Reumatol Clin. 2010;**6(3)**:153–160

Reumatología Clínica

www.reumatologiaclinica.org

Review

Physical exercise as non pharmacologic therapy in knee osteoarthritis

Pedro José Benito Peinado,* Rocío Cupeiro Coto, and Francisco Javier Calderón Montero

Facultad de Ciencias de la Actividad Física y del Deporte, INEF, Universidad Politécnica de Madrid, Madrid, Spain

ARTICLE INFO

Article history:
Received September 25, 2008
Accepted December 1, 2008

Keywords:
Osteoarthritis
Joint disorder
Exercise
Physical activity
Strength

ABSTRACT

Knee osteoarthritis is one of the most frequent joint disorders, and its major symptoms are pain and physical disability. Cartilage regeneration therapies are still under development, and current treatments target pain and disability. Physical activity could be a cheap and effective therapeutic option. However, it is not yet known which types of exercise are the most beneficial, as well as its load or intensity. Therefore, the objective of this work is to integrate all the information about the design of training programs for knee osteoarthritis treatment. All of the selected articles by Talbot and colleagues1 (except one), showed significant improvement in knee pain, physical performance, or both. However, many authors do not describe the main elements of the programs, so its application as a therapy or for contrasting the results is not possible.

Ejercicio físico como terapia no farmacológica en la artrosis de rodilla

Palabras clave:
Artrosis
Enfermedad articular
Ejercicio
Actividad física
Fuerza

RESUMEN

La artrosis de rodilla es una de las enfermedades articulares más frecuentes, sus síntomas principales son dolor e incapacidad física. La regeneración del cartílago es un tratamiento todavía en desarrollo, por lo que los tratamientos actuales se centran en aliviar los síntomas. El ejercicio físico se presenta como una alternativa u opción de tratamiento barata y efectiva. Sin embargo, todavía no está claro qué tipo de ejercicio, cantidad, intensidad, etc., son más recomendables. Por lo tanto, el objetivo de esta revisión es integrar toda la información posible de cara al diseño de programas de entrenamiento para el tratamiento de la artrosis de rodilla. Todos los artículos seleccionados tras la revisión, salvo el de Talbot et al[1], mostraron mejoras significativas en el dolor de la rodilla, en la capacidad física o en ambas variables. Sin embargo, muchos autores obvian elementos cruciales del programa, por lo que no es posible la aplicación con fines terapéuticos o para contrastar los resultados en otras muestras.

Introduction

Among the different types of treatments that can be used as an intervention for knee osteoarthritis, exercise seems to have the least side effects or sequelae. However, there is considerable controversy[2] regarding what type of exercise is appropriate and what the recommended doses are. This paper aims to help define, from a practical standpoint, the characteristics of the treatments used in clinical trials.

Background

It is estimated that symptomatic knee osteoarthritis (defined as pain on most days, in addition to evidence of the disease on a radiograph of the affected knee) has a prevalence of 11% in individuals older than 65 years of age.[3]

In Spain, according to the National Health Survey 2003, 10% of Spaniards have SLE or other rheumatic problems[4] that in women increases to 22%.

The most characteristic symptoms of osteoarthritis are pain and physical disability,[5-8] which combined reduce the quality of life of those affected.[8]

Pain in the affected joint is the most common symptom, and contributes to a significant decline in the persons functional capacity.[9,10] The anatomic cause is unclear and is likely to vary between individuals; somerecent studies confirm the heterogeneity of arthritic pain by location, severity, etc.[10]

Impact on risk factors may reduce the symptoms and disability associated with osteoarthritis. Many authors mention overweight and obesity as risk factors, and some studies suggest that the reduction of symptoms correlates more with the reduction in fat

* Corresponding author.
E-mail address: pedroj.benito@upm.es (P.J. Benito Peinado).

mass than to total body weight reduction.[2,8,11] Weakness of the quadriceps, is the variable that in itself predicts further functional limitation of the lower extremity, even more than pain,[3,12] which may be a risk factor for knee osteoarthritis.[5,8] On the other hand, some studies show that a reduced sense of position contributes to the development of osteoarthritis, in addition to the fact that proprioception is significantly decreased in older adults with osteoarthritis.[8,12]

Finally, given the impact it has on the design of possible clinical trials, it should be noted that the most decisive risk factor for both radiologic osteoarthritis as for the radiologic osteoarthritis in any joint, is age.[8] In spite of this, subjects in most of the studies discussed below have an average age around 65, which only allows conclusions for this age group.

Current treatments do not focus on improving the state of cartilage (currently there are no drugs that succeed in this sense), but to treat pain caused by the disease,[2,12,13] in addition to attempting to maximize functional independence and improve quality of life.[8]

Given this orientation of therapies and risk factors, we have observed that a possible non-pharmacological treatment that may have an impact on them (and potentially reduce the symptoms of osteoarthritis), is exercise. This concept refers to any bodily movement performed with a specific methodology and pursuing a defined objective.

