Comparative Effectiveness of Whole- Body Vibration and Aerobic Training among Egyptian Older Adults with Sarcopenia: A Randomized Controlled Trial

Ahmed Hussien Elkadi[1], Omaima Kattabei[1], Eman Ahmed Embaby[1], Heba Mohamed Ezz El Arab[1], Hanaa Kenawy Atta[1]*

[1] Basic Science Department, Faculty of Physical Therapy, Cairo University, Cairo, Egypt.

Corresponding Author:

Ahmed Hussien Elkadi[1]*

Affiliation: Basic Science Department, Faculty of Physical Therapy, Sinai University, Kantara, Egypt.Address: Cairo, Egypt, Postal Code: 41636..

Email: ahmedkadidpt@gmail.com

Abstract: Background and Purpose: Early identification and effective interventions for sarcopenia in older people are crucial to prevent functional decline and improve quality of life. This work aimed to examine and compare the efficacy of aerobic training exercises and whole-body vibration (WBV) in the management of sarcopenia, with respect to muscular strength, muscle mass, and physical performance in older adults.

Methods: This randomized controlled trial involved 70 aged participants with sarcopenia at Outpatient and Inpatient Geriatrics Care Centers. Cases were randomly allocated to 3 groups: Group A (Study group) (n=24): received WBV exercises with diet modification life style and conventional progressive resistance exercises. Group B (Study group) (n=23): received aerobic exercise training with diet modification life style and conventional progressive resistance exercises. Group C (Control Group) (n=23): was administered conventional progressive resistance exercises and a lifestyle modification regimen for 3 sessions per week for 12 weeks. Sessions lasted 6 minutes for WBV and 30 minutes for aerobic training, plus resistance exercises. Outcomes—muscular strength, muscle mass, and physical performance—were measured using BIA, handgrip strength, 6-MWT, gait speed, and TUG. Post-intervention differences were analysed using rm MANCOVA, adjusting for baseline values ($p < 0.05$). The sessions were conducted under direct supervision of qualified physical therapists. Participants trained in small groups, but each one followed an individualized program based on their initial assessment and tolerance. Close supervision was maintained throughout to ensure proper technique and safety, with adjustments made when needed. Attendance was also recorded to monitor adherence to the program.

Results and Discussion: After intervention, group A had significantly increased hand grip strength compared to group C ($p=0.026$) and group B ($p=0.02$). Also, group A demonstrated significantly faster gait speed than group C ($p=0.002$) and group B ($p=0.017$). SMI revealed a significant impact among groups ($F = 124.28$, $p < 0.001$, $\eta^2 = 0.790$) as well as for the hand grip test ($F = 39.17$, \ $\eta^2 = 0.543$) and 6-MWT ($F = 38.47$, $\eta^2 = 0.538$). Moreover, Gait Speed ($F = 21.28$, $\eta^2 = 0.392$) and TUG ($F = 7.58$, \ $\eta^2 = 0.187$) showed group-dependent enhancements in functional flexibility.

Conclusions: The results of the present study support the integration of either WBV or aerobic training into standard sarcopenia management protocols, as both interventions provided measurable benefits beyond conventional resistance training and dietary modification alone..

Keywords: Aerobic Training, Whole- Body Vibration, Sarcopenia, Egyptian older adults

Introduction

Sarcopenia, or the decline of skeletal muscle mass, is a health issue that is well-documented and associated with the aging process. The presence of low muscle quantity or quality, along with low muscle strength, is likely to confirm the diagnosis of sarcopenia. 1, 2 Muscle deterioration and the progression toward functional impairment and disability can be accelerated by genetic and lifestyle factors. Sarcopenia was estimated to affect 10%–16% of the geriatric population worldwide. The prevalence of sarcopenia ranged from 18% in diabetic patients to 66% in patients with unresectable esophageal carcinoma. In Cairo, Egypt, about 18% of older residents of nursing institutions had sarcopenia, with a prevalence of 22.2% in older male participants and 14.4% in older female participants. 3

High-quality evidence highlighted the impact of resistance exercise with or without nutrition and the combination of resistance exercise with aerobic and balance training for improving the quality of life for older adults with sarcopenia.4 Although conventional resistance training is frequently advised, research suggests that the advantages of resistance exercise can be enhanced by incorporating whole-body vibration (WBV). 5

WBV is a treatment or exercise technique that is employed in the fields of physiotherapy, rehabilitation, and sports. During WBV, individuals recline, stand, or exercise on a platform that generates vibrations. These vibrations are typically observed at a frequency of 20 to 60 times per second and have a magnitude of one to several millimeters [2]. Exercise using WBV has recently been implemented as a non-pharmacological therapeutic approach for older individuals who are sarcopenic. The physiological effects of WBV are attributed to increased muscle activation, which results in improved cardiorespiratory responses and muscle activity during exercise. [6]

According to the American College of Sports Medicine, aerobic exercise is any activity that is rhythmic in nature, can be sustained continuously, and utilizes large muscle groups. [7]

