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The Impact of Velocity-Based Resistance Training on Muscle Power, Gait Speed, and Fear of Falling in Older Adults at Risk of Sarcopenia

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ABSTRACT: This randomized controlled trial examined whether a 12-week velocity-based resistance training (VBRT) program could improve lower-limb muscle power, habitual gait speed, and fear of falling in community-dwelling older men at risk of sarcopenia. Forty-four men aged 65-82 years who met screening criteria for possible sarcopenia were allocated to VBRT (n = 22) or an active control condition (n = 22). The VBRT group completed three supervised sessions per week using real-time movement-velocity feedback and a low velocity-loss threshold to guide load adjustment and set termination; the control group attended mobility, stretching, and health-education sessions. The primary outcome was lower-limb peak power measured during a pneumatic leg-press test. Secondary outcomes included habitual 4-m gait speed, Falls Efficacy Scale-International (FES-I) score, five-times sit-to-stand time, and handgrip strength. Linear mixed models tested group, time, and group x time effects, with statistical significance set at $p < 0.05$. Forty-one participants completed post-testing, and we included all 44 randomized participants in intention-to-treat mixed models. Attendance in the VBRT group was 91.3%, and no serious adverse events occurred. Significant group x time interactions favoured VBRT for lower-limb power (between-group change: 61 W; 95% CI: 32 to 90 W; $p < 0.001$; Hedges $g = 0.72$), gait speed (0.08 m/s; 95% CI: 0.03 to 0.13 m/s; $p = 0.003$; $g = 0.61$), and FES-I score (-3.9 points; 95% CI: -6.1 to -1.7; $p = 0.002$; $g = -0.62$). Power improvements correlated with gait speed improvements ($r = 0.46$, $p = 0.009$), and gait-speed improvements correlated with lower fear of falling ($r = -0.34$, $p = 0.041$). These findings indicate that supervised VBRT is a feasible and well-tolerated training strategy for older men at risk of sarcopenia and may improve neuromuscular performance, walking capacity, and confidence during daily mobility.

Keywords: velocity-based resistance training; sarcopenia risk; muscle power; gait speed; functional mobility.

I. INTRODUCTION

Age-related loss of skeletal muscle function is a major concern for health systems, exercise professionals, and families because it threatens independence long before it becomes a clearly diagnosed medical disability. Contemporary sarcopenia definitions emphasize that low muscle strength is the principal clinical feature, while reduced muscle quantity confirms the diagnosis and impaired physical performance indicates more severe disease [1]. Asian and international screening algorithms center on low handgrip strength, slow gait speed, and poor chair-rise performance because they are practical, low-cost, and strongly linked to adverse outcomes [2]. For older men, these changes can be particularly consequential because retirement, comorbidity, and reduced

engagement in structured physical activity often occur at the same life stage as accelerated neuromuscular decline.

Clinical guidelines also underline that sarcopenia is not simply a matter of muscle mass. Screening and treatment recommendations emphasize resistance-based physical activity because the most relevant target is the capacity to produce force for daily tasks [3]. Sarcopenia overlaps with frailty but is not identical to it; the frailty phenotype includes weakness, slowness, exhaustion, inactivity, and unintentional weight loss, whereas sarcopenia focuses more directly on the muscle system and its functional consequences [4]. This distinction matters for intervention design. Programs that improve muscle function may influence both sarcopenia risk and frailty-related outcomes, but the exercise dose, movement speed, recovery period, and level of supervision need to be matched to older adults' functional reserve.

Gait speed has become one of the most widely used indicators of health status in later life. It is simple to measure, highly interpretable, and strongly associated with survival in pooled analyses of older adults [5]. Usual gait speed also predicts disability and functional decline, so small improvements matter when participants start below or near the threshold commonly used to identify elevated mobility risk [6]. In community settings, increasing habitual gait speed by approximately 0.05-0.10 m/s can represent a meaningful change because it may allow an older adult to walk more safely in the community, cross roads with less hesitation, and complete daily tasks with less perceived effort.

Fear of falling is another outcome that deserves attention in exercise trials involving older adults at risk of sarcopenia. The Falls Efficacy Scale-International assesses concern about falling across a range of activities, not just during basic transfers [7]. Earlier work on falls efficacy showed that fear can exist even without a recent fall and may restrict activity independently of objective capacity [8]. Exercise interventions can reduce fear of falling in community-dwelling older people, although effects are often modest and may depend on whether the program improves both physical capability and perceived control [9]. Therefore, an intervention that improves rapid force production and walking ability could have behavioral effects beyond its direct neuromuscular effects.

Progressive resistance training is one of the most consistently supported non-pharmacological approaches for older adults. Meta-analytic evidence shows that resistance exercise improves muscular strength in older populations [10], and professional position statements recommend carefully supervised, progressive programs that include individualization and appropriate recovery [11]. However, traditional resistance training often focuses on maximal force production or fixed percentages of one-repetition maximum. Although these methods can increase strength, they may not fully address the rapid-force demands of daily living, such as arresting a trip, rising quickly from a chair, climbing stairs, or recovering balance after a perturbation.

Muscle power equals force times velocity, and it tends to decline earlier and faster than maximal strength. Systematic reviews indicate that resistance training can improve lower-extremity power in middle-aged and older adults [12], but power appears especially relevant to functional independence because it captures how quickly force can be produced. Reviews of aging and muscle power have argued that power may explain mobility limitations more directly than strength alone [13], [14]. Mechanistic discussions of high-velocity training further suggest that rapid concentric intent may improve neural drive, motor-unit recruitment, rate of force development, and task-specific transfer [15].

