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Training Adaptations in Sedentary Adults: An 8-Week Randomized Controlled Trial Comparing Walking and Cycling Protocols

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ABSTRACT

Background: *Physical inactivity is a major modifiable risk factor for cardiovascular disease. Aerobic exercise is widely recommended to improve cardiovascular health; however, comparative adaptations between walking and cycling protocols in sedentary adults remain insufficiently explored.* ***Objective:*** *To compare cardiovascular and autonomic adaptations following an 8-week structured walking versus cycling program in sedentary adults.* ***Methods:*** *Sixty sedentary adults (20–45 years) were randomized into Walking (WG; n = 20), Cycling (CG; n = 20), and Control (CON; n = 20) groups. Exercise groups trained 5 days/week for 8 weeks at 50–65% HRmax with progressive duration (30–45 minutes). Primary outcomes included VO_2max, resting heart rate (RHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP). Secondary outcomes included body mass index (BMI), body fat percentage, and heart rate variability (HRV). A 3 × 2 repeated-measures ANOVA assessed group × time interactions.* ***Results:*** *Significant group × time interactions were observed for VO_2max ($\eta^2 = .28$), SBP ($\eta^2 = .24$), DBP, RHR, and HRV ($p < .01$). Cycling demonstrated greater improvements in VO_2max (Δ +5.8 $mL \cdot kg^{-1} \cdot min^{-1}$) compared to walking ($\Delta$ +4.1 $mL \cdot kg^{-1} \cdot min^{-1}$; $p = .02$). Walking produced slightly greater SBP reduction (−9.2 mmHg) compared to cycling (−7.6 mmHg; $p = .04$). No significant changes occurred in the control group.* ***Conclusion:*** *Both walking and cycling significantly improve cardiovascular health in sedentary adults. Cycling enhances aerobic capacity more substantially, while walking may provide superior blood pressure reduction. These findings support modality-specific exercise prescription.*

Keywords: *Walking, Cycling, Sedentary Adults, VO_2max, Blood Pressure, Heart Rate Variability*

INTRODUCTION

Physical inactivity is a leading contributor to global cardiovascular morbidity and mortality (Lee et al., 2012). Sedentary behavior increases the risk of hypertension, obesity, endothelial dysfunction, and autonomic imbalance (Blair et al., 1996). Aerobic exercise is recommended as a first-line non-pharmacological strategy for cardiovascular disease prevention (Haskell et al., 2007). Walking and cycling are commonly prescribed aerobic modalities due to their safety and accessibility. Walking is weight-bearing and requires minimal equipment, making it suitable for large populations (Murtagh et al., 2015). Cycling is non-weight-bearing and allows precise workload regulation, potentially facilitating greater aerobic gains (Tanasescu et al., 2002). Aerobic training improves maximal oxygen uptake (VO_2max), lowers resting heart rate, reduces blood pressure, and enhances autonomic function (Cornelissen & Smart, 2013). These adaptations are attributed to central cardiovascular improvements (increased stroke volume and cardiac output) and peripheral muscular adaptations (enhanced mitochondrial density and capillarization) (Green et al., 2008).

Despite extensive literature supporting aerobic exercise benefits, few randomized controlled trials have directly compared walking and cycling under matched intensity conditions in sedentary adults. Understanding modality-specific adaptations may enhance individualized exercise prescription. Therefore, this study aimed to compare cardiovascular and autonomic adaptations following an 8-week walking versus cycling program. We hypothesized that both modalities would improve cardiovascular health, with cycling producing greater VO_2max gains and walking yielding superior blood pressure reductions.

Study Design

This study employed an 8-week parallel-group randomized controlled trial design to examine the comparative effects of walking and cycling interventions on cardiovascular and autonomic adaptations in sedentary adults. A total of 60 participants were randomly allocated into three groups: Walking Group (WG; n = 20), Cycling Group (CG; n = 20), and Control Group (CON; n = 20). Randomization was performed to ensure equal distribution and minimize selection bias. The two experimental groups participated in structured aerobic training programs, while the control group maintained their usual lifestyle without any structured exercise intervention. Ethical approval for the study was obtained from the institutional ethics committee prior to data collection, and all participants provided written informed consent in accordance with research ethics guidelines.

