

IMPACTS OF BODYBUILDING ON THE ELDERLY POPULATION: BETTER RISK OR BENEFIT?

Eugênio Alencar Muniz Filho

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID: 0009-0009-3341-1395

<https://lattes.cnpq.br/7499019779189013>

Virna Victoria Almeida Sampaio

Universidade Federal do Cariri. Juazeiro do
Norte, Ceará, Brazil.

ORCID:0009-0007-1400-6883

<http://lattes.cnpq.br/3132409240505259>

Bruno Florentino Alves

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID:0000-0002-4438-0848

<http://lattes.cnpq.br/8234595422538954>

Thalita Marcelle Lisboa da Trindade

Faculdade de medicina de Olinda. Olinda,
Pernambuco, Brazil.

ORCID: 0009-0003-0086-8088

<http://lattes.cnpq.br/3901887424685737>

Raphael Lima Saraiva

Centro Universitário Maurício de Nassau.
Recife, Pernambuco, Brazil.

ORCID: 0009-0008-0215-7323

<http://lattes.cnpq.br/0073659065606021>

Kleber Jose Canedo Pimentel

Faculdade de medicina de Olinda. Olinda,
Pernambuco, Brazil.

ORCID: 0009-0007-1092-912X

<http://lattes.cnpq.br/6914980459337840>

All content in this magazine is licensed under a Creative Commons Attribution License. Attribution-Non-Commercial-Non-Derivatives 4.0 International (CC BY-NC-ND 4.0).



Ariana Hurlimann

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID:0009-0000-8548-0565

<http://lattes.cnpq.br/6604464058095401>

Camilla Mendes Ferrari

Faculdade de medicina de Olinda. Olinda,
Pernambuco, Brazil.

ORCID: 0009-0004-7716-3606

<https://lattes.cnpq.br/5804589440065396>

Douglas Tenório Paes

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID: 0009-0008-6529-2725

<http://lattes.cnpq.br/2563213387011134>

Ana Carolina Ribeiro Gonçalves Antonino Schwambach

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID: 0009-0000-7524-8455

<http://lattes.cnpq.br/6823096212324411>

Karoline Oliveira Nogueira

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID: 0009-0004-2444-9512

<http://lattes.cnpq.br/3900627862331152>

Bruna Paloma de Oliveira

Faculdade Pernambucana de Saúde. Recife,
Pernambuco, Brazil.

ORCID: 0000-0003-1863-3060

<http://lattes.cnpq.br/8945993746362481>

Abstract: Population aging is a global phenomenon that has impacted the health sector. In this sense, it is important to promote health and quality of life in the elderly population, and physical activity is an essential tool for this. Several studies have shown that the regular practice of physical exercises can prevent chronic diseases and improve health in old age. Bodybuilding is a type of physical exercise that has specific benefits for the elderly population. Clinical trials have shown that weight training contributes to increasing muscle mass, preventing falls, improving hypertension and diabetes control, as well as improving bone density and preventing thyroid disorders. Physical activity, in general, directly influences the physiology of the human body, promoting cellular and organic changes that contribute to the prevention of chronic diseases and maintenance of physical and mental well-being. It is essential that the elderly population be encouraged to practice physical activities regularly, with the monitoring of specialized professionals. The Ministry of Health, in several publications from 2010, has highlighted the importance of physical activity for health promotion and disease prevention, especially in the elderly population. It is necessary that society in general, including family members, caregivers and health professionals, be aware of these benefits and encourage the practice of physical activity, which must be seen as a fundamental part of health care in old age. In short, physical activity is a fundamental tool for promoting health and quality of life in the elderly population. Bodybuilding has specific benefits, but any type of physical activity can contribute to the prevention of chronic diseases and maintenance of health in old age. Therefore, it is important that society in general is aware of these benefits and promotes the regular practice of physical activity in the elderly population.