Power-oriented training has therefore become an important area of gerontological exercise science. Meta-analytic comparisons show that power training is feasible in older persons and may offer advantages for functional outcomes compared with conventional slow resistance training [16]. Multicomponent and resistance-based programs can also reduce fall-related risk by improving gait, balance, and lower-limb capacity [17]. More specifically, systematic reviews of resistance training concentric velocity suggest that faster concentric execution can improve functional capacity in older adults more than slow-only approaches when programs are carefully prescribed [18].

The quality of each repetition may be as important as the external load. Evidence on resistance training velocity and rate of force development indicates that fast intent and movement specificity contribute to improvements in rapid force expression [19]. Gait and balance reviews also show that resistance training can improve straight-line walking speed and balance-related parameters in older people [20]. Reviews linking

aging, sarcopenia, falls, and resistance training further support a combined focus on strength, power, and mobility rather than an isolated emphasis on hypertrophy [21].

Movement velocity can estimate relative load, monitor fatigue, regulate set termination, and adjust training loads within and between sessions. Foundational work has shown strong relationships between movement velocity and relative intensity in resistance exercise [22], and velocity loss during a set has been proposed as an objective marker of neuromuscular fatigue [23]. Subsequent studies showed that restricting velocity loss can preserve high-quality repetitions and influence strength and power adaptation [24]. Applied reviews describe VBRT as a practical bridge between laboratory testing and day-to-day coaching because it lets practitioners use immediate feedback rather than relying only on a strength test performed weeks earlier [25].

Research directly applying VBRT in older adults remains smaller than the broader literature in athletes, but the available evidence is promising. A velocity-based approach has been associated with improved functional capacity and strength in older adults [26], and power training studies have linked improved neuromuscular activation to gait-speed changes in mobility-limited participants [27]. Recent reviews of high-speed resistance training in independent older adults also report favorable effects on physical performance outcomes [28]. Earlier trials of power-oriented resistance exercise demonstrated functional benefits in community-dwelling older adults [29] and suggested that different loading zones can improve muscle power when concentric actions are performed explosively [30].

Despite this evidence, studies still need to link VBRT, sarcopenia risk, gait speed, and fear of falling within the same intervention. Many studies report strength or performance outcomes but do not measure psychological confidence, while many fear-of-falling studies use balance or multicomponent interventions without directly targeting movement velocity. Older men at risk of sarcopenia may benefit from a program that is both precise and acceptable: precise enough to regulate loading through velocity feedback, and acceptable enough to avoid excessive soreness, fatigue, or discouragement. This study aimed to address this gap by testing whether a supervised, low-fatigue VBRT program could improve lower-limb power, habitual gait speed, and fear of falling over 12 weeks.

II. AIMS AND HYPOTHESES

1. *AIMS*

- To determine whether 12 weeks of VBRT improves lower-limb muscle power compared with an active control condition.
- To examine whether VBRT improves habitual gait speed in older men at risk of sarcopenia.
- To determine whether changes in functional capacity are accompanied by lower fear of falling, assessed using the FES-I.
- To evaluate adherence, tolerability, and adverse events during a supervised velocity-guided programme.
- To explore whether changes in lower-limb power are associated with changes in gait speed and fear of falling.

2. *HYPOTHESES*

- Participants allocated to VBRT will show a greater increase in lower-limb muscle power than participants allocated to the active control condition.
- Participants allocated to VBRT will show a greater improvement in habitual gait speed than participants allocated to the active control condition.
- Participants allocated to VBRT will show a greater reduction in FES-I score, indicating lower concern about falling, than participants allocated to the active control condition.
- Improvements in lower-limb power will be positively associated with improvements in gait speed and inversely associated with fear-of-falling scores.

III. RELATED WORK

Sarcopenia research has moved from a narrow focus on muscle mass toward a broader understanding of muscle function. The most influential consensus statements now emphasize low strength and impaired physical performance because these features most directly affect daily life [1], [2]. In older men, reduced lower-limb strength and power can compromise the ability to rise from a chair, climb steps, accelerate during walking, and recover after slips [13], [14]. Low muscle quantity may contribute to these limitations, but muscle quality, neural activation, tendon stiffness, motor coordination, and confidence also shape functional outcomes [15]. This is why exercise interventions should be judged by more than their effect on muscle size alone [3], [11].

Screening for sarcopenia risk in community settings often combines symptom-based questionnaires with simple performance tests. The SARC-F questionnaire is widely used because it captures perceived difficulty with strength tasks, walking, stair climbing, rising from a chair, and falls, and consensus algorithms recommend pairing symptom screening with objective markers of strength and performance [1], [2]. However, SARC-F is more useful as a case-finding tool when combined with objective markers such as grip strength, gait speed, or chair-rise time [2], [3]. For men, handgrip cut-points in consensus algorithms are generally higher than those used for women, and gait speed below approximately 1.0 m/s is often treated as a warning sign [1], [2], [6]. The present study therefore focused on men with a cluster of risk indicators rather than men with severe disability, because early intervention is more likely to preserve independence [5], [6].

