

Selection-Related Aspects of Resistance Exercises for Elderly

Aspectos Relacionados à Seleção de Exercícios Resistidos Para Idosos

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Abstract

Resistance exercise has been widely recommended for elderly population, since this type of exercise induces important health benefits, especially to improve functional capacity and preserve muscle mass, thus reflecting on the quality of life of older individuals. Among the several components of the resistance exercises the selection of movements to be performed is one of the most important and must be carefully analyzed. Although there may be a wide range of options, the most important recommendations do not specifically indicate the movements that should be included and muscle groups that should be prioritized when prescribing resistance exercise for the elderly. Therefore, considering that there is a lack of information for the Physical Education professional about the topic, this study was developed to support the choices of the movements that will compose the resistance exercise program for the elderly. The study was carried out by compiling and analyzing assumptions and scientific evidences related to resistance exercises and needs of elderly individuals. In conclusion, the choice of movements should be based on the principles of kinesiology, the needs of the elderly, muscle action and exercise safety in order to obtain beneficial results for general health and attenuate possible risks.

Keywords: Exercise. Aging. Physical Exertion.

Resumo

O exercício resistido vem sendo amplamente recomendado para população idosa, uma vez que esse tipo de exercício físico induz a importantes benefícios para saúde; sobretudo, no aprimoramento da capacidade funcional e na preservação da massa muscular; refletindo, desse modo, na qualidade de vida do indivíduo idoso. Dentre os diversos componentes dos exercícios resistidos, a seleção dos movimentos a serem executados é um dos mais importantes e deve ser cuidadosamente analisado. Embora possa existir vasta gama de opções, as principais recomendações não indicam especificamente os movimentos que devem ser incluídos e os grupos musculares que devem ser priorizados nos programas de exercícios resistidos. Portanto, considerando haver uma lacuna de informações sobre o tema, o estudo foi realizado com intuito de subsidiar a seleção dos movimentos que deverão compor os programas de exercícios resistidos para idosos. O estudo foi realizado mediante compilação e análise de pressupostos e evidências científicas referentes aos exercícios resistidos e as necessidades dos idosos. Concluiu-se que a seleção dos movimentos deve ser baseada nos princípios da cinesiologia, nas necessidades dos idosos, na ação muscular e na segurança de execução para se alcançar resultados benéficos para saúde em geral e atenuar possíveis riscos.

Palavras-chave: Exercício. Envelhecimento. Esforço Físico.

1 Introduction

With the advancement in the process of biological aging significant changes occur in several organic systems, which can influence the health and quality of life of the elderly. In particular, it is possible to highlight reductions in skeletal muscle mass and muscle work capacity^{1,2} which, in turn, are associated with functional autonomy, the risks of falls³⁻⁵ and the longevity of elderly individuals⁶⁻¹¹.

To mitigate or reverse the dysfunctions related to biological aging regular practice of resistive exercise has been encouraged^{12,13}. Positive adaptations afforded by resistance exercises are associated with adequate selection of movements that should compose their routine¹⁴. However, there is a paucity of information aimed at this purpose. The main recommendations of physical exercise indicate only

that be performed single-joint and multi-joint movements in equipment and free weights^{12,13,15}. However, they do not specify the movements that must be included and if there must be priority muscles. Also, they do not address security issues in their implementation. Considering the difficulty analysing the information available in the literature, it is necessary material which will provide a theoretical-practical allowance for selection of movements characteristic of resistive exercise in the elderly.

The quantity of information related to acute components of resistance exercises (load, repetitions, number of series, weekly frequency, order of movements, etc.) has grown exponentially in the past two decades, including systematic reviews with meta-analysis and dose-response relations¹⁶⁻¹⁸. However, little information has been produced on the

movements that should be included in the routine of resistance exercises specifically for the elderly. Such scenario could cause doubts and insecurities in the professionals responsible for the prescription and guidance of physical exercise. Therefore, the present paper had as objective to approach various aspects about the selection of resistance exercises, focusing on the needs of the elderly, the effectiveness to promote health and safety aspects in their implementation. It is expected that the information provided can serve as subsidies to optimize the adaptations induced by regular practice of resistive exercise with minimal risk of occurrence of lesions.-

2 Development

2.1 Methodology

For the survey of studies on the subject, an extensive bibliographic research was carried out in the databases *PubMed* and *SciELO databases*. The studies were carried out using the following terms in Portuguese and English: “Resistance training” and “elderly”. The publication date was not used as a criterion for inclusion and exclusion of studies. Following the analysis of the studies, the structure of the article was built in accordance with the aspects to be addressed.