This idea of using exercise is supported by the consensus of several organizations and researchers (AGS, EULAR, OARSI and ACR) to include in their guidelines the recommendation of the use of exercise as therapy.[8,14-20] In addition, experts agree that arthritic pain management should be approached holistically and in a multidisciplinary way that includes both nonpharmacologic and pharmacologic therapy. They also mention that initial treatment should be non-pharmacological,[8] making physical activity an important tool in the early stages of the disease.

However, the causes by which pain occurs in osteoarthritis are not entirely clear[2,21] and certainly, until these are better defined, it will be difficult to clarify the mechanism by which exercise reduces these symptoms.

Furthermore, most studies that consider physical exercise as an intervention have been performed on knee osteoarthritis, but the same principles are likely to be applied to other anatomic locations.[2]

Despite these recommendations and the many studies that have found improvements in pain and functional capacity through exercise programs used as treatment, there is a lack of practical information. That is, it is less clear what type of exercise to use or the core features of the program (duration, volume, intensity, etc.).

Systematic literature search

To recover all ofl the recently performed studies that investigated the efficacy of exercise as a treatment for osteoarthritis of the knee, we performed a literature search in all of the major databases: PubMed, Dialnet and Sportdiscus. The search phrases were composed by "ejercicio *OR* exercise" or "actividad física *OR* physical activity" and "artrosis rodilla *OR* knee osteoarthritis". This review was conducted following the systematic search procedure proposed by Benito et al,[22] in which a search phrase is established with keywords that are then entered into the major national and international databases of the area under study. After obtaining the results of different searches, the researcher chooses items according to predetermined inclusion criteria. The references of the selected articles are also reviewed in order to obtain potentially interesting new studies.

Inclusion criteria for selecting clinical trials for review were: articles published during the past 10 years, ie the period between 1999 and 2008, Spanish or English languages, osteoarthritis only on the knee joint, with a detailed description of the training program (mentioning its main features: volume, intensity, duration and progression of the program), specifying which had a control group that did not exercise or comparing before and after training values for the same group (clinical studies), and the variables of knee pain and/or self-perceived functional capacity and / or performance on functional capacity tests.

Publications rejected were those in which it was not possible to obtain the full text version as well as those in which subjects received a combination of non-pharmacological treatments or had undergone surgical treatment.

Selected studies

Figure shows the literature search protocol for this study, detailing the number of items found and those included and excluded.

Of all the items found after the literature search, we selected a total of 12 trials and a systematic review. The results of all selected trials, except one,[1] showed significant differences with respect to baseline or the control group. The differences occurred in either knee pain or perceived and/or proven functional capacity (by specific physical tests) or in both procedures at once. Moreover, the results of studies comparing two different training programs showed no differences between groups for perceived pain in any of the cases. However, in the study by Topp et al[9] there was a significant difference between groups for the WOMAC Index (Western Ontario and McMaster Universities Osteoarthritis Index) subscale which assesses functional limitation.

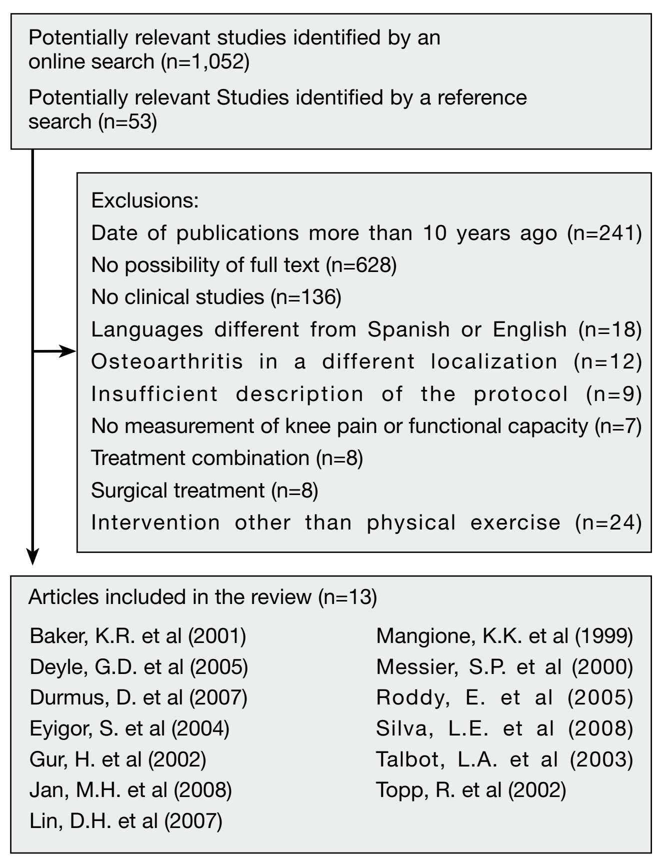

Figure. Systematic review protocol used for the selection of original articles.