Programmes emphasising progressive overload can increase maximal strength even in advanced age [10], [11]. Nevertheless, strength gains do not always transfer proportionally to walking speed or balance confidence, partly because functional mobility depends on rapid force production, coordination, and task-specific practice [12]-[15]. Several explanations are possible. First, maximal strength tests are usually slow and controlled, while daily mobility often requires a rapid response. Second, older adults may improve force capacity without learning to express that force quickly. Third, fatigue-heavy programs may cause soreness or caution that limits confidence in movement. These issues have encouraged researchers to examine power-oriented training methods [16], [18].

Power-oriented resistance training usually requires participants to perform the concentric phase as quickly as safely possible and then return the load under control. This structure targets the velocity component of muscle power while maintaining safety [15], [16]. In older adults, power training is not the same as maximal or ballistic exercise. It can be implemented on machines with moderate loads and strict supervision [29], [30]. The key coaching instruction is intentional fast movement, not uncontrolled movement. This distinction is important for older men at risk of sarcopenia because they may need to train rapid force production without exposing joints or balance to unnecessary risk [11], [18].

Lower-extremity muscle power is closely related to gait speed, stair-climb performance, and chair-rise ability [12]-[14]. These outcomes require force production within a limited time window. A person may be able to generate sufficient force during a slow test but still struggle when the same force must be generated quickly during a real-life task [13], [15]. The decline in rapid force production may therefore explain why some older adults appear only mildly weak in clinical testing yet experience difficulty with sudden balance recovery or outdoor walking [14], [27].

Gait speed is a particularly useful outcome because it integrates strength, balance, coordination, confidence, and cardiorespiratory reserve. It is also familiar to clinicians and can be measured with minimal equipment. Large cohort evidence shows that usual gait speed is strongly associated with survival and functional prognosis in older adults [5], [6]. A gait-speed increase of 0.08-0.12 m/s, while seemingly small, can be meaningful for an older adult who starts below 1.0 m/s [6], [20]. Such a change may shift an individual from a frailty- and disability-associated risk category toward a more independent walking profile. Because gait speed reflects integrated function, it provides a practical test of whether a resistance program transfers beyond the exercise machine [20], [21].

A man who has lost confidence may slow his walking, avoid uneven surfaces, reduce social activity, and gradually lose further strength. This cycle can occur even without a recent fall, because falls efficacy reflects perceived capability as well as actual physical performance [8]. Fear of falling is therefore both a consequence and a driver of functional decline. The FES-I is useful because it assesses concern during common activities, from basic to socially demanding tasks [7]. A reduction in FES-I score after training may indicate that

participants feel more capable and less threatened by movement, which is consistent with evidence that exercise can reduce concern about falling in community-dwelling older adults [9].

Exercise can reduce concern about falling. Balance training may improve postural control, multicomponent training may improve general function, and resistance training may increase confidence by making everyday tasks feel less demanding [9], [17], [20]. VBRT may add another mechanism: it provides immediate, objective feedback. When participants see that they can move a load faster, maintain quality, and progress safely, they may develop a stronger sense of control over their movement [22], [25]. This feedback loop could be especially helpful for older men who hesitate to do vigorous exercise because of fear, pain, or prior negative training experiences [7]-[9].

Velocity monitoring is grounded in the relationship between load and movement speed. As relative load increases, concentric velocity generally decreases, allowing movement velocity to serve as a practical indicator of loading intensity [22]. Conversely, as fatigue accumulates during a set, velocity declines even when external load remains constant [23]. Practitioners can use these patterns to prescribe a target velocity zone, adjust load based on daily readiness, and stop a set when velocity loss exceeds a planned threshold [23]-[25]. Instead of asking every participant to complete the same number of repetitions regardless of fatigue, VBRT allows the exercise dose to respond to the person in front of the practitioner [25], [26].

This approach is attractive for older adults because readiness fluctuates. Sleep, medication, joint discomfort, hydration, recent activity, and emotional stress can all affect performance. A fixed percentage of a previous strength test may be too heavy on one day and too light on another. Velocity feedback provides a practical method of autoregulation because it links load adjustment to the actual speed and quality of each repetition [22], [25]. If the participant moves a warm-up load slower than expected, the practitioner can reduce the training load. If the participant moves the load faster than expected and maintains technique, a small progression can be introduced. This individualisation may reduce unnecessary fatigue while preserving the stimulus needed for adaptation [11], [23], [24].

A high velocity loss within a set implies that later repetitions are slower, more fatiguing, and less specific to rapid force production [23], [24]. Low velocity-loss thresholds, such as 10-20%, prioritize movement quality and reduce metabolic fatigue, consistent with the goal of preserving high-velocity concentric actions [15], [19]. For older men at risk of sarcopenia, this may be preferable to training near failure because the goal is not maximal exhaustion. The goal is repeated exposure to fast, technically sound concentric actions that build confidence and transfer to functional tasks [18], [25], [26].

The evidence base for VBRT in older adults is still developing, but several related research streams support its use. First, traditional resistance training improves strength and physical function in older adults [10], [11]. Second, power training can provide additional benefits for functional outcomes [12], [16], [29], [30]. Third, fast-intentional movements improve rate of force development and may enhance task-specific neuromuscular transfer [15], [19], [27]. Fourth, velocity monitoring has been validated as a tool for prescribing and regulating resistance exercise [22]-[25]. Together, these findings support the rationale for testing VBRT as an intervention for men at risk of sarcopenia [26], [28].

