Original Research

Open Access

The effect of the multimodal intervention on blood pressure in patients with first ischemic stroke: A randomized controlled trial

Belitung Nursing Journal
Early View

https://doi.org/10.33546/bnj.2432

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Abstract

Background: Multimodal intervention is currently promoted to control blood pressure in patients with first ischemic stroke. However, a dearth of studies has examined the influence of the intervention among patients with ischemic stroke, particularly in Thailand.

Objective: This study aimed to determine the effect of the multimodal intervention on blood pressure in patients with first ischemic stroke.

Methods: A randomized controlled trial was conducted. Sixty participants were randomly selected from two tertiary hospitals in Thailand. Eligible participants were randomly assigned into an experimental group (n = 30) and a control group (n = 30). The experimental group was provided with the multimodal intervention, while the control group was given the usual care. Data were collected from May 2021 to October 2021 at baseline (pre-test), 4th week, 8th week, and 12th week using the demographic data form and sphygmomanometer. The data were analyzed using the Chi-square test, t-test, and repeated measure analysis of variance (ANOVA).

Results: The participants' blood pressures after receiving the multimodal intervention were lower than those before receiving the multimodal intervention. Both systolic and diastolic blood pressure were statistically significantly decreased over time, starting from baseline to the 8th week and 12th week (p <0.001). In addition, the participants' mean scores of systolic blood pressure (F (1, 58) = 4.059, p = 0.049) and diastolic blood pressure (F (1, 58) = 4.515, p = 0.038) were lower than the control group.

Conclusion: The multimodal intervention is effective in controlling blood pressure. Therefore, nurses should educate patients with ischemic stroke to manage systolic and diastolic blood pressure, facilitate the patient's participation in the exercise program, and monitor the patients via telephone to continue blood pressure control.

Trial Registry: Thai Clinical Trials Registry (TCTR) identifier number 20210318001.

Keywords

ischemic stroke; blood pressure; multimodal intervention; nurses; Thailand

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Article info:
Received: 13 November 2022
Revised: 26 December 2022
Accepted: 28 December 2022

E-ISSN: 2477-4073 | P-ISSN: 2528-181X

Background

High blood pressure is the major risk factor for stroke disease. It is reported to be a leading contributor to long-term disability, functional status decline, decreased quality of life, and death (Bath et al., 2022). In the United States, over 795,000 people have a stroke, and approximately 610,000 are first strokes (Virani et al., 2020). About 87% of all strokes are ischemic strokes, where blood flow to the brain is blocked (Yousufuddin & Young, 2019). In Thailand, the prevalence of stroke was 4.00%, 3.80%, and 3.90% in 2014, 2015, and 2018, respectively (Chantkran et al., 2021). About 104,028 strokes, up to one-third of these affect people who have already had a stroke (Chantkran et al., 2021).

Although using medication is considered effective in preventing recurrent stroke; however, worldwide studies have shown nearly half of patients diagnosed with stroke remain untreated, and over half of them being treated continue to have uncontrolled blood pressure (Oftedal et al., 2018; Pandian et al., 2018). For example, in Thailand, it was found that 41.60% of strokes in the Thai population cannot control their blood pressure (Areechokchai et al., 2017). In comparison, a community-based study found that the prevalence of uncontrol blood pressure in patients with stroke was about 54.40% (Meelab et al., 2019). In addition, a meta-analysis study found that 91% of patients with stroke who cannot control their blood pressure had recurrent strokes during the follow-up period. Of these, 86.80% were ischemic strokes, and 13.20% were intracerebral hemorrhages (Kitagawa et al., 2019). Therefore, blood pressure control is a cornerstone for preventing recurrent stroke especially ischemic stroke.

The 2017 American College of Cardiology/ American Heart Association Blood Pressure Guideline recommended keeping blood pressure below 130/80 mmHg in ischemic stroke (Kim et al., 2020; Whelton et al., 2018). A meta-analysis study reported that intensive blood pressure control of less than 120/80 mm Hg reduced stroke recurrence compared with blood pressure control of less than 140/90 mm Hg (Kitagawa et al., 2019). Regarding the 2017 ACC/AHA BP Guideline, the cut point of well blood pressure control in patients with stroke in this study is less than 130/80 mmHg (Whelton et al., 2018). However, patients with ischemic stroke reported having difficulty controlling blood pressure due to several modifiable factors, including lack of knowledge, consuming unhealthy food, higher sodium intake, less exercise, tobacco use, excessive alcohol intake, lower potassium intake, lack of motivation to change behaviors (Benjamin et al., 2017) and lack of medical adherence (Hameed & Dasgupta, 2019; Williams et al., 2018). Thus, these modifiable factors should be managed to control blood pressure in these patients.

