THE MUSCLE STRENGTH OF THE KNEE IN WOMEN: OBJECTIVE ASSESSMENT OF THE QUADRICEPS AND HAMSTRINGS

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Contents

INTRODUCTION

Aging, pathologies appear, among which we find knee arthrosis, which is one of the most important causes of pain and disability in adults and which has a high prevalence that increases with age, being more frequent in women and especially after 50 years. Before the onset and diagnosis of osteoarthritis, we can find many cases of people with knee pain, an annual prevalence is estimated in the general population of 22.7% and in teenagers of 28.9% (Smith BE et al..2018). The onset and progress of knee arthrosis is associated with muscle atrophy and secondary inactivity, which decreases the physical condition of the person with this pathology (Mahmoudian A et al, 2021; Katz JN et al,2021).

The evolution of muscle strength varies with age. From the age of 30 there is a progressive decrease in strength and muscle mass.

The muscles involved in the knee are the quadriceps and hamstrings. The quadriceps are very powerful, their strength is three times greater than the hamstrings. To ensure the stability of the knee, the balance between these two muscle groups is also important (Blum D et al, 2020).

If reference values were known regarding muscle strength and the balance between the musculature surrounding the knee, the objective evolution of strength with age, as well as whether there are differences in strength between the lower limbs (right and left) in a healthy population, we could propose exercise programs to strengthen these muscle groups, which are so important for the stability of the knee and avoid or delay as much as possible the effects of osteoarthritis.

For this reason, an observational study is proposed in a healthy female population aged between 20 and 50 years, with the aim of observing the muscle behaviour of quadriceps and hamstring strength objectively with an isokinetic dynamometer and making a study of the different parameters, such as peak torque, total work and average power. Based on the bibliography consulted, it is expected to observe a decrease in strength with age, which will make us consider an exercise program to prevent the loss of strength and the effects/consequences of knee osteoarthritis.

THE KNEE

The knee is the largest joint in the body, it is made up of two joint compartments: the femoro-tibial joint (both internal and external) and the femoro-patellar joint. The bones that form the knee joint are the femur, tibia, and patella[1] (Flandry F et al, 2011)

The knee must support the weight of the body and keep the leg in extension to be able to stay upright (standing position). It is part of the lower extremity (LE) and must act in standing and walking.

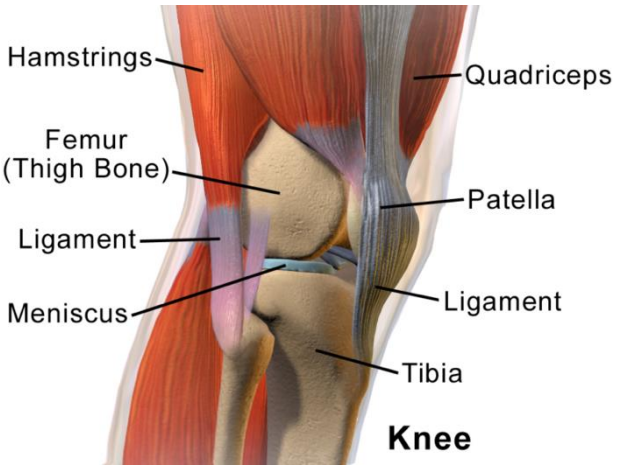


Figure 1: Knee structure

Under normal conditions, it should allow us good stability to be able to walk and carry out activities of daily living (ADL). This stability depends on the ligaments and the strength of the surrounding muscles, the quadriceps and hamstrings.

Pathologies such as knee arthrosis are common in this joint, the incidence of this pathology increases with age and is more common in women, especially after the age of 50.

Knee osteoarthritis affects all the structures of the joint as there is not only a loss of cartilage but also a weakness of the muscles that makes the joint not work well and does not have the appropriate stability.

[1] Flandry.et al (1998) . *Normal anatomy and biomechanics of the knee*

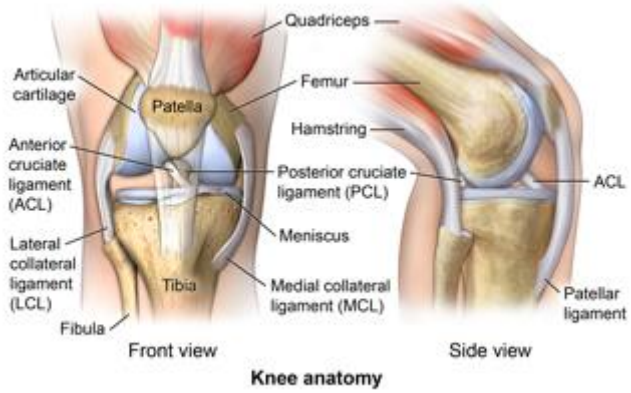


Figure 2: Knee anatomy

The menisci are oval-shaped fibrocartilaginous cartilages found between the femur and tibia and their aim is to prevent friction between the two bones and to give consistency to the joint, that is, to make the two bones fit better. The knee is reinforced on each side by collateral ligaments and two extraordinarily strong ligaments (cruciate ligaments) that connect the ends of the femur and tibia, maintaining their opposite positions during movement. The stability of the knee depends largely on the ligaments and the power of the muscles that surround it, mainly the quadriceps and hamstrings; the muscular balance between both is important to ensure the stability of the knee. The movements of the knee are flexion and extension.

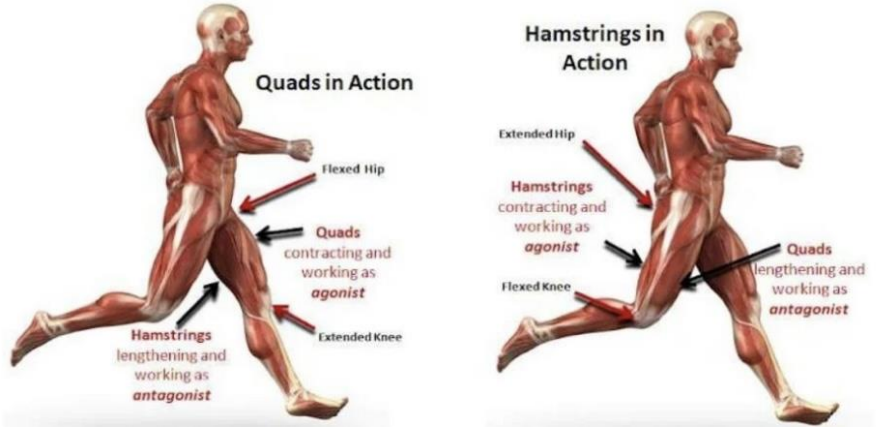


Figure 3: Flexion and extension movements of the knee

MUSCULATURE

EXTENSOR MUSCLES

The extensor muscles start at the front of the thigh, all muscles emerge from the femoral or pelvic bones. The extensor of the knee joint is the quadriceps muscle, which is composed of four muscle bodies: rectus femoris, vastus internus, vastus intermedius and vastus lateralis, and they arise in the femoral shaft. The four muscles join in a common tendon (quadriceps tendon) that extends over the kneecap until reaching the tuberosity of the tibia.

