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Ocena czynników wpływających na skuteczność terapii integracji sensorycznej u dzieci w wieku przedszkolnym i wczesnoszkolnym

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Effectiveness of moderate to vigorous physical activity among stroke risk predicted population. A pilot study

Skuteczność umiarkowanej do intensywnej aktywności fizycznej wśród populacji z przewidywanym ryzykiem udaru. Badanie pilotażowe

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Abstract

Background. The increasing prevalence of stroke, particularly among younger populations in countries like India, necessitates effective preventive strategies. Modifiable risk factors such as hypertension, diabetes, and smoking contribute significantly to stroke incidence. This study focuses on the implementation of a 12-week moderate to vigorous physical activity (MVPA) program to address these risk factors and reduce stroke incidence.
Methodology. The study involved a structured MVPA intervention among individuals at risk of stroke, emphasizing consistent adherence to the protocol. Key outcomes, including systolic blood pressure, fasting blood glucose, and total cholesterol levels, were monitored. Cardiovascular fitness improvements were assessed using the Cooper's Run Test. The study also examined the feasibility and acceptability of the MVPA intervention through participant adherence rates.
Results. The MVPA group exhibited significant reductions in systolic blood pressure, fasting blood glucose, and total cholesterol levels compared to the control group. These findings underscore the efficacy of MVPA in managing major stroke risk factors. Additionally, participants demonstrated enhanced cardiovascular endurance, highlighting the program's positive impact on overall cardiovascular health. High adherence rates in the MVPA group indicated the feasibility of implementing structured exercise protocols for individuals at risk of stroke.
Conclusion. This pilot study demonstrates the effectiveness of a 12-week MVPA program in reducing key stroke risk factors and improving cardiovascular fitness among individuals at risk of stroke. The findings emphasize the importance of structured exercise interventions in stroke prevention efforts. While promising, further research with larger sample sizes and longer durations is necessary to establish the sustained benefits and feasibility of such interventions. Implementing tailored MVPA programs holds significant potential for mitigating stroke risk, offering valuable insights for global stroke prevention strategies.

Keywords

stroke, MVPA, risk factors of stroke, physical activity

Streszczenie

Wprowadzenie. Rosnąca prevalencja udaru mózgu, szczególnie wśród młodszych populacji w krajach takich jak Indie, wymaga skutecznych strategii prewencyjnych. Modyfikowalne czynniki ryzyka, takie jak nadciśnienie, cukrzyca i palenie tytoniu, znacząco przyczyniają się do występowania udarów. Niniejsze badanie skupia się na wdrożeniu 12-tygodniowego programu umiarkowanej do intensywnej aktywności fizycznej (MVPA) w celu adresowania tych czynników ryzyka i redukcji incydentów udaru.
Metodologia. Badanie obejmowało strukturalną interwencję MVPA wśród osób zagrożonych udarem, kładąc nacisk na konsekwentne przestrzeganie protokołu. Kluczowe wyniki, w tym ciśnienie krwi skurczowe, poziom glukozy na czczo i całkowity poziom cholesterolu, były monitorowane. Poprawa kondycji sercowo-naczyniowej była oceniana za pomocą testu biegu Coopera. Badanie oceniło również wykonalność i akceptowalność interwencji MVPA poprzez wskaźniki przestrzegania zaleceń przez uczestników.
Wyniki. Grupa MVPA wykazała znaczące redukcje ciśnienia krwi skurczowego, poziomu glukozy na czczo i całkowitego poziomu cholesterolu w porównaniu z grupą kontrolną. Wyniki te podkreślają skuteczność MVPA w zarządzaniu głównymi czynnikami ryzyka udaru. Dodatkowo, uczestnicy wykazali zwiększoną wytrzymałość sercowo-naczyniową, co podkreśla pozytywny wpływ programu na ogólną kondycję sercowo-naczyniową. Wysokie wskaźniki przestrzegania zaleceń w grupie MVPA wskazują na wykonalność wdrażania strukturalnych protokołów ćwiczeń dla osób zagrożonych udarem.
Wnioski. Niniejsze badanie pilotażowe demonstruje skuteczność 12-tygodniowego programu MVPA w redukcji kluczowych czynników ryzyka udaru i poprawie kondycji sercowo-naczyniowej wśród osób zagrożonych udarem. Wyniki podkreślają znaczenie strukturalnych interwencji ćwiczeniowych w wysiłkach prewencyjnych przeciwko udarowi. Chociaż obiecujące, dalsze badania z większymi próbami i dłuższym czasem trwania są konieczne, aby ustalić trwałe korzyści i wykonalność takich interwencji. Wdrażanie dostosowanych programów MVPA ma znaczący potencjał w łagodzeniu ryzyka udaru, oferując cenne wglądy dla globalnych strategii zapobiegania udarom.