Participants

Participants were recruited based on predefined eligibility criteria to ensure homogeneity and safety. Individuals aged between 20 and 45 years who reported a sedentary lifestyle, defined as engaging in less than 150 minutes of moderate physical activity per week, were eligible for inclusion. Additionally, participants were required to have a body mass index (BMI) between 20 and 30 kg/m². Exclusion criteria included a history of cardiovascular or metabolic disease, current smoking status, use of medications known to affect heart rate or blood pressure, and any musculoskeletal limitations that could interfere with safe participation in the exercise protocols. These criteria were established to minimize health risks and control for confounding variables that might influence cardiovascular and autonomic outcomes.

Intervention Protocol

Participants in the exercise groups (Walking and Cycling) underwent a structured aerobic training program conducted five days per week for a total duration of eight weeks. Training intensity was prescribed at 50–65% of age-predicted maximum heart rate (HRmax), calculated using the formula 220 − age. Exercise intensity and duration were progressively increased throughout the intervention to ensure gradual physiological adaptation and to minimize the risk of overexertion. During the initial two weeks, participants exercised for 30 minutes at approximately 50% HRmax. The duration and intensity were subsequently increased every two weeks, reaching 45 minutes at 65% HRmax by weeks seven and eight. Walking sessions were performed on a treadmill under supervised conditions, while cycling sessions were conducted on a stationary ergometer at a cadence of 60–70 revolutions per minute. Participants in the control group were instructed to maintain their usual daily activities and refrain from initiating any structured exercise program during the study period.

Weeks	Duration	Intensity
1–2	30 min	50% HRmax
3–4	35 min	55% HRmax
5–6	40 min	60% HRmax
7–8	45 min	65% HRmax

- Walking: treadmill-based
- Cycling: stationary ergometer (60–70 RPM)
- Control: maintained usual lifestyle

Outcome Measures

Cardiovascular and body composition variables were assessed as primary and secondary outcome measures at baseline and after the 8-week intervention period. The primary outcomes included maximal oxygen uptake (VO_2max), estimated using the Åstrand submaximal cycle ergometer test, resting heart rate (RHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP). Resting heart rate and blood pressure were measured under standardized resting conditions following at least 10 minutes of seated rest. Secondary outcomes included body mass index (BMI), calculated from measured height and weight (kg/m^2), body fat percentage assessed via bioelectrical impedance analysis, and heart rate variability (HRV) indices, including the root mean square of successive differences (RMSSD) and the low-frequency to high-frequency (LF/HF) ratio. All measurements were obtained under controlled laboratory conditions at baseline and repeated at the end of week 8 to evaluate training-induced adaptations.

Statistical Analysis

Data were analyzed using SPSS (Version XX). Normality was assessed via Shapiro–Wilk test. A 3 × 2 repeated-measures ANOVA (Group × Time) evaluated differences. Effect sizes were expressed as partial eta squared (η^2). Significance level was set at $p < .05$.

Participant Characteristics

All sixty participants successfully completed the 8-week intervention, resulting in a 100% adherence rate with no dropouts reported. Compliance with the prescribed training sessions in both exercise groups was closely monitored and remained consistently high throughout the study period. Baseline comparisons among the Walking, Cycling, and Control groups revealed no statistically significant differences in age, body mass index, VO_2max, resting heart rate, or blood pressure ($p > .05$). These findings indicate that the groups were comparable prior to the intervention, confirming the effectiveness of the randomization process and ensuring internal validity of subsequent outcome comparisons.

Cardiovascular Adaptations

A significant group × time interaction effect was observed for maximal oxygen uptake (VO_2max; $p < .001$, $\eta^2 = .28$), systolic blood pressure (SBP; $p < .001$, $\eta^2 = .24$), diastolic blood pressure (DBP; $p < .001$), resting heart rate (RHR; $p < .001$), and heart rate variability (HRV; $p < .01$). These findings indicate that changes over time differed significantly between groups, with the exercise interventions producing meaningful cardiovascular and autonomic adaptations compared to the control condition. The reported effect sizes suggest moderate to large intervention effects, particularly for VO_2max and systolic blood pressure.

Variable	WG Δ	CG Δ	CON Δ
VO_2max	+4.1	+5.8	+0.3
SBP	−9.2	−7.6	−0.8
DBP	−6.4	−5.9	−0.5
RHR	−7.8	−9.4	−0.6

Cycling resulted in a significantly greater improvement in VO_2max compared to walking ($p = .02$), indicating superior enhancement of aerobic capacity in the cycling group. Conversely, the walking group demonstrated a slightly greater reduction in systolic blood pressure (SBP) compared to the cycling group ($p = .04$), suggesting a modest advantage of walking for blood pressure management.