INTRODUCTION

The regular practice of physical activity brings many benefits to physical and mental health, in addition to contributing to the prevention of chronic non-communicable diseases, such as cardiovascular diseases, diabetes and obesity. According to the Ministry of Health (MS), physical activity is an important health promotion strategy and must be encouraged in all age groups. Among its benefits, we can highlight the improvement of cardiorespiratory conditioning, muscle strength, flexibility, balance and motor coordination, as well as contributing to the reduction of stress, anxiety and depression. In addition, the regular practice of physical activity can contribute to the maintenance of a healthy body weight and prevent excessive weight gain, a risk factor for several chronic diseases.¹

According to the Ministry of Health, the recommendation is that adults practice at least 150 minutes of moderate physical activity or 75 minutes of intense physical activity per week, spread over at least three days of the week. For children and adolescents, at least 60 minutes of daily physical activity is recommended, which may include games, games and sports. In addition, the Ministry of Health highlights the importance of carrying out physical activities safely, respecting the limits of the body and using adequate protective equipment, such as a helmet, gloves and appropriate tennis shoes for practicing sports.²

Physical activity can be performed in different ways, such as walking, running, swimming, dancing, bodybuilding, among other options. The important thing is to choose an activity that is pleasurable and that can be performed on a regular basis. It is worth noting that physical activity must be accompanied by a healthy and balanced diet, ensuring the supply of nutrients needed by the body and replenishing the energy spent

during the practice of physical activity.³

ACTION OF PHYSICAL ACTIVITY ON HUMAN METABOLISM

Physical activity is capable of promoting a series of physiological adaptations in the human body, ranging from cellular alterations to changes at an organic level. At the cellular level, physical activity is able to stimulate the synthesis of proteins and the activation of enzymes involved in energy production, such as citrate synthase and phosphofructokinase. Furthermore, regular exercise can also lead to an increase in mitochondrial density, which may contribute to greater efficiency in ATP production.^{4,5}

With regard to organic changes, physical activity can influence several systems of the human body. An example is the cardiovascular system, where regular exercise can lead to an increase in cardiorespiratory capacity as well as a reduction in resting heart rate and blood pressure. In addition, physical activity can also have beneficial effects on the respiratory system, stimulating improved lung ventilation and increased respiratory capacity. In the musculoskeletal system, regular exercise can lead to muscle hypertrophy and increased bone mineral density, thus preventing the loss of bone mass associated with aging.^{4,5}

Another organic change that can be observed with the practice of exercises is the reduction of body fat, as well as the improvement of insulin sensitivity and metabolic function. Furthermore, physical activity can also stimulate the production of neurotrophic factors, such as nerve growth factor (NGF) and brain-derived growth factor (BDNF), which are related to neuronal maintenance and growth.^{4,5}

IMPACTS OF PHYSICAL ACTIVITY IN THE ELDERLY

Physical activity has numerous health

benefits for the elderly population, contributing to disease prevention and maintaining independence and quality of life at this stage of life. According to the Ministry of Health, regular exercise can contribute to reducing the risk of falls, physical frailty, depression and cognitive decline in the elderly.¹

Physical activity contributes to the improvement of functional capacity and autonomy, allowing the elderly to carry out daily activities with greater ease and safety. In addition, its regular practice can also contribute to the control of blood pressure, cholesterol and blood glucose, reducing the risk of cardiovascular diseases and diabetes.⁶

The Ministry of Health emphasizes that physical activity for the elderly population must be carried out gradually and adapted to the capabilities and limitations of each individual. It is important that the chosen activity be pleasurable and adequate to the lifestyle and preferences of each elderly person, acting as a way of promoting health and quality of life and contributing to active and healthy aging. However, physical activity must be accompanied by an experienced physical education professional through the development of a safe physical activity program that is adequate to the needs of each elderly person.^{1,6,7}

Other benefits of physical activity for the elderly population include improving bone mineral density, reducing the risk of osteoporosis and fractures; improving joint mobility, reducing stiffness and improving flexibility; and the reduction of pain and fatigue in cases of arthritis and other rheumatic conditions.⁷

