Effect of SMS Reminders to Medication Adherence among Hypertensives in an Outpatient Clinic: A 12-week Two-arm, Parallel Group Randomized Clinical Trial

Penny Joy H. Barbadillo, RN, MD; Yahya-Mar M. Alip, RN, MD, DFM and Hans Mathew Lua, RN, MD, DFM

Background: There has been a growing prevalence of hypertension and its associated diseases. Medication adherence is one of the primary factors of uncontrolled blood pressure in patients and non-adherence to medication can result in morbidity and mortality for the patient and increased financial strain on the healthcare system. With the wide availability of mobile phones, using short messaging system (SMS) reminders as an intervention has shown promising results in improving medication adherence. The present study aims to see if SMS reminders can help improve medication adherence among hypertensive patients seen in the out-patient department.

Objective: To determine the effect of short messaging system reminders on the medication adherence among hypertensive patients seen in the outpatient department of Cebu South Medical Center (CSMC) in a 12-week trial period.

Methods: This was a two-arm parallel group, double blind, randomized clinical trial using short text messaging reminder to hypertensive patients conducted last October 4, 2023 to December 27, 2023 at CSMC Outpatient Clinic under Family Medicine Service. A two-part questionnaire composed of baseline clinical variables and the Hill-bone Medication Adherence Scale (HB-MAS) (Kim, et al 2000) was utilized pre- and post-intervention. STATA Software was used to analyze the date with intention to treat analysis. Descriptive statistics was computed for dichotomous variables while continuous variables were expressed as means and measured before and after intervention. The mean HB-MAS scores pre-intervention and post-intervention per group were compared using the Wilcoxon signed rank test, while scores between intervention and control groups pre- and post-intervention were analyzed using the Wilcoxon rank-sum test with 95% confidence intervals (CIs), with two-sided p values reported and statistical significance set up at $p < 0.05$.

Results: A total of 102 patients were enrolled in the study (51 in intervention group and 51 in control group) with no dropouts. There was no significant difference between the baseline and post-intervention medication adherence scores in both the intervention and control groups, however, there was a significant difference of the scores between the intervention and control groups post-intervention ($p = 0.001$). There was also noted improvement of the blood pressure among participants in the intervention group, with lower blood pressures post-intervention on average (120/80 mmHg) compared to baseline (130/90 mmHg), while participants in the control group still exhibited high blood pressure (130/90 mmHg) post-intervention.

Conclusion: Given the widespread availability of mobile devices and the increased awareness generated by social media, it may be easier to put interventions in place that improve drug adherence. Through the use of easily accessible technology, this study helps patients remember to take their prescription by offering straightforward reminders that can help them overcome these obstacles to medication adherence.

Key words: Medication adherence, Hill-Bone Medication Adherence Scale, short messaging system (SMS) reminders

INTRODUCTION

The growing prevalence of hypertension around the world, particularly in low- and middle-income nations, has placed a significant strain on the healthcare system. The WHO estimates that 1.2 billion people globally, between the ages of 30 and 79, have hypertension; most of these people, or two thirds, reside in low- and middle-income nations.[1] It was noted by the Philippine Heart Association that hypertension was a leading cause of cardiovascular disease[2], and last 2022, ischemic heart disease accounted for 38,707 deaths or 18.6% of all deaths in the nation with cerebrovascular diseases coming in second with 21,602 deaths, or 10.4% of all deaths. In Central Visayas last 2020, the morbidity rate of hypertension was 130.6 per 100,000 people.[3] Uncontrolled blood pressure poses serious risks and challenges and can be attributed to inadequate compliance with antihypertensive medication, a poor diet heavy in salt and cholesterol, and inactivity.[4-6]

One of the most important aspects of managing and preventing cardiovascular disease is medication[6], however, several studies noted prevalence to medication non-adherence was note to be high, especially in resource-limited settings[6], and in Asian nations with low and lower middle incomes.[7] Ten percent of hospital admissions among older adults are related to pharmaceutical non-adherence, which places a significant financial strain on health care systems.[8] According to Thakkar, et al.[9], it is also linked to a rise in the need for medical interventions, an increase in morbidity and mortality, an increase in the expense of healthcare, and repeated hospitalization. Medication remains an affordable therapeutic option, and compliance with these medications offers the chance to improve health outcomes and the efficiency of the healthcare system, despite estimates indicating that 50% of adult patients with chronic illnesses do not adhere to long-term therapy.[8] Adherence-improving treatments may have a greater influence on a population's health than any progress in a specific medical treatment. Practical innovations that help patients take their medications as prescribed are much sought after, as are straightforward strategies to deal with medication non-adherence in clinical settings.[9-10] Behavioral counseling, phone follow-up, home visits, patient education, and self-management treatments including self-care and self-monitoring are examples of interventional techniques that increase medication adherence.[10-11]

In the past years, the use of mobile phones has been widely integrated into daily life, with a projected increase in the number of smartphone users in the Philippines between 2024 and 2028 by a total of 11 million.[12] This may provide an opportunity to use the wide availability of mobile phones as a practical intervention to help improve medication adherence, with several studies on addressing adherence to medication and other interventions among patients with other diseases such as diabetes, cancer, showing varying levels of success.[13-19] Studies on enhancing medication adherence among hypertensive medications using text messaging technology show promising results, with most studies showing a positive effect on adherence and even on clinical outcomes.[20-26]

While there have been studies to determine factors affecting medication adherence among hypertensive patients in the Philippines,[27] there have been no published studies looking into the use of short messaging system (SMS) to improve medication adherence, hence this study aims to see whether providing simple reminders using SMS to hypertensive patients seen in the outpatient department of a healthcare facility can help increase their medication adherence. The study's main objective was to determine the effect of short messaging system reminders on the medication adherence among hypertensive patients seen in the outpatient department of Cebu South Medical Center in a 12-week period. Specifically, it also aimed to measure baseline and post-intervention clinical characteristics such as blood pressure, height, weight, basal metabolic index (BMI), and Waist & Hip Circumference Ratio (WHC) and to compare baseline and post -intervention medication adherence scores using the Hill-bone Medication Adherence Scale (HB- MAS) among study participants between the two treatment arms.

