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EFFECTIVENESS OF FIGURE-OF-EIGHT WALKING ON FUNCTIONAL FITNESS, BALANCE, AND BLOOD PRESSURE AMONG MIDDLE-AGED HYPERTENSIVE ADULTS

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ABSTRACT

Background: Curved-path walking tasks such as the Figure-of-Eight Walk Test (F8WT) capture everyday walking skill, balance and mobility more comprehensively than straight-path gait tests. Although regular walking is known to reduce blood pressure, and F8WT has been validated as a measure of functional mobility, there is limited evidence on the use of figure-of-eight walking as a therapeutic intervention, particularly in hypertensive adults. Aim: This study aims to evaluate the effectiveness of a structured figure-of-eight walking programme on functional fitness, balance and blood pressure among middle-aged adults with hypertension. Methods: A randomized controlled trial will assign adults aged 40–65 years with hypertension to either (a) a 12-week supervised and home-based figure-of-eight walking intervention plus usual care or (b) usual care alone. Primary outcomes will be changes in functional fitness and balance, assessed using the F8WT, timed up-and-go test and chair stand test; secondary outcomes include clinic blood pressure and resting heart rate. Expected significance: Demonstrating improvements in both mobility and blood pressure would support figure-of-eight walking as an efficient, low-cost, nurse-delivered intervention for hypertensive adults at risk of mobility decline.

Keywords: *Hypertension, Figure-of-eight walking, Functional fitness, Blood pressure, middle-aged adults.*

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INTRODUCTION

Hypertension commonly coexists with age-related declines in cardiorespiratory fitness, muscle strength and balance, particularly in middle age and early older age. These declines increase the risk of functional limitations, falls and reduced quality of life in later life. Conventional hypertension management focuses primarily on pharmacological treatment and risk factor modification, with less emphasis on interventions that simultaneously target mobility, balance and blood pressure.

Walking-based exercise programmes are attractive in this context because they can be delivered at low cost, require minimal equipment and can be tailored to individual fitness levels. Systematic reviews of walking interventions demonstrate modest but clinically important reductions in resting blood pressure in adults with elevated or established hypertension. However, most programmes use straight-line walking, which may not sufficiently challenge dynamic balance, turning ability and walking skill needed for complex real-world environments. Curved-path walking tasks, such as the Figure-of-Eight Walk Test, were developed to better represent everyday walking, which often involves frequent direction changes around obstacles. Validation studies show that F8WT time, step count and smoothness are reliable and sensitive indicators of walking skill and balance in community-dwelling older adults and people with neurological conditions. Translating this assessment paradigm into a structured exercise programme may enhance both functional mobility and cardiovascular health in middle-aged hypertensive adults.

The proposed intervention is based on the premise that figure-of-eight walking simultaneously challenges neuromuscular control and cardiovascular function. Unlike conventional straight-line walking, repeated curved-path walking requires continuous postural adjustments, directional changes, coordinated trunk and limb movements, and controlled weight transfer. These demands may enhance functional fitness and dynamic balance while providing sufficient aerobic stimulation to improve cardiovascular health. The theoretical pathways through which the intervention is expected to influence functional fitness, balance, and blood pressure are illustrated in Figure 1.

