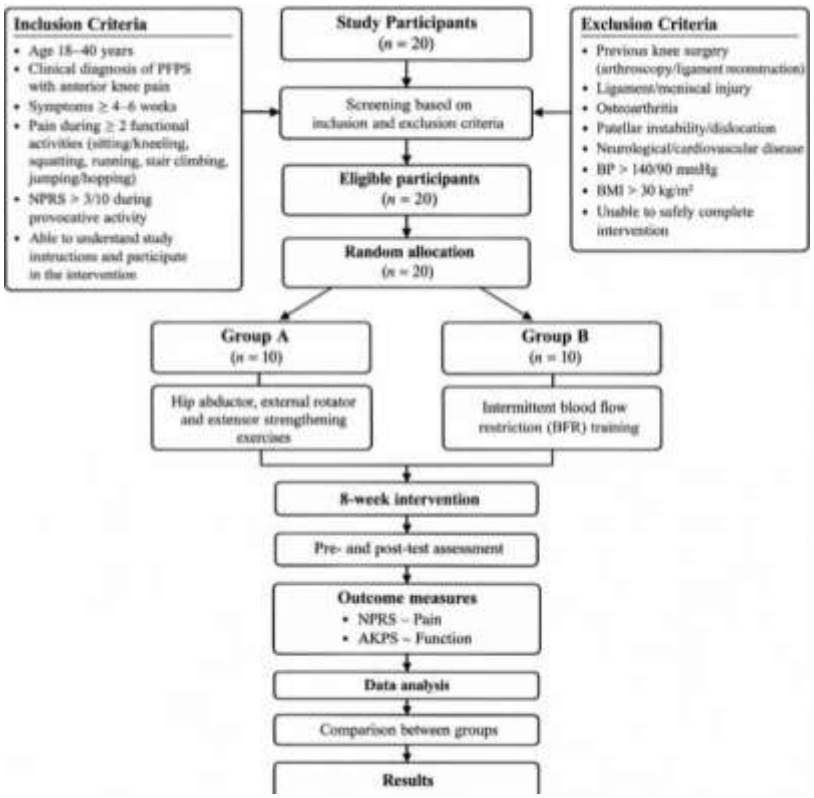
Group B: Intermittent Blood Flow Restriction (BFR) Training

Participants underwent intermittent BFR training for 8 weeks using a pneumatic cuff applied to the proximal thigh at 40–80% limb occlusion pressure. Training consisted of 4 sets (30-1515-15 repetitions) with 20–30% of one-repetition maximum (1RM) resistance. The cuff remained inflated during each set and was deflated for 1–2 minutes between exercises. The exercise program included:,Knee extension (pain-free range),Mini squats (30–45° knee flexion)

Outcome measures

Numerical Pain Rating Scale (NPRS):

Pain intensity was assessed using the 11-point Numerical Pain Rating Scale (0–10), where 0 = no pain and 10 = worst imaginable pain. The NPRS is a valid and reliable self-reported measure for evaluating pain intensity in individuals with patellofemoral pain syndrome.



Anterior Knee Pain Scale (AKPS):

Functional status was assessed using the Anterior Knee Pain Scale (Kujala Score), a 13-item self-reported questionnaire evaluating pain and functional limitations during activities such as walking, running, stair climbing, squatting, prolonged sitting, and jumping. Scores range from 0 to 100, with higher scores indicating better knee function and fewer symptoms. The AKPS is a valid and reliable outcome measure for patients with patellofemoral pain syndrome.

Statistical analysis

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS) version 24, with a significance level of p value less than 0.05 and a 95% confidence interval set for all analysis. The Shapiro Wilk test was used to determine the normality of the data. In this study, Shapiro Wilk test showed that the data was normally distributed on the dependent values at $P > 0.05$. Hence parametric test was adopted. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-Test) was adopted to find statistical difference between the groups.

Results

20 subjects clinically diagnosed have patellofemoral pain syndrome were divided into two groups, group A and group B.Group A subjects were treated with hip strengthening exercises.Group B subjects were treated with intermittent blood flow restriction training.

