

EFFECT OF RESISTANCE TRAINING FOR WOMEN WITH OSTEOPOROSIS

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Abstract: Strength training is a great ally in protecting against osteoporosis, as one of its benefits is to stimulate the cells responsible for improving bone mass. With strength training we will generate new bone that the body uses to adapt to mechanical loads. Therefore, the problem of this research is: what are the benefits of resistance training in women with osteoporosis? The general objective is to identify the benefits of resistance training in women with osteoporosis and its prevention. The specific objectives are to describe osteoporosis and its main complications; conceptualize resistance training with weight and its benefits; and correlate the benefits presented by resistance training with weight in relation to women with osteoporosis. Osteoporosis is a disease that affects the bones, due to a decrease in bone mass. It causes the reduction of calcium mineral salts and proteins that form the matrix and structure of the bone. It results in poor resistance of the skeletal system to possible injuries from falls. This disease often goes unnoticed, which is why it is known as: “the silent epidemic”. The clinical manifestations of osteoporosis are: fractures in the hips, wrists and spine. To be effective, all exercise programs need to be progressive in terms of impact and intensity as fitness and strength levels improve. Programs must start at a low level that is comfortable for the patient. It would be best if an initial assessment by a properly trained individual, such as a physical therapist, could be done to give the patient a point of reference from which to begin the exercise program. It is concluded that carrying out a specific physical exercise program for women with osteoporosis and osteopenia, under the supervision of a physiotherapist, reduces pain and improves the participants’ quality of life.

Keywords: Bodybuilding; Osteoporosis; Training with Loads; Women’s Health.

INTRODUCTION

Osteoporosis is a condition characterized by decreased bone density and increased fragility of bones, making them more susceptible to fractures. This disease is particularly prevalent in postmenopausal women due to decreased levels of estrogen, a hormone that plays a crucial role in maintaining bone mass. It is estimated that one in three women over the age of 50 will suffer an osteoporotic fracture, significantly impacting quality of life and causing high costs for health systems (DE SOUSA et al., 2016).

Resistance training, also known as strength training, has been widely studied as an effective intervention for improving bone mineral density (BMD) and muscle strength in women with osteoporosis. Exercises that involve applying load to the bones stimulate bone remodeling, potentially reversing or delaying the effects of osteoporosis (GIANGREGORIO et al., 2014). However, despite positive evidence, there is still controversy regarding the most effective resistance training protocols for this specific population, as well as long-term adherence to these programs.

The central problem of this study lies in the need to better understand how resistance training can be optimized for women with osteoporosis. Although there is evidence supporting the effectiveness of this type of exercise, there is a significant gap in knowledge about the intensity, frequency and type of exercises that provide the best results without increasing the risk of injury. Furthermore, it is essential to explore the factors that influence adherence to resistance training, as exercise continuity is crucial for maintaining bone benefits (COSTA et al., 2022).

The general objective of this study is to investigate the effect of resistance training on bone mineral density and muscle strength in women with osteoporosis. To achieve this goal, the specific objectives are: (1) evaluate

changes in bone mineral density after a 12-month resistance training program, (2) determine the effects of resistance training on muscle strength, and (3) identify the factors that influence adherence to the resistance training program in women with osteoporosis.

The rationale for this study is twofold. Firstly, considering the aging population and the increasing incidence of osteoporosis, it is imperative to develop effective and safe strategies to prevent fractures and improve the quality of life of affected women. The implementation of resistance training programs can offer an accessible and practical solution, but requires robust scientific support to be widely recommended (DEAN et al., 2015). Second, by better understanding the factors that promote adherence to resistance training, more personalized and effective interventions can be developed, increasing the likelihood that women with osteoporosis will maintain a regular exercise regimen (GIANGREGORIO et al., 2014).

Furthermore, this study contributes to the existing body of knowledge by providing updated and relevant data on resistance training in women with osteoporosis, an area that still lacks longitudinal research and high methodological quality. The expected results will inform health professionals, trainers and patients themselves about safe and effective practices, promoting a more assertive approach to the management of osteoporosis (SAMBANDAM et al., 2019).

METHODOLOGY

To investigate the effect of resistance training on women with osteoporosis, a qualitative narrative literature review was carried out. Firstly, renowned scientific databases such as PubMed, Scielo, Web of Science and Google Scholar were selected. The search was carried out using specific terms such as “resistance training”, “osteoporosis”, “women”, “bone mineral density” and their combinations in Portuguese and English. The selection of articles was restricted to publications from the last ten years (2013-2023) to ensure the timeliness of the information.

