ABSTRACT
Osteoarthritis is the most common joint disease in the world, and in Brazil it is estimated to affect 6 to 12% of the adults and one third of the elderly population. There is evidence that exercise, especially resistance exercise, may reduce disease progression. **Objective:** The aim of this study was to review the literature regarding resistance exercise as a treatment for osteoarthritis. **Method:** Articles indexed in the PubMed database were reviewed by employing the “therapy narrow” filter, through the “clinical queries” interface. Twenty studies were selected for full text review. Several types of resistance exercise interventions, with different intensities, duration and speed were studied by other authors. **Results:** The various types of resistance exercise seem to be safe and effective in promoting functional improvements and pain reduction in osteoarthritis patients. Low intensity and isometric exercises can also promote benefits. **Conclusion:** Adherence to the programs is close to 50% and the combined use of supplements or drugs along with exercise has been little studied so far in this population.

**Keywords:** Osteoarthritis, Exercise, Rehabilitation
INTRODUCTION

Osteoarthritis (OA) is the most common joint disease in the world.\(^1\) It is estimated that in Brazil it affects approximately 6-12% of adults and more than a third of the elderly.\(^2\) Osteoarthritis of the knee is considered as the main cause of disability for people older than 50 years.\(^3\) As a disease that generates high costs for the health system, in the US alone the annual costs from OA are around US$ 47.8 billion.\(^4,5\)

Osteoarthritis is a chronic multifactorial disease that compromises the joint components. This compromising generates joint stiffness, deformities, pain, and functional reduction.\(^6\) Many treatments have been pointed to as forms of intervention for the broad clinical presentation of the disease, among them medications, surgeries, physical therapy, natural remedies, and the practice of physical exercises.\(^7,12\)

With osteoarthritis, exercising seeks to improve the amplitude of movement, muscle strength, and physical well-being, instead of the immobility formerly recommended for this type of disease.\(^13\) Among the various types of exercises, resistance exercises stand out (RE, performed against some form of gravitational resistance), and their effectiveness demands attention.\(^14,16\)

Probably due to muscle weakness being one of the main physical signs of OA, interventions with RE have been more recommended in recent years. Individuals with OA show about 15-18% muscle strength loss at the onset of the disease, and that increases with its progression.\(^17\)

Muscle weakness has been associated with functional loss,\(^18\) and it is known that loss of strength in the perarticular region can result in instability and abnormal stress on the joint.\(^19\) Thus, there is evidence suggesting that muscle strengthening may reduce the progression of the disease.\(^18\)

OBJECTIVE

The objective of this study was to review the literature of works on RE as a treatment for OA in order to identify the clinical advantages that this type of intervention can bring to sufferers of this condition.

METHOD

This study reviewed articles indexed in the PubMed database, without restricting the publication date. The descriptors used were the terms “osteoarthritis” AND “resistance training.” The search was made in March of 2014. The filter applied was “therapy narrow” of the interface “clinical queries,” which yielded 44 publications. The abstracts were analyzed and those whose subjects showed arthroplasty in the joint studied, that discussed only experimental protocols, studies that did not involve RE, and those whose sample involved patients with functional disabilities from diverse etiologies were excluded. Only randomized studies were included in this review. The authors analyzed the selected articles, following the chronological order of publications, and the occasional disagreements were resolved in consensus.

RESULTS

Twenty-four of the 44 studies analyzed by abstracts were excluded. They discussed: patients who went under arthroplasty (10 studies), research protocols (5 studies), other types of exercise (6 studies), and various functional disabilities (3 studies). Thus, 20 articles were selected for review and after a careful analysis of their content, 4 categories were identified: RE seeking to improve pain and/or function (n = 12); adherence to a program (n = 4); comparison between aerobic exercises (AE) and RE (n = 4), and RE associated with a supplement or medications (n = 2). Three studies were classified into 2 categories simultaneously.

The 20 studies included in this review provided data from 2614 individuals with OA who participated in the proposed interventions, divided into experimental group (n = 1645) and control group (n = 969).

Resistance exercises to improve pain and/or function

The studies seeking to improve pain and/or function obtained their samples using clinical and radiological diagnostic criteria, dividing them into one or more experimental groups (EG) and into one control group (CG). However, 2 studies\(^15,16\) opted to analyze a program with minimum load and no progression as the control condition versus an EG whose program was based on load progression; and another study,\(^21\) comparing two types of RE, did not include a CG.