Empirically, several interventions have been developed to control blood pressure in particular patients with ischemic stroke. The intervention studies have reported results of implementing both single and multiple components of the intervention to reduce blood pressure. For example, a meta-analysis showed that exercise interventions significantly reduced systolic and diastolic blood pressure among patients after stroke (Wang et al., 2019). Other studies found that taking a healthy diet, consuming low salt, exercising, and quitting smoking reduced blood pressure in patients with ischemic stroke (Chen et al., 2022; Wajngarten & Silva, 2019). In Thailand, a quasi-experimental study reported that patients who received information regarding food, exercise, and medication had proper systolic blood pressure control (Thongbupa et al., 2022). Another meta-analysis study found that patients with stroke who participated in the multimodal intervention had better blood pressure control (Bai et al., 2017). Therefore, developing a multimodal intervention should benefit patients with ischemic stroke who have difficulty controlling blood pressure.

It is noted that the multimodal intervention is an integrated approach addressing multiple risk factors for patients with ischemic stroke to control blood pressure. This intervention combined three components, including health-related behaviors education, exercise, and telephone monitoring. It is possible that patients can improve their health when they receive specific knowledge and apply it to everyday practice to maintain well-being. Moreover, active exercise could reduce stimulation of the sympathetic nervous system and strengthen the blood vessels to lower blood pressure. This intervention has been implemented and reported good progress in blood pressure control among patients with ischemic stroke in other countries (Chen et al., 2022; Wajngarten & Silva, 2019). However, few studies have explored its effect among patients with ischemic stroke in Thailand. Thus, this study aimed to examine the effect of the multimodal intervention on blood pressure in patients with first ischemic stroke.

Methods

Study Design

A randomized controlled trial was employed in this study. Consolidated Standards of Reporting Trials (CONSORT) Statement (Schulz et al., 2010) was used to report the study.

Participants/Samples

Adults diagnosed with first ischemic stroke and visiting the outpatient department to receive continuing care from Buddhachinaraj Hospital and Naresuan University Hospital were recruited into this study. The inclusion criteria were: 1) adult aged 45 years and over, 2) diagnosed with ischemic stroke, 3) severity of stroke in mild to moderate when completing the National Institute of Health Stroke Scale-Thai version (NIHSS-T) confirmed by a physician at stroke units, 4) ability to perform activities of daily living by themselves, 5) had a caregiver who supported them during exercise, and 6) had a telephone and line application. In addition, the participants were excluded if they had a severe disability, mental illness, disabling chronic diseases, or participated in another trial.

The sample size was calculated using the G*power program. The effect size was estimated based on a previous study (Kirk et al., 2014) which had similar characteristics to the study, including 1) patients with minor stroke, 2) using the multiple components intervention, and 3) the measured outcome was blood pressure. For this study, the minimal sample size was 60, calculated based on the estimated effect size of 0.24, the power of the test of 0.95, the significance level of 0.05, and four repeated measurements.

A cluster randomization technique was utilized to select the study settings in the 2nd public health region of Thailand. Since there were five provinces in this region, a simple random sampling technique was used to select one province. Consequently, Phitsanulok province was chosen. This study was conducted at two tertiary hospitals, which only have a stroke unit in Phitsanulok province. These hospitals utilized the clinical practice guidelines for ischemic stroke 2019 recommended by the Neurological Institute of Thailand.

All patients who had a first-event stroke from May 2021 to July 2021 were screened. First, eligible participants were identified through active screening by a research assistant. Then, a systematic randomization technique was utilized to assign the participants into experimental and control groups. This systemic randomization was performed until it reached 30 participants in each group (Figure 1).