Słowa kluczowe

udar, MVPA, czynniki ryzyka udaru, aktywność fizyczna

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Introduction

According to World Health Organisation (WHO) Stroke is defined as “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin”. Stroke is traditionally defined as a neurological impairment caused by a sudden focal injury to the central nervous system (CNS) due to a vascular event, such as cerebral infarction, intracerebral hemorrhage (ICH), or subarachnoid hemorrhage (SAH). It stands as a significant global contributor to both disability and mortality [1]. Global Burden of Disease (GBD) reported Vascular-related conditions are major contributors to global mortality, with stroke ranking as the second leading cause of death worldwide. Among stroke types, ischemic strokes constitute the majority. When assessing the global burden of stroke in terms of mortality and disability-adjusted life-years (DALYs), a significant portion is attributed to hemorrhagic stroke. Particularly in low- and middle-income countries, hemorrhagic stroke results in an 80% mortality rate [2]. In recent decades, there has been a notable rise in the incidence of stroke among individuals under the age of 65, with a 25% increase observed globally among adults aged 20 to 64 years. In regions such as Russia, China, and India, a significant increase in cardiovascular risk factors among young adults is a key factor in the rising prevalence of strokes in this age group. Remarkably, in India, approximately 12% of stroke cases are reported in individuals under the age of 40 (2) a study in the year of 2017 reported in various regions of India, the crude stroke prevalence ranged from 44.29 to 559 per 100,000 persons over the past two decades. Additionally, the cumulative incidence of stroke in different parts of the country during the same period ranged from 105 to 152 per 100,000 persons per year [3]. In India, there are 46 stroke-related hospitalizations per 100,000 individuals (equivalent to 0.1 million persons), incurring an average out-of-pocket expenditure of INR 37,388 (US$ 500.00) per hospitalization episode. By extrapolating this hospitalization rate to the national population, it is estimated that India experiences approximately 641,962 stroke-related hospitalizations annually, leading to an economic burden totaling INR 240,017 crores or US$ 322 million [4]. The Global Burden of Disease study validates that around 90% of the population-attributable risk of stroke is associated with ten modifiable risk factors. These factors include hypertension, smoking, diabetes mellitus, physical activity, diet, psychosocial factors, abdominal obesity, alcohol consumption, cardiac problems, and high cholesterol level. The existing evidence indicates that focusing on these ten modifiable risk factors, particularly hypertension, could significantly decrease the global and regional burden of stroke [5]. In 2018, a study investigating ischemic stroke profiles and risk factors in India underscored the pressing need to address modifiable vascular risk factors, not only in India but also in other lower middle-income countries. The research revealed that the average age of stroke patients in India was 58 years, with a notably lower proportion of female patients (33%) compared to Western and Chinese populations. Notably, the economic burden of strokes in India disproportionately affects individuals under the age of 60, primarily male bread winners. The study also highlighted a high prevalence of tobacco and alcohol use, especially among men, in addition to elevated rates of hypertension and diabetes mellitus in comparison to Western populations. Among tobacco users, 53% smoked cigarettes, while others opted for prevalent Indian forms like bidis, smokeless tobacco, and hookah, which are likely associated with higher risks [6]. Although the pathophysiology of stroke is well understood, nearly 90% of strokes are caused by modifiable factors. Despite this knowledge, current preventive strategies have shown limited effectiveness in reducing the global burden of stroke. With the world's population aging and many low- to middle-income countries undergoing epidemiological transitions, the incidence of stroke is expected to rise. The field of stroke prevention is still in its early stages, and there is limited information on how to optimize healthcare systems. This involves healthcare providers prescribing evidence-based care for stroke prevention, ensuring individuals have access to these services, improving adherence to treatment, enhancing control of risk factors, and empowering people to self-manage their risk factors and embrace healthier lifestyles. These lifestyle modifications include consuming a diet abundant in fruits, vegetables, and whole grains, low in sodium and sugary beverages; engaging in regular physical activity; refraining from smoking; and moderating alcohol intake [7]. Studying the impact of exercise on stroke outcomes has been challenging due to the absence of standardized definitions for exercise intensity, variations in exercise routines, difficulties in measuring exposure, and the extended period required to observe effects. Additionally, research suggests a protective gradient linked to activity level, but specific optimal exercise regimens for different population subsets have yet to be determined [8]. However many guidelines have recommended to follow Moderate to Vigorous Physical Activity, but lack of a definite trial may affect the stroke risk survivors to adhere to strict exercise protocol. Considering this concern we have designed and carried out moderate and vigorous intensity physical activity program, this study aims to determine the effect of 12 week moderate to vigorous physical activity protocol for stroke risk survivors.