The present study extends this work by focusing on three outcomes that matter to older adults and clinicians: lower-limb power, habitual gait speed, and fear of falling. Muscle power represents the primary neuromuscular mechanism [12]-[15]. Gait speed represents functional transfer and is strongly associated with clinically meaningful prognosis [5], [6], [20]. Fear of falling reflects confidence and behavior and can limit activity even when physical capacity improves [7]-[9]. Studying these outcomes together allows a more complete interpretation than studying strength alone. If power improves without gait change, the intervention may lack transfer. If gait improves without confidence change, participants may still restrict activity. If both physical and psychological outcomes improve, the programme may be more useful in community practice [17], [21].

We chose a male-only sample to reduce sex-related variability in strength thresholds, body composition, and baseline performance. This improves internal consistency but limits generalization to women. Consensus statements use sex-specific strength thresholds, supporting the need to interpret male and female sarcopenia risk profiles separately [1], [2]. The decision also reflects the need for more exercise trials focused specifically on older men at sarcopenia risk, because men may be less likely to participate in community fall-prevention

programmes and may respond differently to coaching style, feedback, and performance monitoring. A structured VBRT programme may be acceptable for this group because it uses measurable progress, clear targets, and exercise language familiar to sport and strength settings [11], [25], [26].

IV. MATERIAL AND METHOD

1. STUDY DESIGN

This study used a two-arm, parallel-group randomized controlled design with baseline and 12-week assessments. Participants were community-dwelling men aged 65 years or older who were at risk of sarcopenia but able to walk independently with or without a customary aid. The trial compared a supervised VBRT intervention with an active control condition consisting of mobility, flexibility, and health-education sessions. The study protocol followed the ethical principles of the Declaration of Helsinki. Participants provided written informed consent before participation.

2. PARTICIPANTS

We recruited participants through community centers, primary-care notice boards, and local older-adult activity networks. Interested men completed an initial telephone screening followed by an in-person assessment. Inclusion criteria were: age 65-82 years; male sex; SARC-F score of 4 or higher or a score of 3 with at least one objective functional risk marker; ability to attend supervised sessions; medical clearance for moderate-intensity resistance exercise; and willingness to avoid starting a new structured resistance programme during the trial. Functional risk markers included handgrip strength below accepted male thresholds, five-times sit-to-stand time of 12 seconds or longer, or habitual gait speed below 1.0 m/s.

Exclusion criteria were unstable cardiovascular disease, uncontrolled hypertension, recent myocardial infarction or stroke, severe knee or hip osteoarthritis preventing machine-based lower-limb exercise, neurological disorders substantially affecting gait, fracture or major surgery during the previous six months, severe visual or vestibular impairment, progressive cognitive impairment limiting safe participation, and participation in structured resistance training more than once per week during the previous three months. Participants were advised to continue usual medical care and medications throughout the study.

Randomisation occurred after baseline assessment using a computer-generated allocation sequence with a 1:1 ratio and block sizes of four. A researcher not involved in testing or supervision prepared sequentially numbered, opaque envelopes to conceal allocation. Outcome assessors were blinded to group allocation. Participants and exercise supervisors could not be blinded because of the nature of the intervention. To minimize expectation bias, both groups were informed that the study compared two supervised activity models for older-adult mobility and confidence.

The VBRT group trained three times per week for 12 weeks. Each session lasted about 50-60 minutes and was supervised by exercise professionals experienced in resistance training for older adults. Sessions began with eight minutes of low-intensity cycling or treadmill walking, followed by dynamic mobility exercises for the hips, knees, ankles, thoracic spine, and shoulders. Participants then completed one or two warm-up sets for the primary lower-limb exercise while the supervisor checked technique and established daily movement quality.

The exercise programme included a sit-to-stand squat variation, 45-degree leg press, knee extension, calf raise, hip hinge or cable pull-through, seated row, and chest press. The lower-limb exercises received priority because the primary outcome was lower-limb power and the main functional target was gait. We included upper-body exercises to balance the session and maintain engagement. The concentric phase of each repetition was performed with the instruction “move fast but stay controlled,” while the eccentric phase was performed under control for approximately two seconds.

We measured movement velocity with a commercially available linear position transducer or inertial velocity device, attached according to the manufacturer's instructions. The primary training range was set so that participants performed repetitions at a velocity consistent with moderate loading and power-oriented intent. Sets were terminated when mean concentric velocity fell by approximately 15% from the fastest successful repetition in that set or when technique deteriorated. We chose this low velocity-loss threshold to

preserve repetition quality and avoid excessive fatigue. Loads were increased by 2-5% in the following session when the participant completed all prescribed sets above the target velocity range with stable technique and no adverse symptoms.

During weeks 1-2, participants performed two sets of 8-10 repetitions at light-to-moderate loads to learn technique and become familiar with feedback. During weeks 3-8, lower-limb exercises progressed to two or three sets of 6-8 repetitions with velocity loss capped at approximately 15%. During weeks 9-12, participants maintained the same velocity-loss threshold but loads were adjusted more frequently based on readiness and movement quality. Rest intervals ranged from 90 to 150 seconds. Rating of perceived exertion was monitored after major exercises, with the target session effort generally between 5 and 7 on a 0-10 scale.

The active control group attended one supervised weekly session lasting 45-55 minutes. Sessions included light stretching, breathing exercises, low-intensity mobility drills, and health-education discussions about sleep, hydration, safe walking, and general physical activity. Control participants were asked to maintain usual daily activity and avoid starting resistance training during the study. We selected this condition to reduce attrition and provide equivalent social contact without delivering a targeted resistance-training stimulus.