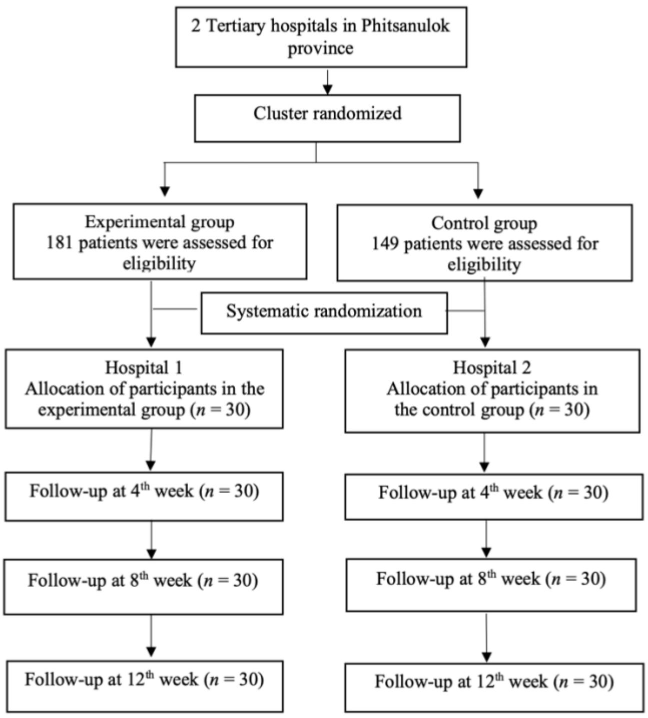

Figure 1 Flowchart of the sampling procedure

Instruments

Four parts of instruments were used in this study, including:

1) A demographic data form was developed by researchers to collect the general characteristics, including age, gender, education level, and marital status. The clinical characteristics included smoking, co-morbidity-related ischemic stroke, medication taking, and exercise.
2) Barthel index score (Dajpratham et al., 2006) was used to assess the ability to perform activities of daily living. Items are rated in terms of whether individuals can perform activities independently (scored as 10), with some assistance (scored as 5), or are dependent (scored as 0). A total score was out of 100. The interpretation of mobility and self-care are as follows, a score of 0-19 suggests total dependence, 20-39 severe dependence, 40-59 moderate dependence, 60-79 slight dependence, and 80-100 independent. Inter-rater reliability for the mobility subscale was 0.85, and the self-care subscale was 0.86.
3) The National Institute of Health Stroke Scale-Thai (NIHSS-T) version (Nilanont et al., 2010) was used to assess stroke severity. This instrument measures 15 neurological items. There are 3- or 4- point scales for each item, resulting in a total score of 0-42. It assesses consciousness, motor, perception, and cognition in patients with stroke. The scale interpretation consisted of four categories: very severe impairment (score ≥ 25), severe impairment (15–24), mild to moderate (5–14), and mild impairment (≤ 4). Inter-observer reliability of the total NIHSS-T score was 0.99. The Spearman rank correlation coefficient was 0.53.
4) A sphygmomanometer was used to measure blood pressure. A calibrated automated device OMRON HBP-1300 was used by two research assistants. It had a proper-sized cuff and sitting position after 5 minutes of rest and 1 minute apart. The cut point of well-controlled blood pressure in patients with stroke is less than 130/80 mmHg (Whelton et al., 2018). Therefore, the average of the second and third measures was used. Measuring blood pressure was based on the Eight Joint National Committee (JNC 8) guidelines (James et al., 2014). It was calibrated once a year by Buddhachinaraj Hospital's technicians.

Interventions

The multimodal intervention in this study was developed based on a literature review and selected studies with the highest effect size (Chiu et al., 2008; Kono et al., 2013; Moore et al., 2015; Wang et al., 2014). The components and activities of the multimodal intervention are explained in the following.

The first component was the education component, developed to improve patients' knowledge of appropriate behavior after the first ischemic stroke. The knowledge components included 1) eating a healthy diet, 2) limiting salt intake, 3) increasing physical activities, 4) quitting smoking and avoiding secondhand smoke, and 5) medication adherence. The first component was divided into four sessions. Each session was set one by one based on the patient's characteristics and because the patients were admitted at different times. However, the participants received knowledge in one session per week, with a total of 4 weeks.

The second component was the 12-week exercise component. This component was developed to train the exercise skills of the participants, which consists of 1) walking exercise 3 times/week (40-minute/session) and 2) resistance exercise 2 times/week (20-minute/session).

The third component was telephone monitoring. This component instilled a positive attitude and a follow-up telephone for 20 minutes/time as strategies to improve adherence to interventions. Patients recorded health behaviors about eating, physical activity and exercise, smoking, and medication intake in self-monitor form every week. For each telephone follow-up, the researcher discussed the participants' health behaviors, barriers-related behaviors, and approaches to address the barriers and gave some suggestions related to the participants' needs. The telephone follow-up was done on week 8th and week 12th.

This intervention was validated for content validity by five experts: 1) a physician (an expert in ischemic stroke), 2) a nurse instructor (an expert in ischemic stroke and behavior change), 3) a physical therapist (an expert in ischemic stroke and has experience in stroke rehabilitation), 4) a nutritionist (an expert in diet patients with ischemic stroke), and 5) an Advanced Practice Nurse (APN) (an expert in nursing care in patients with stroke). The revised program was tried out on five patients with first ischemic stroke with similar characteristics to the study population.

