

Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis

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Abstract

Given the practicality and low cost of using elastic resistance in training for different populations and its effectiveness in a range of outcomes, a comparison with conventional devices could clarify and quantify the benefits provided by both mode. To compare the effects of resistance training with elastic devices (tubes and Thera-Bands) and conventional devices (weight machines and dumbbells) on the outcome muscular strength. A search was performed in the databases PubMed/MEDLINE, EMBASE, PEDro (Physiotherapy Evidence Database), and CENTRAL (Cochrane Central Register of Controlled Trials) from the earliest records up to 20 December 2017. Data were pooled into a meta-analysis and described as standardized mean difference with a 95% confidence interval (registration number: CRD42016042152). Eight studies were included. The results of the meta-analysis demonstrated no superiority between the methods analyzed for upper limb (standardized mean difference = -0.011; 95% confidence interval = -0.40, 0.19; $p = 0.48$) or lower limb muscular strength (standardized mean difference = 0.09; 95% confidence interval = -0.18, 0.35; $p = 0.52$). Elastic resistance training is able to promote similar strength gains to conventional resistance training, in different population profiles and using diverse protocols.

Keywords

Thera-Band, physiotherapy, dumbbells, weight machine, accessibility

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Introduction

The use of elastic resistance training (ERT) as a modality and clinical tool became popular in the 1980 and has been increasing in recent years. Its benefits include improved functional capacity, increased strength and endurance with increased muscle activation, and improved body composition, potency, and quality of life.^{1–9} In addition, it is practical to use, being low cost and able to be used in different places.

Studies have demonstrated similar outcomes in training response using conventional resistance training (CRT) and ERT in different populations. Ramos et al.³ investigated the effects of training with both mode in patients with moderate chronic obstructive pulmonary disease (COPD) and did not observe differences between the groups in relation to strength gains in the analyzed population. In this study, muscle strength was measured using a digital dynamometer. The same was observed in sedentary adolescents of both sexes,¹

sedentary healthy adults,¹⁰ and high-performance athletes with a similar strength level between them.²

Strength training is defined as the practice of systematic repetitions capable of altering the shape and function of tissues. In this scenario, in order to obtain good levels of performance, the proposed training should be based on the biological

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principles of training. From this, several studies^{1–10} demonstrate that strength training is capable of promoting outcomes related to functionality, balance, cardiovascular conditioning, disposition, quality of life, and, consequently, less probability on the incidence of chronic injuries.

The benefits of strength conditioning on several local and systemic variables have also been highlighted in maintenance and rehabilitation programs. Despite the widespread use of conventional devices, such as weight machines and dumbbells, and their results regarding strength gains,^{11–13} it is believed that, on average, 50% of people who adopt this type of training give up during the first year of practice. These data are justified by factors related to financial cost, logistical difficulty, and lack of time, which make its use unfeasible in certain scenarios.¹⁴ Thus, strategies that may allow greater adherence and accessibility with similar results deserve specific scientific exploration.

Thus, considering the benefits provided by the use of elastic devices, a systematic review with meta-analysis, comparing with conventional devices could clarify and quantify the benefits provided by both modes. Therefore, the objective of this study was to describe the effects of ERT training compared to CRT training on muscular strength, in different population profiles.

Methods

This systematic review was recorded in the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD42016042152. The guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were followed in order to report the items necessary for a good quality systematic review and meta-analysis.

Search strategies

The studies were selected from five databases; PubMed/MEDLINE, PEDro (Physiotherapy Evidence Database), EMBASE, LILACS, and CENTRAL (Cochrane Central Register of Controlled Trials) from the earliest records until 20 December 2017. The search strategy used a combination of the following Medical Subject Headings (MeSH) terms: randomized controlled trials, elastic bands and performance (details of the search strategy in Supplemental Appendix 1). A manual search was carried out in the references of the eligible studies to complement the electronic searches.

There was no restriction on the condition of the sample (age, sex, clinical condition), publication date, or language of the studies.

Study selection

The selected studies were compared for training performed using ERT training (tubes and bands) with CRT (weight machines and dumbbells), regardless of complementary

training performed concomitantly, provided it was similar for both groups. To be included, the studies were required to meet the following criteria: (1) randomized clinical trial comparing training performed with elastic resistance with training using weight machines and/or free weights and (2) muscular strength as an outcome. All types of elastic resistance were eligible for inclusion.