Materials and methods

Study design and setting

This study was a pilot randomized, single-center trial with two arms and parallel groups. It was conducted by the Department of Physiotherapy of Chettinad Hospital and Research Institute. The Institutional Human Ethics Committee approved the study (IHEC-II/0140/22).

Randomization

An external investigator, not part of the trial, conducted web-based simple randomization using a computer-generated list, allocating participants in a 1:1 ratio between the experimental and active control groups. The randomization process included also an allocation concealment, with the method of the opaque sealed envelopes.

Selection criteria

All participants provided written informed consent, and the inclusion criteria were met, age above 30 years, both genders, subjects who will be predicted with stroke risk score more than 6% in Stroke Riskometer tool, subjects willing to participate. The exclusion criteria included previous stroke subjects, subjects with musculoskeletal deformities, subjects with epileptic cases and subjects with other neurological diseases.

Interventions

After we assigned the recruited subjects to the two study groups, we initiated the scheduled intervention which lasted 12 consecutive weeks and consisted of 25 supervised training sessions and 25 semi-supervised sessions each approximately 1 hour (4-5 sessions/week) for Experimental group the 12-week program was divided into Phase-I, II and III based on Aerobic training (weeks 1-4) followed by aerobic training and strengthening exercises (weeks 5-8), lastly High Intensity Interval Training and strengthening exercises (week 9-12), whereas control group underwent Aerobic training, Flexibility training and weight training. Each session included a period of warm up and cool down session for 10 minutes.

Moderate to vigorous physical activity – experimental group

· Engaging in physical activity enhances physical function across all age groups, enabling individuals to carry out their daily activities energetically and without excessive fatigue in non-communicable diseases or adults with disabilities.

· Absolute rates of energy expenditure or increase in heart rate during physical activity are commonly described as light, moderate or vigorous intensity.

· ***Moderate physical activity requires*** 3.0 METs to less than 6.0 METs or Heart Rate ranging from 64-76% using Karvonen's formula, performing exercises for 150-180 minutes/week.

This period was based on a structured walking program for 30 minutes previously employed in subjects with chronic diseases and non-communicable diseases [9] adapted for the duration of the study. Training sessions in Phase-1 consists of walking to running included two 10-minute bouts of intermittent walking (1 minute of walk, 1 minute of seated rest) separated by a total of 10 minutes of stretching exercises for both upper and lower limb muscles. The two bouts of over-ground walking were performed at a prescribed speed maintaining the heart rate of about 60-70%.The walking speed underwent a fixed progression after each session with the possibility of reducing the speed by a fixed number of 4 steps/minute for each session when there was any exhaustion by the patient. 20 minutes of weight training and progressing to balance training in week 4 maintaining the same heart rate was carried out in sessions.