Aerobic exercise is crucial for maintaining health as it enhances muscle strength, endurance, immune function, and the cardiovascular system, as well as reduces body fat and increases muscle mass. Additionally, it appears to enhance muscle hypertrophy and strength.[8] Regular exercise, mostly consisting of resistance and aerobic training (such as cycling, jogging, walking, and swimming), is linked to several physical health advantages, [9] and a lower risk of sarcopenia-related comorbidities. [10]

Every resistance training program has a specific objective to increase muscle strength and mass, which ultimately helps to advance physical performance and life quality, whereas aerobic exercise improves cardiorespiratory fitness. Given that each training variable can cause a particular response in these workout modes, a wide variety of variables can be controlled for these reasons. [7] To our knowledge, there is a lack of research regarding the comparison between WBV combined with resistance training and aerobic exercise combined with resistance exercises in older individuals with sarcopenia. [11]

Accordingly, this study aimed to evaluate and contrast the efficacy of WBV and aerobic training exercises in the management of sarcopenia, focusing on the impact on physical performance, muscle strength, and muscle mass in the older population.

Methods

This three-arm parallel group's randomized double- blind controlled trial was carried out on 70-year-old individuals with sarcopenia diagnosed based on an algorithm created by the European Working Group on Sarcopenia in Older People (EWGSOP), [12] at the Outpatients and Inpatients Geriatrics Care Centers. Informed written consent was obtained from the participants. The study was done after approval from the Ethics Committee of the Faculty of Physical Therapy.

Inclusion criteria: participants older than 60 years, with hand grip strength below < 27 kg in men and < 16 kg in women, and skeletal muscle mass index (SMI) below 8.87 kg/m^2 and 6.42 kg/m^2 in males and females, respectively, cognitive impairment were detected using mini mental state examination (MMSE, scores > 21) and with no regular exercise habit for more than 3 months, with gait speed > 0.8 m/s and with proper conscious.

Exclusion criteria: participants with acute injury, severe heart diseases, pacemaker, history of orthopedic surgery of the lower limbs and/or fracture less than 1 year earlier. In addition, participants unable to walk without assistance, with improper consciousness and cognitive impairment detected by MMSE (scores < 21), or those with neurological diseases or acute conditions that would interfere with testing and training, who couldn't exercise at all because of conditions like blood clotting issues or deep vein thrombosis, were excluded. Moreover, participants who had major spinal conditions or surgical histories, and those with severe illnesses that influence assessments and interventions, were also excluded.

Randomization:

Participants were randomly divided into 3 groups study groups using a block randomization method (blocks of six). Random sequences were computer-generated by an independent researcher who was not included in the treatment or assessment process. Allocation concealment was achieved using sealed, opaque, and sequentially numbered envelopes.

Group A (Study group) (n=24): received WBV exercises with diet modification, lifestyle, and conventional progressive resistance exercises.

Group B (Study group) (n=23): received aerobic exercise training with diet modification, lifestyle, and conventional progressive resistance exercises.

Group C (Control Group) (n=23): received diet modification, lifestyle, and conventional progressive resistance exercises. **Figure 1**

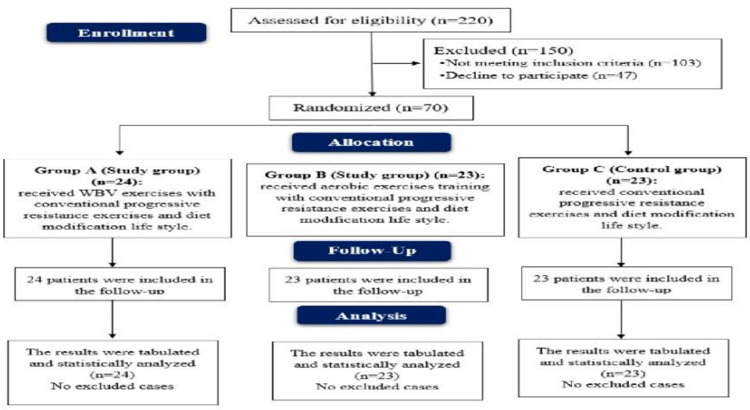

Figure 1: CONSORT flowchart of the enrolled participants

Assessment Instruments:

Analysis of bioelectrical impedance BIA: [13] We used the InBody Dial H20B, InBody Co., Ltd., South Korea, InBody. Participants had been asked to stand barefoot, wearing light clothes, with their right and left feet on the corresponding leg electrodes. Placing the heel at the end of the heel electrodes and allowing the feet to rest in a forward-pointing position, while holding the two hand electrodes, with the arms extended at a 90° angle to the trunk, ensuring that the arms and legs do not touch each other.