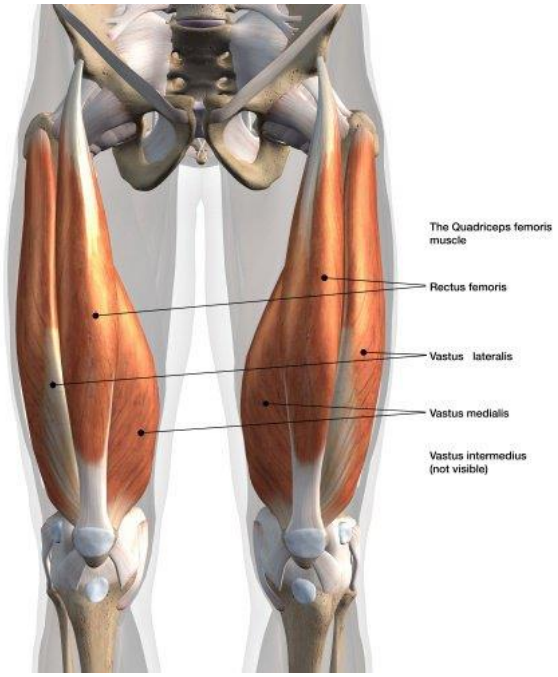


Figure 4: quadriceps muscles

FLEXOR MUSCLES

The flexor muscles start at the back of the leg, all muscles have their root in the femoral or pelvic bones. The main flexors of the knee joint are the hamstrings formed by the biceps femoris, the semitendinosus and the semimembranosus.

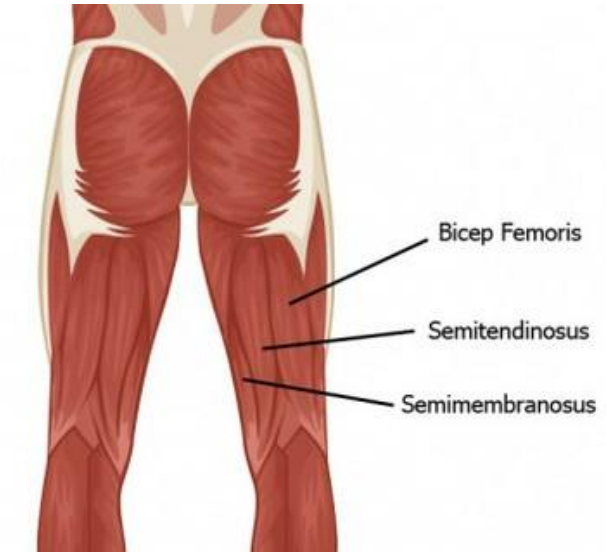


Figure 5: Hamstring muscles

The quadriceps can be three times more powerful than its antagonist muscle group, the hamstrings.

There are different methods to assess the strength of the quadriceps and hamstring muscles, the two most common in the clinic are manual tests and isokinetic tests. Manual tests are more uncomplicated, but the results are more subjective and less accurate, on the other hand, the isokinetic test is more objective from a clinical point of view.

In the past, muscle strength was primarily measured using isometric, isotonic, or densiometric techniques. The advent of isokinetic dynamometers has provided an objective method of measuring peak torque throughout a range of motion at a predetermined contraction speed.

ISOKINETIC TEST

Isokinesis is an evaluation system that uses computer and robotic technology to obtain and process quantitative data on muscle capacity. Isokinetic dynamometers are passive devices that resist applied forces and control the speed of exercise at a predetermined rate. These dynamometers provide a record of applied force throughout a joint range of motion. Some of the postulated advantages of isokinetic exercise include safety, accommodating resistance, and ease of muscle strength analysis.

With the isokinetic method, a movement is performed at a constant speed throughout the arc or range of motion and with an adjustable resistance throughout the entire range of motion of a joint.

Isokinetic devices allow us to assess muscle performance and provide us with quantitative, objective, and documented data on muscle capabilities. The parameters can be measured with an analytical movement, in one or multiple axes and, within these, agonist and antagonist muscles can be assessed [2-3] (Kambic T et al, 2020; Zawadzkj J et al, 2010). The results are obtained in physical quantities, in terms of force, work and power.

[2] Kambic et al.(2020) *Reproducibility of isokinetic knee testing using the novel isokinetic SMM iMoment dynamometer*

[3] Zawadzki et al (2010) *Validity analysis of the Biodex System 3 dynamometer under static and isokinetic conditions*

Figure 6: Biodex System 4 Pro isokinetic dynamometer

PEAK TORQUE (PT)

The peak torque relates to the maximum value of force of the moment recorded, expressed in absolute value, and measured in Newton per meter (Nm). It occurs at the point of maximum mechanical advantage of the muscle and is the parameter most used in evaluations since it is the maximum muscle force at any time during a repetition, indicating muscle capacity.

TOTAL WORK (TW)

The total work is the total muscle strength for the repetition with the greatest amount of work, the absolute value is expressed and measured in Joules (J). It indicates the muscle's ability to produce strength throughout a range of motion, having a direct relationship with joint functionality.

AVERAGE POWER (AP)

Average power is total work divided by time and represents how fast a muscle can produce force, expressed in absolute value and measured in Watts (W). High power values will indicate that the subject performs a greater amount of work in less time.

RATIO QUADRICEPS-HAMSTRINGS (H:Q)

The hamstrings/quadriceps ratio (H:Q) refers to the relationship between the peak torque of the two muscle groups. Traditionally, the H:Q ratio has been calculated as the maximum concentric force of the hamstrings divided by the of the quadriceps one for the same angular speed. However, over time, different authors have suggested that the agonist-antagonist strength relationship for knee extension and flexion would be better described as the ratio between the peak torque in eccentric contraction of hamstrings and the concentric peak torque of quadriceps. It is what has been called the functional H:Q ratio. As we already know, the quadriceps is one of the largest and most powerful muscles in our body, so it will be vitally important to also have high strength values in hamstrings, especially in the eccentric contraction, so that way, they can counteract and slow down the action of the quadriceps.