Table 1. Phase I of moderate to vigorous physical activity training consisting of only moderate intensity exercises

Week	Type	Duration	Intensity	Frequency
Week 1	1. Walking 2. Weight training for upper limb (3 sets)	30 min 20 min	60-70% Heart Rate	4 days/week
Week 2	3. Brisk walking 4. Weight training for lower limb (3 sets)	30 min 20 min	60-70% Heart Rate	4 days/week
Week 3	5. Jogging 6. Weight training and balance training (2 sets)	30 min 20 min	60-70% Heart Rate	4 days/week
Week 4	7. Running 8. Weight training and balance training (2 sets)	30 min 20 min	60-70% Heart Rate	4 days/week

· ***Vigorous physical activity*** requires > 6.0 METs or Heart Rate ranging from 77%-93%, performing exercises for more than 180 minutes/week.

In this Phase-2 and 3 each training session largely focused on aerobic exercises, resistance exercises and High Intensity Interval Training maintaining a heart rate of around 70-90%. Intermediate level such as reducing the bouts of training for 5 minutes were done when the subjects were not able to maintain in the given heart rate speed. Subjects were given resistance exercises after measuring 1RM for each muscle group and any exhaustion during the exercises were asked to be reported immediately, vitals of subjects were measured regularly. In phase 3 exercises were done for 5 days/week reducing the duration to only 40 minutes of exercises and 10 minutes of warm up and cool down. Warm up and cool down phases were taught to the subjects and clear instructions to adhere to the protocol was done by the investigator.

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Table 2. Phase II from week 5-8 consisting of moderate to vigorous training protocol with increased heart rate

Week	Type	Duration	Intensity	Frequency
Week 5	9. Cycling 10. Resistance training for abdomen and chest (3 sets)	30 min 20 min	75-85% Heart Rate	4 days/week
Week 6	11. Cycling 12. Resistance training for back muscles, abdomen and upper limb (2 sets)	30 min 20 min	75-85% Heart Rate	4 days/week
Week 7	13. Stepping exercises 14. Lunges (10rep x 3 sets) hold for 5 seconds with 0.5 kg weight	30 min 20 min	80-85% Heart Rate	4 days/week
Week 8	15. Stepping exercises 16. Lunges(10 rep x 5 sets) hold for 3 seconds with 1.0 kg weight	30 min 20 min	80-85% Heart Rate	4 days/week

Table 3. Phase III exercise protocol consisting of vigorous training with maximum heart rate

Week	Type	Duration	Intensity	Frequency
Week 9	17. High intensity interval training (HIIT)* 18. Push ups(3 sets)	20 min	80-90% Heart Rate	5 days/ week
Week 10	19. HIIT 20. Squats (3 sets)	20 min	80-90% Heart Rate	5 days/ week
Week 11	21. HIIT 22. Push ups and squats(2 sets)	20 min	80-90% Heart Rate	5 days/ week
Week 12	23. HIIT 24. Carrying weights and walking	20 min	80-90% Heart Rate	5 days/ week

**HIIT includes exercises which will have both aerobic and anaerobic exercises, activity will be intense with resting period more*

• ***Control Group Exercise Protocol*** - This group underwent 12 weeks session 3 days/week, exercises included aerobic exercises, free exercises and stretching of all the muscle groups.

Table 4. Control group exercise protocol maintaining only moderate heart rate and performing exercises for 3 days/week

Week	Type	Duration	Frequency
Week 1	Walking	30 min	3 days/week
Week 2	Stretching Upper limb	20 min	3 days/week
Week 3	Walking Stretching upper limb	30 min	3 days/ week

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Week	Type	Duration	Frequency
Week 4	Walking Stretching upper limb	20 min	3 days/ week
Week 5	Walking Stretching lower limb	20 min	3 days/week
Week 6	Walking Stretching lower limb	20 min	3 days/week
Week 7	Walking Marching in one place	20 min	3 days/ week
Week 8	Stretching Marching one place	20 min	3 days/ week
Week 9	Free exercises Lifting weights	20 min	3 days/week
Week 10	Free exercises Lifting weights	20 min	3 days/week
Week 11	Cycling Free exercises	20 min	3 days/ week
Week 12	Cycling Free exercises	20 min	3 days/ week

Outcome measures

Outcome measures were assessed at baseline, at the end of the 6th week, and at the end of the 12th week of the exercise program. Baseline demographic data were gathered, and all measurements were conducted at the designated study centres in a quiet, separate area within a temperature-controlled environment. The expert operators that performed the testing sessions were not blinded to the treatment.

