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Effectiveness of Physiotherapy for Athletes and Runners with Patellofemoral Pain Syndrome

A Literature Review

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Patellofemoral pain syndrome (PFPS) is a common musculoskeletal impairment that occurs among athletes and runners. In the general population as annual incidence PFPS is reported 22.7% and 28.9% of adolescent aged population are detected with patellofemoral pain syndrome. Female athletes in age 10 to 24 years are two to 10 times much prone to be diagnosed with PFPS than male athletes. 74% of athletes and runners terminate their career due to patellofemoral pain.

This literature review aims for understand the effects of physiotherapy in athletes and runners having patellofemoral pain syndrome.

The method used for this thesis follows the principles of the literature review. The systematic search was done in Cochrane Library, CINAHL, PEDro and Pubmed. According to the inclusion criteria, final three randomized control trials and randomized clinical trials were selected for this thesis.

Most athletes and runners could have patellofemoral pain syndrome due to exercises done in wrong techniques, wrong foot wear and muscle imbalances. Results show that guided gait retraining, lower limb strengthening exercises and general manipulation technique provided significant results in reducing pain and improving lower limb function. Even though interventions like using foot orthosis did not show a significant result, it could be used as a combination with other treatment methods.

Keywords	Patellofemoral pain syndrome, athletes, runners, physiotherapy, effects, effectiveness

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1 Introduction

Patellofemoral pain syndrome (PFPS) is common musculoskeletal impairment. This condition is also called runner's knee. (Houghton et. al 2007). In the year 2017, Halabchi et.al (2017) defines the patellofemoral pain," the pain generating in peri-patellar/ retro-patellar area which aggravates by one activity at least that loading the patellar femoral joint while it is in the weight-bearing on a flexed knee". The common flexed knee activities examples are stair climbing, running, squatting, and jumping. (Halabchi et.al 2017). Patellofemoral pain syndrome can affect various groups in the general population such as the elderly community, adolescents and adults that engaged in sports activities. (Smith et. al 2018). PFPS have a high percentage of an incidence rate globally. According to Smith et al., among the general population the annual incidence rate of patellofemoral pain syndrome is 22.7%. (Smith et.al 2018).

Runners can be classified according to the running distance which they compete for. Middle- distance, long - distance and marathon are some of the examples for running events. Sprinters are the runners competing up to 400m running. (Kluitenberg et.al 2015). This literature review population were selected depending on the similarities of athletes and runners like competing for a prize, exercise intension and exercise level. The included population of this literature review are both male and female and age 18 to 50. This study has included both athletes and runners for the included population.

Moving on to the sports, adolescent age is the most common age of the career start of an athlete or a runner. According to Smith et.al (2018), among the adolescent's community (age 10 -19), the incidence rate of the patellofemoral syndrome was reported as 28.9 % in the general population. (Smith et.al 2018). Therefore his study reveals that there is a higher chance to have patellofemoral pain syndrome in this age range. (Smith et.al 2018). Most of the elite sports in the world partake lower limb activities like running and jumping. Conferring to Vora, et. al. (2017), patellofemoral pain syndrome is the primary diagnosis of all running injuries in young adults, which is 25%. In this study, According to Vora, et. al. (2017),12.7% of female athletes have a higher chance to have patellofemoral syndrome than male athletes in the young adult population. (Vora, et. al. 2017) Also according to Halabchi et.al (2017), the prevalence rates were between 13% and 26%, are reported in female athletes who are participating in activities such as running, fencing, soccer, volleyball and rock climbing. This study also defines, that the incidence

of patellofemoral pain in juvenile female and young adult women in the age range of 10 - 24 years, is 2-10 times high than a male participant. (Halabchi et.al 2017).