In this way, a low hamstring-quadriceps strength ratio (H:Q) will increase the moment of knee extension, requiring an eccentric contraction and stretching of the hamstrings beyond their capacity.[4]

[4] Guex et al. (2013) *Conceptual Framework for Strengthening Exercises to Prevent Hamstring Strains*

OSTEOARTHRITIS

Osteoarthritis is a degenerative joint disease characterized by the initial alteration of the integrity of the cartilage and the subchondral bone and, subsequently, of the rest of the joint structures. It can affect any joint, with the knee joint being the most frequent and the most common in women. Osteoarthritis can be initiated by multiple factors among which are include genetic, metabolic and environmental factors[5] (Svetlize HD, 1991).

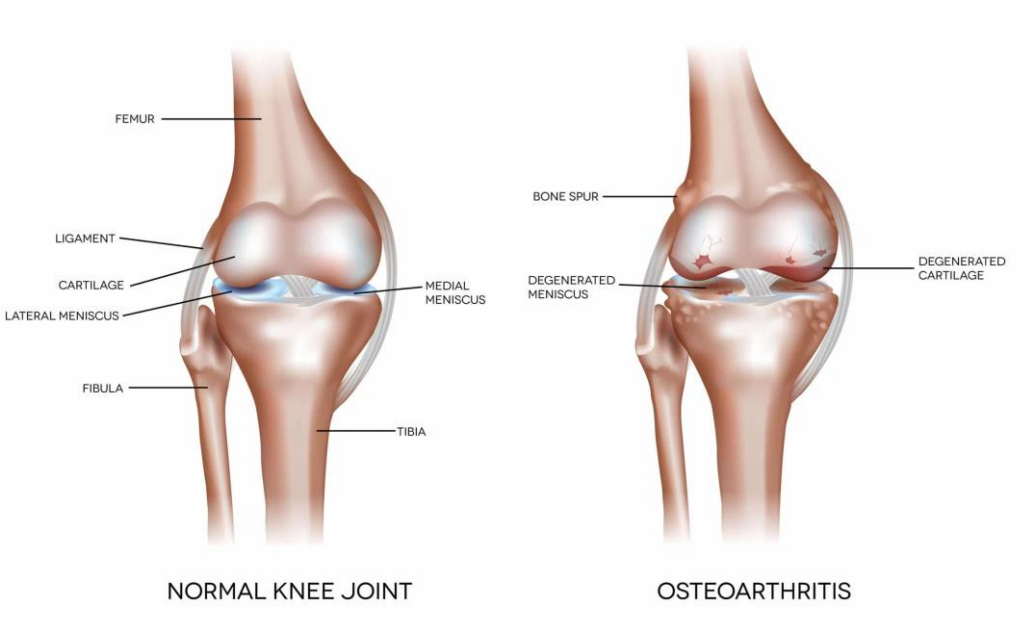


Figure 7: Comparison between a normal knee and a knee with osteoarthritis

There are numbers of risk factors that can be classified into; non-modifiable and modifiable.

NON-MODIFIABLE FACTORS

- Genetic factors: arthrosis of a genetic type cannot be avoided, although an early detection can help to slow down the progress of the disease.

[5] Svetlize (1991) *Muscular isokinetic dynamometry*

- Age: a marked increase in the frequency of severe osteoarthritis has been found in the elderly, probably due to aging and wear of the joints[6] (Pincivero et al. 1997)

- Gender: the incidence in the female population is better, although this difference is smaller as age increases[7] (Felson DT; Zhang Y,1998).

MODIFIABLE FACTOR

• Overweight and obesity: there are many studies that defend the relationship between obesity and knee osteoarthritis, although the mechanisms by which obesity could promote the appearance of osteoarthritis are not known. The most accepted theory would be that it is related to the excess load it has to bear, especially in the case of the hip and knee [8](Reyes C et al,2016)

- Occupational factors: knee osteoarthritis has been associated with work that requires long and repeated flexions of this joint[9](Katz JN et al, 2021)

Elite sports activity: can be associated with an increased risk of osteoarthritis, although other risk factors must coexist[10](Impivaara O, et al, 2011)

- Muscular strength: knee injuries are related to the appearance of osteoarthritis as a result of the lack of mobility and the atrophy of the quadriceps[11] (Brandt K D et al ,1999)

[6] Pincivero et al. (1997) *Reliability and precision of isokinetic strength and muscular endurance for the quadriceps and hamstrings*

[7] Felson et al. (1997) *An update on the epidemiology of knee and hip osteoarthritis with a view to prevention*

[8] Reyes et al- (2016) *Association Between Overweight and Obesity and Risk of Clinically Diagnosed Knee, Hip, and Hand Osteoarthritis: A Population-Based Cohort Study*

[9] Katz et al. (2021) *Diagnosis and Treatment of Hip and Knee Osteoarthritis*

[10] Impivara et al (2011) *Knee osteoarthritis in former runners,soccer pl ayers, weight lifters, and shooters*

[11] Brandt et al. (1999) *Quadriceps strength in women with radiographically progressive osteoarthritis of the knee and those with stable radiographic changes*

Muscle weakness, especially of the quadriceps muscle, is one of the biggest consequences of knee osteoarthritis. This muscle acts as an important shock absorber at the level of the knee, so its loss of power and functional capacity exposes the knee joint to progressive structural damage.

Current data suggest that in knee osteoarthritis quadriceps muscle weakness influences painful symptoms, disability and progression of joint damage. The benefit of aerobic exercise and muscle strengthening has been demonstrated with symptomatic relief of knee osteoarthritis in addition to its positive effect on depression, anxiety and functional capacity[12] (Blanco,2018).

[12] Blanco (2018) . *La artrosis y la ateroesclerosis de la articulación*

HYPOTHESIS AND OBJECTIVE

The values of the isokinetic parameters of the muscular strength in healthy women, decrease with age, therefore they have a greater risk of knee osteoarthrosis.

MAIN OBJECTIVES

1. Evaluate the isokinetic parameters of muscle strength, such as peak torque, average power and total work of the quadriceps and hamstring muscles involved in the knee joint in healthy women from 20 to 50 years old.
2. Study the influence of age in every isokinetic parameter.
3. Get to know the normal strength parameters in healthy women based on age.

SECONDARY OBJECTIVES

1. Study the relationship between age, physical activity and knee pain.

STUDY DESIGN

STUDY TYPE

In this project I have carried out a descriptive observational study, observational studies correspond to research designs that aim to observe and record facts without intervening in their natural course.

Scientific studies can be classified according to the type of analysis (descriptive or analytical), according to the time of recording the observations (cross-sectional or longitudinal), according to the temporal sequence with respect to the design (retrospective or prospective), according to the intervention of the researcher (observational or experimental), according to the unit of analysis (individual and ecological or population), understanding that each study must be designed specifically to answer each research question, and each type of study has indications (for example, descriptive studies allow generating hypotheses that will have to be tested through analytical studies). Descriptive studies with descriptive

purposes are cross-sectional studies that allow the generation of etiological hypotheses as a step before carrying out studies that can verify them.