Primary outcome measures

Systolic Blood Pressure: According to GBD studies [10], hypertension is one of the major risk factors for stroke; therefore, systolic blood pressure was measured using a digital sphygmomanometer after resting for 10 minutes.

Fasting blood glucose measured by instructing the participants not to eat for almost 8-12 hours.
Lipid Profile measurements of Total Cholesterol and High-Density Lipoprotein were taken. Body Mass Index measurements were also taken.

Secondary outcome measures

Cooper's Run Test

In the Cooper's Run Test, VO2max refers to the maximum achievable rate of aerobic metabolism during dynamic work, leading to the subject's exhaustion within 5–10 minutes. It is widely recognized internationally as an indicator of one's cardiorespiratory fitness [11]. In this study, a modified equation was used to apply CRT as a valid method for evaluating cardiorespiratory fitness in terms of VO2max. Participants in our study briskly walked a 400-meter corridor for a total duration of 12 minutes, demonstrating high motivation to complete as many rounds as possible. The distance covered in meters was converted into kilometers and the specified equation was employed to predict the VO_2max:
VO_2max (ml × kg^{-1} × min^{-1}) = (22.351 × distance covered in kilometres) 11.288

International Physical Activity Questionnaire

This questionnaire, used to evaluate participants' physical activity, covers five domains: job-related and transportation activities, housework, house maintenance and caregiving, and

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recreational, sports, and leisure-time activities. Additionally, it assesses the duration of time spent sitting [12].

Statistical analysis

The collected data were structured and analyzed using both descriptive and inferential statistical techniques. All variables were evaluated using the Statistical Package for the Social Sciences (SPSS) version 24, with a significance level established at p-value less than 0.05 and a 95% confidence interval applied to all analyses. The Shapiro-Wilk test was used to determine the normality of the data. It indicated that the dependent variables in this study, such as systolic blood pressure (significance 0.090), fasting blood glucose (significance 0.118), total cholesterol (significance 0.211), Body Mass Index (significance 0.052), and Cooper's Test (significance 0.313), were normally distributed at $P > 0.05$. Hence parametric test was adopted.

Repeated Measures ANOVA was utilized to identify statistical differences within the group across various time intervals, while the Independent t-test (Student t-Test) was employed to determine statistical differences between different groups. The data from the IPAQ survey did not exhibit normal distribution for the dependent variable (with a significance level of 0.17) at $P < 0.05$. Consequently, a non-parametric test was applied. Within-group differences were assessed using Friedman's test, and between-group differences were examined using the Mann-Whitney U test.

Results

Thirty of the 50 subjects assessed for eligibility were randomized into the two study arms (Experimental – Group A: N = 15, Control – Group B: N = 15). The two groups were comparable at baseline in terms of anthropometric measurements, stroke risk predicted using stroke riskometer App and outcome measures (table 5). All of the subjects were able to perform moderate to vigorous training, but three subjects in the experimental group required continuous motivation as they felt exhausted and wanted to give up. No adverse effects of training were reported.