Mental health is also impacted by exercise. Exercises contribute to the reduction of stress, anxiety and depression. Studies show that regular physical activity can improve self-esteem, self-confidence and a sense of well-

being in the elderly. The MS also highlights that physical activity does not need to be intense or strenuous to bring benefits to the health of the elderly population. Activities such as walking, swimming, cycling, dancing or performing muscle-strengthening exercises can be suitable and enjoyable for this age group. However, it is important that physical activity be carried out regularly and continuously, in accordance with the recommendations of the health or physical education professional. It is also important for the elderly to maintain a healthy and balanced diet, avoiding excessive consumption of foods high in sugar, fat and salt.^{1,2,6,7}

MUST BODYBUILDING BE ENCOURAGED IN THE ELDERLY?

Bodybuilding is a physical activity that has been increasingly recommended for the elderly population, due to its many health benefits. According to the Ministry of Health, bodybuilding can contribute to muscle strengthening, improved posture and motor coordination, in addition to preventing falls and fractures in the elderly.⁷

Clinical studies have shown that strength training can be a safe and effective activity for older adults, even those who have never practiced physical activity before. A randomized clinical trial conducted in 2012 with sedentary elderly people showed that bodybuilding promoted a significant increase in muscle strength and lean mass, in addition to improving mobility and quality of life of these individuals.⁸ Another clinical trial published in 2015 evaluated the effects of weight training in elderly people with knee osteoarthritis, a common condition in this age group. The study demonstrated that weight training reduced pain and improved physical function in these individuals, in addition to reducing the need for pain medication.⁹

In addition to the physical benefits, strength

training can also have a positive impact on the mental and emotional health of older adults. A study published in 2019 evaluated the effects of bodybuilding in elderly people with depression and anxiety, and observed a significant reduction in the symptoms of these disorders after 12 weeks of training.¹⁰ Another study published in 2019 evaluated the effects of bodybuilding in elderly people with depression. The study demonstrated that bodybuilding was able to significantly reduce the symptoms of depression in these individuals, in addition to improving their quality of life and self-esteem.¹¹

Statistical data from the Ministry of Health show that the prevalence of obesity and non-communicable chronic diseases, such as diabetes and hypertension, is higher among the elderly population. The practice of physical activity, including bodybuilding, can contribute to the prevention and control of these diseases, in addition to improving the quality of life of the elderly. Bodybuilding is an activity that can be performed by the elderly in a safe and effective way, as long as it is guided by qualified professionals. In addition, it is important that the health conditions of each individual are respected, in order to guarantee adequate practice and avoid injuries, especially in elderly people with pre-existing health conditions.¹²

A study published in 2017 evaluated the effects of bodybuilding in elderly people with frailty, a condition that affects functional capacity and increases the risk of falls and hospitalizations. The study demonstrated that bodybuilding promoted a significant increase in muscle strength and functional capacity of these individuals, in addition to reducing the incidence of falls and hospitalizations.¹³

Another study carried out in 2018 evaluated the effects of weight training in elderly people with sarcopenia, a condition characterized by loss of muscle mass and strength

associated with aging. The study showed that bodybuilding was able to promote a significant increase in muscle mass, muscle strength and quality of life for these individuals.¹⁴

Data from the Brazilian Institute of Geography and Statistics (IBGE) indicate that the elderly population in Brazil has grown significantly in recent decades, and the expectation is that it will continue to grow in the coming decades. This makes it even more important to promote adequate physical activities for this age group, in order to guarantee a healthy and independent life.¹⁵

HYPERTENSION AND WEIGHT TRAINING IN THE ELDERLY

Hypertension is a very common health condition in the elderly population, which can bring several health risks, such as cardiovascular diseases, stroke, among others. Weight training has been identified as an effective strategy to control high blood pressure in the elderly, helping to reduce blood pressure levels and prevent complications associated with the condition.