Analysis of selected studies

Strength or aerobic training?

As for the main feature to be developed, we found that both aerobic and resistance exercise have shown their validity in clinical studies. But, to our knowledge, there is only one systematic review aimed to compare the efficacy of the two types of exercise indirectly. According to their results, we concluded that although both training regimens reduce pain and functional disability, there are no differences in their effectiveness.[23] That is, both programs are equally effective in the treatment of symptomatic pain in the absence of any further evidence for this comparison. This conclusion is derived from the recommendations of the osteoarthritis research organizations, which reccomend performing both types of exercise[18]; however, load training has shown greater efficiency in strenght gain and muscle mass in middle-aged men, than other forms of exercise.[24]

It has been stated that muscle weakness is a risk factor for and a major cause of dysfunction; therefore, strenght exercise should be obligatory for patients with osteoarthritis. Reduced strength in the lower extremity is associated with poorer balance,[25] and it has been seen that increasing it leads to improved proprioception.[26] On the other hand, aerobic exercise improves the subjects ability for individual tasks that involve the transfer of body weight, such as walking or climbing stairs.[12]

General characteristics of the programs

Table 1 summarizes these characteristics, in which we have included the training objectives, methodology and materials used, the duration of the program, the anatomic location upon which the program acted and whether or not there were warm-up and cool-down periods.

Objectives of the program and methodology

Basically, we could reduce the objectives pursued to two: development of strenght (in whatever form) and aerobic training. Based on these objectives and the environment in which the exercise program was developed, we found a great variety of methods and materials.

The definition of the objectives in clinical studies follow the recommendations, both for the general population as well as for persons suffering from osteoarthritis[8,15-19,27] that advise developing these two physical qualities. Although the development of these two qualities in patients with osteoarthritis is essential, it is also necessary to work on flexibility or range of motion and balance, physical characteristics that are important to improve the quality of life, prevent falls and improve the subjects proprioception.[28-30]

Flexibility training as an objective only appears in two of the reviewed studies,[31,32] but its effect cannot be differentiated because the treatment is given in conjunction with other physical qualities.

On the other hand, balance training in many cases is performed in an indirect way along with other exercises, but the reviewed articles did not find an exercise that directly pursued the development of this quality, nor was its development mentioned in the recommendation guidelines consulted.

As to the methods used to develop an aerobic capacity, both using a static cycle as well as walking have been employed, although the latter method was used in combination with strength training.

For the development of strenght we found that isometric exercises were used,[9,31-33] isotonic exercises in an open or closed chain,[3,9,13,31,32,34-36] isokinetic exercises[5,13] and electrostimulation.[1,33]

Coping with isotonic and isometric exercises (the two methods most accessible to the general population), we saw that the limitation of those studies employing isometric training is that the strength gain occurs at small joint angles, but a possible advantage of this type of training is that the joint might be under less stress.[9] On the other hand, it has been seen that dynamic strength training is correlated with an improvement in neuromuscular performance,[9] which could positively influence other risk factors that is also seen in those affected by osteoarthritis: reduced proprioception.

Isokinetic exercises require special machines, which are not common in the recovery room, making them expensive and inaccessible, and no significant improvements have been seen different from those produced by conventional strength exercises,[13] The same thing happens with electrostimulation,[33] despite being more accessible than the isokinetic machines.

Another key issue to address is how to link the exercises in strength training, ie the method used. At this point we found that all studies that detail this aspect develop a program in the form of a series. One possible line of research, therefore, is to compare two different methodologies (in the form of series or circuit), since they affect the development of strength and hypertrophy differently and could influence the effects of the intervention.

In the materials used for the development of strength training programs there is also great diversity, although the most used are ankle weights, dumbbells and/or autoloader. Six of the twelve studies reviewed used this type of material.[3,9,13,31,32,36]

The use of light with ankle weights (low intensity) can be justified by the fact that patients with severe osteoarthritis may not tolerate training with heavier weights, but in two articles that used a percentage of intensity greater than 50% of load for one repetition maximum (RM) or 10 RM, there were significant improvements in both pain and functional capacity.[13,34]

Program length

The program duration varies from the four weeks employed by Deylen et al[31] to 6 months used by Messier et al,[36] the average value being a period of approximately 11 weeks. Although the program by Deylen et al might seem insufficient stimuli due to its brevity, these authors observed a significant improvement when comparing the beginning and ending of the program, in the distance walked in 6 min (10% improvement) and in the WOMAC index (26% improvement).[31] However, even having seen improvements with this short intervention, it would be ideal to perform a program of indefinite duration, given the results of follow-up conducted by Talbot et al[1] after the intervention, which sees a loss of the improvements obtained with the program. In relation to the duration mentioned above, some studies show that the effects of exercise on osteoarthritis are temporary and that the performance declines when exercise ceases.[19]