METHODS

Study Design

This study was a two-arm, parallel group, double blind, randomized clinical trial. Hypertensive patients who consulted at CSMC Family Medicine Outpatient Service were recruited during a 2 - week recruitment period. Participants were then equally randomly assigned to either the intervention group or control group. Both groups received short messaging system (SMS) for 12 weeks. However, the treatment groups' SMS contain message based on hypertension management recommendations from American Heart Association while the control group contain general knowledge.[4] Baseline and post – intervention clinical characteristics and Hill-bone Medication Adherence Scale (HB- MAS) were measured, compared and analyzed using STATA software.

Study Setting

This study was conducted at the Cebu South Medical Center, a Level III, 210-bed capacity healthcare facility located in San Isidro, Talisay City, Cebu Province. The institution provides out-patient services with its out-patient department that operates from Mondays to Fridays from 8:00am to 5:00pm. Different specialties and subspecialties provide services to patients seeking consult including Family Medicine Service. Participant recruitment started from September 18, 2023 to October 3, 2023. The 12-week SMS Intervention started from October 4,2023 to December 27,2023. Data collection post – intervention and analysis were done from December 27, 2023 to January 5,2024.

Study Participants

Adult patients aged 18 years old and above who are hypertensive patients clinically diagnosed using the 8th Joint Nation Committee on Hypertension, able to read or living with someone that can read for them, with working mobile phone and mobile number and has been taking anti-hypertensive medications for at least 1 month regardless of number of hypertensive medications, were recruited to participate in the study. Exclusion Criteria included severe mental illness, pregnant patients, post-partum patients (within 3 months after delivery), unable

to take their medications on their own due to physical disability, deaf patients, blind patients and patients with unstable condition at initial consult or referred to emergency room for admission.

A period of two weeks was done for patient recruitment employing the simple random sampling without replacement, which enrolled a total of 102 hypertensive patients. Hypertensive patients who sought consult at CSMC Family Medicine Outpatient Service were asked to participate in the study and informed consent was taken. Once with consent, the study participant was enlisted in the study population.

Randomization

Patient enrollment in the trial was done by the researchers. After enrollment, a third party was contacted by the researchers that conducted randomization and patient assignment to either treatment or control group. Randomization was done using the table of random numbers generated using Microsoft Excel, with each participant assigned to a corresponding random number or code. Study participants were then randomly assigned to either the intervention group or control group using the odd and even numbers as basis for determining which group they belong. Participants with odd numbers were then assigned to the control group while participants with even numbers were assigned to the intervention group. Study participant allocation and assignment to either treatment or control group was concealed to both the participant and the researchers.

Data Collection Tool

The study utilized a 2 – part questionnaire. The first part of the tool was about baseline variables in terms of systolic blood pressure and diastolic blood pressure, height, weight, hip, and waist circumference. The researcher collected these baseline variables and computed for the baseline Body Mass Index (BMI) and Weight for Height Ratio (WHR). The second part of the tool assessed baseline adherence to anti-hypertensive medications using the Hill-Bone Medication Adherence Scale.[10,11] This is a validated 9-item scale that assessed the respondent's medication adherence using a Likert scale with a 4-point response: (4) all the time, (3) most of the time, (2) some of the time, and (1) never. The total possible score is 36 points with the lowest score at 9. Scores more than 9 indicate non-adherence and higher scores indicate further non-adherence.[29]

The Hill – bone medication adherence scale (HB-MAS) tool was translated into the vernacular by a professional linguist then translated back to English by a lay person. Pilot testing was done prior to utilization of tool in the trial, with a total of 30 hypertensive patients included. These respondents were excluded from total study population. Criterion-related validity and reliability testing was used in to validate the adapted questionnaire to be used. Criterion-validity testing was done to evaluate accurately how the adapted HB-MAS questionnaire measures outcome set to a criterion being the standardized HB-MAS questionnaire. Results showed that scores had close dispersion for each item, indicated by the p-value of less than 0.05 per item. This indicates good criterion validity for all items in the questionnaire.

Validity Test:

Item No.	Test Statistics	p-Value
1	0.738	0.000**
2	0.568	0.001**
3	0.753	0.000**
4	0.547	0.002**
5	0.770	0.000**
6	0.664	0.000**
7	0.778	0.000**
8	0.763	0.000**
9	0.715	0.000**

*significant at α=0.05
**significant at α=0.01

Reliability testing revealed a Cronbach's alpha of 0.863 indicating a high level of internal consistency and thus, acceptable reliability. The results also showed that removal of any question would result in a lower Cronbach's alpha. Therefore, all questions were retained.

