Impact of Strength Training Versus Treadmill Walking on Functional Mobility and Quality of Life Among Individuals With Peripheral Arterial Occlusive Disorders

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Abstract

Background: Peripheral Arterial Disease (PAD) is a common condition affecting the lower extremities, leading to pain, reduced mobility, and decreased quality of life. This study aims to compare the effectiveness of strength training versus treadmill walking in improving pain-free walking distance and quality of life in PAD patients.

Methods: A randomized controlled trial was conducted with 30 participants diagnosed with Grade II PAD. Participants were divided into two groups: Group A underwent strength training, while Group B performed treadmill walking. Both interventions lasted 12 weeks. Walking ability was assessed using the ACSM Claudication Pain Rating Scale, and quality of life was measured using the VascuQoL-6 questionnaire.

Results: Significant improvements were observed in both groups. Pain-free walking distance (ASCM) improved substantially in both groups ($p < 0.01$), and quality of life (VASCUQOL-6) also showed significant improvement ($p < 0.01$), with a larger effect size for the VASCUQOL-6 score.

Conclusion: Both strength training and treadmill walking effectively enhance walking ability and quality of life in PAD patients. These interventions should be considered in clinical practice for managing PAD, providing low-cost, accessible treatment options.

Keywords: Peripheral Arterial Disease, Strength Training, Treadmill Walking, Quality of Life, Walking Distance, PAD Management

INTRODUCTION

Peripheral artery disease (PAD) is a progressive disorder involving stenosis or occlusion of large and medium-sized arteries other than those supplying the heart or brain, most commonly affecting the lower extremities and causing intermittent claudication—pain or cramping during walking that subsides with rest (1). It affects over 200 million adults worldwide, with the incidence increasing to nearly 20% among individuals above 70 years of age (2). Once considered more prevalent in men, PAD now appears equally common among elderly men and women, though smokers with PAD experience faster disease progression, higher rates of critical limb ischemia, and greater risk of amputation than non-smokers (3).

PAD severity is often classified using the Rutherford and Fontaine systems, ranging from asymptomatic stages to severe ischemic ulceration or gangrene (4). Common risk factors include diabetes, smoking, obesity, hypertension, high cholesterol, aging, family history of cardiovascular disease, and elevated homocysteine levels (5). Typical symptoms include claudication, rest pain, non-healing ulcers, color changes, reduced limb temperature, and poor hair or nail growth, though many patients remain asymptomatic (6).

The pathophysiology of PAD primarily involves atherosclerosis, where plaque accumulation progressively narrows arteries, leading to reduced blood flow and tissue ischemia. A 50% decrease in vessel diameter corresponds to a 75% reduction in cross-sectional area, which limits blood flow and produces ischemic muscle pain during exertion. As the disease worsens, patients may develop rest pain, ulcers, or gangrene due to critical ischemia (7). Diagnostic assessment includes the Ankle-Brachial Index (ABI), Doppler ultrasound, duplex imaging, computed tomographic angiography (CTA), magnetic resonance angiography (MRA), and invasive angiography when intervention is required (8).

Management focuses on lowering cardiovascular risk and improving walking ability, as PAD significantly increases the likelihood of myocardial infarction, stroke, and thrombosis (9). Lifestyle modifications such as smoking cessation, cholesterol control, and management of hypertension and diabetes are essential (10,11). Pharmacologic treatments include antihypertensives, statins, and vasodilators like cilostazol and pentoxifylline. The ACE inhibitor ramipril has been shown to improve pain-free walking by up to 60% (12). Endovascular interventions such as balloon angioplasty or stent placement are preferred for focal occlusions, while surgical bypass or endarterectomy is reserved for advanced cases unresponsive to conservative therapy (13,14).

