Role of physical activity in enhancing physical quality of life for stroke prevention

Papel de la actividad física en la mejora de la calidad de vida física para la prevención del ictus

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Abstract

Introduction: stroke remains a leading cause of mortality and long-term disability worldwide. physical activity has been increasingly recognized as a modifiable lifestyle factor for improving health outcomes and preventing chronic diseases.
Objective: the objective of this study was to examine the role of physical activity in enhancing physical quality of life and reducing stroke risk, with a particular focus on the effects of different activity intensities.
Methodology: a longitudinal intervention study was conducted involving 180 participants aged 45 to 70, divided into moderate-intensity, low-intensity, and control groups. data were collected at baseline and after a six-month intervention period using validated physiological and quality of life measures.
Results: participants in the moderate-intensity group showed significantly greater improvements in physical quality of life and cardiovascular health indicators compared to other groups. statistical analyses confirmed a dose-response effect and significant mediation by cardiovascular health.
Discussion: the findings aligned with existing literature indicating that structured physical activity reduces stroke risk and enhances physical well-being. the results also confirmed that these benefits are partly explained by improvements in cardiovascular function.
Conclusions: moderate-intensity physical activity should be promoted as an effective strategy for enhancing quality of life and preventing stroke in middle-aged and older adults.

Keywords

Cardiovascular health; intervention; moderate exercise; physical activity; prevention; quality of life; stroke; aging.

Resumen

Introducción: el ictus sigue siendo una de las principales causas de mortalidad y discapacidad a largo plazo en todo el mundo. la actividad física ha sido cada vez más reconocida como un factor de estilo de vida modificable para mejorar los resultados de salud y prevenir enfermedades crónicas.
Objetivo: el objetivo de este estudio fue examinar el papel de la actividad física en la mejora de la calidad de vida física y la reducción del riesgo de ictus, con especial atención a los efectos de diferentes intensidades de actividad.
Metodología: se llevó a cabo un estudio de intervención longitudinal con la participación de 180 personas entre 45 y 70 años, divididas en grupos de actividad física de intensidad moderada, baja y un grupo control. los datos se recogieron al inicio y tras un periodo de intervención de seis meses utilizando medidas fisiológicas y de calidad de vida validadas.
Resultados: los participantes del grupo de intensidad moderada mostraron mejoras significativamente mayores en la calidad de vida física y en los indicadores de salud cardiovascular en comparación con los otros grupos. los análisis estadísticos confirmaron un efecto dosis-respuesta y una mediación significativa a través de la salud cardiovascular.
Discusión: los hallazgos coincidieron con la literatura existente que indica que la actividad física estructurada reduce el riesgo de ictus y mejora el bienestar físico. los resultados también confirmaron que estos beneficios se explican en parte por las mejoras en la función cardiovascular.
Conclusiones: la actividad física de intensidad moderada debe promoverse como una estrategia eficaz para mejorar la calidad de vida y prevenir el ictus en adultos de mediana y avanzada edad.

Palabras clave

Actividad física; calidad de vida; envejecimiento; ejercicio moderado; ictus; intervención; prevención; salud cardiovascular.

Introduction

Stroke remains one of the leading causes of death and long-term disability globally, posing a significant burden on healthcare systems and society at large (Viktorisson et al., 2021). It is well established that lifestyle factors, particularly physical inactivity, are major modifiable risk contributors to stroke incidence and recurrence (Ali et al., 2021). In this context, increasing attention has been directed toward the preventive potential of physical activity not only in mitigating stroke risk but also in enhancing overall physical quality of life (QoL), particularly among populations at elevated risk (Yunus et al., 2024).

Physical activity is broadly recognized as a cornerstone of cardiovascular health, which is intricately linked to stroke prevention (Nayak et al., 2025). Regular engagement in aerobic and resistance-based exercises contributes to improved endothelial function, blood pressure regulation, lipid profile balance, and glycemic control factors that collectively reduce the likelihood of cerebrovascular events (Damsbo et al., 2025). More importantly, beyond physiological benefits, physical activity also enhances an individual's perception of physical well-being by improving mobility, muscular strength, endurance, and independence in daily living (Nindorera et al., 2022).

While much of the existing literature has concentrated on post-stroke rehabilitation, a growing body of research suggests that physical activity has a profound preventive capacity that can delay or even avert stroke onset altogether (Peltonen et al., 2025). However, the mechanisms through which physical activity exerts its protective effects are multifactorial, involving both direct physiological adaptations and indirect enhancements in physical quality of life, such as increased self-efficacy, vitality, and functional independence (Barakou et al., 2025). Thus, it becomes imperative to investigate how physical activity might serve as a modifiable behavioral intervention that targets both risk reduction and well-being enhancement.