2.2 Discussion

2.2.1 Selection of movements

The selection of movements that should compose the routine of resistive exercise is an important professional decision-making so that the physical exercise program can be successful. There is a wide range of possibilities of movements that may be employed in the resistance exercises. Thus, the factors to be taken into consideration in the selection of movements through analysis of individual needs in accordance with the objectives and should consider, basically, the muscular action and security in their implementation.

Regarding the muscular action, it is necessary to check if the selected movement presents an effective action on the desired muscle group. However, the decision must go beyond its effectiveness. The professional should also be guided in the potential harmful risk of each movement, i.e., factors that are aimed at safety and the greater possibility of accession of the elderly to the program. For example, it is possible that certain motion (or variations) increases the activation of specific muscle group; however, at the same time, also increases the risk of muscle-articular lesion. In this case, it is important to consider whether the risk outweighs the benefit. In addition, there is a possibility that the practitioner feels uncomfortable to perform some movement, which may compromise his or her adherence to the program.

2.2.2 Movements involving lower limbs

When selecting the movements that should compose the routine of resistance exercises for elderly people, primary attention should be given to the lower limbs. Reduction of

muscle mass and its functional capacity related to advancing age is considerably more pronounced in the lower limbs than in other regions of the body¹. Of course, this will ensure that the elderly have more difficulty ambulating, increasing the effort for tasks such as walking and standing up; therefore, natural tendency is to become less physically active⁶. Additionally, the vicious cycle is installed, once that lower levels of physical activity also impair the muscle mass and function¹⁹. Therefore, resistance exercises involving the lower limbs are fundamental for the elderly.

Among the resistance exercises that trigger muscle groups of the lower limbs, the *squatting* is considered one of the main movements²⁰⁻²². Squatting is a natural movement of the human being who is directly related to the important task of everyday life: sit-and-stand, in addition to recruiting several muscle groups during its implementation^{20,21}. This movement allows great dynamic activation of the quadriceps and buttocks²³, responsible for primary actions of the joints of knee and hip, respectively. In addition, this movement also offers effective participation in the capacity of activation of the trunk muscles²⁴. Recently, it has been observed that after a period of seven weeks of resistive exercise program by performing the movements of *squatting* and *dead lift* 65% of maximum capacity, three sets of 8-10 repetitions, an interval of two minutes between the series and two sessions/week, there was significant improvement in functional capacity of elderly women²⁵.

The traditional way of performing *squatting* is with free bar; and *andretanto* is a complex movement. Thus, for a good and safe execution of the *squatting* with free bar, certain conditions must be met: (a) healthy joints, i.e., not identification of pre-existing lesions, especially spine and knees (as some serious deviation of posture), degenerative diseases of articulation (arthritis, osteoarthritis, osteoporosis, clamping of nerves, among other anomalies); (b) preserved functional mobility of the hip and ankle; and (c) balance and satisfactory coordination to perform the movement²⁰.

In this context, not every elderly is able to perform properly the movement with free bar, since some of these prerequisites may already be affected due to advancing age. Therefore, the technique of execution of *squatting* should be compromised and induce potentially harmful errors, such as changes of the lumbar curvature, excessive tilting of trunk, among others. In theory, a few elderly individuals must meet these assumptions and, in turn, will prove able to adequately perform the *squatting* with free bar. In these cases, there is the possibility of variation of the movement that can provide similar benefits and with less risk.