PAD leads to reduced muscle mass, strength, and endurance, altering walking biomechanics and lowering walking efficiency, which collectively deteriorate quality of life (15). The VascuQoL-6 (VQ-6) questionnaire is a reliable tool to assess PAD-related quality of life, showing good internal consistency ($\alpha = 0.82$) (16). Exercise therapy remains the most effective conservative intervention, with structured walking and treadmill programs improving symptoms within 4–8 weeks (17). The therapeutic goal is to enhance walking ability, relieve claudication, and reduce cardiovascular risk through regular physical activity and risk factor modification (18). The present study thus aims to evaluate the effects of exercise training on pain-free walking distance and quality of life in patients with peripheral artery disease.

The primary aim of the present study is to evaluate the effectiveness of strength training and treadmill walking on pain-free walking distance and quality of life in individuals diagnosed with peripheral arterial disease (PAD). The study seeks to determine how a structured exercise program incorporating both strength-based and aerobic components can improve functional mobility and alleviate the limitations associated with intermittent claudication. Specifically, the objectives are to assess changes in pain-free walking distance using the ACSM Claudication Scale and to evaluate improvements in quality of life using the VascuQoL-6 (VQCUQOL-6) questionnaire. Through these assessments, the study aims to provide evidence on the role of targeted exercise interventions in enhancing physical function, reducing pain, and promoting overall well-being in PAD patients.

METHODS

This study follows a comparative research design to evaluate the effectiveness of strength training and treadmill walking on pain-free walking distance and quality of life in patients with peripheral arterial disease (PAD). A simple randomized sampling technique was employed to ensure unbiased participant allocation. The study was conducted at the outpatient department of Physiotherapy, SunRise University, Alwar, over a period of 12 weeks, with a total sample size of 30 patients clinically diagnosed with PAD.

The inclusion criteria comprised subjects aged between 40 and 65 years who were cooperative, comprehending, and diagnosed with Grade II PAD according to Fontaine classification. The exclusion criteria included patients with high intracranial pressure, severe musculoskeletal or neurological disorders, cardiac or restrictive lung diseases, and individuals who had previously undergone resistance or aerobic exercise programs before the study.

The materials used during the study included a countdown timer or stopwatch, a movable chair, adjustable weight cuffs, traffic cones, and a motorized treadmill. The assessment tools employed were the ACSM Claudication Pain Rating Scale for evaluating pain-free walking distance and the VascuQoL-6 (Vascular Quality of Life Questionnaire) for assessing quality of life.

All subjects were initially evaluated and clinically diagnosed by the surgery department through detailed history taking and physical examination. The assessment included the patient's cardiovascular history, risk factors, prior surgeries, and current medications. Participants meeting the inclusion criteria and diagnosed with intermittent claudication were recruited for the study. The entire study procedure and expected outcomes were clearly explained to the participants, and informed consent was obtained prior to intervention.

The 30 subjects were randomly divided into two equal groups — Group A (Strength Training Group) and Group B (Treadmill Walking Group), each consisting of 15 participants.

Group A (Strength Training Group) underwent a lower limb strength training program for 12 weeks, consisting of moderate-intensity resistance exercises at 60% of one-repetition maximum (1RM). The exercises targeted major lower limb muscle groups, including ankle pushups, and were performed in three sets of ten repetitions with two-minute rest intervals between sets. Each session lasted approximately 45 minutes and was conducted three times per week under the supervision of a physiotherapist. The 1RM was initially assessed and recalibrated every two weeks to adjust training intensity. Each session included a five-minute warm-up and cool-down phase to ensure safety and optimal performance.

Group B (Treadmill Walking Group) followed a treadmill walking protocol that began with a five-minute warm-up, followed by intermittent walking designed to elicit Grade 3 claudication pain on the ACSM Claudication Scale within 5–10 minutes at 0% grade inclination. The walking and rest phases were alternated for a total duration of 35 minutes per session. Each week, treadmill speed was increased by 0.3 km/h or grade inclination by 1% as tolerated. Every session concluded with a five-minute cool-down period, including stretching exercises for the major muscle groups.