The World Health Organization emphasizes that even moderate increases in physical activity can yield significant health benefits, particularly for individuals in mid-to-late adulthood when stroke risk typically escalates (Edmizal et al., 2024). Despite these recommendations, global physical activity levels remain below optimal thresholds, especially in populations facing barriers such as sedentary occupation, urbanization, and chronic comorbidities (Elendu et al., 2023). Consequently, understanding the multidimensional role of physical activity is essential for crafting public health policies that promote stroke prevention through lifestyle modification.

Furthermore, disparities in physical quality of life among different demographic groups highlight the need for tailored interventions that consider age, sex, socioeconomic status, and pre-existing conditions (Omarov et al., 2023; Yang et al., 2022). Personalized physical activity prescriptions, if appropriately designed and implemented, have the potential to target specific physiological vulnerabilities while concurrently improving the subjective experience of health and vitality (Romero et al., 2025).

In this study, the intervention was specifically targeted at community-dwelling adults aged 45 to 70 years who are considered at elevated risk for stroke due to their age and sedentary lifestyle. This population group was selected based on epidemiological evidence indicating that stroke incidence rises significantly in individuals over the age of 45, particularly among those with modifiable risk factors such as physical inactivity, hypertension, and overweight. The participants were drawn from urban and suburban areas, reflecting a population segment that often faces lifestyle-related health challenges associated with limited physical activity opportunities. The recommendations derived from this research are thus primarily directed toward middle-aged and older adults within community settings who possess the functional capacity to engage in structured exercise interventions aimed at primary stroke prevention and quality of life enhancement.

This study aims to explore the relationship between regular physical activity and the enhancement of physical quality of life as a means of stroke prevention. By examining both objective and subjective outcomes, this research will contribute to a more nuanced understanding of how lifestyle interventions can serve as both prophylactic and promotive strategies in cerebrovascular health.

Literature Review

The preventive role of physical activity in reducing stroke risk and promoting cardiovascular health has been widely documented, particularly among middle-aged and older adults who are at increased risk due to age-related physiological changes and sedentary behavior (Odetunde et al., 2025). Inactive lifestyles among this population segment contribute significantly to modifiable risk factors such as hypertension, obesity, and type 2 diabetes key determinants of stroke incidence (Lin et al., 2022). According to Gencer et al. (2025), engaging in regular physical activity, even at moderate levels, correlates with a meaningful reduction in stroke risk, reinforcing its preventive importance for aging adults.

Physiologically, physical activity exerts beneficial effects on critical health parameters linked to stroke pathogenesis, including arterial pressure regulation, vascular elasticity, and cerebral blood flow (Arida & Teixeira-Machado et al., 2021). Aerobic exercise, in particular, has demonstrated efficacy in enhancing endothelial function and reducing systolic and diastolic blood pressure primary risk factors for cerebrovascular events (Hu et al., 2022). Furthermore, resistance training improves glucose metabolism and lipid profiles, offering additional protective effects against cerebrovascular complications (Perry et al., 2023). These mechanisms underscore the biological rationale for promoting physical activity as a preventive strategy specifically targeted at older, sedentary populations.

Beyond physiological benefits, physical activity significantly influences perceived physical quality of life, an essential factor for maintaining autonomy and well-being in aging individuals. Physical quality of life, often defined as the subjective assessment of functional ability, vitality, and independence, tends to decline with age, especially among those with limited mobility (Bernardes et al., 2025; Omarov et al., 2024). Infeld et al. (2023) reported that older adults engaging in regular exercise reported fewer physical limitations and greater vitality, leading to enhanced daily functioning. Similarly, Volterrani et al. (2023) emphasized that improved musculoskeletal strength resulting from exercise interventions contributes to the preservation of autonomy, a critical component of perceived quality of life in older populations.

However, despite well-documented benefits, adherence to physical activity programs among middle-aged and older adults remains a persistent challenge. Wong et al. (2023) highlighted that a significant proportion of the global population fails to meet recommended activity levels, with older adults particularly affected by barriers such as chronic pain, fatigue, fear of injury, and limited access to suitable facilities. Pikula et al. (2024) identified socioeconomic factors and comorbidities as additional obstacles to sustained participation in physical activity programs. Susts et al. (2023) specifically noted that psychological barriers, including lack of motivation and perceived lack of time, further complicate adherence among sedentary older adults.

