Original Article

Comparing the Effects of Interactive and Noninteractive Education Using Short Message Service on Treatment Adherence and Blood Pressure among Patients with Hypertension

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ABSTRACT

Background: Poor treatment adherence among patients with chronic conditions is a major global health-care problem. **Objectives:** The aim of this study was to compare the effects of interactive and noninteractive education using short message service (SMS) on treatment adherence and blood pressure among patients with hypertension (HTN). **Methods:** This single-blind pretest–posttest randomized controlled clinical trial was conducted on 63 adult patients with HTN who were consecutively recruited from a military hospital in Tehran, Iran, and were randomly allocated to an interactive SMS (ISMS), a non-ISMS (NISMS), and a control group. Initially, all patients in all groups were individually trained about HTN and adherence to its treatments in a 45-min session. Then, four messages were weekly sent for four consecutive months to those in the ISMS and the NISMS groups. The Treatment Adherence Questionnaire for Patients with Hypertension was used to assess treatment adherence both before and after the study intervention. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were also measured before and every 1 month during the study. Data were analyzed using the paired sample *t*, the Chi-square, and the Fisher's exact tests as well as the one-way and the repeated-measures analysis of variance. **Results:** At baseline, the mean score of treatment adherence was 81.43 ± 9.15 in the ISMS group, 81.14 ± 7.21 in the NISMS group, and 83.38 ± 14.43 in the control group. After the intervention, the mean score of treatment adherence in the ISMS group significantly increased to 89.67 ± 4.47 ($P = 0.003$), while it insignificantly changed to 83.24 ± 7.18 in the NISMS group ($P = 0.15$) and to 87.86 ± 6.62 in the control group ($P = 0.16$). The among-group difference respecting the posttest mean score of treatment adherence was statistically significant ($P = 0.004$). Although the means of SBP and DBP significantly decreased in both the intervention groups ($P < 0.05$) and did not significantly change in the control group ($P > 0.05$), the among-group differences respecting the variations of SBP and DBP across the four measurement time points were not statistically significant ($P > 0.05$). **Conclusion:** ISMS-based education is effective in significantly promoting treatment adherence, while neither interactive nor NISMS-based educations are effective in significantly reducing blood pressure among patients with HTN.

Keywords: *Blood pressure, Hypertension, Interactive, Patient education, Short message service, Treatment adherence*

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Introduction

Hypertension (HTN) is one of the most important modifiable risk factors for cardiovascular disease.[1] In 2014, its prevalence among people over 18 years was 22% and it is expected to reach 1.656 billion by 2025.[2] HTN is called the silent killer due to the absence of obvious symptoms and its high death rate.[1] It is associated with many different health problems including stroke, heart attack, congestive heart failure, pulmonary edema, kidney failure, visual problems, obesity, chronic cardiovascular disease, and death.[3,4] In 2009, the World Health Organization attributed 13% of all deaths in the world to HTN.[2]

Despite the increasing level of public health-related knowledge, poor adherence to the treatments of chronic diseases such as HTN is still a global problem. According to the World Health Organization, the prevalence of poor treatment adherence is 50%, on average. Poor treatment adherence is also common among patients with HTN.[5]

Poor treatment adherence is associated with many different health problems such as increased risk for cerebrovascular and coronary diseases,[5] increased rate of hospital readmission,[6] limited treatment success, and ineffective disease control.[7] A study reported that more than 30% of hospital readmissions are due to poor treatment adherence.[6] The most important factors affecting treatment adherence include forgetfulness, high costs of medications, lack of knowledge, low quality of life, lack of obvious disease symptoms,[8] demographic characteristics, perceptual and social factors, quality of healthcare providers' interactions with patients, characteristics of healthcare systems, patients' general health status, and their degree of involvement in treatments.[9] Understanding these factors plays an important role in the development of interventions for promoting treatment adherence and recovery.[9]