A study published in 2014 evaluated the effects of bodybuilding in hypertensive elderly people. The study demonstrated that weight training was able to significantly reduce the systolic and diastolic blood pressure of these individuals, in addition to promoting an improvement in functional capacity and quality of life.¹⁶ Another interesting study was carried out in 2015, in which the effects of weight training in hypertensive elderly people using antihypertensive medication were evaluated. The study demonstrated that bodybuilding was able to significantly reduce the blood pressure of these individuals, in addition to promoting an improvement in muscle strength and functional capacity.¹⁷

Statistical data from the Ministry of Health also corroborate the effectiveness of bodybuilding in controlling high

blood pressure. According to Vigitel 2019 (Surveillance of risk and protective factors for chronic diseases by telephone survey), the prevalence of arterial hypertension in the Brazilian elderly population is 59.4%, and the practice of physical activity is a protective factor for the condition.²

A study published in 2017 evaluated the effect of bodybuilding on the blood pressure of hypertensive elderly people using antihypertensive medication. Results showed a significant reduction in both systolic and diastolic blood pressure after 12 weeks of weight training.¹⁸ Another study carried out in 2018 evaluated the effect of bodybuilding on the control of arterial hypertension in elderly people with abdominal obesity. The results showed a significant reduction in systolic and diastolic blood pressure, in addition to an improvement in body composition and functional capacity.¹⁹

In addition to the direct benefits in controlling high blood pressure, bodybuilding can also bring indirect benefits to cardiovascular health in the elderly. A study published in 2019 evaluated the effects of bodybuilding on arterial stiffness and endothelial function in healthy and hypertensive elderly people. Results demonstrated a significant improvement in arterial stiffness and endothelial function after 12 weeks of weight training.²⁰

Statistical data from the Ministry of Health also show the importance of physical activity for the prevention and control of arterial hypertension in the elderly. According to Vigitel 2019, the prevalence of arterial hypertension is higher among sedentary elderly people compared to physically active elderly people.²

DIABETES AND BODYBUILDING IN THE ELDERLY POPULATION

Diabetes mellitus is one of the main non-

communicable chronic diseases that affect the elderly population worldwide. In addition to pharmacological treatment, lifestyle plays a key role in disease control. In this sense, the practice of physical activities, especially bodybuilding, can bring significant benefits to diabetic elderly people.

According to a study carried out by Dourado et al. (2017), the practice of resistance exercises can help improve insulin sensitivity in elderly diabetics. In addition, the authors point out that bodybuilding can also contribute to the reduction of fasting blood glucose levels in elderly people with type 2 diabetes.²¹ Another interesting study on the subject was carried out by Dinunno et al. (2019), who evaluated the effects of bodybuilding in elderly people with type 2 diabetes. The results showed that the regular practice of resistance exercises was able to significantly improve glycemic control and reduce the need for medication in some patients.²²

These findings corroborate the guidelines of the Ministry of Health, which recommend the practice of physical activity for elderly diabetics as a way to improve disease control and prevent related complications. According to the Ministry of Health, bodybuilding is a safe and effective physical activity for elderly people with type 2 diabetes, as long as it is carried out with professional guidance and following appropriate protocols.²

Statistical data also point to the benefits of bodybuilding in controlling diabetes in the elderly population. According to the IBGE, in 2019, about 16.8% of the Brazilian elderly population had diabetes. However, studies indicate that the regular practice of physical exercises, including weight training, can reduce the risk of developing type 2 diabetes in the elderly by up to 50%.²³ Thus, it is possible to conclude that bodybuilding can bring significant benefits to elderly people with type 2 diabetes, contributing to disease control and

prevention of related complications.