In the sports field, patellofemoral joint pain can cause a lot of damage to the runners and athlete's performance and the individual's career. According to Halabchi et al., 74% of the athletes will cause complete termination of the sport that they engaged in due to patellofemoral pain syndrome. (Halabchi et.al 2017). It is important for sports physiotherapists to understand how vital PFPS can be for an athlete's career. (Dhillon H and Dhillon S., Dhillon M.S 2017). In the modern era, sports have become a sporting industry, because of the high competition. The demand for new training methods and modernization of the sport can have a risk of injuries including patellofemoral pain syndrome for the athletes. Moreover, athletes might be under immense pressure to returning to sport soon after having an injury such as patellofemoral pain syndrome. So definitely the new effective approach of sport-specific injury management is needed. (Dhillon H and Dhillon S., Dhillon M.S 2017). According to Dhillon H and Dhillon S., Dhillon M.S (2017), assessing tissue health, tissue stress and modifiers for risk tolerance are applied by a physiotherapist before returning to the sport. Moreover, by studying the athlete's symptoms, personal and medical history, the type of sport which an athlete engaged in a physiotherapist can give treatments and advice to improve performance before returning to the sport. (Dhillon H and Dhillon S., Dhillon M.S 2017).

The purpose of this Bachelor's Thesis is to determine the effectiveness of physiotherapy for patellofemoral pain syndrome in athletes and runners.

2 Literature review

2.1 Patellofemoral anatomy and the function

The Patellofemoral joint is a complex joint formed of the posterior adjacent of the patella bone and the distal termination of the femur bone. The special structure, patella bone is the prime sesamoid bone in the human body. Patella improves the flexion of the tibiofemoral joint and protects it by distributing the compression forces. Patella stability depends on medial and lateral retinaculum, quadriceps tendon and patella tendon. These tendons work as a combination. (Waryasz and McDermott, 2008). This combination and its controlled movement are known as the patellar tracking. Alteration of this stability forces can lead to imbalances and effect on patellar tracking. (Waryasz and McDermott, 2008).

Patella is convex on the anterior side. Patella has a total of seven facets but it is divided into medial and lateral facets. These facets are important to compressive dysfunction mechanism. Lateral facet is longer and more sloped to articulate with the lateral condyle of femur, while medial facet is short and very sheer. Patella stabilization is mainly depending on the nature of the trochlear groove of the femur. As the groove extends distally, it gets deep. Before it reaches the femoral notch, it will be divided into two branches of the groove. (Mullaney and Fukunaga, 2016).

A study done by Peterson et al. (2017) using 3T MRI technology has found evidence recently that it is not the patellofemoral cartilage abnormality which causes patellofemoral syndrome in most situations. (Peterson et.al 2017). This study demonstrates patellofemoral pain is caused mainly by patellofemoral pain syndrome and patellofemoral osteoarthritis. Patellofemoral osteoarthritis can be caused by the origination of patellofemoral pain syndrome, deformity, and trauma or patellofemoral instability. (Peterson et.al 2017). According to Peterson's study, most common reasons for PFPS are weak hip muscles and rear foot eversion which can be due to dynamic valgus and lower back problems like sacral inclination. (Peterson et.al 2017). In the same study, they found out the association of patella maltracking with patellofemoral pain was associated by quadriceps dysbalance and iliotibial tract tightness. Patients with a higher lateral translation of patella and lateral spin of the patella may have PFPS compared to the healthy persons. (Peterson et.al 2017). The quadriceps angle, which is also known as Q angle also influences patella maltracking when the vector of the forces of quadriceps is more

lateral to the joint line. Women have a naturally greater Q angle than male. When the Q angle increases, the patella will translate towards the lateral side. This might explain how female athletes have a higher tendency to have PFPS than male athletes because women have a greater Q angle than men. During the activity, when the internal rotation of the femur and tibia occurs with more stress and hyper movements, patients might generate a patellofemoral pain. (Peterson, et.al 2017).

When a high joint reaction force occurs on patellofemoral joint, the area of contact of the joint is less and causes high stress to the joint. This can lead to damaged cartilage in the knee joint. (Weitman et.al 2018). In another study (Rabelo and Lucareli 2018) explains, the cause for the dynamic valgus is a low strength of hip abductors or abnormal calcaneus bone eversion with pes valgus. Also, patellofemoral pain can be associated with hamstring tightness, iliotibial band tightness or vastus medialis or vastus lateralis imbalance. (Rabelo and Lucareli 2018). A study (Peterson et.al 2014) done regarding the relation and effect of hip muscle weakness and dynamic knee valgus has demonstrated significant improvement of the difficulties caused by patellofemoral pain syndrome after applying sessions with gluteal muscle strengthening. In the same study they found that even if discomfort diminishes, it will not change the biomechanics of the people who have patellofemoral pain. (Peterson et.al 2014).