Table 5. Baseline characteristics

Characteristics	Experimental group	Control group
Age	45.73 ± 4.96	43.73 ± 5.50
Male	6	7
Female	9	8
Risk Score- Pre	11%	10%
Risk Score-Post	6%	8%
Total	N = 15	N = 15

Primary outcome measures

When we compared the variation between baseline and 12th week data of systolic blood pressure (Mean value 142.73 ± 8.92 and 128.40 ± 7.04), fasting blood glucose (Mean value 138.80 ± 9.63 and 110.73 ± 9.64), and total cholesterol levels (Mean value 235.80 ± 22.60 and 198.86 ± 30.61) of MVPA group exhibited reduced levels of stroke risks when compared with control group systolic blood pressure(Mean value 142.00 ± 12.78 and 137.00 ± 10.82), fasting blood glucose (Mean value 137.13 ± 8.00 and 127.46 ± 6.87), and total cholesterol levels (Mean value 236.80 ± 14.40 and 222.26 ± 12.00). However, the Body Mass Index (BMI) did not show much difference between the two groups. (Table 6)

Table 6. Mean, standard deviation and RMA within groups

Outcome measures	Groups	Baseline and post test	Mean	SD	F-value
Systolic blood pressure	Group A	0 week	142.73	8.92	83.25**
		6th week	139.40	9.40	
		12th week	128.40	7.04	
	Group B	0 week	142.00	12.78	6.04**
		6th week	141.33	10.43	
		12th week	137.00	10.82	
Fasting blood glucose	Group A	0 week	138.80	9.63	112.07**
		6th week	132.80	9.48	
		12th week	110.73	9.64	
	Group B	0 week	137.13	8.00	42.23**
		6th week	131.66	5.97	
		12th week	127.46	6.87	

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Outcome measures	Groups	Baseline and post test	Mean	SD	F-value
Total Cholesterol	Group A	0 week 6^{th} week 12^{th} week	235.80 224.40 198.86	22.62 20.34 30.61	42.73**
	Group B	0 week 6^{th} week 12^{th} week	236.80 231.93 222.26	14.40 12.74 12.00	60.45**
Body Mass Index	Group A	0 week 6^{th} week 12^{th} week	28.42 27.86 26.80	5.56 5.34 4.65	25.04**
	Group B	0 week 6^{th} week 12^{th} week	28.30 27.98 27.52	1.85 1.90 1.85	73.26**
Cooper's test	Group A	0 week 6^{th} week 12^{th} week	2.66 3.40 4.53	0.723 0.507 0.915	36.65**
	Group B	0 week 6^{th} week 12^{th} week	2.53 2.66 3.13	0.516 4.87 0.516	13.79**
IPAQ	Group A	0 week 6^{th} week 12^{th} week	1095.00 2164.50 3566.20	685.85 596.20 561.58	Chi-square 30.00
	Group B	0 week 6^{th} week 12^{th} week	1011.33 1646.31 2596.11	455 449.62 521.85	Chi-square 30.00

***- $P \leq 0.05$ - Significant*

Secondary outcome measures
Cooper's run test of MVPA group variation in baseline and 12th week(Mean value 2.66 ± 0.723 and 4.53 ± 0.915) showed higher values when compared with control group (Mean value 2.53 ± 0.516 and 3.13 ± 0.516). IPAQ of MVPA group in baseline and 12th week (Mean value 1095.00 ± 685.85 and 3566.20 ± 561.58) showed higher values compared to control group (Mean value 1011.33 ± 455 and 2596.11 ± 521.85).

Baseline data for both groups showed no significant difference. However, at the end of the program, we observed statistically significant differences between the MVPA and control groups at the 6th and 12th week post-test (as shown in Table 7). The exception was Body Mass Index, where no significant difference was found in either group, as participants were not focused on a strict diet and weight loss program in this study.

Table 7. Mean difference, t-test and p = value between groups A and B

Outcome measures	Baseline and post test	Mean difference	t-test	p-value
Systolic blood pressure	0 week 6^{th} week 12^{th} week	0.733 0.599 3.33	0.182 −0.532 −2.65	0.857* 0.599* 0.013**
Fasting blood glucose	0 week 6^{th} week 12^{th} week	1.66 1.13 16.73	0.515 0.392 5.47	0.610* 0.698* 0.003**
Total Cholesterol	0 week 6^{th} week 12^{th} week	1.00 7.53 23.40	0.145 1.21 2.75	0.885* 0.234* 0.010**