Improving patients' knowledge is one of the basic nursing strategies for promoting their treatment adherence. Knowledge improvement promotes treatment adherence, facilitates HTN management,[10] encourages patient involvement in the treatment process and self-care, and reduces hospital readmission rate.[11,12] Health information technology, including mobile phone, can be used for patient education.[13] Mobile phone technology can be used to promote health, prevent disease spread, improve self-management, provide medical counseling, and provide medication reminders.[14] The widespread use of mobile phone for health-related purposes has resulted in the development of a term called mobile health, which involves the use of various mobile phone features such as text and video messaging, voice calling, and Internet-based messaging in health-care delivery.[15] Studies showed that this technology helped to reduce the annual maternal and neonatal deaths by 40,000 in Bangladesh, 75,000 in India, and 290,000 in Pakistan and can help to treat tuberculosis by 50,000 cases in Russia, 40,000 cases in Thailand, and 10,000 cases in Malaysia.[16] Moreover, this technology has reduced the annual cost of care delivery to elderly people by around five million Euros in Europe.[16]

Text messaging is one of the features of mobile phones. As a simple and inexpensive feature, text messaging is available on all mobile phones. Its use is simple and does not need extraordinary skills, and hence, it can be used for different health-care-related purposes. Studies showed that text messaging through mobile phones has significant effects on primary health outcomes,[17] outpatient service management,[17,18] smoking cessation,[18,19] management of medication side effects,[9,17] and improvement of medication use by patients with physical and behavioral problems.[9,17-21] It also has beneficial effects on medication use among patients with chronic conditions such as diabetes mellitus, chronic renal failure, thalassemia major, and valvular heart disease.[22,23] Yet, there are controversies over the effects of text messaging through mobile phones. For instance, a systematic review reported that three studies found interventions based on short message service (SMS) effective in improving HTN management, while three studies found its insignificant effects on HTN management.[24] Moreover, a study found that although an automated adherence support program based on text messaging could reduce blood pressure among adults with HTN, there was no evidence that an interactive intervention can also produce this effect.[25] Besides, most previous studies into the effects of text messaging on HTN outcomes used questionnaires such as the Morisky Medication Adherence Scale and Brief Medication Questionnaire for adherence assessment. These instruments solely measure adherence to medications and provide no information about the other aspects of treatment adherence.[26] Moreover, adherence-related interventions in previous studies were mostly implemented in short periods of time.[17,19,20,27] In addition, previous studies did not compare the effects of interactive and noninteractive text messaging on HTN outcomes. Consequently, the present study was designed and conducted to address these gaps.

Objectives

The aim of this study was to compare the effects of interactive and noninteractive SMS (NISMS)-based education on treatment adherence and blood pressure among patients with HTN.

Methods

Design and participants

This randomized controlled clinical trial was conducted with a single-blind pretest–posttest design from December 25, 2017, to May 22, 2019. Participants were adult patients with HTN who were consecutively recruited from a military hospital in Tehran, Iran. Inclusion criteria include clinical diagnosis of HTN, use of antihypertensive medications for at least 1 month, systolic blood pressure (SBP) of 140–220 mmHg, diastolic blood pressure (DBP) of 90–120 mmHg, age of 35–64 years, ownership of or daily access to a mobile phone, ability to read and send SMS messages, residence close to the study setting with no intention to change the place of residence during the study, no comorbid conditions which necessitated the use of medications other than antihypertensive medications, no use of complementary therapies for HTN management, no affliction by known heart diseases (such as myocardial infarction), dementia, memory impairments, mental and psychological problems, end-stage liver or kidney diseases, or cancer, and willingness to participate in the study. Exclusion criteria were changes in antihypertensive medications by the prescribing physician, unwillingness to stay in the study, pregnancy, or breastfeeding during the study.

The sample size was calculated based on the results of a former study which showed that SMS-based education improved treatment adherence among patients with prosthetic heart valves from 52.13 ± 4.45 to 56.53 ± 3.5. Then, with a type I error of 0.05, a type II error of 0.1, a S_1 of 4.45, a S_2 of 3.5, a $\mu 1$ of 56.53, and a $\mu 2$ of 52.13, the sample size for each study group was estimated to be 17 [Figure 1]. Considering a probable attrition rate of 20%, the sample size was increased to 21 in each group to produce more reliable results.

