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Review Article

Impact of Elastic Band Training on Functional Outcomes and Muscle Mass in the Elderly with Sarcopenia: A Meta-Analysis

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SUMMARY

Although resistance exercise is a well-known and accepted method for treatment of sarcopenia, its effectiveness varies. Through this meta-analysis, we investigated the effectiveness of elastic band resistance exercises in improving the physical performance of individuals with sarcopenia. Well-controlled prospective clinical trials investigating the treatment effect of elastic band training for sarcopenia were found from the PubMed, Embase, Cochrane Library, and Google scholar databases up to July 2021 by using "sarcopenia" and "elastic band" as the search terms. Four studies — three randomized controlled trials and one quasiexperimental study — met our inclusion criteria. A total of 231 older adults with sarcopenia were included. After 12 weeks of training, significant improvements were observed in the timed up and go test result, maximal grip strength, gait speed, and appendicular skeletal muscle index in the elastic band training group compared with the control group (95% CI, –2.93 to –1.41, 1.14 to 5.27, –0.06 to –0.02, and 0.03 to 0.26, respectively). However, no significant differences were observed in performance in the 6-minute-walk test (95% CI, –11.00 to 27.00). Elastic band resistance training may benefit older adults with sarcopenia. Further randomized controlled studies with larger samples and longer follow-up periods are warranted to strengthen the clinical evidence regarding the effectiveness of elastic band training for sarcopenia.

1. Introduction

Sarcopenia is characterized by progressive and generalized loss of skeletal muscle mass and strength.[1–4] The prevalence of sarcopenia among healthy older adults is approximately 15%,[5] but it can be up to 44% in older adults with hip fracture.[6] Sarcopenia is associated with adverse health outcomes in older adults, including increased risk of falls and incidence of hip fracture;[7] reduced performance in activities of daily living; and increased risks of hospitalization, institutionalization, and mortality.[8,9] Sarcopenia is also related to the severity of cardiovascular disease and cancer and may affect the survival outcomes of patients with these conditions.[10] Methods and mechanisms for preventing and weakening the impact of sarcopenia on older adults warrant further exploration.

Current treatment for sarcopenia focuses on resistance exercise.[11] Resistance exercise enhances the muscle mass and physical function of the elderly with sarcopenia. However, the actual training content of the exercise varies. Instrumented resistance exercise has generally been well accepted and includes training with barbells, dumbbells, kettlebells, or other gym machines.[12–14] Elastic band training (EBT) was found to be an easily accessible and convenient approach for home-based resistance exercise in elderly adults.[15,16] EBT has several advantages. First, EBT can provide muscle training efficiency and self-perceived efficacy comparable to those offered by free-weight resistance training.[17] Second, excessive muscle training may be dangerous for older adults with sarcopenia because these individuals usually have coexisting osteoporosis, giving them higher fracture risk. EBT was proven to be safe and effective for muscle training in older women with osteosarcopenic adiposity.[18] Although EBT is a potential treatment for fragile and older adults with sarcopenia, strong evidence regarding its effectiveness in treating sarcopenia is lacking.

EBT was hypothesized to be effective in facilitating the physical performance of the elderly with sarcopenia. In this study, we conducted a meta-analysis on the currently available evidence to investigate the clinical effectiveness and safety of EBT in older adults with sarcopenia.

2. Methods

2.1. Search strategy

All candidate studies were initially identified by conducting a

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systematic review of online databases — PubMed, Cochrane Library, Embase, and Google scholar — until July 2021 by using the search terms “sarcopenia” and “elastic band.” Randomized controlled trials (RCTs) and quasi-experimental studies that evaluated the outcomes of older adults with sarcopenia who were undergoing EBT and controls were reviewed. This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[19]

2.2. Study selection and data extraction

Studies with clinical trials; papers written in English or not written in English and translated into English; those with participants having sarcopenia; those in which resistance exercises were performed using solely EBT; and those that reported the outcome measures of physical function, including mobility and walking capability, were included.

Studies that included *in vitro* or *in vivo* trials conducted in an animal model and those with a non-RCT design — such as case reports, case series, and prospectively designed trials without a comparison group — were excluded.

2.3. Data extraction and management

To avoid bias, two authors (C-HC and Y-HC) independently searched for and examined the articles. In the event of disagreement between the two authors, another author (H-HS) would help to resolve the issue and make a final decision. Data collected were author(s), year of publication, study design and country, participants' characteristics, the type of resistance training and training protocol, and the outcome measurements.

