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A Review of the Literature on The Impact of Weight Training on The Elderly's Fat Free Mass Index

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ABSTRACT

Elderly people's health and quality of life may suffer if their muscle mass declines and their fat mass increases. It is well established that weight training is a useful strategy for gaining muscle mass and losing body fat. In order to determine how weight training affects.To identify the effect of weight training on fat-free mass index (FFMI). To identify the effect of weight training on fat-free mass index (FFMI), we used a literature review as a guide to search for research articles obtained from the internet using the PubMed site. Analysis of the five selected research articles showed that weight training can increase fat-free mass index in the elderly. The result of this literature review article is that weight training has an influence on increasing or maintaining FFMI in the elderly. The result in this literature review article is that weight training has an influence in increasing or maintaining FFMI in the elderly. The ideal exercise program for the elderly is regular exercise 2-3 times per week. For weight training in the elderly, it is better to use a professional trainer in order to prevent injury and maximize benefits. Balanced nutritional intake is also very necessary in the process of weight training for the elderly. Meanwhile, if you do not do weight training, it can reduce FFMI in the elderly. It it is explained that the group that was not given a weight training program, did not experience an increase in FFMI.

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1. INTRODUCTION

The elderly is the final stage of human development, this development process is natural and cannot be avoided by every individual. The increase in the elderly in the world is very fast, in 2020, the number of elderly will reach 1 billion (Serrano-Durá et al., 2020). Also, according to the central statistics agency in Indonesia, it shows that the percentage of the elderly population is 11.75% in 2023 (ateng hartono, 2023). The elderly as a whole will experience a decrease in biological conditions (Puzzy Handayani & Puspita Sari, 2020). According to Peterson et al., (2011) physical and physiological changes in humans are a natural human process. One of the significant changes is a decrease in muscle mass and an increase in body fat, which also affects the reduction of the free fat mass index (FFMI). Fat-free mass is one of the two components of the human body such as bone, muscle, water and connective tissue are part of it (Kyle et al., 2003). Fat free mass can be measured by FFMI. FFMI is an important measure to evaluate body composition, especially in the elderly, because it can show their general health and fitness level (Peterson et al., 2011).

Physical activity or exercise can improve body composition, such as bone health, body fat, and also increase endurance, muscle strength, and flexibility, making the elderly fitter and (Rachmah & Ambardini, 2015). There are several types of physical activity for the elderly such as aerobic exercise, weight training, flexibility training, and balance training (Izquierdo et al., 2021). Weight training is a physical activity that uses weights systematically as an aid to build muscle strength to achieve goals such as improving the physical condition of members, preventing injury, or for health reasons (Sucipto & Widiyanto, 2016). Various studies have shown that weight training can help improve FFMI. However, the effectiveness of weight training in improving FFMI in the elderly is still a topic that requires further research and a comprehensive literature review.

This article aims to review the existing literature on the effect of weight training on FFMI in the elderly. By analyzing the results of previous studies, it is hoped to provide a deeper understanding of the benefits of weight training in improving muscle health and body composition in the elderly.

2. METHODS

2.1 Search Strategy

Text The search was conducted on a single database, PubMed, for all published articles from the last 5 years. The search strategy consisted of the following combination of keywords and Boolean operators: (“weight training” OR “resistance training” OR “strength training”) AND (“fat free mass index” OR “fat mass” OR “fat free mass” OR “fat-fat-free”) AND (“older” OR “elderly” OR “older people” OR “older adult” OR “mature”).

