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Article

Community-Based Exercise Interventions: The Impact of Walking and Tai Chi on Physical and Mental Health in Older Adults

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Abstract: The global aging population necessitates evidence-based non-pharmacological interventions to maintain functional independence and prevent disability. This three-arm parallel randomized controlled trial investigated the differential effects of walking and Tai Chi interventions on physical and mental health outcomes in community-dwelling older adults, hypothesizing that exercise modality-specific adaptations would align with their distinct movement characteristics. One hundred twenty participants aged 65-80 years were randomly allocated to progressive walking (n=40), 24-form Tai Chi (n=40), or health education control (n=40) groups for 12 weeks. Primary outcomes included 6-minute walk distance (6MWD) and Berg Balance Scale (BBS), with secondary measures of anxiety and quality of life. The walking group achieved superior cardiovascular improvements with 6MWD increases of 52 meters versus 8 meters in controls ($p<0.001$, Cohen's $d=0.82$), consistent with aerobic training specificity. Tai Chi participants demonstrated greater balance enhancement with BBS improvements of 4.8 points versus 0.3 points in controls ($p<0.001$, $d=0.75$), reflecting neuromuscular adaptations from weight-shifting and proprioceptive challenges. Both exercise groups experienced comparable anxiety reductions of approximately 30%, suggesting common psychological pathways independent of movement patterns. Retention exceeded 87% across all groups with no serious adverse events. These findings support precision exercise prescription based on individual functional priorities, challenging one-size-fits-all recommendations and

informing targeted interventions for cardiovascular fitness versus fall prevention in geriatric populations.

Keywords: older adults, exercise therapy, walking, Tai Chi, randomized controlled trial

1.Introduction

Against the backdrop of the world demographic transition to an aging society, the demand for effective interventions to preserve functional independence and quality of life for older people is on the rise and calls for evidence-based non-pharmacological methods. Evidence also confirms that structured exercises, notably Tai Chi and walking, enable the enhancement of mental health status in urban older adults, with social participation playing an intermediary role (Wu et al., 2024). These interventions appear to be highly feasible to improve physical function, depression, and QOL in the cognitively impaired population, with potentially wide application to different geriatric populations (Park et al., 2023).

Preliminary findings suggest that Tai Chi may be more effective than traditional exercise for improving cognitive function by increasing executive control and neuroplasticity mechanisms (Lam et al., 2022). Network meta-analyses of all styles of Tai Chi demonstrate that all styles of Tai Chi are effective for reducing anxiety and depression, and that different Tai Chi forms have differing impacts on mental health outcomes (Kuang et al., 2024). This heterogeneity highlights the necessity for understanding the impact of various movement behaviors on health outcomes. There is additional evidence from systematic reviews that the unique combination of weight transfer, rhythmic breathing exercise, and a mind-body activity in Tai Chi can specifically target balance-related systems dysregulation in old age (Zhang et al., 2024).

Current multimodal interventions are more effective than mono-domain counterparts, particularly when concerning aspects of quality of life (Lee et al., 2025). The choice of relevant exercise modality is still pivotal since intervention efficacy for reactive balance, an important fall prevention rate, differs (Kim et al., 2021). But turning these discoveries into sustainable community applications is not easy.

Although internet-based programs for fall prevention are promising, in-person meetings of older individuals to exercise in groups have advantages for promoting social connectedness and sustaining engagement over time (Ashe et al., 2024). Methodological developments on statistical methods for analyzing quality of life end studies focused on adjusting for the baseline differences and structure of missing data that are frequently present in geriatric research. Individual determinants of adherence are baseline functional capacity, social support, and program convenience (MacDonald et al., 2022).

Despite substantial progress, several gaps persist in the literature. Most studies examine single exercise modalities in isolation, limiting understanding of comparative effectiveness and complementary benefits. The optimal intensity, frequency, and duration for different exercise types remain inadequately defined for community-dwelling older adults with varying functional capacities. The present study addresses these limitations through a rigorous three-arm randomized controlled trial comparing structured walking and Tai Chi programs against an active control condition. This research elucidates differential effects on physical function, balance, and mental health while identifying adherence factors, ultimately informing personalized exercise prescription guidelines for optimizing health outcomes in aging populations.