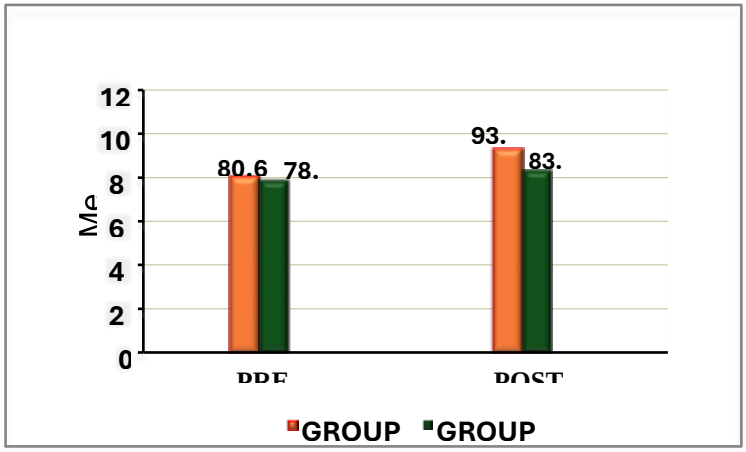
The patients were treated for 3 sessions per week. Before starting the intervention of intermittent blood flow restriction were taken by anterior knee pain scale and the numerical pain rating scale .The measurements were repeated at the end of the study.

Table 1 Mean value, mean difference, standard deviation and t-test, degree of freedom and p value between Group A & Group B in pre and post test value of AKPS

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	80.60	6.91	78.80	6.33	.607	18	.552*
POST TEST	93.20	5.76	83.40	7.51	3.27	18	.001**

(*- P > 0.05 - Not Significant) & (**- P ≤ 0.05 Significant).

GRAPH-I



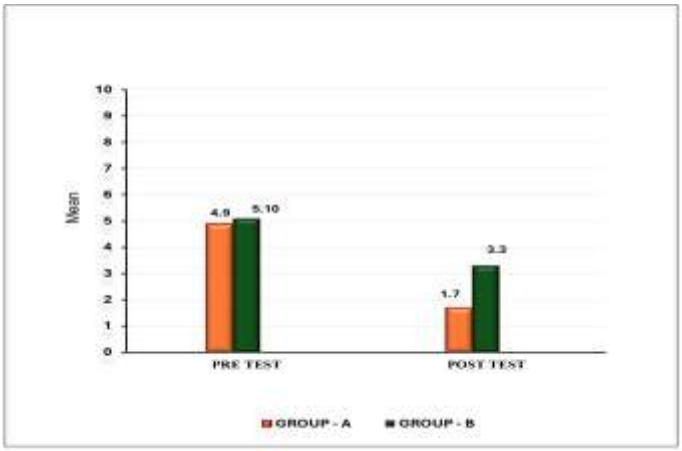
Graphical representations of comparison of Anterior knee pain scale Between group A – Group B in pre and post test

Table-2 Mean value, mean difference, standard deviation and t- test, degree of freedom and p value between Group A & Group B in pre and post test value of Numerical knee pain scale.

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	4.90	.567	5.10	.737	-.679	18	.506*
POST TEST	1.70	.483	3.30	.674	-6.09	18	.001**

(*- P > 0.05 – Not Significant) & (**- P ≤ 0.05 – Significant).

GRAPH-II



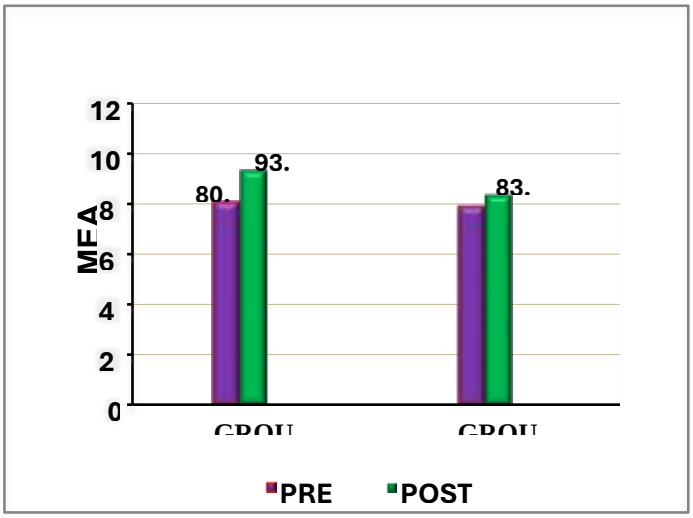
Graphical representation of comparison of NPRS score between Group A -Group B in pre and post test.

