

# Effects of strength training with variable elastic resistance across the lifespan: a systematic review

## Efectos del entrenamiento de la fuerza con resistencia variable elástica a lo largo de la vida: una revisión sistemática

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### Abstract

The benefits of strength training programs with isotonic free weights or machines have been well-documented in all age groups. However, exercise and healthcare professionals sometime question whether it is possible to obtain the same results with devices of variable resistance, such as elastic bands. To answer this question, the purpose of this systematic review was to identify and summarize the positive effects of elastic resistance exercises used across the lifespan on health outcomes including body composition, functional and performance capacity, and biochemical variables. A secondary aim was to identify common dosage parameters of strength training programs using elastic resistance.

**Key words:** elastic bands; functional capacity, body composition; health biomarkers.

### Resumen

Los beneficios de los programas de entrenamiento de la fuerza con peso libre y máquinas isocinéticas del tipo isotónico han sido bien documentados en todas las franjas de edad. Sin embargo, los profesionales del ejercicio y la salud algunas veces se preguntan si es posible obtener los mismos resultados con dispositivos de resistencia variable, como por ejemplo las bandas elásticas. Para responder a esta pregunta, el objetivo de esta revisión sistemática fue identificar y resumir los efectos positivos de los ejercicios de fuerza con elásticos empleados a lo largo de las diferentes etapas de la vida sobre resultados relacionados con la salud, incluyendo la composición corporal, capacidad funcional, rendimiento físico y algunas variables bioquímicas. Un objetivo secundario fue identificar los parámetros de dosificación comunes de los programas de entrenamiento de la fuerza usando resistencia elástica.

**Palabras clave:** bandas elásticas; capacidad funcional; composición corporal; biomarcadores de salud.

## Introduction

Resistance training has been recommended across the lifespan for muscular fitness in support of health-related physical fitness. Exercise and health professionals need effective resistance training devices that stimulate these positive adaptations while promoting adherence to exercise (Capodaglio, Ferri & Scaglioni, 2005; Capodaglio et al., 2002; Gómez-Álvarez, Jofré-Hermosilla, Matus-Castillo, & Pavez-Adasme, 2019). Many strength training devices are available, each with its own advantages and disadvantages.

As the most common and traditional devices for external resistance in training programs, free weights and machines have been shown beneficial for physical function, body composition and other health-related variables (Kwak, Kim & Lee, 2016; Liao, Chung & Chen, 2017; Winters-Stone & Snow, 2006). However, free weights and machines often require special facilities and/or great cost, thus limiting access for everyone (Colado & Triplett, 2008). Furthermore, some individuals may fear using free weights and machines because these are commonly associated with high physical demands (Jakobsen, Sundstrup, Andersen, Aagaard & Andersen, 2013) or possible injury.

In contrast, variable resistance training with elastic bands provides a more user-friendly, portable and less-expensive alternative to traditional isotonic resistance training. Furthermore, evidence suggests that elastic resistance can improve muscular hypertrophy, strength and power (Suchomel, Nimphius, Bellon & Stone, 2018). Although these elastic devices have traditionally been used for rehabilitation purposes (Page & Ellenbecker, 2003), the benefits of elastic resistance in apparent healthy populations has been studied as well (Colado et al., 2010). Researchers have demonstrated that variable elastic resistance can provide similar muscle activation as constant-resistance equivalents when matched in intensity, as well as provide a mechanical advantage over the “sticking point” of free weights and machines. (Aboodarda, Hamid, Che Muhamed, Ibrahim & Thompson, 2013; Aboodarda, Page & Behm, 2016; Calatayud et al., 2015; Hughes & Mcbride, 2005; Kompf & Arandjelovic, 2016; Matheson, Kernozek, Fater & Davies, 2001; Soria-Gila, Chiroso, Bautista, Baena & Chiroso, 2015). In addition, the authors of recent review articles have concluded that elastic resistance training can provide both strength and functional improvements among adults (de Oliveira et al., 2016) and elderly participants (Martins et al., 2013), suggesting elastic resistance may provide benefits across a variety of age groups. However, there are no systematic reviews on the effects or parameters of elastic resistance

training throughout the lifespan. For example, while it's been shown that resistance training produces positive results in youths (Granacher et al., 2016), there is not systematic review of elastic resistance training showing benefits in this specific population.

This knowledge would be necessary to provide effective and safe exercise prescriptions for a wider range of individuals. While individual studies have described adaptations of important physiological variables after elastic resistance training (such as biomarkers or body composition), a systematic review of these adaptations would be beneficial. (Colado, Triplett, Tella, Saucedo & Abellán, 2009; Colado & Triplett, 2008; Flández et al., 2017; Gargallo et al., 2018; Thiebaud et al., 2013).

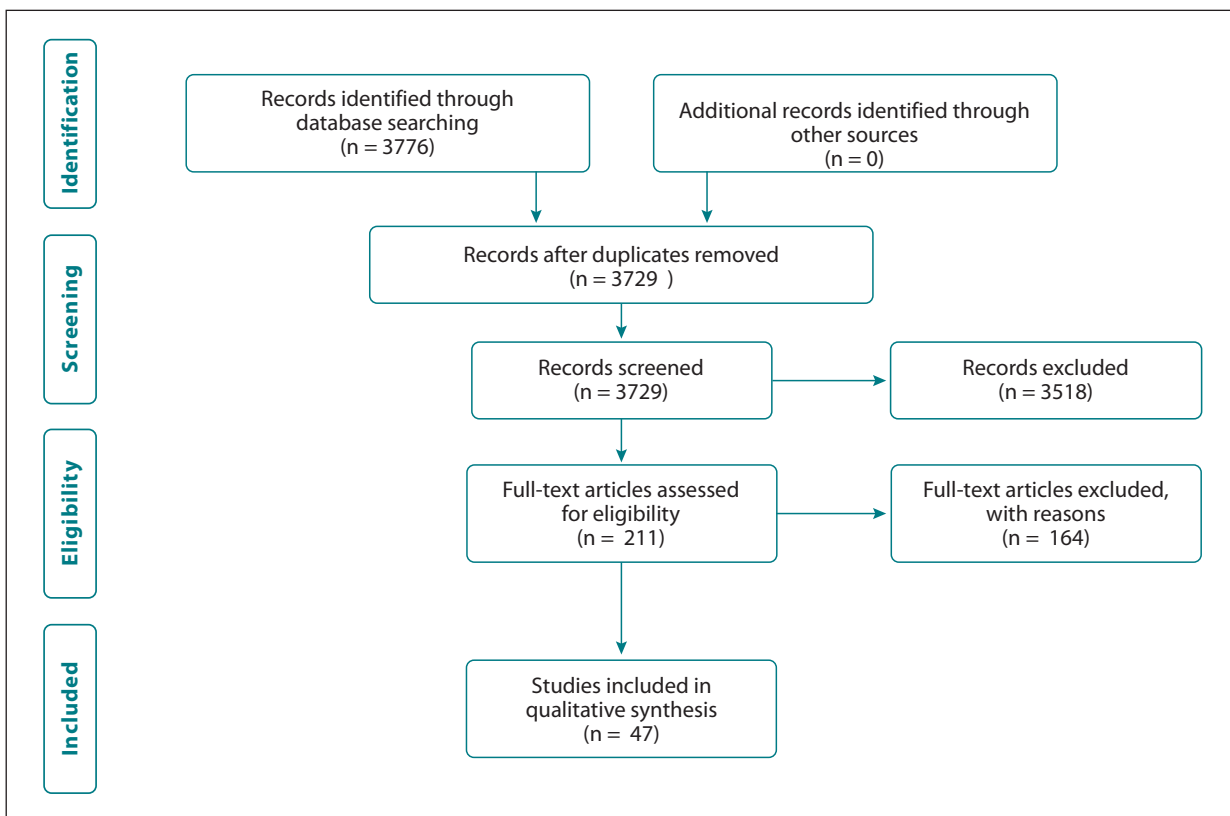
Therefore, the aim of this systematic review was to identify and summarize the health outcomes of elastic resistance training across the lifespan on body composition, functional capacity and some biochemical variables. A secondary aim was to identify elastic resistance exercise parameters in order to establish safe and effective exercise prescriptions.

## Method

This systematic review is reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations (Moher, Liberati, Tetzlaff & Altman, 2009).