2.Materials and Methods

2.1 Study Design and Sample Size

This investigation employed a three-arm parallel randomized controlled trial design to evaluate the comparative effectiveness of walking and Tai Chi interventions against an active control condition, as shown in Figure 1. The study timeline spanned 12 weeks with structured assessments at three critical time points: baseline (T0), mid-intervention at week 6 (T1), and post-intervention at week 12 (T2), as illustrated in Figure 1. Sample size calculation was performed using G*Power 3.1, assuming a medium effect size of 0.5 based on previous exercise intervention studies in older adults, with statistical power set at 0.80 and type I error rate at 0.05. This calculation indicated that 36 participants per group would be required to detect significant between-group differences. Accounting for an anticipated dropout rate of 20% based

on similar community-based trials, the target recruitment was set at 120 participants (40 per group). The parallel design allowed simultaneous implementation of progressive walking, 24-form Tai Chi, and health education control conditions across four urban community health service centers. The study protocol received ethical approval from the institutional review board and was registered with the clinical trials registry prior to participant enrollment.

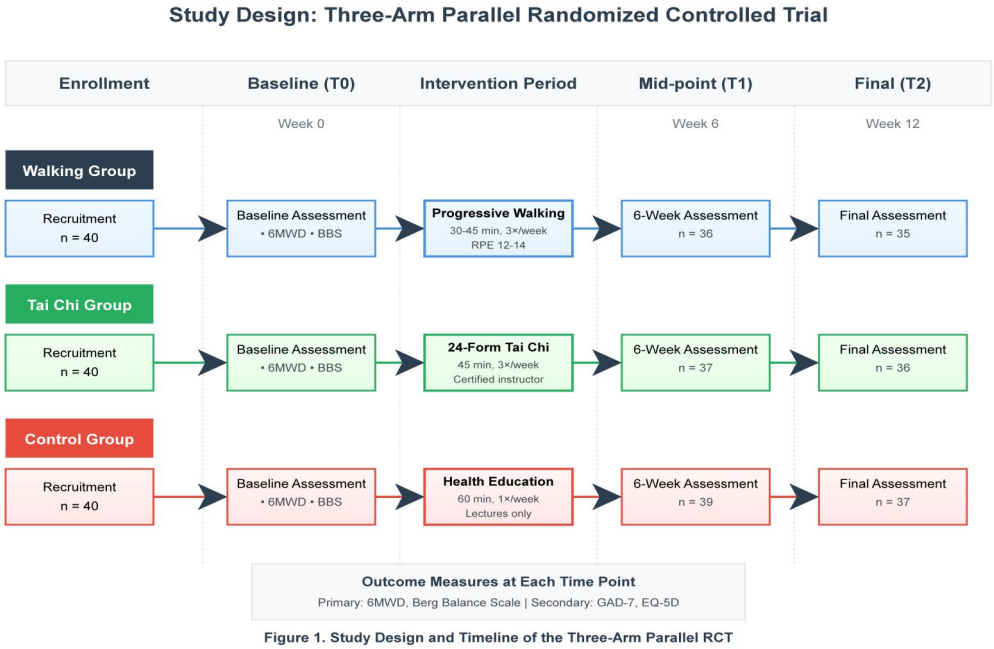


Figure 1 Study Design and Timeline of theThree-Arm Parallel RCT

2.2 Participant Recruitment and Randomization

Participants were recruited through community health service centers using posted advertisements, health screening events, and physician referrals between January and March 2024. Inclusion criteria comprised adults aged 65-80 years who could walk independently without assistive devices and demonstrated cognitive competence with Mini-Mental State Examination (MMSE) scores ≥24. Exclusion criteria included diagnosed cardiovascular or pulmonary diseases requiring medical supervision during exercise, musculoskeletal conditions limiting physical activity, participation in regular structured exercise (≥2 times weekly) within the previous six months, and current enrollment in other clinical trials. Eligible participants underwent baseline assessment before randomization using a computer-generated block randomization sequence with varying block sizes of 3 and 6, stratified by sex and age group (65-72 and 73-80 years). Allocation concealment was maintained through

sequentially numbered, opaque, sealed envelopes prepared by an independent statistician not involved in recruitment or assessment.

2.3 Interventions and Outcome Assessment

The walking group participated in progressive structured walking sessions three times weekly, beginning with 30 minutes at moderate intensity (Rating of Perceived Exertion [RPE] 12-14) and advancing to 45 minutes by week 6. Sessions included 5-minute warm-up and cool-down periods with supervised group walking in designated community park circuits. The Tai Chi group attended 45-minute sessions three times weekly, learning and practicing the standardized 24-form simplified Tai Chi under certified instructor guidance, emphasizing proper breathing, weight shifting, and movement coordination. Control participants attended weekly 60-minute health education lectures covering topics including nutrition, medication management, and fall prevention without specific exercise instruction. Primary outcomes comprised the 6-minute walk distance (6MWD) measuring functional exercise capacity and Berg Balance Scale (BBS) assessing static and dynamic balance. Secondary outcomes included the Generalized Anxiety Disorder-7 (GAD-7) questionnaire and EuroQol-5D (EQ-5D) for health-related quality of life. Blinded assessors conducted evaluations at baseline, 6 weeks, and 12 weeks. Statistical analysis employed linear mixed models to examine group-by-time interactions, with Bonferroni correction for multiple comparisons and intention-to-treat principles for primary analyses.