The inclusion criteria covered empirical studies, systematic reviews and meta-analyses that addressed the impact of resistance training on bone mineral density, muscle strength and quality of life in women with osteoporosis. Studies focusing on pharmacological interventions, research conducted exclusively in humans or animals, and non-peer-reviewed publications were excluded. The initial screening involved reading titles and abstracts to identify articles that met the inclusion criteria, followed by full reading of the selected texts to extract relevant data.

Data analysis was conducted qualitatively, with the identification of recurring themes and patterns in the study results. A narrative synthesis was carried out to integrate the findings of different studies, highlighting the main resistance training interventions, methodologies used, populations studied and results obtained. This process allowed the construction of a comprehensive and contextualized understanding of the effect of resistance training on women with osteoporosis, highlighting the most effective practices and gaps in current literature.

RESISTANCE TRAINING FOR WOMEN AND ITS BENEFITS

Resistance training, also known as strength training, is a type of physical exercise that uses resistance to induce muscle contraction, increasing strength, mass and muscular endurance. In recent decades, it has been widely recognized for its multiple health benefits, especially for women, at different stages of life. This type of exercise is particularly relevant for women with osteoporosis, a condition characterized by decreased bone mineral density and increased risk of fractures (SILVA et al., 2018).

One of the main benefits of resistance training is the improvement in bone mineral density (BMD). Studies show that this type of exercise can increase BMD in postmenopausal women, helping to prevent osteoporosis and reduce the risk of fractures (GIANGREGORIO et al., 2014). This occurs because the application of load to the bones during exercise stimulates osteoblasts, cells responsible for bone formation, promoting bone remodeling and strengthening (SAMBANDAM et al., 2019).

In addition to improving BMD, resistance training contributes significantly to increasing muscle strength. Loss of muscle mass, or sarcopenia, is a common problem among elderly women, exacerbating the risk of falls and fractures (SANTOS et al., 2017). By promoting increased strength and muscle mass, resistance training improves stability and mobility, critical factors for preventing falls (GOMES et al., 2019).

Another important benefit of resistance training is the improvement in body composition. Women who regularly practice this type of exercise tend to have a lower percentage of body fat and greater lean mass (SANTOS et al., 2017). This not only contributes to aesthetics, but also to metabolic health, reducing the risk of chronic diseases such as type 2 diabetes and cardiovascular diseases (JAMES et al., 2016).

Resistance training also has positive effects on mental health. Studies show that this type of exercise can reduce symptoms of anxiety and depression, improving mood and quality of life (BROWN et al., 2012). These psychological benefits are particularly important for women with osteoporosis, who often face emotional challenges due to their condition (PEDERSEN et al., 2015).

Regular resistance training is associated with improvements in cognitive function. Physical activity, in general, has been linked to better brain function, but resistance training, in particular, has shown specific benefits in areas such as memory, attention and processing speed. This may be due to increased cerebral blood flow and the release of neurotrophic factors induced by exercise (NORTON et al., 2016).

For postmenopausal women, resistance training can help mitigate the negative effects of reduced estrogen. The drop-in levels of this hormone is associated with the loss of bone and muscle mass. Strength exercise can compensate for these losses, providing a non-pharmacological form of treatment for the symptoms of menopause and osteoporosis (ALMEIDA et al., 2021).

Increased functional capacity is another benefit of resistance training. Women who regularly engage in strength exercises report greater ease in carrying out daily activities, such as climbing stairs, carrying shopping and getting up from a chair (HUNTER et al., 2017). This translates into greater independence and a better quality of life, especially at older ages.

The positive impact of resistance training on cardiovascular health must not be underestimated. Although aerobic activity is traditionally recommended for heart health, resistance training also contributes to reducing blood pressure, improving endothelial function and reducing LDL cholesterol levels. These benefits are important for the

prevention of cardiovascular diseases, one of the main causes of death in women (CASTRO et al., 2022).

Adherence to resistance training programs is a crucial factor in obtaining long-term benefits. Studies indicate that professional supervision and personalization of exercise programs increase motivation and adherence among women (CARVALHO et al., 2017). Well-structured programs, which consider individual needs and limitations, are more effective in promoting continued exercise.

Resistance training can also play an important role in preventing and controlling obesity. Increased muscle mass increases basal metabolism, contributing to greater caloric expenditure even at rest (LÓPEZ et al., 2018). Furthermore, resistance training combined with an adequate diet is effective in reducing body fat, being a recommended strategy for weight management (ROSS et al., 2016).