MATERIAL AND METHOD

STUDY POPULATION

The study population was made up of healthy women aged between 18 and 50 who had an objective assessment of the muscle strength of the Quadriceps and Hamstrings.

This objective assessment was carried out using an isokinetic dynamometer located in the Rehabilitation, Physiotherapy and Speech Therapy Service of the Sant Joan de Reus University Hospital. To be able to do it, permission was requested from the person in charge of the Service.

All the participants who were assessed were hospital workers who volunteered to work in the field work. In addition, in order to have younger women, this work was discussed with the students of the Degree in Physiotherapy of the Rovira I Virgili University who do internships and volunteered to be evaluated.

All women did not present pain or any other pathology in the knee joint. These evaluations were carried out during the months of August and September 2022 at the Sant Joan de Reus University Hospital.

In order to be able to play an active role in the assessments, I received a small training from the physiotherapists who are experts in carrying out these assessments. Even so, the tests were always carried out with the supervision and help of a physiotherapist from the Rehabilitation service.

All the participants were given an isokinetic assessment which consisted of measuring muscle strength with an isokinetic dynamometer (Biodex4Pro).

Figure 8: Isokinetic hamstring-quadriceps torque test in the Biodex 3 system

ISOKINETIC POPULATION OF THE MUSCULAR STRENGTH

The isokinetic technique with the use of computerized dynamometry allows the study of muscle function, analysing, among other parameters, the evolution of strength, work, resistance and muscle power. The evaluation was done with a Biodex System 4 isokinetic dynamometer and the test consisted of performing a series of five repetitions at the angular speed of 60º/s and a series of ten repetitions at the speed of 180º/s of the flexion movement/ extension of both knees. A one-minute break was allowed between sets. During the test the following data were obtained: maximum torque, total work and maximum power at the two nominal speeds.

After the series is completed, the individual evaluation sheet is printed with all evaluated parameters of the quadriceps and hamstrings. All this data was entered into an excel sheet to create a database and to be able to study the results obtained.

RESULTS

To make the results more clear, certain important aspects are remembered to be considered and will appear throughout their description.

- An isokinetic assessment was carried out, at speeds of 60°/SEG and 180°/SEG.
- The isokinetic test that was performed was a concentric isokinetic work of the quadriceps and hamstring muscles respectively responsible for the extension and flexion movements.
- The isokinetic variables assessed were peak torque (PT), total work (TW) and average power (AP).
- The PT is the maximum moment of force that the muscle can do in one repetition. It is measured in Newton- meter.
- The TW is the ability of the muscle to maintain the contraction force throughout the test. It is measured in Joules.
- AP is how quickly a muscle can make strength. It is measured in W.
- The main variables are shown with the subgroups when dividing the population by age (> 30 years and ≤ 30 years).
- The n was 30.

SAMPLE DESCRIPTION

A descriptive analysis of the entire sample was carried out. The distribution of the sample is going to be established at n=30. In table 1 it is possible to observe characteristics of the population according to the variables of age, weight and sex.

Variable	
Age; years	31,33±8,38
Weight; Kg	59,20±8,12
Gender; female n (%)	30 (100%)

The results are expressed in median ± standard deviation and frequency (%).

The average age of the participants was 31,33 years.
The minimum age variable was 20 years and the maximum 47 years.
The average weight was 59.20 Kg. The minimum was 46 Kg and the maximum 75Kg.

ISOKINETIC RESULTS

Table 2 shows the results of the isokinetic variables peak torque (PT), total work (TW) and average power (AP) in flexion and extension movement of the knee joint, at speeds of 60°/SEG and 180°/SEG.

	SPEED	MOVEMENT			
PT	60º/SEC	FLEXION	63,97	±	14,65
		EXTENSION	131,67	±	31,18
	180º/SEC	FLEXION	47,93	±	11,82
		EXTENSION	85,82	±	20,36
AP	60º/SEC	FLEXION	42,08	±	13,09
		EXTENSION	81,78	±	24,56
	180º/SEC	FLEXION	62,47	±	22,85
		EXTENSION	121,00	±	40,21
TW	60º/SEC	FLEXION	291,61	±	72,44
		EXTENSION	565,05	±	158,60
	180º/SEC	FLEXION	422,49	±	102,21
		EXTENSION	798,38	±	196,92

The results are expressed as median ± standard deviation.

PEAK TORQUE

Regarding the peak torque, we can observe that the maximum moment of force that the muscle can make in one repetition expressed as PT, is twice as much in the extension movement at 60º/sec as in the flexion movement and almost double at the speed of 180º/sec

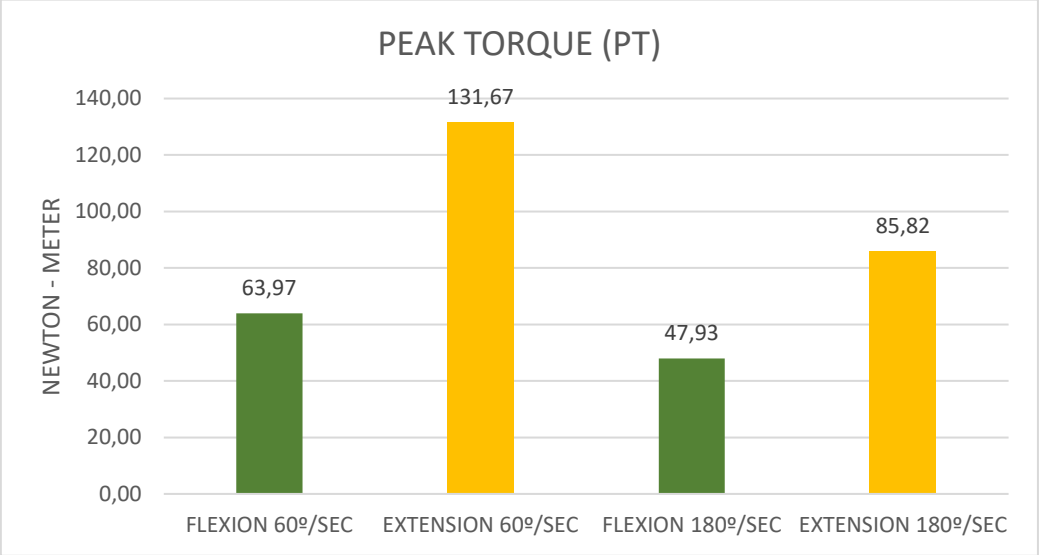


Figure 9: Global results of the peak torque isokinetic variable.

AVERAGE POWER

Regarding the average power, we also see that it is almost twice as much in the extension movement as in the flexion movement at the two speeds analysed.