Data Collection

Data were collected from May 2021 to October 2021 by the researcher and two research assistants. The research assistants were nurses, and they were trained before data collection. The researcher's assistant asked the participants in both groups to measure baseline blood pressure before starting the intervention. Then the experimental group was given the multimodal intervention, while the control group was provided the usual care. The research assistants repeatedly measured the control and intervention groups' blood pressure in the 4th week, 8th week, and 12th week, and the accurate measurement was based on the clinical practice guideline (Whelton et al., 2018).

The researchers were concerned about the data collection during the COVID-19 pandemic and the protection of the participants and their family members. Thus, this study followed the announcement of the Phitsanulok Provincial Public Health office and taking D-M-H-T-T (Distancing, Mask wearing, Hand washing, Temperature check, and Thaichana application) precautions to prevent the spread of COVID-19. In addition, the researcher completed two COVID-19 vaccines in the first month of collecting data. The researcher tested ATK 2-3 days before contacting participants. During collecting data, no participants or their family members reported positive cases of COVID-19. Details of the data collection in each group are in the following.

The experimental group

The research assistants were asked to assess the demographic data.

Baseline (week 0): The research assistants measured blood pressure following the guideline. The participants received the five education booklets for ischemic stroke patients and the self-monitoring form. Then, the participants were trained to perform walking exercises and resistance exercises by researchers. At this step, family members or caregivers observed and walked together with the participants to prevent injury and encourage them to exercise. The researchers provided the sphygmomanometers for these participants. Then, the researcher trained participants and family members to measure blood pressure following the guidelines (James et al., 2014).

From 1st to 4th week: The researcher provided four education sessions (40 minutes per week). Each session was set at the stroke unit or their houses. The participants received knowledge in one session per week, with a total of four weeks. The sessions include 1) providing knowledge about eating a healthy diet for the first ischemic stroke patient (40 minutes at week 1st), 2) providing knowledge about limited salt intake (40 minutes at week 2nd), 3) providing knowledge about increasing physical activities and quit smoking and avoid secondhand (40 minutes at week 3rd), and 4) providing knowledge about medication (40 minutes at week 4th). In addition, participants performed exercises, and the family member or caregiver was closely observed during the participants walking at their house. At 4th week, the participants were measured blood pressure by the research assistants.

From the 5th to the 12th week: The participants performed exercises and recorded their behavior data in self-monitoring form. The participants were measured blood pressure by the research assistants in the 8th week and 12th weeks. The researcher made a phone call to the participants to discuss and suggest their activities based on the procedure of the multimodal intervention in the 8th week and 12th weeks.

The control group

Baseline (week 0): The participants were asked to respond to demographic data. The research assistants measured the participants' blood pressure.

From 1st week to 12th week: in discharge planning, the participants received general and very brief information covering lifestyle modification in discharge plans from nurses in the stroke unit. Physicians provided medication and took blood exams at the neurological outpatient clinic when they had a follow-up. The researcher made an appointment and measured their blood pressure in the 4th week, 8th week, and 12th week.

Data Analysis

The data were analyzed using Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows. The comparison of demographic characteristics between groups at baseline was examined using a *t*-test for continuous variables and Chi-square tests for categorical variables. To examine the effect of the intervention on blood pressure, repeated ANOVA was used to test the difference in mean scores at different points in time. All relevant assumptions were tested prior to the analysis process. Statistical significance was accepted for *p*-value <0.05.

Ethical Considerations

This study was approved by the Research Ethics Committee of Human Subjects of Chulalongkorn University (Reference COA No.046/2021) and the Research Ethics Committee of Human Subjects of Buddhachinaraj Hospital, Phitsanulok province, Thailand (Reference No.027/64). The study participants were asked to sign a consent form. The researchers provided information about study objectives, procedures, and rights, including the right to withdraw until data analysis was started without affecting their quality of service. The confidentiality and anonymity of participants were protected throughout the study.

Results

Characteristics of the Participants

In the experimental group, the mean age of the participants was 60.70 years old (SD = 6.53), ranging from 48 to 70 years old. Most of the participants were males (93.33%), married (86.67%), and completed primary school (63.33%). In contrast, in the control group, the mean age of the participants was 62.93 years old (SD = 5.18), ranging from 52 to 71 years old. The majority of the control group were males (86.67%), married (83.34%), and completed primary school (73.33%). There were no statistically significant differences between the experimental and control groups regarding the characteristics, specifically gender, age, marital status, and education level (**Table 1**).