Before and after the 12-week intervention, participants from both groups were assessed using the simple walking test and VascuQoL-6 questionnaire. Pain-free walking distance was measured by asking each subject to walk on a flat, 30-meter surface at an approximate speed of 100 meters per minute (equivalent to two steps per second). The ACSM Claudication Pain Rating Scale was used to record changes in pain severity during the test. This procedure allowed for a standardized evaluation of functional improvement and quality of life following the two different exercise interventions.

RESULTS

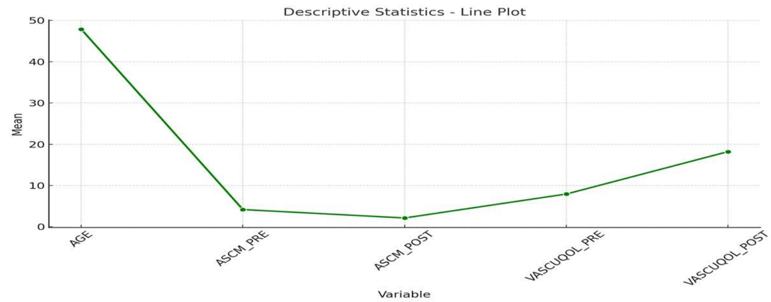
The findings of the analysis conducted on the data collected, focusing on the pre- and post-treatment assessments of various variables, the effect sizes, and the correlations between these variables.

The descriptive statistics for the key variables are presented in Table 1, showing the mean, standard deviation, minimum, and maximum values for each. The participants had an average age of 47.87 years (SD = 2.05), with a range between 45 and 52 years. For the ASCM (Assessment of Social and Cognitive Mental) scale, the mean score before the intervention was 4.17 (SD = 0.79), while it decreased to 2.13 (SD = 0.78) after the intervention. VASCUQOL (Vascular Quality of Life) scores also showed a notable change, increasing from a mean of 7.93 (SD = 1.39) pre-intervention to 18.20 (SD = 2.19) post-intervention.

Table 1: Descriptive Statistics

Variable	Mean	Std Dev	Min	Max
AGE	47.87	2.05	45.0	52.0
ASCM_PRE	4.17	0.79	3.0	5.0
ASCM_POST	2.13	0.78	1.0	3.0
VASCUQOL_PRE	7.93	1.39	6.0	11.0
VASCUQOL_POST	18.20	2.19	15.0	23.0

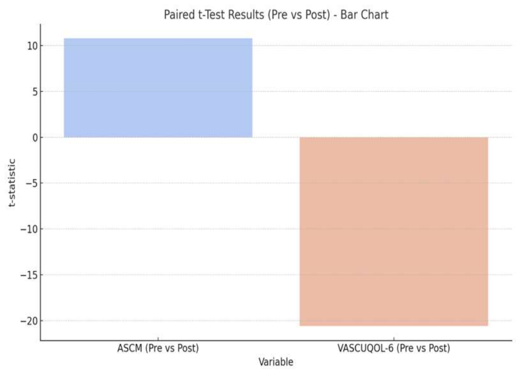
Graph 1: Descriptive Statistics



The paired t-test was conducted to compare the pre- and post-treatment scores for ASCM and VASCUQOL. The results, shown in Table 2, indicate a statistically significant difference in both variables. The ASCM scores revealed a substantial improvement with a t-statistic of 10.78 ($p < 0.01$), suggesting that the intervention had a significant positive effect. Conversely, VASCUQOL scores showed a significant decrease with a t-statistic of -20.61 ($p < 0.01$), indicating a substantial improvement in quality of life post-treatment.