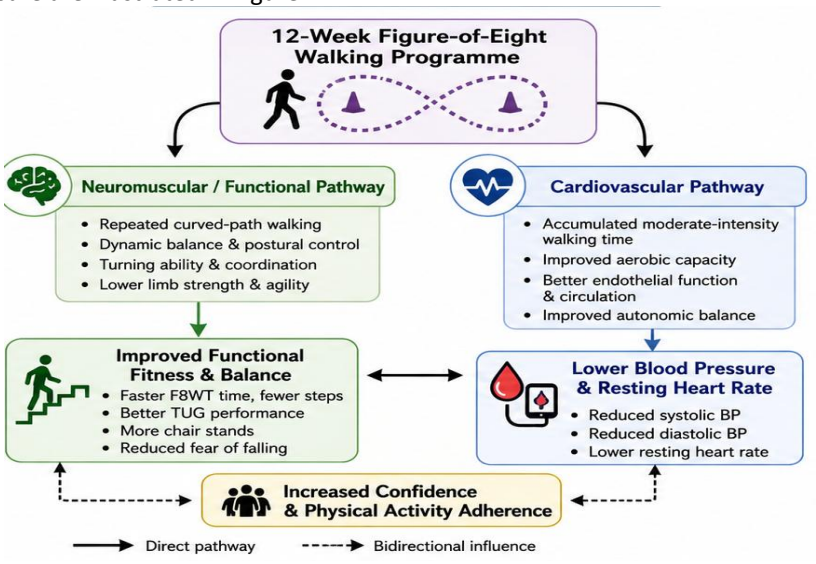

Figure 1: Conceptual model of figure-of-eight walking effects

Source: Adapted by the authors from Richard J. Hess et al. (2010).

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As shown in Figure 1, the figure-of-eight walking programme is expected to influence health outcomes through two complementary mechanisms. The neuromuscular pathway emphasizes improvements in coordination, balance, turning ability, and lower-limb strength resulting from repeated practice of curved-path walking. These adaptations are anticipated to enhance performance on functional fitness measures such as the Figure-of-Eight Walk Test, Timed Up and Go Test, and Chair Stand Test. Concurrently, the cardiovascular pathway highlights the benefits of moderate-intensity walking exposure, including improvements in aerobic capacity, endothelial function, and autonomic regulation, which may contribute to reductions in resting blood pressure and heart rate. The interaction between improved mobility, increased confidence, and greater adherence to physical activity may further reinforce both functional and cardiovascular gains over the course of the intervention.

LITERATURE REVIEW

Walking interventions and blood pressure in hypertensive adults

Walking interventions have been widely studied as non-pharmacological therapies for hypertension. Meta-analyses of randomised controlled trials report average reductions of approximately 4 mmHg in systolic blood pressure and 2 mmHg in diastolic blood pressure among participants engaging in 30–40 minutes of moderate-intensity walking three to five times per week for 10–16 weeks. Community-based walking programmes in older hypertensive adults have demonstrated systolic blood pressure reductions of 5–10 mmHg, along with improvements in exercise capacity and self-efficacy.

Short-term studies prescribing daily step goals, such as 10,000 steps per day, and quality improvement projects implementing structured walking in hypertensive adults have also reported significant improvements in clinic blood pressure and cardiovascular risk profiles. These data support the inclusion of brisk walking as a core component of lifestyle management for hypertension and suggest that modest increases in physical activity can yield meaningful hemodynamic benefits.

Figure-of-eight walk test and functional fitness

The Figure-of-Eight Walk Test was designed to assess walking skill along both straight and curved paths, reflecting the demands of everyday ambulation. In the standard protocol, two cones are placed a fixed distance apart, and participants are instructed to walk in a figure-of-eight pattern around them while the assessor records the time taken, number of steps and qualitative smoothness of the path. Studies in community-dwelling older adults with mobility disability have shown that F8WT measures have strong correlations with gait speed, balance scales, physical function indices and fear of falling scores.

Reliability analyses indicate excellent test–retest reliability for F8WT time and steps, with intraclass correlation coefficients typically above 0.90. More recent work has validated automated or instrumented versions of the F8WT using digital systems, demonstrating high agreement with manually timed tests and confirming its suitability for monitoring changes in walking performance over time. Together, these findings support the use of F8WT as a robust, responsive measure of functional fitness and balance in older and middle-aged adults.

Curved-path walking, balance and fall risk

Curved-path walking tasks challenge anticipatory postural adjustments, trunk rotation control and lateral stability more than straight-line walking. Impairments in turning and curved-path walking have been linked to increased fall risk in older adults and in people with neurological disorders such as Parkinson's disease and stroke. Exercise interventions that include direction changes and obstacle negotiation appear to improve turning ability and confidence more than straight walking alone.