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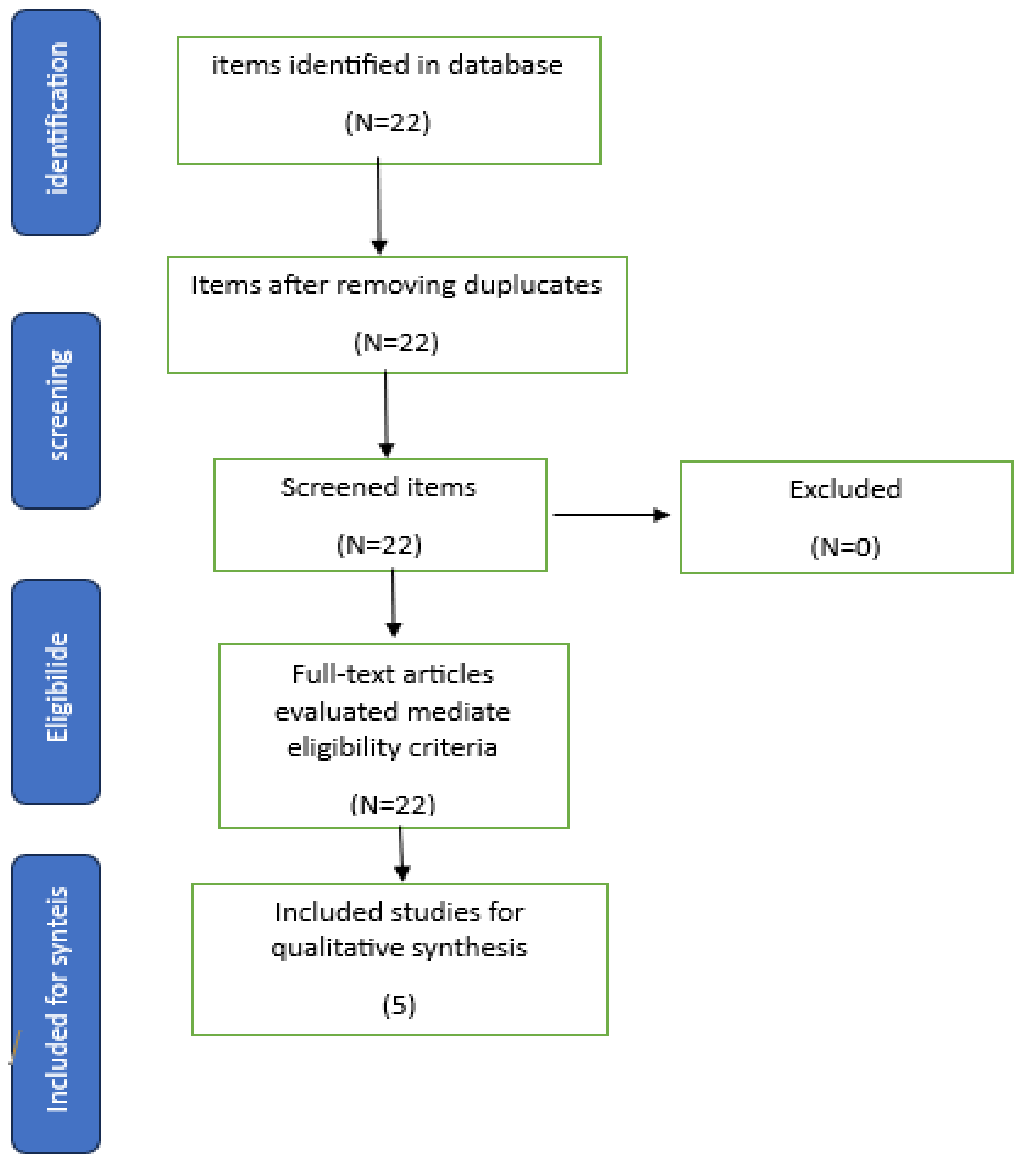

Figure 1. Flowchart of the process of searching and selecting the studies.

2.2 Eligibility Criteria

To be considered for this review, studies had to meet the following eligibility criteria: articles published in indexed journals; articles on weight training; studies that included information on fat free mass index (FFMI); the population in the study was older adults; and articles published in English.

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2.3 Removing and Analyzing Data

For consideration, the extracted data were evaluated by researchers who independently reviewed the titles and summaries of the articles found, considering the eligibility criteria. Disagreements were found with the articles, considering the eligibility criteria.

3. RESULTS

Initially, a total of 220 studies were identified in the database. After filtering in the form of free full text, randomized controlled trial, and research from the last 5 years, 22 articles were found. After manually reading the titles and abstracts of these 22 articles that met the required criteria, there were 5 articles. Therefore, this study included a total of 5 articles.