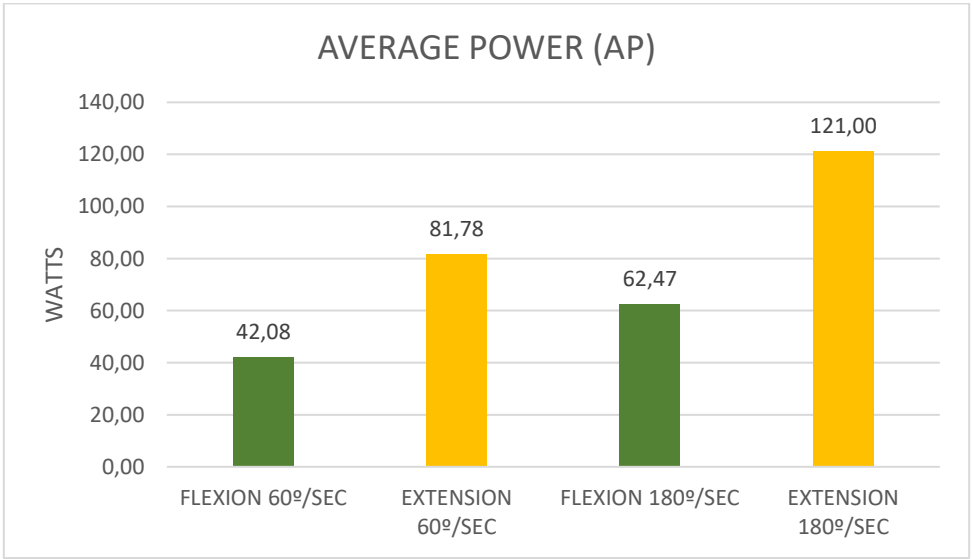


Figure 10: Global results of the isokinetic variable average power.

TOTAL WORK

In the total work variable, we can observe that in the two speeds the capacity of the muscle to maintain the contraction strength throughout the test, expressed as total work is superior in the extension movement at both 60º/sec as 180º/sec

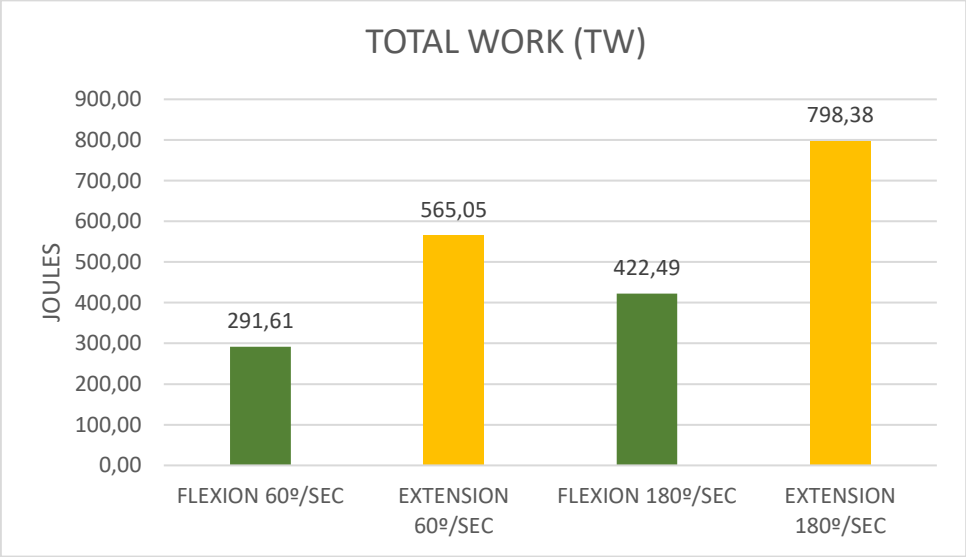


Figure 11: Global results of the isokinetic variable total work.

RATIO HAMSTRINGS/QUADRICEPS (Q: H)

In general, in all isokinetic variables it is observed that the average is higher in the extension movement, as we indicated before the quadriceps can be 3 times more powerful than its antagonistic muscle group: the hamstrings

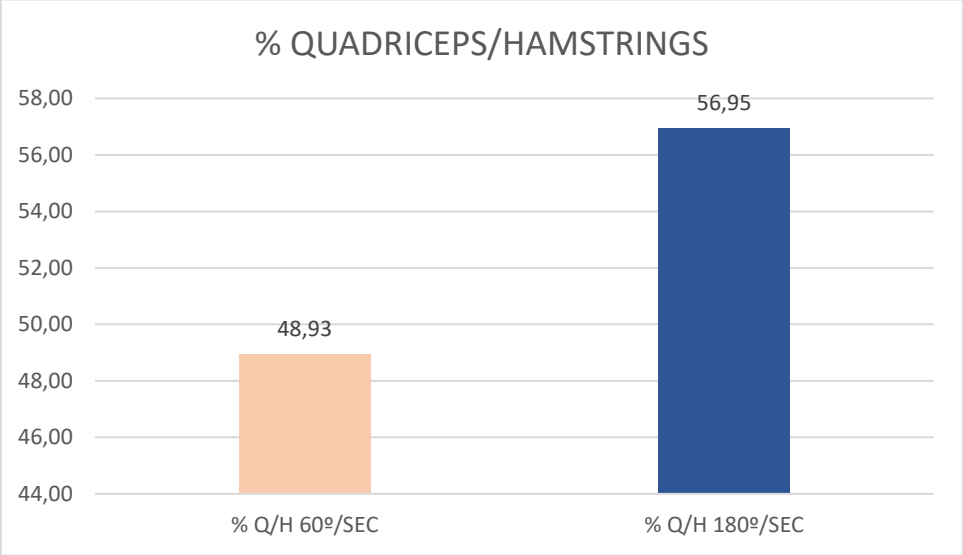


Figure 12: Global results of the isokinetic variable ratio % Q/H.

ISOKINETIC RESULTS ACCORDING TO AGE

The same isokinetic variables differentiated by age were also assessed. Table 3 reproduces the results obtained for the variables
PT, TT and AP differentiated by age (over 30 and under 30).