Incorporating figure-of-eight walking into exercise programmes may therefore yield additional benefits for balance and functional mobility beyond those achieved with straight walking. By repeatedly practising

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controlled turns and curved trajectories at a safe, self-selected pace, participants can strengthen lower limb musculature, improve proprioception and enhance dynamic balance, potentially reducing fall risk as they age.

Combined mobility and blood pressure benefits of walking

The same walking sessions that improve mobility and balance also contribute to cardiovascular health by increasing energy expenditure, improving endothelial function, reducing sympathetic activity and promoting favourable changes in weight and body composition. Thus, a figure-of-eight walking programme has the potential to simultaneously address two key domains of health for middle-aged hypertensive adults: functional fitness and blood pressure control.

Despite these theoretical synergies, there is a paucity of intervention studies that explicitly use figure-of-eight walking patterns as the core exercise modality. Most current evidence on F8WT comes from its use as an assessment tool rather than as an intervention. This study seeks to extend the literature by operationalising figure-of-eight walking as a structured training component and examining its impact on mobility, balance and blood pressure outcomes in a hypertensive population.

Conceptual Framework

The conceptual framework posits that repeated practice of figure-of-eight walking at moderate intensity will improve functional fitness and balance through neuromuscular and biomechanical adaptations, while concurrently reducing blood pressure through cardiovascular conditioning. Neuromuscular adaptations include improved coordination of trunk and limb movements during turning, enhanced proprioceptive feedback, and increased activation of stabilising musculature in the hips and lower limbs. Biomechanically, curved-path walking requires controlled weight shifts, step length adjustments and precise foot placement, which together strengthen dynamic balance.

From a cardiovascular standpoint, accumulating at least 150 minutes per week of moderate-intensity figure-of-eight walking should elicit improvements in aerobic capacity, endothelial function and autonomic balance similar to those observed in straight-line walking interventions. Over time, these changes are expected to lower resting blood pressure and heart rate. Psychological benefits, such as increased confidence in mobility and reduced fear of falling, may further encourage sustained physical activity, creating a virtuous cycle of improved fitness and blood pressure control.

METHODS

Study design

A single-blind, two-arm randomised controlled trial will be conducted to evaluate the effectiveness of a figure-of-eight walking programme on functional fitness, balance and blood pressure among middle-aged hypertensive adults. Participants will be randomly assigned in a 1:1 ratio to the intervention group (figure-of-eight walking plus usual care) or the control group (usual care alone). Outcome assessors will be blinded to group allocation.

Setting and participants

The study will be conducted in outpatient hypertension clinics and community health centres serving adults aged 40–65 years. Eligible participants will have a documented diagnosis of primary hypertension for at least six months, be on stable antihypertensive therapy for four weeks or longer, and have clinic blood pressure measurements of at least 140/90 mmHg on two occasions. Participants must be able to walk independently without assistive devices, but may report concerns about balance, slow walking speed or reduced fitness.

Exclusion criteria include secondary hypertension, unstable cardiovascular disease, severe musculoskeletal or neurological conditions affecting gait, uncontrolled diabetes with neuropathy, and any condition that, in

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the opinion of the investigator, would make participation unsafe. Individuals currently engaged in structured balance or high-intensity exercise programmes more than three days per week will also be excluded to avoid contamination.

Sample size

Sample size will be determined based on detecting clinically meaningful improvements in functional fitness and blood pressure. Assuming a moderate effect size for improvement in F8WT completion time and a 5 mmHg between-group difference in systolic blood pressure reduction, with 80% power and a two-sided alpha of 0.05, it is anticipated that approximately 70 participants per group will be required. Accounting for an estimated 15–20% attrition rate, the target sample size will be 170–180 participants.

Randomisation and allocation concealment

A computer-generated randomisation schedule with variable block sizes will be created by a statistician not involved in recruitment or assessment. Group assignments will be concealed in sequentially numbered, opaque, sealed envelopes opened only after completion of baseline measurements. Randomisation will be stratified by sex and baseline functional fitness (for example, dichotomised by median F8WT time) to ensure balanced distribution of key prognostic factors.