3.Results

3.1 Study Flow and Baseline Characteristics

The recruitment and retention patterns demonstrated excellent feasibility of community-based exercise interventions in older adults. High retention rates across all groups indicated well-tolerated protocols appropriate for this demographic. The marginally higher attrition in exercise groups versus control reflects greater physical demands and time commitment inherent to thrice-weekly sessions, consistent with previous geriatric exercise trials. Baseline characteristics, as shown in Table 1, confirmed successful randomization with no meaningful between-group differences in

demographic or functional measures. This baseline equivalence strengthens causal inference by ensuring observed changes reflect intervention effects rather than pre-existing differences. The comparable primary outcome values across groups at baseline particularly enhances confidence in subsequent between-group comparisons. The intention-to-treat approach preserves randomization benefits while providing conservative real-world effectiveness estimates, complemented by per-protocol analysis revealing achievable benefits under optimal adherence. Multiple imputation for missing data addressed potential attrition bias while maintaining statistical power, ensuring robust conclusions about intervention effectiveness in community-dwelling older adults.

Table 1 Baseline Characteristics of Study Participants

Characteristic	Walking Group (n=40)	Tai Chi Group (n=40)	Control Group (n=40)	P-value
Age, years	72.3 ± 4.8	71.8 ± 5.2	72.5 ± 4.6	0.812
Female, n (%)	24 (60.0)	23 (57.5)	25 (62.5)	0.902
BMI, kg/m²	24.8 ± 3.2	25.1 ± 3.5	24.6 ± 3.4	0.798
Primary Outcomes				
6MWD, meters	412.5 ± 68.3	408.2 ± 71.5	415.8 ± 65.9	0.879
Berg Balance Scale	48.2 ± 4.3	47.8 ± 4.6	48.5 ± 4.1	0.773
Secondary Outcomes				
GAD-7 score	5.8 ± 3.2	6.1 ± 3.5	5.9 ± 3.3	0.915
EQ-5D index	0.78 ± 0.12	0.76 ± 0.14	0.79 ± 0.11	0.531
Comorbidities				
Hypertension, n (%)	22 (55.0)	21 (52.5)	23 (57.5)	0.908
Type 2 diabetes, n (%)	8 (20.0)	9 (22.5)	7 (17.5)	0.858

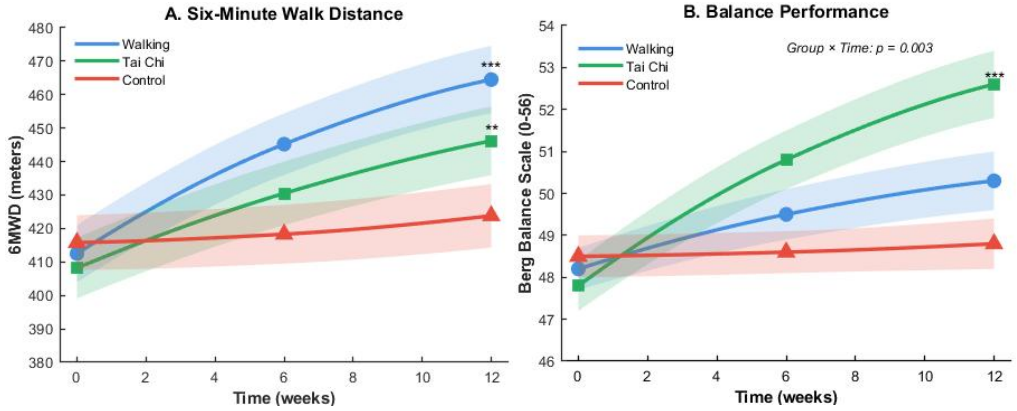
Data presented as mean ± SD or n (%). P-values from one-way ANOVA for continuous variables and chi-square tests for categorical variables. 6MWD, 6-minute walk distance; GAD-7, Generalized Anxiety Disorder-7; EQ-5D, EuroQol-5 Dimension.