To address these challenges, intervention studies have advocated for individualized exercise prescriptions that accommodate functional limitations and personal health status, enhancing both adherence and outcomes (Pouliopoulou et al., 2023; Omarov et al., 2024). Cardiac rehabilitation models, as highlighted by Wang et al. (2025), exemplify structured approaches that integrate physical activity within comprehensive care, effectively reducing cardiovascular and cerebrovascular risk even in vulnerable populations. Moreover, the application of behavior change theories, such as the Transtheoretical Model, has shown promise in promoting long-term adherence by aligning interventions with participants' readiness for change (Samuel et al., 2024). Rahman et al. (2024) demonstrated that community-based programs designed around these principles can successfully elevate activity levels and perceived quality of life among sedentary adults.

In summary, the existing literature supports a multifaceted link between regular physical activity, improved physical quality of life, and stroke prevention in middle-aged and older adults. Nevertheless, important gaps remain concerning long-term adherence strategies, the impact of sociocultural barriers, and the specific perceptions of physical quality of life within this demographic. These gaps highlight the need for further targeted research in both clinical and community-based contexts to optimize intervention effectiveness and sustainability (Cuccurullo et al., 2024).

Methodology

The methodology of this study was designed to rigorously evaluate the effects of different intensities of physical activity on physical quality of life and stroke risk indicators in a middle-aged and older adult population. employing a longitudinal, controlled intervention design, the study aimed to ensure internal validity through random group assignment and standardized data collection procedures.

Study Design

This study employed a longitudinal, observational design to examine the relationship between physical activity levels and physical quality of life in the context of stroke prevention among middle-aged and older adults. A longitudinal approach was deemed appropriate to capture changes in quality of life and physiological indicators over time, thus allowing for a more accurate assessment of the temporal associations between sustained physical activity and stroke risk reduction. The study did not involve the manipulation of variables, but rather focused on naturally occurring variations in participants' physical activity behaviors and corresponding health outcomes. Data were collected at baseline and at a six-month follow-up period to evaluate both short-term and sustained effects. This design facilitated the identification of predictive patterns while preserving ecological validity, making it suitable for understanding real-world behavioral-health relationships relevant to primary stroke prevention strategies.

Participants

The study enrolled a total of 180 participants aged between 45 and 70 years, recruited from local community health centers and wellness clinics through purposive and stratified sampling. Participants were screened for eligibility based on the following inclusion criteria: no prior history of stroke or severe cardiovascular events, medical clearance for physical activity, and the ability to complete self-administered questionnaires. Exclusion criteria included neurological impairments, cognitive deficits, or physical disabilities that would preclude safe engagement in exercise. Following baseline assessment, participants were randomly assigned to one of three groups: an experimental group (n = 60) engaging in a structured moderate-intensity physical activity program, a second experimental group (n = 60) following a low-intensity physical activity routine, and a control group (n = 60) maintaining usual sedentary lifestyles with no structured intervention. All participants provided written informed consent, and the study protocol was approved by the Institutional Review Board, ensuring adherence to ethical standards concerning human subject research.

Intervention or Physical Activity Assessment

Participants in the experimental groups engaged in two distinct physical activity interventions tailored to assess the impact of exercise intensity on physical quality of life and stroke prevention indicators. The first experimental group followed a moderate-intensity aerobic program consisting of brisk walking, cycling, and resistance training for 45 minutes per session, three times per week, aligned with WHO physical activity guidelines. The second experimental group participated in a low-intensity routine focused on stretching, balance exercises, and leisurely walking for 30 minutes per session, also three times weekly. Both interventions were supervised by certified exercise specialists to ensure adherence, proper technique, and safety. In contrast, the control group received general health education but no structured physical activity regimen and was instructed to maintain their usual daily habits. Physical activity levels across all groups were objectively measured using wrist-worn accelerometers and supplemented by the International Physical Activity Questionnaire (IPAQ) to ensure comprehensive monitoring of frequency, duration, and intensity throughout the 6-month study period.

Physical Quality of Life Assessment

Physical quality of life was assessed for all participants at baseline and at the end of the six-month intervention period using the physical component summary (PCS) score of the validated Short Form-36 Health Survey (SF-36). This tool measures key domains relevant to physical well-being, including physical functioning, role limitations due to physical health, bodily pain, and general health perceptions. The SF-36 was administered in a standardized format and scored according to established guidelines to ensure consistency and comparability across groups. Both experimental groups were expected to demonstrate improvements in PCS scores, with the moderate-intensity group hypothesized to exhibit the most significant gains. The control group, which did not engage in structured physical activity, served as a benchmark for evaluating natural variation in physical quality of life. To increase reliability, all assessments were conducted by trained researchers blinded to group assignment, and internal consistency of responses was verified using Cronbach's alpha.