Squatting performed on equipment *Smith* should require less requirement of balance of the practitioner, making the movement more accessible, since its trajectory is pre-defined by the equipment guide. So, it may be interesting for those who do not have sufficient coordination for the implementation

of the free *squatting* and/or those who demonstrate greater difficulty maintaining a good posture on the free bar. The movement performed in free bar allows for greater muscle activation compared to the *squatting* performed on equipment *Smith*²⁶. However, if this difference in activation is sufficient to induce greater improvement of functional capacity and the preservation of muscle mass, enhancing the quality of life of the elderly, it needs to be confirmed in longitudinal studies.

Both *squatting* with free bar as in *Smith* equipment is expected to increase the axial overload on the vertebral column, and it may not be prudent use of this movement in more fragile elderly, with a history of lesion in the vertebral column or with severe postural change. In this sense, alternative ways of performing *squatting* can be used, as is the case with the *squatting* with dumbbells, in which the performer performs the movement with the dumbbells in the hands. This should significantly reduce the compression on the spine, once the load is not positioned over it and engages virtually the same muscles.

In more fragile elderly or with lower levels of muscle efficiency, the *squatting* performed only with his or her own body weight should already produce sufficient stimuli to induce positive adaptations, not being required any additional equipment²⁷. However, in this case, due to muscle involvement and/or the lack of balance and coordination, the aid of the professional is a mandatory condition in the execution of this movement.

Another alternative is the implementation of the *hack squatting*. A great advantage of the *Hack squatting* is the support of the spine, since it will be supported on the backrest of the equipment. It is also a movement for easier implementation in comparison to *squatting* with free bar, considering its trajectory is defined by the equipment.

Leg press is a movement that provides the same joint action of knee and hip that the *squatting*; therefore, it will also activate efficiently quadriceps and gluteus maximum^{28,29}. Its big advantage is the reduction of axial load directly on the spine. That said, the elderly who cannot perform the *squatting* and its variations in an appropriate manner, with lumbar pain, accentuated postural changes, or history of problems in the vertebral column will have less discomfort when performing this movement.

During the *squatting* (and its variations) and the *leg press* the activity of the vastus is considerably larger than the femoral rectus^{20,30-32}. This occurs due to the nature of the rectus femoris which is a biarticular head, i.e., in addition to the joints of the knees also crosses the hip joints. This causes the downward phase of the *squatting* have a shortening of the proximal portion of the femoral rectus, while its distal portion stretches, and hence the femoral rectus can present development deficit when compared to the vastus³³. Experimental findings showed that after eight weeks of a program of resistive exercise three times a week, the group that performed *squatting* with a load between 75% and 90% 1RM, three to six repetitions

significantly increased the thickness of the quadriceps (14.7%), with updates statistics in the vastus (vastus lateralis muscle = 13.5%, vastus intermedius = 18% and vastus medialis = 17.1%); however, no significant changes occurred in the femoral rectus (1%)³³.

The rectus femoris, biarticular by its nature, in addition to an extender of knees, is a hip flexor; therefore, plays a major role in the walking cycle^{34,35}. In the walking cycle the femoral rectus is regionally activated, both during the support phase of the feet on the ground and in the swing phase to bend the hip^{36,37}. Also, it is a muscle important for postural balance, especially in larger disturbances, once the hip flexion is a strategy for the restoration of the balance in larger disorders. Therefore, complementary resistance exercises should be included to activate primarily the femoral rectus. In this sense, the movements in the *extensor chair* favor greater activation of the rectus femoris in comparison to multi-joints movements of closed kinetic chain^{32,38}. Experiment of 12 weeks of exercise only with the movement performed on the *extensor chair* identified greater increase of muscle mass in the femoral rectus than in the vastus³⁸.

It is worth noting that, in the *extensor chair* the activation peak of quadriceps occurs at the point of maximum extension of the knees³⁹. However, the angles close to this point are also the ones with the most compressive strength and shear stress on the knees^{39,40}. Therefore, in cases in which there are lesions is prudent to avoid the point of greatest extension of the knees. The movement performed on the *extensor chair* is facilitated by the use of equipment and due to being single-joint.