## Literature search

We reviewed scientific literature specialized using 9 databases (Web of Science, Pubmed, Sportdiscus, Scopus, Medline, Scielo, Central, Embase and PEDro). The search was limited to full-text, clinical trials studies published in English between 1900 and March 2017. With the search strategy for relevant articles included the following search terms with the Boolean operator “OR”: “elastic band”, “resistance elastic”, “elastic resistance training”, “elastic tubing”, “elastic tubing exercise”, “elastic band”, “elastic band exercise”, “exercise band”, “surgical tubing”, “theraband”, “rubber band”, and “elastic straps”. In the Boolean operators, “and” was also added to provide the corresponding terminology for each age group analyzed in this study: (i) For children: “kids” or “children” or “child” or “lad” or “baby” or “infant” or “laddie” or “cully” or “chap” or “kiddy” or “nipper” or “boyhood” or “girlhood”; (ii) For young people: “adolescent” or “shaver” or “teenager” or “young people” or “teen” or “junior” or “young”; (iii) For adults: “adults” or “middle age”; (iv) and finally for seniors: “old



**Figure 1.** Flow diagram showing the phases of the search and study selection.

man” or “old-timer” or “old person” or “elderly” or “elder” or “ancient” or “aged” or “older adults” or “aging” or “maturation” or “older” or “old people”.

### Selection criteria

The studies had to meet the following inclusion criteria: 1) Healthy subjects; 2) Results in at least one of the following variables: Strength, functional capacity, body composition or biomarkers of health; 3) Results of chronic nature. Exclusion criteria were: 1) Descriptive studies, or validation; 2) Results of acute nature; 3) Subjects with pathology; 4) Studies that have not focused on the variables mentioned above; 5) Studies with highly trained subjects.

### Classification of the studies

The included articles meeting selection criteria were classified with the following data in Table 1: (1) Author and year of publication; (2) Number, Gender, Age, distribution and characteristics of the sample; (3) Duration of the session and the intervention, weekly sessions, number of series, repetitions, rest, intensity and progression; (4) Groups of training and exercises; (5) Variables analyzed: muscle strength, body composition,

functional capacity, and biomarkers of health; (6) Results between pre- and post- intervention.

### Methodological quality assessment

The methodological quality of studies, was analyzed using the “PEDro scale”, which has been validated by Maher, Sherrington, Herbert, Moseley & Elkins. (2003). Ten of 11 PEDro criteria were scored “yes (1)” or “no (0)” with a maximum score of 10 (the first criterion of the PEDro scale is not used to calculate the PEDro score). Studies with a score of  $\geq 6$  were considered of high methodological quality while a score of  $\leq 5$  points was considered to be low quality.

### Results

Figure 1 shows the PRISMA flow chart diagram from the systematic search; 47 studies were included in the analysis. Included studies were classified into 4 age groups: 3 studies in children and adolescents (youths) ( $\leq 18$  years), 6 in young adults (19 and 35 years), 6 in middle-aged adults (45-64 years), and finally, 32 in older adults ( $>64$  years). Table 1 presents the main characteristics of these trials.

### Characteristics of the studies in youths

Only 3 studies examined elastic resistance training in subjects less than 18 years old (Coskun & Sahin, 2014; Lubans, Aguiar & Callister, 2010; Sahin, Aslan & Demir, 2016). These studies used 2 weekly sessions and included a total of 159 subjects: 65 used elastic bands, 37 free weights and 22 used their own body weight. Two studies used 6 weeks of intervention (Coskun & Sahin, 2014; Sahin, Aslan & Demir, 2016), while Lubans, Aguiar & Callister (2010) used 8 weeks. Coskun & Sahin (2014) and Sahin, Aslan & Demir (2016) used a 10 repetition-maximum (RM) intensity without publishing the time of rest, while Lubans et al. (2010) used between 15 and 18 in the Borg's scale, performing 2 sets of 10 to 12 repetitions with a rest between sets of 60-90 seconds. The duration of the sessions ranged between 30 and 50 minutes. Sahin, Aslan & Demir (2016) evaluated the effect of using elastic resistance in the squat and the jump, while Coskun & Sahin (2014) and Lubans, Aguiar & Callister (2010) used overall body exercises.

### Characteristics of the studies in young adults

Seven studies were included. 136 subjects were studied with adults between 19 to 35 years old: 83 used elastic bands, 12 other devices, and 41 as a control group. The interventions lasted from 6 to 13 weeks, with 6 weeks being the most frequent training duration. Three weekly sessions were conducted in five of the studies. The study protocols ranged from 2 to 9 sets, while 3 sets was the most widely used pattern (Behm, 1991; Rhyu, Kim & Park, 2015; Thorborg et al., 2016). Most trials used 10 repetitions, while one study performed repetitions to maximal muscle fatigue (Hostler et al., 2001). Regarding the intensity, all studies utilized percentage of the 1RM, with 70-75% of 1RM the most representative value; however, Bellar et al. (2011) and Hostler et al. (2001) used between 85% and 100% of 1RM. The rest between sets ranged from 60 to 120 seconds. Unfortunately, no study provided the duration of each session with the exception of Thorborg et al. (2016). The majority of studies compared exercises with elastic resistance and other devices; the most used exercises were the bench press, squat and shoulder press.

### Characteristics of the studies in middle-aged adults

Six studies were included with adults 45 to 64 years old. All studies used healthy pre- and post-menopausal women. 244 women were evaluated: 130

used with elastic bands, 28 used weight machines and 32 exercised in the aquatic environment. The programs lasted between 8 and 24 weeks, with the most common durations being 8 (Heislein, Harris & Jette, 1994; Thiebaud et al., 2013) and 10 (Colado et al., 2012a; Colado & Triplett, 2008) weeks. Common parameters included 2-3 sessions per week, 3 sets of 20 repetitions, and rest between sets was 30 seconds. The intensity was generally based on a score of 5 to 7 using the OMNI-RES scale for elastic resistance training (Colado, Triplett, Tella, Saucedo & Abellán, 2009; Colado et al., 2012a; Colado et al., 2012b), while Winters-Stone & Snow (2006) used a 60-80% of the 1RM. Only Colado, Triplett, Tella, Saucedo & Abellán (2009) and Heislein, Harris & Jette (1994) provided the total duration of each session, which was 30 to 60 minutes. Full body exercises were used in nearly all the studies, although Thiebaud et al. (2013) exclusively used upper limbs exercises.

### Characteristics of the studies in older adults

For older adults (over 64 years old), 32 studies with a total of 1746 subjects were evaluated: 1045 trained with elastic bands and 701 served as a control group. The duration of the training program ranged between 3 and 52 weeks. The most frequently used durations were 8 and 24 weeks; however, 12 weeks were used in six studies. Weekly training frequency ranged from 2 to 4 days. The number of sets ranged between 1 and 4, and repetitions ranged from 8 to "as many as possible" (Damush & Damush, 1999). Nine studies utilized 10 repetitions per set; unfortunately, 6 trials did not provide repetition information. The least reported parameter in this age group was intensity, with 19 studies (59%) not providing this information. Seven studies used scales of perceived effort to prescribe intensity (five used the Borg's scale and 2 used the OMNI-RES for elastic bands). Four studies used the % of the 1RM, and Hofmann et al. (2016) prescribed intensity based on the progressive increase in resistance based on the different colors of the elastic bands. The rest time between exercises was only provided in five studies, ranging between 30 and 120 seconds. Most studies used a 60 minute session duration, although 7 trials did not report this information. 13 studies used multi-joint exercises such as squats, lunges, lat pull down or horizontal rows, among others. 16 trials did not mention the specific exercises that were used, providing only the number of exercises performed in the session. Two articles were exclusively focused on the lower limbs (Kwak, Kim & Lee, 2016; Yasuda et al., 2016), while one study

only used in upper limbs (Yasuda et al., 2014). Both studies of Yasuda et al. (2014, 2016) used blood flow restriction using elastic cuffs.

### Methodological quality of included trials

After grading the individual study quality using the PEDro scale, the average data obtained in studies among each age group was: (a) Youths: 5 points on average (High quality: 1 Study; Low Quality: 2 studies). (b) Young Adults: 4.66 points on average (High quality: 2 studies; Low Quality: 4 studies). (c) Middle-aged adults: 4.83 points on average (High quality: 2 studies; Low Quality: 4 studies). (d) Older Adults: 4.68 points on average (High quality: 10 studies; Low Quality: 22 studies).

A majority of studies in each group scored below 6 on the PEDro scale, indicating low methodological quality. Table 1 shows the specific PEDro scores of each article.

### Discussion

This systematic review suggests that elastic resistance training programs are effective to improve muscle strength, physical function and other health-related variables across the lifespan. These data expand the current evidence on the effectiveness of these exercise programs among adults (de Oliveira et al., 2016) and elderly participants (Martins et al., 2013). Elastic resistance programs improved the functional capacity of young, middle, and older adults (Colado, Triplett, Tella, Saucedo & Abellán, 2009; Cyarto, Brown, Marshall & Trost, 2008; Franzke et al., 2015) as well as body composition (Colado, Triplett, Tella, Saucedo & Abellán, 2009; Lubans, Aguiar & Callister, 2010) in all ages, except in the oldest adults, where the results were mixed (Skelton, Young, Greig & Malbut, 1995; So et al., 2013). Interestingly, some recent studies have demonstrated positive health effects in 80 year olds (Chupel et al., 2017; Furtado et al., 2019; Rieping et al., 2019). Finally, there were few or irrelevant results on health biomarkers after elastic resistance training (Hostler et al., 2001; Lubans, Munday, Lubans & Lonsdale, 2013).