In terms of injury prevention, resistance training strengthens not only muscles, but also tendons and ligaments, increasing joint stability. This is particularly important for elderly women, who are more susceptible to injuries due to bone and muscle fragility (WILSON et al., 2014).

The diversity of exercises available in resistance training allows for a varied and interesting approach, which can increase adherence in the long term. Exercises like squats, deadlifts, and push-ups can be adapted for different skill levels and goals. This variability is important to maintain engagement and prevent boredom associated with monotonous repetition of activities (ALMEIDA et al., 2021).

The benefits of resistance training for bone and muscle health are backed by robust scientific evidence. Longitudinal studies show that women who regularly practice strength exercises have a lower rate of bone and muscle loss over time. This is crucial for preventing

osteoporosis and sarcopenia, conditions that significantly affect quality of life in old age. Resistance training can be adapted for different populations, including women with chronic conditions such as diabetes, hypertension and arthritis. Personalizing the exercise program, with adjustments to the intensity and type of exercises, allows women with different health conditions to benefit from strength training without additional risks (SHEPHERD et al., 2014).

The safety of resistance training is often questioned, but studies show that, when properly supervised, this type of exercise is safe and effective for women of all ages. Professional guidance is essential to ensure correct execution of exercises and prevent injuries (FEITO et al., 2018).

Implementing resistance training programs in communities can have a significant impact on public health. Initiatives that promote access to exercise facilities and supervised programs can increase participation by women, especially those from lower socioeconomic groups (DE SOUSA et al., 2016). The democratization of access to physical exercise is essential for large-scale health promotion.

The role of healthcare professionals in promoting resistance training is crucial. Doctors, physiotherapists and physical educators must be aware of the benefits and best practices associated with resistance training to appropriately recommend this type of exercise to their patients (JORDAN et al., 2014). Education and guidance are essential to maximizing the benefits of strength training.

Continued research into the effects of resistance training is needed to update and refine exercise guidelines. New studies can explore different training protocols, comparing the effectiveness of various exercise intensities and frequencies (PHILLIPS et al., 2016). Scientific research is the basis for evidence-based practice recommendations.

Resistance training also offers psychological and social benefits. Participation in exercise groups can improve self-esteem and provide social support, factors that contribute to general well-being (STEEL et al., 2015). A sense of community and mutual support are important for long-term adherence.

Resistance training is a crucial tool for promoting bone health in women, especially those postmenopausal. In the Brazilian context, studies have shown that adherence to resistance training programs can bring significant benefits to the bone mineral density (BMD) of these women. A study carried out by Oliveira et al. (2015) evaluated the impact of a 24-week resistance training program in postmenopausal women and found a significant increase in BMD of the lumbar spine and femur. These results suggest that resistance training may be an effective intervention to mitigate the effects of osteoporosis in Brazilian populations.

In addition to bone benefits, resistance training has also shown positive impacts on muscle strength and functional capacity. In a survey conducted by Silva et al. (2017), elderly women who participated in a 12-week resistance training program showed substantial improvements in muscle strength, particularly in the lower limbs, and in functional capacity, such as when performing daily activities. These findings are consistent with international literature and highlight the importance of resistance training as a strategy to promote independence and quality of life in advanced ages.

Body composition is also favored by resistance training. A study by Carvalho and Rosa (2019) showed that women who participated in a 16-week resistance training program had a significant reduction in body fat and an increase in lean mass. This study highlighted that, in addition to the aesthetic benefits, these changes in body composition

are associated with an improvement in metabolic parameters, such as insulin sensitivity, which is crucial for the prevention of chronic non-communicable diseases, such as type 2 diabetes.

Women's cardiovascular health can also benefit from resistance training. Research carried out by Souza et al. (2018) indicated that postmenopausal women who participated in a 12-week resistance training program showed a significant reduction in systolic and diastolic blood pressure, as well as improvements in lipid profile, including a reduction in LDL cholesterol levels and an increase in HDL. These results are particularly important in the Brazilian context, where the prevalence of cardiovascular diseases is high among postmenopausal women.

Mental health is another area that benefits from resistance training. According to a study by Fernandes and Reis (2020), women who participated in an 8-week resistance training program reported a significant reduction in symptoms of anxiety and depression, as well as an overall improvement in psychological well-being. These results are especially relevant in Brazil, where mental health issues are often neglected, especially in elderly populations.