The primary outcome was lower-limb peak muscle power measured during a pneumatic leg-press test. After familiarisation and warm-up trials, participants completed repeated efforts against progressive loads until peak power could be identified safely. The best value across valid trials was recorded in watts. Habitual gait speed was assessed using a 4-m walk at the participant's usual pace. Participants completed three trials from a standing start, and we used the average speed for analysis. We measured fear of falling with the FES-I, a 16-item scale in which higher scores indicate greater concern about falling. Secondary outcomes included handgrip strength using a calibrated dynamometer and five-times sit-to-stand time from a standard-height chair.

Safety was monitored at every training session. Supervisors recorded attendance, load modifications, symptoms, and adverse events. Participants reported mild, transient soreness if it did not limit ordinary activities beyond 48 hours. Serious adverse events were defined as events requiring medical attention, hospitalization, or withdrawal because of exercise-related injury. Participants were encouraged to report any fall, near fall, or musculoskeletal complaint occurring during the intervention period, regardless of whether it occurred during training.

V. STATISTICAL ANALYSIS

We used linear mixed models because they accommodate repeated measures and incomplete post-test data without excluding participants who withdrew after randomization. Each model included fi×ed effects for group, time, and group × time interaction, with a random intercept for participant. The group × time interaction was the primary statistical test for intervention effect. Baseline comparability was e×amined using independent-samples t tests for continuous variables and Fisher's e×act test for categorical variables. Statistical significance was set at $p < 0.05$.

We reported estimated marginal means, mean changes, between-group differences in change, 95% confidence intervals, F statistics, and p values. We calculated Hedges' g for the between-group difference in change scores to provide an interpretable standardized effect size corrected for small-sample bias. We examined correlations between changes in lower-limb power, gait speed, and FES-I scores using Pearson correlation coefficients when residuals were approximately normally distributed. Descriptive safety data included attendance, withdrawals, soreness reports, falls, and serious adverse events.

VI. DATA ANALYSIS

We screened 61 men; 44 met the eligibility criteria, and we randomized 44. The VBRT group included 22 participants and the active control group included 22 participants. Forty-one participants completed post-testing. One participant in the VBRT group withdrew due to relocation, and two control participants withdrew due to scheduling conflicts. The mixed-model analyses included all randomised participants. Figure 1 presents the participant flow. The figure shows that attrition was low and balanced enough to support interpretation of the intervention effects.

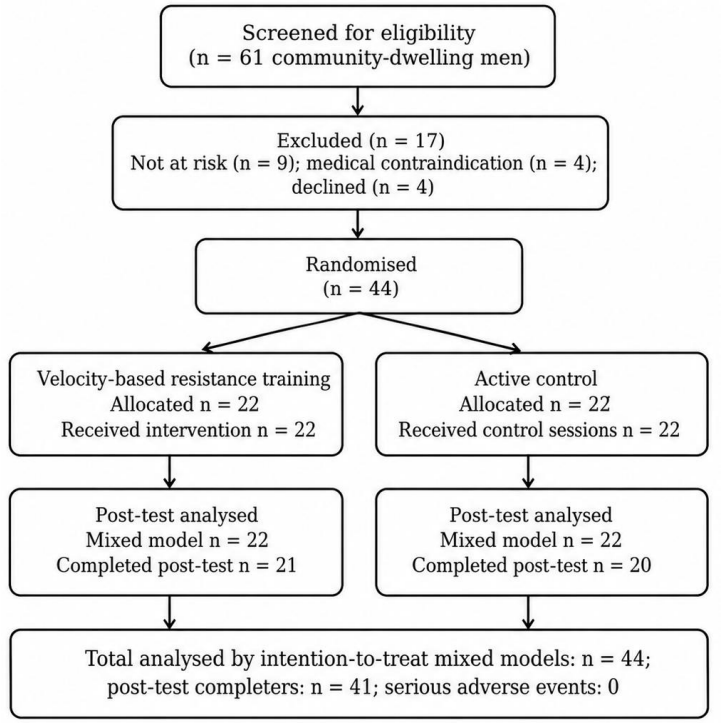


FIGURE 1. Participant flow through screening, randomisation, intervention, and analysis.

Table 1 presents baseline characteristics. The groups were similar in age, body mass index, SARC-F score, handgrip strength, five-times sit-to-stand time, lower-limb power, habitual gait speed, and FES-I score. The baseline profile indicates a male sample with early functional risk: gait speed was below or close to 1.0 m/s, SARC-F scores were elevated, and chair-rise performance was slow enough to suggest reduced lower-limb function. These values are consistent with an at-risk group rather than a severely disabled sample.

Table 1. Baseline characteristics of the male study sample.

Variable	VBRT (n = 22)	Control (n = 22)	p value
Age, years	72.9 ± 4.6	73.2 ± 4.8	0.832
Body mass index, kg/m²	26.9 ± 3.4	27.2 ± 3.6	0.777
Male sex, n (%)	22 (100)	22 (100)	1.000
SARC-F score	4.7 ± 1.0	4.8 ± 1.1	0.754
Handgrip strength, kg	25.8 ± 3.6	26.1 ± 3.9	0.792
Five-times sit-to-stand, s	14.3 ± 2.4	14.1 ± 2.6	0.792
Lower-limb peak power, W	486 ± 107	491 ± 104	0.875
Habitual gait speed, m/s	0.90 ± 0.12	0.91 ± 0.13	0.792
FES-I score	30.1 ± 5.9	29.8 ± 6.1	0.868

Values are mean ± SD. Baseline comparisons used independent-samples t tests or Fisher's exact test as appropriate. VBRT: velocity-based resistance training; FES-I: Falls Efficacy Scale-International.