Intervention: figure-of-eight walking programme

The intervention will consist of a 12-week programme combining supervised clinic-based figure-of-eight walking sessions with home-based practice. The figure-of-eight path will be created using two cones placed at a fixed distance (for example, 1.5 metres) apart, with a clear path marked on the floor. Participants will be instructed to walk in a continuous figure-of-eight pattern around the cones at a self-selected, moderate intensity that allows conversation but induces mild breathlessness.

Each supervised session will last approximately 30 minutes, including a 5-minute warm-up of straight-line walking and gentle stretching, 20 minutes of figure-of-eight walking, and a 5-minute cool-down. Sessions will be conducted two to three times per week at the clinic under the supervision of trained nurses or physiotherapists. Participants will also be encouraged to perform at least two additional 20–30-minute home-based figure-of-eight walking sessions per week in a safe, unobstructed area, with basic safety instructions provided. Progression will involve gradually increasing walking duration and, where appropriate, modestly increasing walking speed while maintaining safety.

To ensure consistency across supervised and home-based training sessions, a standardized figure-of-eight walking pathway will be used throughout the intervention period. The arrangement consists of two cones positioned at a fixed distance apart, enabling participants to repeatedly perform curved-path walking involving clockwise and counter-clockwise turns. The configuration was selected to challenge dynamic balance, turning ability, and walking coordination while maintaining a safe and easily reproducible exercise environment. The detailed layout of the training pathway is presented in Figure 2.

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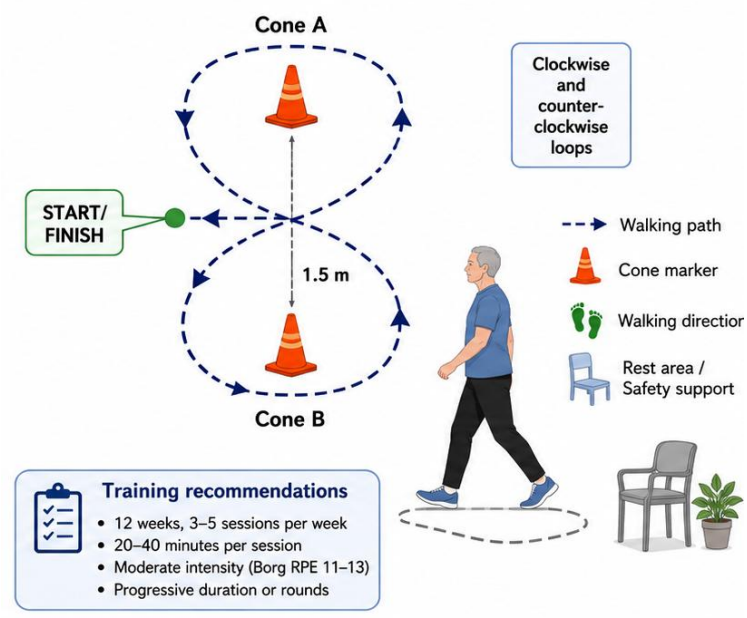

Figure 2: Schematic layout of the figure-of-eight walk test and training area

Source: Adapted by the authors from Richard J. Hess et al. (2010).

The figure-of-eight pathway shown in Figure 2 provides a practical and low-cost method for integrating balance-oriented mobility training into hypertension management programmes. Unlike straight-line walking, the repeated curved trajectories require continuous adjustments in posture, foot placement, and body orientation, thereby increasing the neuromuscular demands of the activity. The inclusion of both clockwise and counter-clockwise loops ensures symmetrical movement practice and may contribute to improvements in balance, coordination, and lower-limb function. Because the pathway requires minimal equipment and space, it is particularly suitable for implementation in outpatient clinics, community health centres, and home-based exercise settings.

Table 1: Figure-of-eight walking programme parameters

Parameter	Description
Path layout	Two cones 1.5 m apart; continuous figure-of-eight
Session duration	30 minutes (5-min warm-up, 20-min F8 walking, 5-min cool-down)
Supervised frequency	2–3 sessions/week at clinic
Home-based practice	2 sessions/week, 20–30 minutes each
Intensity target	Moderate (talk test; Borg 11–13)
Progression	Gradual increase in duration and, if tolerated, pace
Safety criteria	Stop for chest pain, severe breathlessness, dizziness, SBP ≥180 or DBP ≥110 mmHg

Table 1. Structure, dose and safety parameters of the 12-week figure-of-eight walking programme.

