

EFFECT OF FIGURE OF 8 WALKING ON FUNCTIONAL MOBILITY AND BALANCE IN OSTEOPOROTIC, TYPE-1 OBESE PATIENTS

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ABSTRACT

Background: Osteoporosis and obesity can adversely affect postural control, gait, physical performance and independence. The coexistence of osteoporosis with Type-1 obesity may create additional challenges because reduced skeletal strength is accompanied by altered biomechanics, impaired balance and mobility limitations. The source study proposes Figure of 8 Walking as a multidirectional gait-training intervention that repeatedly challenges turning, weight shifting, trunk control and lower-limb coordination.

Objective: To evaluate the effect of Figure of 8 Walking, added to conventional physiotherapy, on balance and functional mobility in osteoporotic patients with Type-1 obesity aged 55–65 years.

Methods: Forty eligible participants were allocated to an Experimental Group (n=20) and a Control Group (n=20). The Experimental Group received Figure of 8 Walking in addition to conventional physiotherapy, while the Control Group received conventional physiotherapy alone. Treatment was delivered for 45 minutes per session, 5 days per week, for 6 weeks. Balance and mobility were assessed using the Berg Balance Scale (BBS) and Timed Up and Go (TUG); the source document also reports a Functional Independence Measure (FIM)-labelled outcome using seconds.

Results: Baseline groups were comparable in age, BMI, gender distribution and BBS. The reported post-intervention BBS was 50.15 in the Experimental Group versus 45.35 in the Control Group, with an adjusted between-group difference of 4.80 ($F=25.40$, $p<0.001$). TUG was 9.12 versus 10.94 seconds, with an adjusted difference of 1.82 seconds ($F=34.00$, $p<0.001$). The FIM-labelled reported measure was 7.94 versus 9.16 seconds, with an adjusted difference of 1.22 ($F=25.20$, $p<0.001$). Mean improvement favoured the Experimental Group for all reported outcomes.

Conclusion: The reported findings support Figure of 8 Walking as a potentially useful adjunct to conventional physiotherapy for improving balance and functional mobility in this selected population. Because the source document labels the FIM outcome in seconds, this measure and its units should be verified against the original data and instrument before journal submission.

Keywords: Osteoporosis; Type-1 obesity; Figure of 8 Walking; balance; functional mobility; Berg Balance Scale; Timed Up and Go; physiotherapy; gait training.

1. INTRODUCTION

1.1 Background

Osteoporosis is characterized by reduced bone strength and increased susceptibility to fragility fracture. The condition is clinically important because fractures may lead to pain, disability, loss of independence and reduced quality of life. The source document describes osteoporosis as a chronic skeletal disorder associated with reduced bone mineral density, deterioration of bone microarchitecture and compromised bone strength. It further identifies age, physical inactivity, nutritional factors and other clinical risk factors as contributors to disease burden [1,6].

Obesity is also a major health problem and has important musculoskeletal consequences. The traditional view that greater body mass is protective for bone has been challenged because adipose tissue has endocrine and inflammatory functions. Excess adiposity may be associated with metabolic and inflammatory changes that influence bone remodeling and physical performance. Obesity can additionally alter the centre of gravity, increase joint loading and reduce movement efficiency [10,16–18].

When osteoporosis and obesity coexist, the rehabilitation problem becomes multidimensional. Reduced skeletal strength increases the consequences of falls, while obesity can contribute to altered gait mechanics, decreased endurance and impaired postural control. Balance depends on integration of visual, vestibular and somatosensory information with adequate muscular strength and anticipatory postural adjustments [20,21].

1.2 Rationale for Figure of 8 Walking

Conventional walking in a straight line provides a relatively predictable motor task. Everyday mobility, however, requires turning, changing direction, avoiding obstacles, transferring weight and adapting body position. Figure of 8 Walking is designed to reproduce these multidirectional demands. The source document describes it as a structured gait-training exercise involving repeated changes in direction, weight shifting, trunk rotation, precise foot placement and continuous postural adjustment.

The proposed therapeutic rationale is therefore functional: repeated curved walking may challenge dynamic balance and coordination more directly than straight-path walking. The intervention requires participants to control the centre of gravity while moving through changing directions, potentially promoting proprioceptive feedback, motor planning and neuromuscular coordination.

1.3 Need for the Study

The source document identifies a research gap concerning patients who simultaneously have osteoporosis and Type-1 obesity. Much of the rehabilitation literature addresses osteoporosis, obesity, balance training or gait training separately. The present study focuses on the combined clinical population and evaluates a low-cost, easily administered multidirectional walking intervention. This is relevant because improved balance and mobility may reduce dependence and support safer performance of everyday activities.