The study selection process was performed by two independent researchers (J.S.S.L., J.K.M.) and conducted in stages (title, abstract, and full text), as represented in the flowchart (Figure 1). In the case of disagreement, a third researcher was contacted (A.F.M.).

Data extraction

Relevant information about the characteristics of the study such as the design, characteristics of the participants, description of the training protocols of the groups, evaluated outcomes, and the PEDro scale were extracted using a standardized form. This stage was conducted by two authors (J.S.S.L., J.K.M.) and again, in case of divergences, a third researcher was contacted (A.F.M.).

The final values of mean, standard deviation, and sample size were extracted, as in the other steps, by two independent researchers (J.S.S.L., J.K.M.). In the case of studies that did not report standard deviation, these data were calculated using methods recommended by the Cochrane Handbook for Systematic Reviews of Interventions. As an example, in the study by Colado et al.,⁴ the standard deviation was obtained from the standard error of the mean multiplied by the square root of the sample size.

When more than one muscle group was evaluated by the same article, the data obtained from the muscle group with the least effect were chosen, thus avoiding interpretation risks.

Quality assessment

The included studies were evaluated for their methodological quality using the PEDro scale (0–10). This process was carried out by two independent researchers (J.S.S.L., J.K.M.). Each study was evaluated regarding the eligibility criteria, random allocation, secret allocation, baseline comparisons, blinding of subjects, therapists, evaluators, follow-up with less than 15% loss, adequate treatment according to allocation or intention to treat, intergroup statistical comparisons, and measures of precision and variability.

In the case of previously evaluated clinical trials, the value of the PEDro scale contained in the inherent database was used. Methodological quality was not considered an inclusion criterion.

Data synthesis and analysis

Data were analyzed using Review Manager (RevMan, version 5.3.5), grouped in the meta-analysis and reported as

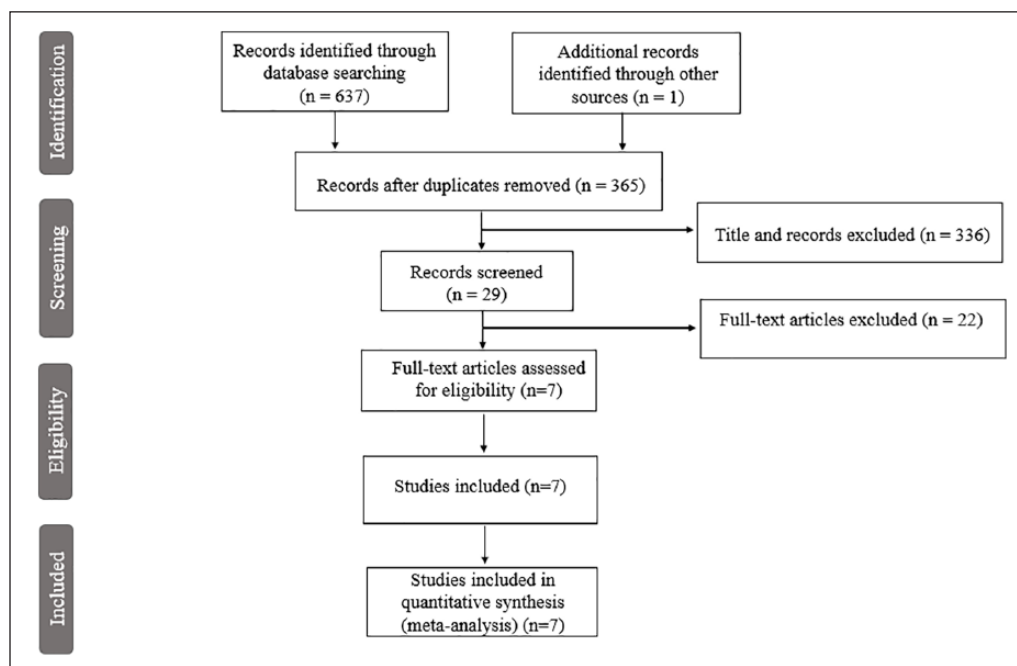


Figure 1. Flowchart for selection of studies.

standardized mean difference (SMD) with a 95% confidence interval (CI). The fixed effect model was adopted due to the homogeneity of the included studies, reported through the I^2 value.