Reliability Test:

Cronbach's Alpha = 0.863 No. of Items = 9	
Item	Cronbach's Alpha If Item Deleted
1	0.843
2	0.861
3	0.844
4	0.861
5	0.839
6	0.852
7	0.839
8	0.842
9	0.846

Intervention

At the start of the trial, baseline clinical characteristic variables in terms of blood pressure, weight, height, basal metabolic index and hip-waist ratio and baseline mediation adherence using Hill-bone mediation adherence scale were taken from all participants. Each participant enrolled 2 existing mobile numbers (1 of the participant's and 1 of a significant other currently living with the participant of the study). Those not capable of using mobile phones were allowed to have a legally authorized representative. Both the intervention and control groups received standard of care SMS at the same days 3 times a week (Monday – Wednesday – Fridays), with the same average message length at 160 characters. The SMS received by the intervention contained hypertension management recommendations from American Heart Association emphasizing on: a) general patient education information (hypertension and its treatment, complications and symptoms and

signs, common side effects of medications, medications, consequences of non-adherence, physical activity, diet low in fat and salt; b) reminders for taking medications; and c) smoking and alcohol related messages. The SMS received by the control group contained messages on general knowledge/information not related to hypertension management, such as: a) the weather forecast today will be a rainy day; b) make sure to be ready with your umbrellas and raincoat; c) wear boots in case of flood; among others. Details of the content of messages sent to both groups are described in detail in the (Tables 1 & 2). All patients in both groups were prescribed anti-hypertensive medications based on their needs. The conduct of sending text messages was done by a third party hired by the researchers. To ensure that messages were received by the study participant, the researchers required each participant to reply after receiving the message as form of acknowledgement. Failure to respond for more than or equal to 3 times were automatically dropped out from the study.

Table 1. Sample text messages for medication adherence for anti-hypertensive drugs (Adapted from Bhandari et al,2022).

Barriers/ Facilitators	Linking with BCTs	Context of text message	Unod sa text message
Capability barriers Literacy of Hypertension and its treatment	Shaping Knowledge	1. Do you know? You may have no symptoms and still have high blood pressure. Remember to take your medicines regularly.	1. Nakahibaw baka? Nga posibli nga naa nakai high blood pressure bisag wala kai mga simptomas. Hinumdumi sa pag tomar sa imung mga tambal permaninti.
	Health Consequences	2. Do you know? Uncontrolled Blood pressure which is above 140/90 puts you in danger of having complications. Remember to check your BP regularly.	2. Nakahibaw baka? Nga ang wala ma control nga blood pressure sobra sa 140/90 makabutang nimu sa peligro nga sitwasyon kung diin adunay mga kumplikasyun. Hinumdumi sa pag tan-aw sa imung BP permaninti.
Motivation barriers/facilitators Beliefs about consequences of diseases Faith in traditional medicine/ Local herbs	Threat Negative reinforcement	1. Uncontrolled High blood pressure can lead to heart attack, paralysis, vision problems and kidney failures so take your medicine regularly.	1. Ang wala ma kzontrol nga taas nga blood pressure mu pa-ingon sa ataki sa kasing-kasing, paralysis, problema sa mga mata ug pagka hagba sa kidney. Tumaron ang inyung tambal permaninti.
	Shaping Knowledge	2. Do not rely on local remedies like bitter things to control your blood pressure. There are no other supplements to blood pressure medications. You must take medicine if your doctor prescribed it.	2. Ayaw pag salig sa mnga lokal nga alibyu pareha anang mga pa-it nga butang para ma control ang inyung blood pressure, walai la-in nga supplemento sa blood pressure nga tambal. Mu tumar gyud ka ug tambal kung gi resita sa imung doctor.

Capability/Opportunity /Motivation/Barriers Nonadherence	Reinforcement Shaping knowledge/Emotional consequences	1. Are you taking your medicine regularly? Remember! NEVER change your medication or stop taking your medication unless the doctor tells you to.	1. Permaninti kaba nag inum sa imun tambal? Hinumdumi ni, ayaw gyud ilisi o undangi sa pag inum sa imung tambal kung dili ka sultian sa imung doctor.
	Prompts/Cues	2. If you are not sure you really need your blood pressure medicine, ask your doctor to explain the reasons why it was prescribed.	2. Ug dili ka sigurado nga kinahanglan nimu imung tambal pagpa esplikar sa imung doctor nganung gi resitahan ka aning tambala.
	Habit formation	3. Try putting your pillbox or bottles near something to see every day, like your toothbrush to help remember to take your blood pressure medication!	3. Ibutang ang kahon o botilya sa imung tambal ug lugar nga humok nimu makit-an para maka tabang nimu ug hinumdum sa pag tumar sa imung tambal kada adlaw.
		4. Do you know? You can set an alarm on your mobile phone to remind you to take medications.	4. Nakihibaw baka nga pwedi nimu mapa himutang ang imung celpon nga mu alarma para papahinumdum sap ag inum sa imung tambal.
Opportunity/motivation barriers Unhealthy dietary habits (Cultural practices)	Shaping knowledge	1. Do you know? Smoking, drinking alcohol,eating unhealthy food (High salt and high fat food), little exercise and being mentally stressed puts you in danger of high blood pressure.	1. Nakahibaw baka nga ang pag panigarilyo, pag inum ug ilimnung maka-hubog, pag kaon ug maka daot sa lawas sama sa parat ug tambok, gamay nga ehersisyo ug estress posibling maoy makapa taas sa imung blood pressure.