1.4 Aim

To evaluate the effect of Figure of 8 Walking on balance and functional mobility among osteoporotic, Type-1 obese patients aged 55–65 years.

1.5 Objectives

- To evaluate the effect of Figure of 8 Walking on functional mobility and balance.
- To assess changes in balance using the Berg Balance Scale.
- To assess changes in functional mobility using the Timed Up and Go Test.
- To examine the reported change in the FIM-labelled outcome included in the source document.
- To compare the magnitude of improvement between the Experimental and Control Groups.

1.6 Hypothesis

Patients aged 55–65 years with osteoporosis and Type-1 obesity who receive Figure of 8 Walking in addition to conventional physiotherapy will demonstrate greater improvements in balance and functional mobility than patients receiving conventional physiotherapy alone.

2. REVIEW OF LITERATURE

The literature summarized in the source document consistently frames balance and functional mobility as important clinical targets in older adults with musculoskeletal disorders. The review also provides the conceptual basis for using exercise, balance training and multidirectional gait activities in osteoporosis and obesity.

2.1 Osteoporosis and Exercise

Compston, McClung and Leslie describe osteoporosis as a major metabolic bone disorder with a substantial fracture burden [1]. Exercise is relevant to management because rehabilitation aims not only to address bone health but also to preserve muscle performance, balance and functional independence. The Too Fit To Fracture recommendations emphasize appropriately prescribed exercise for people with osteoporosis and osteoporotic vertebral fracture, with individualization according to functional capacity and fracture risk [14].

Systematic reviews in the source reference list support balance and exercise interventions for reducing falls and improving physical performance. Sherrington et al. reported that exercise can reduce falls in community-dwelling older people [8]. Zhao et al. and Zhu et al. synthesized evidence concerning balance training and non-pharmacological interventions in osteoporosis or osteopenia [9,10]. More recent work in the source list also highlights tailored exercise support and adherence as relevant components of rehabilitation [12].

2.2 Obesity, Mobility and Balance

The source literature describes obesity as a condition associated with altered gait biomechanics and mobility disability. Hruby and Hu, Blüher, Bray et al., and Villareal et al. are included as references addressing the epidemiology and clinical consequences of obesity [17–20]. Excess body mass may increase mechanical demand during locomotion and may be associated with reduced walking efficiency, lower endurance and difficulty with movement tasks.

These changes are clinically important in people who also have osteoporosis. A person who is slower, less stable or less confident during walking may have greater exposure to falls, and the consequences of a fall can be more serious when bone strength is reduced. Therefore, rehabilitation that combines strength, balance and functional gait practice is clinically rational.

2.3 Balance and Functional Mobility

The Berg Balance Scale is a 14-item clinical measure of static and dynamic balance, with a maximum score of 56 [15]. Higher scores indicate better balance performance. The Timed Up and Go assesses functional mobility through a sequence of standing, walking, turning and sitting and is reported in seconds [13]. These instruments are appropriate to the study's stated focus on balance and mobility.

Walking speed and mobility are frequently treated as clinically meaningful indicators of physical function. The source reference list includes work describing walking speed as a functional vital sign and evidence linking gait performance with health outcomes [23,24]. Although the present study did not use a conventional walking-speed outcome in the reported tables, its emphasis on multidirectional walking remains consistent with the broader functional-gait literature.

2.4 Multidirectional and Figure of 8 Walking

The source document describes Figure of 8 Walking as an intervention requiring repeated directional changes, weight transfer, trunk rotation and controlled foot placement. The cited studies within the source manuscript report improvements in dynamic balance, gait symmetry, postural control and functional mobility following curved or multidirectional walking practice. The proposed mechanism is repeated sensory-motor challenge: participants must continuously update their centre of gravity, integrate sensory information and coordinate the lower limbs and trunk.

This functional approach is particularly relevant to older adults because daily ambulation rarely consists only of uninterrupted straight-line walking. Turning, navigating confined spaces and responding to environmental demands require adaptable postural control. Thus, a Figure of 8 pattern can be viewed as a practical way to introduce controlled multidirectional challenge into physiotherapy.

2.5 Research Gap

The principal gap identified in the source study is the limited evidence specifically addressing Figure of 8 Walking in osteoporotic patients with Type-1 obesity aged 55–65 years. The present study attempts to address this gap by comparing conventional physiotherapy with conventional physiotherapy plus Figure of 8 Walking over six weeks.