Anatomic location

Although the muscle groups worked upon differ between studies, most are very analytical. A third of programs focuses solely on the quadriceps, or on this and the ischiotibial muscles,[1,5,13,33] and only one study acts not only on the lower body but on the top as well.[36]

If the objective of the training program is the localized improvement of an anatomical region, it may be much more convenient to use an analytical program, but we must not forget that there is a strong association of osteoarthritis with age and it seems clear that a program working with general loads can provide added health benefits.[28,29]

Warm up and cool down

We did not find evidence of the influence of warm-up and cool-down periods and symptoms of osteoarthritis. However, in the general population, regarding the initial part, even when stretching does not

Table 1
General characteristics of the training programs employed in the reviewed clinical studies

Studies	Sample and age	Objectives	Duration	Method and/or material	Localization	Warm up	Cool down
Silva (2008)	32; 59±7.6 years 32; 59±6.1 years	Flexibility, isometric and dynamic strenght, improvement in walking	18 weeks In room	In water	Lower limbs	No	No
Jan (2008)	34; 63±6.6 years 32; 62±7.1 years	Dynamic closed chain	8 weeks	In Dynamic Track Leg Press Machine, high intensity In Dynamic Track Leg Press Machine, low intensity	Lower limbs	10 min of static cycle	10 min cold application
Lin (2007)	26; 61±7.7 years	Closed chain dynamic strenght	8 weeks	Shuttle Mini Clinic Resistance Device	Lower limbs	No	No
Durmus (2007)	25; 55±2 years 32; 55±1.7 years	Strenght	4 weeks	Electrostimulation Isometric with biofeedback	Quadriceps	No	No
Deyle (2005)	68; 62±9 years	Isometric and dynamic strenght and dynamic flexibility	4 weeks	Performed at the subjects home. Conventional strenght exercises	Lower limbs	No	No
Talbot (2003)	18; 70±5.6 years	Strenght	12 weeks	Electrostimulation	Quadriceps	No	No
Gür (2002)	9; 55±12 years 8; 56±12 years	Dynamic strenght	8 weeks	Isokinetic concentric Isokinetic concentric-excentric	Quadriceps, ischiotibial	No	No
Topp (2002)	32; 55±1.7 years 32; 55±1.7 years	Isometric or dynamic strenght	16 weeks	Isometric exercises Conventional strenght exercises	Muscles of the ankle and the knee	No 5 min of leg movements	5 min stretching
Eyigor (2004)	21; 53±6.7 years 18; 52±8.1 years	Dynamic strenght	6 weeks	Isokinetic exercise Progressive resistance exercises	Quadriceps	10 min walk	No
Baker (2001)	23; 69±6 years	Dynamic strenght	4 months	Executed in every extremity of the subject. Conventional strenght exercises	Lower limbs	No	No
Messier (2000)	11; 69±5 years	Aerobic resistance, dynamic strenght	6 months	Conventional strenght exercises	Upper and lower limbs	5 min (no details)	5 min (no details)
Mangione (1999)	20; 71±6.2 years 19; 71±7.7 years	Aerobic resistance	10 weeks	Low intensity cycloergometer Hight intensity cycloergometer	Lower limbs	Rapid walk, stretching	Walk, respiration exercises

appear to reduce the rate of injury among athletes,[37,38] warming is related to this fact.[39]

We found that only five of the papers[9,13,34,36,40] mention that they carried out warm-up periods, while only four included a cool-down period.[9,34,36,40]

In general, studies used between 5 and 10 minutes for warm-up, with the same interval for cool-down. The methods used for warm-up are mostly aerobic, sometimes also including stretching and joint movements.[9,13,34,36,40] For cooling methods differ a little more: application of cold[34] stretching,[9] walking and breathing exercises.[40]

Characteristics of the training load

These features, which are summarized in Table 2 and 3, include information on the duration of the sessions, weekly frequency, the volume of exercise performed and its progression during the program (in number of exercises, number of sets and number of repetitions), exercise intensity and its progression, the breaks between exercises, sets or repetitions, and the pace of implementation in the case of dynamic strength exercises.

Session length

Although not all studies mention this, the variability in this feature is great, ranging from 15 to 60 min. The interventions that used electrostimulation were those with shorter sessions (15-20 min),[1,33] while the other programs only used sessions of less than 50min in the early stages.