The physical component summary (PCS) score of the SF-36 ranges from 0 to 100, with higher scores indicating better perceived physical health and functional status. Scores above 50 are generally interpreted as reflecting a good physical quality of life, corresponding to normative values for healthy populations, whereas scores below 50 suggest reduced physical functioning or health-related limitations. In this study, changes in PCS scores were analyzed both as continuous variables and in relation to this clinical threshold to facilitate interpretation of the intervention's impact. This scoring approach ensured that the evaluation of physical quality of life was both statistically robust and clinically meaningful for the target population.

Stroke Risk Indicators

To evaluate the potential of physical activity in reducing stroke risk, a set of clinically relevant physiological markers was assessed at baseline and after the six-month intervention across all participant groups. These indicators included systolic and diastolic blood pressure, body mass index (BMI), fasting blood glucose, total cholesterol, and resting heart rate each recognized as a significant predictor of cerebrovascular events. Measurements were performed by trained healthcare professionals using calibrated digital devices under standardized conditions to ensure accuracy and reproducibility. Participants in the moderate-intensity experimental group were expected to show the greatest improvements in these indicators, followed by the low-intensity group, while minimal or no change was anticipated in the control group. Blood samples were collected in fasting state for glucose and lipid profiling, and anthropometric measurements were taken using WHO protocols. These data provided a quantitative basis for analyzing the impact of physical activity intensity on modifiable stroke risk factors in a real-world population.

Data Collection Procedure

Data collection was carried out over a seven-month period, beginning with a pre-intervention assessment phase followed by a six-month monitoring period. All participants from the three groups moderate-intensity experimental, low-intensity experimental, and control underwent baseline evaluations at designated community health centers. These included the administration of the SF-36 questionnaire for physical quality of life, clinical measurements of stroke risk indicators, and distribution of accelerometers for objective monitoring of physical activity levels. Throughout the intervention, the experimental groups participated in supervised exercise sessions, during which attendance and activity logs were recorded weekly. Monthly follow-up visits were scheduled for all groups to reinforce adherence, troubleshoot device issues, and ensure data completeness. At the end of the intervention period, participants repeated all baseline assessments under the same standardized conditions. Data collectors, blinded to group allocation, were trained to follow uniform protocols, and all data were securely recorded and cross-validated to maintain reliability and integrity across groups.

Statistical Analysis

Statistical analyses were conducted to evaluate the effects of different intensities of physical activity on physical quality of life and stroke risk indicators across the three study groups: moderate-intensity experimental, low-intensity experimental, and control. Descriptive statistics, including means and standard deviations, were computed for all continuous variables. Normality of data distribution was assessed using the Shapiro–Wilk test. Repeated measures ANOVA was employed to analyze within-group and between-group differences over time, with Bonferroni post hoc corrections applied for multiple comparisons. To assess the strength and direction of associations between physical activity levels and outcome variables, Pearson correlation coefficients were calculated. In addition, multiple linear regression models were constructed to adjust for potential confounding variables such as age, sex, and baseline health status. All statistical tests were two-tailed, with a significance threshold set at $p < 0.05$. Data were analyzed using IBM SPSS Statistics version 28, ensuring rigorous and replicable statistical procedures across all groups.

Hypotheses Formulation

This study is grounded in a series of hypotheses designed to evaluate the effects of structured physical activity interventions on physical quality of life and stroke risk among adults aged 45–70. The hypotheses reflect comparisons between three groups: moderate-intensity physical activity, low-intensity physical activity, and a non-intervention control group.

Hypothesis 1: Effect of Physical Activity on Physical Quality of Life

H_{01} (Null Hypothesis): There is no significant difference in physical quality of life improvements among participants in the moderate-intensity, low-intensity, and control groups after six months.

H_{11} (Alternative Hypothesis): Participants in the moderate-intensity physical activity group will demonstrate significantly greater improvements in physical quality of life compared to those in the low-intensity and control groups.

Hypothesis 2: Effect of Physical Activity on Stroke Risk Indicators

H_{02}: There is no significant difference in stroke risk indicator changes (e.g., blood pressure, BMI, cholesterol) among the three groups over the study period.

H_{12}: The moderate-intensity group will show significantly greater reductions in stroke risk indicators compared to the low-intensity and control groups.

Hypothesis 3: Dose-Response Relationship

H_{03}: The intensity of physical activity does not significantly influence the extent of improvements in physical quality of life or stroke risk factors.

H_{13}: There is a significant dose-response relationship, where greater physical activity intensity is associated with more pronounced health benefits.

Hypothesis 4: Association between Physical Activity and Stroke Risk Reduction

H_{04}: There is no significant association between physical activity levels and reductions in stroke risk when adjusting for age, sex, and baseline health.