	YEAR	SPEED	MOVEMENT			
PEAK TORQUE (PT)	< 30 years	60º/SEC	FLEXION	69,16	±	13,16
			EXTENSION	137,76	±	26,05
		180º/SEC	FLEXION	52,19	±	12,90
			EXTENSION	89,86	±	19,48
	> 30 years	60º/SEC	FLEXION	59,43	±	14,76
			EXTENSION	126,33	±	35,02
		180º/SEC	FLEXION	44,21	±	9,70
			EXTENSION	82,28	±	21,07
AVERAGE POWER (AP)	< 30 years	60º/SEC	FLEXION	47,21	±	13,53
			EXTENSION	86,63	±	24,25
		180º/SEC	FLEXION	68,43	±	25,11
			EXTENSION	131,33	±	38,39
	> 30 years	60º/SEC	FLEXION	37,58	±	11,25
			EXTENSION	77,54	±	24,81
		180º/SEC	FLEXION	57,26	±	20,03
			EXTENSION	111,96	±	40,76
TOTAL WORK (TW)	< 30 years	60º/SEC	FLEXION	291,76	±	67,67
			EXTENSION	530,61	±	120,56
		180º/SEC	FLEXION	427,69	±	107,81
			EXTENSION	807,47	±	146,60
	> 30 years	60º/SEC	FLEXION	291,48	±	78,59
			EXTENSION	595,18	±	184,28
		180º/SEC	FLEXION	417,94	±	100,39
			EXTENSION	790,43	±	237,06

The results are expressed as median ± standard deviation.

PEAK TORQUE

Regarding PT, we observed that participants under 30 years old were statistically superior to those over 30 years old in both 60º/sec and 180º/sec speeds in flexion and extension.

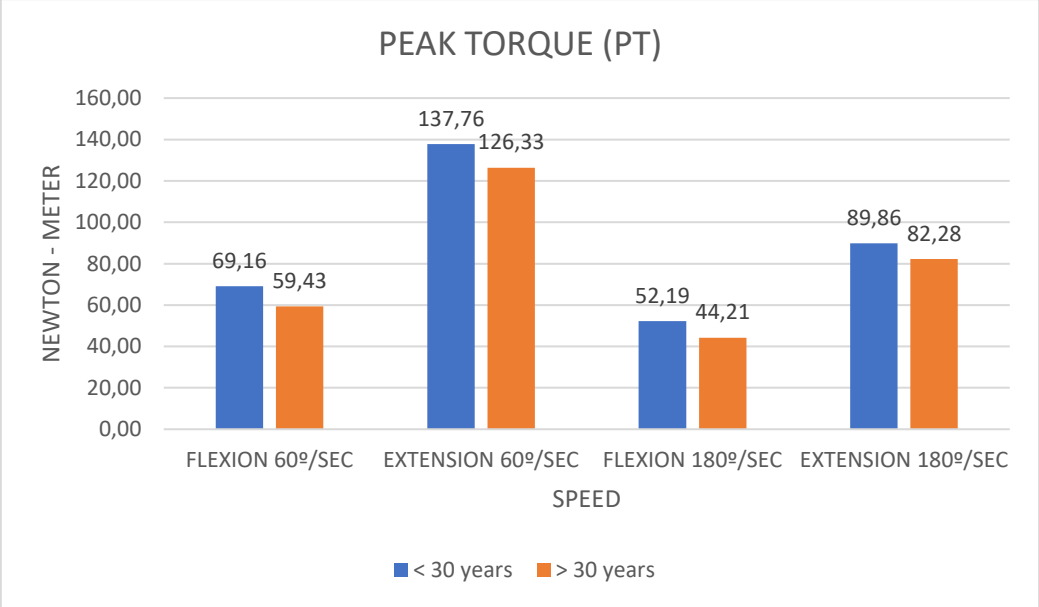


Figure 13: Global results of the isokinetic variable peak torque according to age.

AVERAGE POWER

Regarding AP, we observed that participants under 30 years old were statistically superior to those over 30 years old in both 60º/sec and 180º/sec speeds in flexion and extension.

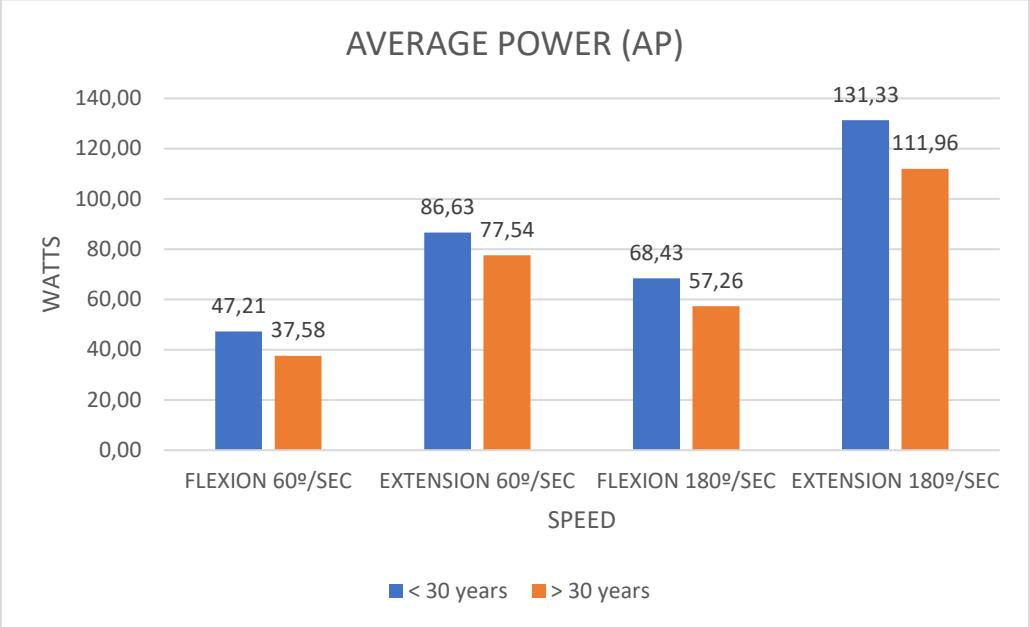


Figure 14: Global results of the isokinetic variable average power according to age.

TOTAL WORK

Regarding the TT, we observed in the extension to 60º/sec that those over 30 years of age were statistically above those under 30 years of age, referring to the fact that the total resistance to 60º/sec was greater than that of those over 30 30 in extension.