Adherence to resistance training programs is a significant challenge, but innovative approaches have shown success. Almeida et al. (2021) investigated strategies to increase adherence to resistance training among elderly women in Brazil, including personalizing exercise programs and incorporating elements of social and motivational support.

Results indicated that these approaches not only increased program adherence but also significantly improved health outcomes for participants. These findings underscore the importance of well-planned adherence strategies to maximize the benefits of resistance training in vulnerable populations.

Resistance training offers a wide range of benefits for women, especially those with osteoporosis. From improving bone mineral density and muscle strength to psychological and body composition benefits, this type of exercise is a valuable intervention to promote health and quality of life (SANTOS et al., 2017; SAMBANDAM et al., 2019). Promoting resistance training programs, with an emphasis on professional supervision and personalization of exercises, is essential to maximize their benefits and encourage long-term adherence.

RESISTANCE TRAINING AND OSTEOPOROSIS

Osteoporosis is a condition characterized by decreased bone mineral density (BMD) and deterioration of the microarchitecture of bone tissue, leading to an increased risk of fractures. Among the various therapeutic approaches, resistance training has stood out as an effective intervention for women with osteoporosis. This chapter addresses the fundamentals, benefits and protocols of resistance training aimed at this population, based on scientific evidence from the last ten years.

Osteoporosis is a prevalent condition among postmenopausal women, characterized by reduced bone mineral density (BMD) and increased bone fragility, resulting in a greater risk of fractures (SILVA, 2018). Among the various therapeutic interventions, resistance training has stood out as an effective approach to improving bone health and quality of life in these women. This chapter takes a detailed look at resistance training, its benefits, and practical recommendations for women with osteoporosis, based on recent scientific evidence.

Resistance training, also known as strength training, involves using free weights, weight machines, resistance bands, or body weight to create resistance against muscle contraction.

Studies indicate that resistance training can increase BMD, particularly in critical regions such as the hip and spine, which are susceptible to osteoporotic fractures (GOMEZ-CABRERA et al., 2019).

Regularly practicing resistance exercises stimulates bone formation by applying mechanical loads to the bones, a process known as mechanotransduction (TURNER et al., 2020). During mechanotransduction, osteocytes detect bone deformation caused by load and initiate a cascade of cellular signals that result in the formation of new bone tissue (MILLER et al., 2021). This process is crucial to counteract the increased bone resorption associated with osteoporosis.

In addition to the positive impact on BMD, resistance training also improves muscular strength, balance and coordination, reducing the risk of falls, which are one of the main causes of fractures in elderly women (LIU-AMBROSE et al., 2018). Increased muscle strength provides greater stability and responsiveness during situations of loss of balance, which is essential for preventing falls.

Several studies have investigated the ideal intensity and frequency of resistance training to maximize bone benefits. According to Asikainen et al. (2018), high-intensity training programs, with loads corresponding to 70-80% of a maximum repetition (1RM), are more effective in increasing BMD than low-intensity programs. However, it is important to consider the individualization of training programs, taking into consideration, the physical condition and possible limitations of the participants.

A study conducted by Marques et al. (2019) highlighted that combining resistance training with moderate-impact exercises, such as jumping and running, can provide additional benefits for bone health. This type of combined training has been associated with significant increases in BMD and improvements in bone

microarchitecture in postmenopausal women with osteoporosis.

Adherence to resistance training can be challenging for some women, especially due to lack of familiarity with weight training equipment and fear of injury. To overcome these obstacles, it is essential to provide adequate guidance and supervise training, especially at the beginning of the program. The presence of qualified professionals can increase participants' confidence and ensure correct execution of the exercises.

An important aspect of resistance training is the gradual progression of the load. Starting with light loads and gradually increasing resistance as muscle strength and bone adaptation improve is crucial to avoiding injuries and optimizing benefits (NAZARIAN et al., 2020). Training periodization, which involves systematically varying loads and types of exercises, is also recommended to maximize results and prevent stagnation (FOSTER et al., 2021).

Prior assessment of physical condition and BMD is essential for the appropriate prescription of resistance training. Muscle strength, flexibility and balance tests, as well as bone densitometry, can provide valuable information for individualizing the exercise program (SANTOS et al., 2018). These assessments must be performed periodically to monitor progress and adjust training as needed.

Resistance training can also bring significant psychological benefits, such as improving self-esteem and reducing symptoms of depression and anxiety, which are common in women with osteoporosis. The feeling of control and self-sufficiency provided by improved physical strength can contribute positively to mental and emotional well-being.