3. MATERIALS AND METHODS

3.1 Research Design

The source document describes a two-group comparative intervention study with random allocation. Forty participants were divided equally into an Experimental Group (n=20) and a Control Group (n=20).

3.2 Participants and Sampling

Participants were aged 55–65 years, had a confirmed diagnosis of osteoporosis and met the source-defined Type-1 obesity criterion of BMI 30.0–34.9 kg/m². Convenience sampling was used for recruitment, followed by computer-generated random allocation to the two study groups.

3.3 Intervention

The Experimental Group received Figure of 8 Walking in addition to conventional physiotherapy. The Control Group received conventional physiotherapy alone. Sessions were 45 minutes, five days per week, for six weeks, giving a planned treatment exposure of 1,350 minutes (22.5 hours) per participant. Conventional physiotherapy components described in the source include lower-limb strengthening, flexibility exercises, balance retraining, posture correction and gait training.

Group	n	Intervention	Duration
Experimental	20	Figure of 8 Walking + conventional physiotherapy	45 min/session, 5 days/week, 6 weeks
Control	20	Conventional physiotherapy only	45 min/session, 5 days/week, 6 weeks

3.4 Eligibility

The source inclusion criteria specified participants aged 55–65 years with osteoporosis confirmed through DEXA documentation and BMI 30.0–34.9 kg/m². Exclusion criteria included conditions that could interfere with safe participation or outcome measurement; the source protocol should be consulted for the complete operational list when this manuscript is submitted in a journal.

3.5 Outcome Measures

Outcome	Purpose	Reported unit/scale
Berg Balance Scale (BBS)	Static and dynamic balance	0–56 points
Timed Up and Go (TUG)	Functional mobility	Seconds
FIM-labelled outcome	Reported functional/gait-related outcome in source	Seconds in source tables*

*Important data-quality note: the source document labels this outcome as Functional Independence Measure (FIM) but reports values in seconds and interprets them as gait speed. This is internally inconsistent with the standard FIM scoring framework. The reported values are preserved here rather than silently altered; the original dataset and instrument should be verified before publication.

3.6 Procedure

Baseline demographic and outcome assessments were completed before intervention. Following six weeks of treatment, the same outcomes were reassessed. The source states that testing procedures were kept consistent between pre-test and post-test. Statistical analysis was conducted using IBM SPSS Statistics, with descriptive statistics and inferential comparisons.

3.7 Statistical Analysis

Descriptive statistics included frequency, percentage, mean and standard deviation. Within-group changes were examined using paired t-tests where appropriate, while between-group comparisons were performed using inferential tests. ANCOVA was identified as the principal adjusted analysis for post-test outcomes, with baseline scores entered as covariates. Statistical significance was set at $p < 0.05$. The reported ANCOVA results are therefore emphasized in this manuscript because they adjust for baseline performance.

3.8 Ethical Considerations

The source protocol states that institutional ethics approval would be obtained, written informed consent would be taken, confidentiality would be maintained, participants could withdraw without consequence, and the Declaration of Helsinki would be followed.

4. RESULTS

4.1 Participant Characteristics

Age group (years)	Experimental n (%)	Control n (%)	Total	Overall %
55–58	7 (35.0)	6 (30.0)	13	32.5
59–62	8 (40.0)	9 (45.0)	17	42.5
63–65	5 (25.0)	5 (25.0)	10	25.0
Total	20 (100)	20 (100)	40	100