Tabel 1. Effect of weight training on Fat Free Mass Index (FFMI) in the elderly

No.	Authors (years)	Titles	Populations	Methods	Results
1.	Kim et al., (2022)	*Effects of Twenty- Four Weeks of Resistance Exercise Training on Body Composition, Bone Mineral Density, Functional Fitness and Isokinetic Muscle Strength in Obese Older Women: A Randomized Controlled Trial*	30 obese women aged 73-89 years. Resistance training group (RT) = 15 people, control group (CON) = 15 people.	*Randomized control trial. Each group conducted a pretest-posttest.*	In the RT group there was no significant change (p=0.07). In the CON group there was a change (p = 0.58)
2.	T. Balachandran et al., (2023)	*Comparison of traditional vs. lighter load strength training on fat-free mass, strength, power and affective responses in middle and older-aged adults: A pilot randomized trial*	23 people aged between 50 and 80 years old. The groups were divided into 2, ST (lighter load) =11 people and LLHR (traditional load) = 12 people.	*Randomized control trial. Each group conducted a pretest-posttest.*	Both groups showed an increase in fat-free mass, strength, power and affective responses. There was little difference between the ST group and the LLHR group.

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3.	Valdés-Badilla et al., (2023)	*Effectiveness of elastic band training and group-based dance on physical functional performance in older women with sarcopenia: a pilot study*	44 women aged 60-90 years old	*Randomized control trial. Each group conducted a pretest-posttest.*	Statistical analysis results showed significant differences between the two groups in terms of fat-free mass, dominant and non-dominant hand grip strength, limb strength, time to complete TUG (Timed Up and Go), and walking speed.
4.	Herda et al., (2021)	*Changes in Strength, Mobility, and Body Composition Following Self-Selected Exercise in Older Adults*	A total of 124 participants (38 males and 86 females) were enrolled in the study, but only the data of 101 participants (34 males and 67 females) were analyzed. The age criterion for this study was 50	*Randomized control trial. Each group conducted a pretest-posttest.*	Self-selected and self-regulated exercise intensity for 12 weeks improved resting heart rate, fat-free mass, body fat percentage, handgrip strength, bench press strength, leg press strength, and all mobility measures ($p < .05$) in both men and women despite supplementation status. This suggests that additional protein in well-fed and healthy older people does not increase the benefits

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			years and above.		of exercise.
5.	Campa et al., (2021)	*Effects of a 12-Week Suspension versus Traditional Resistance Training Program on Body Composition, Bioimpedance Vector Patterns, and Handgrip Strength in Older Men: A Randomized Controlled Trial*	Thirty-six sedentary elderly men (age 67.4 ± 5.1 years, body weight 76.6 ± 10.7 kg, height 1.68 ± 0.72 m, body mass index 27.1 ± 3.3 kg/m2)	*Randomized control trial.* Setiap kelompok dilakukan pretest-posttest.	The results of the analysis showed significant changes in the observed variables, such as increased muscle mass, decreased fat mass, and increased hand grip strength after suspense training over a period of time.

In study no. 1, Kim et al. study, this study was conducted for 24 weeks from July 19, 2021 to January 23, 2022. 40 obese women aged 73-89 years were involved in this study. Inclusion criteria were participants with body fat percentage >30% and participants with low physical activity levels according to the International Physical Activity Questionnaire-short form (<600 MET minutes/week/not exercising for the past 6 months). Exclusion criteria were uncontrolled chronic diseases, history of acute myocardial infarction, history of joint replacement or lower limb fracture within the previous 6 months, and severe cognitive impairment. The participants were randomly divided into two groups: a weight training group (RT) and a control group (CON). However, ten participants withdrew due to personal reasons and injuries. Thus, 30 participants completed the study (RT: n=15, CON: n=15).

The training group followed the RT program for 60 minutes per session (10:30 to 11:30) and 2 sessions per week for 24 weeks. The training program consisted of 10 minutes of warm- up (dynamic and static stretching), 40 minutes of RT, and 10 minutes of cool-down (static stretching). Weight training consisted of abdominal curl-up, biceps curl, chest press, front shoulder raise, lateral shoulder raise, seated row, triceps extension, calf raise, chair squat, hip extension, hip flexion, standing abduction, standing adduction, and toe raise. The intensity of the exercises including the number of reps increased progressively every 4 weeks.