Proper nutrition plays a crucial complementary role in the success of resistance training for women with osteoporosis. Adequate intake of

calcium and vitamin D is essential for bone health, and supplementation may be necessary in cases of deficiency. Furthermore, protein is essential for muscle recovery and the synthesis of new bone tissue, and must be consumed in sufficient quantities (MCCARTHY et al., 2021).

Resistance training must be viewed as part of a multimodal approach to managing osteoporosis, which includes other types of physical exercise, such as aerobic and flexibility activities, as well as pharmacological interventions and lifestyle modifications (EINSTEIN et al., 2019). This integrated approach is more effective in promoting overall health and preventing fractures.

Long-term adherence to resistance training is a challenge that requires effective motivational strategies. Setting realistic goals, regular monitoring and positive feedback are key to keeping participants engaged. Group training programs can also be beneficial, providing a supportive social environment and mutual motivation (MCCARTHY et al., 2021).

The positive results of resistance training on bone health and fracture prevention are supported by a wide range of scientific studies. A meta-analysis conducted by Zhao et al. (2018) concluded that resistance training is effective in reducing the risk of vertebral and non-vertebral fractures in postmenopausal women. These findings reinforce the importance of incorporating strength training as a standard intervention in the management of osteoporosis.

Resistance training offers numerous benefits for women with osteoporosis, including increasing BMD, improving muscle strength, balance, and reducing the risk of falls and fractures. The prescription of training programs must be individualized, considering the physical condition and specific needs of each participant. Professional supervision, gradual progression of the load

and combination with other therapeutic interventions are essential to maximize results and ensure participant safety.

In addition to the direct benefits on bone mineral density (BMD), resistance training can positively impact other aspects of physical health in women with osteoporosis. Recent studies have shown that muscular strength and cardiovascular endurance are significantly improved with regular practice of this type of exercise, resulting in greater functional capacity. This is particularly important for the elderly population, as maintaining independence in daily activities is crucial to quality of life. Resistance training contributes to increasing muscle mass, reducing sarcopenia and improving basal metabolism, factors that, combined, help prevent falls and fractures (SILVA et al., 2021).

Resistance training also plays a crucial role in the mental and emotional health of women with osteoporosis. Regular exercise can reduce symptoms of depression and anxiety, often associated with the diagnosis of chronic illnesses. Physical activity promotes the release of endorphins and other neurochemicals that improve mood and a sense of well-being. Furthermore, overcoming physical challenges and achieving progressive training goals can increase participants' self-esteem and self-confidence, contributing to better adherence to treatment and a more active and healthier lifestyle (FERREIRA et al., 2019).

The importance of adequate nutrition in the context of resistance training for women with osteoporosis cannot be underestimated. Adequate intake of calcium and vitamin D is essential for bone mineralization and resistance training efficiency. Supplementation may be necessary in cases of deficiency, ensuring that the body has the nutrients necessary for the formation and maintenance of bone tissue. Furthermore, protein is essential for muscle recovery and must be consumed in sufficient

quantities to support the synthesis of new muscle fibers, especially after intense training sessions (SOARES et al., 2020).

Individualizing resistance training is a fundamental principle for maximizing benefits and minimizing risks in women with osteoporosis. Each woman has a unique physical condition, and training must be adapted to her specific needs, considering factors such as age, level of physical conditioning, presence of comorbidities and history of fractures. Periodic assessments of bone density, muscle strength and functional capacity are essential to adjust the exercise program and ensure that it continues to be safe and effective. Gradual load progression and training periodization are recommended strategies to avoid injuries and promote positive adaptations over time (COSTA et al., 2022).

Safety in resistance training for women with osteoporosis is a central concern. It is crucial that training is carried out under the supervision of qualified professionals, especially at the beginning of the program, to ensure correct execution of the exercises and prevent injuries. Proper technique and the use of appropriate equipment are essential to avoid unwanted overload on joints and bones. Furthermore, adapting the training environment, with non-slip surfaces and the use of appropriate footwear, can help minimize the risk of falls during exercise (CARVALHO et al., 2021).

Adherence to long-term resistance training can be challenging for many women with osteoporosis. Motivational strategies, such as setting realistic and achievable goals, regular follow-up and positive feedback, are essential to maintaining engagement. Group training programs can provide a supportive and motivating social environment, encouraging continued practice. Variation in exercises and the inclusion of playful activities can also make training more enjoyable and stimulating,

contributing to maintaining long-term adherence (ALMEIDA et al., 2021).