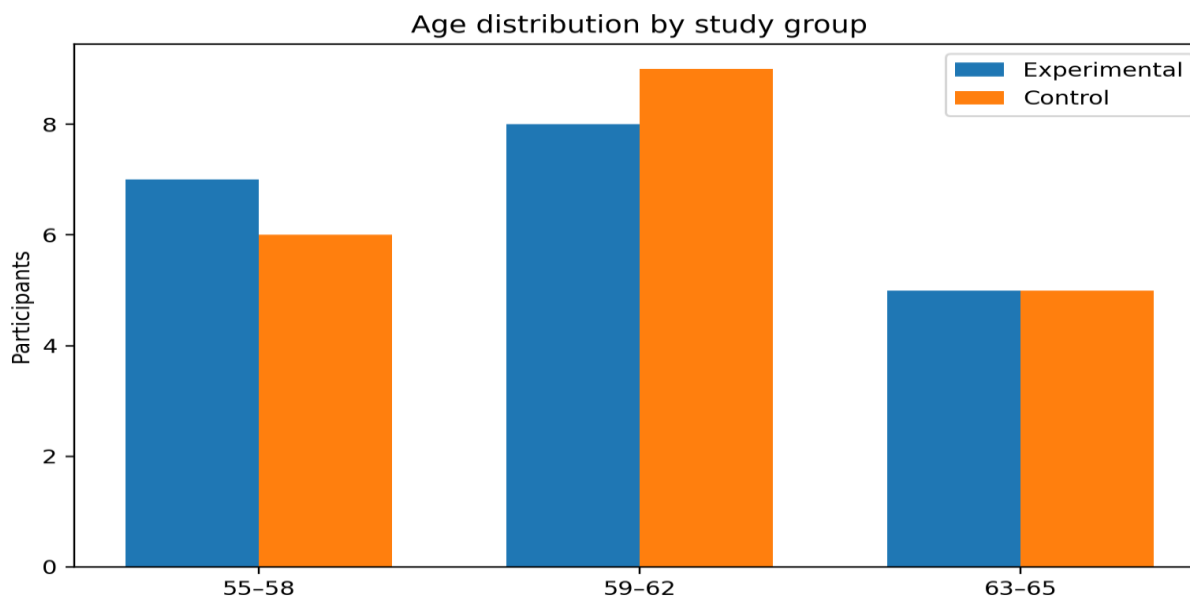


Figure 1. Age distribution of participants by study group.

Gender	Experimental n (%)	Control n (%)	Total	Overall %
Male	8 (40.0)	9 (45.0)	17	42.5
Female	12 (60.0)	11 (55.0)	23	57.5
Total	20 (100)	20 (100)	40	100

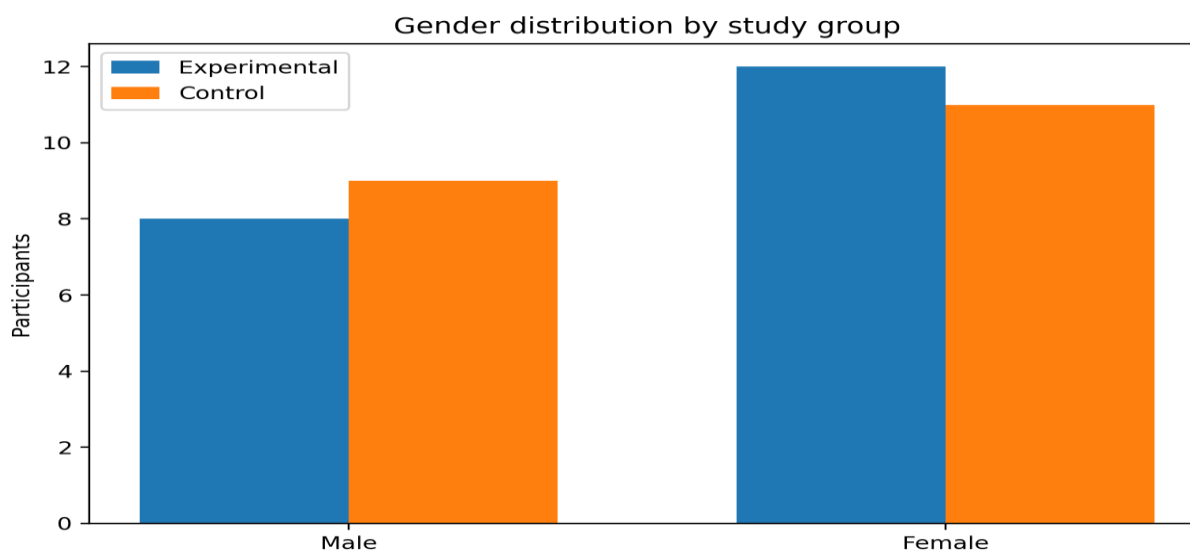


Figure 2. Gender distribution of participants by study group.

BMI (kg/m ²)	Experimental n (%)	Control n (%)	Total	Overall %
30.0–31.4	6 (30.0)	5 (25.0)	11	27.5
31.5–32.9	8 (40.0)	9 (45.0)	17	42.5
33.0–34.9	6 (30.0)	6 (30.0)	12	30.0
Total	20 (100)	20 (100)	40	100

4.2 Baseline Comparability

Variable	Experimental Mean ± SD	Control Mean ± SD	t/ χ^2	p
Age (years)	59.95 ± 3.18	60.05 ± 3.12	0.10	0.920
BMI (kg/m ²)	31.92 ± 1.28	32.05 ± 1.34	0.31	0.758
Gender	8 M / 12 F	9 M / 11 F	$\chi^2=0.10$	0.752
BBS pre-test	39.20 ± 2.74	39.45 ± 2.69	0.29	0.774

There were no statistically significant baseline differences in age, BMI, gender distribution or BBS. The reported baseline characteristics therefore support comparability of the two groups before treatment.