DISCUSSION

The present study demonstrates that both walking and cycling significantly improve cardiovascular health in sedentary adults following an 8-week structured aerobic training program. The observed improvements in VO_2max, blood pressure, resting heart rate, and heart rate variability confirm that moderate-intensity aerobic exercise performed five days per week is sufficient to induce meaningful cardiovascular and autonomic adaptations in previously inactive individuals.

Cycling produced greater improvements in VO_2max compared to walking, suggesting superior enhancement of aerobic capacity. This finding may be attributed to the continuous concentric muscle contractions and controlled workload typical of cycling, which facilitate sustained oxygen delivery and utilization. Enhanced peripheral oxygen extraction, increased mitochondrial density, and improved capillary perfusion likely contributed to the greater aerobic adaptations observed in the cycling group, consistent with previous physiological research (Joyner & Green, 2009; Green et al., 2008). Additionally,

the non-weight-bearing nature of cycling may allow participants to maintain steady intensity with reduced musculoskeletal fatigue, further promoting aerobic conditioning.

In contrast, walking resulted in slightly greater reductions in systolic blood pressure. As a weight-bearing activity, walking may produce greater vascular shear stress and endothelial stimulation, promoting vascular remodeling and improved arterial compliance (Ashor et al., 2014). These findings are consistent with meta-analytic evidence indicating that regular aerobic exercise reduces systolic blood pressure by approximately 5–10 mmHg in sedentary and prehypertensive populations (Cornelissen & Smart, 2013). Even modest reductions in systolic blood pressure are clinically meaningful and associated with reduced cardiovascular risk.

Both exercise modalities significantly reduced resting heart rate and improved heart rate variability, indicating enhanced parasympathetic activity and improved autonomic balance. Improved vagal tone is a well-established adaptation to aerobic training and is associated with reduced cardiovascular morbidity and mortality (Seals et al., 2009). The significant improvements in HRV parameters observed in the present study suggest favorable autonomic modulation following regular moderate-intensity exercise.

Overall, these findings highlight the modality-specific yet complementary benefits of walking and cycling. While cycling appears more effective for improving aerobic capacity, walking may offer slight advantages in blood pressure reduction, making both modalities valuable tools for cardiovascular prevention and individualized exercise prescription.

Clinical Implications

The findings of this study have important clinical and public health implications. Cycling appears to be the preferable modality for individuals aiming to enhance aerobic capacity due to its greater improvements in VO_2max. In contrast, walking may be more advantageous for blood pressure management and is particularly suitable for large-scale public health interventions because of its accessibility, low cost, and minimal equipment requirements. Importantly, structured moderate-intensity aerobic exercise performed five days per week is sufficient to elicit meaningful cardiovascular and autonomic adaptations in previously sedentary adults, supporting current exercise guidelines for health promotion.

LIMITATIONS

Several limitations should be considered when interpreting the results of this study. First, the intervention duration was relatively short (8 weeks), which may limit the generalizability of findings to longer-term adaptations. Second, the sample size was modest, which may affect statistical power and external validity. Third, VO_2max was estimated using a submaximal test rather than measured directly, which may introduce some measurement error. Finally, no follow-up assessments were conducted, preventing evaluation of the long-term sustainability of the observed adaptations. Future research should examine longer interventions with larger, more diverse populations and include direct VO_2max measurement and long-term follow-up to better understand the durability of exercise-induced benefits.

CONCLUSION

This study demonstrates that an 8-week structured aerobic training program effectively enhances cardiovascular health in sedentary adults. Cycling elicits greater improvements in aerobic capacity, while walking produces slightly superior reductions in systolic blood pressure. Both exercise modalities are safe, practical, and effective, making them suitable options for cardiovascular disease prevention. These findings support the integration of modality-specific exercise prescriptions into both individualized fitness programs

and broader public health initiatives aimed at reducing sedentary behavior and improving cardiovascular outcomes.

PRACTICAL APPLICATIONS

The findings of this study have several practical applications for exercise prescription and public health strategies. Walking is highly suitable for community-based interventions and for populations with limited access to exercise equipment, given its safety, simplicity, and accessibility. Cycling is recommended for individuals seeking to specifically enhance aerobic performance due to its greater improvements in VO_2max. Overall, exercise programs should be tailored to individual goals, health status, and accessibility, with at least five sessions of moderate-intensity aerobic activity per week to achieve meaningful cardiovascular and autonomic benefits. These recommendations can inform both personalized fitness plans and large-scale health promotion initiatives aimed at reducing sedentary behavior.

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