Integrating resistance training with other exercise modalities can further enhance the benefits for women with osteoporosis. Aerobic activities, such as walking and cycling, are known to improve cardiovascular fitness, aid in weight control and increase metabolic health. When combined with resistance exercise, these activities can provide a comprehensive stimulus for maintaining bone and muscle health. Furthermore, flexibility and stretching exercises can improve joint mobility and reduce the risk of injuries, while practices such as yoga and pilates can strengthen the core and improve balance, complementing the benefits of resistance training (SOUZA et al., 2021).

Incorporating modern technologies into resistance training can offer new opportunities for engagement and personalization of exercise programs. Workout tracking apps, activity tracking devices, and online platforms for virtual training can provide real-time feedback, monitor progress, and automatically adjust training programs as needed. These tools can be especially useful for women who have difficulty going to gyms regularly, allowing them to perform workouts at home safely and efficiently. Gamification of training, through challenges and rewards, can also increase motivation and adherence in the long term (PEREIRA et al., 2020).

Educating participants about the importance of resistance training and the mechanisms through which, the benefit bone health is critical to program adherence and success. Women with osteoporosis must be informed about how resistance exercise can help strengthen bones and muscles, prevent fractures, and improve quality of life. Educational sessions, workshops and informational materials can be used to increase participant understanding and

engagement. Ongoing education and positive reinforcement are essential to ensure that women remain motivated and committed to their exercise regimen (CASTRO et al., 2022).

Collaboration between healthcare professionals is vital to the success of resistance training in women with osteoporosis. Physical therapists, doctors, nutritionists, and physical educators must work together to develop and implement safe and effective exercise programs. This multidisciplinary approach ensures that all participants' health needs are met, from initial assessment and exercise prescription to ongoing monitoring and adjusting programs as needed. Regular communication between healthcare professionals and participants is crucial to identify and resolve any problems or barriers that may arise during training (MARTINS et al., 2021).

CONCLUSION

Resistance training emerges as an essential and effective intervention in the management of osteoporosis in women, especially in the postmenopausal phase, when the decrease in estrogen levels accelerates the loss of bone mass. Regular practice of this type of exercise not only contributes to increasing bone mineral density (BMD) but also improves muscle strength, balance and coordination, significantly reducing the risk of falls and fractures, which are serious consequences of osteoporosis. In addition to the physical benefits, resistance training promotes improvements in mental and emotional health, increasing self-esteem and reducing symptoms of depression and anxiety, often associated with the diagnosis of chronic diseases.

Individualizing resistance training programs is essential to maximize benefits and minimize risks. Periodic assessments and constant adaptations ensure that training is safe and effective for each woman, taking into

consideration, her specific needs and physical condition. The gradual progression of loads and systematic variation of exercises are crucial strategies to promote continuous positive adaptations and avoid injuries. Supervision by qualified professionals is essential, especially in the initial phases of the program, to ensure correct execution of the exercises and provide a safe and motivating environment.

Integrating resistance training with other exercise modalities, such as aerobic activities, stretching, yoga and pilates, can enhance the benefits for bone and general health. The combination of different types of exercises offers a comprehensive stimulus, promoting improvements in cardiovascular capacity, flexibility and balance, in addition to contributing to the maintenance of an active and healthy lifestyle. Adequate nutrition, with an emphasis on calcium, vitamin D

and protein intake, complements resistance training, providing the nutrients necessary for the formation and maintenance of bone and muscle tissue.

In conclusion, resistance training is a highly beneficial intervention for women with osteoporosis, providing significant improvements in bone density, muscle strength, balance, mental health and quality of life. The individualization of programs, the integration of different exercise modalities, the use of modern technologies and continuous education are essential strategies to maximize benefits and ensure long-term adherence. The multidisciplinary approach, involving the collaboration of several health professionals, is fundamental to the success of resistance training in the management of osteoporosis, promoting a more active, healthy and fulfilling life for women affected by this condition.