2.4. Outcome measurements

The primary outcome was the change in the timed up and go (TUG) test result after the 12-week study duration. The secondary outcomes were changes in maximal grip strength, gait speed, 6-minute walk test (6MWT) result, and appendicular skeletal mass index (ASMI) from baseline to 12 weeks. Any adverse effects during the EBT were recorded.

The TUG test assesses an individual's balance, turning, walking, and sit-to-stand ability; the purpose of this test is to determine the muscle power of the lower extremities and fall risk.[20] The gait speed test, which also evaluates the muscle power of the lower extremities, has not only been recommended as a potentially useful clinical indicator of well-being among older adults but has also been shown to be associated with their survival.[21,22] Grip strength is associated with upper body strength and overall strength and is also a reliable indicator of many health conditions associated with aging.[23–29] The 6MWT was designed to assess the integrated global response of multiple cardiopulmonary and musculoskeletal systems involved in exercise.[24] Appendicular skeletal muscle mass was defined as the sum of the muscle mass of the four limbs, and the ASMI was calculated as the appendicular skeletal muscle mass divided by the square of body height (kg/m^2) in accordance with the European Working Group for Sarcopenia guidelines.[10]

2.5. Statistical analysis

Descriptive statistics were used to describe the extracted data, and RevMan software version 5.3 was used to perform the meta-analysis. The mean difference between values before and after the experiment was calculated for every study parameter. Then, the calculated mean difference of the parameters in the elastic band group was compared with that in the control group. A significance level of 5% was used for all statistical procedures. Heterogeneity among the included studies was assessed using the chi-squared test (χ^2), Cochrane Q, and I^2 statistic tests. A Cochrane Q p value < 0.1 and I^2 values > 50% indicated significant heterogeneity. A random-effects model was selected on the basis of the amount of heterogeneity.

2.6. Appraisal of methodological quality and publication bias

Two authors independently assessed the methodological quality of each reviewed study by using the Cochrane Collaboration's tool for assessing the risk of bias in randomized trials.[19] The RCTs were awarded an overall risk of bias grade of high, some, or low. This grade was calculated by assessing the following six domains: bias arising from the randomization process, bias owing to deviation from the intended intervention, bias in the measurement of the outcome, bias owing to missing outcome data, bias in the selection of reported results, and other bias. Possible publication bias was visually checked using a funnel plot. We did not perform Egger's test because our meta-analysis did not involve more than 10 studies.

3. Results

3.1. Study selection

From the 44 studies identified through the literature search, 21 were identified as potentially relevant. After complete review and data abstraction, 13 studies were excluded because they did not meet the inclusion criteria, three were duplicated publications and trials, and one had not yet completed data collection. The excluded studies and reasons are summarized in the Supplemental Table 1. The remaining four studies met the inclusion criteria.[30–33] These four eligible studies used both qualitative and quantitative methods. The flowchart depicted in Figure 1 reflects the precise process of literature search and selection.

3.2. Study characteristics

This meta-analysis enrolled 231 participants with sarcopenia; 124 participants were assigned to the EBT group and 107 participants were assigned to the control group. The mean age of the enrolled participants was 68.7 (range, 64.0–73.4) years. The mean ages of the participants in the EBT and control group were 69.0 years and 68.3 years, respectively.

The sex ratio of the participants in the included studies was summarized in Table 1. In two of enrolled studies, all participants were female;[30,31] one study included 29 female participants in EBT group (72.5% in total 40 participants) and 29 female participants in control group (78.4% in total 37 participants);[33] one study did not mentioned sex ratio in each arms, but 18 women were enrolled in total participants (27.69% in total 65 participants).[32]

The four studies were conducted in different countries, namely Taiwan, Iran, Hong Kong, and Malaysia. Details of the four trials are also provided in Table 1.