In total, 63 eligible patients were recruited and randomly allocated to three 21 person groups, namely an interactive SMS (ISMS), a NISMS, and a control group. Randomization was done through dice throwing. Numbers 1 and 2 on the dice were related to the ISMS group, numbers 3 and 4 were related to the NISMS group, and numbers 5 and 6 were related to the control group. Dice throwing was done by a research assistant, the only person who was aware of the allocation codes. A cardiologist supervised the sampling process.

Instruments and data collection

The study data were collected using a personal characteristics questionnaire, a sphygmomanometer, and the Persian version of the Treatment Adherence Questionnaire for Patients with Hypertention (TAQPH). TAQPH was developed by Ma *et al*.[28] and translated into Persian and validated by Dehghan *et al*.[26] We obtained permission for using TAQPH from both Ma *et al*. and Dehghan *et al*. The questionnaire consisted of 23 items in four dimensions, namely medication adherence and HTN monitoring (eight items), adherence to dietary regimen (ten items), physical exercise (two items), and smoking cessation (three items). Items were scored from 1 ("Never") to 5 ("Always"), resulting in a total score of 23–115. Scores 86 and higher indicate good treatment adherence. The validity and reliability of this questionnaire were approved in a former study, with a Cronbach's alpha of 0.95 and a test–retest correlation coefficient of 0.74.[26] Treatment adherence was measured before and 4 months after the onset of the study intervention.

Blood pressure was measured using an electronic sphygmomanometer (BM16, Germany) via the right arm and in the sitting position. Blood pressure of each patient was measured twice between 08:00 and 12:00 with a 10-min interval, and then, the average value of the two measurements was documented. To evaluate the reliability of the sphygmomanometer, its readings were compared with the readings of an aneroid sphygmomanometer (E-Mega, Germany). The difference between the two readings was not statistically significant. All participants were asked to avoid caffeine intake and smoking 30 min before blood pressure measurement. Blood pressure measurement was performed monthly for 4 consecutive months, i.e., four times in total.

Intervention

All patients in all groups were individually trained in a 45-min session through a lecture and received a booklet about dietary and medication regimens, physical exercise, blood pressure monitoring, stimulations, weight control, and stress management. Based on the primary need assessment, each patient in the ISMS and NISMS groups determined some behavioral goals and wrote one or more operational plans in collaboration with the first author. The mobile phone numbers of patients in the intervention groups were taken, and were trained on how to use the SMS feature on their phones, and the charge-free SMS delivery report option was activated on their phones. Then, four educational SMS messages were weekly sent to each patient in both intervention groups during the 4-month course of the study intervention, i.e., 64 messages in total. Messages were related to dietary regimen, medications, stimulants (such as caffeine, alcohol, and tobacco), physical exercise, weight control, and stress management. Examples of the messages were as the following: "In adults, normal blood pressure is 120/80 mm Hg." "Symptoms of high blood pressure

include headache, visual problems, dizziness, chest pain, flushed face, nosebleed, and warmth at the sole, though it may be asymptomatic." "Losing 4.5–9 kilograms of weight reduces the risk of heart disease." The length of each message was <140 Persian characters. The validity of the educational booklets and SMS messages was confirmed by the instructors of a faculty of nursing and midwifery and several cardiologists in Tehran, Iran. Unlike participants in the NISMS group, their counterparts in the ISMS group were provided with the opportunity to communicate with the first author to ask their questions from 08:00 to 22:00. Each patient in the ISMS group was expected to communicate with the first author at least twice a month. In the absence of any contact during a month, the first author contacted the intended patient to remember him/her of blood pressure monitoring and asked him/her to respond. At the end of the 4-month course of the study intervention, all participants were invited to complete TAQPH. After the posttest, all messages were provided to participants in the control group.

Ethical considerations

This study was approved by the Institutional Review Board and the Ethics Committee of AJA University of Medical Sciences, Tehran, Iran (code: IR.AJAUMS.REC.1396.90) and was registered in the Iranian Registry of Clinical Trials (code: IRCT20190120042423N1). Participants were informed about the study aims and their individual informed consents were obtained. The authors attempted to closely adhere to the ethical principles of research on humans outlined in the Declaration of Helsinki as well as the principles set by the Committee on Publication Ethics for publishing the results. They also ensured participants about their rights to refuse participation or to voluntarily withdraw from the study, confidential management of the study data, and no harmful effects of the study intervention.