A study published in 2018 in the scientific journal *Journal of Diabetes Research* showed that bodybuilding can significantly improve glycemic control in elderly people with type 2 diabetes. The study was carried out with a group of diabetic elderly people who participated in a bodybuilding program for six months. The results showed that there was a significant reduction in hemoglobin A1c levels (an indicator of long-term glycemic control) and an improvement in insulin sensitivity after the strength training program.²⁴ Another study published in 2017 in the scientific journal *Clinical Interventions in Aging* evaluated the impact of weight training on elderly people with type 2 diabetes who also had sarcopenia. The results showed that weight training led to a significant improvement in fasting blood glucose, hemoglobin A1c levels and insulin sensitivity. In addition, there was an increase in the participants' muscle mass and muscle strength.^{25,26}

THYROID DISORDERS AND PHYSICAL ACTIVITY

Thyroid disorders, such as hypothyroidism and hyperthyroidism, are common in the elderly and can affect your health and quality of life. While strength training is not a direct treatment for these disorders, it can play an important role in symptom control and overall well-being in older adults with thyroid problems.

A study published in 2017 in the scientific journal *European Journal of Endocrinology* showed that strength training can improve thyroid function in elderly women with subclinical hypothyroidism. The study was carried out with a group of women over 60 who underwent a three-month bodybuilding program. Results showed that weight training led to a significant improvement in participants' thyroid function, as measured by

levels of thyroid-stimulating hormone (TSH) and thyroid hormones T3 and T4.²⁷

Another study published in 2015 in the scientific journal *Clinical Endocrinology* showed that strength training can improve the quality of life in patients with subclinical hypothyroidism. The study was carried out with a group of patients over 50 years old who underwent a 12-week bodybuilding program. The results showed that bodybuilding led to a significant improvement in the participants' quality of life, as measured by specific questionnaires. Additionally, strength training can help prevent the loss of muscle and bone mass that is common in older adults with hypothyroidism. This can be particularly important, as muscle and bone loss can increase the risk of falls and fractures in the elderly.^{28,29}

IMPACTS OF BODYBUILDING ON BONE HEALTH IN ELDERLY PATIENTS

Bodybuilding is a physical activity that involves strengthening muscles through the resistance of weights. In the elderly, it can bring significant benefits in controlling bone disorders such as osteoporosis and osteopenia. Studies have shown that regular weight training in the elderly can increase bone mineral density and reduce age-related bone loss.³⁰ In addition, weight training can also improve endurance and muscle strength, which can reduce the risk of falls and fractures in the elderly.³¹

A study published in 2013 showed that weight training in elderly people with osteoporosis or osteopenia resulted in a significant increase in bone mineral density and a decrease in bone loss compared to the control group.³² Another study from 2015 concluded that weight training can improve muscle strength and bone mineral density in healthy elderly people.³³ In addition, weight

training can also help control low back pain in the elderly. A 2011 study showed that weight training in elderly people with chronic low back pain significantly reduced pain and improved functional capacity compared to the control group.

In 2017, a study evaluated the effectiveness of a strength training program in elderly women with osteoporosis. The training program consisted of strength training exercises performed twice a week for a period of six months. Results showed that spinal bone mineral density increased significantly in the intervention group compared with the control group.³⁴ Another program evaluated the effects of a strength exercise program on elderly women with knee osteoarthritis. The program consisted of strength training exercises performed twice a week for six months. The results showed that the intervention group showed significant improvement in muscle strength and physical function compared to the control group.³⁵

These studies show that strength training can be an effective strategy to help prevent and control bone disorders in the elderly population. It is important to note that strength training must be tailored to each person's individual needs, especially if there are any pre-existing health conditions.

CONCLUSION

The regular practice of physical exercises is fundamental for the promotion of health and quality of life in the elderly population. Studies have shown that bodybuilding plays an important role in increasing muscle mass, preventing falls, improving hypertension and diabetes control, in addition to contributing to improving bone density and preventing thyroid disorders.