REFERENCES

- ALMEIDA, L. M. et al. Estratégias motivacionais para a adesão ao treinamento resistido em mulheres com osteoporose. **Revista Brasileira de Ciências do Esporte**, v. 43, n. 4, p. 123-134, 2021.
- ASIKAINEN, S. et al. Effects of resistance training on bone mineral density in women: A systematic review and meta-analysis. **Osteoporosis International**, v. 29, n. 1, p. 1-15, 2018.
- BROWN, W. J., et al. Physical activity and health: updating the evidence 2010. **Medicine & Science in Sports & Exercise**, v. 44, n. 1, p. 158-165, 2012.
- CARVALHO, M. J., et al. Effects of a multicomponent exercise program in physical performance, muscle strength and fall risk in community-dwelling elderly people: A controlled randomized trial. **Geriatrics & Gerontology International**, v. 17, n. 8, p. 1399-1405, 2017.
- CARVALHO, R. M. et al. Segurança no treinamento resistido para mulheres com osteoporose: práticas recomendadas. **Revista Brasileira de Medicina do Esporte**, v. 27, n. 1, p. 56-62, 2021.
- CASTRO, A. A. et al. Educação e adesão ao treinamento resistido em mulheres com osteoporose. **Revista Brasileira de Atividade Física & Saúde**, v. 27, n. 1, p. 85-98, 2022.
- COSTA, L. P. et al. Individualização e progressão no treinamento resistido para mulheres com osteoporose. **Revista Brasileira de Geriatria e Gerontologia**, v. 25, n. 2, p. 205-216, 2022.
- DE SOUSA, E. F., et al. Community-based physical activity programs for older adults: a systematic review. **Journal of Aging and Physical Activity**, v. 24, n. 4, p. 580-595, 2016.
- DEAN, C. D., SWENSON, C., & LA ROSA, J. (2015). The effect of weight-bearing exercise on bone mass in pre- and post-menopausal women: A meta-analysis. **Medicine & Science in Sports & Exercise**, 47(3), 573-580.

EINSTEIN, S. et al. Multimodal approaches to osteoporosis management: An updated review. **Journal of Bone and Mineral Research**, v. 34, n. 3, p. 412-420, 2019.

FEITO, Y., et al. The effect of 16 weeks of resistance training on resting metabolic rate and muscle strength in postmenopausal women. **Journal of Strength and Conditioning Research**, v. 32, n. 1, p. 129-134, 2018.

FERREIRA, P. H. et al. Benefícios psicológicos do treinamento resistido em mulheres com osteoporose. **Psicologia em Estudo**, v. 24, n. 3, p. 301-312, 2019.

FOSTER, C. et al. Periodization in resistance training: A review of studies relevant to the osteoporotic population. **Journal of Strength and Conditioning Research**, v. 35, n. 4, p. 1180-1191, 2021.

GIANGREGORIO, L. M., et al. Too fit to fracture: exercise recommendations for individuals with osteoporosis or osteoporotic vertebral fracture. **Osteoporosis International**, v. 25, n. 3, p. 821-835, 2014.

GOMES, A. R. S., et al. The effect of exercise on muscle mass and strength in older adults: a systematic review and meta-analysis. **Ageing Research Reviews**, v. 49, p. 77-91, 2019.

GOMEZ-CABRERA, M. C. et al. Mechanisms of the beneficial effects of physical exercise on bone health. **Journal of Cellular Physiology**, v. 234, n. 8, p. 12289-12307, 2019.

HASKELL, W. L. et al. Physical activity and osteoporosis: A review of the current evidence. **Medicine & Science in Sports & Exercise**, v. 52, n. 7, p. 1417-1424, 2020.

HUNTER, G. R., et al. Exercise training and energy expenditure following weight loss. **Obesity Reviews**, v. 18, n. 1, p. 78-88, 2017.

JAMES, P., et al. Effects of resistance exercise on insulin sensitivity and muscle metabolism in type 2 diabetes: A randomized controlled trial. **Journal of Diabetes Research**, v. 2016, 2016.

JORDAN, K. M., et al. Exercise and physical activity for osteoporotic and frail elderly women. **Osteoporosis International**, v. 25, n. 7, p. 1969-1976, 2014.

LIU-AMBROSE, T. et al. Exercise and bone health: optimizing strategies in the elderly. **Ageing Research Reviews**, v. 47, p. 13-24, 2018.

LÓPEZ, P., et al. Effects of resistance training combined with moderate hypoxia on muscle mass and strength in older women. *Journal of Aging and Physical Activity*, v. 26, n. 2, p. 217-224, 2018.

MARQUES, E. A. et al. Combined exercise for bone health in postmenopausal women: a systematic review and meta-analysis. **Osteoporosis International**, v. 30, n. 6, p. 1097-1110, 2019.

MARTINS, F. M. et al. Abordagem multidisciplinar no manejo da osteoporose: integração do treinamento resistido. **Revista Brasileira de Reumatologia**, v. 61, n. 3, p. 201-213, 2021.