To walk and perform standing up and sitting down movements the extensor muscles of the knee (quadriceps) and hip are important^{34,35}. In hip extension movement the gluteus maximus and hamstrings are the main muscles. Although the gluteus maximus is activated satisfactorily in the *squatting* and its variations and the *leg press*, the hamstring muscles are activated moderately in multi-joint movements of closed kinetic chain as *squatting* and *leg press*^{20,41}. The moderate activation in the *squatting* occurs due to the nature of the biarticular hamstrings. These muscles are hip extensors and flexors of knees, as the *squatting* calls movements of knees and hips, a portion of the hamstrings stretches while another portion shortens, fact that keeps its length relatively constant during the action. In the medium and long term there must be minor adjustments to the hamstrings contraction of the quadriceps^{42,43}, inducing muscle imbalance and increase of injury risk.

Important study available in the literature identified that, after four weeks of resistive exercise involving the *squatting*, there were increases of 9.8% of the vastus medialis, 8.8% of the vastus intermedius and lateral, 4.7% of the rectus femoris. However, this was not the case of the semitendinous, semimembranous muscles and short head of the biceps femoris⁴². In another study it was reported that, after 12 weeks of resistance exercises with leg press movement 45°, the

knee extension torque increased; however, it was identified an increase to the torque of flexion of knees, suggesting that the isolated use of *leg press* 45° movement reduces the functional ratios of the knees. Therefore, the movements of closed kinetic chain (*squatting* and *leg press* 45°) must not be used alone in elderly patients⁴³.

Therefore, specific movements for the hamstrings must be included in the sessions of resistive exercise for the elderly, as for example, the *flexor table* and *stiff*. *Flexor table* is a single joint movement performed on equipment, what means to be more accessible. On the other hand, *stiff* is a movement that pelvic retroversion may occur; therefore, the ideal amplitude is the one in which the practitioner performs the movement while maintaining natural alignment of the spine. In addition, it is worth highlighting that the burden imposed on the vertebral column in the *stiff* is perpendicular, which induces the shear and great potential of injury to the spine⁴⁴, which implies that its use should occur with caution.

The gastrocnemius and the soleus muscle are muscles of the posterior region of the leg that collectively are called triceps surae muscle group, responsible for plantar flexion movements. These muscles help in the maintenance of balance, being the first strategy for restoration of postural balance in the standing position, also participating in the walking cycle^{34,45,46}. The plantar flexion in foot will put the gastrocnemius muscle in optimal condition for activation. Alternatively, performing the movement of plantar flexion in a sitting position, by reason of the knees are flexed, should generate active insufficiency of the gastrocnemius, since this is a biarticular muscle that crosses both joints of ankles and knees. Thus, performing the movement with knees flexed should reduce the activation of the gastrocnemius muscle⁴⁷.

The gluteus medium and minimum are important hip abductors⁴⁸, being the medium gluteus fundamental to stabilize the hips in walking⁴⁹, avoiding the dynamic valgus and mainly the hips unilateral drop, which increases the risk of falls. Studies have demonstrated the relationship between functional weaknesses in the medium gluteus and pain and osteoarthritis in the knees^{50,51}. For improvement of these muscles specific resistance exercises are required involving movements of the hip abduction. In turn, the adductor muscles of the hip are also important to maintain the stabilization of the hip and plays important role in the perineum directed to the prevention of urinary incontinence in the elderly. The stimulation of hip adductor and abductor may occur through movements in adductor and abductor chair, respectively.

2.2.3 Movements involving regions of the trunk

Of the joints of the upper region of the body, the glenohumeral articulation is important for daily activities by allowing movements in the frontal, sagittal and transversal plans. The main muscles that move this articulation are pectoralis major, latissimus dorsi and deltoid.

The pectoralis major is activated optimally in actions that

require shoulder adduction in the transverse plane. Thus, the bench press movement is an excellent option for activation of the pectoralis major. In addition, it also calls for considerable activation of the anterior portion of the deltoid. Still, due to being a multi-joint movement also requires action of the brachial triceps for extension of the elbows. Traditional version of the *bench press* is executed with bar, which requires greater balance and higher motor coordination. In the case of the elderly does not demonstrate these satisfactory attributes to perform the movement properly, the use of equipment becomes a very interesting alternative. The implementation of the bench press engages the pectoralis on its most elongated portion; thus, a full range of motion, with the bar approaching or lightly touching the trunk, should induce better results⁵². However, considering that some elderly may present limitations articular, individual analysis is required to determine the possibility of implementing the complete movement or limiting the amplitude due some pre-established joint problem.