Training exposure and safety outcomes are shown in Table 2. Attendance in the VBRT group was high, with participants completing 91.3% of scheduled sessions. Participants completed an average of 32.9 of 36 resistance-training sessions. The average perceived exertion rating remained moderate, suggesting the low velocity-loss strategy delivered a challenging but tolerable stimulus. No serious adverse events occurred. Three participants

reported mild, transient knee soreness during the first two weeks, which resolved after load reduction, technique adjustment, and a longer warm-up.

Table 2. Intervention exposure, adherence, and safety during the 12-week program.

Measure	VBRT group	Control group
Scheduled supervised sessions, n	36	12
Completed sessions, n	32.9 ± 3.1	10.9 ± 1.4
Attendance, %	91.3 ± 8.6	90.8 ± 11.7
Mean session duration, min	54.2 ± 5.7	47.8 ± 4.9
Mean session RPE (0-10)	6.1 ± 0.8	2.4 ± 0.7
Mild transient soreness, n	3	1
Falls reported during study period, n	1	2
Serious adverse events, n	0	0

RPE: rating of perceived exertion. Reported falls occurred outside supervised sessions and did not require medical treatment.

The main outcome results are shown in Table 3 and Figure 2. A significant group × time interaction favoured VBRT for lower-limb peak power. The VBRT group improved from 486 ± 107 W to 566 ± 116 W, whereas the control group changed from 491 ± 104 W to 510 ± 107 W. The between-group difference in change was 61 W (95% CI: 32 to 90 W), with $p < 0.001$ and Hedges $g = 0.72$. This magnitude represents a moderate effect and indicates that the velocity-guided programme improved the primary neuromuscular outcome beyond the change observed with light mobility and education.

Habitual gait speed also improved significantly more in the VBRT group. The mean increase was 0.12 m/s in the VBRT group and 0.04 m/s in the control group, producing a between-group difference of 0.08 m/s (95% CI: 0.03 to 0.13 m/s; $p = 0.003$; $g = 0.61$). This result is clinically relevant because participants started below or near the commonly used 1.0 m/s threshold, and the VBRT group's post-intervention mean exceeded that level. VBRT also improved five-times sit-to-stand time and handgrip strength more, supporting the program's broader functional effect.

Fear of falling decreased after VBRT. The FES-I score fell from 30.1 ± 5.9 to 24.9 ± 5.5 in the VBRT group, compared with a smaller reduction from 29.8 ± 6.1 to 28.5 ± 5.7 in the control group. The between-group difference in change was -3.9 points (95% CI: -6.1 to -1.7; $p = 0.002$; $g = -0.62$). Because lower FES-I scores indicate less concern about falling, this result suggests that gains in power and walking capacity were accompanied by improved confidence in daily activities.

Table 3. Main and secondary outcomes before and after the 12-week intervention.

Outcome	VBRT baseline	VBRT 12 weeks	Control baseline	Control 12 weeks	Between-group change (95% CI)	F	p value	Hedges g
Lower-limb peak power (W)	486 ± 107	566 ± 116	491 ± 104	510 ± 107	61 (32 to 90)	18.31	<0.001	0.72
Habitual gait speed (m/s)	0.90 ± 0.12	1.02 ± 0.13	0.91 ± 0.13	0.95 ± 0.12	0.08 (0.03 to 0.13)	10.78	0.003	0.61
FES-I score	30.1 ± 5.9	24.9 ± 5.5	29.8 ± 6.1	28.5 ± 5.7	-3.9 (-6.1 to -1.7)	11.94	0.002	-0.62

Five-times sit-to-stand (s)	14.3 ± 2.4	12.2 ± 2.2	14.1 ± 2.6	13.6 ± 2.5	-1.6 (-2.6 to -0.6)	9.44	0.004	-0.59
Handgrip strength (kg)	25.8 ± 3.6	28.1 ± 3.8	26.1 ± 3.9	26.5 ± 3.7	1.9 (0.4 to 3.4)	6.84	0.012	0.51

Values are mean ± SD unless otherwise indicated. Between-group change refers to the difference in change from baseline to 12 weeks estimated from mixed models. FES-I: Falls Efficacy Scale-International; VBRT: velocity-based resistance training.

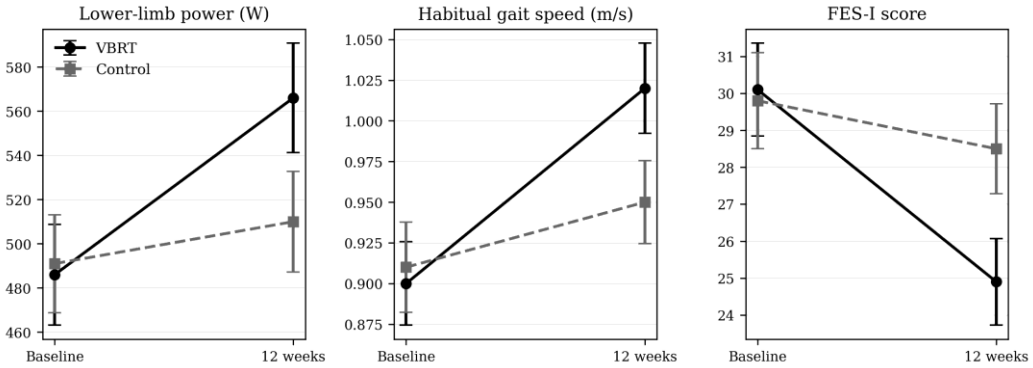


FIGURE 2. Baseline-to-12-week trajectories for lower-limb peak power, habitual gait speed, and FES-I score. Error bars show standard error of the mean.