Weekly

The frequency of training, except in three of the reviewed studies[13,31,33] was always 3 days per week. This is no coincidence, since most studies use the work guidelines of ACSM (American College of Sports Medicine) for the elderly, that propose two days a week as the minimum frequency for strength training.[28,29,41] For aerobic training, the frequency recommended by this association is 5 days. With this statement we note that, although studies in osteoarthritis have demonstrated efficacy with only three days a week, a better design of the program should be aimed at improving health comprehensively, so this frequency should be respected as the stipulated minimum.

Initial volume and its progression

In strength training, analysis of the number of exercises per muscle group indicates that most programs used a single exercise. And if we have found beforehand that most of the studies involved only work the affected joint, this could be an impediment to the continuity in the program by the subject (although this is not reflected in the studies), because a single exercise with a single joint working involves a monotony that could be avoided by increasing and varying the number of exercises as the subject's experience and fitness improves.

The number of sets used is between 1 and 10, without showing a common pattern among studies. Regarding the number of repetitions, the most common finding in the studies is 8-12. Here we find agreement with the recommendations of the ACSM, making this another pattern to follow.[27,29]

With regard to progression, increasing sets and repetitions is employed only in two studies.[9,32] Despite an increase in the number of sets and repetitions necessary for an adequate adjustment,[42] this pattern is not observed in studies and is not recommended for use in the reviews on the subject.[2,8,7,15-19]

Initial intensity and its progression

In aerobic training programs, the intensity employed is between 40% and 75% of the maximum heart rate.[36,40] That is, moderate-high intensity, which allowed significant differences from baseline, although in no case was a progression in intensity scheduled. Both cases showed significant differences in terms of pain and physical ability, so that this degree of intensity can be used without affecting the osteoarthritis symptoms. It is necessary to clarify at this point that, in the case of the use of an ergometer, the intensity required is always reached without using pedal resistance, but an increase in cadence.

Although the intensity shows large heterogeneity between studies, the authors show moderate loads between 60% of 1 RM[34] and 50% to 100% of 10 RM.[13]

Only three of the twelve studies reviewed did not program an increase in intensity,[5,13,33] because from the beginning of the program, they require a maximum contraction. The rest of the programs progress very differently from the use of subjective scales or perceptions of the effort and ranges to use materials to add strength, such as dumbells or elastic bands. In this regard, we found a common pattern of progression, and since all programs showed favorable results, we can say that any progress that respects the adaptation of the subject itself is correct, despite the fact that progression in some cases seems overly cautious.[9,31]

In this regard, we must also note the role that joint pain has in the progression of the burden to overcome. Some items on recommendations and guidelines address this issue and advise that when pain increases after exercise is maintained, the weight at the next session is to be reduced.[9,43,44]

Breaks

Although not all studies report this information, we identified a more or less constant interval for those that do detail it: between 50 s and 1min for rest between sets and 5 min between exercises or legs.

Speed of execution

This concept refers to the speed with which concentric and eccentric phases of dynamic strength exercises were performed. In the case of isokinetic exercise, the pace is determined by the angular

Table 2
Characteristics of the training load of the programs i (studies from 2003 to 2008)

Study	Group	Time of session	Weekly frequency	Initial volumen and progression (exercises/series/repetitions)	Initial intensity and progression	Breaks	Rate of execution
Silva et al (2008)	Water. Room	50 min	3 days	Stretching: 1 series/2 20 s repetitions. Isometric strenght: 2/1/7-10 of 6 s. Isotonic strenght (10 exercises): weeks 1-3: 20 repetitions; week 4: 40 repetitions	Isotonic strenght: week 1: no resistance; week 2-4: elastic band or 1 kg weight	No detail	No detail
Jan et al (2008)	High intensity strenght	30 min	3 days	1/3/8	60%, 1 estimated RM. Every 2 weeks: 1 RM Retest. Increase in 5%	1 min between series; 5 min between legs	1-1
	Low intensity strenght	50 min		1/10/15	10%, 1 estimated RM		
Lin et al (2007)	Closed chain strenght	No details	3 days	1/10/10	Initial: 10% of body weight. Increase in 5% every 2 weeks	1 min between series; 5 min between legs	1-1
Durmus et al (2007)	Electrostimulation	20 min	5 days	10 s contraction	In apparent muscle contraction (between 70 and 120 mA)	10 s	–
	Isometric with biofeedback			1 exercise	Maximum contraction	50 s	
Deyle at el (2005)	Execution at the subjects house	No details	7 days: flexibility; 3 days: strenght	In strenght (3 exercises): 10 repretitions or untilcompleting 30 s. Maintain 3 s isometrically in each repetition	Self administered. Self administered increase in intensity	No detail	No detail
Talbot et al (2003)	Electrostimulation	15 min	3 days	10s contraction	Weeks 1-4: 10%-20% of MVC; weeks 5-8: 20%-30% of MVC; weeks 9-12: 30%-40% of MVC	50s	–

MVC indicates maximum voluntary contraction; RM, maximum repetition.