2.2 Causes of patellofemoral pain syndrome

Maximum performance is the primary aim of an athlete or a runner. The coaching staff and the spectators also expect good performance from a sporting individual. Therefore continuous performance with fewer injuries is an important task for the multidisciplinary team including the physiotherapist. (Hettrich & Liechtie cited orthoinfo.aaos.org).

Hettrich & Liechtie (orthoinfo.aaos.org) categorizes two main causes of patellofemoral pain. The first cause is overuse by high-intensity exercises. (Hettrich & Liechtie cited orthoinfo.aaos.org). Activities such as jogging, squatting and climbing stairs are some of the few examples which cause grinding mechanism and put more stress on the patellofemoral joint. Also, wrong training techniques and improper use of the equipment can cause pain on the knee. Wrong footwear also plays a key role to start patellofemoral pain which alternates the weight-bearing of the joint (Hettrich & Liechtie cited orthoinfo.aaos.org). The weakness of the muscles in knee function also can cause patellofemoral pain. An athlete without proper strength training for the lower limbs and training without any kind of stretching and warm- up exercises can have a higher chance to be diagnosed with patellofemoral pain syndrome. According to Halabchi et.al (2017), patellofemoral pain syndrome has intrinsic and extrinsic risk factors. Intrinsic factors are such as anatomical and biological factors. The most common examples for these are the weakness of the quadriceps and the vastus medialis obliques (VMO) weakness, abductors and external rotator dysfunction, weak core muscle endurance, tightness of hamstrings, quadriceps, and iliotibial band and gastrocnemius- soleus complex. (Halabchi et.al 2017). In this study (Halabchi et.al 2017), they found the biomechanical factors like hyper foot pronation, genu varum and gait abnormalities also can be a potential risk to generate patellofemoral pain syndrome. The extrinsic factors, common factors, are exercise type and the exercise intake for the body, environmental conditions and equipment used for the exercise. (Halabchi et.al 2017). The worst effects of the patellofemoral pain syndrome that it may lessen the mobility of runners and athletes, it might lead to immobilization. (Halabchi et.al 2017).

The pain assessment for patellofemoral pain syndrome is taken by different measurements and scales. Mostly used scales are anterior knee pain scale (AKPS), lower ex-

tremity functional scale (LEFS) and visual analogue scale (VAS). Among these measurements, AKPS and LEFS are used to assess disability, dysfunction and pain have higher reliability. The most popular pain measurement is VAS. In a study, the VAS scales taken from participants show more on and off the type of pain which depends on the day that assessment has taken after the injury. Most people have low VAS, on the week that injury occurred and high VAS on the week that assessment has been taken. The main cause for this is that athletes and runners will still do activities with pain and it can increase the pain levels. (Papadopoulos et.al 2014).

2.3 Physiotherapy treatment methods

Exercise therapy is a common application by a physiotherapist to a patient with PFPS. According to Halabchi et.al (2017), this is a cost-effective method of treatment for young adults. (Halabchi et.al 2017). Exercise therapy is a major physiotherapy application in sports rehabilitation too. The types of exercises that are used for PFPS are home exercises, open and closed kinetic chain exercises, hip and knee exercises, stretching with proprioceptive neuromuscular facilitation and exercises and the classic lower limb exercises. In this study, there is a positive result generated from types of strengthening exercises from a meta-analysis of RCT's. Knee extension, types of squats, static quadriceps strengthening, step down and step up exercises, leg press and active leg raise exercises were implemented. (Halabchi et.al 2017).In the study by Halabchi et.al (2017), they applied stretching to lower limb and hip muscles like hamstrings, quadriceps, iliopsoas, and gastrocnemius and iliotibial band. The tightness of these muscles might increase the joint reaction force in full knee extension and flexion. Stretching alone or as a combination with exercise and other treatment methods has reduced the symptoms. (Halabchi et.al 2017). A Cochrane systematic review by Heijden et.al (2019) has studied the effects of exercise therapy to reduce knee pain and improving the function of the knee. In their conclusion, they found that exercise therapy is effective in reducing pain in PFPS and improving the functional ability and enhancing the long term recovery. They were unable to find the best form of exercise for patellofemoral pain syndrome, but they found some evidence that is low-quality, that hip with knee exercises are marginally better than other exercises applied to patellofemoral pain syndrome (Heijden et.al 2019).