### Effects of training with elastic bands in youths

An important finding among elastic resistance training studies in youths was improvement in the motivation and participation of the child (Barkley, Ryan, Bellar, Bliss & Roemmich, 2011), possibly because

it seems more attractive and provides more security than heavy weights (Annesi, Westcott, Faigenbaum & Unruh, 2005). In addition, elastic resistance training has shown greater physical performance improvements than bodyweight exercises (Coskun & Sahin, 2014). Most likely, the stimulus provided by the bodyweight exercises was not enough or the exercise was too difficult to adapt to each subject (Faigenbaum, 2000), while the elastic band resistance could be easily adapted, thus providing a proper stimulus for the neuromuscular improvements (Ignjatović, Stanković, Radovanović, Marković & Cvečka, 2009). Studies of Lubans, Aguiar & Callister (2010) and Sahin, Aslan & Demir (2016) found improvements in strength similar or higher to free weights training. For body composition, Lubans, Aguiar & Callister (2010) found changes in the percentage of fat-free and fat mass in both sexes, although the bodyweight training group achieved greater results than the elastic resistance group. It is possible that suboptimal dosing of intensity, duration, and frequency of elastic resistance training may provide a low stimulus for improving body composition due to the suboptimal intensity, short duration and frequency of the protocols used. It is also interesting that some investigations were focused on the effects of elastic resistance training in children with special needs such as cerebral palsy (Shin & Kim, 2016). Finally, it's important to note that no study provided data on functional capacity or health biomarkers, thus leaving a need for further investigation.

### Effects of training with elastic bands in young adults

The majority of the studies including young adults were focused on evaluating the effects of elastic resistance training on muscle strength. Bellar et al. (2011) obtained better results by adding elastic bands to a bench press compared to free weights alone; this combination was more effective at improving muscle strength than the isolated use of free weights, even in inexperienced subjects. These results may be due to a mechanical change created by using elastic resistance that helps to overcome the "sticking point" during the concentric phase of the movement, possibly facilitating neural adaptations (Kompf & Arandjelovic, 2016). Hostler et al. (2001) reported an RM increase in the squat with no change in the number of repetitions during knee extension. Behm (1991) analyzed the effect of different devices (i. e. free weights, aquatic resistance and elastic resistance) finding a similar response in muscle strength between them. Sugimoto & Blanpied (2006) analyzed the

effect of elastic band exercise of the shoulder rotator cuff; they found that the elastic resistance provided greater internal and external rotator strength than a flexible foil (Bodyblade). Thorborg et al. (2016) observed an improvement in isometric hip flexion strength after 6 weeks of elastic resistance training. Some researchers have combined elastic resistance with proprioceptive neuromuscular facilitation (PNF) techniques, reporting improvements in joint mobility, reporting benefits in the development of the strength, and the balance through of improving the responsiveness of the skeletal-muscle system (Jonghwan, Chulhyun, Kyumoon, Hyeonju & Byeungok, 2003; Rhyu, Kim & Park, 2015). Only Hostler et al. (2001) analyzed the effect of elastic resistance exercise on some physiological biomarkers of health, finding no significant improvements. No research has been published on body composition and functional capacity outcomes in young adults using elastic resistance training.

#### Effects of training with elastic bands in middle-aged adults

The majority of the studies including middle-aged adults evaluated the effects of elastic resistance training on functional capacity. Colado & Triplett (2008), Colado et al. (2009) and Colado et al. (2012b) analyzed functional capacity, reporting significant increases after the intervention. Thiebaud et al. (2013) observed that two training groups (low and medium-high intensity) increased their 1RM in upper and lower limb exercises. Heislein et al. (1994) reported 20 and 8.8% increases in quadriceps and hamstrings strength respectively, using elastic bands together with PNF techniques similar to Rhyu et al. (2016). Five studies reported improvements after elastic resistance training interventions on body composition, measured with bioelectrical impedance analysis (Colado & Triplett, 2008; Colado, Triplett, Tella, Saucedo & Abellán, 2009; Colado et al., 2012a; Winters-Stone & Snow, 2006) or musculoskeletal ultrasound (Thiebaud et al., 2013). Colado & Triplett (2008), Colado, Triplett, Tella, Saucedo & Abellán (2009) and Colado et al. (2012a) reported more improvements in body composition using elastic bands than compared to other resistance devices. They indicated that a similar routine during a short-term training program is sufficient to reduce the percentage of fat mass, regardless of the type of resistance. Winter-Stone & Snow (2006) assessed bone mineral density after a lower and/or upper body elastic resistance program that was complemented with jump exercises, demonstrating

significant improvement in the greater trochanter, probably because the skeletal system needs high load exercises to maintain or develop their levels of density (Iwamoto, 2013). Only Colado, Triplett, Tella, Saucedo & Abellán (2009) and Flández et al. (2017) analyzed health-related biomarkers, showing improvement both metabolic health as well as motor function. Colado, Triplett, Tella, Saucedo & Abellán (2009) also showed a reduction in diastolic blood pressure with a medium-term elastic resistance training program. Importantly, the majority of these changes exposed were found in only short and medium-term programs; therefore, it seems logical that longer programs would provide greater results (Braith & Stewart, 2006), although more research is needed.

#### Effects of training with elastic bands in older adults

In 23 studies of older adults exercising with elastic resistance, functional capacity was the most analyzed variable, reporting improvements of 20-25%. 15 studies reported strength improvements of 15-20%, either in the lower limbs or upper limbs. Eight studies investigated the effect of elastic resistance training on body composition; only 3 found significant improvements. 12 trials carried out measurements on health-related biomarkers using blood tests, hormonal levels, enzyme activity or oxidative stress. Interestingly, chromosomal damage tended to decrease after elastic resistance training (Franzke et al., 2015a and b). Hofmann et al. (2016) showed a decrease in the percentage of myostatin and increases in follistatin, but no change in the hormone IGF-1. Park et al. (2016) found a 14% improvement in systolic blood pressure, while Lubans, Aguiar & Callister (2010) reported a tendency to improve. Aniansson, Ljungberg, Rundgren & Wetterqvist (1984) revealed improvements of up to 39% in the myokinases and 44% in the citrate synthase after 40 weeks of exercising with elastic bands and with the own body weight. Lastly, inconsistent data was observed for hemodynamic parameters, such as blood pressure, cardiac output, ejection volume, or heart rate, likely due to a lack of appropriate training stimulus (Vincent, Vincent, Braith, Bhatnagar & Lowenthal, 2003) as was the case in the majority of studies included in this age group.

It appears that elastic resistance training in older adults is beneficial either in healthy subjects or those with pathology. Older adults consistently experience strength gains with elastic resistance training programs (Capodaglio et al., 2002; Martins et al., 2013; Martins et al., 2015; Oh et al., 2016). These

findings support the benefits of strength training with elastic resistance to prevent and treat dynapenic and/or sarcopenic processes associated with age (Clark & Manini, 2008; Rosenberg, 1997).

### Limitations of the study

Based on data from the included studies, the present systematic review provides novel data about evidence on the effectiveness of elastic resistance training programs across the lifespan. However, the small number of articles using elastic resistance training (especially at the youngest ages) and the general poor quality of the studies are the main limitations of this study. Because of these limitations, and due to the heterogeneity of training parameters between studies, a dose-response relationship can not be provided from these data. In addition, the lack of information about the dose or exercises used in some studies, especially among elderly subjects, limits the ability to provide recommendations.

High-quality dose-response clinical trials are needed to better understand the optimal dose and the effectiveness of these programs at different ages, especially in children. More research is needed on the effects of training with elastic resistance on health-related biomarkers and body composition variables. Future studies should clearly describe the training volume, intensity, frequency, duration and rest intervals used in the exercise programs. Until then,

practitioners should follow standard strength training parameters in elastic resistance programs.

Finally, this review included only articles published before March 2017 due to the lengthy time that it was needed for editing, and also due to the usual time needed for being reviewed and accepted to definitive publication in a high quality scientific journal.

### Conclusions

Based on this systematic review, training with elastic resistance improves muscle strength and functional capacity across the lifespan. These results suggest that elastic resistance benefits are similar to those seen with traditional isotonic machines and free weights. In addition, elastic training seems to be effective in improving body composition and may have positive results in some health biomarkers, although further research is needed.

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Table 1. Characteristics, results and PEDro Scale Scores.