Table 1 Demographic characteristics of the study participants at baseline (*N* = 60)

Demographic characteristics	Experimental group (*n* = 30) *n* (%)	Control group (*n* = 30) *n* (%)	χ^2	*p*-value
Gender			0.74[b]	0.39
Male	28 (93.33)	26 (86.67)		
Female	2 (6.67)	4 (13.33)		
Age			0.54[a]	0.76
45-59	12 (40.00)	10 (33.33)		
60-69	17 (56.67)	18 (60.00)		
70-79	1 (3.33)	2 (6.67)		
Marital status			2.82[a]	0.24
Single	3 (10.00)	1 (3.33)		
Married	26 (86.67)	25 (83.34)		
Divorced/Widow	1 (3.33)	4 (13.33)		
Educational level			2.11[a]	0.55
Primary school	19 (63.33)	22 (73.33)		
Secondary school	8 (26.67)	5 (16.67)		
Certificate	1 (3.33)	0 (0.00)		
Bachelor	2 (6.67)	3 (10.00)		

a = Chi-Square, b = Fisher's Exact Test, **p*-value <0.05

Table 2 shows the clinical characteristics of the participants. For the experimental group, over half of the participants reported currently smoking (56.67%), and almost all of them did not do exercise (96.67%). Concerning co-morbidity, many were diagnosed with hypertension (70.00%). However, all participants (100%) used prescribed antiplatelet and anti-hyperlipidemic medications. Stroke severity was assessed using NIHSS-T, and the mean score was 1.27 (SD = 0.45). The capability of the participants to perform the activity of daily life was assessed using the Barthel index (BI), and it was found that the mean score was 97.33 (SD = 3.88), ranging from 96 to 100.

In comparison, nearly half of the study participants in the control group were currently smoked (40.00%), and most of them did not do exercise (93.33%). Concerning co-morbidity, many of the participants were diagnosed with hypertension (86.67%). All participants (100%) used prescribed antiplatelet and anti-hyperlipidemic medication. Stroke severity was assessed using the NIHSS-T, and the mean score was 1.33 (SD = 0.48). The mean score of the participants' capability to perform daily life activities using the Barthel index (BI) was 96.33 (SD = 4.34), ranging from 96-100.

It was noted that there were no statistically significant in terms of smoking status, co-morbidity, medication taking, the severity of the stroke, and capability of the participants to perform the activity of daily life between the experimental and control groups.

Table 2 Clinical characteristics of participants (*N* = 60)

Clinical characteristics	Experimental group (*n* = 30)	Control group (*n* = 30)	χ^2	*p*-value
	***n* (%)**	***n* (%)**		
Smoking			2.51[a]	0.29
Never smoked	3 (10.00)	7 (23.33)		
Smoked in the past	10 (33.33)	11 (36.67)		
Currently smoked	17 (56.67)	12 (40.00)		
Exercise			0.35[b]	0.55
No exercise	29 (96.67)	28 (93.33)		
Exercise	1 (3.33)	2 (6.67)		
Co-morbidity-related ischemic stroke			3.52[a]	0.62
No co-morbidity	9 (30.00)	4 (13.33)		
HT	4 (13.33)	4 (13.33)		
HT and DLP	8 (26.67)	13 (43.34)		
HT and DM	2 (6.67)	1 (3.33)		
HT, DLP, and DM	6 (20.00)	7 (23.34)		
HT, DLP, and HD	1 (3.33)	1 (3.33)		
Medication taking			8.66[a]	0.12
Anticoagulant drug	30 (100.00)	30 (100.00)		
Antihypertensive drug	20 (66.67)	26 (86.67)		
Antihyperlipidemic drug	30 (100.00)	30 (100.00)		
Diabetic drug	8 (26.67)	7 (23.34)		
Anti-hypouricemic drugs	1 (3.33)	1 (3.33)		
Alpha-adrenergic blocker	1 (3.33)	1 (3.33)		
NIHSS-T			0.32[b]	0.57
Score 1	22 (73.33)	20 (66.67)		
Score 2	8 (26.67)	10 (33.33)		
BI score			6.04[a]	0.11
≤85	0 (0.00)	2 (6.67)		
86-90	5 (16.67)	2 (6.67)		
91-95	6 (20.00)	12 (40.00)		
96-100	19 (63.33)	14 (46.66)		

Abbreviations: HT=hypertension, DLP=dyslipidemia, DM=diabetes mellitus, BPH= benign prostate hyperplasia, HD=heart disease, NIHSS-T = the National Institute of Health Stroke Scale-Thai version, BI = Barthel index, a = Chi-Square, b = Fisher's Exact Test, *p-value <0.05

Blood Pressure Level among Patients with First Ischemic Stroke

Table 3 demonstrates the blood pressure level between the experimental and control groups at four points. In the experimental group, the mean systolic blood pressure score decreased more than the control group in the 8th week and 12th week (p = 0.003, p <0.001, respectively). In addition, the mean score of diastolic blood pressure in the experimental group decreased more than the control group in the 8th week and 12th week (p = 0.003, p <0.001, respectively). The mean score of systolic blood pressure and diastolic blood pressure decreased from the 8th week (**Figure 2**).