Most samples were composed of subjects of each gender\(^21,22,24-30\) with age above 50 years.\(^23,26,28-31\) Eight studies had small samples, with less than 30 subjects per group.\(^19,22,27,29,31\)

The studies analyzed the impact of exercises on the functional capacity, especially with the tests going up and down stairs,\(^22,25,29,30\) getting up from a chair,\(^21,22,29,30,31\) the WOMAC physical function subscale,\(^16,26,28,30,31\) and walking.\(^19,22,24-31\) Pain was evaluated in most studies with the WOMAC pain subscale.\(^19,20,21,24,25,27,29,30\)

The proposed interventions varied in method, intensity, duration, and type of therapy, as shown in Chart 1. The time to analyze the intervention effect was diversified, with the analyses of the immediate pre- and post-intervention periods,\(^19,21\) follow-up after 6 weeks,\(^29\) 2 months,\(^24,25\) 6 months, and 12 months after the therapy.\(^25\)

Some studies associated the RE with the AE,\(^24,25,37\) while others examined forms of RE;\(^19,21,26,28,30\) one study compared conventional RE with electrostimulation,\(^29\) and three studies examined RE interventions by using elastic bands.\(^21,23,31\) Studies that involved interventions with different performance intensities or speeds\(^21,28,30\) observed greater benefit related to the more intense/quicker intervention. The influence of weight reduction on the variables studied was also analyzed,\(^29\) and the intervention showed better results with the combination of exercises and diet.

Resistance exercises seeking adherence to a program

All the studies composed their samples dividing them into CG and EG,\(^24,25,32\) with one of them creating two EGs.\(^33\) The samples were composed by males and females, mostly aged above 60 years,\(^24,25,33\) and all of them had more than 50 subjects per group.

The studies analyzed the impact of interventions on the adherence to exercise through session attendance\(^24,25,31,33\) and duration of exercise in each session.\(^23\) The level of physical activity was evaluated through an accelerometer,\(^12\) and self-efficacy was analyzed through the application of efficacy scales.\(^24,25\)

The interventions of the four studies analyzed involved participation in three weekly sessions, however, they varied as to the type of therapy, intensity, and duration, as shown in Chart 2. All the studies analyzed the pre- and post-intervention periods, but one of them monitored it for more than 15 months,\(^13\) and two other studies monitored their subjects for six months after the intervention.\(^24,25\)

One study compared RE with AE,\(^34\) two studies evaluated an RE and an AE program,\(^24,25\) and another evaluated the impact of an RE program and education on adherence and the level of physical activity of OA patients.

All the interventions resulted in greater adherence of the EG, close to 50%,\(^24,33\)
### Chart 1. List of the articles on RE intervention to improve pain and/or function

<table>
<thead>
<tr>
<th>Study</th>
<th>EG</th>
<th>CG</th>
<th>Frequency Intensity</th>
<th>Duration Sessions</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faroughi et al. 2011a [K]</td>
<td>High intensity RE (knee extension and flexion, hip abduction and abduction, leg press and plantar flexion)*</td>
<td>RE with minimum load, without progression, neither hip abduction nor abduction*</td>
<td>3 times/week</td>
<td>26 weeks w/supervision</td>
<td>Duration of session NI</td>
</tr>
<tr>
<td>Faroughi et al. 2011b [K]</td>
<td>Progressive RE (knee extension and flexion, hip abduction and abduction, leg press and plantar flexion)*</td>
<td>RE with minimum load, without progression, neither hip abduction*</td>
<td>3 times/week</td>
<td>26 weeks w/supervision</td>
<td>Duration of session NI</td>
</tr>
<tr>
<td>Fukumoto et al. 2014 [H]</td>
<td>RE with elastic bands at high speed*</td>
<td>RE with elastic bands at low speed*</td>
<td>There was none</td>
<td>7 times/week</td>
<td>Duration of session NI</td>
</tr>
<tr>
<td>Gür et al. 2002 [K]</td>
<td>Concentric RE*</td>
<td>Concentric and eccentric RE*</td>
<td>W/O intervention</td>
<td>3 times/week</td>
<td>Duration of session NI</td>
</tr>
<tr>
<td>Topp et al. 2002 [K]</td>
<td>Isometric RE=</td>
<td>Dynamic RE=</td>
<td>W/O intervention</td>
<td>3 times/week</td>
<td>16 weeks</td>
</tr>
<tr>
<td>Hughes et al. 2004 [KH]</td>
<td>RE*</td>
<td>AE=</td>
<td>education#</td>
<td>orientation booklet</td>
<td>3 times/week</td>
</tr>
<tr>
<td>Hughes et al. 2006 [KH]</td>
<td>RE*</td>
<td>AE=</td>
<td>flexibility exercises#</td>
<td>orientation booklet</td>
<td>3 times/week</td>
</tr>
<tr>
<td>Lin et al. 2007 [K]</td>
<td>Computerized proprioceptive facilitation exercises*</td>
<td>education</td>
<td>3 times/week</td>
<td>Duration of session NI</td>
<td>Functional and proprioceptive improvement, increase of strength for both GE</td>
</tr>
<tr>
<td>Ghraibi et al. 2008 [K]</td>
<td>RE and AE*</td>
<td>diet, RE and AE*</td>
<td>diet</td>
<td>3 times/week</td>
<td>Duration of session NI</td>
</tr>
<tr>
<td>Jan et al. 2008 [K]</td>
<td>High-intensity RE* and education</td>
<td>Low-intensity RE group* and education</td>
<td>No intervention</td>
<td>Duration of session NI</td>
<td>Functional improvement and pain reduction in the two EG, with slightly greater effects in the high-intensity group</td>
</tr>
<tr>
<td>Bruce-Brand et al., 2012 [K]</td>
<td>RE*</td>
<td>Electrical stimulation*</td>
<td>No intervention</td>
<td>Duration of session NI</td>
<td>Functional improvements in pain, physical and mental health, and in the muscular cross-sectional area in both groups</td>
</tr>
<tr>
<td>Sayers et al. 2012 [K]</td>
<td>Explosive power RE*</td>
<td>Slow-speed RE*</td>
<td>Flexibility and warm-up exercises*</td>
<td>Duration of session NI</td>
<td>Functional improvements in pain, physical and mental health, and in the muscular cross-sectional area in both groups</td>
</tr>
<tr>
<td>Chang et al. 2012 [K]</td>
<td>RE with elastic band* and standard treatment</td>
<td>Standard treatment</td>
<td>2-3 times/week</td>
<td>Duration of session NI</td>
<td>Improvement in function, balance, and pain in the EG</td>
</tr>
</tbody>
</table>