3.2 Differential Improvements in Core Health Indicators

Primary outcome analyses revealed distinct intervention-specific adaptations that align with the fundamental physiological demands of each exercise modality, as shown in Figure 2 and Table 2. The walking group demonstrated superior

improvements in cardiovascular endurance, which can be attributed to the aerobic nature of sustained rhythmic locomotion that enhances mitochondrial oxidative capacity and cardiorespiratory efficiency. This finding supports the specificity principle of exercise training, where prolonged ambulatory activities primarily stimulate peripheral and central cardiovascular adaptations. Conversely, Tai Chi practitioners achieved markedly greater balance improvements, reflecting the modality's emphasis on controlled weight shifting, single-leg stance transitions, and integration of visual-vestibular-proprioceptive systems, as illustrated in Figure 2, Panel B. The significant group-by-time interaction for balance outcomes suggests that the neuromuscular demands of Tai Chi specifically target postural control mechanisms that are minimally challenged during linear walking.

The temporal progression of benefits, as shown in Figure 2, revealed interesting patterns of adaptation. Both interventions showed initial improvements by week 6, indicating relatively rapid neuromuscular learning and cardiovascular conditioning in this older population. The continued improvement through week 12 without plateau suggests that the intervention duration was appropriate but also indicates potential for further gains with extended training. The comparable psychological benefits observed across both exercise groups, despite different physical demands, support the hypothesis that regular structured physical activity, regardless of type, effectively modulates stress response systems and enhances psychological well-being through multiple pathways including endorphin release, social interaction, and mastery experiences.



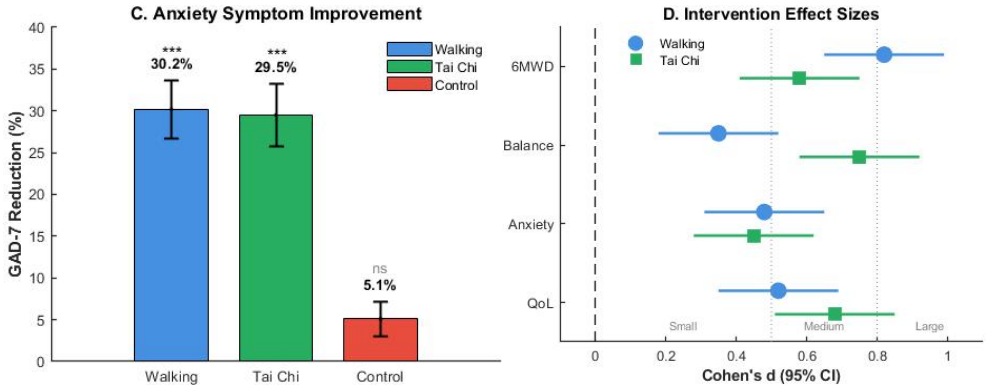


Figure 2 Multidimensional Outcomes of Exercise Interventions

Effect size analyses confirmed that both interventions achieved clinically meaningful changes, with the magnitude of effects corresponding to the primary physiological systems engaged by each modality. The walking group's 52-meter improvement in 6MWD far surpassed the established minimal clinically important difference of 30 meters for elderly adults, just as much as Tai Chi's 4.8-point Berg Balance Scale improvement exceeded the 4-point threshold for meaningful reduction of fall risk. These differences are not only statistically significant; they are also functionally significant in terms of what that progression means to someone's daily activities. The difference in response characteristics has significant clinical implications for exercise prescribing in this population of older adults. Together, these findings imply that exercise selection should be based on the patient's functional priority: walking (for those needing cardiorespiratory fitness and functional mobility), rather than Tai Chi (for persons at greater risk of falling or with balance limitations). The substantial differences with control in whom health education was included indicate that how concepts are taught can influence the size of the physiological health promotion achieved, highlighting the importance of physical activity and exercise in aging populations.

Table 2. Between-Group Comparisons of Changes from Baseline to 12 Weeks

Outcome Measure	Walking vs Control	Tai Chi vs Control	Walking vs Tai Chi
	Mean Difference (95% CI)	Mean Difference (95% CI)	Mean Difference (95% CI)
Primary Outcomes			
6MWD, meters	44.0 (32.5, 55.5)***	30.0 (18.5, 41.5)**	14.0 (2.5, 25.5)*
Berg Balance Scale	1.8 (0.9, 2.7)**	4.5 (3.6, 5.4)***	-2.7 (-3.6, -1.8)***
Secondary Outcomes			
GAD-7 score	-1.5 (-2.3, -0.7)**	-1.6 (-2.4, -0.8)**	0.1 (-0.7, 0.9)