PNF stretching (proprioceptive neuromuscular facilitation) is an innovative stretching technique that is used for patellofemoral pain syndrome. In a study done comparing the effectiveness of static stretching versus the proprioceptive neuromuscular facilitation and IASTM (Instrument assisted soft tissue mobilization) techniques has demonstrated that effectiveness is higher in hip flexion range of motion with PNF and IASTM than static stretching for hamstrings. (Gunn et.al 2019).

Patient advising and guidance also play a major role when it comes to the attainment of applying exercise therapy. A study proves that supervised exercises with care and respect will also provide a better motion range and lesser pain to the patient. (Linschoten et.al 2009)

3 Methods

3.1 Objective

The aim of this literature review is to determine the effects of physiotherapy in athletes and runners with patellofemoral pain syndrome.

3.2 Search strategy

The data collection was done by systematic search. The method followed the principles of a literature review.

This literature review was executed using the publications after the year 2000. The search was done in between 17th November 2019 and 17th April 2020. Examining the literature was done by using databases such as PubMed, PEDro, Cochrane Library and CINAHL using the keywords patellofemoral pain syndrome, patellofemoral pain, PFPS, Sports, Athletes, runners, effects, effectiveness, physiotherapy, physical therapy, RCT and randomised controlled trials as the search strategy.

The keyword combinations for the search were;

"Patellofemoral pain syndrome and athletes and physical therapy and effectiveness and randomised controlled trials"

"Patellofemoral pain syndrome and runners and physiotherapy and effectiveness and randomised controlled trials"