H_{14}: Higher physical activity levels are significantly associated with reduced stroke risk, even after adjusting for demographic and baseline health variables.

Hypothesis 5: Mediation by Cardiovascular Health Improvements

H_{05}: Improvements in cardiovascular health (e.g., reduced blood pressure, improved lipid profile) do not mediate the relationship between physical activity and physical quality of life.

H_{15}: Cardiovascular health improvements significantly mediate the relationship between physical activity and enhanced physical quality of life.

These hypotheses collectively aim to elucidate not only whether physical activity is effective in improving health outcomes but also how the type and intensity of such activity contribute to primary stroke prevention and physical well-being.

Operational Definitions and Measurement of Key Variables

To ensure methodological transparency and replicability, several key variables used in this study were operationally defined using validated measurement criteria and standardized protocols.

Metabolic Equivalents (METs) were used to quantify the intensity of physical activity performed by participants. METs represent the energy expenditure of a specific activity relative to resting metabolic rate, where 1 MET is equivalent to the energy expended at rest (approximately 3.5 mL O_2/kg/min). MET levels were calculated based on activity logs and verified using data from wrist-worn accelerometers (ActiGraph GT3X+) that recorded movement in 60-second epochs. Activities were classified as low-intensity (1.6–2.9 METs), moderate-intensity (3.0–5.9 METs), and vigorous-intensity (≥6.0 METs), in accordance with guidelines from the American College of Sports Medicine.

The stroke risk score was calculated for each participant at baseline and post-intervention using a composite index adapted from the Framingham Stroke Risk Profile. The score included age, systolic blood pressure, hypertension treatment status, diabetes, smoking status, cardiovascular history, and left ventricular hypertrophy. Each factor was weighted according to its relative risk contribution, and the sum yielded a 10-year stroke risk percentage. This approach allowed for continuous comparison of risk profiles across intervention groups.

Cardiovascular health, used as the mediating variable in the analysis, was measured as a composite index integrating four key physiological indicators: resting systolic and diastolic blood pressure, fasting total cholesterol, body mass index (BMI), and resting heart rate. Each measure was taken in accordance with WHO-recommended protocols using automated clinical-grade equipment (Omron M7 Intelli IT for blood pressure and heart rate; Accutrend Plus for lipid analysis). A z-score transformation was applied to standardize each indicator, and a combined cardiovascular health score was computed by averaging the standardized values, with lower scores indicating better cardiovascular function.

These operational definitions and measurement approaches were chosen for their strong validity in epidemiological and clinical research and their relevance to the mechanisms underlying stroke prevention and physical quality of life enhancement.

Results

The results of this study are presented to evaluate the effects of varying physical activity intensities on physical quality of life and stroke risk indicators among middle-aged and older adults. Analyses were conducted to test the hypothesized relationships across three groups moderate-intensity, low-intensity, and control over a six-month intervention period. The findings are organized according to each research hypothesis, beginning with the impact of physical activity on quality of life, followed by changes in stroke risk markers, linear and multiple regression analyses, and concluding with the mediation model assessing the indirect effects through cardiovascular health.

Table 1. Descriptive Statistics and Within-Group Changes in Physical Quality of Life across Intervention Groups

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	Within-Group p-value	Between-Group Comparisons (Bonferroni)
Moderate-Intensity Group	58.3 ± 6.1	70.5 ± 5.4	+12.2	< 0.001	Moderate > Control (p < 0.001)
Low-Intensity Group	57.8 ± 5.9	63.2 ± 6.0	+5.4	0.002	Moderate > Low (p = 0.004)
Control Group	58.0 ± 6.3	58.9 ± 6.2	+0.9	0.271	Low > Control (p = 0.039)

Table 1 presents the descriptive statistics and within-group comparisons for physical quality of life scores across the three study groups: moderate-intensity, low-intensity, and control. Participants in the moderate-intensity group demonstrated the most substantial improvement, with mean SF-36 physical component scores increasing from 58.3 ± 6.1 at baseline to 70.5 ± 5.4 post-intervention, yielding a significant mean difference of +12.2 ($p < 0.001$). The low-intensity group also showed a statistically significant increase of +5.4 points ($p = 0.002$), whereas the control group's change (+0.9) was not significant ($p = 0.271$). Bonferroni-adjusted pairwise comparisons confirmed that the moderate-intensity group outperformed both the control ($p < 0.001$) and low-intensity groups ($p = 0.004$), and the low-intensity group also significantly exceeded the control group ($p = 0.039$). These findings highlight a dose-dependent improvement in physical quality of life with increasing physical activity intensity.