Effect of the Multimodal Intervention on Blood Pressure

Normality, sphericity, and homogeneity of variance were tested, and the assumptions of repeated measures ANOVA were not violated. The results showed that participants in the experimental group had statistically significantly different mean blood pressure scores between baseline, 4th week, 8th week, and 12th week (p <0.05). In contrast, the control group had no statistically significant difference in mean blood pressure scores (p >0.05). In addition, the participants in the experimental group who received the multimodal intervention had the average systolic blood pressure and diastolic blood pressure better than the participants in the control group who received usual care (F (1, 58) = 4.059, p = 0.049; F (1, 58) = 4.515, p = 0.038, respectively) (**Table 4**).

Table 3 Level of blood pressure between the experimental and control groups at four points in time

Time	Experimental group (*n* = 30)		Control group (*n* = 30)		*t*	*p*-value
	Mean	SD	Mean	SD		
Baseline (week 0)						
SBP	142.87	10.57	141.90	9.98	0.387	0.702
DBP	89.67	7.16	87.93	7.18	0.919	0.366
4th week						
SBP	141.33	11.31	141.40	11.46	-0.022	0.983
DBP	88.27	7.41	88.73	7.63	-0.239	0.812
8th week						
SBP	135.97	9.56	144.10	8.83	-3.257	0.003*
DBP	84.60	5.47	89.53	6.09	-3.279	0.003*
12th week						
SBP	131.90	8.59	142.93	7.76	-5.967	0.000*
DBP	80.53	5.69	89.43	5.20	-6.940	0.000*

SBP, Systolic blood pressure. DBP, Diastolic blood pressure
**p*-value <0.01

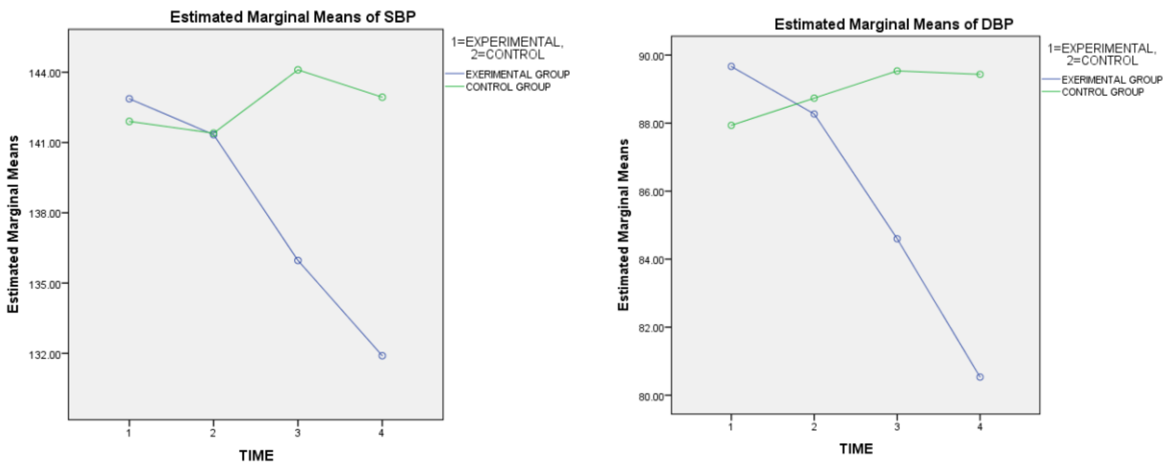

Figure 2 Mean score of systolic blood pressure and diastolic blood pressure between groups at 4 points in time

Table 4 Effect of the multimodal intervention on blood pressure control (between time differences)

Blood pressure	Time	Experimental group (*n* = 30)		Control group (*n* = 30)		F-test between group	*p*-value
		Mean ± SD	F-test within group	Mean ± SD	F-test within group		
Systolic blood pressure	Baseline (week 0)	142.87 ± 10.57	44.121**	141.90 ± 9.98	1.214	4.059	0.049
	4th week	141.33 ± 11.31		141.40 ± 11.46			
	8th week	135.97 ± 9.56		144.10 ± 8.83			
	12thweek	131.90 ± 8.59		142.93 ± 7.76			
Diastolic blood pressure	Baseline (week 0)	89.67 ± 7.16	54.214**	87.93 ± 7.18	0.948	4.515	0.038
	4th week	88.27 ± 7.41		88.73 ± 7.63			
	8th week	84.60 ± 5.47		89.53 ± 6.09			
	12thweek	80.53 ± 5.69		89.43 ± 5.20			

***p*-value <0.05

Due to the effects of time changed mean score of systolic and diastolic blood pressure in the experimental group, at least one pair was found. Thus, the analysis of the mean difference of each pair in each group using Post Hoc tests comparisons was needed.