Data analysis

Data were analyzed using the SPSS software v. 16.0 (SPSS Inc, Chicago, IL, USA). The measures of descriptive statistics (such as mean, standard deviation, frequency, and percentage) were used for data description. The one-way analysis of variance (ANOVA) and the Chi-square or the Fisher's exact test were used to compare the groups in terms of numerical and categorical variables, respectively. The paired-sample *t*-test was used for within-group comparisons respecting the mean score of treatment adherence, while the repeated-measures ANOVA was used for within-group comparisons respecting the means of SBP and DBP across the four measurement time points. The effect size of the study intervention was calculated through the Cohen's method. The level of significance was set at <0.05.

Results

In total, 63 patients with HTN participated in this study [Figure 1]. No statistically significant differences were found between the groups in terms of participants' personal characteristics [$P > 0.05$; Table 1].

The pretest mean score of treatment adherence in all the three groups was <86, and the results of the one-way ANOVA showed no significant difference among the groups respecting this mean score ($P = 0.76$). However, the between-group difference respecting the posttest mean score of treatment adherence was statistically significant [$P = 0.004$; Table 2].

The results of the paired-sample *t*-test showed that in the ISMS group, the posttest mean score of treatment adherence was significantly greater than the corresponding pretest mean score ($P = 0.003$). However, the mean score of treatment adherence did not significantly change in the NISMS ($P = 0.15$) and the control ($P = 0.16$) groups [Table 2].

One-way ANOVA showed no significant differences among the groups respecting the mean of SBP in the 1st ($P = 0.44$), 2nd ($P = 0.22$), 3rd ($P = 0.26$), and 4th ($P = 0.42$) months of the study intervention as well as respecting the mean of DBP in the 1st ($P = 0.12$), 3rd ($P = 0.05$), and 4th ($P = 0.26$) months of the study intervention. However, the difference among the groups respecting DBP was statistically significant in the 2nd month of the intervention [$P = 0.02$; Table 2].

The repeated-measure analysis showed that the means of SBP and DBP significantly reduced across the four measurement time points in both the intervention groups ($P < 0.05$), while it did not significantly change in the control group [$P > 0.05$; Table 2 and Figures 2 and 3]. The interaction of time × group was statistically significant for both SBP ($P = 0.016$) and DBP ($P = 0.024$). However, there were no significant differences among the groups respecting the variations of SBP ($P = 0.430$) and DBP ($P = 0.099$) across the four measurement time points [Table 2].

Based on the Cohen's method, the effect sizes of ISMS and NISMS on treatment adherence were 0.12 and 0.3, respectively. Moreover, the effect sizes of ISMS on SBP and DBP were 0.12 and 0.21, respectively, and the effect sizes of NISMS on SBP and DBP were 0.05 and 0.1, respectively.

Discussion

Before the intervention, treatment adherence in all the three groups was poor. Earlier studies showed that

more than half of cases of treatment nonadherence were due to patients' misunderstanding about the barriers to and the benefits of treatment adherence.[5,17,21,27,29] The baseline treatment adherence in the present study was better than treatment adherence in some of the earlier studies.[21,27,30] This discrepancy can be attributed to the fact that the present study focused on the different aspects of treatment adherence such as medications, stimulation, weight control, physical exercise, and social support. Patients' perceived social support has significant effects on the different aspects of their treatment adherence.[10,31,32] Moreover, our findings showed no significant difference among the groups respecting the pretest mean score of treatment adherence. This is in line with the findings of several studies[21,27,29] and contradicts the findings of another study.[30] This contradiction may be due to the differences in the population and treatment adherence measurement instruments of the studies.