Figure 2 reinforces the numerical pattern in Table 3. The separation between groups was greatest for lower-limb power, the primary outcome. The gait-speed panel shows a smaller but functionally meaningful shift, with the VBRT mean moving above 1.0 m/s at 12 weeks. The FES-I panel shows a downward trajectory in the VBRT group, indicating reduced concern about falling, while the control group changed only slightly.

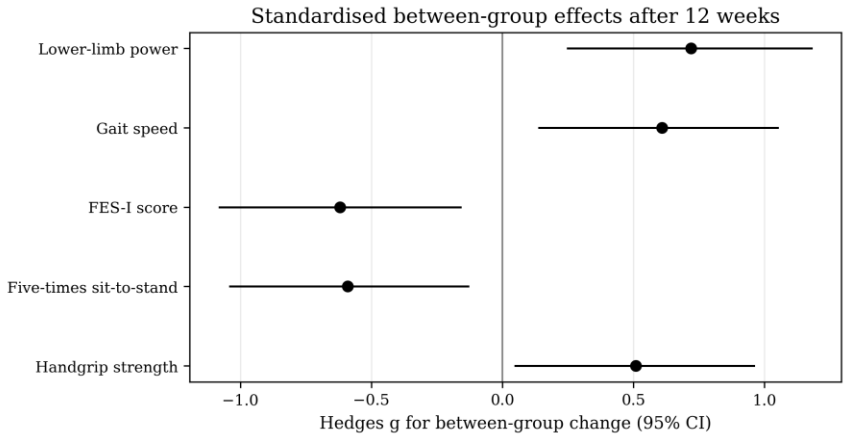


FIGURE 3. Hedges g values for between-group changes in primary and secondary outcomes. Negative values favour VBRT for outcomes where lower scores indicate improvement.

The standardized effects in Figure 3 show that VBRT produced moderate improvements across the main outcomes. The direction of the FES-I and chair-rise effects is negative because lower scores and faster times represent improvement. The consistency of the effects across power, gait speed, chair-rise performance, and

fear of falling supports the interpretation that the programme improved both neuromuscular capacity and functional confidence.

Exploratory correlations supported a mechanistic link between changes in power and walking performance. Lower-limb peak power increased were moderately associated with improved gait speed ($r = 0.46$, $p = 0.009$). Gait speed improvement was associated with a reduction in FES-I score ($r = -0.34$, $p = 0.041$). The association between power change and FES-I change was weaker and did not reach statistical significance ($r = -0.27$, $p = 0.084$). These findings suggest that improved rapid force production may contribute to better walking performance, while confidence may improve partly through the experience of walking more effectively.

VII. DISCUSSION

The main finding was that 12 weeks of supervised VBRT improved lower-limb muscle power, habitual gait speed, and fear of falling in older men at risk of sarcopenia. The intervention effect was strongest for lower-limb peak power, as expected, because the program specifically targeted high-quality concentric intent and used velocity feedback to regulate fatigue. The moderate effect on gait speed indicates meaningful functional transfer, while the reduction in FES-I score suggests that physical improvement was accompanied by greater confidence during daily activities.

The improvement in lower-limb power is consistent with the broader literature showing that power-oriented resistance exercise can improve functional performance in older adults. Previous reviews have argued that power declines faster than maximal strength and is more closely related to mobility outcomes. The present findings support that interpretation by showing that a training model designed around movement speed produced a clear gain in peak power. Using a low velocity-loss threshold may have helped preserve the training stimulus. Instead of completing slow, fatiguing repetitions at the end of a set, participants performed fewer, higher-quality repetitions with faster concentric intent.

Meta-analyses of resistance training in older adults show consistent strength improvements, but functional transfer varies depending on programme design, velocity, and baseline limitations. The VBRT group's gait-speed gain of 0.12 m/s is not exaggerated; it falls within a clinically meaningful range for older adults starting near mobility-risk thresholds. The control group also improved slightly, likely because supervised mobility sessions, social contact, and repeated testing can produce modest benefits. The between-group difference therefore provides a more conservative estimate of the VBRT-specific effect.

The gait-speed outcome aligns with previous research indicating that resistance training can improve walking speed and balance-related parameters in older adults. However, this intervention differs from many traditional programs because load progression was not based solely on fixed percentages or repetitions to fatigue. By using velocity feedback, supervisors adjusted load to daily readiness and maintained rapid movement intent. This may be particularly important for gait because walking requires repeated submaximal force production under time constraints. An older man who can generate force faster during leg extension, leg press, and sit-to-stand patterns may be better able to increase step propulsion and walking rhythm.

Reducing fear of falling matters because fear may prevent older adults from using their improved physical capacity. The FES-I change suggests that participants perceived daily activities as less threatening after training. This finding aligns with exercise reviews showing that fear of falling can be reduced, but it adds specificity by showing improvement after a velocity-guided resistance program rather than a conventional balance-only approach. The likely explanation is multifactorial: participants became stronger and more powerful, saw objective evidence of progress, practiced controlled, high-intent movement, and repeatedly experienced safe exposure to challenging lower-limb tasks under supervision.