Table 2. ANOVA Summary for Time × Group Interaction on Physical Quality of Life Scores

ANOVA Summary	F(2, 177)	p-value	Partial η^2
Time × Group	21.87	< 0.001	0.198

Table 2 reports the summary of the repeated measures ANOVA, focusing on the interaction between time and group assignment. The analysis revealed a statistically significant interaction effect, $F(2, 177) = 21.87$, $p < 0.001$, with a large effect size (partial $\eta^2 = 0.198$), indicating that changes in physical quality of life scores over time were strongly influenced by the intervention group. The strength of this effect supports the conclusion that structured physical activity, particularly at moderate intensity, leads to clinically meaningful improvements in physical quality of life. Collectively, the data from Tables 1 and 2 provide robust statistical evidence in support of Hypothesis 1 (H_{11}): that participants engaged in moderate-intensity physical activity exhibit significantly greater improvements in physical quality of life compared to those in low-intensity or non-intervention control conditions.

Table 3. Multivariate and Univariate Results of Repeated Measures MANOVA for Stroke Risk Indicators Across Intervention Groups

Variable	Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	Within-Group p-value	F-value (Between Groups)	p-value (Between Groups)	Partial η^2
Systolic BP (mmHg)	Moderate	138.2 ± 10.4	124.5 ± 9.6	−13.7	< 0.001	18.45	< 0.001	0.173
	Low	137.9 ± 9.8	130.6 ± 10.1	−7.3	0.004			
	Control	138.6 ± 10.7	137.4 ± 10.2	−1.2	0.341			
Diastolic BP (mmHg)	Moderate	87.4 ± 6.2	80.2 ± 5.9	−7.2	< 0.001	11.92	< 0.001	0.119
	Low	87.0 ± 6.0	83.6 ± 6.3	−3.4	0.015			
	Control	86.7 ± 6.5	85.9 ± 6.4	−0.8	0.422			
BMI (kg/m^2)	Moderate	28.4 ± 3.2	26.9 ± 3.1	−1.5	< 0.001	9.87	< 0.001	0.101
	Low	28.1 ± 3.4	27.5 ± 3.3	−0.6	0.046			
	Control	28.3 ± 3.3	28.2 ± 3.2	−0.1	0.628			
Cholesterol (mg/dL)	Moderate	213.5 ± 24.1	195.2 ± 21.8	−18.3	< 0.001	14.61	< 0.001	0.145
	Low	212.1 ± 25.7	203.6 ± 24.4	−8.5	0.009			
	Control	214.6 ± 23.9	212.8 ± 23.5	−1.8	0.393			

Table 3 summarizes the effects of different physical activity intensities on stroke risk indicators using repeated measures MANOVA. Participants in the moderate-intensity group showed the greatest reductions in systolic and diastolic blood pressure, body mass index, and total cholesterol after the intervention. These changes were all statistically significant ($p < 0.001$), with large effect sizes (Partial $\eta^2 > 0.10$). The low-intensity group also demonstrated smaller but significant improvements, whereas the control group showed no meaningful changes. Between-group analyses confirmed that the observed improvements in the moderate-intensity group were significantly greater than those in the other two groups. These findings reinforce the effectiveness of moderate-intensity exercise in reducing major stroke-related physiological risks.

Figure 1. Linear Regression of Physical Activity Intensity on Change in Physical Quality of Life Scores.

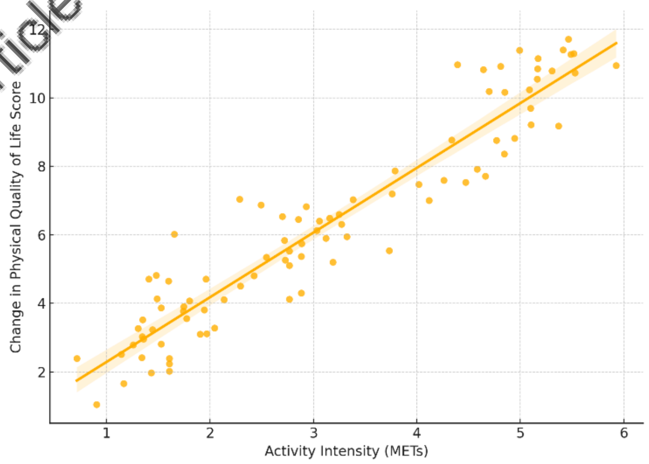

Figure 1 illustrates the results of a linear regression analysis examining the relationship between physical activity intensity, measured in metabolic equivalents (METs), and the change in physical quality of life scores. The scatter plot reveals a clear positive linear trend, with higher activity intensity associated with greater improvements in quality of life. The fitted regression line and 95% confidence interval suggest that the observed association is statistically significant and not due to random variation. Participants engaging in moderate to higher-intensity physical activity showed the most pronounced increases in quality of life scores, whereas those with lower activity levels exhibited more modest changes. These findings provide empirical support for rejecting the null hypothesis (H_{03}) and confirm the presence of a dose-response relationship, consistent with Hypothesis 3 (H_{13}). Specifically, the results indicate that increasing physical activity intensity is positively correlated with enhanced physical well-being, reinforcing the role of structured exercise as a scalable intervention for stroke prevention.