***Handheld dynamometer*:** Handheld dynamometry is an objective method for identifying the minimum change in muscle strength. The participant was instructed to press the dynamometer with their strongest hand three times. Subsequently, an average score was determined for both palms. Men with a cut weight of less than 27 kg and women with a cut weight of less than 16 kg were diagnosed with low grasp strength. In this study, we used the CAMRY EH101, Zhongshan Camry Electronic Co., Ltd. China, dynamometer for excellent reliability and validity. [14]

The TUG test: The Timed Up and Go Test (TUG) assessed physical function by requiring participants to exit a standard chair, proceed to a marker that is situated three meters away, turn around, return, and re-establish oneself to the chair. [15] Moreover, excellent reliability was demonstrated for the TUG test with an Intraclass Correlation Coefficient of (ICC = 0.92–0.99), validity with fall risk and functional mobility levels and minimal detectable change (MDC) of 0.8 and 1.1 seconds.[16]

Speed gait test: A gait speed test, specifically a 4-meter usual walking speed test, was used. This test measured walking speed either manually, with a stopwatch. An excellent reliability was retrieved with ICC of 0.90 to 0.98. The test is strongly valid for the prediction of functional decline, as well as lower-extremity muscle power and balance. The MDC is 0.08 to 0.13 m/s. [17]

***Six-minute walk test (6-MWT)*:** The 6-MWT was implemented to assess the aerobic capacity and endurance of a participant, as well as to determine their exercise tolerance and prognosis. The participant was instructed to walk at his usual pace for a period of six minutes. This duration was selected to improve participant adherence and minimize excessive mechanical loading due to their sarcopenic condition. The test showed excellent test reliability (ICC = 0.91 to 0.96), validity with physical performance indices in older participants. The minimal detectable change (MDC) is 30-50 meters.[18]

Interventions:

The 1-repetition maximum (1RM) test was administered to each participant in all the studied groups before the commencement of the intervention. This test was designed to assess muscle strength and ascertain the appropriate resistance exercise training intensity. Based on 1RM test results, the intensity of resistance exercise training was specified according to the individual's 1RM. The intensity was 60% 1RM in the first 4 weeks, 65% 1RM in the second 4 weeks, and 70% 1RM in the third 4 weeks. Immediately following the aforementioned exercise training, a five-minute cool-down was implemented, which is analogous to the warm-up exercise. Resistance exercise movements consist of exercises for the upper limbs (shoulder extension, elbow flexion, and abduction), trunk (chest press), and lower limbs (knee flexion, hip abduction, and extension). [19] Finger pulse oximeters were used to monitor heart rate and O_2 saturation of all participants during all sessions. The TheraBand elastic band was employed for resistance exercise training in all of the groups that were examined.

***In group A*,** WBV training was administered using a vertical vibration platform. The vibration frequency was set at 40 Hz with a peak-to-peak displacement of 2–4 mm, depending on the device specifications. Each session lasted for 360 seconds (6 minutes) of continuous vibration. Participants completed a total of 36 sessions over 12 weeks, with three sessions per week. [20] During WBV, participants stood on the platform barefoot or wearing flat shoes, with their feet shoulder-width apart. The knees were slightly flexed at approximately 30° to reduce vibration transmission to the head and spine, while the hands rested either on the waist or on the side handles. The trunk was kept upright with the gaze directed forward. No rest periods were required within each session, although the 6-minute bouts could be divided into three 2-minute bouts with 1-minute rest intervals for participants who experienced fatigue. In addition to WBV, the participants were also administered a 12-week resistance exercise program (three times per week) at the same time. Three components comprised each exercise session: a five-minute warm-up that primarily involved stretching the neck, shoulders, lower back, hips, knees, and ankles; a resistance exercise training session that included three sets and ten reps of each exercise session; and a one-minute relaxation period between sets.

In group B, participants received aerobic training by cycling on an ergometer for 30 minutes for upper and lower limbs at a maximum heart rate (HR max) for age of 60-70% (HR max = 220- age), followed by exercises involving 75% of the 1RM for the lower limbs. Participants were monitored every five minutes to ensure that the intensity was maintained during the aerobic training session. We were utilized for the initial five minutes as a preparatory period and for the final five minutes as a recovery period. Following this, the sural triceps, hamstrings, iliopsoas, and rectus femoris muscles were stretched for four sets of 20 seconds.[21] Additionally, the participants had a progressive resistance exercise program that was administered three times per week. Each exercise session was divided into three components: a five-minute warm-up, which primarily involved stretching the neck, shoulders, lower back, hips, knees, and ankles; a resistance exercise training session that consisted of 3 sets and ten reps of each exercise session; and a one-minute relaxation period between sets.

In group C, three times per week, the participants were administered a progressive resistance exercise program. Three components comprised each exercise session: a five-minute warm-up, which primarily involved stretching the neck, lower back, shoulders, knees, hips, and ankles; a resistance exercise training comprised 3 sets of ten repetitions for each exercise session; and a one-minute break between sets.

Dietary intervention in the present study was individualized according to each participant's medical condition and nutritional needs. Diet modification was tailored to ensure appropriateness for the underlying disease status while maintaining overall nutritional adequacy. Due to the heterogeneity of clinical conditions among participants, applying a single standardized diet to all participants was challenging. However, careful consideration was given to achieve the highest possible level of consistency across dietary recommendations, while allowing necessary adjustments to address individual medical requirements. This approach was implemented to optimize participants' health status and support the effectiveness of the rehabilitation program.