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Exercise intensity was set in three sets of 10-15 repetitions (yellow band: 1-4 weeks 10 reps, 5-8 weeks 12 reps, 9-12 weeks 15 reps; red band: 13-16 weeks 10 reps, 17-20 weeks 12 reps, 21-24 weeks 15 reps) with a perceived exertion score of 7 or 8 on the OMNI-Resistance Exercise Scale of Perceived Exertion (0: very easy to 10: very hard). This range has been reported to correspond to an exercise intensity level of 70-80% of one-repetition maximum (1RM) with 90 seconds rest per set.

The RT group fat-free mass results were: pre-test = 35.15 ± 4.17 (32.85-37.46), post-test = 35.22 ± 3.97 (33.02-37.42), mean = 0.07 (-0.43-0.57). That is, weight training does not make significant changes to the fat-free mass index in the elderly. While the results of the fat-free mass of the CON group (who did not do weight training) were: pre-test = 35.03 ± 3.53 (33.15-36.90), post-test = 34.45 ± 3.31 (32.68-36.21), mean = -0.58 (-0.89--0.27). That is, when not doing weight training there is a change in the fat-free mass index in the elderly. The conclusion of the study is that weight training is suitable for maintaining or increasing the fat-free mass index in the elderly, otherwise if you do not do weight training, it will decrease the fat-free mass index in the elderly.

In study no. 2, according to Balachandran et al. this study was conducted over a period of 10 weeks, with twice weekly exercise. The sample used in this study was 23 people with criteria aged between 50 and 80 years, living independently in the community, and able to read and communicate in English. Exclusion criteria included neurological disorders, severe musculoskeletal disorders, severe depression, severe vestibular problems, concurrent use of cardiovascular, psychotropic, and antidepressant medications, participation in a structured exercise program using weights in the past six months, and active participation in resistance training or balance programs. The sample was grouped into 2 groups, traditional weight training (LLHR) = 12 people and light weight training (ST) 11 people.

The exercise program performed by both groups was based on the ACSM resistance training guidelines, with participants maintaining an exercise intensity of 7-8 on the 0-10 RPE scale and a volume of 2-3 sets. Participants were instructed to lift the weight in a controlled manner, and the load was increased by 5-10% when they could perform 2-3 sets of 12 or 24 repetitions while reporting an RPE of <7. A 2-3-minute recovery period was given between sets for multi-joint exercises and 1-2 minutes for single-joint exercises. Both groups performed three lower body exercises (leg press, leg extension, and leg curl) and five upper body exercises (chest press, shoulder press, seated row, arm curl, and triceps pushdown).

For body composition, FFM increased (ST: 0.24 kg, 1%; LLHR: 0.67 kg, 1.4%) and showed a small between-group difference of 0.27 kg, 95% CI (- 0.87, 1.42). PP analysis was similar (ST: 0.52 kg, 1%; LLHR: 0.85 kg, 2%) with a trivial between-group difference of 0.22 kg, 95% CI (- 0.87, 1.31). For leg press strength (1RM), both groups increased strength (ST: 20kg, 14%; LLHR: 8kg, 5%) and showed a small effect of -14 kg (-23, -5) in favor of the ST group. Strength endurance (repetitions) (ST: 2 repetitions, 6.1%; LLHR: 10 repetitions, 37%), however, showed a moderate effect of 8 repetitions (2, 14) in favor of the LLHR group. Leg press strength (ST: 86.60W, 8%; LLHR: 110W, 9.6%) showed a moderate effect of 41 (-42, 124) in favor of the LLHR group. For physical function, chair stand (ST: - 4.3s, 21%; LLHR: -2.2s, 12%) showed a small effect of 1.66 s (0.44, 2.88) in favor of the ST group, while GUG (ST: - 0.6 s, 11%; LLHR: - 0.7 s, 13%) showed a small effect-0.12 s (- 0.53, 0.29) in favor of the LLHR group. For self- reported function, PROMIS mobility 2.29 (- 2.96, 7.53) and physical function 1.95 (- 3.23, 7.13) showed small and trivial effects in favor of the LLHR group.

This study revealed that pragmatic whole-body high-intensity strength training with lighter loads (20-24 reps) to deliberate failure (7-8 RPE) is feasible and acceptable in healthy middle-

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aged and older individuals. Furthermore, both groups improved FFM, strength, power, physical function and strength endurance.