Table 5 presents the comparison of systolic blood pressure of the experimental group across four points of time. The results revealed that the mean systolic blood pressure score at baseline was higher than in the 4th week, 8th week, and 12th week, respectively. Systolic blood pressure was statistically decreased over time comparing between baseline, 8th week, and 12th week (p <0.001, p <0.001, p <0.001, respectively). The biggest difference was found in the 12th week compared to the baseline. Considering the mean difference in each pair over time, the systolic blood pressure started to decrease statistically significantly in the 8th week (p <0.001). The systolic blood pressure level tended to decrease from the 8th week to the 12th week.

Table 5 Pairwise comparison of systolic blood pressure of the experimental group across four points in time (*n* = 30)

Time to measure	Mean	Baseline	4th week	8th week	12th week
Baseline	142.87				
4th week	141.33	1.53			
8th week	135.97	6.90*	5.37*		
12th week	131.90	10.97*	9.43*	4.07*	

**p*-value <0.001

A comparison of the diastolic blood pressure of the experimental group across four points of time is presented in **Table 6.** The results showed that the mean score of diastolic blood pressure at baseline was higher than the 4th week, 8th week, and 12th week, respectively. Diastolic blood pressure was statistically decreased over time comparing between baseline, 8th week, and 12th week (p <0.001, p <0.001, p <0.001, respectively). The biggest difference was found in the 12th week compared to the baseline. Considering the mean difference in each pair over time, the diastolic blood pressure started to decrease statistically significantly in the 8th week (p <0.001). The diastolic blood pressure level tended to decrease from the 8th to the 12th week. In addition, the 12th week was significantly lower than the 4th and 8th weeks, and the 8th week was significantly lower than the 12th week.

Table 6 Pairwise comparison of diastolic blood pressure of the experimental group across four points of time (*n* = 30)

Time to measure	Mean	Baseline	4th week	8th week	12th week
Baseline	89.67				
4th week	88.27	1.40			
8th week	84.60	5.07*	3.67*		
12th week	80.53	9.13*	7.73*	4.07*	

**p*-value <0.001

Discussion

The study showed that the multimodal intervention decreased systolic and diastolic blood pressure in patients with first ischemic stroke. In addition, the systolic and diastolic blood pressure of the participants in the experimental group was reduced in the 8th week and 12th week. These results are consistent with earlier studies that systolic and diastolic blood pressure is decreased in the 8th week or 12th week rather than at baseline (Kono et al., 2013). Moreover, systolic and diastolic blood pressure in the experimental group was significantly decreased than in the control group in the 8th week and 12th week.

Regarding the results of this study, the multimodal intervention that consisted of various components, including education, exercise, and telephone monitoring, affected blood pressure control among patients with first ischemic stroke. This may be because giving education could optimize their engagement in learning experiences (Merriam & Bierema, 2014). In addition, adequate education, including eating healthy food, taking salt restriction, increasing physical activities, quitting smoking, and medication adherence, increase the level of knowledge and understanding of the patients to change risk behaviors for controlling blood pressure in patients with first ischemic stroke.

Patients with ischemic stroke who performed regular exercise within 12 weeks resulted in better blood pressure control. This finding indicates that blood pressure can be controlled by enhancing physical activity, and it needs time to control it. This result is consistent with a previous study that continuous exercise lowers stimulation of the sympathetic nervous system, strengthens the blood vessels, increases muscle fat metabolism, and decreases fat in adipose tissue, which lowers cholesterol and builds muscles (Abou Elmagd, 2016). Moreover, utilize glucose without insulin to encourage the stabilization of plaque and beneficial vascular wall modifications for lowering blood pressure (Abou Elmagd, 2016). Exercise and skills of self-blood pressure monitoring gained their skill, enhanced their attitude, drove them to maintain behaviors, and avoided a further stroke.