Resistance in behavior modification /	Self- monitoring of behavior	2. Did you exercise this week? Aim at exercising 30 minutes / day at least five times per week	2. Nag ehersisyo ka karung semanaha? Paninguha-a ug ehersisyo treynta ka minutos ka lima sa usa ka semana.
	Goal setting	**Salt intake**: Foods high in sodium(salt) can increase your blood pressure. Try to limit your sodium intake to 5g/day, including what is in and what is added to food.	**Pagkaon nga parat**: Ang mga pagkaon nga daghan ug asin , makapa taas sa imung blood pressure. Suwayi sap ag limita sa imung konsumo sa Sodium /asin sa lima ka gramo kada adlaw, apil sa gi timpla ug naa na daan sa imung pagkaon.
	Shaping Knowledge	**Festive food:** Please remember to enjoy the festival limiting food with high salt and high fat which will affect your blood pressure.	**Pagkaon sa pista**: Palihug ug kahinumdum sa paglingaw-lingaw pero limitahi ang pag konsumo sa mga pagkaon nga daghan ug asin ug tambok nga maka apektar sa imung blood pressure.
		Physical Activity: Moderate physical activity of 30 minutes can make your blood pressure medications work more efficiently and reduce your blood pressure. Try a 30- minute brisk walk or three 10-minute walks	**Pisikal nga aktibidades:** Igo -igong pasingot nga traynta minutos mas maka epektibo sa imung mga tambal ug maka pa ubos sa imung blood pressure. Suwayi ang treynta minutos paspas nga lakaw o tulo ka tag diyes minutos nga lakaw.
	Reinforcements	Don't feel ashamed in disclosing your high blood pressure status. Please disclose yours and encourage others to disclose for the timely diagnosis and seek treatment to prevent the complications.	Ayaw ka ulaw sa pagpa hibaw sa imung high blood pressure nga estado. Pagpahibaw sa imung estado ug awhaga ang uban mga magpahibaw para malikayan ang komplikasyon.
		Don't worry! If you have high blood pressure, it does not mean you are ill or weak. If you can keep the blood pressure under control (< 140/90) then it will not harm you.	Ayaw kabalaka ug naa kay high blood pressure, dili buot ipa sabot nga masakiton o huyang ka. Ug pwedi nimu ma kontrol ang blood pressure nimu ubos sa 140 /90 dili ni makadaut nimu.

Table 2. Sample text messages for general knowledge text messages for control group.

Weather	
English	**Bisayan Translation**
1. We will be having a Sunny day today, don't forget to bring your umbrellas and drink water to keep hydrated!	1. Hayag ug init ang atoang adlaw karun, ayawg kalimot ug sa pagdala ug payong ug inum ug tubig para dili ma- uhawan.
2. The weather forecast today will be a rainy day! Make sure to be ready with your umbrellas and rain coat. Wear boots in case of flood!	2. Ang weather forecast karong adlawa kai ulanon. Siguradu-a nga andam ang inyung payong ug kapote. Sul-ob ug bota in kaso ug mag baha.
Health Protocols	
1. Always wear your mask.	1. Sigeg sul-oba ang imung mask.
2. Maintain social distancing	2. Perminantiha ang social distancing.
3. Wash your hands	3. Hugasi permi imung mga kamot.
4. When sick stay at home and stay healthy	4. Kung masakit pagpuyo sa balay para ma bilin ang ka piskay sa lawas.
Lifestyle Modification	
1. Exercise regularly	1. Kada adlawa ang ehersisyo.
2. Maintain a healthy body weight	2. Mantinihi ang insakto nga timbang.
3. Stand more and avoid sitting and / or being stationary	3. Barog sige ug likayi ang permanenting ga lingcod.
4. Avoid sugar	4. Likayi ang mga matam-is nga pagkaon.
5. Eat more vegetables and fruits	5. Kaon ug daghang prutas ug utanon.
6. Drink more water	6. Inum ug daghang tubig.
7. Get a good night's sleep	7. Kuha ug maayung katulog kada-gabii
8. Quit smoking	8. Undang sa panigarilyo.
9. Don't drink too much alcohol	9. Ayaw pagpalabi ug inum sa ilimnong makahubog
10. Love yourself	10. Pangga-a imung kaugalingon
11. Get regular health check -ups	11. Pagpa check -up ug regular.
Safe Driving	
1. Regularly check your car's condition	1. Kanunay susiha ang kondisyon sa imung sakyanan
2. Always put a seat belt on	2. Kanunay e-taod ang seatbelt kung mag sakay sa imung sakyanan.
3. Don't text and drive	3. Ayaw pag text mentras ga maneho.
4. Respect traffic rules	4. Respetuhi ang balaod sa dalan.
5. Respect pedestrian lanes	5. Respetari ang pedestrian lanes.

Follow – up and Outcome Measurement

The primary study outcome was the change in the HB-MAS scores while secondary outcomes were changed in clinical characteristics (i.e. blood pressure, body weight, height, and weight). After a period of 12 weeks, participants were convened at the Department of Family and Community Medicine office on scheduled dates. The administration of 9 - item Hill-Bone Medication Adherence Scale was repeated, 12 weeks post-intervention. Similarly, blood pressure, weight, and height which calculated for body mass index and weight-for-height ratio were again measured. There were no dropouts recorded throughout the trial. All data were encoded digitally and analyzed.

Data Management and Statistical Analysis

The calculated minimum sample size required was 102 determined by: 1) average of 492 reported hypertensive patients seen monthly in a span of 6 months (July 2022 to December 2022); 2) confidence interval of 95% and 5% margin of error and; 3) effect size of -0.1534.

The gathered data in this study was analyzed through the STATA software using the intention to treat analysis method. Means and SD were used to summarize the data for the continuous variables such as weight, height, BMI and waist-hip circumference. In addition, frequency distribution table was used to summarize the blood pressure before and after the intervention. The mean HB-MAS scores pre-intervention and post-intervention per group were compared using the Wilcoxon signed rank test, while scores between intervention and control groups pre- and post-intervention were analyzed using the Wilcoxon rank-sum test with 95% confidence intervals (CIs), with two-sided p-values reported and statistical significance set at $p < 0.05$.