Author & year	N° subject; Gender; Age; Characteristics of the sample	Time OF Intervention; Frequency; N° Sets/Reps; Intensity; Rest; minutes per session	Training Groups/ Exercises	Measurements: Strength; Body Composition; Functional Capacity; Biomarkers; Others	Results
<b>Youths</b>					
Coskun & Sahin. (2014) PEDro SS: 4	30 TG: BWG:14 EBG:16	6wk 2d/wk 1-2 sets of 10-12reps 10 RM 30min.	EBG: Hamstring Curl, legs press, front raises, push-ups, lat pull down. BWG: Push-ups, Squats, Lunge, Box jump.	Leg press (KG), Sit-up y Push-up (Reps) Test	<b>Strength:</b> EBG: ↑ ** Press (15%) and Sit-up (10.4%); ↑ * Push-up (2.1%). BWG: ↑ * Press (57.7%), Sit-up (24%) and ↓ * Push-up (15%).
Lubans et al. (2010) PEDro SS: 6	108 (56M, 52W) FWG: 37 EBG: 41 CG: 30 15 ± 0.7 years. Not trained High school students.	8wk 2d/wk 2sets of 10-12 reps (1-4wk); 8-12reps (5-8wk) 15-18 Borg's scale 60-90" 40-50min	FWG and EBG: Squat, lunge, calf raise, vertical row, bench press, front raise, biceps curl, triceps extension, crunch and Russian twist. CG: Normal activity.	1 RM in bench press and legs press. Body composition (Bioimpedance)	<b>Strength:</b> Boys: ↑ ** FWG (24%) and EBG (12%) in bench press; FWG (35%), and EBG (32%) in the press. CG: No sign. Change Girls: ↑ ** FWG (32%) and (19%) EBG in Press Without sign. Changes in bench press CG: No sign. Change <b>Body Composition:</b> Boys and girls: TG: ↑ *** (2%) Fat Free Mass and ↓ ** (5.5%) fat mass. % Body Fat: FWG: ↓ ** (10%) and EBG: ↓ ** (6%) Waist circumference, weight, BMI: No sign. Changes. CG: No sign. Change
Sahin et al. (2016) PEDro SS: 5	21 TG: (BWG:8 EBG:8) CG:5 11.5 ± 0.53 years. Healthy children with training experience	6wk 2d/wk 2 sets of 20-30reps 10RM	TG: EBG: Squats with elastic band + vertical jump. BWG: Squats without elastic band + vertical jump. CG: Normal activity.	Static Squat (ES), dynamic (DS) And vertical Jump (VJ) Test	<b>Strength:</b> EBG: ES (↑35%), DS (↑43%) BWG: ES (↓25%), DS (↑33%) and VJ (↓ 16%). CG: ES (↓48%), DS (↑9%), VJ (↑1.5%).
<b>Young Adults</b>					
Behm (1991) PEDro SS: 5	31M 20.4 ± 1.4 years. Healthy men.	10wk 3d/wk 3 sets of 10 reps 50% 1RM 60s	3 shoulder actions: Press with Hydragym (HP). Traditional Shoulder Press (TSP). Elastic tubing shoulder Press (ETSP)	Shoulder abduction torque 1RM shoulder press. Specific speed.	<b>Strength:</b> Shoulder abduction torque: ↑ ** HP (10.4%), TSP (14.1%) and ETSP (14.7%). 1RM shoulder press: ↑ ** HP (14%), TSP (17.5%) and ETSP (13.8%). No changes in specific speed.
Bellar et al. (2011) PEDro SS: 4	11M TG: FWG and EBG 23.6 ± 3.2 years. Healthy University students.	13wk 2d/wk 5 sets of 5 reps 1RM 90s.	EBG: Bench press with elastic bands. FWG: Bench press with olympic barbell.	1RM Bench press.	<b>Strength:</b> EBG: ↑ ** 9.95 ± 3.7Kg. (9.9%) FWG: ↑ * 7.56 ± 2.8 Kg. (7.3%)
Hostler et al. (2001) PEDro SS: 2	23 10M 13W M: 20.3 ± 1.1 W: 20.2 ± 1.2 years. Young men and women.	8wk 2d/wk (1-5wk); 3d/wk (6-8wk) 2 sets to failure. 60-100% 1RM.	One leg Squat and leg extension	1RM Squat and leg extension. N° reps. Vo2max. Histochemical analysis of the fibers and cross-sectional area of the vastus lateralis (Biopsy).	<b>Strength:</b> ↑ ** 1RM in Squat (M: 9.6%; W: 23.5%) Without change in press. ↑ * N° reps in Squat and leg extension in M and W. Biomarkers: VO2max: No changes. Histochemical analysis: ↑ * fibers IIAB and ↓ * IIB in M and W. (more in W). Cross-sectional area: ↓ * fibers I and IIAB+IIB in M. No changes in W.



Author & year	N° subject; Gender; Age; Characteristics of the sample	Time of Intervention; Frequency; N° Sets;Reps; Intensity; Rest; minutes per session	Training Groups/ Exercises	Measurements: Strength; Body Composition; Functional Capacity; Biomarkers; Others	Results
Thorborg et al. (2016) PEDro SS: 7	33 (18M 15W) TG: 16, CG: 17 24 ± 5 years. Physically active Men and women	6wk 3d/wk 3 sets of 15 (1wk); 10(2-4wk); 8 (5-6wk) reps 15-10-8 RM 120s 10min.	TG: Standing hip flexion with elastic band tied above the knee	Isometric flexion strength. Dominant and non-dominant leg.	<b>Strength:</b> TG: ↑** (17%) Isometric flexion strength in Dominant leg. Without changes in non-dominant leg.
Rhyu et al. (2015) PEDro SS: 4	28 (14M 14W) TG: 14 CG: 14 CG: M: 26.14 ± 2.19; W: 21.57 ± 1.9 years. TG: W: 27.14 ± 5.87 M: 24.43 ± 2.94 years. Healthy students	6wk 3(1-2wk)-5(3-6wk) sets of 10 reps. 50%(1-2wk)-70%(3-6wk) of 1RM 60s.	TG: PNF techniques with elastic bands in extension, abduction and internal rotation movements for hips and legs. CG: Normal activity.	Power peak, average power, peak speed, average speed, strength peak, average strength of hip abductors. (EN-TreEM).	<b>Strength:</b> TG: ↑** power peak, average power, peak speed, average speed, average strength, and strength peak in lower limbs abductors.
Sugimoto & Blanpied (2006) PEDro SS: 6	40 (13M 27W) TG: (EBG:12 BBG:14) CG:14 24.3 ± 5 (EBG: 24.3 ± 5 BBG:23.8 ± 5.1 CG: 24.9 ± 5.2) years. Young adult without shoulder intervention.	8wk 3d/wk EBG:3 sets of 10-20 reps, BBG:2 sets of 30-60 seg. 30-60 s	EBG and BBG: Internal and external rotators exercises with elastic band or with Bodyplate® device. CG: Normal activity.	Isometric, concentric and eccentric strength in internal and external shoulder rotators (Dynamometer).	<b>Strength:</b> Internal rotators: EBG ↑**14%, BBG 5%, CG: 2%. External rotators: EBG ↑**34%, BBG 8%, CG: 3%.
<b>Middle-aged Adults</b>					
Colado & Triplett (2008) PEDro SS: 6	45W TG: (GEBG: 21 MG: 14) CG:10 TG: (EBG: 54.14 ± 2.87 MG: 51.07 ± 6.81) CG: 53.9 ± 1.85 years. Middle-aged sedentary women.	10wk 2d/wk 2 sets (Lower limbs) 1 set (Upper limbs) (1-4wk); 2 sets (5-8wk), 3 sets (9-10 wk) of 20 reps 5 or "some hard" (1-4wk); 7 or "hard" OMNI-RES AM (5-10wk) 30s	6 of 12 exercises/session: Squat, horizontal shoulder abduction, triceps extension, hips abduction, elbow flexion, shoulder abduction, elbow extension, shoulder flexion.	Functional capacity: KPU test: ↑** MG (62.4%) EBG (27.3%) S test: ↑** EBG (27.3%) MG (21%) <b>Body Composition:</b> ↑** fat-free mass EBG (1.2%) and MG (2.4%) and ↓** fat mass EBG (2.2%) and MG (5%) CG: Without changes.	Functional capacity: KPU test: ↑** MG (62.4%) EBG (27.3%) S test: ↑** EBG (27.3%) MG (21%) <b>Body Composition:</b> ↑** fat-free mass EBG (1.2%) and MG (2.4%) and ↓** fat mass EBG (2.2%) and MG (5%) CG: Without changes.
Colado et al. (2009) PEDro SS: 5	46 W TG: (AAG:15 EBG:21) CG:10 TG: (AAG: 54 ± 2.0; EBG: 54 ± 2.8) CG: 52.9 ± 1.9 years. Post-menopausal women	24wk 2d/wk (1-12 wk); 3d/wk (13-24 wk). 1-3 sets of 20 reps (1-18 wk); 2 supersets of 15 reps (19-24 wk) 5 (1-4wk) to 7 (5-24 wk) OMNI RES. 35(1-4 wk); 40 (5-8 wk); 50 (9-12 wk); 45 (13-18 wk) and 60 (19-24wk) min. 30s.	EBG: Abduction shoulder, hips and legs extension, elbow extension, horizontal shoulder extension, hips abduction, trunk flexion, diagonal shoulder abduction, elbow flexion and lateral trunk flexion. AAG: lateral flexion trunk, vertical one leg jump, trunk flexion, diagonal shoulder abduction, elbow flex- ext., hips abduction and adduction, shoulder adduction and abduction, two legs jump.	Functional capacity: TG: ↑** Sit and reach (AAG: 27.9%, EBG: 44.2%) KPU (AAG: 84.7%, EBG: 51.6%) 60s squat (AAG: 65.7%, EBG: 46%). Only AAG ↑** abdominal crunch test (AAG: 28.1%, EBG: 12.4%). CG: Without changes. <b>Body Composition:</b> TG: ↑** Fat free mass (AAG: 2.8%, EBG: 1.2%) and ↓** fat mass (AAG: 14.6%, EBG: 1.2%), BMI (AAG: 4.4%, EBG: 4.1%) and waist circumference (AAG: 4.1%, EBG: 4%). CG: ↓** waist circumference (2.7%). Biomarkers: Blood test: TG: EBG ↑** HDL (12.3%) and cholesterol/HDL ratio (11.2%). CG: ↓** cholesterol (8.5%), LDL (15.2%), glucose (7.2). Blood pressure: TG: ↓** Diastolic pressure (AAG: 9%, EBG: 5.1%).	Functional capacity: TG: ↑** Sit and reach (AAG: 27.9%, EBG: 44.2%) KPU (AAG: 84.7%, EBG: 51.6%) 60s squat (AAG: 65.7%, EBG: 46%). Only AAG ↑** abdominal crunch test (AAG: 28.1%, EBG: 12.4%). CG: Without changes. <b>Body Composition:</b> TG: ↑** Fat free mass (AAG: 2.8%, EBG: 1.2%) and ↓** fat mass (AAG: 14.6%, EBG: 1.2%), BMI (AAG: 4.4%, EBG: 4.1%) and waist circumference (AAG: 4.1%, EBG: 4%). CG: ↓** waist circumference (2.7%). Biomarkers: Blood test: TG: EBG ↑** HDL (12.3%) and cholesterol/HDL ratio (11.2%). CG: ↓** cholesterol (8.5%), LDL (15.2%), glucose (7.2). Blood pressure: TG: ↓** Diastolic pressure (AAG: 9%, EBG: 5.1%).