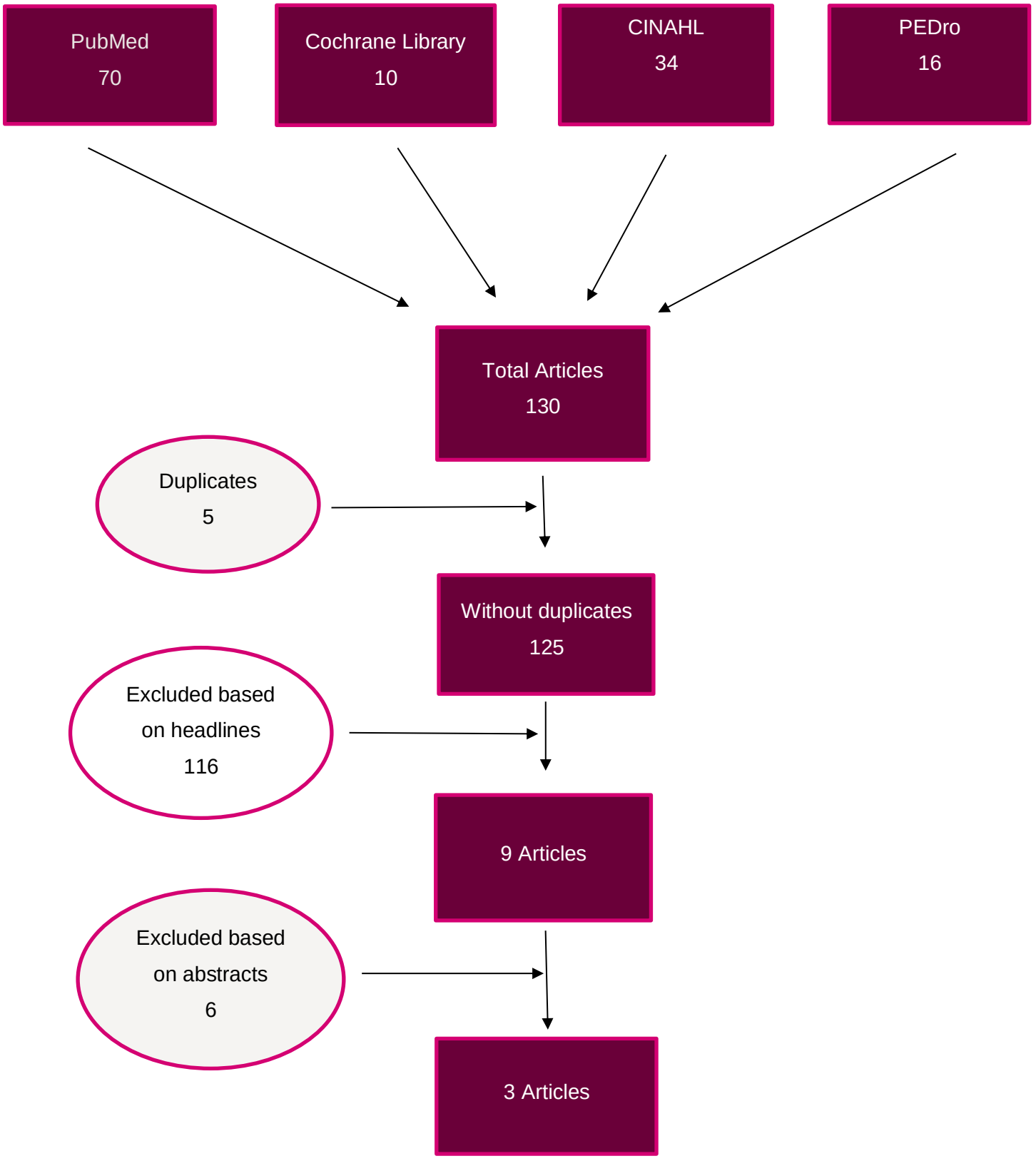

Figure 1. Study flowchart of the search process for the literature review.

The selected publication language of publications is English and the population of athletes and runners, above age 18 were selected. All the selected articles are randomized controlled trials and randomized clinical trials. Figure 1 shows the flowchart of the search process for literature review. During the process of selecting final articles for the study through databases, a total number of hundred thirty articles were found. Among them five were duplicate articles. The total number of articles without duplicates were a hundred and twenty-five. Hundred and fifteen articles were excluded due to purpose of the study and headlines. Moreover, the total number of three articles were found for the final analysis, according to inclusion criteria. (Table 1).

Assessment of the quality of the articles was done by using the critical appraisal tool. Critical appraisal was done according to the application of Joanna Briggs institute (JBI) with critical appraisal checklist (Joanna Briggs Institute, 2017).

Table 1. Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
population	Athletes and runners diagnosed with patellofemoral pain syndrome Treated by physiotherapy treatment methods Age above 18	Athletes and runners not diagnosed with patellofemoral pain syndrome Not treated by physiotherapy treatment methods Age under 18
Publication date	Publications after year 2000	Publications before year 2000
Publication language	Publications published using English language	Publications not published in English language
method	Randomized controlled trials and clinical trial publications Systematic literature review publications if they are done by RCT	Publications done by other than Randomized control trial or clinical trial methods.
Contents	Articles related to the effects and effectiveness by physiotherapy treatment methods.	Articles not related to effects or effectiveness of physiotherapy treatment methods.

4 Results

Three articles were selected for the final articles among nine. Even though, the search was done using four databases all final three articles were found in the PubMed database. There was a low number of randomized control trials or clinical trial studies concerning physiotherapy effects or effectiveness for the athletes and runners with patellofemoral syndrome. Quality assessment was done by using Joanna Briggs institute (JBI) critical appraisal checklist. Concerning the quality of the studies, all these articles got at least 7 yes answers from JBI critical appraisal checklist. Results in effectiveness of physiotherapy treatment methods according to the search are presented in Table 2.

Gait retraining was more effective physiotherapy method than using foot orthosis according to (Bonacci et.al. 2018) Gait retraining group underwent 10 sessions on a treadmill under the supervision for 6 weeks. In the first 4 weeks, participants were assigned to physiotherapy clinic twice a week and then once a week. On the anterior knee pain scale there was a significant difference between groups and also in the worst pain in the visual analogue scale, but there was no significant difference in average pain on the visual analogue scale between the groups. It was recorded after 12 weeks from the baseline, that the difference of the anterior knee pain scale between gait retraining group and foot orthosis group was 17.21%, difference of average pain 12.21%. Analyzing all the individual data of each participant for anterior knee pain scale and average and worst pain of visual analogue scale demonstrates that participants that were in gait retraining group had pain reduction and improvement in knee function after the program. Results show improvement, which is moderate to mark on the global rate of change scale in 86% for the gait retraining group and 29% for the foot orthosis group. (Bonacci et.al. 2018).