In study no. 3, Badilla et al. study, this study revealed a significant interaction in several physical variables between the Experiment-Based Gym (EBG) group and the Diet-Based Gym (GBD) group. The results of statistical analysis showed significant differences between the two groups in terms of fat-free mass, dominant and non-dominant hand grip strength, leg strength, time to complete TUG (Timed Up and Go), and walking speed. As the EBG group showed a significant increase of 10.9% ($F_{1,16} = 18.91$; $p < 0.001$) compared to the GBD group which experienced a decrease of 1.97%. The EBG group showed a significant increase of 10.9% ($F_{1,16} = 7.44$; $p = 0.014$) compared to the GBD group which only experienced an increase of 0.59%. The EBG group experienced a significant increase of 10.21% ($F_{1,16} = 6.41$; $p = 0.022$) compared to the GBD group which experienced an increase of 3.80%. The EBG group showed a significant increase of 9.1% ($F_{1,16} = 17.98$; $p < 0.001$) compared to the GBD group which experienced an increase of 3.83%. The EBG group experienced a significant decrease of 14.7% in time to complete the TUG ($F_{1,16} = 7.52$; $p = 0.014$) compared to the GBD group who only experienced a decrease of 1.0%. The EBG group showed a 7.6% increase in walking speed ($F_{1,16} = 6.40$; $p = 0.019$) compared to the GBD group who experienced a 4.35% increase in speed. Overall, these results suggest that the gym-based exercise program (EBG) provided more significant physical benefits compared to the diet and gym-based program (GBD), especially in terms of improvements in fat-free mass, handgrip strength, leg strength, walking speed, and efficiency in completing physical tasks (TUG).

In sutdy no. 4, Ashley A Herda et al study, the purpose of this trial was to examine the effects of self-selected exercise intensity plus whey protein supplementation or placebo on vital signs, body composition, bone mineral density, muscle strength, and mobility in older adults. A total of 101 participants aged 55 years and older (men [n = 34] and women [n = 67]) were evaluated before and after 12 weeks of self-selected free weight training plus 30 minutes of independent walking three times per week. The participants were randomized into two groups: whey protein (n = 46) or placebo (n = 55). A three-way mixed factorial analysis of variance was used to test mean differences for each variable. Self-selected and self-regulated exercise intensity for 12 weeks increased resting heart rate, fat-free mass, body fat percentage, handgrip strength, bench press strength, leg press strength, and all mobility measurements ($p < .05$) in both men and women despite supplementation status. This suggests that additional protein in well-fed and healthy older people does not increase the benefits of exercise.

In study no. 5, Campa et al. study, the data results from the article showed that suspension training was more effective in improving body composition, muscle strength, and hand grip strength in an elderly population compared to traditional exercise methods. The studies used bioimpedance methods to measure body composition and muscle strength, as well as statistical analysis to evaluate changes over time during the intervention. The results of the analysis showed significant changes in the observed variables, such as increased muscle mass, decreased fat mass, and increased handgrip strength after suspension training over a period of time. In addition, the suspension training program was also shown to be more effective in preventing the decline of muscle mass and hand grip strength in the elderly compared to traditional exercises. This study provides important insights into health and fitness care in older adults, and highlights the importance of appropriate physical activity in maintaining health and muscle strength in the elderly population.

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4. DISCUSSION

This literature review examined the effect of different types of weight training, frequency and intensity of RT on fat-free mass index in older adults. A positive effect on increasing the fat-free mass index of RT was found in 4 of the 5 included studies, while the other one had no significant effect, meaning it only maintained the fat-free mass index.

4.1 Empirical Evidence

(Kyle et al., 2004) examined the effects of 24 weeks of resistance training on body composition in obese older women. The study found that weight training did not lead to significant changes in FFMI compared to the control group. This suggests that although weight training helps maintain FFM, it may not significantly improve it in all elderly populations. Factors such as exercise intensity, duration, and individual variability may affect the results.

(Peterson et al., 2010) compared traditional strength training with light-weight strength training. Both methods showed improvements in FFM, suggesting that variations in resistance training intensity may be beneficial for muscle health in the elderly. This finding is in line with the principle of progressive loading, where a gradual increase in resistance or load during exercise stimulates muscle adaptation and growth.