3.3. Exercise protocol

Among the four enrolled studies, two studies compared EBT and

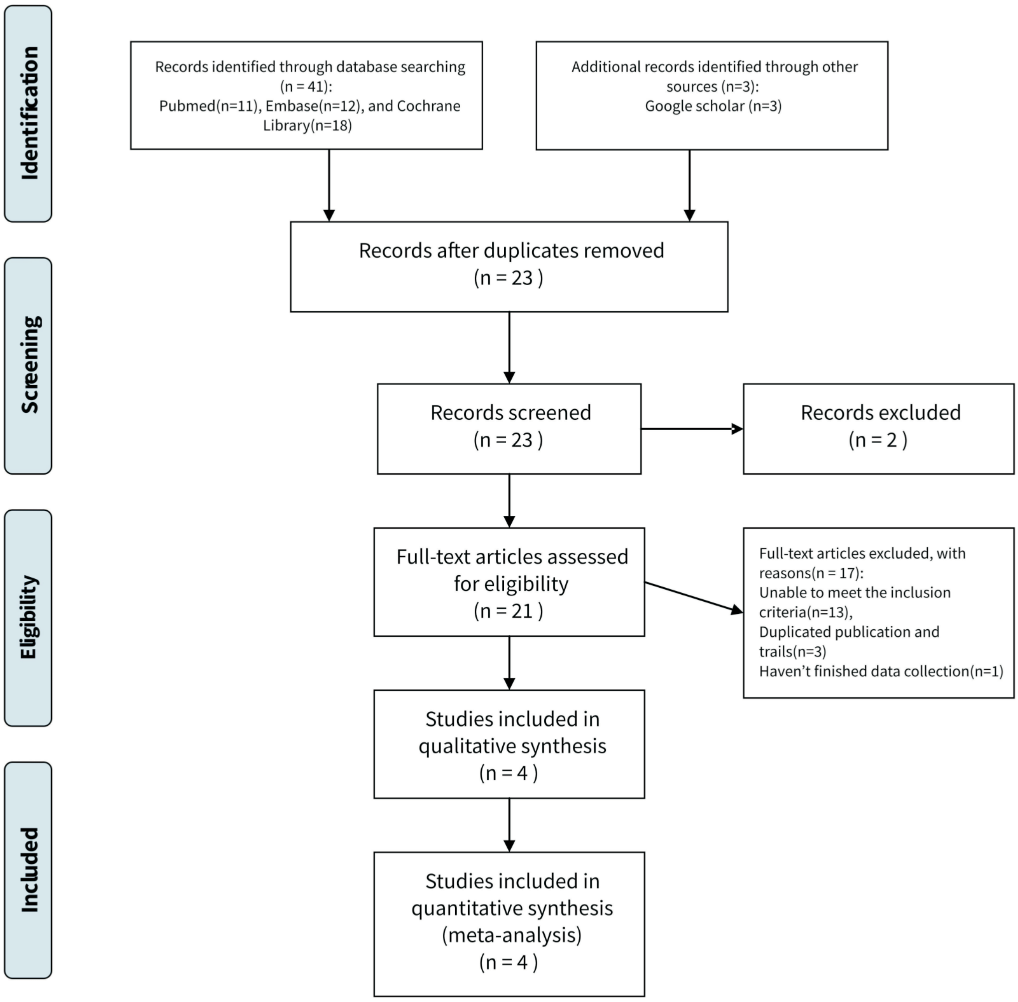

Figure 1. Flow diagram of study selection.

control groups;[30,31] one study compared a control group, EBT group, protein supplementation group, and a group given both EBT and protein supplementation;[32] and the other study compared an EBT group, a waitlist control group, and a group given both EBT and nutrition supplementation.[33] However, because the present study was designed to elucidate the effects of EBT on physical performance, groups that combined EBT with supplementation or used supplementation alone were excluded. The training periods and details of exercise type, intensity, and duration in the included studies are summarized in Supplemental Table 2.

3.4. Methodological quality of the included studies

Supplemental Figure 1 presents the methodological quality of the included trials. All included studies had low risk of bias. Possible publication bias was visually checked using a funnel plot in Supplemental Figure 2.

3.5. Primary outcomes

3.5.1. TUG test

Performance in the TUG test was assessed in three of the four studies immediately after 12 weeks of the intervention,[30–32] and a significant difference was discovered between the two groups (Figure 2). The mean differences in the time taken for the TUG test in these three studies were –2.36 s (95% confidence interval [CI], –3.07 to –1.65), –1.60 s (95% CI, –2.23 to 0.97), and –3.16 s (95% CI, –4.73 to –1.59), respectively. The pooled mean difference in the TUG test was –2.17 s (95% CI, –2.93 to –1.41; I^2 = 57%).

3.6. Secondary outcomes

The maximal grip strength test, gait speed test, and ASMI results differed significantly between the EBT and control groups. However, no significant intergroup difference was found in the 6MWT between the two groups.

3.6.1. Maximal grip strength test

Three studies provided data regarding the maximal grip strength of the EBT and control groups.[30,32,33] The results of the meta-analysis showed that the EBT group exhibited greater improvement in maximal grip strength. The mean difference between the groups was 3.20 kg (95% CI, 1.14 to 5.27; I^2 = 82%; Figurre 3).

3.6.2. Gait speed test

The gait speed test was performed in three studies.[30,31,33] Participants in the EBT group showed greater improvement in gait speed than those in the control group. The mean difference was –0.04 m/s (95% CI, –0.06 to –0.02; I^2 = 0%; Figure 4).