In addition, an exploratory analysis was performed a posteriori grouping studies that evaluated upper limbs and lower limbs, studies that evaluated populations in a pathological condition, and studies that evaluating healthy subjects. The analysis was performed using the same data extraction and analysis procedures as the main analysis.

Results

Characteristics of the studies

The search carried out in the databases identified a total of 365 articles, of which 23 were considered eligible. Of these, 10 studies were excluded as they did not compare training between elastic devices and conventional machines, three did not use muscular strength as an outcome, and two did not perform training with elastic devices. Thus, eight articles (Table 1) corresponded to the inclusion criteria, comprising a total of 224 individuals aged between 15 and 88 years. All included studies were composed of subjects who had a systematic habit of performing strength training. Regarding health, the sample varied from physically active individuals^{1,4,6} and athletes² to individuals with coronary heart disease⁷ and moderate COPD.^{3,8} The publication dates ranged from 2003 to 2016. No articles appropriate for inclusion were found in the review of bibliographic references. Figure 1 illustrates the flowchart of the information described above.

The methods used to assess strength within the different studies also were explored in previous studies, which verified their reliability and validity. In addition, all included studies explicitly stated that the purpose of the training performed was for the outcome gain of muscle strength.

The included studies were conducted in different countries, such as Brazil,^{3,8} Spain,^{4,6} the United States,² France,⁷ and Australia.¹

All studies used weight machines as the traditional tool¹⁻⁶ and only one study additionally used free weights.⁴ The Thera-Band was used as an elastic device by four studies,^{4,6,7} while the others used elastic tubes.^{1,2,3,8}

The duration of training ranged from 4 to 12 weeks, two to five times a week. Only two studies performed routine training, concomitantly with the training analyzed.^{2,7} Routine training refers to another type of physical activity performed continuously by the specific populations prior to the study and not interrupted during the study. For example, the Ghigiarelli et al.² study includes athletes. In this case, routine training characterized the practice of sports practiced by these athletes. Vanbiervliet et al.⁷ study, however, includes cardiopathy, in which routine training was characterized by sessions of cardiovascular rehabilitation. The characteristics of the included studies are summarized in Figure 1.

Methodological quality of included studies

The evaluation of the methodological quality of the included studies using the PEDro scale reported an average of 6.5. One study³ scored 8, four^{1,6} scored 7, one scored 6, and two² scored 5 on the scale, thus classifying the articles as “moderate

Table 1. Characteristics of the included studies.

Study	Characteristics of participants	Exercise protocol	Intervention	Outcomes	Muscle group/exercise analyzed	Muscle group/exercise analyzed (exploratory analysis)	PEDro score
Vanbiervliet et al. ⁷	N=26 males; patients with coronary disease (age: 45–65 years)	4 weeks 3 sessions/week	CRT: weightlifting exercises ERT: elastic bands	Muscle strength (IRM)	LL	UL LL	7
Ghigiarelli et al. ²	N=24 males; soccer players (age: 20.27 ± 1.1 years)	7 weeks 4–5 sessions/week	CRT: weight machine ERT: elastic band	Maximum muscular strength (IRM)	Bench press exercise	UL: bench press exercise	5
Colado et al. ⁴	N=23 females; physically fit (age: 21.79 ± 0.7 years)	8 weeks 2–4 sessions/week	CRT: weight machine and free weights ERT: Thera-Band	Maximum isometric voluntary contraction (digital dynamometer)	Vertical stroke exercise	UL: vertical stroke exercise LL: squat exercise	6
Lubans et al. ¹	N=78 male and female; adolescents (age: 15.0 ± 0.7 years)	8 weeks 2 sessions/week	CRT: free weights ERT: elastic tubing	Maximal muscular strength (IRM)	Leg press exercise	UL: bench press exercise LL: leg press exercise	7
Ramos et al. ³	N=34 patients with moderate COPD CT: 67 (60–69) years ETT: 66 (61–68) years	8 weeks 3 sessions/week	CRT: weight machine ERT: elastic tubing	Muscle strength (digital dynamometer)	Shoulder abduction	UL: shoulder abduction LL: knee extension	8
Silva et al. ⁸	N=19 patients with moderate COPD	12 weeks 3 sessions/week	CRT: weight machine ERT: elastic tubing	Muscle strength (digital dynamometer)	Elbow flexion and knee extension	UL LL	7
Calatayud et al. ⁶	N=20 university students	5 weeks 2 sessions/week	CRT: bench press ERT: elastic band	Muscle strength (IRM)	Bench press and band push-up	UL	5

CRT: conventional resistance training; ERT: elastic resistance training; IRM: one maximum-repetition; UL: upper limb; LL: lower limb; COPD: chronic obstructive pulmonary disease.

quality” according to the classification used in the review and meta-analysis study by Machado et al.¹⁵ (Table 2).