K: osteoarthritis of the knee(s); KH: osteoarthritis of the knee (s) or hip(s); H: osteoarthritis of the hip(s); 8 sessions in group; * individual sessions; ≈ some sessions in group and some individual; EG: experimental group(s); CG: control group; RE: resistance exercise; AE: aerobic exercise. NI: not informed.
Self-efficacy for exercise tends to increase with the participation in a structured program, in which there is careful planning according to the characteristics of the volunteer so that the sessions are individualized.

Comparison between aerobic and resistance exercises

All the studies in this category refer to the same sample, divided into one CG and two EGs (or “groups” like before?), composed of subjects with clinical and radiological evidence of OA. Each group had more than 100 subjects, males and females and older than 60 years.

Together, the four studies analyzed the impact of the interventions on functionality, aerobic aptitude, strength, pain, depression, social support, self-efficacy, general state of health, and cost of the interventions.

The interventions proposed in the two EGs involved three weekly sessions of either RE or AE, as shown in Chart 3. The researchers conducted the programs with close supervision in the first three months, and after that period, the subjects started to exercise at home for another 15 months, with less frequent supervision.

The main findings of these works were the improvement in function and in physical performance for both groups, greater pain reduction in the group submitted to AE, increase of self-efficacy for exercise, mediation of pain and of self-efficacy in the effect of treatments, similar retention in the three groups of the study, functional benefits similar for AE and RE, and lower cost of intervention with RE.

Resistance exercises associated with supplements or medications

The studies shown here had a CG in which the subjects received the intervention with RE and made use of a placebo substance. In the EGs, in addition to participating in the intervention, the individuals made use of either a supplement, anti-inflammatory, or an articular cartilage-protecting medication.

These samples were composed of subjects aged above 50 years, either with only females or with both genders, and the groups studied contained from 11 to 13 subjects.

The studies analyzed the efficacy of interventions by evaluating lean mass, strength and function tests, quality of life, pain and stiffness, muscular cross-sectional area, strength and power, functional capacity, and satellite cells count.

In both studies, the subjects received treatment three times a week for 12 weeks (Chart 4). The RE associated with creatine supplements produced improvements in function, quality of life, and an increase of lean mass in the lower limbs. When associated with an anti-inflammatory or cartilage-protecting medication, the RE caused strength improvement and pain reduction.

**DISCUSSION**

The review of the literature on RE in the treatment of OA revealed that this type of intervention is an efficacious treatment modality, since all the studies analyzed showed improvements in the variables analyzed.