4.3 Balance Outcome

BBS assessment	Experimental	Control	Between-group statistic	p
Pre-test mean ± SD	39.20 ± 2.74	39.45 ± 2.69	t=0.29	0.774
Post-test adjusted mean	50.15	45.35	F=25.40	<0.001
Mean improvement	+10.95	+5.90	Adjusted difference=4.80	<0.001

The Experimental Group improved by 10.95 BBS points compared with 5.90 points in the Control Group. After adjustment for baseline BBS, the reported group effect was 4.80 points and was statistically significant (F=25.40, p<0.001).

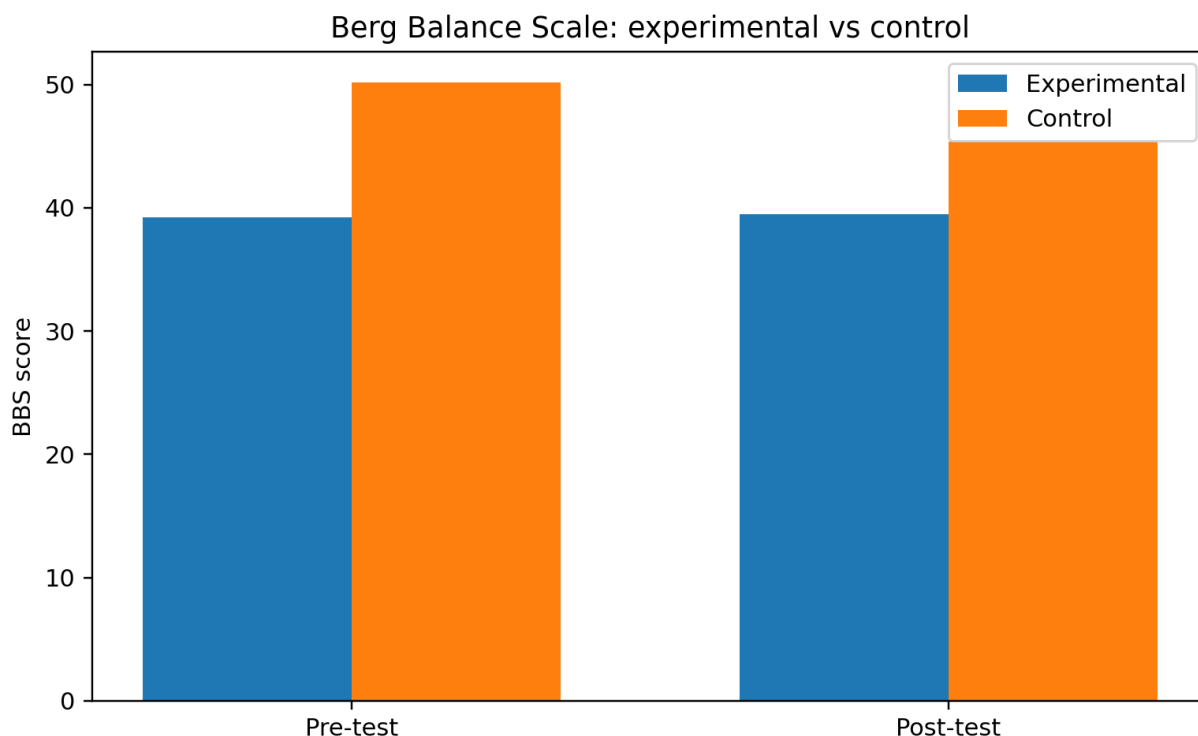


Figure 3. BBS pre-test and post-test values by group; post-test values are the adjusted means reported in the source.

4.4 Functional Mobility Outcome

TUG assessment	Experimental	Control	Between-group statistic	p
Pre-test (derived from reported change)	13.45 sec	13.61 sec	—	—
Post-test	9.12 sec	10.94 sec	F=34.00	<0.001
Mean improvement	-4.33 sec	-2.67 sec	Adjusted difference=1.82 sec	<0.001

Lower TUG time indicates better functional mobility. The Experimental Group reduced TUG time by 4.33 seconds compared with 2.67 seconds in the Control Group. The adjusted post-test difference was 1.82 seconds in favour of the Experimental Group, with F=34.00 and p<0.001.