Ethical Consideration

This paper was submitted and approved by the Ethics Review Committee of Cebu South Medical Center. Participation to this study

was purely voluntary. Informed consent which includes the purpose, benefits, and risks behind the study were provided and carefully explained to the participants. Anonymity and confidentiality were strictly implemented all throughout the course of the study as no names or any identifying marks were used. A randomly assigned identification number was placed on each questionnaire form to be used as an identifier. All responses gathered were shredded by the researchers at the end of the trial. There was only minimal risk to the respondents of this study. The outcome of the study will benefit the institution involved with regards to improved medication adherence among hypertensive patients.

RESULTS

A total of 102 hypertensive patients were identified using the sampling method used, with all fulfilling the inclusion criteria and all consented to be part of the study. Thus, a total of 102 were included in the research during the 2-week recruitment period. Random assignments to either intervention or control group were equal at 51 participants per group and the trial ran for 12 weeks, from October 4, 2023 - December 27, 2023. There were no dropouts noted among the respondents. Table 3 shows baseline and post-intervention clinical characteristics and HB-MAS scores for both groups. Both the intervention and control group had marginal differences in terms of height, weight, computed body mass index and waist-to-hip ratio. The average height of the respondents in the intervention group was 1.57 m (SD: 0.11 m) and 1.58 m (SD: 0.10 m) in the control group The average weight of the respondents in the intervention group was 68.64 kg (SD: 13.39 kg), and 72.49 kg (SD: 20.11 kg) in the control group. The average BMI for respondents in both groups was 28.19 kg/m^2 (Intervention group = 27.64 kg/m^2 and control group = 28.74 kg/m^2) prior to start of the trial. For both groups,

the average WHC of the respondents is 0.95 (SD: 0.05) indicating that, on the average, the respondents have low health risk (for male) and moderate health risk (for female).

Post-intervention, there was no noticeable change in weight, BMI, and WHC among participants in the intervention group. In the control group, there was a noticeable decrease in the average weight among participants from 72.49kg to 68.63kg. There was no noticeable change in the BMI and WHC among participants in the control group.

Table 4 displays the frequency distribution of the respondents' blood pressure from the intervention and control group pre- and post-intervention. At baseline, the intervention group had 7.8% (8 respondents) with a blood pressure of 130/90 mmHg, 5.9% (6 respondents) with a blood pressure of 150/90 mmHg, and 4.9% (5 respondents) with a blood pressure of 130/80 mmHg, with the participants of the intervention group exhibiting high blood pressure at 130/80 on average. Similarly, participants in the control group also exhibit an average of high blood pressure, specifically at 140/90 mmHg, with 5.9% (6 respondents) had a blood pressure of 140/90 mmHg, 4.9% (5 respondents) had a blood pressure of 120/80 mmHg, and 74.9% (5 respondents) had a blood pressure of 130/90, with the participants of the control group exhibiting high blood pressure at 140/90 on average. Post-intervention, there was a noted change in the average blood pressure seen in the intervention group, with majority or 21.6% (22 respondents) exhibiting normal blood pressure (120/80 mmHg), followed by 15.7% (16 respondents) having a blood pressure of 130/90, and 2.9% (3 respondents) having a blood pressure of 140/90. On average, the blood pressures of the intervention group were at 120/80 mmHg from an average of 130/90 mmHg at baseline. Among the control group 7.8% (8 respondents) had a blood pressure of 130/90, 5.9% (6 respondents) have a blood pressure of 150/90, and 4.9% (5 respondents) have a blood pressure of 130/80. On average, participants in the control

Table 3. Descriptive statistics of clinical characteristics among intervention and control group at baseline and post-intervention.

Intervention Group	Clinical Characteristics	Mean	Standard Deviation (SD)	Minimum	Maximum
Baseline	Height (m)	1.57	0.11	1.25	1.78
	Weight (kg)	**68.64**	13.39	40.00	105.00
	BMI	**27.64**	4.33	20.48	38.78
	WHC	0.95	0.05	0.78	1.06
Post-intervention	Height (m)	1.57	0.11	1.25	1.78
	Weight (kg)	**69.04**	12.59	43.00	103.00
	BMI	**27.85**	4.25	20.48	38.78
	WHC	0.95	0.05	0.78	1.06
Control Group	Clinical Characteristics	Average	Standard Deviation	Minimum	Maximum
Baseline	Height (m)	1.58	0.10	1.25	1.78
	Weight (kg)	**72.49**	20.11	33.00	145.00
	BMI	**28.74**	7.17	16.31	62.43
	WHC	0.95	0.05	0.83	1.06
Post-intervention	Height (m)	1.57	0.12	1.25	1.78
	Weight (kg)	**68.63**	13.39	40.00	105.00
	BMI	**27.64**	4.33	20.48	38.78
	WHC	0.95	0.05	0.78	1.05

group still exhibited high blood pressure at 130/90 mmHg, though there was a noted improvement from an average of 140/90 mmHg at baseline.

Based on the results of the Wilcoxon signed rank test, there was no noted significant difference of the scores at baseline and post-intervention scores of both the intervention (p-value 0.126) and control (p-value 0.084) group participants. However, participants in the intervention group had lower scores on average (15.76 SD: 4.78) post-intervention than at baseline (16.59 SD 6.07) indicating improvement on adherence based on HB-MAS on average, while participants in the control group had higher scores on average (16.79 SD: 6.07) post-intervention than at baseline (14.63 SD: 5.30), indicating a decline on adherence based on HB-MAS on average. (Table 5)

Comparing the scores of both groups at baseline and post-intervention using the Wilcoxon rank sum test, there was no significant difference on the average scores of both the intervention and control groups at baseline. However, it was noted that there was a significant difference (p-value 0.001) in the post-intervention scores between control and intervention groups.