3.6.3. ASMI

The ASMI before and after intervention was calculated in two

Table 1
Detailed characteristics of the selected studies.

Study	Years	Study sites	Type of study	Total number/elastic band group/ control group	Sex (female ratio)	Age (years old ± SD)	Diagnostic criteria for sarcopenia	Intervention	Intervention time(frequency/ duration)	Measured time point	Outcomes
Liao et al.[31]	2018	Single center in Taiwan	RCT; SB	56/33/23	100%	67.3 ± 5.18	SMI that was two standard deviations lower than reference value (SMI < 27.6%) proposed by Janssen et al.[4]	40 minutes of elatic band training (using Theraband, Hygenic Co., Akron, OH, USA).	3 times/wk for 12 weeks	baseline; 12 weeks; 36 weeks	ASMI, GS, 3m-TUG
Banitalebi et al.[30]	2020	Single center in Iran	RCT; SB	63/32/31	100%	64.08 ± 3.56	SMI with a cutoff value ≤ 28% (or ≤ 7.76 kg/m^2) in reference with Hita-Contreras et al.[3]	60 minutes of elastic band training (using Thera-Band®, The Hygienic Corporation, Akron, OH, USA)	3 times/wk for 12 weeks	baseline; 12 weeks	GS, 3 m-TUG, 6MWT, MGST
Zhu et al.[33]	2019	Single center in Hong Kong	RCT; SB	77/40/37	75% (58/77)	73.4 ± 6.92	1. Asia working group for sarcopenia[2]: ASMI measurements using DXA, Men: < 7.0 kg/m^2 Women: < 5.4 kg/m^2 2. Handgrip strength (< 26 kg for men and < 18 kg for women), 3. Usual gait speed (< 0.8 m/s)	20-30 minutes of elastic band training (using TheraBand)	3 times/wk for 12 weeks	baseline; 12weeks; 24 weeks	ASMI, GS, MGST, 6MWT
Shahar et al.[32]	2013	Single center in Malaysia	Quasi-experimental study	35/19/16	27.6% (18/65)	68.60 ± 5.53	SMI: (Men: < 10.75 kg/m^2, Women: < 6.75 kg/m^2) in reference with Janssen et al.[4]	30 minutes of elastic band training (using TheraBand® exercise bands, Hygenic Corporation, OH, USA)	2 times/wk for 12 weeks	baselin; 6 weeks; 12 weeks	MGST, 8 foot-TUG, 6MWT

Abbreviation: ASMI = appendicular skeletal muscle index (appendicular lean mass/height^2, kg/m^2); DXA = dual-energy X-ray absorptiometry; GS = gait speed; MGST = maximum grip strenghth test; RCT = randomized controlled trial; SB = single blinded; SMI = skeletal muscle mass index (whole body skeletal muscle mass/weight, %) = (TSM/total body mass × 100%) or (appendicular skeleton mass/height^2, kg/m^2); TUG = timed up and go test; 6MWT = 6-minute-walk test.

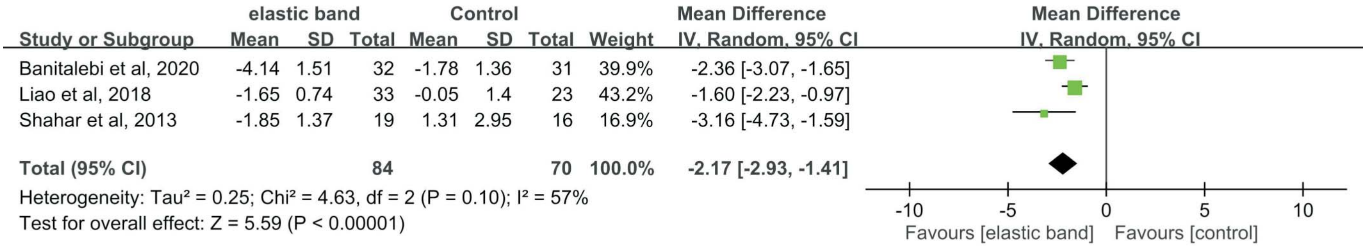

Figure 2. Forest plot of timed up and go test between elastic band training group and control group at 12 weeks after intervention.