Effects of ERT and CRT on muscular strength

The results of the meta-analysis for the upper and lower limbs, respectively, showed that there is no superiority between training performed with elastic resistance and training with weight machines and/or free weights on strength gain (upper limbs: SMD=−0.11; 95% CI=−0.40, 0.19; $p=0.48$ and lower limbs: SMD=0.09; 95% CI=−0.18, 0.35; $p=0.52$) (Figures 2 and 3).

Secondary analyses were performed in order to group specific populations. There were no statistically significant differences between training with ERT and CRT (upper limbs: SMD=−0.07; 95% CI=−0.52, 0.37; $p=0.74$ and lower limbs: SMD=−0.19; 95% CI=−0.63, 0.25; $p=0.40$) for patients with chronic diseases and healthy individuals (upper limbs: SMD=−0.07; 95% CI=−0.52, 0.37; $p=0.74$

and lower limbs: SMD=−0.19; 95% CI=−0.63, 0.37; $p=0.74$).

Discussion

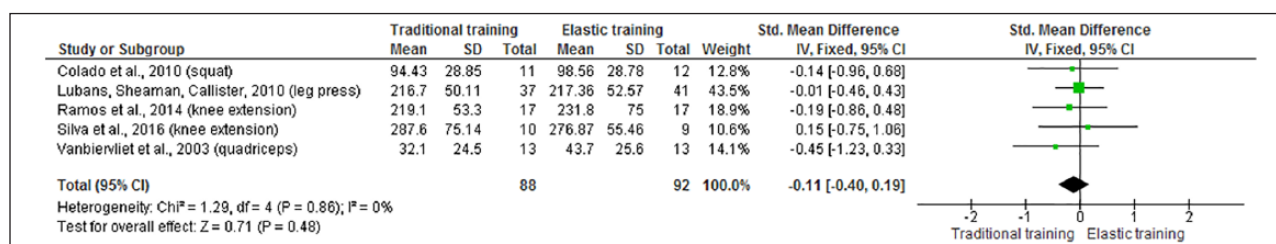
The outcomes of this systematic review and meta-analysis demonstrated that training with elastic resistance provide strength gains similar to training with conventional resistance.

The findings are in accordance with systematic reviews with meta-analysis that demonstrated positive effects on muscular strength gain from the use of elastic resistance when compared with a control group in the elderly¹⁶ and individuals with osteoarthritis¹⁷ and fibromyalgia.¹⁸

Diretrizes¹⁹ indicated that different modalities of physical training that consider the principles of training as well as periodization are capable of promoting alterations in the shape and function of body tissues, which could justify the similarity of the findings, since the included studies followed training protocols with periodization dynamics.

Table 2. PEDro scores of included studies.

Study	Eligibility criteria specified	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	Adequate follow-up	Intention-to-treat analysis	Between-group comparisons	Point estimates and variability	Total (0–10)
Vanbiervliet et al. ⁷	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	7
Ghigiarelli et al. ²	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5
Colado et al. ⁴ 2010	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	6
Lubans et al. ¹	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	7
Ramos et al. ³	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	8
Silva et al. ⁸	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	7
Calatayud et al. ⁶	No	Yes	No	Yes	No	No	No	Yes	No	Yes	Yes	5

**Figure 2.** Forest plot illustrating the effects of training with elastic devices versus conventional devices on the outcome muscular strength in the upper limbs.

SD: standard deviation; Std: standardized; CI: confidence interval.

Regarding the above, the results provide a rationale for the possibility of practical applications using ERT, when the objective includes an increase in muscular strength, broadening the characteristics of individuals who could achieve health-related benefits from the emphasized method, because the studies included meta-analysis that approached different population profiles, with different preventive and therapeutic conditions. Besides that, studies included^{1–8} have demonstrated similar effects also for outcomes related to resistance, power, balance, quality of life, and body composition. This fact potentiates the possibilities of using ERT in clinical and scientific contexts in healthy and pathological populations.

