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Research Article

Association Between Physical Activity and Stroke Recurrence: A Cross-Sectional Study

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What is already known on this topic?

- *Physical inactivity is a modifiable risk factor that contributes to the likelihood of stroke recurrence.*
- *Previous studies have shown that engaging in regular moderate-to-vigorous physical activity can reduce the risk of recurrent stroke.*

What this study adds on this topic?

- *This study identifies a significant negative correlation between physical activity levels and stroke recurrence, indicating that higher physical activity is associated with lower recurrence rates.*
- *It underscores the importance of promoting physical activity as part of stroke rehabilitation for recurrence prevention.*
- *Physical activity may help prevent stroke recurrence by reducing oxidative stress, controlling inflammation, and enhancing neural regeneration through Brain-Derived Neurotrophic Factor (BDNF).*

Abstract

AIM: This study investigated the association between physical activity and stroke recurrence.

METHODS: This is a descriptive cross-sectional study. Convenience sampling was used to collect data on 75 stroke survivors. The inclusion criteria were patients with stroke recurrence. The sample size was determined using G*Power software with an effect size of 0.35, *p*-value of .05, power of 80%, and attrition rate of 20%. Data were collected using a sociodemographic questionnaire and International Physical Activity Questionnaire short-form (IPAQ-SF), then categorized into mild, moderate, and vigorous physical activity. Data were analyzed using Spearman's rho correlation test.

RESULTS: This result showed that 84% of participants had ischemic stroke, had mild physical activity (46.7%), and experienced first stroke recurrence (92%). There is a significant association between physical activity and stroke recurrence ($p = .02$, $r = -0.26$), which means that higher physical activity will decrease stroke recurrence.

CONCLUSION: Lack of physical activity is associated with stroke recurrence. Physical activity plays a critical role in secondary prevention for stroke survivors by improving cardiovascular health and reducing the chance of stroke recurrence. Thus, nurses and health professionals should motivate stroke survivors to perform regular physical activity and ensure safety and effectiveness in promoting recovery and overall health for post-stroke patients.

Keywords: International Physical Activity Questionnaire, ischemic, physical activity, recurrence, stroke

Introduction

Stroke is a leading cause of death and disability worldwide for adults (Aini et al., 2023; World Stroke Organization, 2024). According to the World Health Organization, stroke ranks third among the top 10 causes of death globally from 2000 to 2021 (World Health Organization, 2024). A stroke is characterized by quickly developing clinical indications of a focused (or global) disruption of brain function that lasts longer than 24 hours or results in death and has no discernible cause other than vascular origin (Sacco et al., 2013). The classic definition of a stroke is a neurological deficit caused by a vascular event, such as cerebral infarction, intracerebral hemorrhage (ICH), or subarachnoid hemorrhage (SAH), which results in an acute focal injury to the central nervous system (CNS) (Sacco et al., 2013). The prevalence of stroke is rising annually despite a global trend toward a decrease in the incidence of stroke. Due to the aging population, more than 1 million people in Europe have a stroke yearly, and the prevalence is estimated to rise to 1.5 million by 2025 (Wajngarten & Silva, 2019). A meta-analysis in 2011 found that 11% of stroke survivors will have a recurrence within a year of their first stroke and 26% within 5 years (Flach et al., 2020). According to Riskesdas 2018, the prevalence of stroke in Indonesia increased by around 56% in 5 years, from 0.7% (2013) to 1.09% (2018). From these data, only about 39.4% of stroke survivors performed routine control at health facilities (Kemenkes, 2022). Moreover, a study by Aini et al. (2023) found the incidence of the first stroke recurrence was 63%, while Kariasa et al.

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(2019) revealed stroke has a 39.2% chance of recurrence, and around 13% of stroke survivors experience stroke recurrence in the first year.