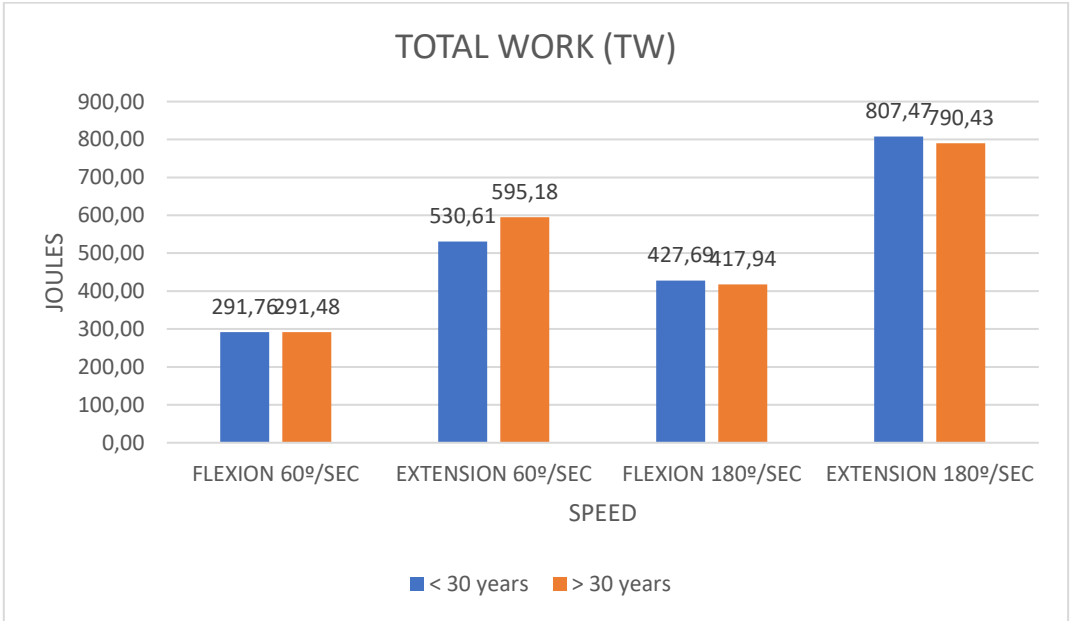


Figure 14: Global results of the isokinetic variable total work according to age.

RATIO H: Q

Regarding the Q: H ratio, we observed that the tan percent in both speeds at 60º/sec and at 180º/sec in those under 30 is higher statistically speaking.

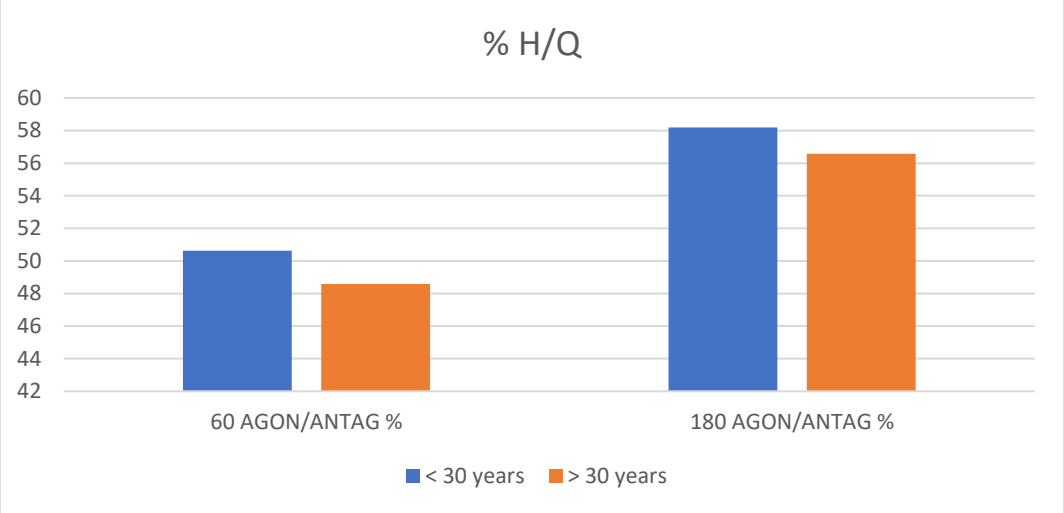


Figure 15: Global results of the isokinetic variable ratio H/Q according to age.

DISCUSSION

Osteoarthritis (OA) is the most common joint disease, specifically in the knee it causes significant disability in middle and advanced age. People with this pathology have pain and inflammation of the affected knee joint, but also a muscular affectation of the muscle groups that surround it (quadriceps muscle and hamstring muscles). The treatment of this pathology is to reduce the symptoms and improve the state of the musculoskeletal system that surrounds the joint with physiotherapy. A good assessment of the loss of functionality of the musculature related to the joint, objectively, as with an isokinetic device, would allow us to act early in the initial phases of OA. A possibility for action is to strengthen the muscles, since this is diminished from the age of 30.

In the study, the isokinetic variables assessed were PT, TT and PM. PT is the maximum muscle force at any time during a repetition and is indicative of muscle capacity. The TT is the total muscle strength for the repetition with the highest amount of work and is indicative of the muscle's ability to produce force throughout a range of motion. And PM is total work divided by time and represents how quickly a muscle can produce force. The PT and the TT are variables that indicate the capacity of the muscle but with differences: the PT reflects the behaviour of the muscle in a specific sector of the entire route while the TT reflects the work of the muscle throughout the test; therefore, this last variable is more related to joint functionality.

In isokinetic assessments, variables such as PT and TT allow us to see the strength of a muscle and how it can keep it in a given working time. However, a muscle must not only have strength, but must also react quickly and we can see this with the PM variable.

The assessment of the PT, TT and PM isokinetic variables can be done at different angular velocities: slow, medium or fast. Currently, there is controversy in the literature regarding angular velocities, but the manufacturers of the devices suggest recommendations regarding the position and speed that must be taken into account when performing the test (Alqualo, 2010).

In our study we assessed at a slow speed (60°/SEG) and at a medium speed (180°/SEG).

In OA, the condition of the muscles that surround the joint and that will give it stability is very important. The musculature directly involved in this joint is made up of the quadriceps muscle, responsible for the extension movement of the knee, and the hamstring muscles, responsible for bending the knee. The loss of extensor and flexor strength is attributed to the weakness of the quadriceps muscle, because its strength (the generation of PT) is an important determinant of physical function in subjects with knee OA (Hafez et al., 2013). Muscle alterations in patients with knee OA are not limited to the quadriceps muscle, but also involve the hamstring muscles (Hafez et al., 2013).

In individuals with knee OA, a decrease in bending moment is thought to be a compensatory strategy used to reduce the load on the knee joint (Astephen et al., 2008).

In this study, muscle measurements were made using a baseline methodology, with a dynamometer and a computerized system that allows arcs of motion to be measured at a constant angular velocity. The isokinetic assessment is a precise method for assessing muscle activity (Molczyk et al., 1991). The data obtained with this assessment could be used to implement rehabilitation programs that were more effective (Douglas, 1995), since they would be prepared through the result of objective assessments.

In our study we provide reference values of PT, PM and TT from basal isokinetic tests in healthy women.

In this study we only assessed muscle strength in women. Muscle strength varies according to sex and age, in a healthy population; women have less muscle strength than men in all age groups and it decreases around the age of 41 (Danneskiold-Samsoe et al., 2009).