Sample Size:

By employing G*Power (version 3.1.9.2), the sample size was determined. The total sample size was 84 participants after the addition 20 % drop outs (28 participants per group), who investigated the influence of resistance training on sarcopenia in nursing care facilities. [22]

Statistical Analysis:

Following data collection and coding, the information was entered into a spreadsheet using Microsoft Excel 2016 for Windows, an application that is included in the Microsoft Office suite. The spreadsheet was created in 2016 by Microsoft Corporation in the United States. We used IBM's statistical package for Windows, SPSS, which is based in Armonk, New York, USA, to analyze the data

(IBM SPSS Statistics for Windows, Version 26.0). To ensure the distribution was normal, the Kolmogorov-Smirnov test was employed. Numbers and percentages were used to represent categorical data, whereas means ± standard deviation, median, and interquartile range were used to display continuous data. A significant statistical value was defined as less than 0.05. Post hoc tests, Kruskal-Wallis, chi-square, and one-way analysis of variance were employed. For outcome measures, analysis of covariance (rm MANCOVA) was performed to compare post-intervention values among the three groups, with corresponding baseline values included as covariates. This approach was selected as it is recommended for randomized controlled trials with pre–post designs, as it improves statistical power and adjusts for any baseline differences.

Before analysis, the assumptions of rm MANCOVA were assessed, using normality (Shapiro–Wilk test), multicollinearity, Mahalanobis (for multivariate outliers), homogeneity of variances (Levene's test), and homogeneity of covariance (Box's M test). Although Levene's test indicated a violation of homogeneity of variances in some variables, MANCOVA is considered robust to moderate violations when group sizes are approximately equal. Post hoc pairwise comparisons were conducted with Bonferroni adjustment to control for Type I error associated with multiple comparisons (at alpha 0.05). Effect sizes were calculated using partial eta squared (η^2). Because Box's M test was significant ($p < 0.001$), Pillai's Trace was used for the multivariate analysis as it is more robust to violations of homogeneity of covariance matrices.

Results

The final number of participants who completed the study was 70 due to dropouts or withdrawals. The slight inequality in group sizes was statistically adjusted during the analysis.

BIA measurement and the WBV intervention (**Figures 2a-2b**).

Figures 2: a.WBV intervention

Figure 2 b. BIA measurement

Figures 2: a.WBV intervention and b. BIA measurement

There were no significant differences in gender and age among the three groups. However, weight differed significantly (p=0.011), with group A having a lower median weight than groups B and

C. Height also showed a significant difference ($p<0.001$), favoring group A over groups B and C. Additionally, BMI varied significantly across all groups ($p<0.05$), with group A presenting a lower mean BMI compared to groups B and C. **Table 1**

After the intervention, SMI showed significant improvement in groups A and B (all $p<0.001$), while group C remained unchanged. Hand grip strength differed among the groups before intervention ($p<0.05$), with group A showing significant improvement compared to groups B ($p=0.02$) and C ($p=0.026$) post-intervention. All groups improved their grip strength ($p<0.001$). For gait speed, no differences were noted before intervention, but post-intervention, group A was significantly faster than groups B ($p=0.017$) and C ($p=0.002$), with all groups improving ($p<0.001$). **Table 2 & Figures (3-5).**

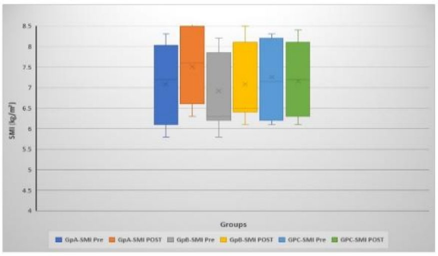

Figure 3: Comparison between the three studied groups regarding skeletal muscle mass index before and after intervention

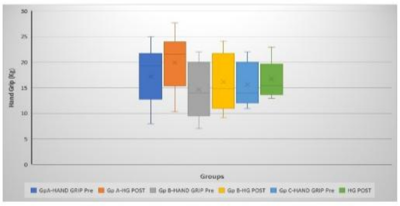

Figure 4: Comparison between the three studied groups Hand grip before and after intervention

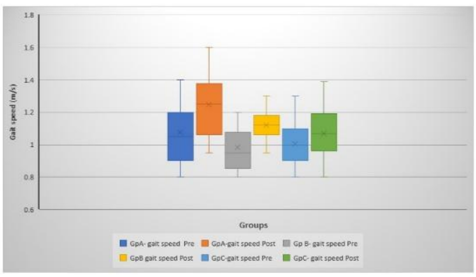

Figure 5: Comparison between the three studied groups gait speed before and after intervention

There were significant differences in 6-MWT distances among the three groups before intervention (p=0.006), with notable differences between group A and group B (p=0.008) and group C (p=0.007). Post-intervention, a significant difference was observed (p<0.001), with group A showing greater improvements than group B (p=0.005) and group C (p<0.001). Within-group analyses demonstrated significant improvements in 6-MWT for all groups (p<0.001). In contrast, there were no significant differences in the (TUG) prior to intervention, but significant improvements were noted for all groups after the intervention (p<0.001). **Table 3 &Figures (6&7)**