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Colado et al. (2012a) PEDro SS: 5	62W TG: (MG:14 EBG:21 ADIDFG:17) CG:10 CG: 53,9 ± 0,59 TG: (MG: 51,07 ± 1,82 EBG: 54,14 ± 0,63 ADIDFG: 54,71 ± 0,45). Post-menopausal women.	10wk. 2d/wk. 2 sets of (lower limbs) and 1 set (upper limbs) (1-4wk); 2 sets (5-8wk) 3 sets (9-10wk) (lower and upper limbs). 20 reps. 5(1-4wk) to 7 (5-10wk) de OMNI RES-AM. 30s.	6 of 12 exercise/session: Squat horizontal shoulder abduction, triceps extension, hips abduction, elbow flexion, shoulder abduction, elbow extension, shoulder flexion.	Functional Capacity: TG: ↑** KPU (EBG: 30.6 %, ADIDFG: 98%, MG: 62.6%) ↑** ST (EBG: 27.4%, ADIDFG: 40.2%, MG: 21.1%) ↑** CT (EBG: 16.3%, ADIDFG: 18.2%, MG: 31.1%) <b>Body Composition:</b> TG: ↑** fat mass: (EBG: 1.5%, ADIDFG: 2.6%, MG: 5%) ↑** fat free mass: (EBG: 1.2%, ADIDFG: 0.5%, MG: 2.5%) ↑** arms fat free mass: (EBG: 3.7%, ADIDFG: 2.9%, MG: 4.3%) ↑** legs fat free mass: (EBG: 0.5%, ADIDFG: 0.8%, MG: 1.2%)	
Heislein et al. (1994) PEDro SS: 3	18W 55.7 ± 4.5 years. Post-menopausal women.	8wk 2d/wk. 20 reps. 50-60min.	Exercises in progressive sequence of weight load from lying down to a standing posture. Limb and trunk movements that incorporate diagonal and rotation movements associated with PNF.	Quadriceps, hamstring and grip strength (Dynamometer).	<b>Strength:</b> ↑** Quadriceps (20.8%), hamstrings (8.8%) and grip strength (14.2%).
Thiebaud et al. (2013) PEDro SS: 4	14W TG: (MAI:8 RS-BI:6) 61 ± 5 years. Post-menopausal women.	8wk. 3d/wk. MAI: 3 sets of 10 reps; BI-RS: 1 sets of 30 reps followed by 2 sets of 15 reps. 7-9 in OMNI-RES-AM or 70-90% of 1RM. 30s.	TG: Bench press; shoulder press, and seated row, legs press, unilateral knee flex-ext. CG: Bench press; shoulder press, and seated row. Muscles thickness (Ultrasounds).	1RM in lower limbs (legs press, unilateral knee flex-ext.) and upper limbs (Bench press, shoulder press, and seated row). Muscles thickness (Ultrasounds).	<b>Strength:</b> Both TG: ↑** Upper limbs and lower limbs in all exercises. <b>Body Composition:</b> Muscles thickness: ↑** in pectoral major in both TG.
Winters-Stone & Snow (2006) PEDro SS: 6	59 W TGL(MTG:19 UMTG:16) CG:24 CG:24 41,3 ± 3,8 years. Pre – menopausal women.	12 wk. 3d/wk. LMTG: 9 sets of 10-12 jump and 2-6 sets of 10-12 reps for other exercises; UMTG: 9 sets of 10-12 jumps and 3 sets of 8-12 reps for other exercises. 8-12 RM. 30-120 s.	LMTG: Squats, Lunges, calf raises + jump UMTG: Biceps curl, vertical row, + squat, triceps extension, unilateral row + lunge, lat pull down, bench press.	Body composition (DXA). Bone mineral density (BMD) of hips, greater trochanter, femoral neck, lumbar spine and whole body (X-Ray absorptiometry)	<b>Body Composition:</b> TG: ↑** Total lean mass (2%) y ↓** Total fat mass (5.5%). Arms: TG: ↑** Lean body mass (4%) y ↓** fat mass (4.5%). Legs: TG: ↑** Lean body mass (5%) y ↓** fat mass (2.3%). CG: Decreases in all measurements. BMD: TG: ↑** BMD greater trochanter (2.4%); CG: ↑* (0.7%). UMTG: ↑** BMD lumbar spine (1.3%); LMTG: ↓* (0.3%); CG ↓* (5%) Without sign. changes in BMD of femoral neck, hips and whole body
<b>Older Adults</b> Aniansson et al. (1984) PEDro SS: 4	26 (22W 4M) M: 73 H: 74 years. Older adults.	40wk 2d/wk 11-14 Borg's scale. 40min.	Home training program based on: exercises for walking, running, and arms, legs and trunk exercises.	Quadriceps Strength (Dynamometer). Composition and area of muscle fibers (CAFMI) (Biopsy). Histopathological analysis. Enzymatic activity. Heart rate, oxygen consumption (Bicycle ergometry). Capillary density	<b>Strength:</b> Quadriceps strength ↑** 7-13%. <b>Body Composition:</b> CAFMI: Fta ↑** (33%) (N° and area) Biomarkers: No changes in histopathological analysis, capillar density and ergometry. Enzymatic activity: ↑** myokinase (17-39%) and synthetase (32-44%).
Capodaglio et al. (2002) PEDro SS: 4	22M TG:10 CG:12 TG: 68.5 CG:72.1 years. Older adults	16wk 3d/wk 1 sets of 10 reps 50-80% 1RM (Lower limbs); 40-64% (Upper limbs).	TG: Leg press; shoulder press, vertical row, bench press, calf raises; lateral shoulder machine press. CG: Normal activity.	Dynamic concentric strength (DCS) Leg press, shoulder press, vertical row, bench press, calf raises; lateral shoulder machine press. Max. Isometric Strength (MIS) of knee extensors (KE) and elbow flexors (EF).	<b>Strength:</b> TG: ↑** MIS (KE: 14.5%, EF: 16.6%) and DCS (Leg press: 7.2 %, calf raises: 7.9%, shoulder press: 9.5%, bench press: 6.1%, vertical row: 3.6%). CG: ↓** MIS and DCS in all exercise.