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Control group: usual care

Control group participants will continue to receive usual hypertension care from their clinicians, including medication management and general lifestyle advice such as recommendations for healthy diet, weight control, smoking cessation and physical activity. They will not receive structured figure-of-eight walking training or supervised sessions during the intervention period. After the final follow-up assessment, they may be offered a brief demonstration of figure-of-eight walking for informational purposes.

Outcome measures

Primary outcomes will focus on functional fitness and balance. The Figure-of-Eight Walk Test will be administered using standardised procedures, recording time to completion, number of steps and smoothness rating. The timed up-and-go test will assess mobility and dynamic balance by measuring the time taken to rise from a chair, walk three metres, turn, walk back and sit down. The 30-second chair stand test will be used to assess lower limb strength and functional fitness.

Secondary outcomes will include clinic systolic and diastolic blood pressure and resting heart rate, measured using standardised automated devices and procedures, as well as self-reported confidence in walking and fear of falling. Optional additional measures may include gait speed over a short distance and self-reported physical activity levels. Assessments will be conducted at baseline and at 12 weeks by assessors blinded to group assignment.

Data collection and analysis

Data will be collected using standardised forms and entered into a secure database with quality checks for accuracy and completeness. Intention-to-treat analyses will be undertaken, with all randomised participants included in the primary analyses. Continuous outcomes such as F8WT time, timed up-and-go, chair stand repetitions and blood pressure will be analysed using analysis of covariance, adjusting for baseline values. Between-group differences with 95% confidence intervals will be reported.

Categorical outcomes, such as the proportion of participants with clinically significant improvements in functional fitness or blood pressure control, will be analysed using chi-square tests or logistic regression. Sensitivity analyses using per-protocol populations (for example, those attending at least 70% of supervised sessions and completing prescribed home practice) will be performed to explore dose–response relationships between adherence and outcomes.

Ethical considerations

Ethical approval will be obtained from the institutional review board before commencement of the study. Written informed consent will be obtained from all participants. Potential risks include musculoskeletal strain, fatigue, dizziness or transient blood pressure changes associated with exercise; these will be mitigated through pre-participation screening, gradual progression of intensity, and close monitoring during supervised sessions. Participants will be instructed to report any adverse symptoms immediately and will be advised to consult their physicians regarding any concerns related to their hypertension management.

Participant confidentiality will be safeguarded by assigning unique study identifiers and storing data securely with restricted access. The study will be registered in a clinical trials registry prior to enrolment of the first participant, and findings will be disseminated through peer-reviewed publications and conference presentations.

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DISCUSSION

This study is designed to generate rigorous evidence on the effectiveness of figure-of-eight walking as a combined mobility and blood pressure intervention for middle-aged adults with hypertension. By moving beyond straight-line walking and incorporating curved-path patterns that challenge balance and turning ability, the intervention targets domains of functional fitness that are particularly relevant for preventing future mobility limitations and falls. At the same time, the accumulated walking time and intensity are expected to yield reductions in resting blood pressure comparable to those observed in conventional walking trials.

If the trial demonstrates significant improvements in functional fitness, balance and blood pressure, figure-of-eight walking could be incorporated into nurse-led hypertension management programmes in outpatient and community settings. The intervention requires minimal equipment, can be delivered in small spaces, and is easily adaptable to individual fitness levels, making it suitable for resource-constrained healthcare environments. The findings will also inform future research on integrating functional mobility training into cardiovascular risk reduction strategies.

CONCLUSION

The proposed randomised controlled trial will evaluate whether a 12-week figure-of-eight walking programme can improve functional fitness, balance and blood pressure among middle-aged hypertensive adults. By focusing on curved-path walking that reflects everyday mobility demands, the intervention has the potential to address both cardiovascular risk and functional independence, supporting more holistic, movement-centred approaches to hypertension care.

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