Table 3
Characteristics of the training load of programs ii (studies from 1998 to 2002)

Study	Group	Session time	Weekly frequency	Initial volume and progression (series and repetitions)	Initial intensity	Breaks	Rate of execution
Gür et al (2002)	Isokinetic concentric Isokinet concentric excentric	No details	3 days	12 flexoextensions of the knee, all concentric 6 concentric extensions and 6 excentric flexions (alternatives); 6 excentric extensions and 6 concentric flexions (alternatives)	Maximum effort in a range of angular speeds between 30º/s and 180º/s	5 min between legs 2 min between series; 5 min between legs	Angular speed
Topp et al (2002)	Isometric exercises	40 min-1 h	3 days	6 exercises/1 series/ 8 repetitions. Increase in volume every week; weeks 9-16: 3 series/ 12 repetitions	Weeks 1-2: medium tension; after week 2: maximum tension	Weeks 9-16: 2 min between series	–
	Dinamic exercises			6 exercises/1 series/ 8 repetitions of 3-5 s	Weeks 1-2: medium fatigue; weeks 9-16: moderate fatigue		No details
Eyigor et al (2004)	Isokinetic exercise	No details	3 days	1 exercise/ 4 angular speed/3 series/ 6 repetitions	Maximum effort at 60º/s, 90º/s, 120º/s and 180º/s	20 s between series	Angular speed
	Progressive resistance exercises		5 days	1 exercise/3 series/ 10 repetitions with 5 s isometrics in each repetition in each	1st series: 50% of 10 RM; 2nd series: 75% of 10 RM; 3rd series: 100% of 10 RM. 10 RM Restest a week	No detail	Slow movement
Baker et al (2001)	At the house of the subject	No detail	3 days	7 exercises/2 series/ 12 repetitions	3-5 in 10 point Borg scale. 1st: increase to 8 in Borg; 2nd: increase of 1 lb in each leg when effort is less than 6 or more than 12 repetitions are performed	No details	No details
Messier et al (2000)	In room	1 h	3 days	Aerobic: 2 series of 10 min walking. Strenght: 7 exercises/1 series/ 10-12 repetitions	Aerobic: 50%-75% of maximum heart rate. Strenght: no detail	Strenght: 1-1.5 min between exercises	No detail
Mangione et al (1999)	Low intensity cycloergo-meter High intensity cycloergometer	1 h	3 days	25 min continuous pedaling	40% of maximum heart rate, no pedal resistance 70% of maximum heart rate, no pedal resistance	–	–

RM indicates maximum repetiton.

velocity used. Among the studies, only three papers detailing this aspect, two of them employed a 1-1 rate (1 s for the concentric exercise, and 1 s for the eccentric),[34,35] and the other simply states that it was carried out in slow motion.[13]

The effects of the implementation rate on muscle mass has been previously described[45,46]: we observed that, when the rest of the training was the same, a higher speed produces a greater increase in muscle mass and strength.[45]

Conclusions

All trials except one, showed significant differences in knee pain, perceived and/or proven functional capacity (by specific physical evidence) or in both variables at once.

After review, we can reach conclusions on the characteristics of a standard program for the treatment of osteoarthritis of the knee. These are detailed in Table 4 and have been selected with the criterion of a greater concordance between the reviewed studies.

The standard program described has limitations arising from the heterogeneity of the studies selected. Scientific evidence from sturdier studies regarding design could lead to different conclusions.

When describing the training programs employed, many of the authors forgets crucial elements to the definition of the program, making it impossible to implement these programs with a therapeutic objective or to contrast the results to other populations.

Future research in this area should concern the comparison of different methods and types of training in a long-term intervention, besides attempting to verify the type of strengh that is more beneficial to the disease, and the most appropriate content of an exercise program for treatment of osteoarthritis of the knee. On the other hand, studies with much greater range of age groups are needed to obtain conclusions in older age groups.

Table 4
Characteristics of the standard program for the treatment of knee osteoarthritis

Objective	Dynamic strenght
Methodology	Self load exercises
Materials	Weights and dumbells
Duration of the program	11 weeks, although a program with undefined durration is recommended to avoid the loss of the improvements gained by exercise
Anatomical localization	Lower extremities, although all important muscle groups must be worked
Warm up and cool down	Warm up: aerobic. Cool down: depending on the effect of training, ice, stretching or breathing exercises; 5 min for each one
Duration of the session	50 min-1 h
Weekly frequency	3 days
Initial volume and progression	Exercises: 1 per muscle group. Series and repetitions: 1 series, 8-10 repetitions. Progression: no progression, although we recommend increasing the number of exercises performed by the muscle group to avoid monotony and program abandonment
Initial intensity and progression	Light to moderate, around 60% of 1 RM or 50%-100% of 10 RM. Progression: must respect the capacity of adaptation of the subject
Breaks	50 s-1 min between series and 5 min between exercises
Rythm of execution	Medium-slow

RM indicates maximum repetition.