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Capodaglio et al. (2005) PEDro SS: 4	28 G65:14, G75:14 G65:66.3 G75:77.8 years. Over 75 years. old subjects	16wk 3d/wk 1 sets of 10 reps 50-80% 1 RM (Strength), 4 Borg's scale (Aerobic).	G65 y G75: Leg press, and calf raises + 20-45 min in cycloergometer.	1RM leg press (Knee extensors (KE)) and calf raises (plantar flexors (PF))	<b>Strength:</b> G75: ↑**; PF (49.2%); KE (87.5%) G65: ↑**; PF (11.6%); KE (29.9%).
Capodaglio et al. (2007) PEDro SS: 4	38 (19M; 19W) TG:23 CG:15 M: 76.6 ± 3.1 W: 77.5 ± 4 years. People over 75 who live in a community.	A year 2d/wk TG: 1 sets of 12 reps; CG:20 reps 60-70-80% 1RM 120s. 60 min.	TG: Tai-Chi movements, leg press and calf raises. CG: Leg press and calf raises with elastics bands.	Max. isometric knee extensors (KE) and plantar flexors (PF) strength. Leg extensor power (LEP) Functional capacity: functional reach (FR); chair rise 1 (CR1) and 10 times (CR10); bed rise (BR); 6-min walking test (6MWT); stair climbing (SC); get up and go (GU&G); one-leg standing (1LS).	<b>Strength:</b> PF: TGW: +21.5%; CGW: -5%; TGM +8%; CGM: -4%. ER: TGW: +12%; GMC: -2%; TGM: +4%; CGM: -5%. LEP: TGW: +22.5%; GMC: -9%; TGM +4%; CGM -8%. Functional capacity: FR: TGW: +85%; CGW: -1.7%; TGM +60%; CGM: 1%. 1LS: TGW: +29.1%; CGW: -11%; TGM +25%; CGM: -4.8%. CR1: TGW: +29%; CGW: -11%; TGM +17%; CGM: -2%. CR10: TGW: +28%; CGW: -8%; TGM +20%; CGM: -7%. BR: TGW: +29%; CGW: -4%; TGM +8%; CGM: -3%. GU&G: TGW: +20.5%; CGW: -0.6%; TGM +18.6%; CGM: -2%. SC: TGW: +12%; CGW: -3.3%; TGM +12%; CGM: -2%. 6MWT: TGW: +4.7%; CGW: -2.7%; TGM +4.5%; CGM: -2%.
Cyarto et al. (2008) PEDro SS: 5	167 (132W 35M) TG1:38 TG2:81 CG:48 78.8 ± 6.4 years. Older adults.	20wk 2d/wk 2 sets of 5-15 reps.	TG1 y TG2: 9 strength exercise, with elastics band and body weight, 2 balance exercises and 10 mobility exercises. CG: walking 30 min.	Functional capacity: 30s chair stand test (Lower limbs strength); 30s arm-curl test (upper limbs strength); chair sit-and-reach test (lower limbs mobility); back-scratch test (upper limbs mobility); 8-foot, Time up & go test (balance)	Functional capacity: TG2 y TG1 ↑** chair stand (TG2: 20.7%, TG1: 20%) and arm curl test (TG2: 29.7%, TG1: 29.2%). TG2: ↑** Sit and reach (48.3%) and up and go (7.2%). TG1: ↑*: back scratch test (24.7%). Without changes in other measurements. CG: ↓** Sit and reach (74.4%). Without changes in other measurements.
Damush & Damush (1999) PEDro SS: 6	68W TG:40 CG:28 68 ± 5.58 years. Older women	8swk 2d/wk 1 sets of "as many repetitions as you can until you reach more than 4 Borg's scale 90s 45 min.	TG: seated lat pull down, one leg press, horizontal push press, calf raise, triceps extension, biceps curl, leg extension.	3RM of latissimus dorsi, pectoral major, knee extension and handgrip strength. (Dynamometer).	<b>Strength:</b> TG ↑** in latissimus dorsi (19.7%), Pectoral major (27.7%) and quadriceps (16.5%). CG: No changes. Without changes in handgrip
Franzke et al. (2015a) PEDro SS: 5	105 (92W, 13M) TG: (TG:34 STG:30) CG: (EC:32) 83.1 ± 6.08 years. Older institutionalized adults.	24wk + de 1d/wk 1 sets of 15 reps (1-4wk) 2 sets of 15 (5-24wk); 60 min.	TG: 10 exercise for: legs, back, trunk, chest, shoulder and arms. CG: Cognitive exercises (CEG)	Functional capacity: chair rise, 6min-walking and handgrip strength test DNA damage (Electrophoresis) Enzymatic activity	Functional capacity: TG: ↑** Chair rise (TG: 17%) (STG: 19%); ↑** 6MWT (TG: 6%) (STG: 8%). Handgrip test: No changes. CEG: No changes. Biomarkers: TG and CEG: DNA: Without changes. TG: ↑** enzymatic activity; (TG: 22%) (STG: 6%); CEG: Without changes.
Franzke et al. (2015b) PEDro SS: 5	97 TG: (TG: 35 STG: 29) CG: (CEG: 33). 83.0 ± 6.1. TG: (TG: 82.8 ± 5.7 STG: 82.5 ± 7.5) CG: (CEG: 83.5 ± 5) years. Older institutionalized adults.	24wk + de 1d/wk 1 sets of 15 reps (1-4wk) 2 sets of 15 (5-24wk) 60 min.	TG: 10 exercise for: legs, back, trunk, chest, shoulder and arms. CG: Cognitive exercises (CEG)	Functional capacity: Chair rise, handgrip strength and 6 min walking test Chromosomal damage B12 vitamin	Functional capacity: TG: ↑** Chair rise: (TG: 23%) (STG: 24%); ↑** 6MWT: (TG: 13%) (STG: 11%) Handgrip test: Without changes in TG and CG. Biomarkers: Chromosomal damage: ↓* in TG and CG. B12: ↑** STG (130%), without changes in TG and CEG:

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Harrirattisai et al. (2015) PEDro SS: 5	40 (7M/33W) TG:20 CG:20 71.08 ± 1.15 years. That seniors.	8wk 3d/wk 45min	TG: Basic movements of activities of daily life: sitting / getting up from a chair, standing up after getting up from a chair, and transfer to the chair + physical activity (walk). TG: TG: Strength training. STG: Strength training + supplementation. CG: CEC: Cognitive training.	Functional capacity: stand balance, (Berg's test), security not to fall and physical performance. TG: ↑** Balance (6%) ↑** Security not to fall (17.3%). ↑** Physical performance (24.6%) CG: No changes.	
Hofmann et al. (2016) PEDro SS: 6	91 W TG: (TG:33 STG:28) CG: (CEG:30) 83.6 TG: (TG:82.9 GES: 83.9) CG (CEG: 84.5) years Older women.	24wk 2d/wk 1-2 sets of 15 reps 60 min.	TG: TG: Strength training. STG: Strength training + supplementation. CG: CEC: Cognitive training.	Functional capacity: Chair stand and handgrip test Myostatin, activina A, folistatin, IGF-1 levels. TG: ↓** Myostatin: (TG:-7%), STG and CG: No changes. CG: ↓** Activina A (-7%). STG: No changes. TG: ↑** Folistatin: (TG: 18%), STG and CG: No changes. IGF-1: No changes.	
Kwak et al. (2016) PEDro SS: 4	45 TG:22 CG:23 TG: 80.1 ± 4.7 CG: 77.4 ± 5.5 years. Elderly rural people	8wk 3d/wk 3 sets of 10 reps. 60 min.	TG: Ankle flexion, Ankle extension, Knee flexion, knee extension, Hip flexion, hip extension, hip abduction, hip adduction + physical therapy. CG: Physical therapy.	Functional capacity: TG and ↑** FRT (21.5%), BBS (24.6%), UP&G (8.8%), DW (22.5%), SRT (2.3%) and CSBSA (10.3%). CG: FRT (1.1%), BT (5.7%), UP&G (1.7%), DW (4%), SRT (0.3%) and CSBSA (4.1%).	
Lee et al. (2015) PEDro SS: 2	20 TG:10, CG:10 CG: 73 ± 6.4 TG: 74 ± 4.6 years. Elderly women	8wk 4d/wk 3 sets of 12 reps 50-60% heart rate and 11-12 RPE (1-6wk) 60-70% heart rate and 12-13 Borg's scale (7-8wk) 90s 40 min.	TG: Core exercises, gymnastic exercise, elbow extension, monster walk, lies press, knee extension, plantar flexion. CG: Normal activity.	Functional capacity: TG: ↑** chair stand 30s: Test (102.8%), 2m knee up (45%) and balance (62%). CG: No changes.	
Liao et al. (2017) PEDro SS: 5	22 TG:10 CG:12 Older adults.	24wk 3d/wk. 40min.	TG: 12 min. of 7 warm-up exercise, 10 min of 7 aerobic exercise and 18 min of 6 stretching exercise. CG: Normal activity.	Biomarkers: TG and CG: Without changes.	
Lubans et al. (2013) PEDro SS: 6	44 (23M/21W) TG:22 CG:22 75.8 ± 5.8 years. Sedentary older adults.	8wk 2d/wk 2 sets of 10 reps 12-16 Borg's scale. 45-60 min	TG: Biceps, curl, triceps extension, front raises, pectoral push press, vertical row, squat, lunge, calf raises, core exercises. CG: 10.000 steps per day.	Functional capacity: TG: ↑** 30s chair stand test; ↑* balance. CG: Without changes. <b>Body Composition:</b> TG: Without changes. CG: Without changes. Biomarkers: TG: ↑* Blood pressure, heart rate. CG: Without changes.	
Martins et al. (2015) PEDro SS: 7	40 TG:20 CG:20 CG: 66.2 ± 6.6 TG: 69.1 ± 6.3 years. Untrained older adults.	8wk	TG: Bench press, row, knee flexion, hips flexion, hip extension.	<b>Strength:</b> TG: ↑** Knee strength at 120°/s (4.5%). No changes at 60°/s No changes in handgrip test CG: Without changes.	
Mikesky et al. (1994) PEDro SS: 4	62 TG:31 CG:31 71.2 years. Older adults	12wk 3d/wk 1(1-2wk)/2(3-4wk)/3(5-12wk) sets of 10 reps 60min.	TG: Chair squat, hips extension knee flexion, ankle dorsiflexion, Wall push-up, vertical row, shoulder abduction, triceps extension, biceps curl and abdominal crunch.	<b>Strength:</b> TG: ↑** KE (11.7%) and KF (10.1%) in eccentric phase. No sign. Changes in concentric phase.	