Various modalities of interventions with RE were tested, which varied in intensity and duration. In the shortest duration study (6 weeks), although showing only a tendency to increase isometric and isokinetic strength, it was possible to observe improvements in function, pain, physical and mental health, as

<table>
<thead>
<tr>
<th>Chart 2. List of articles with RE intervention seeking adherence to a program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Hughes et al. 2004[^JQ]</td>
</tr>
<tr>
<td>Hughes et al. 2004[^JQ]</td>
</tr>
<tr>
<td>Fair et al. 2010[^J]</td>
</tr>
<tr>
<td>Rejeski et al. 1997[^J]</td>
</tr>
</tbody>
</table>

K: Osteoarthritis in the knee(s); KH: osteoarthritis in the knee(s) or hip(s); # sessions in group. EG: experimental groups; CG: control group; RE: resistance exercise; AE: aerobic exercise.

<table>
<thead>
<tr>
<th>Chart 3. List of articles that compared RE and AE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Rejeski et al. 1997[^J]</td>
</tr>
<tr>
<td>Ettinger et al. 1997[^J]</td>
</tr>
<tr>
<td>Rejeski et al. 1998[^J]</td>
</tr>
<tr>
<td>Sevick et al. 2000[^J]</td>
</tr>
</tbody>
</table>

K: Osteoarthritis in the knee(s); # Sessions in group. EG: Experimental groups; CG: Control group; RE: resistance exercise; AE: Aerobic exercise; NI: not informed.
The groups that trained at high speed obtained a better advantage\(^{30,31}\) and a more dramatic improvement in muscle composition\(^{21}\). The authors suggest that high-speed exercises be part of programs for OA patients, for they increase their confidence in the daily activities that demand speed\(^{30}\).

The studies related to adherence revealed that about half of the OA patients adhered to the RE programs\(^{24,33}\). The strongest adherence predictor seemed to be previous experience with physical activity\(^{33}\) and participation in the RE seemed not to reduce the level of the patients’ other daily physical activities\(^{22}\). The long-term benefits to the OA patient stemming from the regular practice of resistance exercise are highly dependent on adherence to the program\(^{43}\), therefore this matter should not be neglected when developing interventions for these patients.

Comparisons between RE and AE revealed improvements in function and physical performance in both cases\(^{34,35}\), greater pain reduction in the patients submitted to AE\(^{35}\) and similar functional benefits\(^{26}\).

More than simply choosing the type of exercise, the structure of the program seems to be a key consideration when prescribing exercises to OA patients. In clinical practice, it is perceived that non-structured efforts and the application of overloads that exceed the physical condition of the patient worsen his clinical presentation. One example is the common complaint after intense efforts such as going up and down stairs, long walks, and other activities that demand the strength and resistance of the muscles adjacent to the knee joint. Thus, the gradual increase of loads that considers the pain threshold could interrupt the pain-movement inhibition-muscle weakness cycle.

RE associated with creatine supplements can produce improvements in function, quality of life, and increase the lean mass in the OA patients\(^{37}\). However, the use of anti-inflammatory or cartilage-protecting medication associated with RE can bring improvement in strength and pain reduction, without increa-


dsing lean mass\(^{38}\).

There are reports of sensory-motor function decline in OA patients\(^{44,45}\), which may contribute to the progression of the disease. Nevertheless, in the present review, no study directly pointed to this question as an object of evaluation. As RE can be considered an efficacious treatment for OA and its limitations, it is probable that the sensory-motor function be also improved in patients submitted to an RE intervention, however, new studies that seek confirmation of this benefit should be made.

**CONCLUSION**

The many forms of RE studied in the literature seem to be safe and efficacious in promoting functional improvements and pain reduction in OA patients. The adherence to exercise programs is close to 50% in the long term (more than six months) and the combined and supervised use of supplements or medications was not well studied, although creatine seemed to have a positive effect in relation to the increase of lean mass and functionality.

**REFERENCES**


**Chart 4. List of articles involving the association of RE to supplements or medications**

<table>
<thead>
<tr>
<th>Study</th>
<th>EG</th>
<th>CG</th>
<th>Frequency</th>
<th>Duration of Intervention</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neves et al. 2011(^{12})</td>
<td>- RE and placebo*</td>
<td>- RE and placebo*</td>
<td>3 times/week</td>
<td>12 weeks</td>
<td>Improvement in physical function, increase in lean mass and quality of life</td>
</tr>
<tr>
<td>Petersen et al. 2011(^{14})</td>
<td>- progressive RE and glucosamine*</td>
<td>- progressive RE and ibuprofen*</td>
<td>3 times/week</td>
<td>12 weeks</td>
<td>Increase in strength and pain reduction in EG</td>
</tr>
</tbody>
</table>

K: Osteoarthritis in the knee(s); * Individual sessions; EG: Experimental groups; GC: Control group; RE: Resistance exercise; EA: Aerobic exercise; NI: Not informed.
Resistance exercise in osteoarthritis: a review