Table 3: Comparison between the studied groups regarding Six-minute walk test (6MWT) before and after intervention

		Group A (N= 24)	Group B (N= 23)	Group C (N= 23)	P-value	Test value	Effect Size (Ω^2)
Six-minute walk test (6-MWT)	**Before intervention**	385.64 ± 75.66	330.61 ± 37.13	328.17 ± 43.02	**0.006***	F=5.65	0.260
	After intervention	431.75±83.96	368.65 ± 37.14	346.09 ± 43.83	**<0.001 ****	F=9.62	0.171
	p-value (Paired t test)	**<0.001****	**<0.001****	**<0.001** (Wilcoxon test)**	--		
Timed Up and Go Test (TUG, seconds)	**Before intervention**	12.5 (10.6-13.7)	12.5 (11.5-13.2)	12.0 (11.0-12.7)	0.480	H=1.470	0.030
	After intervention	10.7 (9.5-11.8)	10.3 (9.8 - 11.7)	10.8 (9.7-11.4)	0.979	H=0.043	0.023
	p-value (Wilcoxon test)	**<0.001****	**<0.001****	**<0.001****	--		

Data are presented as mean ± SD, median (IQR) or frequency (%), * Significant as P-value ≤ 0.05. F: One-Way ANOVA test, H: Kruskal Wallis Test

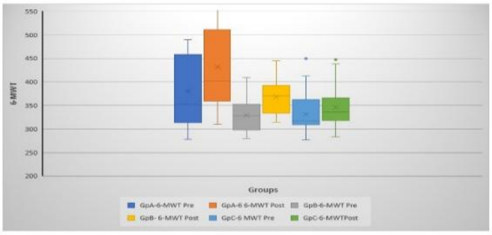

Figure 7: Comparison between the three studied groups regarding 6-MWT before and after intervention

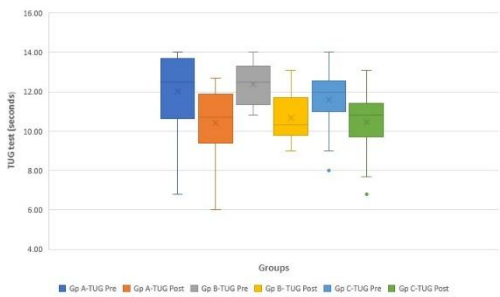

Figure 7: Comparison between the three studied groups regarding TUG test before and after intervention

As shown in **Table 4**, MANCOVA reveals a statistically significant difference over time in all measured parameters; particularly, the hand Grip test (F=31.513, p<0.001, ηp2=0.323) and SMI (F=16.022, p<0.001, ηp2=0.195). Moreover, using BMI as a covariate does not show a significant impact over time. However, all measured parameters demonstrated a significant change over time among different groups.

Table 4: Multivariate Analysis (MANCOVA) for the effect of different interventions on physical performance

	Parameters measured	Type III Sum of Squares	F(df)	P- value	Partial η^2
Change in time	**Hand Grip**	1.716	31.513 (1)	**<0.001**	0.323
	SMI	0.043	16.022 (1)	**<0.001**	0.195

	TUG	1.154	14.622 (1)	**<0.001**	0.181
	Gait Speed	0.006	7.558 (1)	**0.008**	0.103
	6-MWT	341.005	6.198 (1)	**0.015**	0.086
Change in time/ BMI	**Hand Grip**	0.076	1.402(1)	0.241	0.021
	SMI	0.001	0.483 (1)	0.489	0.007
	TUG	0.002	0.031 (1)	0.861	0.000
	Gait Speed	0.000	0.358 (1)	0.552	0.005
	6-MWT	60.706	1.103(1)	0.297	0.016
Change in time among different groups	**Hand_Grip**	4.267	39.170 (1)	**<0.001**	0.543
	SMI	0.668	124.278 (1)	**<0.001**	0.790
	TUG	1.197	7.582(1)	**0.001**	0.187
	Gait Speed	0.034	21.275 (1)	**<0.001**	0.392
	6-MWT	4233.106	38.470 (1)	**<0.001**	0.538

*Assumption violation P<0.001, Pillai's Trace was reported

Table 5 presents baseline assessments for hand Grip, TUG, Gait Speed, and 6-MWT, which all demonstrate significant differences among all groups. All measured parameters except SMI show a predictable effect (all p<0.001).

Table 5: Univariate analysis among intervention groups between-subjects on sarcopenia measured parameters

	Measured parameters	Type III Sum of Squares	Mean Square	F(df)	P-value	Partial η^2
Comparing the effect of physical exercise among different groups	**Hand Grip**	481.152	240.576	5.858 (2)	0.005	0.151
	SMI	7.134	3.567	2.296 (2)	0.109	0.065
	TUG	10.275	5.138	1.082 (2)	0.345	0.032
	Gait Speed	0.507	0.254	5.736 (2)	0.005	00.148
	6-MWT	126438.167	63219.084	9.838 (2)	0.000	0.230

In **Table 6**, pairwise comparison between intervention groups revealed a significant improvement in all measured parameters over 12 weeks of training among the intervention groups (Vibration plus Resistance or Aerobic plus Resistance) in comparison to the control group.