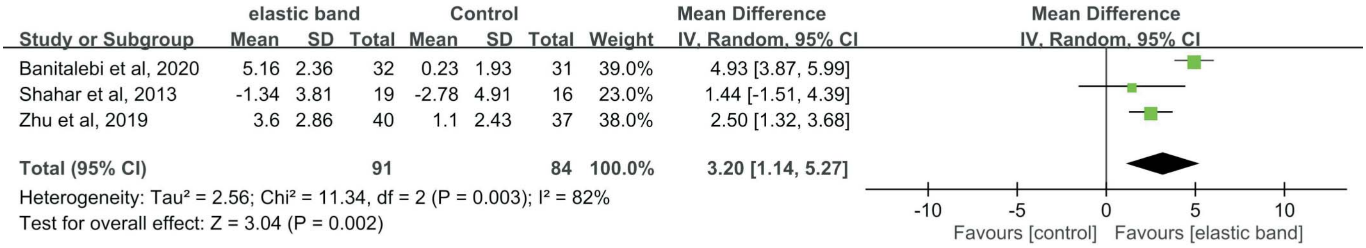

Figure 3. Forest plot of maximal grip strength test between elastic band training group and control group at 12 weeks after intervention.

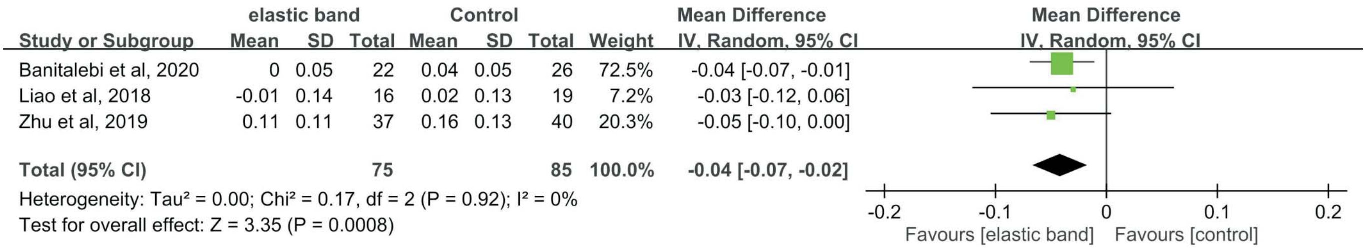

Figure 4. Forest plot of gait speed test between elastic band training group and control group at 12 weeks after intervention.

studies.[31,33] Participants in the EBT group had a greater gain in the ASMI than those in the control group after 12 weeks of the intervention. The mean difference was 0.14 kg (95% CI, 0.03 to 0.26; I^2 = 0%; Figure 5).

3.6.4. 6MWT

Three studies used the 6MWT as an outcome to compare the changes in the EBT and control groups,[30,32,33] but the differences between the two groups were not significant. The mean difference was 8.00 m (95% CI, −11.00 to 27.00; I^2 = 47%; Figure 6).

3.7. Adverse effects

No significant adverse events were reported. However, a few participants (25%) in the EBT group reported muscle soreness, knee pain, and shoulder pain in the first three sessions of training in one of the four included studies.[30]

4. Discussion

This meta-analysis revealed that EBT significantly enhanced the physical performance of elderly individuals with sarcopenia in re-

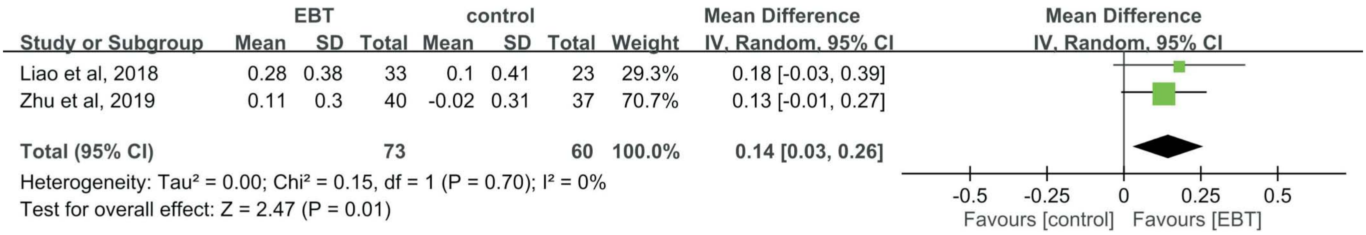

Figure 5. Forest plot of appendicular skeletal muscle index between elastic band training group and control group at 12 weeks after intervention.