Enhancement of usual training methods can also provide positive results for the athletes with patellofemoral pain syndrome. Changes of the foot positions like changing rear foot to forefoot foot strike provided optimistic feedback in the study done by Roper (2015), it was found that there were momentous interaction effects of time and group in knee flexion angle in initial contact, knee valgus angle at initial contact and ankle loading. In the post retraining, experimental group, which changed rear foot strike to forefoot strike, has improved knee flexion angles in mean 6.044 degrees. The control group did not perform a significant change from the baseline. Also, like the knee flexion angle improved, knee valgus angle also improved by 2.782 degrees in the experimental group while the control group stayed in the baseline. After one month follow-up experimental group were able to

maintain in mean 4.066 degrees. Difference in ankle dorsiflexion and plantar flexion angles was improved in mean (- 23.958 degrees). Same as the other kinetic and kinematic variables, the experimental group was able to increase the ankle loading into mean 14.738 degrees and was eligible to maintain it one month follow up into mean 17.192 degrees. Pain reduced in both groups, but experimental group was able to reduce pain more than the control group. Pain reduction reported on experimental vs control group mean – 4.225 on VAS scale vs -1. 725 on VAS scale. Also, both of the groups have maintained the improvement in one-month follow-up in post retraining in mean -4.278 on VAS scale vs -0.457 on VAS scale. Even though calf soreness reported in the experimental group at the first few sessions it was subsided in the next few weeks. Comparing the results of male athletes and female athletes, only the men in the experimental group had a significant knee loading reduction. Female athletes in both groups had no significant male vs female difference. (Roper, 2015).

Modern technologies like Electro diagnostic medical techniques also help to determine the effectiveness of physiotherapy. Electromyography (EMG) activity was used in the study of (Motealleh et. Al., 2015). EMG activity on vastus medius and gluteus medius muscles were tested before and after the unspecific lumbopelvic manipulation technique on athletes with patellofemoral syndrome. Group one received the unspecific lumbopelvic manipulation technique for patellofemoral pain syndrome, group two received sham manipulation. EMG activity from vastus medius and gluteus medius had quicker onset and higher amplitude in group one, who received lumbopelvic manipulation than group two. One leg hop test and step down test were tested, both to evaluate functional abilities. The results of the one-leg hop test were found to be similar in both groups. Intervention group that received lumbopelvic manipulation has reduced pain more than group that received sham manipulation. The intensity of the pain has reduced significantly in the lumbopelvic manipulation group than the sham manipulation group. The pain intensity was measured using visual analogue scale. Mean differences of intervention and control group was VAS (0-10) = 2.6, step down test = 2.4 and one leg hop = 6.8 cm. (Motealleh et. Al., 2015).

Table 2. Effectiveness of physiotherapy methods of PFPS according to the search.

Authors year and place	**Purpose of the study**	**methods and measurements**	**participants**	**Results**	**Validation assessment**
Bonacci, et al., 2018 Deakin university, Australia	Determine feasibility of clinical trial: physiotherapy; program of guided gait retraining and a foot orthosis intervention to runners.	Randomized clinical trial by allocating the participants randomly to either gait training or using minimalist shoes or prefabricated foot orthoses. Intervention done for 12 weeks. Anterior knee pain scale and visual analogue scale average and worst	16 Runners 18 - 40 years of age diagnosed with patellofemoral pain. Both male and female	Gait retraining program was more effective compared to orthosis group, clinically meaningful effect on runners with lesser pain in anterior knee pain scale than foot orthoses. After 12 weeks from the baseline, difference of anterior knee pain scale values between gait retraining group and foot orthosis group were 17.21%, difference of average pain values between two groups were 12.21%.	Yes – 11 No – 1 Unclear – 0 N/A - 1