People with stroke are prone to recurrence, leading to prolonged hospitalization, worsening functional conditions, and increased mortality (Arsava et al., 2016). Some factors have been identified as risk factors for recurrent ischemic stroke, for instance, alcohol use, unhealthy diet, smoking, and low physical activity (Ushio et al., 2018). Additionally, there are six modifiable factors linked to the risk of stroke recurrence: hypertension, smoking, high cholesterol, HbA1c level, low physical activity, and obesity (Mackie et al., 2019). Stroke recurrence can occur due to not paying attention to a modified lifestyle, including lack of physical activity (Esenwa & Gutierrez, 2015). Low levels of post-stroke physical activity can lead to decreased condition and depressed mood (Kringle et al., 2020). Therefore, improving patient's lifestyle is essential to prevent stroke recurrence. Among these lifestyle behaviors, physical inactivity is a critical issue and needs to be addressed since evidence in Indonesia reported that 572 adults had stroke recurrence due to physical inactivity (52.48%) (Poniasih et al., 2024).

Stroke survivors have experienced a decline in physical activity since being discharged from hospitalization, and the physical activity of post-hospitalization stroke survivors was mild (68.3%) (Agustiyaningsih et al., 2020). Physical activity plays a role in reducing stroke recurrence (Choi & Jihye, 2015; Mackie et al., 2019). Ushio et al. (2018) found ischemic stroke patients who experienced recurrence had low-to-moderate-to-vigorous physical activity, and Ashizawa et al. (2024) found that less light-intensity physical activity and sedentary behavior were independent factors for the recurrence of stroke. Thus, physical activity guidelines are recommended to prevent stroke recurrence and maintain physical function (Billinger et al., 2014). In addition, the participation of post-stroke patients in physical activity has an impact on reducing stroke recurrence and improving quality of life (Saunders et al., 2014). Although no direct evidence supports that physical activity reduces stroke recurrence, physical activity is correlated with cardiovascular improvement and prevention of ongoing stroke recurrence (Lee et al., 2017).

Regular physical activity will train heart muscles and peripheral endurance to prevent increased blood pressure through vasodilation of blood vessels and burn fat in the coronary vessels, thereby ensuring smooth blood flow. Physical activity influences neurohormonal and structural factors to reduce sympathetic nerve activity and increase artery diameter by lowering the levels of norepinephrine, renin, and systemic vascular resistance (Maskanah et al., 2019). The blood vessels become smooth and stable when someone maintains physical activity as recommended, and the likelihood of atherosclerosis decreases (Maskanah et al., 2019). Furthermore, physical activity promotes better circulation and lowers the risk of blood clot formation, which reduces the possibility of another ischemic attack (World Health Organization, 2024a). World Health Organization (2020) recommends physical activity for adults for at least 150–300 minutes of moderate-intensity or at least 75–150 minutes of vigorous-intensity aerobic physical activity or an equivalent combination of moderate- and vigorous-intensity activity throughout the week for substantial health benefits. However, stroke survivors are recommended to participate in physical activity three times per week, with each session lasting between 20 and 60 minutes (Kringle et al., 2020).

Most previous studies have focused on the risk factors for stroke recurrence (Arsava et al., 2016; Elnady et al., 2020; Kariasa et al., 2019; Setyowati et al., 2021), characteristics of recurrent stroke (Ramdani, 2018), and the prevention of stroke recurrence (Esenwa & Gutierrez, 2015; Oza et al., 2017). Moreover, Ushio et al. (2018) and Ashizawa et al. (2024) proved that lower physical activity was a significant independent predictor of stroke recurrence. However, to the authors' knowledge, limited studies have discussed the association between physical activity and stroke recurrence among stroke patients in Indonesia. Thus, this study examines the association between physical activity and stroke recurrence. This study hypothesizes that there would be a significant association between physical activity and stroke recurrence.

Research Question

1. Is there a significant association between physical activity levels and stroke recurrence among stroke patients in Indonesia?

Methods

Research Design

This was a descriptive cross-sectional study.

Sample

The authors conducted the study in the neurology policlinic of University of Muhammadiyah Malang Hospital, Malang, East Java, from April 2020 to February 2021. We used convenience sampling to collect data from 75 stroke survivors from the neurological polyclinic at the University of Muhammadiyah Malang Hospital. The inclusion criteria in this study were patients with stroke, conscious and willing to be respondents, and experiencing stroke recurrence. In contrast, if patients are diagnosed with stroke for the first time and are in critical condition, they will be excluded from this study. The sample size was calculated using G*Power software with an effect size of 0.35 (medium), a *p*-value of .05, and the power of the study at 80%. According to the calculation, a minimum of 61 respondents were found but 20% attrition rate was considered to avoid dropout. Thus, finally 75 respondents were included. Informed consent was obtained from respondents and their families before data collection started.