We also found a significant difference among the groups respecting the posttest mean score of treatment adherence. This is in line with the findings of several earlier studies[19,21,27,29] and contradicts the findings of another study.[30] Moreover, our findings showed that the mean score of treatment adherence in the ISMS group significantly increased after the study intervention, while it did not significantly change in the NISMS and the control groups. Several earlier studies also reported the same finding.[21,27,29,30] These findings imply that noninteractive text messaging is ineffective in promoting treatment adherence, while interactive text messaging can motivate patients for treatment adherence. It seems that ISMS is more effective in reminding patients of self-care activities, sensitizing them to treatment adherence, and motivating them for closer treatment adherence. Furthermore, when patients are asked to submit new questions or problems as text messages, they are also more likely to read messages. Having a two-way interaction gives them the sense that members of the treatment team took care of their health and they have a special value that can be attributed, together with the frequent follow-up of the nurse, to the effective factors in treatment adherence of patients.

Our findings also showed that the effect sizes of ISMS and NISMS on treatment adherence were small and medium, respectively. Due to the effect sizes of ISMS and NISMS on treatment adherence, it seems that the higher sample and the longer course of a study are needed to detect significant changes in the promotion of treatment adherence among patients. It is also recommended to use other interventions with ISMS and NISMS.

Other studies also showed that training can significantly promote treatment adherence among patients with HTN.[33,34] Another study found that SMS-based reminders about medications increased treatment