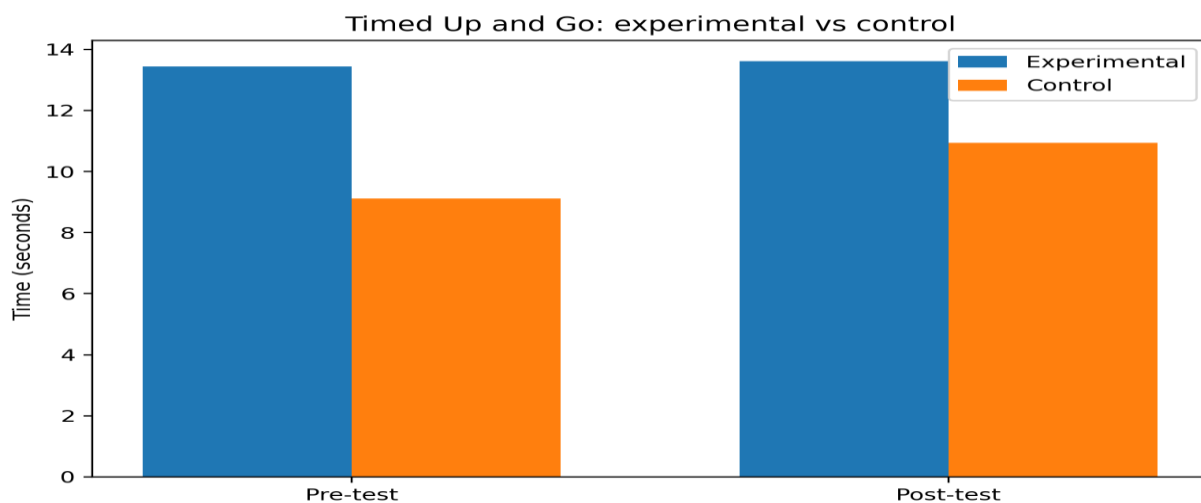


Figure 4. TUG pre-test and post-test values by group. Pre-test values are reconstructed from the reported post-test values and mean changes.

4.5 FIM-Labelled Reported Outcome

Assessment	Experimental	Control	Statistic	p
Pre-test	10.82 ± 0.91	10.76 ± 0.88	—	—
Post-test	7.94 ± 0.73	9.16 ± 0.81	F=25.20	<0.001
Mean change	-2.88	-1.60	Adjusted difference=1.22	<0.001

The source reports a reduction from 10.82 to 7.94 in the Experimental Group and from 10.76 to 9.16 in the Control Group. The reported adjusted post-test difference was 1.22, with F=25.20 and p<0.001. The source interprets this measure as gait performance. Because standard FIM scores are not measured in seconds, the instrument name, scoring and units require verification before external dissemination.

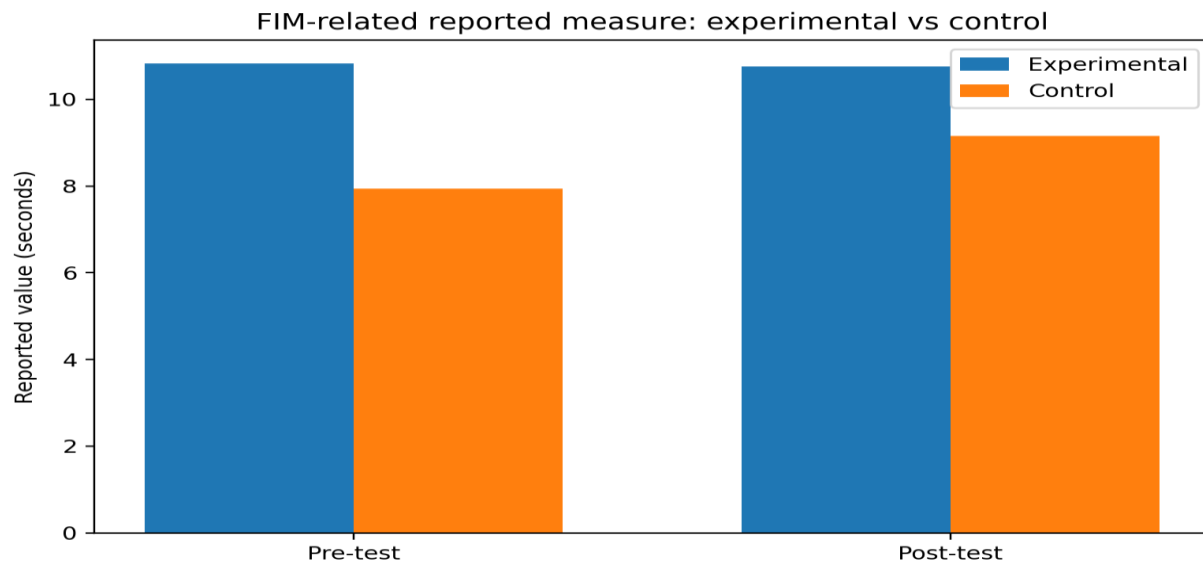


Figure 5. FIM-labelled reported outcome. Values are reproduced from the source tables; unit/scoring inconsistency should be verified.