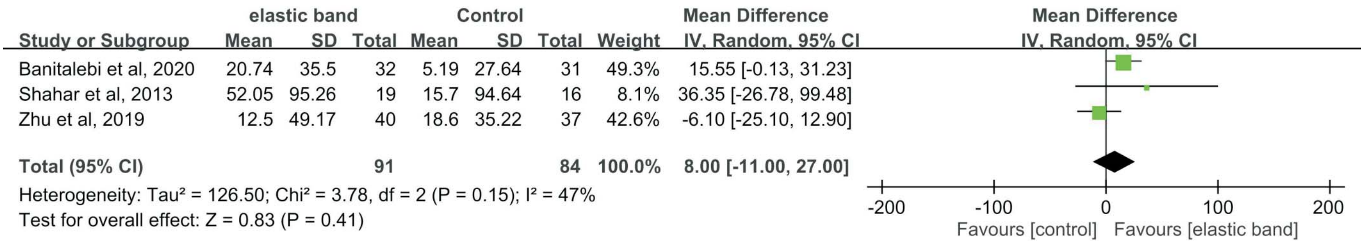

Figure 6. Forest plot of 6-minute-walk test between elastic band training group and control group at 12 weeks after intervention.

gards the TUG test, gait speed, and maximal grip strength. In addition, muscle mass, which was represented by the ASMI, was also improved after EBT. However, EBT did not result in significantly better performance in the 6MWT in the EBT group compared with the control group. No significant adverse effects were reported in any of the enrolled trials during the 12-week training period.

Resistance exercise is effective in improving physical function and increasing muscle mass in frail elderly individuals.[34–36] EBT was reported to be a safe instrumented resistance exercise in older adults;[15,16] it generates a constant and controlled resistive force and is a resistive type of exercise for training the major muscle groups with isotonic and isometric muscle contractions. EBT also has practical benefits because it can be performed almost everywhere and can be easily modified to fit the participants' specific needs. In addition, an instrumented exercise program involving EBT can be more beneficial than conventional free-weight resistance programs because it increases functional strength, is less likely to cause injury, has greater ability to change muscle emphasis during exercises, and enables greater muscle power development.[37] Moreover, EBT can combine the range of motion and acceleration benefits of ballistic training but allowing higher loads, proven to be superior in increasing strength and power, lean body mass and overall electromyography activity when compared to conventional resistance training.[38] Evidence also revealed that EBT can facilitate walking speed and dynamic balance in the elderly.[39] Consistent with previous studies, our meta-analysis proved that 12 weeks of EBT can effectively enhance the physical performance of elderly individuals with sarcopenia without causing any significant adverse effects. Considering the potential benefits of EBT in muscle training, EBT was recommended as one of the most suitable resistive exercise programs for older individuals with sarcopenia.[15]

In addition to improvement in physical performance, this meta-analysis revealed that 12 weeks of EBT resulted in an effective increase of muscle mass. Poor physical performance and low muscle mass are two major elements indicating sarcopenia.[10] When selecting a treatment for sarcopenia, physicians should consider its impact on both physical performance and muscle mass. A systemic umbrella review including 14 meta-analyses obtained high-quality evidence regarding the positive and significant effects of resistance training on the muscle mass of older adults with sarcopenia.[12] Consistent with previous reports, the present meta-analysis proved the effects of EBT on both physical performance and muscle mass, strengthening the evidence regarding the value of EBT as a treatment for older adults with sarcopenia in clinical practice. However, only two studies[31,33] that recorded the change in the ASMI after EBT could be analyzed in this meta-analysis; thus, the evidence of EBT increasing muscle mass remains weak, and more clinical evidence is warranted for its certification.

EBT might have some limitations for muscle training. Although this meta-analysis revealed that 12 weeks of EBT is effective to improve the physical performance of older adults with sarcopenia, the EBT effect may be more beneficial for muscle power rather than muscle endurance. Our findings indicated that 12-week EBT is effective in improving muscle-power-related performance, including balancing, turning, walking, and sit-to-stand motion among elderly adults with sarcopenia. Additionally, participants in the EBT group had a superior ASMI, directly indicating the ability of EBT to enhance muscle quality. However, performance in the 6MWT, which depends on muscle endurance and the global response of multiple cardiopulmonary and musculoskeletal systems, may not be easily improved by the EBT. Different from the positive results on 6MWT after EBT in other included studies,[30,32] participants in the study by Zhu et al. had the highest mean age but presented with the opposite result favoring control group (Figure 6),[33] implicating the a potential weakness of EBT programs for the improvement in the 6MWT especially for elderly adults with sarcopenia. In addition, the intensity of EBT program varied among the included studies. This may also cause the inconsistent results on the 6MWT after EBT among the included studies, since 6MWT is developed to evaluate functional performance during the activity of walking and highly associated with high-intensity of exercise training.[40,41] A more comprehensive training program that includes a high-intensity design of dynamic resistance exercises to enhance muscle endurance among elderly adults with sarcopenia is warranted for further clarification.