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Outcome measures	Baseline and post test	Mean difference	t-test	p-value
Body Mass Index	0 week	0.120	0.079	0.937*
	6th week	−0.120	0.082	0.935*
	12th week	−0.720	0.557	0.582*
Cooper's test	0 week	0.133	0.581	0.566*
	6th week	0.733	4.03	0.000**
	12th week	1.40	5.15	0.000**
IPAQ		**Mann-Whitney U test**	**Z test**	
	0 week	99.50	−0.539	0.590*
	6th week	52.50	−2.48	0.013**
	12th week	16.00	−4.00	0.000**

**- P > 0.05 - Not Significant, **- P ≤ 0.05 - Significant*

Discussion

The results of this pilot study provide valuable insights into the effectiveness of a 12-week moderate to vigorous physical activity (MVPA) program among individuals at risk of stroke. The study aimed to address the increasing burden of stroke, particularly in countries like India, where modifiable risk factors such as hypertension, smoking, and diabetes significantly contribute to the rising incidence of stroke. This is highlighted in a review by Tapas Kumar Banerjee and Shyamal Kumar Das (2016) conducted in different cities of India [13].

The study focused on the implementation of a structured MVPA intervention and its impact on several key risk factors associated with stroke.The primary outcomes of the study, including systolic blood pressure, fasting blood glucose, and total cholesterol levels, demonstrated significant reductions in the MVPA group compared to the control group. These findings align with existing literature that emphasizes the role of physical activity in managing hypertension, diabetes, and hyperlipidemia, all major contributors to stroke risk, as reviewed in a 2018 study [14].

A 2018 study conducted in Japan on prescribing MVPA and evaluating its effect on the recurrence of ischemic stroke showed that MVPA resulted in a reduced rate of recurrence compared to the non-MVPA group [15]. The consistent adherence to the MVPA protocol resulted in notable improvements in these risk factors, suggesting the potential of MVPA as a preventive strategy. Additionally, the MVPA group exhibited significant improvements in Cardio-Respiratory fitness, as evidenced by the Cooper's Run Test results which is in line with the previous study done in the year 2019 to measure prospective relationship between objectively measured sedentary time, MVPA and cardiometabolic health indicators [16]. This improvement signifies enhanced cardiovascular endurance, which is crucial for overall health and reduces the risk of cardiovascular events, including stroke. The ability of the MVPA program to enhance cardiovascular fitness is particularly valuable, considering its direct impact on reducing stroke risk and improving the quality of life for individuals at risk of stroke.

A noteworthy aspect of this study is the high adherence rate observed in the MVPA group. Despite the challenges associated with maintaining a rigorous exercise routine, the majority of participants in the experimental group completed the 12-week program. This high adherence rate underscores the feasibility and acceptability of the MVPA intervention, indicating that stroke risk survivors can adhere to a structured exercise protocol. The findings of this pilot study have significant implications for stroke prevention strategies, especially in regions facing an increasing burden of stroke among younger populations. Implementing structured MVPA programs tailored to individuals at risk of stroke could be a feasible and effective approach. The comprehensive approach of this study, which addressed multiple modifiable risk factors, provides a valuable framework for future interventions.

Limitations and future directions

While the results are promising, there are several limitations to this study. The sample size is relatively small, and the study duration is limited to 12 weeks. Long-term studies with larger sample sizes are needed to assess the sustained effects of MVPA on stroke risk factors over an extended period. Additionally, dietary habits and other lifestyle factors were not extensively monitored in this study, which could have influenced the outcomes. Future research could explore the long-term effects of MVPA on stroke incidence and mortality, as well as delve deeper into the impact of dietary modifications and other lifestyle changes in conjunction with physical activity. Moreover, studies examining the cost-effectiveness of implementing such interventions on a larger scale would provide valuable insights for healthcare policymakers.

Conclusion

In conclusion, this pilot study demonstrates the potential of a 12-week moderate to vigorous physical activity program in reducing key stroke risk factors and improving cardiovascular fitness among individuals at risk of stroke. The results highlight the importance of structured exercise interventions in stro-

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ke prevention efforts. Further research with larger sample sizes and longer durations is warranted to establish the long-term benefits and feasibility of such interventions, ultimately contributing to more effective stroke prevention strategies on a global scale.

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