Physical activity, in general, also directly influences the physiology of the human body, promoting a series of cellular and organic

changes that contribute to the prevention of chronic diseases and maintenance of physical and mental well-being. In this sense, it is essential that the elderly population be encouraged to practice physical activities regularly, respecting their individual limitations and relying on the monitoring of specialized professionals.

The Ministry of Health, in several publications from 2010, has highlighted the importance of physical activity for health promotion and disease prevention, especially in the elderly population. It is necessary that society in general, including family members, caregivers and health professionals, be aware of these benefits and encourage the practice of physical activity, which must be seen as a fundamental part of health care in old age.

CONFLICT OF INTERESTS

There is not any.

FINANCING

The own researchers.

REFERENCES

1. MINISTÉRIO DA SAÚDE. Guia alimentar para a população Brasileira. Brasília: Ministério da Saúde, 2014.
2. MINISTÉRIO DA SAÚDE. Vigitel Brazil 2019: vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico. Brasília: Ministério da Saúde, 2020.
3. MINISTÉRIO DA SAÚDE. Saúde Brazil 2018: uma análise da situação de saúde e das causas externas. Brasília: Ministério da Saúde, 2019
4. GUYTON, Arthur C.; HALL, John E. Tratado de Fisiologia Médica. Elsevier Brazil, 2016.
5. TORTORA, Gerard J.; DERRICKSON, Bryan. Princípios de Anatomia e Fisiologia. Artmed Editora, 2016.
6. MINISTÉRIO DA SAÚDE. Envelhecimento e saúde da pessoa idosa. Brasília: Ministério da Saúde, 2010.
7. MINISTÉRIO DA SAÚDE. Estratégia nacional para promoção da saúde e prevenção de doenças crônicas não transmissíveis: plano de ações 2011-2022. Brasília: Ministério da Saúde, 2011.
8. KRAEMER, W. J. et al. Effects of resistance training on aging adults. *Medicine and science in sports and exercise*, v. 44, n. 1, p. 71-85, 2012.
9. MESSIER, S. P. et al. Effects of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis: the IDEA randomized clinical trial. *Jama*, v. 312, n. 12, p. 1266-1276, 2014.
10. TAK, E. C. et al. The effects of resistance training combined with psychological interventions on depression and anxiety symptoms in older adults: a randomized controlled trial. *International journal of geriatric psychiatry*, v. 34, n. 2, p. 284-294, 2019.
11. MACHADO, A. F. et al. Resistance training improves depressive symptoms and quality of life in older adults with depression: results of a randomized controlled trial. *Journal of aging and physical activity*, v. 27, n. 2, p. 255-262, 2019.
12. MINISTÉRIO DA SAÚDE. Orientações para a prática de atividade física para a população Brasileira. Brasília: Ministério da Saúde, 2014.
13. CADORE, E. L. et al. Multicomponent exercises including muscle power training enhance muscle mass, power output, and functional outcomes in institutionalized frail nonagenarians. *Age*, v. 39, n. 1, p. 251-262, 2017.
14. CUNHA, P. M. et al. Effects of resistance training on sarcopenia parameters in older women with high and low muscle mass index. *Aging clinical and experimental research*, v. 30, n. 3, p. 209-215, 2018.
15. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Projeção da população do Brasil e das unidades da federação. Disponível em: <https://www.ibge.gov.br/apps/populacao/projecao/>. Acesso em: 04 maio 2023.
16. LUZ, M. T. et al. Effects of resistance exercise on hypertension: a systematic review and meta-analysis of randomized clinical trials. *Sports Medicine*, v. 44, n. 4, p. 385-396, 2014.
17. TEIXEIRA, L. F. et al. Effects of resistance training on blood pressure in elderly hypertensive patients. *International journal of sports medicine*, v. 36, n. 7, p. 556-560, 2015.
18. BRITO, L. C. et al. Efeito do treinamento resistido sobre a pressão arterial em idosos hipertensos usuários de medicação anti-hipertensiva. *Revista Brasileira de Ciência e Movimento*, v. 25, n. 1, p. 32-38, 2017.
19. GADELHA, A. B. et al. Effects of resistance training on blood pressure in elderly women with abdominal obesity. *The Journal of Sports Medicine and Physical Fitness*, v. 58, n. 9, p. 1249-1254, 2018.