4.6 Overall Comparison

Outcome	Experimental improvement	Control improvement	p-value	Interpretation
BBS	+10.95	+5.90	<0.001	Greater improvement in Experimental Group
TUG	−4.33 sec	−2.67 sec	<0.001	Greater reduction in time in Experimental Group
FIM-labelled measure	−2.88	−1.60	<0.001	Greater reported reduction in Experimental Group

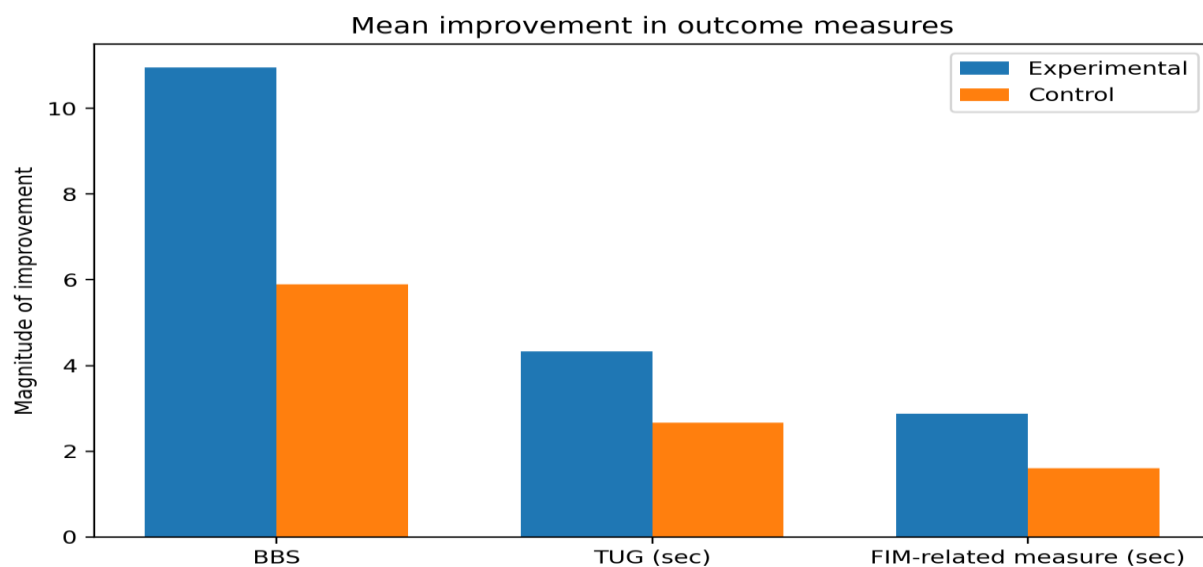


Figure 6. Mean magnitude of improvement across the three reported outcomes. Direction of change is shown as magnitude for comparison.

5. DISCUSSION

The present research paper was developed from the uploaded study document, which reports that Figure of 8 Walking added to conventional physiotherapy produced greater improvements than conventional physiotherapy alone in osteoporotic patients with Type-1 obesity aged 55–65 years. The central finding is consistent across the reported outcomes: the Experimental Group showed larger changes in balance and mobility, and the adjusted between-group analyses were statistically significant.

5.1 Balance

The BBS findings are particularly relevant because balance impairment is an important contributor to falls in older adults. Baseline BBS scores were similar between groups (39.20 versus 39.45), while the reported post-test adjusted means were 50.15 and 45.35. The Experimental Group therefore demonstrated a substantially larger mean improvement. The adjusted group effect of 4.80 points ($p < 0.001$) indicates that the difference was unlikely to be explained by baseline imbalance alone.

A plausible rehabilitation explanation is that Figure of 8 Walking provides repeated opportunities to practice controlled weight transfer and directional change. Each curve requires the participant to reorganize foot placement and trunk position while maintaining the centre of gravity over the base of support. This type of task-specific practice is conceptually consistent with the source literature emphasizing dynamic balance, proprioception and functional movement.