Table 3 Mean value, mean difference, standard deviation and t-test, degree of freedom and p value within Group A & Group B in pre and post test value of Anterior knee pain scale.

GROUPS	PRE TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	80.60	6.91	93.20	5.76	-15.38	.001**
GROUP- B	78.80	6.33	83.40	7.51	-10.17	.001**

(**- P ≤ 0.05 – Significant).

GRAPH-III



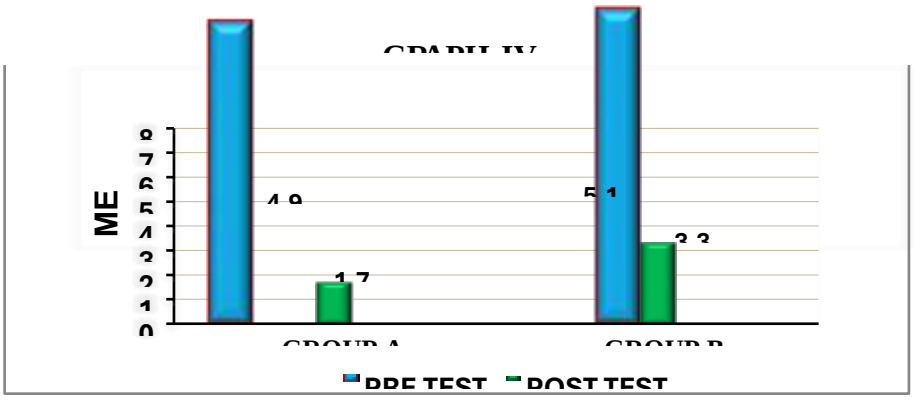
Graphical respresenatation of comparison of Akps score within group A and group B in pre and post test

Table 4 Mean value, mean difference, standard deviation and t-test, degree of freedom and p value within Group A & Group B of Numerical pain rating scale.

GROUPS	PRE TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	4.90	.567	1.70	.483	16.00	.001**
GROUP- B	5.10	.737	3.30	.674	9.00	.001**

(**- P ≤ 0.05 - Significant).

GRAPH-IV



Graphical representation of comparison of NPRS score between group A – group B in pre and post teat

Discussion

This study compared the effectiveness of intermittent blood flow restriction (BFR) training and hip abductor, external rotator, and extensor strengthening exercises in 20 patients with Patellofemoral pain

syndrome. Participants were equally divided into two groups and received their respective interventions for 8 weeks. Pain and functional outcomes were assessed using the Numeric Pain Rating Scale (NPRS) and Anterior Knee Pain Scale (AKPS) before and after the intervention.

Both interventions produced improvements in pain and functional outcomes. However, the hip strengthening group demonstrated greater improvement compared with the blood flow restriction group. Hip abductor, external rotator, and extensor strengthening may improve proximal hip and pelvic stability, reduce excessive hip adduction and internal rotation, and improve lower-limb biomechanics, thereby reducing Patellofemoral joint stress and improving function.

These findings are consistent with Giles et al. (2017), who reported that BFR training can improve quadriceps strength and reduce pain while using low mechanical loads, thereby reducing stress on the Patellofemoral joint. Similarly, Aiswarya Raju et al. (2024) reported that strengthening the hip abductors, external rotators, and extensors improves hip stability, lower-limb kinematics, and functional outcomes in individuals with Patellofemoral pain syndrome.

In the present study, the greater improvement observed with hip strengthening suggests that addressing proximal muscle weakness and lower-limb biomechanical factors may provide additional functional benefits in patients with Patellofemoral pain syndrome.