A review¹² compared muscle activation between exercises with elastic resistance and isokinetic resistance. The authors verified that there were no significant differences between the analyzed groups and also pointed out that these results can be justified by the biomechanics of movement in each of the analyzed modalities, which despite being different are capable of producing similar effects. These findings are similar to those observed in this study, and both found similar results, although the methods compared are composed of distinct biomechanical mechanisms.

Although its use has increased in recent years, studies that use the ERT modality report difficulties related to intensity control in this type of exercise.^{2,20} In this sense, authors employ subjective effort perception scales to control intensity and prescription parameters.^{1,4,21,22} Other strategies employed include progression of intensity through stress caused by stretching or elastic devices classified by different colors.²³

Lubans et al.¹ study demonstrated a lower dropout rate in exercises performed with ERT in adolescents. The evidence presented suggests a possible favoritism for protocols consisting of ERT exercises. On the contrary, it should not be discarded that such finding may have been observed by chance, in response to specific logistical questions of the analyzed population.²⁴

To the authors' knowledge, this is the first systematic review and meta-analysis to investigate the effects of resistance training for strength gain performed with ERT versus CRT. Regarding the limitations of the study, we highlight the variety of protocols and the lack of standardization of training load performed with elastic resistance. In this sense, although the literature on the subject is vast, published studies demonstrate low quality and display important gaps in

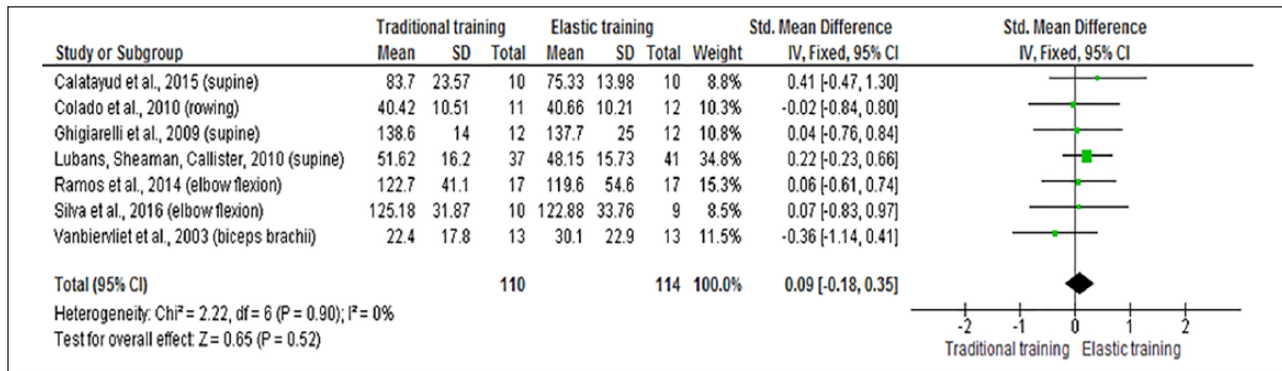


Figure 3. Forest plot illustrating the effects of training with elastic devices versus conventional devices on the outcome muscular strength in the lower limbs.

SD: standard deviation; Std: standardized; CI: confidence interval.

the standardization of load dynamics and training prescription. Second, the observed variation between the outcome measures inserted in the meta-analysis also characterizes a limitation. Therefore, it is suggested that new review studies investigate the efficacy of evaluation methods, control of intensity, and different populations and variables. In addition, few studies were included in this review, which may hamper more reliable evidence of quality. On the contrary, the strength of the present review is the search strategy used, which was without restrictions.

Finally, we reiterate the importance of the findings for clinical and scientific practice, providing important evidence on an increasingly popular modality of physical training which is low cost and accessible.²⁴ Studies with themes related to “home-based exercises” are gaining increasing interest in the scientific community. In this scenario, the described modality allows protocols to be executed initially with supervision and later at home, fulfilling specific needs.

Conclusion

Evidence from this study suggests that resistance training with elastic devices provides similar strength gains when compared to resistance training performed from conventional devices. These findings allow coaches, physiotherapists, and even patients to opt to use devices with low costs, ease of handling, and which can be used in different places, such as elastic devices, for maintenance and gain in muscular strength.

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Supplemental material

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