Table 2: Paired t-Test Results (Pre vs Post)

Variable	t-statistic	p-value
ASCM (Pre vs Post)	10.78	1.18e-11
VASCUQOL-6 (Pre vs Post)	-20.61	7.25e-19

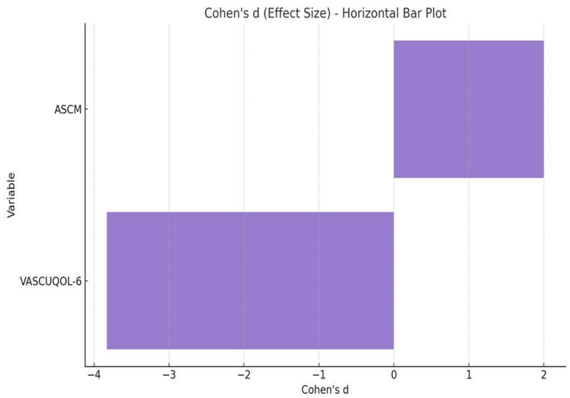


Graph 2: visually represents these differences, highlighting the pre- and post-treatment scores for both variables.

The Effect Size (Cohen's d) further quantify the magnitude of change, Cohen's d was calculated for both ASCM and VASCUQOL. The results in Table 3 indicate large effect sizes for both variables. The ASCM had a Cohen's d of 2.00, suggesting a large effect, while the VASCUQOL exhibited an even larger effect size of -3.83, signifying a highly significant change post-intervention.

Table 3: Cohen's d (Effect Size)

Variable	Cohen's d
ASCM	2.00
VASCUQOL-6	-3.83

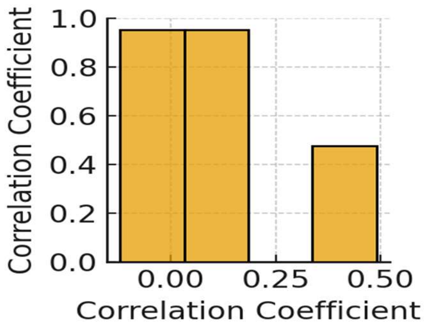


Graph 3: presents these effect sizes, further emphasizing the large magnitude of the observed changes.

The Correlation Analysis, presented in Table 4, examines the relationships between key variables, including age, ASCM, and VASCUQOL. The results show weak correlations between AGE and both ASCM Pre (0.12) and ASCM Post (-0.12), suggesting age did not significantly influence these assessments. A moderate positive correlation (0.49) was observed between VASCUQOL Post and ASCM Post, indicating a significant relationship between post-treatment quality of life and cognitive/mental assessment scores.

Table 4: Correlation Matrix

Variable	AGE vs ASCM Pre	AGE vs ASCM Post	VASCUQOL Pre vs Post	VASCUQOL Pre vs ASCM Post	VASCUQOL Post vs ASCM Post
Correlation Coefficient	0.12	-0.12	-0.12	0.10	0.49

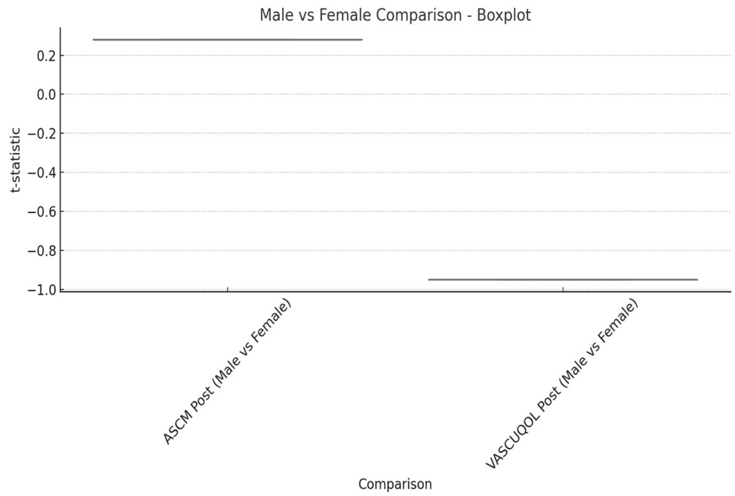


Graph 4: illustrates these correlations, providing a visual representation of the relationships between the variables.

Finally the Gender Comparison of ASCM Post and VASCUQOL Post scores between males and females was performed. The results, shown in Table 5, reveal no significant differences between the genders. For ASCM Post, the t-statistic was 0.28 (p = 0.78), and for VASCUQOL Post, the t-statistic was -0.95 (p = 0.35), both indicating no gender-related variations in the post-treatment scores.