Table 6: Post-hoc pairwise comparison between different post-interventions

Dependent Variable	**Group randomization**	**Group randomization**	**Mean Difference ± (SE)***	**P-value ** **	**95% Confidence Interval for Difference**
POST SMI test	**A**	**B**	0.208±0.024	<0.001	0.150-0.267
		C	0.390±0.026	<0.001	0.326-0.453
	B	**C**	0.181±0.021	<0.001	0.129-0.234
POST Hand Grip test	**A**	**C**	0.896±0.123	<0.001	0.595-1.198
	B	**C**	0.400±0.101	0.001	0.151-0.649
		A	0.896±0.123	<0.001	1.198-0.595

Post Gait Speed test	**A**	**C**	0.083±0.015	<0.001	0.046-0.120
	B	**C**	0.057±0.012	<0.001	0.027-0.088
		A	0.083±0.015	<0.001	0.120- 0.046
Post 6-MWT test	**A**	**C**	25.421±3.816	<0.001	16.031-34.812
	B	**C**	19.905±3.151	<0.001	12.152-26.659
		A	25.421±3.816	<0.001	34.812-16.031
Post TUG test	**A**	**C**	0.357±0.142	0.045	0.708- 0.006
	B	**C**	0.420±0.118	0.002	0.710- 0.313
		A	0.357±0.142	0.045	0.006-0.708

* Significant at P<0 .05 level

**Bonferroni-adjusted.

Discussion

Sarcopenia is linked to a heightened risk of falls, fractures, functional impairment, reduced quality of life, and premature mortality, rendering effective interventions of critical importance in its management.[2] with current evidence strongly supports exercise interventions as the most effective way to treat sarcopenia, particularly WBV training and aerobic exercise.[23-25]

This study showed a statistically as well as a clinically meaningful difference among the measured parameters between different groups

No significant difference was detected in age or sex among our studied participants. Similarly, Zhuang et al.[2] revealed no significant differences between groups in age, gender, or BMI. This comes in line with ours, where BMI did not show a significant impact over time. On the other hand, the findings of Wang et al.'s[26] study showed an inverse association between sarcopenia occurrence and higher BMI. Their study demonstrated that higher BMI had better SMI and body composition indices, opposing our finding where the lowest BMI group (Group A) was allocated to receive specialized intervention. This discrepancy may reflect different study populations, as their community-dwelling older individuals may represent a different sarcopenia phenotype compared to our clinically-recruited participants, who may have had more advanced sarcopenia requiring intervention.

Moreover, analysis of clinical history and comorbidity burden in our study demonstrated insignificant differences between groups. Yang et al., [27] studied a population with significantly higher disease severity and comorbidity complexity than our community-dwelling older participants. All participants had end-stage renal disease requiring dialysis, representing 100% serious comorbidity compared to our distributed comorbidity pattern, where renal disease affected only 8.7-29.2% of participants across groups.

Furthermore, multivariate analysis in our study revealed a significant enhancement in all measured parameters over the training period among the test groups in comparison to the control. This suggests that the addition of either WBV or aerobic training to conventional resistance exercise provides measurable benefits for muscle mass preservation that cannot be achieved through resistance training and dietary intervention alone over time. Similarly, Zhuang et al.[2] revealed that within-group analysis, the WBVT group found significant improvement in the appendicular SMI index. On the contrary, Jo et al.[28] demonstrated no increase in SMI in the WBVT group, whereas it decreased significantly in the control group. The authors attributed the results to the insufficient time for significant increases in muscle mass, which also could justify our remarkable results.

Hand grip strength assessment in our study revealed significant enhancement between groups, over time, and following intervention, particularly Group A achieving the greatest improvement. In alignment with that, Wang et al. [29] demonstrated superior strength improvements of WBV training compared to other exercise modalities.

Also, our study showed a higher magnitude of improvement in the WBV group, suggesting that this intervention provides superior neuromuscular stimulation for strength development. Contrary to that, de Oliveira et al. [30] concluded enhancement in the strength of the lower limbs, with no significant results in the lower limb power, upper limb strength, or muscular endurance performance in senior adults using WBV. The discrepancy may be explained by their focus on WBV-only interventions versus our combined approach, incorporating resistance training, which may have provided more comprehensive strength benefits.

Moreover, Zhang et al. [31] demonstrated that the WBV group showed significant improvements in the 6-meter gait speed test compared to controls, with greater improvement magnitudes in the WBV group than the control group. The authors noted which improvements in physical performance assessments, including gait speed, were observed in both groups; nonetheless, in the WBV group, improvement was significantly greater than in the control group. This finding supports our observation that while all intervention groups showed significant within-group improvements, WBV training produced the most significant functional gains in walking performance and hand grip test.