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Oh et al. (2016) PEDro SS: 6	38 TG:19 CG:19 TG 74.9 ± 15 CG: 73.5 ± 12 years. Older adults	18wk (8wk supervised y 10 wk at home) 2d/wk 3 sets of 10-20 reps 10-20 RM 60 min.	TG: Bicep curl, triceps extension, lateral and front elevation, calf raises, squats, leg press, leg abduction. CG: Dynamic and static stretching.	Max. Knee extensors strength (KE) and knee flexors (KF) (Dynamometer) Body composition (absorptiometry). Functional capacity (SPPB): static balance, gait speed, Chair rise test. Muscular quality (Strength/muscle mass)	<b>Strength:</b> TG: ↑** Strength a 60° (KE: 11.2%, KF: 18%) and 120° (KE: 9.8%, KF: 23.5%) CG: ↓** Strength a 60° (KE: 12.6%, KF: 9%) and 120° (KE: 7.9%, KF: 5.2%) <b>Body Composition:</b> TG and CG: Without changes. Functional capacity: TG: ↑** Chair raise (24%) ↑** SPPB (10.6%). ↑** gait speed (11.7%) CG: ↓** Chair raise (13.8%) and SPPB (5%). Biomarkers: Muscular quality: TG: ↓** (8.5%) CG: ↓** (11%)
Oesen et al. (2015) PEDro SS: 6	117 (103W, 14M) TG: (TG:41 STG:36) CG: (CEG:40) 82.8 ± 6 years. Older adults.	24wk 2d/wk 1-2 sets of 15 reps 7 in OMNI-RES scale 50 min.	TG y STG: Exercise for legs, back, shoulder, arms and chest. CG: CEG: Cognitive training.	Quadriceps and hamstring strength (Dynamometer). Knee extensors (KE) and flexors (KF) torque. Functional capacity: handgrip test; Chair stand test; Arm lifting test; gait speed; 6min walking test; Functional reach test (FRT) and physical activity level.	<b>Strength:</b> TG: TG and TGS: After 3 months ↑** KE and KF torque at 120°/s. After 6 months: Maintained results, except KE at 60°/s. Functional capacity: TG y CG: ↑** in all test, except in handgrip and FRT.
Papadopoulos & Jager (2016) PEDro SS: 4	28 TG: (TG:9 ECG:9) CG:10 (CEG:40) 83.8 ± 8 years. Older adults.	8wk 2d/wk 1(1-2wk)/2(3-4wk)/3(5-12wk) sets of 10 reps. 60min.	TG: Chair squat, hips and knee extension, femoral curl, calf raises, chest press, horizontal row, lateral shoulder raises, triceps extension, biceps curl. CG: 20min. of aerobic training, 10min. balance training, and 15 strength training and 10 min. mobility training. SPPB exercises test.	Functional capacity: handgrip test.	Functional capacity: TG: ↑** U&G test (ECG: -3.6s) and (TG: -3.3s) ECG and TG: ↑** Handgrip test. CG: No changes.
Park et al. (2015) PEDro SS: 1	48 (8M 36W) 73.41 ± 8.77 years. Elderly rural people	8wk 80 min.	SPPB exercises test.	Limbs Strength, balance and mobility during the execution of the previous exercises.	Functional capacity: ↑** Biceps curl (39.9%), chair stand test (25.2%), Harvard step test (37%), Balance exercises (58.5%), Sit and reach (23.1%) and ankle flex- ext. (15.4%). ↓ * tandem walk (9.1%) and time up and go (6.2%).
Park et al. (2016) PEDro SS: 3	30 TG:15 CG:15 CG: 70.9 ± 3.9 TG: 73.1 ± 3 years. Older adults.	24wk 3d/wk 3 sets (1-12wk) 5 sets (13-24wk) of 10reps (1-12wk) 15 reps (13-24wk). 60s 30-50min.	TG: Elbow flexion, lateral elevation, shoulder flexion, shoulder extension, biceps curl, chest push press, abdominal crunch, trunk extension, mini squat, leg press, calf raise, ankle inversion, trunk lateral flexion.	Functional capacity: Handgrip test, Chair stand up test, Time up & go, Sit and reach, Gait Speed and 2 min step test. Body composition (Bioimpedance). Blood pressure. Stiffness and carotid diameter.	Functional capacity: TG: ↑** Handgrip test (7%), Chair stand up test (11.6%), Time up & go (3.9%), Sit and reach (10.1%), gait speed (5.7%), 2 min step test (10.5%). CG: Without changes. Body composition: TG: ↓** % fat mass (2.4%) and ↑** % lean mass (3%). CG: Without changes. Biomarkers: TG: ↑** Systolic blood pressure (14.8%) No changes in diastolic blood pressure, Stiffness and carotid diameter. CG: Without changes.