There were no identified and recorded adverse events or difficulties in either the intervention or control group and during the trial.

DISCUSSION

The results showed that there were no changes in the height, weight, BMI as well as the health risk among the participants in the intervention group. Indicating that the intervention did not influence the respondent's behavior towards achieving and maintaining a healthy lifestyle which includes proper diet, physical activity and attaining healthy weight that would play an important role in achieving good BP control, alongside medication adherence. Noticeably, in the control group, there was a decrease in weight post – intervention although no significant change was seen in the BMI, still authors can see a decrease in the weight. Several factors could have affected the weight change,

Table 4. Frequency distribution of blood pressure levels at baseline and post-intervention among intervention group and control group.

Intervention Group Baseline			Intervention Group Post-intervention			Control Group Baseline			Control Group Post-intervention		
Blood Pressure	Frequency	Percent	Blood Pressure	Frequency	Percent	Blood Pressure	Frequency	Percent	Blood Pressure	Frequency	Percent
110/50	1	1.0	110/60	1	1.0	100/70	1	1.0	110/50	1	1.0
110/60	1	1.0	110/70	1	1.0	110/70	2	2.0	110/60	1	1.0
110/80	1	1.0	120/70	2	2.0	110/75	1	1.0	110/80	1	1.0
120/70	1	1.0	**120/80**	**22**	**21.6**	110/80	1	1.0	120/70	1	1.0
120/74	1	1.0	120/90	1	1.0	**120/80**	**5**	**4.9**	120/74	1	1.0
120/80	2	2.0	125/72	1	1.0	125/87	1	1.0	120/80	2	2.0
121/68	1	1.0	130/80	2	2.0	130/100	1	1.0	121/68	1	1.0
130/70	3	2.9	**130/90**	**16**	**15.7**	130/74	1	1.0	130/70	3	2.9
130/80	**5**	**4.9**	**140/90**	**3**	**2.9**	130/80	3	2.9	**130/80**	**5**	**4.9**
130/90	**8**	**7.8**	150/100	1	1.0	**130/90**	**5**	**4.9**	**130/90**	**8**	**7.8**
140/100	1	1.0	160/100	1	1.0	130/95	1	1.0	140/100	1	1.0
140/60	1	1.0	**Total**	**51**	**100.0**	140/100	2	2.0	140/60	1	1.0
140/70	1	1.0				140/80	4	3.9	140/70	1	1.0
140/80	4	3.9				**140/90**	**6**	**5.9**	140/80	4	3.9
140/90	3	2.9				150/100	2	2.0	140/90	3	2.9
150/100	2	2.0				150/80	1	1.0	150/100	2	2.0
150/90	**6**	**5.9**				150/90	1	1.0	**150/90**	**6**	**5.9**
160/100	1	1.0				160/110	3	2.9	160/100	1	1.0
160/90	4	3.9				160/80	1	1.0	160/90	4	3.9
161/106	1	1.0				160/90	3	2.9	161/106	1	1.0
170/90	1	1.0				165/88	1	1.0	170/90	1	1.0
180/100	1	1.0				170/70	1	1.0	180/100	1	1.0
180/110	1	1.0				170/80	1	1.0	180/110	1	1.0
Total	**51**	**100.0**				180/100	1	1.0	**Total**	**51**	**100.0**
						180/90	1	1.0			
						200/100	1	1.0			
						Total	**51**	**100.0**			

Table 3. Wilcoxon Signed Rank and Rank Sum Test Statistics comparing baseline and post-intervention medication adherence scores and scores between groups using the Hill-bone Medication Adherence Scale (HB- MAS).

	Baseline	Post-intervention	Mean Change	Wilcoxon signed rank test	*p*-value
Mean HB-MAS scores Intervention Group	**16.59 (SD: 6.07)**	**15.76 (SD: 4.78)**	-0.83	-1.531	0.126
Mean HB-MAS scores Control Group	**14.63 (SD: 5.30)**	**16.59 (SD: 6.07)**	1.96	-1.730	0.084
Wilcoxon rank sum test	2368.5	2143.5			
p-value	0.083	0.001**			

**significant at α < 0.05

for one – it could be that the general knowledge SMS texts sent to them could be on weight loss and influenced them on being conscious on their weight.

Results of the blood pressure changes were evident on both the intervention and control group. In the intervention group, from increased average blood pressure of 130/ 80 mmHg to normal blood pressure of 120 /80 mmHg post- intervention, a marked improvement on the blood pressure control was observed. SMS reminders sent to the intervention group were mainly on the management, complications and adherence to medication on hypertension, it clearly impacted on the patient's behavior towards health medication compliance to maintain good bp control. Meanwhile in the control group, although there was a decrease in the blood pressure, it was not that low enough to attain the normal pressure that was desired. In the intervention group the mean change of scores was at -0.83, which indicates increased adherence due to the decrease in their mean scores. On the other hand, the mean change of scores in the control group was 1.96 indicating that the participants were more non-adherent post-intervention due to an increase in their mean score.

Based on the results of the Wilcoxon signed rank test, there was no noted significant difference of the scores at baseline and post-intervention scores of both the intervention (p-value 0.126) and control (p-value 0.084) group participants, however group participants from the intervention group had lower scores on HB-MAS post-intervention while the HB—MAS scores from the control group increased, indicating that post -intervention participants was more non-adherent. Although both groups still went beyond the cut- off HB-MAS of 9 for the adherence, still there was an improvement of the score in the intervention group compared to the control group.