Data Collection

In this study, the independent variable was physical activity and stroke recurrence was the dependent variable. Sociodemographic data on gender, age, level of education, and occupation were collected, and for disease characteristics, only stroke type is available. Moreover, the International Physical Activity Questionnaire short-form (IPAQ-SF) was used to measure physical activity. The IPAQ-SF was developed by Booth in 1996. The IPAQ has been validated in 14 centers in 12 countries,

standardized internationally, with significant validity (r = 0.40) and reliability (Purnama & Suahda, 2019). The study by Suyoto et al. (2016) showed that the Indonesian version of the IPAQ-SF showed small results but had a significant value (r = 0.28). The short-form IPAQ consists of seven items that provide a comprehensive view of an individual's physical activity over the past 7 days. This helps quantify energy expenditure in terms of MET minutes/week (Metabolic Equivalent of Task). A MET is a unit used to express the energy cost of physical activities, with one MET representing the energy expenditure of sitting quietly. International Physical Activity Questionnaire assessed various dimensions of physical activity, including (1) Intensity: vigorous (such as running, jogging), moderate (such as brisk walking, gardening), walking, and sitting activity; (2) Frequency: records the number of days per week that activities are performed; and (3) Duration: measures the time spent on each type of activity per day.

Next, weekly physical activity will be calculated based on MET quantification. Vigorous physical activity has a MET value of 8.0, moderate has a MET value of 4.0, and cycling and walking have a MET value of 3.3. After that, the total value of the MET quantification was calculated with the formula: frequency × duration × MET. Next, the total minutes of all METs were added to get the total physical activity (total V + total M + total walking). Finally, total weekly physical activity was categorized as mild (total physical activity <600 METs minutes/week), moderate (total physical activity 600–1500 METs minutes/week), and severe (total physical activity >1500 METs minutes/week).

International Physical Activity Questionnaire short-form is designed to be broadly applicable, but it does not have specific standards or MET values explicitly tailored for stroke patients. However, the general approach to using IPAQ and METs can still be applied to stroke patients with consideration for their specific needs and capabilities. Stroke patients also need personalized adjustments to ensure the activities are appropriate for their recovery and health (Kringle et al., 2020; Ruescas-Nicolau et al., 2021).

The doctor's examination results determine stroke recurrence, and these examination results can be seen in the medical records. Data collection is conducted after the doctor has examined the participants, and the questionnaire is answered by patients and validated with their families.

Statistical Analysis

The Statistical Package for the Social Sciences, version 23 (IBM SPSS Corp.; Armonk, NY, USA), was used to analyze data. We analyzed data using Spearman's rho correlation test to examine the relationship between physical activity and stroke recurrence since the normality test of variables was violated. The sociodemographic variables were explained using descriptive statistics, such as means, standard deviations, frequencies, and percentages. Physical activity and stroke recurrence are significantly correlated when the p-value is <.05. Moreover, in the Spearman test, the direction of the relationship (positive or negative) and the strength of the relationship (r) were described.

Ethical Consideration

This study was approved by the Research and Ethics Committee of the Faculty of Medicine, University of Muhammadiyah Malang (Approval No: E.5.a/038/KEPK-UMM/II/2020 Date: February 19, 2020). All participants were provided with detailed information regarding the study's purpose, procedures, potential risks, and benefits. Prior to data collection, each participant provided written informed consent, and their anonymity and confidentiality were maintained throughout the study.

Results

The participants had a mean age of 62.32 (±11.35) years old, and the majority were elderly (37.30%). Males comprised 56% of the study's participants, and most respondents have a college education (37.30%). Moreover, 84% of participants were diagnosed with ischemic stroke (Table 1).