Furthermore, Nawrat-Szołtysiket al.[32] confirmed that 12-week WBVT significantly enhanced exercise tolerance calculated by the 6-MWT, with the experimental group achieving greater walking distances than controls. Similarly, Zhuang et al. [2] demonstrated better physical performance involving Short Physical Performance Battery scores, which correlate with endurance capacity while using WBVT, which is in line with ours.

The TUG test in our study revealed a significant improvement in all 3 groups, indicating that all interventions were equally effective for enhancing functional mobility and balance in this multifactorial performance measure. Comparable results were presented by Zhang et al. [31] and Rathi et al. [33], validating the efficacy of various exercise approaches for enhancing functional mobility as measured by the TUG test. However, Saucedo et al. [34] revealed contradictory findings. This could be due to shorter intervention duration (6 weeks vs. our 12 weeks)

Limitations and Strengths:

This is the first study to compare the efficacy of WBV and aerobic training exercises in the management of sarcopenia. The study showed the superiority of WBV intervention in sarcopenia management. However, this research's sample size was based on a prior pilot study, potentially lacking sufficient statistical power for conclusive efficacy trials. Consequently, the non-significant findings are attributed to the study's inability to detect small-to-moderate treatment effects (Type II error). Moreover, the limited study duration and single-center design in the Egyptian aged population limit generalizability to other geographic populations.

Conclusion

The study supports integrating whole-body vibration (WBV) or aerobic training into sarcopenia management, showing benefits beyond conventional resistance training and dietary changes. WBV demonstrated superior outcomes, indicating it should be preferred as the primary exercise intervention for older participants with sarcopenia. Future trials should include extended follow-ups, larger multicenter studies, and cost-effectiveness analyses comparing WBV interventions to standard care..

References

Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;(48):16-31.https://doi.org/10.1093/ageing/afy169

Zhuang M, Gu Y, Wang Z, et al. Effects of 12-week whole-body vibration training versus resistance training in older people with sarcopenia. Sci Rep. 2025;(15):69-81.https://doi.org/10.1038/s41598-025-91644-2

Rahman TTA, Elkholy NM, Mortagy AK. Prevalence of sarcopenia among nursing home older residents in Cairo, Egypt. Adv Aging Res. 2014;(3):11-38

Shen Y, Shi Q, Nong K, et al. Exercise for sarcopenia in older people: A systematic review and network meta-analysis. J Cachexia Sarcopenia Muscle. 2023;(14):1199-211.https://doi.org/10.1002/jcsm.13225

Valenzuela PL, Castillo-García A, Morales JS, et al. Physical exercise in the oldest old. Compr Physiol. 2019;(9):1281-304.https://doi.org/10.1002/cphy.c190002

Cochrane DJ. Vibration exercise: the potential benefits. Int J Sports Med. 2011;(32):75-99.https://doi.org/10.1055/s-0030-1268010

Wahid A, Manek N, Nichols M, et al. Quantifying the association between physical activity and cardiovascular disease and diabetes: A Systematic Review and Meta-Analysis. J Am Heart Assoc. 2016;(5):77-86.https://doi.org/10.1161/jaha.115.002495

Yoo SZ, No MH, Heo JW, et al. Role of exercise in age-related sarcopenia. J Exerc Rehabil. 2018;(14):551-8.https://doi.org/10.12965/jer.1836268.134

Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;(43):1334-59.https://doi.org/10.1249/MSS.0b013e318213fefb

Xu HQ, Shi JP, Shen C, et al. Sarcopenia-related features and factors associated with low muscle mass, weak muscle strength, and reduced function in Chinese rural residents: a cross-sectional study. Arch Osteoporos. 2018;(14):20-45.https://doi.org/10.1007/s11657-018-0545-2

Sun J, Zhang W, Han P. Prospects for the diagnosis and treatment of sarcopenia in the Philippines. Front Med (Lausanne). 2025;(11):15-33.https://doi.org/10.3389/fmed.2024.1501501

Nambi G, Abdelbasset WK, Alrawaili SM, et al. Comparative effectiveness study of low versus high-intensity aerobic training with resistance training in community-dwelling older men with post-COVID 19 sarcopenia: A randomized controlled trial. Clin Rehabil. 2022;(36):59-68.https://doi.org/10.1177/02692155211036956

D'Abbronzo G, Scidà G, Quaglia C, et al. Application-based bioelectrical impedance analysis provides accurate body composition parameters in a more cost-efficient and time-efficient Way. J Nutr. 2025;(155):2443-8.https://doi.org/10.1016/j.tjnut.2025.05.013

Huang L, Liu Y, Lin T, et al. Reliability and validity of two hand dynamometers when used by community-dwelling adults aged over 50 years. BMC Geriatr. 2022;(22):58-60.https://doi.org/10.1186/s12877-022-03270-6

Bergland A, Jørgensen L, Emaus N, et al. Mobility as a predictor of all-cause mortality in older men and women: 11.8 year follow-up in the Tromsø study. BMC Health Serv Res. 2017;(17):22-45.https://doi.org/10.1186/s12913-016-1950-0