5. Limitations

This meta-analysis has several limitations. First, the sample was small, with only four trials and 231 participants enrolled. This may have resulted in high heterogeneity and compromised the statistical power of this meta-analysis. Second, the included studies enrolled varied sex ratio of participants, which might cause potential selection bias on the outcomes after EBT. Evidence has disclosed that there are different responses to resistance training for muscle strength between male and female genders.[42] However, further subgroup analysis for the sex difference on the effectiveness after EBT cannot be performed in this meta-analysis owing to the small number of included studies. Third, the diagnostic criteria for sarcopenia and the protocol of EBT varied among the studies, which may have caused bias in participants' selection and treatment consistency. Last, although only RCTs and quasi-experimental studies were considered for inclusion, the quality of the included studies varied. Potential sources of bias in these trials included inadequate methods of concealing random allocation as well as a lack of blinding. However, despite these limitations, to the best of our knowledge, we performed the first meta-analysis on the clinical effectiveness of EBT for sarcopenia, offering comprehensive and clinical evidence that can help clinicians assign EBT programs to elderly adults with sarcopenia.

6. Conclusion

EBT is an ideal and safe instrumented resistant exercise to enhance the physical performance and muscle mass of older adults with sarcopenia. Future large-scale and well-controlled studies are warranted to further elucidate the effect of EBT on the muscle mass and physical function and to compare EBT with other single or combination treatment options for older adults with sarcopenia.

Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=22.

References

1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing.* 2010;39:412–423.
2. Chen LK, Woo J, Assantachai P, et al. Asian Working Group for Sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. *J Am Med Dir Assoc.* 2020;21:300–307.e2.
3. Hita-Contreras F, Martínez-Amat A, Cruz-Díaz D, et al. Osteosarcopenic obesity and fall prevention strategies. *Maturitas.* 2015;80:126–132.
4. Janssen I, Baumgartner RN, Ross R, et al. Skeletal muscle cutpoints associated with elevated physical disability risk in older men and women. *Am J Epidemiol.* 2004;159:413–421.