5.2 Functional Mobility

TUG results similarly favoured the Experimental Group. The reported post-test time was 9.12 seconds compared with 10.94 seconds in the Control Group. Because shorter completion time indicates better mobility, the 4.33-second reduction in the Experimental Group represents a larger improvement than the 2.67-second reduction in controls. The adjusted group effect remained statistically significant ($F = 34.00$, $p < 0.001$).

The TUG result is clinically coherent with the intervention because Figure of 8 Walking repeatedly integrates walking and turning. Turning is a functional component of the TUG sequence and of daily activities such as changing direction in the home, navigating around furniture and moving between spaces. Therefore, the intervention may provide task-specific practice that transfers to functional mobility.

5.3 Reported FIM Outcome

The FIM-labelled outcome also favoured the Experimental Group, with a reported reduction of 2.88 compared with 1.60 in the Control Group. However, interpretation should remain cautious. The source document reports this outcome in seconds and describes it as gait performance, whereas the Functional Independence Measure is ordinarily a multidomain independence scale rather than a time-based gait-speed test. This manuscript intentionally preserves the source values but flags the inconsistency for verification.

5.4 Clinical Implications

The intervention has practical advantages. Figure of 8 Walking requires little equipment and can be performed in a relatively small clinical space under supervision. It can be integrated with strengthening, balance retraining, flexibility and posture exercises. The source document also describes the intervention as economical and clinically feasible. For patients with osteoporosis, safety and individualized progression are essential because the consequences of falls may be serious.

The findings should not be interpreted as evidence that Figure of 8 Walking replaces conventional physiotherapy. Rather, the study supports its use as an adjunct to a broader rehabilitation programme. The Control Group also improved, indicating that conventional physiotherapy itself was beneficial.

5.5 Comparison with the Source Literature

The reported findings align with the conceptual evidence cited in the source document: exercise and balance interventions are important in osteoporosis and fall prevention [8–10,14], while obesity is associated with mobility and musculoskeletal limitations [16–20]. The study extends this rationale to a combined osteoporosis–obesity population and applies a multidirectional walking pattern rather than relying solely on straight-path walking.

5.6 Strengths

- Equal allocation of 20 participants to each group.
- Random allocation was reported in the study protocol.

- Both groups received conventional physiotherapy, allowing the additional contribution of Figure of 8 Walking to be examined.
- Pre-test and post-test outcomes were collected using standardized clinical measures.
- Baseline-adjusted ANCOVA results were reported for the main outcomes.
- An intervention period of six weeks with frequent supervised sessions provided substantial treatment exposure.

5.7 Limitations

The source document identifies several limitations: the sample size was small; the study was conducted in selected clinical settings; the age and BMI criteria restrict generalizability; the intervention lasted six weeks without long-term follow-up; muscle strength, endurance, fear of falling, quality of life and bone mineral density were not evaluated as outcomes; lifestyle factors were not strictly monitored; blinding was not used; and a formal statistical sample-size calculation was not performed. These limitations should be retained in any journal manuscript.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Based on the reported results in the uploaded study document, Figure of 8 Walking combined with conventional physiotherapy was associated with greater improvement in balance and functional mobility than conventional physiotherapy alone in osteoporotic patients with Type-1 obesity aged 55–65 years. The Experimental Group demonstrated a larger increase in BBS and larger reductions in TUG and the FIM-labelled reported outcome. The adjusted between-group analyses were statistically significant at $p < 0.001$.

Figure of 8 Walking may therefore be considered a useful adjunct to conventional physiotherapy when appropriately supervised and individualized. Its multidirectional nature provides repeated practice of turning, weight transfer, postural adjustment and lower-limb coordination, which are relevant to real-world mobility.

6.2 Recommendations

- Use Figure of 8 Walking as an adjunct rather than a replacement for comprehensive osteoporosis rehabilitation.
- Progress the exercise according to balance ability, fracture risk, fatigue and safety.
- Use standardized pre-test and post-test assessments and maintain consistent testing procedures.
- Include longer follow-up periods in future studies to determine whether benefits are sustained.
- Recruit larger samples from multiple centres to improve generalizability.
- Include validated measures of quality of life, fear of falling, lower-limb strength and physical activity in future trials.
- Verify the FIM instrument, scoring and units in the original dataset before publication.

6.3 Practical Clinical Message

For a physiotherapy programme targeting an older adult with osteoporosis and Type-1 obesity, controlled multidirectional gait practice can be integrated after appropriate screening and safety assessment. The reported results suggest that adding Figure of 8 Walking may provide benefits beyond conventional physiotherapy alone, particularly for dynamic balance and functional mobility.

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