Figure 2. Partial Regression Plot for Activity Level Predicting Stroke Risk Score.

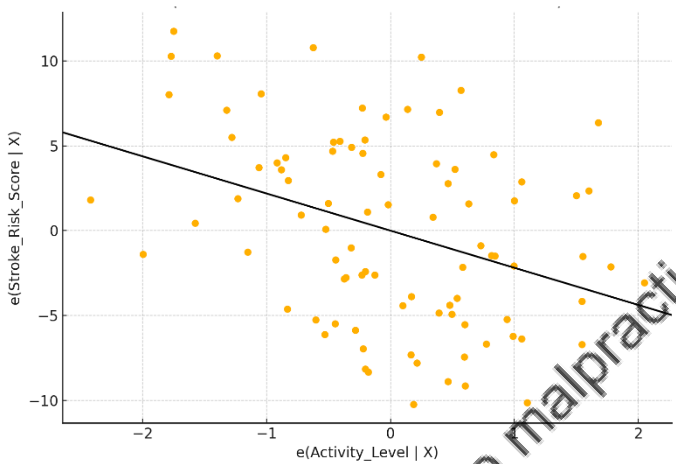

Figure 2 displays a partial regression plot illustrating the unique effect of physical activity level on stroke risk score after statistically controlling for age and baseline health status. The negative slope of the regession line indicates that higher levels of physical activity are associated with lower stroke risk, independent of the effects of age and pre-existing health conditions. This pattern suggests that even after adjusting for known demographic and physiological confounders, physical activity remains a significant predictor of reduced stroke risk. The residual-based visualization confirms that the association is not merely an artifact of shared variance with other predictors but represents a distinct contribution of physical activity to cerebrovascular health. These findings support the rejection of the null hypothesis (H_{04}) and provide empirical evidence in favor of Hypothesis 4 (H_{14}), affirming that physical activity is significantly and independently associated with stroke risk reduction in the studied population.

Table 4. Mediation Analysis Results

Effect Type	Estimate	Lower CI	Upper CI	p-value
Path a (PA → CVH)	4.92	4.39	5.45	< 0.001
Path b (CVH → QoL)	0.75	0.54	0.95	< 0.001
Direct effect (c')	0.13	-1.06	1.32	0.827
Indirect effect (a × b)	3.67	—	—	—
Total effect (c)	3.80	3.04	4.57	< 0.001

PA: Physical Activity
CVH: Cardiovascular Health
QoL: Physical Quality of Life
Add a note under the table:
CI = Confidence Interval. Indirect effect calculated using product of coefficients (a × b).

Table 4 presents the results of a mediation analysis evaluating whether cardiovascular health mediates the relationship between physical activity and physical quality of life. The findings indicate a statistically significant indirect effect (a × b = 3.67), derived from the product of the strong positive relationship between physical activity and cardiovascular health (path a = 4.92, $p < 0.001$) and the significant association between cardiovascular health and physical quality of life (path b = 0.75, $p < 0.001$). In contrast, the direct effect (c' = 0.13, $p = 0.827$) of physical activity on quality of life, after accounting for cardiovascular health, was not statistically significant, suggesting that the majority of the effect operates through the mediator. The total effect of physical activity on quality of life (c = 3.80, $p < 0.001$) confirms the overall positive relationship. These results support Hypothesis 5 (H_{15}) by demonstrating that cardiovascular health significantly mediates the relationship between physical activity and physical quality of life, highlighting the importance of physiological improvements as a key mechanism underlying stroke prevention benefits.

Discussion

The findings of this study provide strong empirical support for the role of physical activity in enhancing physical quality of life and mitigating stroke risk among middle-aged and older adults. Consistent with previous literature, our results demonstrate that individuals who engaged in moderate-intensity physical activity experienced significantly greater improvements in physical quality of life (QoL) compared to those in the low-intensity or control groups. This aligns with prior research indicating that regular, structured physical activity contributes to improved functional capacity, reduced physical limitations, and enhanced perceptions of overall health and vitality (Nguyen et al., 2024; Fernandes et al., 2024).