Most participants had mild physical activity (46.7%) and experienced a first stroke recurrence (92.0%) (Table 2). This current study revealed a significant association between physical

Table 1.
Participant Sociodemographic Characteristics (N=75)

Characteristics	Mean (SD)	*n* (%)
Age	62.32 (11.35)	
Gender		
Male		42 (56)
Female		33 (44)
Age category		
Late adulthood (36–45 years)		5 (6.70)
Early elderly (46–55 years)		17 (22.70)
Late elderly (56–65 years)		25 (33.30)
Elderly (>65 years)		28 (37.30)
Education level		
No education		1 (1.30)
Primary school		16 (21.30)
Junior high school		10 (13.30)
High school		20 (26.70)
College		28 (37.30)
Work		
Private workers		13 (17.33)
Civil servant		4 (5.33)
Entrepreneur		7 (9.33)
Unemployed		17 (22.67)
Others		34 (45.34)
Stroke type		
Hemorrhagic stroke		12 (16)
Ischemic stroke		63 (84)

SD, standard deviation.

Table 2.
Physical Activity Levels and Stroke Recurrence (N=75)

Characteristics	*n* (%)
Physical Activity	
Mild	35 (46.70)
Moderate	19 (25.30)
Severe	21 (28)
Number of stroke recurrences	
First recurrence	69 (92)
Second recurrence	1 (1.33)
Third recurrence	1 (1.33)
Fourth recurrence	3 (4.01)
Sixth recurrence	1 (1.33)
Stroke recurrence based on stroke type	
Hemorrhagic stroke (*N* = 12)	
First recurrence	11 (91.67)
Sixth recurrence	1 (8.33)
Ischemic stroke (*N* = 63)	
First recurrence	58 (92.06)
Second recurrence	1 (1.59)
Third recurrence	1 (1.59)
Fourth recurrence	3 (4.76)

activity and stroke recurrence, with a weak negative correlation ($p = .02$, $r = -0.26$), which means that higher physical activity will decrease stroke recurrence (Table 3).

Discussion

The age of stroke survivors in this study was dominated by individuals more than 45 years old, and the majority of participants experienced their first recurrence, with ischemic stroke being the most common type. Previous research indicates that ischemic stroke patients are more likely than hemorrhagic stroke patients to experience recurrence (Aini et al., 2023; Kariasa et al., 2019; Rizaldy Taslim & Vincent Ongko, 2020; Setyowati et al., 2021; Ushio et al., 2018). Ischemic stroke is more prevalent than hemorrhagic stroke because it occurs more frequently, has a lower mortality rate, and is closely linked to risk factors like hypertension, diabetes, and high cholesterol (Abdu et al., 2021).

Table 3.
Statistical Association between Physical Activity and Stroke Recurrence

Physical Activity Level (*n*; %)	Stroke Recurrence (*n*; %)
Mild (35; 46.70%)	**First recurrence (69; 92%)**
Moderate (19; 25.30%)	**Second recurrence (1; 1.33%)**
Severe (21; 28%)	**Third recurrence (1; 1.33%)**
	Fourth recurrence (3; 4.01%)
	Sixth recurrence (1; 1.33%)
Correlation (Spearman's ρ)	**−0.26**
p	.02

The study's findings demonstrated a significant correlation between physical activity and the risk of stroke recurrence. In line with a study from Kariasa et al. (2019), one of the factors contributing to stroke recurrence is a lack of physical activity, with a higher percentage occurrence rate than other factors. Additionally, patients with a history of mild ischemic stroke had lower levels of moderate-to-vigorous physical activity and higher visceral fat levels, which may be a risk factor for ischemic stroke recurrence (Ushio et al., 2018). According to Saunders et al. (2014), physical fitness is impaired after stroke, and cardiorespiratory fitness (VO_2 peak) is reduced by 50% in stroke survivors compared to healthy people of the same age and sex. Low physical fitness is observed after stroke due to physical inactivity (Saunders et al., 2014). Compared to stroke survivors who committed the same frequency of low-intensity physical activity or routine therapeutic exercise, those who participated in 30 minutes of moderate-intensity physical activity three times a week showed significantly greater improvements in blood pressure and reductions in total cholesterol (Butler & Evenson, 2014).