The combination of education and exercise intervention encourages patients with ischemic stroke to perform their risk behaviors change (eating healthy food and intake salt restriction, increasing physical activities and 12-week exercise, quitting smoking, and medication adherence) and gain their physiological change as regular exercise made patients' hearts good function and could pump blood more efficiently. As a result, the force on patients' arteries decreased, reducing patients' blood pressure (Billinger et al., 2012). A lower sodium intake helps the body retain less salt and water. It also inhibits sodium chloride reabsorption in the distal convoluted tubule, which results in a reduction in extracellular fluid and a decrease in peripheral resistance to lowering blood pressure (Larsson et al., 2016), reducing saturated, trans fats and statin that helps decrease cholesterol (Lim & Choue, 2013). In addition, avoiding sweetened foods and diabetes drugs reduce blood glucose which affects to vessel wall (Lakkur & Judd, 2015). Quit smoking reduces atrial stiffness and improves endothelial cell function to lower blood pressure (Chadwick et al., 2015).

However, evidence suggests that mixing education and exercise intervention does not always lead to controlling blood pressure. Because most patients cannot sustain their behaviors changing as daily activities. Telephone monitoring was used to empower and consult during the intervention. These strategies improved adherence to intervention (Flemming et al., 2013). It is the process of attending to one's actions and recording the presence or absence of target behaviors (McBain et al., 2015). As a result, the patients have increased knowledge, skill, and empowerment in blood pressure control and avoiding further strokes (Ovaisi et al., 2011).

The RCT design, which examined the effectiveness of a multimodal intervention, was one of the strengths of our study.

It is a mixed education, exercise, and telephone monitoring intervention derived during the hospital to the community setting. Furthermore, the results of this study are consistent with previous research (Chiu et al., 2008; Flemming et al., 2013; Kono et al., 2013). However, the study might have various limitations. Firstly, the limitation of this study was the small sample size. Thus, a large number of participants is recommended for future studies, and comparing the results in many settings is necessary to confirm the rigorous procedures of the program. Secondly, the time for substantial change to control blood pressure was relatively short. Therefore, long-term research needs to be explored in future studies. However, the long-term outcomes should be evaluated, and concerned about the cost of intervention should be compared with the long-term effectiveness. It is noteworthy that our study found that most participants had family members who took care of and encouraged them to maintain the intervention activities. Thus, future studies should include family members in this program as social support. Lastly, there was a significant decrease in blood pressure in older adults (mean = 61.82 years, SD = 5.95). It is to observe the effect of the multimodal intervention in the young stroke compared with the adult age group.

Implications for Nursing Practice

The results of this study are relevant to nursing practice. Implementing the multimodal intervention by providing knowledge, enhancing exercise continuously, and telephone monitoring can control blood pressure in patients with first ischemic stroke. For example, patients with first ischemic stroke should be trained to measure their own blood pressure regularly. The nurses should encourage patients with first ischemic stroke to participate in the multimodal intervention, which helps them understand stroke and maintain a healthy lifestyle, such as exercising regularly, eating healthy food, and stopping smoking. In addition, nurses should monitor whether the patients with first ischemic stroke can follow these guidelines to control their blood pressure. During the follow-up period, nurses should evaluate the impacts of this intervention on blood pressure. Any issues and concerns during the program occurred should be discussed between nurses and patients. In addition, healthcare administrators should continuously organize key people who can manage and follow the patients for about three months. These key persons can then deliver the information to community nurses who can provide holistic care to monitor clinical outcomes such as blood pressure.

Conclusion

Our study shows that the components of the multimodal intervention, including educational sessions, exercise, and telephone monitoring enhance the ability of patients with first ischemic stroke to control their blood pressure over 12 weeks compared to those in the control group. These findings indicate that the intervention is effective and can be implemented for patients with first ischemic stroke in the outpatient department. However, other studies with a more extended follow-up period should be conducted to evaluate the impacts of this intervention on blood pressure among this population.

Declaration of Conflicting Interest

All authors declared that there are no conflicts of interest.

Funding

The authors have no external funding for this study.

Acknowledgment

The authors thank all participants who willingly participated in the research activities.

Authors' Contributions

All authors contributed equally to the conception and design, acquisition of data, analysis, and interpretation of data. All were given final approval of the version to be submitted and any revised versions, as well as agreed to be accountable for all aspects of the work.

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Data Availability

Due to privacy and ethical concerns, neither the data nor the source of the data can be made available.

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Cite this article as: Jullmusi, O., Yunibhand, J., & Jitpanya, C. (2023). The effect of the multimodal intervention on blood pressure in patients with first ischemic stroke: A randomized controlled trial. *Belitung Nursing Journal*. https://doi.org/10.33546/bnj.2432