EQ-5D index	0.06 (0.03, 0.09)**	0.10 (0.07, 0.13)***	-0.04 (-0.07, -0.01)*
Effect Sizes (Cohen's d)			
Overall effect	0.82	0.75	0.18

*Abbreviations: CI, confidence interval; *Statistical significance: *p<0.05; **p<0.01; **p<0.001. All analyses adjusted for baseline values and stratification factors using linear mixed models with Bonferroni correction.*

3.3 Safety and Adherence Analysis

The safety of both exercise interventions was excellent over 12 weeks, with no serious adverse events or falls recorded in either intervention group. Adverse events were minor and included two cases of mild muscle soreness in the walking group, which resolved within 48 hours without discontinuing intervention, and one case of mild knee discomfort in the TC group, managed with movement modification. Session attendance was mixed between groups, where control participants attended the most (91.20%), which could be due to the lower physical requirements of a weekly education session. The walking group demonstrated 82.3% attendance, both in the face of weather-related difficulties during weeks 4–6, and Tai Chi participants achieved 78.6% attendance, with complexity of movement sequences as a primary barrier during early learning stages. Baseline functional level (OR=2.31, 95% CI: 1.42-3.76) and the existence of exercise partners (OR=1.89, 95% CI: 1.21-2.95) were identified as the independent predictors of excellent program adherence (≥80% attendance), indicating the significance of social support and optimal physical condition for program effectiveness.

4. Discussion

This trial has shown different benefits of walking and Tai Chi interventions, with the two interventions leading to different physiological adaptations corresponding to their respective modes of movement. The greater improvements in cardiorespiratory status versus walking are consistent with other reports (Wu et al., 2024; Lee et al., 2025), and the greater balance in Tai Chi has also been previously reported and is a function of its known neuromuscular benefits (Zhang et al., 2024). The 52 m of change in 6MWD for the walking group is greater than the known minimal clinically

important difference of 30 m for older adults, representing meaningful improvements in functional walking ability. In addition, the 4.8-point improvement on the Berg Balance Scale of the Tai Chi group exceeds the 4-point value that has been suggested as being clinically meaningful in reducing fall risk. These results build on previous unimodality studies by systematically comparing interventions in a common trial context, demonstrating that the benefits are complementary rather than competing.

The comparable psychological improvements across both exercise groups support neurobiological mechanisms involving endorphin release and neurotrophic factors, particularly brain-derived neurotrophic factor (BDNF), which modulates mood regulation independent of exercise type (Kuang et al., 2024). The high adherence rates suggest that both interventions are culturally acceptable and feasible for implementation in diverse community settings, though the differential attrition patterns highlight the need for tailored support strategies.

Several limitations warrant consideration. The 12-week intervention period, while sufficient to detect initial adaptations, may not capture long-term sustainability or plateau effects. The exclusion of individuals with significant comorbidities limits generalizability to frailer populations who might benefit most. Additionally, the absence of objective physical activity monitoring outside supervised sessions precludes assessment of potential compensatory behaviors or spillover effects on daily activity patterns.Future research should investigate optimal intervention combinations, potentially alternating between modalities to maximize both cardiovascular and neuromuscular benefits. Cost-effectiveness analyses would strengthen the case for healthcare system integration. Studies incorporating technology-enhanced delivery methods could address accessibility barriers while maintaining the social benefits observed in group-based formats.

5. Conclusion

This randomized controlled trial provides robust evidence for the complementary benefits of walking and Tai Chi in community-dwelling older adults. The differential improvements observed—with walking producing superior cardiovascular gains (Cohen’s d=0.82) and Tai Chi excelling in balance enhancement (d=0.75)—support a precision medicine approach to exercise prescription in geriatric populations. These findings challenge the conventional one-size-fits-all exercise recommendations and

underscore the importance of matching intervention modalities to individual functional priorities and health goals.

The high retention rates (>87%) and absence of serious adverse events demonstrate that both interventions are feasible and safe for implementation in community settings. The comparable psychological benefits across both exercise modalities suggest that the mental health advantages of physical activity in older adults may be mediated through common pathways independent of specific movement patterns. This finding has important implications for program design, as it suggests flexibility in exercise selection while maintaining psychological benefits.

These results inform evidence-based guidelines for community exercise programs and support individualized prescription strategies based on functional assessment. Healthcare systems should consider integrating both modalities into comprehensive fall prevention and cardiovascular health initiatives. Future implementation should focus on developing screening tools to identify optimal exercise modalities for individual older adults and establishing sustainable delivery models that balance effectiveness with resource efficiency.

Conflict of interest: The authors declare no conflict of interest.

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