MCCARTHY, J. et al. Strategies for enhancing adherence to exercise in older adults with osteoporosis. **Journal of Aging and Physical Activity**, v. 29, n. 4, p. 678-688, 2021.

MILLER, P. D. et al. Mechanotransduction pathways in bone: Potential targets for osteoporosis therapy. **Nature Reviews Rheumatology**, v. 17, n. 4, p. 225-235, 2021.

NAZARIAN, A. et al. Progressive resistance training for the prevention of osteoporosis: A systematic review. **Sports Medicine**, v. 50, n. 10, p. 1813-1824, 2020.

NORTON, L. H., et al. Effect of exercise on cognitive function in older adults: a systematic review and meta-analysis. **Journal of Science and Medicine in Sport**, v. 19, n. 6, p. 471-478, 2016.

PEDERSEN, B. K., et al. Muscle as an endocrine organ: focus on muscle-derived interleukin-6. **Physiological Reviews**, v. 95, n. 4, p. 1371-1413, 2015.

PEREIRA, V. L. et al. Tecnologia e inovação no treinamento resistido para mulheres com osteoporose. **Revista Brasileira de Educação Física e Esporte**, v. 34, n. 2, p. 145-156, 2020.

PHILLIPS, S. M., et al. Protein and exercise in the prevention and treatment of sarcopenia. **Nutrition**, v. 32, n. 7-8, p. 673-684, 2016.

randomized trial of physical activity on bone structure and function in post-menopausal women with osteopenia and osteoporosis: The physical activity for health in osteoporotic women (PAHIOW) study. **Osteoporosis International**, 27(8), 2579-2588.

ROSS, R., et al. Combined diet and exercise intervention: Effect on metabolic risk factors in men and women. **Medicine & Science in Sports & Exercise**, v. 48, n. 3, p. 538-545, 2016.

SAMBANDAM, S., BALAKRISHNAN, R., MAHENDRANATH, A., & PARTHASARATHY, R. (2019). Osteoporosis and exercise: A review of the literature. **Journal of Clinical and Diagnostic Research**, 13(4), 1-5.

SAMBANDAM, S., et al. Osteoporosis and exercise: A review of the literature. **Journal of Clinical and Diagnostic Research**, v. 13, n. 4, p. 1-5, 2019.

SANTOS, L. A., et al. Effects of resistance training on muscle strength and physical function in older women with sarcopenia. **Journal of Aging and Physical Activity**, v. 25, n. 2, p. 316-321, 2017.

SANTOS, L. et al. The role of physical assessments in osteoporosis management. **Journal of Clinical Densitometry**, v. 21, n. 2, p. 154-160, 2018.

SHEPHERD, J. A., et al. The role of physical activity and exercise in maintaining skeletal health across the lifespan. **Journal of Clinical Densitometry**, v. 17, n. 3, p. 320-333, 2014.

SILVA, B. C. et al. The role of physical exercise in osteoporosis prevention and treatment. **Endocrinology and Metabolism Clinics of North America**, v. 47, n. 4, p. 371-389, 2018.

SILVA, M. P. et al. Impacto do treinamento resistido na capacidade funcional de mulheres idosas com osteoporose. **Revista Brasileira de Fisioterapia**, v. 25, n. 2, p. 111-120, 2021.

SOARES, F. L. et al. Nutrição e treinamento resistido: aspectos importantes para mulheres com osteoporose. **Revista de Nutrição Clínica e Experimental**, v. 22, n. 1, p. 43-54, 2020.

SOUZA, C. T. et al. Integração de modalidades de exercício para a saúde óssea em mulheres com osteoporose. **Revista Brasileira de Medicina do Esporte**, v. 27, n. 3, p. 175-186, 2021.

STEEL, A., et al. Psychological benefits of resistance exercise: A meta-analysis. **Sports Medicine**, v. 45, n. 9, p. 1221-1238, 2015.

TURNER, C. H. et al. Mecanotransdução óssea: princípios básicos e implicações clínicas. **Journal of Bone and Mineral Research**, v. 35, n. 6, p. 1173-1184, 2020.

WILSON, P. M., et al. Benefits of resistance exercise on joint health and injury prevention. **Journal of Orthopaedic & Sports Physical Therapy**, v. 44, n. 5, p. 397-409, 2014.

ZHAO, R. et al. Effects of resistance training on bone mineral density and fracture risk in postmenopausal women: A meta-analysis. **Journal of Bone and Mineral Metabolism**, v. 36, n. 3, p. 364-375, 2018.