The moderate association between lower-limb power change and gait-speed change supports the idea that rapid force production contributed to walking improvement. The association between gait-speed improvement and lower FES-I scores suggests that confidence may be partly linked to observable functional gains. However, the relationship between power and fear of falling was weaker. This suggests that power alone does not determine psychological confidence. Balance history, previous falls, perceived health, pain, social support, and environmental challenge probably influence fear of falling. Future studies should include mediators such as balance confidence, physical activity participation, and gait variability.

Attendance was high, and no serious adverse events occurred. Mild soreness was manageable and resolved with small load adjustments. This matters because some clinicians may hesitate to prescribe fast-intentional resistance training to older adults at sarcopenia risk. The present programme was not maximal. It used supervision, familiarisation, controlled eccentric phases, moderate perceived effort, and velocity-based set termination. These safeguards allowed participants to train with intent without training to failure. The result was a programme that was both challenging and tolerable.

Early power-training trials in older adults showed that power-oriented protocols can improve whole-body function more than traditional strength approaches. Studies examining optimal loading for explosive resistance training suggest that power can improve across load zones when the movement intent is fast. Reviews of concentric velocity in older adults indicate that faster execution may provide better transfer to functional outcomes than slow-only training. The present findings are compatible with all three lines of evidence, but they add the practical element of velocity monitoring. This allows intensity and fatigue to be individualised rather than assumed.

The present results support VBRT for older men at risk of sarcopenia, not for all older adults. Replication in women and mixed-sex samples is necessary. It would also be useful to examine whether baseline strength, baseline gait speed, or prior fall history modifies response to VBRT.

The study has limitations. The sample size was modest, and the 12-week intervention was sufficient to observe early adaptation but not enough to assess long-term maintenance. Fall incidence was recorded for safety, but the study was not powered to detect differences in falls. Muscle mass was not the primary outcome, and the study focused on sarcopenia risk rather than confirmed sarcopenia diagnosed by imaging or bioimpedance. Finally, the intervention required trained supervision and velocity-monitoring equipment, which may limit immediate implementation in low-resource settings.

Future research should compare VBRT directly with traditional percentage-based resistance training using matched exercises, frequency, and supervision. Such trials would clarify whether velocity feedback itself adds benefit beyond fast-intentional training. Longer follow-up is also needed to determine whether improvements in power, gait speed, and FES-I scores persist after supervised training ends. Additional outcomes such as daily step count, fall incidence, quality of life, balance perturbation responses, and health-service use would help determine whether VBRT produces benefits beyond laboratory and clinic-based tests.

The findings support VBRT as a precise and clinically relevant strategy for older men at risk of sarcopenia. The programme addressed the specific deficit that threatens mobility: the reduced ability to generate force quickly. It also respected the variability of older bodies by adjusting load to actual movement performance. This combination of intent, feedback, and fatigue control may explain improvements in muscle power, walking speed, and fear of falling.

VIII. CONCLUSION

A 12-week supervised velocity-based resistance training programme improved lower-limb muscle power, habitual gait speed, and fear of falling in community-dwelling older men at risk of sarcopenia. The intervention was feasible, well attended, and safe under professional supervision, with no serious adverse events and only mild transient soreness in a small number of participants. The strongest effect was in lower-limb peak power, supporting the idea that training with fast concentric intent and low velocity loss can target a key mechanism of functional decline in later life. The gait-speed improvement was also meaningful because participants began near a mobility-risk threshold and moved toward a more favourable walking profile after training.

The reduction in FES-I score broadens the findings' relevance beyond physical performance. Older adults often restrict activity because they do not trust their ability to move safely, and this restriction can accelerate deconditioning. By improving power and walking speed while providing immediate feedback and supervised progression, VBRT may help older men feel more capable during daily activities. The correlation between power and gait-speed improvements suggests that better rapid force production contributed to functional transfer, while the association between gait speed and FES-I reduction suggests that improved walking capacity may support movement confidence.

The findings should be interpreted within the limits of a modest, single-center trial and should not be extended to fall prevention or long-term disability outcomes without further evidence. The study was not

powered for fall incidence, did not test post-intervention maintenance, and did not include women or participants with severe frailty. Nevertheless, the results are consistent with previous work on resistance training, power-oriented exercise, and velocity-guided prescription. They suggest that VBRT can be more than a sport-performance tool; when adapted appropriately, it can serve as a structured clinical exercise method for older men with early signs of sarcopenia risk.

In conclusion, VBRT appears to be a promising intervention for improving the neuromuscular and functional characteristics that matter for independent ageing. Its value lies in combining progressive resistance training with objective movement feedback, autoregulated loading, and fatigue control. This lets older participants train at a purposeful speed while maintaining safety and technique. Larger multicentre trials should now test whether these benefits are reproducible, whether they persist after supervision, and whether they reduce clinically important outcomes such as falls, activity restriction, and loss of independence. Until such evidence is available, supervised VBRT can be considered a rational and evidence-informed approach for improving power, walking performance, and confidence in older men at risk of sarcopenia.

Author Contributions

The author conducted the conceptualization, methodology, data analysis, investigation, writing, review, editing, and final approval of the manuscript.

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Data Availability

The dataset will be available from the author upon reasonable request.

Conflicts of Interest

The author declares no conflict of interest.

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