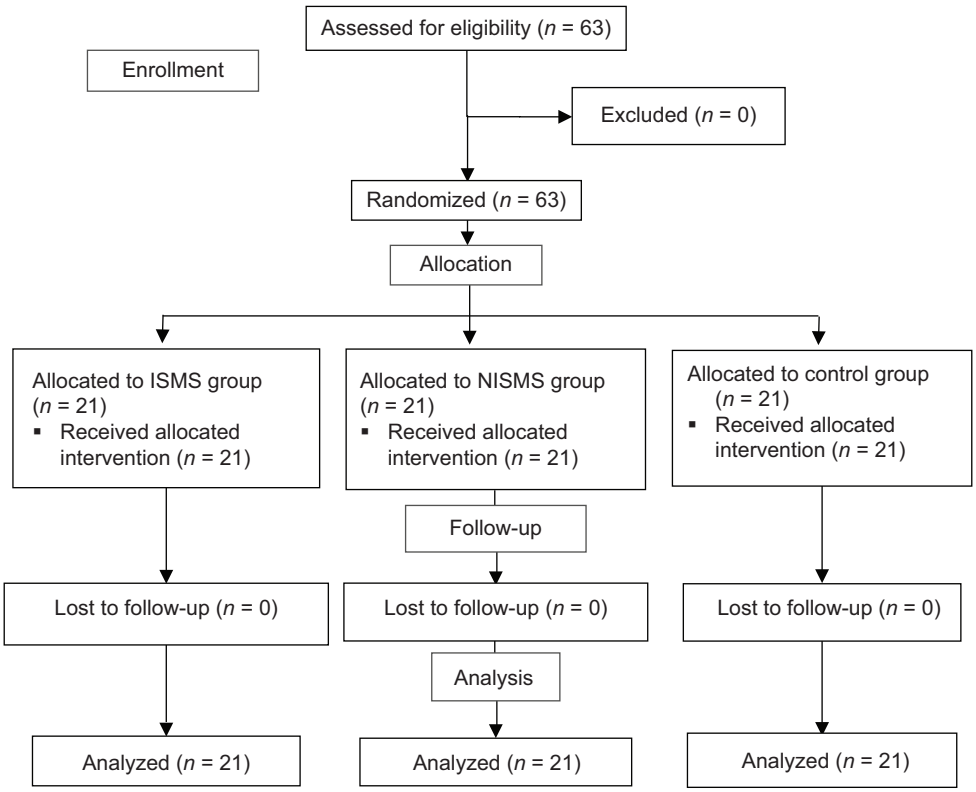

Figure 1: The flow diagram of the study

Table 1: Comparing the groups respecting participants' personal characteristics

Characteristics	Group[a]			*P*
	ISMS	NISMS	Control	
Gender				
Male	10 (47.6)	10 (47.6)	10 (47.6)	0.99[b]
Female	11 (52.4)	11 (52.4)	11 (52.4)	
Marital status				
Single	2 (9.5)	0 (0)	0 (0)	0.11[c]
Married	17 (81)	20 (95.2)	19 (90.5)	
Divorced/widowed	2 (9.5)	1 (4.8)	2 (9.5)	
Occupation				
Unemployed/laborer	0 (0)	0 (0)	0 (0)	0.36[c]
Employee/self-employed	2 (9.5)	2 (9.5)	0 (0)	
Retired	6 (28.6)	5 (23.8)	4 (19)	
Housewife	6 (28.6)	10 (47.6)	10 (47.6)	
Military staff	7 (33.3)	4 (19)	7 (33.3)	
Educational level				
Lower than high school	4 (19)	3 (14.3)	9 (42.9)	0.22[c]
High school diploma	11 (52.4)	14 (66.7)	8 (38.1)	
Academic degrees	6 (28.6)	4 (19)	4 (19)	
Insurance status				
Armed forces insurance	16 (76.2)	14 (66.7)	16 (76.2)	0.82[b]
Others	5 (23.8)	7 (33.3)	5 (23.8)	
Number of antihypertensive medications				
One	12 (57.1)	4 (19)	9 (42.9)	0.09[b]
Two	5 (23.8)	9 (42.9)	9 (42.9)	
Three or more	4 (19)	8 (38.1)	3 (14.3)	
Age (years)	54.71 ± 6.11	55.95 ± 6.1	56.71 ± 5.73	0.55[d]

[a]Data presented as *n* (%) or mean ± SD, [b]The results of the Chi-square test, [c]The results of the Fisher's exact test, [d]The results of the one-way ANOVA. SD: Standard deviation, ANOVA: Analysis of variance, SMS: Short message service, ISMS: Interactive SMS, NISMS: Non-ISMS

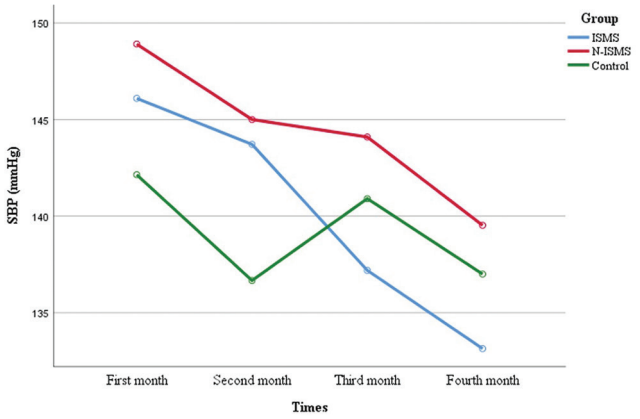

Figure 2: Systolic blood pressure variations in all the three groups across the four measurement time points

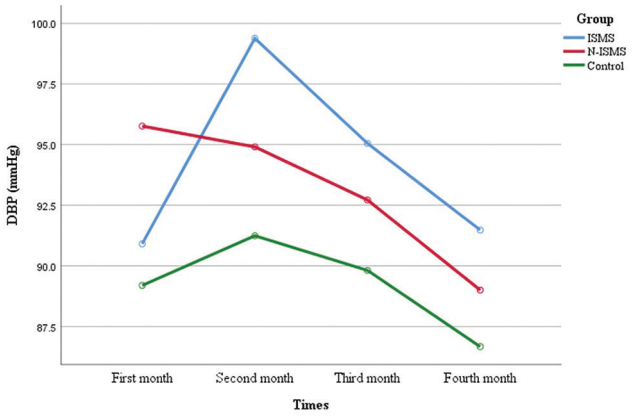

Figure 3: Diastolic blood pressure variations in all the three groups across the four measurement time points

adherence rates from 30% to 49%.[20] Several other studies also showed that SMS-based reminders about medications significantly improved treatment adherence.[17,19,20,27] All these findings are in line with the findings of the present study and highlight the importance of continuous reminders, particularly through simple strategies such as SMS messages, for the promotion of treatment adherence.