Author & year	N° subject; Gender; Age; Characteristics of the sample	Time OF Intervention; Frequency; N° Sets/Reps; Intensity; Rest; minutes per session	Training Groups/ Exercises	Measurements: Strength; Body Composition; Functional Capacity; Biomarkers; Others	Results
Rogers et al. (2002) PEDro SS: 4	22M TG:16 CG:6 TG: 74.8 ± 8.8 CG: 74.7 ± 4.5 years. African Americans elderly women	4wk 3d/wk 3 sets of 8-15 reps 50 min.	TG: Exercises for chest, back, triceps, biceps, knee extensors, knee flexors, leg press, calf raises and feet abduction. CG: No changes.	Functional Capacity: 30s Arm lifting, 30s chair stand test, Up and go test, Handgrip test, Sit and reach test. CG: No changes.	Functional capacity: TG: ↑** 30s Arm lifting (23.8%), 30s chair stand test (18.8%) and U&G (9.8%); ↑* handgrip test (5.4%). CG: No changes.
Schober-Halper et al. (2016) PEDro SS: 6	88 TG: (TG:32 STG:26) CG: (CG:30) 84.5 (CG: (TG: 84.5) TG: (TG: 84.4 STG: 84.3)) years. Older adults.	24wk 2d/wk 1 serie de 15 reps 50 min.	TG: 1-2 exercises for legs, back, trunk, chest, shoulder and arms. CG: Cognitive exercises.	Functional capacity: Handgrip, 6MWT, chair stand and arm-lifting test. Hormonal and blood test.	Functional capacity: TG: ↑** Chair stand test; (TG: 18% after 3 months and 27% after 6 months); ↓** (STG: 15% after 6 months). TG: ↑** Arm lifting test: (TG: 24%), (STG: 61%). TG: ↑** 6MWT: (TG: 9%); STG: No changes. Handgrip test: No changes. CG: No changes. Biomarkers: Hormonal and blood test: No sign. Changes.
Skelton et al. (1995) PEDro SS: 6	40 TG: 20 CG: 20 TG: 79.5 years. Older adults.	12wk 2d/wk 3 sets of 4-8 reps 70% Heart rate. 60 min.	TG: 20 exercises for: Shoulders, abductors, adductors, hip flexors and extensors, elbow flexors and extensors and knee flexors and extensors.	Isometric and power strength of knee extensors (KE), leg extensors (LE) and elbow extensors (EE). CG: No sign. Changes. Body Composition: (Bioimpedance). Functional capacity: Handgrip test, chair stand test, Knee extensor test, sitting raising test, Gait 118m. Test, Step up test.	<b>Strength:</b> TG: ↑** Strength (27%) and power (27%) in KE, ↑** Strength (18%) and power (18%) in LE, ↓** power (22%) EE. CG: No sign. Changes. <b>Body Composition:</b> TG and CG: No changes. Functional capacity: TG and CG: No changes.
So et al. (2013) PEDro SS: 4	40 TG:23 CG:17 TG: 71.6 ± 5.5 CG: 68.4 ± 5.8 years. Older adults.	12wk 3d/wk 2-3 sets of 15-25 reps 60min.	TG: Shoulder press, front raises, lateral raises, biceps curl, triceps extension, vertical row, seated row, chest push, leg press, squat, good morning, abdominal crunch, glute bridge.	Functional capacity: Senior fitness test: Chair stand, one arm curl, 2min step, chair sit and reach, back scratch y 8 feet up and go. Body composition (Bioimpedance). Blood lipid test. Hormonal analysis in blood (GH, IGF-I, and IGF-BP3, anti-inflammatory cytokines).	Functional capacity: TG: ↑** Chair stand (20.5%), arm curl (15%), 2min step (8.1%), chair sit and reach (60.5%), back scratch (39.8%) and 8 foot up and go. ↓** (29%). CG: No changes. <b>Body Composition:</b> TG: ↓** average weight (2.1%), % fat (3.4%), BMI (1.9%) y ↓** lean mass (2.7%). CG: No changes. Biomarkers: Blood and hormonal analysis: TG and CG: No changes.
Topp et al. (1993) PEDro SS: 6	55 TG:25 CG:30 71.1 (TG: 69.2 ± 0.8 CG: 72.8 ± 1) years. Older adults.	12wk 3d/wk 1-3sets of 10 reps 60min	TG: 12 strength exercises (6 for lower limbs and 6 for upper limbs) that imply balance and gait patterns.	Knee extensors and flexors strength. Gait speed (3-10m). Balance (Romberg's test).	<b>Strength:</b> TG: ↑** Strength KE and KF. CG: No changes sign. Functional capacity: TG: ↑** gait speed and ↓** Balance. CG: No changes sign.
Topp et al. (1996) PEDro SS: 4	42 TG:21 CG:21 CG: 72.1 ± 1.31 TG: 70.8 ± 1.03 years. Older adults	14wk 3d/wk 1 sets of 10 reps.	11 exercises for arms, chest, back, and legs used when walking	Ankle dynamic Strength: Dorsiflexion and plantar flexion. Functional capacity: Postural balance and gait speed.	<b>Strength:</b> TG: ↓** Ankle dorsiflexion (14%) No changes in plantar flexion. CG: ↑* 1/2 < TG ankle dorsiflexion (7%). No changes in plantar flexion. Functional capacity: TG and CG: No sign. Changes in postural balance or gait speed.

Author & year	N° subject; Gender; Age; Characteristics of the sample	Time OF Intervention; Frequency; N° Sets/Reps; Intensity; Rest; minutes per session	Training Groups/ Exercises	Measurements: Strength; Body Composition; Functional Capacity; Biomarkers; Others	Results
Yamauchi et al. (2005) PEDro SS: 5	40 TG: 23 CG: 17 TG: 69.2 ± 5.2 CG: 70.1 ± 6.6 years. Older sedentary adults.	12wk 3d/wk (Strength and aerobic training) 4/ wk (Mobility) 20reps (Strength) and 10-12s (mobility) 80-100min.	TG: Aerobic training: Walking Strength training: 8 exercises for upper limbs and 9 exercises for lower limbs in seated position 7 Mobility training: 7 exercises for upper limbs and 8 exercises for lower limbs. CG: Mobility exercises	Functional capacity: 30s-Arm Curl Test, 30s Chair Stand Test, Back scratch, 8 foot Up and Go test, Chair sit and reach test, 12m walk test. CG: No changes.	Functional capacity: TG: ↑** Chair sit and reach (352%) and arm curl (18%). No sign. Changes in 30s Chair Stand Test, Back scratch, 8 foot Up and Go test, 12m walk test. CG: No changes.
Yang et al. (2015) PEDro SS: 5	169 TG: 84 CG: 85 71.28 ± 5.54 years. Older adults.	24wk 3d/wk 40min	TG: Elastic bands exercises. CG: Normal activity.	Functional capacity: Cardiorespiratory fitness, mobility, limbs power and endurance.	Functional capacity: TG: ↑** in all measurements. (Better results after 6 months than after 3 months) CG: ↓*.
Yasuda et al. (2015) PEDro SS: 6	14 TG: 7 CG: 7 TG: 72 ± 7 CG: 67 ± 6 years. Older adults.	12wk 2d/wk 4sets of 75 reps (30-20-15-10 reps) 30s	TG: Arm curl, triceps extension during blood restriction. CG: Arm curl, triceps extension without blood restriction.	Maximum voluntary isometric contraction (MVIC) in upper limbs. Muscular cross section (MTS) (magnetic resonance). Hemodynamic parameters. Arterial functions. Coagulation system. Muscle damage. Oxidative stress.	<b>Strength:</b> TG: ↑** MVIC Flexors (8%), and extensors. (16.5%) CG: No changes. <b>Body Composition:</b> TG: ↑** MTS: Flexors (6.7%) and extensors (7.5%) CG: No changes. Biomarkers: TG and CG: Hemodynamic parameters, Arterial functions, Coagulation system, Muscle damage, Oxidative stress.: No changes
Yasuda et al. (2016) PEDro SS: 5	30 TG: 20 (RS-BI) 10 (RS-MI) 10 CG: 10 TG: 70 ± 6 CG: 68 ± 6 years. Older adults.	12wk 2d/wk BR-MI: 5-6-8,4 in OMNI-RES scale or 70%-90% de 1RM; BR-LI: 5-9 in OMNI-RES scale.	TG: Squat, leg press and knee extension with blood restriction from middle (BR-MI) or low (BR-LI) intensity.	1RM in leg press and knee extension. Maximum voluntary isometric contraction (MVIC) in lower limbs. Body composition. Muscular cross section (MTS) (magnetic resonance). Hemodynamic parameters. Arterial functions. Coagulation system. Muscle damage. Oxidative stress.	<b>Strength:</b> TG: ↑** MVIC knee extensors (BR-BI: 13.7%) and 1RM knee extensors (BR-LI: 7.6%) BR-MI and CG: No changes. TG: ↑** 1RM leg press (BR-LI: 16.4%) and (BR-MI: 17.6%). CG: No changes. <b>Body Composition:</b> TG and CG: No changes in BMI, weight and height. TG: ↑** MTS Quadriceps (BR-LI: 6.9%), ↑* (BR-MI: 1.5%). CG: ↓* MTS Quadriceps (2.2%). Biomarkers: TG and CG: Hemodynamic parameters, Arterial functions, Coagulation system, Muscle damage, Oxidative stress.: No changes.
Yu et al. (2015) PEDro SS: 3	30 TG: 15 CG: 15 75.46 ± 7.36 years. Older adults.	3wk 2d/wk 3sets of 10 reps. 60min.	TG: Diagonal raises, abduction exercises, adduction exercises, lateral step, femoral standing curl.	Hamstring and quadriceps power. Functional capacity: timed up and go and gait speed (6 and 12 m.).	<b>Strength:</b> TG: ↑** quadriceps (24%) and hamstring (15.9%) power. CG: No changes. Functional capacity: TG: ↑** U&G test (11.1%) ↑** Gait speed (15%) CG: No changes.

\*\* : Significant change (p < 0.05); \* : Change; † : Increases; ‡ : Decreases; ↓ : Decreases; ↑ : Increases; M: Men; W: Women; CG: Control group; TG: Training group; FWG: Free weight group; EBG: Elastic bands group; BWG: Body weight group; BBG: Bodyblade group; LMITG: Lower members training group; UMTG: Upper members training group; AAG: Aquagobic group; MTG: Machines training group; STG: Supplementation training group; CTG: Cognitive training group; ECG: Education classes group; CGM: Control group men; TGM: Training group women; TAGW: Training group women; ADIDFG: Aquatic devices that increase drag forces group; AAG: An attempt group; TAG: Two attempt group; CEG: Cognitive exercise group; BR-MI: Blood restriction middle intensity; BR-LI: Blood restriction low intensity; KE: Knee extensors; KF: Knee flexors; LE: Leg extensors; EE: Elbow extensors; G65: 65 years old group; G75: 75 years old group. PEDro SS: PEDro Scale Score (Methodological quality of the studies -Maher et al., 2003-)

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