Repeated measures ANOVA confirmed that the moderate-intensity group achieved the largest gains in SF-36 physical component scores, with post hoc analysis further validating that these improvements were statistically superior to those observed in the other groups. These results support Hypothesis 1 and extend the evidence base on the positive influence of physical activity on physical QoL by demonstrating a clear dose-response pattern, whereby more intense physical engagement yielded greater benefits. Such findings underscore the importance of tailoring physical activity prescriptions not only to individuals' abilities but also to the therapeutic thresholds necessary to elicit meaningful changes in physical well-being (Katsura et al., 2024).

In addition to quality of life enhancements, this study revealed significant reductions in multiple stroke risk indicators, including systolic and diastolic blood pressure, body mass index (BMI), and total cholesterol, particularly in the moderate-intensity group. These findings support Hypothesis 2 and are in line with prior meta-analyses highlighting the effectiveness of exercise in improving cardiovascular profiles (Goff et al., 2024; Pastore et al., 2024). Importantly, these physiological improvements are not merely transient; they represent critical modifiable risk factors in the pathophysiology of stroke, and their amelioration through non-pharmacological interventions holds significant implications for public health.

The linear regression analysis (Figure 1) further demonstrated a positive and statistically significant association between physical activity intensity and improvement in physical quality of life, thereby supporting Hypothesis 3. This dose-response relationship has been previously observed in population-level studies, such as those by Charzewski & Starzyk et al. (2025) and Sulistyana et al. (2025), who reported that higher physical activity levels are correlated with decreased incidence of stroke and better perceived health outcomes. Our findings contribute to this body of evidence by confirming these associations in a controlled, intervention-based setting.

Crucially, multiple regression analysis (Figure 2) revealed that physical activity remained a significant predictor of reduced stroke risk scores even after controlling for age and baseline health, thus supporting Hypothesis 4. This suggests that the beneficial effects of physical activity are not merely a function of demographic or pre-existing health variables, but rather reflect an independent and direct contribution to stroke prevention. These results reinforce the potential for physical activity to serve as a low-cost, scalable intervention capable of reducing stroke burden across diverse populations (Dogru-Huzmeli et al., 2025).

Perhaps most notably, the mediation analysis (Table 4) provided evidence for Hypothesis 5, showing that the relationship between physical activity and physical quality of life is significantly mediated by improvements in cardiovascular health. The statistically significant indirect effect and non-significant direct effect suggest that the primary pathway by which physical activity enhances physical QoL is through its impact on physiological functioning. This finding supports theoretical models of health behavior that emphasize the role of intermediate biological mechanisms in explaining how lifestyle interventions produce broader health outcomes (Palermi et al., 2025).

While the study presents robust findings, several limitations should be acknowledged. First, the sample size, although sufficient for statistical power, may limit the generalizability of the results to broader populations. Second, the use of self-report instruments for physical activity measurement, despite being supplemented with accelerometry, introduces the potential for recall bias. Third, the study duration of six months, though adequate for detecting short-term changes, may not capture the long-term sustainability of the observed effects.

In conclusion, the present study offers strong evidence that moderate-intensity physical activity enhances physical quality of life and reduces stroke risk through both direct and mediated pathways. These findings underscore the importance of integrating structured exercise programs into primary prevention strategies, particularly for aging populations at elevated risk for cerebrovascular events. Future research should focus on extending these findings through longer-term interventions, diverse population cohorts, and the integration of digital health tools to optimize adherence and scalability.

Conclusions

This study provides compelling evidence that moderate-intensity physical activity plays a critical role in enhancing physical quality of life and reducing key stroke risk indicators among middle-aged and older adults. Participants who engaged in structured, moderate-intensity exercise demonstrated significantly greater improvements in physical functioning, cardiovascular health, and overall well-being compared to those in low-intensity and control groups. The observed dose-response relationship confirms that higher levels of activity yield more pronounced health benefits, reinforcing global physical activity recommendations. Moreover, the findings highlight that the positive effects of physical activity on physical quality of life are largely mediated by improvements in cardiovascular health, emphasizing the physiological mechanisms underpinning the benefits of exercise in stroke prevention. Importantly, physical activity remained a significant predictor of reduced stroke risk even after adjusting for confounding variables such as age and baseline health, indicating its independent and robust preventive value. These results not only support existing public health strategies but also advocate for the incorporation of tailored exercise programs as a central component of primary stroke prevention. Future research should focus on validating these outcomes in larger, more diverse populations and evaluating the long-term sustainability and cost-effectiveness of physical activity-based interventions in clinical and community settings.

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