The results of the present study also showed no significant differences among the groups respecting the baseline SBP and DBP. However, we found the significant effects of the time factor and also the interaction between time and the intervention in terms of SBP and DBP, while the effects of the group factor on SBP and DBP were not statistically significant, and the trends of SBP and DBP variations in both the intervention groups were almost

Table 2: Within-and between-group comparisons respecting the mean score of treatment adherence and the means of systolic blood pressure and diastolic blood pressure

Variable/time	Groups[a]			*P*[b]
	ISMS	NISMS	Control	
Treatment adherence				
Before	81.43 ± 9.15	81.14 ± 7.21	83.38 ± 14.43	0.76
After	89.67 ± 4.47	83.24 ± 7.18	87.86 ± 6.62	0.004
Test results[c]	0.003	0.15	0.16	
SBP (mmHg)				
First month	146.1 ± 16.7	148.9 ± 17.13	142.14 ± 17.01	0.44
Second month	143.71 ± 18.79	145 ± 11.92	136.67 ± 17.71	0.22
Third month	138.19 ± 16.2	144.1 ± 9.07	140.9 ± 14.06	0.26
Fourth month	133.14 ± 14.52	139.52 ± 9.79	137.71 ± 20.9	0.42
Test results[d]				
Time factor	<0.001	0.02	0.27	-
Time × group		Pillai's trace=0.245, *F*=2.739, *P*=0.016		
Group		*F*=0.856, df=2, *P*=0.430		
DBP (mmHg)				
First month	90.9 ± 9.18	95.76 ± 9.54	89.19 ± 12.56	0.12
Second month	99.38 ± 10.91	94.90 ± 6.32	91.24 ± 10.3	0.02
Third month	95.05 ± 7.84	92.71 ± 5.87	89.81 ± 6.63	0.05
Fourth month	91.48 ± 5.72	89 ± 5.97	86.67 ± 13.97	0.26
Test results[d]				
Time	<0.001	<0.001	0.31	-
Time × group		Pillai's trace=0.228, *F*=2.528, *P*=0.024		
Group		*F*=2.409, df=2, *P*=0.099		

[a]Data presented as mean ± SD, [b]The results of the one-way ANOVA, [c]The results of the paired-sample *t*-test, [d]The results of the repeated-measure analysis. SD: Standard deviation, ANOVA: Analysis of variance, SMS: Short message service, ISMS: Interactive SMS, NISMS: Non-ISMS, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

similar to the trends in the control group. These findings denote that the study interventions were not effective in significantly reducing SBP and DBP. Similarly, a study showed that neither ISMS nor NISMS interventions were effective in significantly reducing blood pressure among patients with HTN.[25] These findings indicate that these patients need continuous education and follow-up. The effect sizes of the ISMS intervention on SBP and DBP were 0.12 and 0.21, respectively, while the effect sizes of the NISMS intervention on SBP and DBP were 0.05 and 0.1, respectively. These effect sizes imply that the ISMS and the NISMS interventions had low effects on blood pressure among patients with HTN. The sample size of the study might have been inadequate to produce larger effect sizes. This highlights the need for randomized controlled trials with larger samples and longer duration to produce firmer evidence regarding the effects of interactive and NISMS-based education on blood pressure among patients with HTN.

The limitations of the present study included the short course of its intervention, its small sample size, and our inability to check whether participants read and understood our SMS messages. Given the limitations of the present study, studies on the impact of using social networks and media or other SMS-based interventions on treatment adherence of patients with chronic diseases with a larger sample of the study and the longer course of the study are recommended.

Conclusion

This study concludes that ISMS-based education is effective in significantly promoting treatment adherence among patients with HTN, while NISMS-based education has no significant effects on treatment adherence. Moreover, neither interactive nor NISMS-based education is effective in significantly reducing SBP and DBP among patients with HTN. SMS-based text messaging is simple and easy to use, does not need sophisticated equipment, and can be used everywhere and every time. Nurses and other health-care providers can use the results of this study to improve treatment outcomes among patients with HTN. Yet, further studies with larger samples and longer durations are recommended to produce more conclusive evidence respecting the effects of interactive and NISMS-based education and other types of media-based education on treatment adherence and blood pressure among patients with HTN.

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Conflicts of interest

There are no conflicts of interest.

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