Jenevieve Roper., 2015 New Mexico , USA	To determine if patellofemoral pain is reduced by gait training with modifying foot strike patterns from rear foot strike to forefoot strike and improves associated biomechanical measures.	Randomized controlled trial by placing control and experimental group. Experimental group performed 8 gait retraining running sessions with changing rear foot strike to forefoot strike first. Control group did running sessions, no intervention. Both groups did training for 2 weeks. Three dimensional motion analysis using Vicon polygon to measure angles. Pain measurement done by using visual analogue scale.	16 runners with patellofemoral pain. Both male and female. Experimental group average age was 24.63 and control group average age was 21.5.	Knee pain, knee abduction was significantly improved in experimental group, Experimental group knee flexion angle was increased, mean 6.044 degrees and knee valgus was improved mean 2.782 degrees in post training but control group did not perform significant change.	Yes – 7 No – 5 Unclear – 1 N/A - 0
Motealleh et. Al., 2015 Shiraz, Iran	To evaluate general lumbopelvic manipulation´s immediate effect on EMG activity: vastus medialis, vastus lateralis and gluteus medius,	Randomized controlled trial Group 1 received general lumbopelvic manipulation at the side of the involved knee. Group 2 got sham manipulation. EMG activity of vastus medius and gluteus	28 female athletes with patellofemoral pain. Intervention and control group average	Amplitude and onset of EMG activity from vastus medialis and gluteus medialis were ealier and higher in lumbopelvic manipulation group than sham group but no significant	Yes – 11 No – 2 Unclear – 0

	pain and functional performance of athletes with patellofemoral pain syndrome.	medius were recorded before and after manipulation. Step down and one leg hop tests were used to evaluate functional abilities. Pain intensity was assessed by visual analogue scale.	age is 26.9 and 26.1 years	differences. Result from one leg hop test was similar on both groups but there was a significant improvement in step down test and visual analogue scale in lumbopelvic manipulation group than sham group. Mean differences of intervention and control group was VAS (0-10) = 2.6, step down test = 2.4 and one leg hop = 6.8 cm.	N/A - 0

5 Conclusion

Numerous studies have been done regarding patellofemoral pain syndrome, but only a few of them regarding effectiveness of physiotherapy and athletes and runners. Concerning inclusion and exclusion criteria three articles discussed about the effectiveness of physiotherapy for the athletes and runners diagnosed with patellofemoral syndrome.

The athletes and runners have high competition in the current situation of sports. Physiotherapy can be a tool for them to reduce the exposure to injuries including patellofemoral pain syndrome, as well as immediate pain management. The purpose of this study was to determine the effects and effectiveness of physiotherapy for the athletes and runners diagnosed with patellofemoral pain syndrome.

In Modern world athletes and runners train themselves forcefully to achieve their targets and goals. Improper techniques can cause patellofemoral pain syndrome for the athletes and runners because of the training volume. Incorrect running gait pattern was identified as a common cause for patellofemoral pain in studies (Bonacci et.al. 2018). (Roper, 2015). This concludes the effectiveness of gait retraining on athletes and runners. Rather than the general gait retraining, changing rear foot to forefoot strike could generate positive outcomes like improvement of range of motions of knee flexion, knee valgus, dorsiflexion and plantar flexion according to the study of (Roper, 2015).

According to (Bonacci et.al. 2018) gait retraining had more impact on the runners than using foot orthosis. Developing orthosis and shoes for athletes might have a value to reduce patellofemoral pain including other injuries. Combination of restrained shoes or foot orthosis with gait retraining or other physiotherapy methods might reduce patellofemoral pain more effectively than using one treatment method. (Bonacci et.al. 2018).

According to the study of (Motealleh et. Al., 2015) general lumbopelvic manipulation had a rapid effect on important muscles on knee function than sham manipulation. Due to rapid effect on muscles, general lumbopelvic manipulation might be applied to the athletes and runners for recovery. (Motealleh et. Al., 2015).

The main strength of this thesis is the final three articles provide relevant results concerning the objective of the thesis. In the articles physiotherapy intervention was different than the usual treatment methods. The major weakness of this thesis was to find high

quality randomized controlled trials. After searching among four databases three articles were selected finally. None of these physiotherapy interventions used in these studies had worsened the patellofemoral pain. Only some interventions had more effect than others. Moreover, more studies have to be carried out regarding this topic of PFPS for the benefit of the athletes and runners.

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