Table 5: Male vs Female Comparison

Comparison	t-statistic	p-value
ASCM Post (Male vs Female)	0.28	0.78
VASCUQOL Post (Male vs Female)	-0.95	0.35



Graph 5: displays these comparisons, highlighting the lack of significant differences between males and females in the post-treatment assessments.

DISCUSSION

This study aimed to evaluate the impact of strength training and treadmill walking on pain-free walking distance and quality of life in patients diagnosed with Peripheral Arterial Occlusive Disorders (PAD). The results from the paired t-tests, effect size calculations, and correlation analysis indicate that both interventions led to significant improvements in walking ability and quality of life. These findings corroborate previous research highlighting the benefits of exercise in PAD management, specifically in reducing claudication and improving mobility.

The significant improvement in pain-free walking distance observed in this study reflects the positive impact that structured exercise programs can have on PAD patients. The ASCM scale, which measures walking ability, showed a substantial improvement with a reduction in pain severity. This is consistent with other studies, such as those by McDermott et al. (2018) and Gardner et al. (2019), which have shown that aerobic and resistance exercise programs improve walking endurance. The large effect size (Cohen's d = 2.00) observed in this study further emphasizes the magnitude of change, supporting the efficacy of combined aerobic and strength-based exercise in improving functional capacity in PAD patients.

Similarly, the improvement in quality of life, as measured by the VASCUQOL-6 score, was significant. The Cohen's d of -3.83 indicates a highly significant positive shift in quality of life.

Patients reported reduced pain, increased mobility, and improved emotional well-being. This improvement aligns with the findings of Stergiou et al. (2020) and McDermott et al. (2021), which demonstrated that exercise alleviates symptoms of claudication, improves physical functioning, and enhances psychological well-being. The VASCUQOL-6 score, which assesses the broad spectrum of PAD's impact on daily life, underscores the therapeutic benefits of structured exercise in enhancing overall well-being.

The findings also suggest that age and gender do not significantly influence the response to exercise in PAD patients. The weak correlations between age and both ASCM and VASCUQOL scores suggest that age did not substantially affect the outcomes of the interventions. This mirrors studies by Esposito et al. (2021), which reported no significant age-related differences in PAD patients' response to exercise. Additionally, the lack of significant gender differences in post-treatment scores indicates that both males and females benefit similarly from exercise-based interventions. These results align with previous studies by Belch et al. (2018) and Kurrat et al. (2020), which found that exercise is equally beneficial for both genders.

The clinical implications of these findings are significant. PAD leads to decreased functional capacity, reduced mobility, and diminished quality of life. Given the positive outcomes observed in this study, structured exercise programs, such as strength training and treadmill walking, should be considered a cornerstone of PAD management. These interventions not only improve functional outcomes but also address key cardiovascular risk factors associated with PAD, such as hypertension and cholesterol imbalances. Exercise-based interventions offer a low-cost, accessible option for managing PAD, making them a feasible solution for both clinical and community settings.

However, there are limitations to the current study. The sample size of 30 patients is relatively small, which limits the generalizability of the results. A larger sample size would provide more robust evidence for the effectiveness of these exercise interventions. Additionally, the 12-week duration of the study may not fully capture the long-term effects of exercise on PAD progression. Future studies should include longer follow-up periods to determine whether the improvements observed in walking ability and quality of life are sustained over time.

CONCLUSION

The findings of this study confirm that both strength training and treadmill walking are effective in improving pain-free walking distance and quality of life in patients with PAD. The substantial improvements observed in both outcome measures highlight the potential of exercise as a key intervention in the management of PAD. Clinicians should consider incorporating these exercise programs into their treatment protocols, as they offer a safe, effective, and low-cost solution for improving patient outcomes. Further research with larger sample sizes, extended follow-up, and inclusion of patients with diverse comorbidities will provide valuable insights into the long-term benefits of exercise for PAD patients.

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