Chan PP, Si Tou JI, Tse MM, Ng SS. Reliability and Validity of the Timed Up and Go Test With a Motor Task in People With Chronic Stroke. Arch Phys Med Rehabil. 2017;98(11):2213-2220. doi:10.1016/j.apmr.2017.03.008

17.Jarvis LM, Peterson MJ, Caves KM. Development, Validity, and Reliability of a Novel Walking Speed Measurement Device: the GaitBox. Gait Posture. 2021;84:52-57. doi:10.1016/j.gaitpost.2020.11.009

Mostovov A, Jacobs D, Farid L, Dhellin P, et al.. Test-retest reliability of the six-minute walking distance measurements using FeetMe insoles by completely unassisted healthy adults in their homes. PLOS Digit Health. 2023;2(11):e0000262. Published 2023 Nov 22. doi:10.1371/journal.pdig.0000262

Lu L, He X, Ma L, et al. Effects of vibration training vs. conventional resistance training among community-dwelling older people with sarcopenia: three-arm randomized controlled trial protocol. Front Aging Neurosci. 2022;(14):90-100

Wei N, Pang MY, Ng SS, et al. Optimal frequency/time combination of whole-body vibration training for improving muscle size and strength of people with age-related muscle loss (sarcopenia): A randomized controlled trial. Geriatr Gerontol Int. 2017;(17):1412-20.https://doi.org/10.1111/ggi.12878

Lustosa L, Pereira D, Parentoni A, et al. Impact of aerobic training associated with muscle strengthening in elderly individuals at risk of sarcopenia: a clinical trial. J Gerontol Geriatr Res. 2015:75-89

Hassan BH, Hewitt J, Keogh JW, et al. Impact of resistance training on sarcopenia in nursing care facilities: A pilot study. Geriatr Nurs. 2016;(37):116-21.https://doi.org/10.1016/j.gerinurse.2015.11.001

Alfieri GR, Eaton AC, Dourvetakis K, et al. Impact of whole-body vibration therapy in elderly populations: A Scoping Review. Cureus. 2025;(17):36-75.https://doi.org/10.7759/cureus.79296

Moretti A, Tomaino F, Paoletta M, et al. Physical exercise for primary sarcopenia: an expert opinion. Front Rehabil Sci. 2025;(6):33-45.https://doi.org/10.3389/fresc.2025.1538336

Liu M, Li J, Xu J, et al. Graded progressive home-based Resistance combined with aerobic exercise in community-dwelling older adults with sarcopenia: A Randomized Controlled Trial. Clin Interv Aging. 2024;(19):1581-95.https://doi.org/10.2147/CIA.S473081

Wang B, Nong C, Zhang J, et al. Prevalence and associated body composition factors of sarcopenia in community-dwelling older adults. Eur J Med Res. 2024;(29):59-68.https://doi.org/10.1186/s40001-024-02185-9

Yang Y-F, Huang C-C, Chang C-M, et al. Effect of whole-body vibration training on physical fitness and postural control in working-age patients on haemodialysis. J Rehabil Med Clin Commun. 2021;(4):45-68.https://doi.org/10.2340/20030711-1000045

Jo N-G, Kang S-R, Ko M-H, et al. Effectiveness of whole-body vibration training to improve muscle strength and physical performance in older adults: prospective, single-blinded, Randomized Controlled Trial. Healthcare. 2021;(9):65-72.https://doi.org/10.3390/healthcare9060652

Wang X, Wang L, Wu Y, et al. Effect of different exercise interventions on grip strength, knee extensor strength, appendicular skeletal muscle index, and skeletal muscle index strength in patients with sarcopenia: A Meta-Analysis of Randomized Controlled Trials. Diseases. 2024;(12):71-85.https://doi.org/10.3390/diseases12040071

Gonçalves de Oliveira R, Coutinho HMEL, Martins MNM, et al. Impacts of whole-body vibration on muscle strength, power, and endurance in older adults: A Systematic Review and Meta-Analysis. J Clin Med. 2023;(12):44-67.https://doi.org/10.3390/jcm12134467

Zhang H, Huang Z, Li Y, et al. Effects of whole-body vibration training on lower extremity muscle strength and physical function in elderly patients with sarcopenia. Phys Med Rehab Kuror. 2024;(35):213-9.https://doi.org/10.1055/a-2314-4180

Nawrat-Szołtysik A, Sieradzka M, Nowacka-Chmielewska M, et al. Effect of whole-body vibration training on selected intrinsic risk factors in women aged 60+ at fall risk: A Randomized Controlled Trial. Int J Environ Res

Public Health. 2022;(19):17-36.https://doi.org/10.3390/ijerph192417066

Rathi MA, Joshi R, Desai R, et al. Effect of squat training with whole body vibration on balance and functional performance in elderly- A Quasi-experimental Study. J Clin Diagn Res. 2021:36-75.https://doi.org/10.7860/JCDR/2021/50115.15488

Saucedo F, Chavez EA, Vanderhoof HR, et al. Effects of controlled whole-body vibration training on functional performance among healthy older adults: A 6-Week Pilot Study. JAR life. 2021;(10):39-44.https://doi.org/10.14283/jarlife.2021.7.