5. Pacifico J, Geerlings MAJ, Reijnierse EM, et al. Prevalence of sarcopenia as a comorbid disease: A systematic review and meta-analysis. *Exp Gerontol.* 2020;131:110801.
6. Chiang MH, Kuo YJ, Chen YP. The association between sarcopenia and postoperative outcomes among older adults with hip fracture: A systematic review. *J Appl Gerontol.* 2021;40:1903–1913.
7. Landi F, Liperoti R, Russo A, et al. Sarcopenia as a risk factor for falls in elderly individuals: results from the ilSIRENTE study. *Clin Nutr.* 2012; 31:652–658.
8. Bianchi L, Ferrucci L, Cherubini A, et al. The predictive value of the EWGSOP definition of sarcopenia: Results from the InCHIANTI Study. *J Gerontol A Biol Sci Med Sci.* 2016;71:259–264.
9. Hirani V, Blyth F, Naganathan V, et al. Sarcopenia is associated with incident disability, institutionalization, and mortality in community-dwelling older men: The Concord Health and Ageing in Men Project. *J Am Med Dir Assoc.* 2015;16:607–613.
10. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing.* 2019;48:16–31.
11. Dent E, Morley JE, Cruz-Jentoft AJ, et al. International clinical practice guidelines for sarcopenia (ICFSR): Screening, diagnosis and management. *J Nutr Health Aging.* 2018;22:1148–1161.
12. Beckwée D, Delaere A, Aelbrecht S, et al. Exercise interventions for the prevention and treatment of sarcopenia. A systematic umbrella review. *J Nutr Health Aging.* 2019;23:494–502.
13. Hsu KJ, Liao CD, Tsai MW, et al. Effects of exercise and nutritional intervention on body composition, metabolic health, and physical performance in adults with sarcopenic obesity: A meta-analysis. *Nutrients.* 2019;11:2163.
14. Vlietstra L, Hendrickx W, Waters DL. Exercise interventions in healthy older adults with sarcopenia: A systematic review and meta-analysis. *Australas J Ageing.* 2018;37:169–183.
15. Chen KM, Tseng WS, Huang HT, et al. Development and feasibility of a senior elastic band exercise program for aged adults: a descriptive evaluation survey. *J Manipulative Physiol Ther.* 2013;36:505–512.
16. Yasuda T, Fukumura K, Uchida Y, et al. Effects of low-load, elastic band resistance training combined with blood flow restriction on muscle size and arterial stiffness in older adults. *J Gerontol A Biol Sci Med Sci.* 2015;70: 950–958.
17. Andersen LL, Andersen CH, Mortensen OS, et al. Muscle activation and perceived loading during rehabilitation exercises: comparison of dumbbells and elastic resistance. *Phys Ther.* 2010;90:538–549.
18. Lee YH, Lee PH, Lin LF, et al. Effects of progressive elastic band resistance exercise for aged osteosarcopenic adiposity women. *Exp Gerontol.* 2021; 147:111272.
19. Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev.* 2015;4:1.
20. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther.* 2000;80:896–903.
21. Hall WJ. Update in geriatrics. *Ann Intern Med.* 2006;145:538–543.
22. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. *JAMA.* 2011;305:50–58.
23. Beyer SE, Sanghvi MM, Aung N, et al. Prospective association between handgrip strength and cardiac structure and function in UK adults. *PLoS One.* 2018;13:e0193124.
24. Enright PL. The six-minute walk test. *Respir Care.* 2003;48:783–785.
25. Fritz NE, McCarthy CJ, Adamo DE. Handgrip strength as a means of monitoring progression of cognitive decline - A scoping review. *Ageing Res Rev.* 2017;35:112–123.
26. Ibrahim K, May CR, Patel HP, et al. Implementation of grip strength measurement in medicine for older people wards as part of routine admission assessment: identifying facilitators and barriers using a theory-led intervention. *BMC Geriatr.* 2018;18:79.
27. Rijk JM, Roos PR, Deckx L, et al. Prognostic value of handgrip strength in people aged 60 years and older: A systematic review and meta-analysis. *Geriatr Gerontol Int.* 2016;16:5–20.
28. Rodacki ALF, Boneti Moreira N, Pitta A, et al. Is Handgrip strength a useful measure to evaluate lower limb strength and functional performance in older women? *Clin Interv Aging.* 2020;15:1045–1056.
29. Savino E, Martini E, Lauretani F, et al. Handgrip strength predicts persistent walking recovery after hip fracture surgery. *Am J Med.* 2013;126: 1068–1075.e1.
30. Banitalebi E, Faramarzi M, Ghahfarokhi MM, et al. Osteosarcopenic obesity markers following elastic band resistance training: A randomized controlled trial. *Exp Gerontol.* 2020;135:110884.
31. Liao CD, Tsauo JY, Huang SW, et al. Effects of elastic band exercise on lean mass and physical capacity in older women with sarcopenic obesity: A randomized controlled trial. *Sci Rep.* 2018;8:2317.
32. Shahar S, Kamaruddin NS, Badrasawi M, et al. Effectiveness of exercise and protein supplementation intervention on body composition, functional fitness, and oxidative stress among elderly Malays with sarcopenia. *Clin Interv Aging.* 2013;8:1365–1375.
33. Zhu LY, Chan R, Kwok T, et al. Effects of exercise and nutrition supplementation in community-dwelling older Chinese people with sarcopenia: a randomized controlled trial. *Age Ageing.* 2019;48:220–228.
34. Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. *Cochrane Database Syst Rev.* 2009; 2009:CD002759.
35. Vincent HK, Raiser SN, Vincent KR. The aging musculoskeletal system and obesity-related considerations with exercise. *Ageing Res Rev.* 2012;11: 361–373.
36. Yarasheski KE. Exercise, aging, and muscle protein metabolism. *J Gerontol A Biol Sci Med Sci.* 2003;58:M918–M922.
37. Melchiorri G, Rainoldi A. Muscle fatigue induced by two different resistances: Elastic tubing versus weight machines. *J Electromyogr Kinesiol.* 2011;21:954–959.
38. Wallace BJ, Winchester JB, McGuigan MR. Effects of elastic bands on force and power characteristics during the back squat exercise. *J Strength Cond Res*. 2006;20:268–272.
39. Weiss A, Suzuki T, Bean J, et al. High intensity strength training improves strength and functional performance after stroke. *Am J Phys Med Rehabil.* 2000;79:369–376; quiz 391–394.
40. Rodrigues A, Di Martino M, Nellessen AG, et al. Is the six-minute walk test a useful tool to prescribe high-intensity exercise in patients with chronic obstructive pulmonary disease? *Heart Lung.* 2016;45:550–556.
41. Bean JF, Kiely DK, Leveille SG, et al. The 6-minute walk test in mobility-limited elders: what is being measured? *J Gerontol A Biol Sci Med Sci.* 2002;57:M751–M756.
42. Roberts BM, Nuckols G, Krieger JW. Sex differences in resistance training: A systematic review and meta-analysis. *J Strength Cond Res.* 2020;34: 1448–1460.