There is evidence of an association of medication non-adherence and increasing healthcare costs.[8] With the increasing burden of non-communicable disease[1] and with ischemic heart disease identified as the leading cause of death in the Philippines in 2022[3], it is thus important to look for interventions that can improve medication adherence and to prevent disease progression and improve disease control. With the projection that mobile phone users will increase by a total of 11 million between 2024-2028 according to Statista [2019], interventions using SMS reminders to increase adherence in patients would likely to continue to be relevant in the immediate future as a form of community and patient engagement, and it has been shown that SMS reminders is a viable option in reminding patients to take their medications and increase medication adherence [25].

The average HB-MAS scores of both groups at baseline were noted to be more than 10, indicating poor adherence to medication use. This is similar to the findings of a systematic review by Bowry[6] which showed sub-optimal medication adherence among 76 studies that measured adherence to cardiovascular medications of patients with hypertension, diabetes, coronary artery disease, and congestive heart failure in developing countries among patients with a median age of 27-29 years and comprising about 34% males. While adherence scores post-intervention for both groups did not significantly differ from their scores baseline, there was a statistically significant difference between both the intervention versus the control group post-intervention (p-value 0.001), and the intervention group showed numerically lower average scores post-intervention compared to the control group. Similarly, in the study by Buis[26] among hypertensive African Americans using automated SMS reminders, the intervention groups consistently showed numerically greater, yet nonsignificant, improvements in measures of medication adherence. Other studies using phone reminders to improve adherence to medications for patients with diabetes[17], and patients on anti-retroviral therapy[15] also showed non-significant improvement in medication adherence.

The study results differed from the other previous studies[18,22, 25,26] where the participants in the intervention arm showed improvement in medication adherence. It can be noted that one study[25] used the complete Hill Bone compliance scale, and not just the medication

adherence subscale and had a bigger study population (n=200). Another[22] used the Morisky Medication Adherence Scale while the other studies used dispensing records to measure adherence.[18, 23] Differences in methods used to measure medication adherence may need to be considered.

At baseline, both groups had similar averages in blood pressure (130/90 mmHg for the intervention group, 140/90 mmHg for the control group). Post-intervention, it was noted that the average blood pressure for the intervention group was also noted to decrease (120/80 mmHg) compared to baseline, while the average blood pressure for the control group remained high (130/90 mmHg). This was comparable to the results from other studies[18, 20, 26] which used similar interventions.

Noted limitations of this study was the sample size, the length of the study period, the need to account for other factors that may influence medication adherence, and the need to assess the acceptability of SMS reminders for the patients. While medication adherence scores of the intervention group was noted to improve and had significant difference to that of the control group post-intervention, it should be noted that overall, these still indicate a level of non-adherence. Increasing the sample size and the length of time for the intervention can help to establish if sustained messaging of more than 12 weeks can further improve adherence. Other factors that can affect adherence, such as economic burden and accessibility to medications should also be considered in future studies. There is also a need to determine the acceptability of the intervention among the participants, as well as the cost-effectiveness of the intervention.

Conclusion and Recommendations

In summary, the clinical characteristics in both the intervention group and control group had no changes pre and post – intervention, except for the change of weight for the control group that decreased post- intervention. While the HB-MAS scores pre- and post -intervention per group, no significant change was noted. However, when in comparison between intervention and control group HB-MAS scores post – intervention, there was a significant change statistically. Blood pressure changes between intervention and control group showed that the intervention group greatly improved from increased blood to normal blood pressure. With the Medication adherence, a noticeable change of HB-MAS scores between the intervention group and the control group in favor of the intervention group. In conclusion, SMS text messages intervention improved the adherence of hypertensive patients in terms of HB-MAS scores.

The authors recommend the following for future researchers, to widen the sample size, lengthen the duration of study as well as to assess the acceptability of the SMS reminders. Other factors that can affect adherence, such as economic burden and accessibility to medications should also be considered in future studies. The results can be applied in the local setting, for hypertensive patients seen in the outpatient department of the local hospitals in the country. The improvement of medication adherence greatly prevents the complication of hypertension and in turn lessens the burden of disease both to the patient and the community.

References

1. World Health Organization. Noncommunicable diseases [Internet]. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
2. Sison J, Divinagracia R, Nailes J. Asian management of hypertension: Current status, home blood pressure, and specific concerns in Philippines (a country report). J Clin Hypertens [Internet] 2020 Feb 28;22(3):504–7. Available from: https://doi.org/10.1111/jch.13802
3. Philippine Statistics Authority. 2022 Causes of Deaths in the Philippines (Preliminary as of 30 June 2022) | Philippine Statistics Authority | Republic of the Philippines [Internet]. 2022. Available from: https://psa.gov.ph/content/2022-causes-deaths-philippines-preliminary-30-june-2022
4. Statista. Morbidity rate of leading diseases in Central Visayas Philippines 2020 [Internet]. Statista. 2023. Available from: https://www.statista.com/statistics/1119602/philippines-morbidity-rate-leading-disease-central-visayas-region/
5. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Himmelfarb CD, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension [Internet]. 2018 Jun 1;71(6). Available from: https://doi.org/10.1161/hyp.0000000000000065
6. Bowry A, Shrank WH, Lee J, Stedman M, Choudhry NK. A Systematic review of adherence to cardiovascular medications in resource-limited settings. J Gen Int Med [Internet] 2011 Aug 20;26(12):1479–91. Available from: https://doi.org/10.1007/s11606-011-1825-3
7. Mahmood S, Jalal Z, Hadi MA, Khan TM, Haque S, Shah KU. Prevalence of non-adherence to antihypertensive medication in Asia: a systematic review and meta-analysis. Int J Clin Pharm [Internet] 2021 Jan 29;43(3):486–501. Available from: https://doi.org/10.1007/s11096-021-01236-z
8. Cutler RL, Fernández-Llimós F, Frommer M, Benrimoj CS, García-Cárdenas V. Economic impact of medication non-adherence by disease groups: a systematic review. BMJ Open [Internet] 2018 Jan 1;8(1):e016982. Available from: https://doi.org/10.1136/bmjopen-2017-016982