Conclusion

The study was conducted to compare the effectiveness of the intermittent blood flow restriction training vs hip abductor external rotator and extensors muscle strengthening exercises for patients with patellofemoral pain syndrome 20 patient were included in the study and were randomly divided into 2 groups.The group A was treated with hip abductor external rotator and extensors muscle strengthening exercises and group b was treated with intermittent blood flow restriction training for 8 weeks.patellofemoral pain syndrome were assessed before and after the study using anterior knee pain scale and numerical pain rating scale.From the result, it was concluded that there is an significant difference Group A is more effective than that of Group B in enhancing functional ability and reducing pain.

Limitations and Recommendations

This study was limited by its small sample size, short intervention duration, and the lack of assessment of psychological factors that may influence pain and functional outcomes. Future studies should include larger sample sizes, participants from different age groups, and long-term follow-up to evaluate the sustained effects of the interventions.

Conflict of interest

Some individuals are not willing for the study, also the patients matching inclusion and exclusion criteria were limited in the study region.

Acknowledgment

I sincerely thank Tamil Nadu Dr. M.G.R. Medical University, Chennai, and Revathi

Institute of Physiotherapy, Avinashi,

Tiruppur, for providing me with the opportunity and support to conduct this study. I express my heartfelt gratitude to my Principal, Dr. P. Bright Alwin Victor, for his valuable support and encouragement, and to my guide, Dr. Athira M., for her constant guidance, valuable suggestions, and encouragement throughout the study.

Authors contribution

Lavanya.c Conceptualization, Methodology, Participant recruitment, Data collection, Formal analysis, Manuscript drafting.

Dr. Athira M: Supervision, Methodology validation, Critical revision of the manuscript, Final approval of the manuscript.

Dr. P. Bright Alwin Victor: Research guidance, Manuscript review, Administrative support, Final approval of the manuscript.