(Vilaça et al., 2014) showed that exercise with elastic bands and group-based dance improved physical functional performance and FFM in elderly women with sarcopenia. This highlights the effectiveness of resistance training beyond traditional weight training. Elastic bands provide a convenient and accessible way to perform resistance exercise, especially for those with limited access to gym equipment.

Herda et al. (2021) showed that self-selected exercise intensity, including resistance training, improved various health markers, including FFM, regardless of additional protein supplementation. This suggests that intrinsic motivation and self-regulation in exercise intensity can produce positive results. Protein supplements, while beneficial, are not the sole determinant of muscle growth, emphasizing the importance of consistent resistance training.

Campa et al. (2021) found significant improvements in muscle mass and handgrip strength in elderly men after a 12-week suspension training program. This demonstrates the effectiveness of various resistance training methods in improving FFM. Suspension training, which utilizes body weight as resistance, can be a versatile and effective method to increase strength and muscle mass in the elderly.

4.2 Exercise Program

There are many types of weight training programs that can be done. In his research (Tp et al., 2017) the types of exercises performed were abdominal curl-up, biceps curls, chest presses, front shoulder raises, lateral shoulder raises, seated row, triceps extension, calf raise, chair squat, hip extension, hip flexion, standing abduction, standing adduction, and toe raise. In his research (Weiss et al., 2010) the weight training performed was lower body exercise (leg press, leg extension, and leg curl) and upper body exercise (chest press, shoulder press, seated row, arm curl, and triceps pushdown). In his research (Lieberman, 2007) the type of exercise performed was upper body: six movements (pull down, pull back, shoulder abduction, biceps curl, triceps, up right now) and lower body: six movements (leg press, ankle eversion, ankle dorsiflexion, knee extension, knee flexion, hip flexion). In his research Herda et al. (2021) the weight exercises performed were dumbbell chest press exercise, unilateral

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dumbbell bent-over row exercise, and step-up exercise on a 30.5-cm high box with an anti-slip surface while holding dumbbells in both hands. In his research Campa et al. (2021) the exercise program performed was for suspension training, namely: squats, biceps curl, chest press, low row, rotational ward, squats with Y deltoid fly, and triceps pushdown and for traditional training, namely: squats, alternating lunge, alternating curl with elastic tube, push up, plank, row with elastic tube, and alternating lateral raise with elastic tube. A weight training program tailored to the elderly, considering their physical abilities and limitations, is essential. The program should include a variety of exercises that target major muscle groups and progressively increase in intensity. Incorporating exercises that improve balance, coordination and flexibility can also improve overall functional performance.

4.3 Frequency and Duration

Regular training, ideally 2-3 times per week, with sessions lasting 40-60 minutes, performing 2-3 sets, each set doing 8-15 reps, and resting for 1 minute in each set, can optimize muscle hypertrophy and strength gains. Ensuring adequate recovery between sessions is important to prevent overtraining and injury. Alternating different muscle groups can allow for adequate rest and recovery.

4.4 Supervision and Support

Ensuring correct technique and progression through supervised sessions can help prevent injury and maximize benefits. Supervision by a trained professional, such as a physical therapist or certified personal trainer, can provide guidance on correct form, monitor progress, and adjust the program as needed.

4.5 Nutritional Considerations

Adequate protein intake is essential to support muscle protein synthesis and recovery. Seniors may benefit from protein supplements to meet their increased protein needs. Combining resistance training with a balanced diet rich in protein, vitamins, and minerals can increase the effectiveness of an exercise program.

5. CONCLUSION

The result of this literature review article is that weight training has an influence in increasing or maintaining FFMI in the elderly. The ideal exercise program for the elderly is regular exercise 2-3 times per week, for upper body exercises such as biceps curl, chest press, front shoulder raise, seated row, seated row, arm curl, push up. Lower body exercises leg press, leg extension, leg curl, hip flexon, step-up exercise, squat. Upper-lower body exercises with squats with Y deltoid fly and core exercises using plank. Weight training in the elderly is better to use a professional trainer in order to prevent injury and maximize benefits. Balanced nutritional intake is also very necessary in the process of weight training for the elderly. Meanwhile, if you do not do weight training, it can reduce FFMI in the elderly, it is explained that the group that was not given a weight training program, the group did not experience an increase in FFMI.

6. AUTHORS' NOTE

This article has no conflict of interest and is free from plagiarism.

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