References

1. Talbot LA, Gaines JM, Ling SM, Metter EJ. A home-based protocol of electrical muscle stimulation for quadriceps muscle strength in older adults with osteoarthritis of the knee. J Rheumatol. 2003;30:1571-8.
2. Creamer P. Osteoarthritis pain and its treatment. Curr Opin Rheumatol. 2000;12:450-5.
3. Baker KR, Nelson ME, Felson DT, Layne JE, Sarno R, Roubenoff R. The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. J Rheumatol. 2001;28:1655-65.
4. Ministerio de Sanidad y Consumo. Encuesta Nacional de Salud 2003 [accessed 25 May 2006]. Available from: http://www.msc.es/estadEstudios/estadisticas/encuestaNacional/home.htm
5. Gur H, Cakin N, Akova B, Okay E, Kucukoglu S. Concentric versus combined concentric-eccentric isokinetic training: effects on functional capacity and symptoms in patients with osteoarthrosis of the knee. Arch Phys Med Rehabil. 2002;83:308-16.
6. Talbot LA, Gaines JM, Huynh TN, Metter EJ. A home-based pedometer-driven walking program to increase physical activity in older adults with osteoarthritis of the knee: a preliminary study. J Am Geriatr Soc. 2003;51:387-92.
7. Manek NJ, Lane NE. Osteoarthritis: current concepts in diagnosis and management. Am Fam Physician. 2000;61:1795-804.
8. American Geriatrics Society. Exercise prescription for older adults with osteoarthritis pain: consensus practice recommendations. A supplement to the AGS Clinical Practice Guidelines on the management of chronic pain in older adults. J Am Geriatr Soc. 2001;49:808-23.
9. Topp R, Woolley S, Hornyak J, Khuder S, Kahaleh B. The effect of dynamic versus isometric resistance training on pain and functioning among adults with osteoarthritis of the knee. Arch Phys Med Rehabil. 2002;83:1187-95.
10. Brandt K. Ostetoarthritis. Curr Opin Rheumatol. 2000;12:449.
11. Toda Y, Toda T, Takemura S, Wada T, Morimoto T, Ogawa R. Change in body fat, but not body weight or metabolic correlates of obesity, is related to symptomatic relief of obese patients with knee osteoarthritis after a weight control program. J Rheumatol. 1998;25:2181-6.
12. Baker K, McAlindon T. Exercise for knee osteoarthritis. Curr Opin Rheumatol. 2000;12:456-63.
13. Eyigor S, Hepguler S, Capaci K. A comparison of muscle training methods in patients with knee osteoarthritis. Clin Rheumatol. 2004;23:109-15.
14. Pendleton A, Arden N, Dougados M, Doherty M, Bannwarth B, Bijlsma JW, et al. EULAR recommendations for the management of knee osteoarthritis: report of a task force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). Ann Rheum Dis. 2000;59:936-44.
15. Jordan KM, Arden NK, Doherty M, Bannwarth B, Bijlsma JW, Dieppe P, et al. EULAR Recommendations 2003: an evidence based approach to the management of knee osteoarthritis: report of a task force of the Standing Committee for International Clinical Studies Including Therapeutic Trials (ESCISIT). Ann Rheum Dis. 2003;62:1145-55.
16. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, part I: critical appraisal of existing treatment guidelines and systematic review of current research evidence. Osteoarthritis Cartilage. 2007;15:981-1000.
17. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N, et al. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. Osteoarthritis Cartilage. 2008;16:137-62.
18. Roddy E, Zhang W, Doherty M, Arden NK, Barlow J, Birrell F, et al. Evidence-based recommendations for the role of exercise in the management of osteoarthritis of the hip or knee–the MOVE consensus. Rheumatology (Oxford). 2005;44:67-73.
19. Vignon E, Valat JP, Rossignol M, Avouac B, Rozenberg S, Thoumie P, et al. Osteoarthritis of the knee and hip and activity: a systematic international review and synthesis (OASIS). Joint Bone Spine. 2006;73:442-55.
20. National Collaborating Centre for Chronic Conditions. Osteoarthritis: national clinical guideline for care and management in adults. London: Royal College of Physicians; 2008.
21. Hunter DJ, McDougall JJ, Keefe FJ. The symptoms of osteoarthritis and the genesis of pain. Rheum Dis Clin North Am. 2008;34:623-43.
22. Benito PJ, Díaz V, Calderón FJ, Peinado AB, Martín C, Álvarez M, et al. La revisión bibliográfica sistemática en fisiología del ejercicio: recomendaciones prácticas. RYCIDE. 2007;3:1-11.
23. Roddy E, Zhang W, Doherty M. Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. Ann Rheum Dis. 2005;64:544-8.
24. Izquierdo M, Hakkinen K, Ibanez J, Kraemer WJ, Gorostiaga EM. Effects of combined resistance and cardiovascular training on strength, power, muscle cross-sectional area, and endurance markers in middle-aged men. Eur J Appl Physiol. 2005;94:70-5.
25. Messier SP, Glasser JL, Ettinger WH, Craven TE, Miller ME. Declines in strength and balance in older adults with chronic knee pain: a 30-month longitudinal, observational study. Arthritis Rheum. 2002;47:141-8.
26. Hurley MV, Scott DL. Improvements in quadriceps sensorimotor function and disability of patients with knee osteoarthritis following a clinically practicable exercise regime. Br J Rheumatol. 1998;37:1181-7.
27. ACSM. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc. 1998;30:975-91.
28. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. Circulation. 2007;116:1094-105.
29. Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007;39:1435-45.
30. Rao SS. Prevention of falls in older patients. Am Fam Physician. 2005;72:81-8.
31. Deyle GD, Allison SC, Matekel RL, Ryder MG, Stang JM, Gohdes DD, et al. Physical therapy treatment effectiveness for osteoarthritis of the knee: a randomized comparison of supervised clinical exercise and manual therapy procedures versus a home exercise program. Phys Ther. 2005;85:1301-17.
32. Silva LE, Valim V, Pessanha AP, Oliveira LM, Myamoto S, Jones A, et al. Hydrotherapy versus conventional land-based exercise for the management of patients with osteoarthritis of the knee: a randomized clinical trial. Phys Ther. 2008;88:12-21.
33. Durmus D, Alayli G, Canturk F. Effects of quadriceps electrical stimulation program on clinical parameters in the patients with knee osteoarthritis. Clin Rheumatol. 2007;26:674-8.
34. Jan MH, Lin JJ, Liau JJ, Lin YF, Lin DH. Investigation of clinical effects of high- and low-resistance training for patients with knee osteoarthritis: a randomized controlled trial. Phys Ther. 2008;88:427-36.
35. Lin DH, Lin YF, Chai HM, Han YC, Jan MH. Comparison of proprioceptive functions between computerized proprioception facilitation exercise and closed kinetic chain exercise in patients with knee osteoarthritis. Clin Rheumatol. 2007;26:520-8.