Reference

1. Thomeé R, Augustsson J, Karlsson J. Patellofemoral pain syndrome: A review of current issues. Sports Medicine. 1999;28(4):245–262. DOI:10.2165/00007256-199928040-00003
2. Gaitonde DY, Ericksen A, Robbins RC. Patellofemoral pain syndrome. Am Fam Physician. 2019;99(2):88–94.
3. Witvrouw E, Callaghan MJ, Stefanik JJ, Noehren B, Bazett-Jones DM, Willson JD, et al. Patellofemoral pain: consensus statement from the 3rd International Patellofemoral Pain Research Retreat held in Vancouver, . Br J Sports Med. doi:10.1136/bjsports2014-093450. September (2013)
4. Watson R, Sluka B, Stone A, et al. Blood flow restriction therapy: an evidence-based approach to postoperative rehabilitation. doi:10.2106/JBJS.RVW.22.00062.
5. Xie S.Y., Jiang X., Yuan J.B., Luo J., Song S., Hu H.Y. Mechanisms of blood flow restriction training for knee pain: a mini review. Frontiers in Physiology, 16:1542322. (2025)
6. da Silva-Júnior, F. B., Dibai-Filho, A. V., Barros, D. C. C., Ribeiro, J. R., Gonçalves, M. B. S., Soares, A. R., Cabido, C. E. T., Pontes-Silva, A., de-Paula-Gomes, C. F., & Pires, Á. O. (2024). Anterior Knee Pain Scale (AKPS): structural and criterion validity in Brazilian population with patellofemoral pain. BMC Musculoskeletal Disorders, 25:39.
7. Hansen R., Brusko C., Rathleff M.S., Magnusson S.P., Henriksen M. (2023). Quadriceps or hip exercises for patellofemoral pain? A randomized controlled equivalence trial. British Journal of Sports Medicine, 57(21), 1289–1294.
8. Santos TRT, Oliveira BA, Ocarino JM, Holt KG, Fonseca ST. Effectiveness of hip muscle strengthening in patellofemoral pain syndrome patients: a systematic review. Brazilian Journal of Physical Therapy. 2015;19(3):167–176.DOI: 10.1590/bjpt-rbf.2014.0089
9. Xie S.Y., Jiang X., Yuan J.B., Luo J., Song S., Hu H.Y. (2025). Mechanisms of blood flow restriction training for knee pain: a mini review. Frontiers in Physiology.doi.org/10.3389/fphys.2025.1542322.
10. Singer B, Singer K. Anterior knee pain scale. Australian Journal of Physiotherapy. 2009;55(2):140.
11. Ittenbach RF, Huang G, Foss KD, Barber Foss K, Hewett TE, Myer GD. Reliability and validity of the anterior knee pain scale: Applications for use as an epidemiologic screener. PLoS One. ;11(7):e0159204. (2016)
12. Buckinx F, Bornheim S, Remy G, Van Beveren J, Reinstra J, Olivier P. French translation and validation of the Anterior Knee Pain Scale (AKPS). Disabil Rehabil. 2019;41(9):1089– 1094.
13. Hott A, Liavaag S, Juel NG, Brox JI, Ekeberg OM. The reliability, validity, interpretability and responsiveness of the Norwegian version of the Anterior Knee Pain Scale in patellofemoral pain. Disabil Rehabil. 2021;43(11):1605–1614.
14. McCaffery M, Pasero C. Teaching patients to use a numerical pain-rating scale. Am J Nurs. 1999;99(12):22.
15. Lankhorst NE, van Middelkoop M, Crossley KM, et al. Factors that predict a poor outcome 5–8 years after the diagnosis of patellofemoral pain: a multicentre observational analysis. Br J Sports Med. 2016;50:881-886. https://doi.org/10.1136/bjsports-2015-094664
16. Myer GD, Ford KR, Barber Foss KD, et al. The incidence and potential pathomechanics of patellofemoral pain in female athletes. Clincal Biomech (Bristol, Avon). 2010;25:700-707.
17. Bennell KL, Hinman RS, Metcalf BR, et al. Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial. Ann Rheum Dis (2005)64:906-912.
18. Fukuda TY, Rossetto FM, Magalhaes E, et al. Short-term effects of hip abductors and lateral rotators strengthening in females with patellofemoral pain syndrome: a randomized controlled clinical trial.J Orthop Sports Phys Ther. ;40(11):736-742. (2010).
19. .Harvie D, O'Leary T, Kumar S. A systematic review of randomizedcontrolled trials on exercise parameters in the treatment of patellofemoral pain: what works? J Multidiscip Healthc. ;4:383-392. (2011)

20. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy: the journal of arthroscopic & related surgery: official publication of the Arthroscopy Association of North America and the International Arthroscopy Association. ; 9(2):159–63.Epub 1993/01/01. PMID: 8461073.(1993)
21. Ismail MM, Gamaleldein MH, Hassa KA. Closed kinetic chain exercises with or without additional hip strengthening exercises in management of patellofemoral pain syndrome: a randomized controlled trial. Eur J Phys Rehabil Med. 49(5):687-98. PMid:23820880 (2013)
22. Milgrom C, Finestone A, Eldad A, et al. Patellofemoral pain caused by overactivity. A prospective Study of risk factors in infantry recruits. J Bone Joint Surg Am 1991;73(7):1041-3.
23. Mark S, Juhn DO. Patellofemoral pain syndrome: a review and guidelines for treatment. Am Fam Physician 1999;60(7): (2012-18.)
24. van Linschoten R, van Middelkoop M, Berger MY, et al. Supervised exercise therapy versus usual.
25. Stefanik JJ, Guermazi A, Zhu Y, et al. Quadriceps weakness, patella alta, and structural features of patellofemoral osteoarthritis. Arthritis Care Res ;63(10):1391-7. doi:10.1002/acr.20528. (2011)
26. Azizi S, Elahi M, Dadarkhah A, Shirzadi E, Rezasoltani Z, & Abdorrazaghi F. The Effect of Strengthening Exercises of the Hip Extensor and External Rotator Muscles on Patellofemoral Pain Syndrome. Journal of Physical Medicine and Rehabilitation, 1(2), 83–90 (2019)