In the current study, most participants engage in mild physical activity. The definition of mild physical activity includes all activities performed within 1 week with a MET value of <600 MET minutes/week (Agustiyaningsih et al., 2020; Choi & Jihye, 2015). Physical activity in stroke patients plays an important role that has the potential to provide psychosocial benefits, reduce the recurrence of stroke, and improve physical fitness (Saunders et al., 2014). Physical activity can potentially lower the secondary risk of stroke by influencing blood pressure, vasoconstriction, and the levels of circulating lipids (Butler & Evenson, 2014). In another study, physical activity has been shown to enhance balance, mobility, aerobic capacity, depressive symptoms, and cognitive function (Kringle et al., 2020).

Physical activity could induce ischemic stroke tolerance by reducing oxidative stress and neuronal apoptosis, controlling the inflammatory response, and encouraging neural regeneration, such as Brain-Derived Neurotrophic Factor (BDNF). Brain-Derived Neurotrophic Factor promotes the development, survival, and differentiation of neurons, which is crucial for brain repair and neuroplasticity after ischemic injury. Additionally, physical activity strengthens cardiovascular health, which enhances blood flow and oxygen delivery to brain tissues—a vital function during ischemia episodes when blood supply is restricted (Di Raimondo et al., 2020). On the contrary, in hemorrhagic stroke, physical activity stimulates the formation of new blood vessels (angiogenesis), which can improve cerebral perfusion and help in the revascularization of the affected area, aiding in better oxygen and nutrient delivery to the injured tissue. Physical activity also activates several neuroprotective pathways, including BDNF, reduces the oxidative stress that contributes to neuronal damage during cerebral hemorrhage, and reduces inflammation in the brain post-hemorrhage (Di Raimondo et al., 2020).

The duration of physical activity for individuals recovering from a stroke might vary depending on various factors, for instance, the individual's overall health, physical condition, functional abilities,

and any specific recommendations or limitations provided by healthcare professionals (Kringle et al., 2020). Generally, post-stroke survivors are encouraged to engage in regular physical activity tailored to their abilities and needs (Billinger et al., 2015; MacKay-Lyons et al., 2020). Physical activity sessions can start with shorter durations and gradually extend over time as the individual progresses in their recovery (Kringle et al., 2020). The American Heart Association recommends that stroke patients engage in exercise and physical activity programs for 3 days/week, ranging from 20 to 60 minutes (Kringle et al., 2020). These sessions can include gentle stretching, range-of-motion exercises, and light aerobic activities like walking or stationary cycling. Walking also increases physical activity and helps prevent and manages chronic disease (Billinger et al., 2015; MacKay-Lyons et al., 2020). Aerobic exercise for stroke patients is recommended to be around 20 to 60 minutes per session or several 10-minute bouts of exercise per day (Billinger et al., 2015; MacKay-Lyons et al., 2020).

Study Limitations

The strengths of the study are that it is the first to examine the association between physical activity and stroke recurrence in Indonesia. However, the study has several limitations. First, the sample size is relatively small, which may limit the generalizability of the findings. Second, the study was conducted at a single center, which may not fully represent the broader stroke survivor population. Third, limited data were available on disease characteristics, which could have influenced the observed associations. Lastly, subjective measures were used to assess physical activity, which may introduce self-report bias. To address these limitations, future research should consider larger, multicenter studies to enhance generalizability, incorporate objective physical activity measurements (such as accelerometers or caregiver-reported data), and explore a broader range of disease and sociodemographic factors. Additionally, experimental studies are needed to determine the optimal duration and frequency of physical activity and establish a causal relationship between physical activity and stroke recurrence. A meta-analysis and network meta-analysis could also provide further insights into the most effective intensity and type of physical exercise for stroke prevention.

Conclusion and Recommendations

The current study revealed a significant association between physical activity and stroke recurrence. Higher physical activity will decrease stroke recurrence. It should be emphasized that the appropriate duration and intensity of physical activity must be determined according to the person's capabilities, medical condition, and the guidance provided by healthcare professionals. The healthcare provider or rehabilitation specialist can participate by motivating stroke survivors to perform regular physical activity and ensuring safety and effectiveness in promoting recovery and overall health for post-stroke patients.

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author.

Ethics Committee Approval: The Research and Ethics Committee of the Faculty of Medicine, University of Muhammadiyah Malang (UMM) (Approval no: E.5.a/038/KEPK-UMM/II/2020, Date: February 19, 2020)

Informed Consent: Written informed consent was obtained from from the participants and their families who agreed to take part in the study.

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