36. Messier SP, Loeser RF, Mitchell MN, Valle G, Morgan TP, Rejeski WJ, et al. Exercise and weight loss in obese older adults with knee osteoarthritis: a preliminary study. J Am Geriatr Soc. 2000;48:1062-72.
37. Hart L. Effect of stretching on sport injury risk: a review. Clin J Sport Med. 2005; 15:113.
38. Thacker SB, Gilchrist J, Stroup DF, Kimsey CD. The impact of stretching on sports injury risk: a systematic review of the literature. Med Sci Sports Exerc. 2004;36: 371-8.
39. Fradkin AJ, Gabbe BJ, Cameron PA. Does warming up prevent injury in sport? The evidence from randomised controlled trials? J Sci Med Sport. 2006;9:214-20.
40. Mangione KK, McCully K, Gloviak A, Lefebvre I, Hofmann M, Craik R. The effects of high-intensity and low-intensity cycle ergometry in older adults with knee osteoarthritis. J Gerontol A Biol Sci Med Sci. 1999;54:M184-90.
41. Taylor NF, Dodd KJ, Damiano DL. Progressive resistance exercise in physical therapy: a summary of systematic reviews. Phys Ther. 2005;85:1208-23.
42. Baechle TR, Earle RW. Essentials of strength training and conditioning. 2nd ed, NSC Association, editor. Champaig: Human Kinetics; 2000.
43. Ramos Álvarez J, López-Silvarrey Varela F, Segovia Martínez J, Montoya Miñano J, Legido Arce J. Prescripción del ejercicio en pacientes con artrosis. Recomendaciones actuales. Selección. 2006;15:144-53.
44. Foley A, Halbert J, Hewitt T, Crotty M. Does hydrotherapy improve strength and physical function in patients with osteoarthritis–a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening programme. Ann Rheum Dis. 2003;62:1162-7.
45. Shepstone TN, Tang JE, Dallaire S, Schuenke MD, Staron RS, Phillips SM. Short-term high- vs. low-velocity isokinetic lengthening training results in greater hypertrophy of the elbow flexors in young men. J Appl Physiol. 2005;98:1768-76.
46. Tanimoto M. Ishii N. Effects of low-intensity resistance exercise with slow movement and tonic force generation on muscular function in young men. J Appl Physiol. 2006;100:1150-7.