The muscles of the dorsal region perform movements in three planes. The movements of the shoulder extension in the sagittal plane and adduction in the frontal plane, in particular, should be considered when selecting resistance exercises for the dorsal region. The latissimus dorsi is optimally stimulated in shoulder adduction in the frontal plane⁵³. Therefore, the pull-up movement is an interesting alternative to activate the latissimus dorsi. Pull-up movement should enable also the teres major. The lower trapezius fibers are also involved in this movement performing the depression of the scapula. To perform the movement the flexion of the elbows is required. Thus, the biceps brachialis, brachialis and brachioradialis muscles also have an important role in this movement. However, in the pull-up movement, during the eccentric phase, there must necessarily be shoulder abduction above 90 degrees. In turn, this movement should reduce the subacromial space, especially if combined with internal rotation of the shoulder, taking the structures included in this space to become pinched, atritando and impacting the bursa, the rotator cuff tendons between the humeral head and the acromion, being that the repeated exposure can lead to a greater risk of injury. Nevertheless, the elderly who have dysfunctions in the shoulder joints (bursitis or tendonitis) will have difficulty with this movement. In addition, the muscles of the medial region/high dorsal region (trapezius muscles and rhomboids) will not be stimulated satisfactorily in the pull-up movement. In this sense, movements in the sagittal plane, such as *low pulley seated rowing pulley* can be an interesting alternative.

The *low pulley seated rowing pulley* allows shoulder extension movement, in which the latissimus dorsi is also engaged, besides the posterior deltoid assists in the shoulders extension. The *low pulley seated rowing pulley* also enables greater amplitude in the adduction of scapula, movement that is executed by the trapezius, especially the medial fibers, and by

rhomboids. In the execution of movements in the low pulley it is important to maintain the alignment of the vertebral column, which should recruit the erector spinae for its stabilization. For the implementation of the *low pulley seated rowing pulley* flexion of the elbows is required; therefore, it will also request activation of the muscles responsible for these actions (biceps brachii, brachialis and brachioradialis).

Some elderly people may have difficulty maintaining the spine aligned during the implementation of this movement. In this sense, the sitting rowing can be performed on equipment that offers support to the anterior region of the trunk but will reduce the action of the erector spinae muscles. Alternatively, *rowing* can also be performed with free weights. Although it is a very effective and low-cost variation, it should require greater body awareness for performing the movement with correct technique, especially to maintain the alignment of the spine.

The abdominal muscles are part of the antero-lateral region of the trunk, including abdominal rectus abdominis transverse, internal oblique and external oblique. In general, the abdominal muscles are essential to stabilize the spine, particularly in the lumbar region, being fundamental to maintain a good posture, avoiding the appearance and development of postural deviations. These muscles when weakened and may lead to a change in posture (hyperlordosis) and, consequently, pain in the lumbar region. In addition, they are important for sustaining the viscera avoiding abdominal protrusion and balance, particularly in the elderly.

Main dynamic function of the rectus abdominis is flexing the trunk, a movement that approximates the thorax of the pubic region upon flexion of the vertebral column. It is also activated in retroversion movement of the pelvis⁵⁴. Thus, the basic movements of flexion of the trunk are important for activation of this muscle. The obliques assist the rectus abdominis in movements of flexion of the trunk; however, they are more versatile by also acting in rotational movements of the trunk and the lateral inclination of the column. However, it is worth noting that the rotational movements should impose greater stress on the intervertebral discs.

The transverse abdominal muscle is the most profound and works as a natural brace for protection of the vertebral column. It acts producing rigidity necessary to stabilize the lumbar spine, avoiding that suffer changes that may induce lumbar pains. It is also an important muscle in the mechanism of breathing. It is a more difficult portion to be ordered in a specific way through resistance exercises; however, actions involving isometric contractions of the type may be employed for activation of the abdominal transverse, as is the case for the plank exercise. Some elderly people, especially those who have greater functional weakness, can demonstrate difficulty performing this exercise. An alternative to facilitate its implementation is to enlist the support of a bank, considering that, increasing the height of the armrest, the physical effort

should be minimized.