Kasai et al. They observed sex and age differences related to muscle composition and quality. Several studies have also suggested that the loss of ovarian function

could indirectly be associated with the accelerated decline in muscle strength after menopause as well as changes in sex hormones that affect muscle metabolism (Sirola and Rikkonen, 2005).

The results obtained in the study suggest that from the age of 30 this decrease in strength is already observed and the average age of our sample for those over 30 is 37.4 years, therefore according to these authors we must be alert because after menopause this decrease will be accelerated, therefore it would be advisable to detect it early in order to be able to exercise to avoid or delay this loss as much as possible.

Regarding the relationship between the H/Q ratio, a low % has a higher risk of injury, according to Aslan et al., 2020 there is a weakness of the quadriceps and hamstrings in people with OA. The functional H/Q ratio helps to analyze the functions of the knee joint in order to develop preventive therapies for OA, such as therapeutic exercises to improve the condition of the muscles.

In our study the H/Q ratio that has been calculated is the traditional one since the isokinetic tests we performed were concentric, we believe that this has been a possible limitation of the study, as well as the number of the sample.

Future studies are needed to confirm the results described and to be able to have reference values in a healthy population to detect earlier the muscle weaknesses that occur with age and act as soon as possible to prevent or delay OA.

For this reason, we also wanted to design an exercise table to strengthen the muscles involved in the knee joint.

CONCLUSION

1. In the general sample, the PT values are higher at the speed of 60º/sec both in the flexion movement and in the extension movement.
2. In the general sample, the values of AP and TW are higher at the speed of 180º/sec both in flexion movement and in extension movement.
3. When we separate the sample by age, women > 30 years old decrease the PT values in both, the flexion movement and the extension movement, at both speeds.
4. When we separate the sample by age, women > 30 years old decrease the AP values in both, the flexion movement and the extension movement, at both speeds.
5. When we separate the sample by age, women > 30 years have a lower % of the Q/H ratio both, at the speed of 60º/sec and 180º/sec.

EXERCISE AS PREVENTION

In the knee, the muscles not only function to produce movement, but also to absorb the load from the extremities and provide dynamic stability to the joint. Muscle weakness has been identified as a potential risk factor of osteoarthritis development due to the increased contribution on the joint overcharge.

In addition, the presence of osteoarthritis undermines the integrity of the structure and function of the muscles, which could further affect the disease process. Different studies[13]-[14] show how muscle weakness, along with reduction of joint proprioception, are risk factors for osteoarthritis development.

In particular, the weakness of the quadriceps muscle, as a result of inactivity or other processes, has been extensively studied and is considered an important risk factor for knee osteoarthritis[15] [16]. In these patients it is common the appearance of a weakened quadriceps.

Previously, the atrophy of this muscle was attributed to the decrease in load to avoid joint pain in the knee. Some evidence suggests that quadriceps weakness precedes the onset of knee osteoarthritis, potentially increasing the risk of developing the disease, particularly in a cross-sectional study where Slemenda et al. (1997)[17] examined the relationship between muscle strength and knee arthrosis in a randomly selected population over 65 years of age. The authors found that in this population, with no history of knee pain, there was a strong

[13] Hurley et al. (1998) *Improvements in quadriceps sensoriomotor function and disability of patients with knee osteoarthritis, following a clinically practicable exercise regime.*

[14] Hopman et al (2000) *The effects of a health educational and exercise program for older adults with osteoarthritis of the hip or knee*

[15] Jan et al (1991) *The effects of physiotherapy on osteoarthritis knees of females.*

[16] Doerty et al (1999) *Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: a randomised controlled trial*

[17] Slemenda et al (1997) *Quadriceps weakness and osteoarthritis of the knee.*

association between isolated quadriceps weakness and radiographic signs of osteoarthritis.

There are more publications that suggest that quadriceps weakness can be a risk factor for the onset of knee osteoarthritis[18] [19]. The results of different studies show that muscle strengthening, and aerobic exercise programs improve joint integrity, reduce symptoms, increase function and possibly provide protection against disease progression.

Even though causes and development of knee arthrosis are not known yet, the current evidence is enough to design effective therapeutic actions in which the increase in physical activity and a physical exercise program would be a great use for the prevention of osteoarthritis.

[18] Burns et al (2000) *Long term exercise and is effect on balance in older, osteoarthritis adults: results from the fitness, arthritis, and seniors trial (FAST)*

[19] Arden et al (2005) *Evidencebased recommendations for the role of exercise in the management of osteoarthritis of the hip or knee - the MOVE consensus.*

EXERCISE PROGRAM

Knee extension with towel support

3×12 rep each leg

Leg elevation in extension

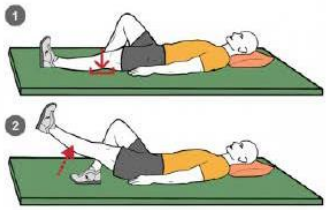
3×12 rep each leg

Double crunch quadriceps and hamstrings

5×10 rep holding it up and relaxing it 10"

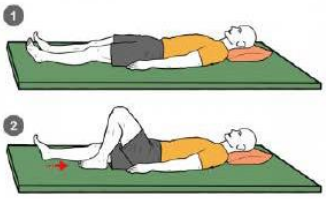
Elevation of a leg in extension

3×12 rep each leg



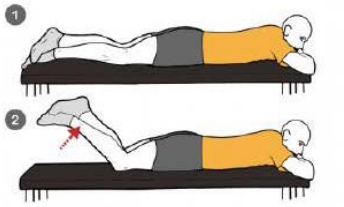
Active knee flexion

3×12 rep each leg



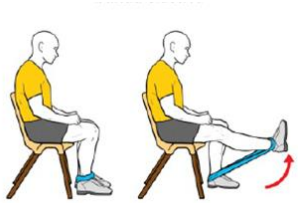
Leg curl with the help of the other leg

3×12 rep each leg



Seated quadriceps extension with elastic band

3×12 rep each leg



Isometric half squat

3×20" rest 30"

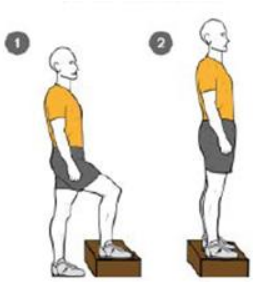
Seated hamstring stretch

12" stretch

Stand up quads stretch

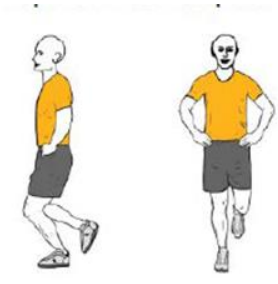
Climb a step

3×12 rep each leg



Go down a step

Balance on one leg



Balance one leg on towel.

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