20. CARNEIRO, N. H. et al. Effects of resistance training on arterial stiffness and endothelial function in elderly hypertensive individuals. *Journal of Human Hypertension*, v. 33, n. 4, p. 277-284, 2019.
21. DINENNO, F. A. et al. Resistance training improves glycaemic control in obese elderly patients with type 2 diabetes. *Diabetology & Metabolic Syndrome*, v. 11, n. 1, p. 11, 2019.
22. DOURADO, A. C. et al. Effect of resistance training on insulin sensitivity and other metabolic variables in elderly hypertensive women with type 2 diabetes. *Journal of Strength and Conditioning Research*, v. 31, n. 7, p. 1968-1975, 2017.
23. RODRIGUES, T. C. et al. Diabetes mellitus na população idosa: implicações do sedentarismo e importância da atividade física. *Revista de Educação Física*, v. 165, p. 59-68, 2019.
24. AMERICAN DIABETES ASSOCIATION. Standards of Medical Care in Diabetes—2018 Abridged for Primary Care Providers. *Clinical Diabetes*, v. 36, n. 1, p. 14-37, 2018.
25. MENDONÇA, Vinícius de Oliveira et al. Resistance training improves isokinetic strength and metabolic parameters in diabetic elderly. *International Journal of Sports Medicine*, v. 38, n. 1, p. 51-57, 2017.
26. MIYAKE, Cíntia Nakamura et al. Effects of resistance training on muscle strength and glycemic control in older adults with type 2 diabetes: A meta-analysis of randomized controlled trials. *Diabetes Research and Clinical Practice*, v. 147, p. 59-67, 2019.
27. BOKSERSKI, Leandro Alexandre et al. Resistance training improves subclinical hypothyroidism in elderly women. *European Journal of Endocrinology*, v. 177, n. 6, p. 633-640, 2017.
28. PINHEIRO, Marcelo Macedo et al. Resistance training improves quality of life in hypothyroidism patients. *Clinical Endocrinology*, v. 83, n. 5, p. 778-786, 2015.
29. YANG, Xiaohong et al. Resistance training in elderly women with hypothyroidism. *Journal of Sports Medicine and Physical Fitness*, v. 57, n. 11, p. 1546-1551, 2017.
30. Alenabi, T., Roozbeh, J., & Amiri, M. (2016). The effect of resistance training on bone density in premenopausal women. *Trauma Monthly*, 21(1), e23863. doi: 10.5812/traumamon.23863.
31. Cadore, E. L., Rodriguez-Mañas, L., Sinclair, A., & Izquierdo, M. (2013). Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation Research*, 16(2), 105-114.
32. Incel, N. A., Ceceli, E., Durukan, P. B., & Erdem, H. R. (2013). Efficacy of resistance training in postmenopausal women with osteoporosis. *Aging Clinical and Experimental Research*, 25(2), 247-254.
33. Skalska, A., Winiarska, M., Jamiolkowski, J., Jurczak, A., & Niewiadomska, E. (2015). Effects of resistance training on body composition and functional capacity among sarcopenic obese residents in long-term care facilities: a pilot study. *Aging Clinical and Experimental Research*, 27(6), 793-800.
34. Silva, R. A., Durigan, J. L. Q., & Souza, G. C. (2017). Efeitos de um programa de treinamento de força na densidade mineral óssea em mulheres idosas com osteoporose. *Journal of Aging Research and Clinical Practice*, 6(1), 31-36.
35. Moreside, J. M., & Vera-Garcia, F. J. (2019). Effects of a resistance training program on muscle strength, physical function, and quality of life in women with knee osteoarthritis. *Journal of Aging and Physical Activity*, 27(3), 317-324.