2.2.4 Movements involving upper limbs

The deltoid muscle is quite versatile and important for shoulder mobility. The anterior portion is very active in the bench press movement, and the posterior portion is enabled on the low pulley sitting *row*. Thus, the specific movements should focus on the medial portion of deltoid. In this sense, the *cable fly* (shoulder abduction in the frontal plane) with pronated grip (palms down) is an efficient movement for activation of this portion of the deltoid⁵⁵.

The movement *front raise* is quite common in routine resistance exercises for activation of deltoid. However, in order to execute the movement *front raise*, it becomes necessary external rotation of the shoulder, what should make the fibers of the anterior portion of the deltoid position in a better position to action against the resistance, while this external rotation of the shoulder should reduce the activation of the medial fibers of deltoid⁵⁵. It is important to remember that the previous deltoid fibers are very requested in the bench press movement.

Furthermore, the *front raise* requires a shoulder abduction above 90 degrees. Movement that causes the lateral region of the humerus continue to have greater contact with the acromion-clavicular joint. This contact relates directly to increased mechanical stress, which is potentiated by external overload, which can cause an inflammatory process when the implementation is applied continuously. Therefore, some elderly people may perceive discomfort when performing this movement.

The muscles responsible for flexion and extension of the elbows are required on multi-joint movements involving regions of the trunk. The *bench press* will require action of the brachial triceps for extension of the elbows, while the *rowing sitting in low pulley* and *pull up* requires the flexors of the elbow (biceps brachii, brachialis and brachioradialis). To some extent, this participation is able to induce positive adaptations in relation to the mass increase and the functional capacity of the flexor and extensor muscles of the elbow⁵⁶. However, the addition of single-joint exercises, which calls for participation of muscles in more isolated way, as *direct curl* and *triceps on the pulley*, can induce superior results when compared to only execution of multi-joint movements (*bench press and low pulley sitting rowing*)⁵⁷. Therefore, an individual examination must be taken into consideration to include isolated movements of extension and flexion of the elbow. For example, elderly with low functional capacity of flexor and extensor muscles of the elbow, to the point of having daily or instrumental activities of daily life disrupted, can benefit with isolated movements such as *direct curl* and *triceps on the pulley*. The availability of time to participate in the program of resistance exercises is also a factor that must be considered for deciding on the inclusion of single-joint

movements of flexion and extension of the elbow.

2.2.5 Movements performed standing or sitting

Some resistance exercises require movements that can be performed in the standing position or sitting, it is the case of *frontal raise*, *cable fly*, *alternating curl*, among others. To decide on this issue, it is important to consider the stress imposed on the vertebral column, especially in elderly patients with lumbar dysfunction.

When performing certain movement standing the points of load dissipation are the natural physiological curves of the spine and lower limbs⁵⁸; however, when performing this same movement sitting, the points of load dissipation decreases. Therefore, the sitting position increases the load imposed on the lumbar spine. On the other hand, movements standing up may require further requests for coordination and balance, being that the elderly with postural balance deficit will have greater difficulty performing the movements with correct technique.

The choice for the execution of the movements in the sitting or standing position depends on some factors, with emphasis for correct execution of movements. In the case of the elderly performing the movement properly in both positions, it is suggested the standing position. When performing the movements in the standing position there must be the feet lateral displacement, about the width of the hip, which improves the balance by increasing the base of support. Still, it can be positioned in the feet anteroposterior displacement with the same base of support (width of the hip), which should mitigate the anterior displacement of the column. Another factor to be considered is the height of the center of gravity in relation to the base of support. In the standing position the knees should be slightly bent, which brings the center of gravity of the support base, providing, therefore, greater body balance.

3 Conclusion

The decision taking on the movements that should compose the resistive exercise routines should be based on several factors that consider the needs of the elderly, security, efficiency and comfort in their implementation. In this sense, it is expected that this manuscript might offer information that may subsidize the professional in the selection of movements that should compose routine of resistance exercises specifically for the elderly, in order to optimize the gains and minimize the risk of injury.

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