9. Thakkar J, Kurup R, Laba T, Santo K, Thiagalingam A, Rodgers A, et al. Mobile telephone text messaging for medication adherence in chronic disease. JAMA Int Med [Internet] 2016 Mar 1;176(3):340. Available from: https://doi.org/10.1001/jamainternmed.2015.7667

10. Costa E, Giardini A, Savin M, Menditto E, Lehane E, Laosa O, et al. Interventional tools to improve medication adherence: review of literature. Patient Preference and Adherence [Internet] 2015 Sep 1;1303. Available from: https://doi.org/10.2147/ppa.s87551

11. Wilhelmsen NC, Eriksson T. Medication adherence interventions and outcomes: an overview of systematic reviews. Eur J Hosp Pharm [Internet] 2018 Nov 16;26(4):187–92. Available from: https://doi.org/10.1136/ejhpharm-2018-001725

12. Statista. Number of smartphone users Philippines 2019-2028 [Internet]. Statista. 2023. Available from: https://www.statista.com/statistics/467186/forecast-of-smartphone-users-in-the-philippines

13. Tan EH, Wong ALA, Tan CC, Wong P, Tan SG, Ang LEY, et al. Improving medication adherence with adjuvant aromatase inhibitor in women with breast cancer: A randomised controlled trial to evaluate the effect of short message service (SMS) reminder. The Breast [Internet] 2020 Oct 1;53:77–84. Available from: https://doi.org/10.1016/j.breast.2020.06.012

14. Tamban C, Isip-Tan IT, Jimeno C. Use of short message services (SMS) for the management of type 2 diabetes mellitus: a randomized controlled trial. Journal of the ASEAN Federation of Endocrine Societies [Internet] 2013 Nov 30;28(2):143–9. Available from: https://doi.org/10.15605/jafes.028.02.08

15. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester R, Mills EJ, Śmieja M, et al. The Cameroon Mobile Phone SMS (CAMPS) Trial: A randomized trial of text messaging versus usual care for adherence to antiretroviral therapy. PLoS One [Internet] 2012 Dec 6;7(12):e46909. Available from: https://doi.org/10.1371/journal.pone.0046909

16. Xu DR, Xiao S, He H, Caine ED, Gloyd S, Simoni JM, et al. Lay health supporters aided by mobile text messaging to improve adherence, symptoms, and functioning among people with schizophrenia in a resource-poor community in rural China (LEAN): A randomized controlled trial. PLOS Medicine [Internet] 2019 Apr 23;16(4):e1002785. Available from: https://doi.org/10.1371/journal

17. O'Connor PJ, Schmittdiel JA, Pathak RD, Harris RI, Newton KM, Ohnsorg K, et al. Randomized trial of telephone outreach to improve medication adherence and metabolic control in adults with diabetes. Diabetes Care [Internet] 2014 Nov 8;37(12):3317–24. Available from: https://doi.org/10.2337/dc14-0596

18. Vollmer WM, Owen-Smith AA, Tom J, Laws R, Ditmer D, Smith DH, et al. Improving adherence to cardiovascular disease medications with information technology. PubMed [Internet] 2014 Nov 1;20(11 Spec No. 17):SP502-10. Available from: https://pubmed.ncbi.nlm.nih.gov/25811824

19. Pernell B, DeBaun MR, Becker K, Rodeghier M, Bryant V, Cronin RM. Improving medication adherence with two-way short message service reminders in sickle cell disease and asthma. Applied Clinical Informatics [Internet] 2017 Apr 1;08(02):541–59. Available from: https://doi.org/10.4338/aci-2016-12-ra-0203

20. Bobrow K, Farmer A, Springer D, Shanyinde M, Yu LM, Brennan TP, et al. Mobile phone text messages to support treatment adherence in adults with high blood pressure (SMS-Text Adherence Support [STAR]). Circulation [Internet] 2016 Feb 9;133(6):592–600. Available from: https://doi.org/10.1161/circulationaha.115.017530

21. Haricharan HJ, Heap M, Hacking D, Lau YK. Health promotion via SMS improves hypertension knowledge for deaf South Africans. BMC Public Health [Internet] 2017 Aug 18;17(1). Available from: https://doi.org/10.1186/s12889-017-4619-7

22. Saputri GZ, Akrom A, Darmawan E. Counseling and motivational short text messages increase adherence and behavioral changes in patient with hypertension. JKKI: Jurnal Kedokteran Dan Kesehatan Indonesia [Internet] 2016 Jan 20;7(3):87–94. Available from: https://doi.org/10.20885/jkki.vol7.iss3.art3

23. Contreras EM, GarcÍa OV, Claros NM, Guillén VG, De La Figuera Von Wichmann M, Martínez JJC, et al. Efficacy of telephone and mail intervention in patient compliance with antihypertensive drugs in hypertension. ETECUM-HTA study. Blood Pressure [Internet] 2005 Jul 1;14(3):151–8. Available from: https://doi.org/10.1080/08037050510008977

24. Saputri GZ, Akrom A, Darmawan E. Counseling and motivational short text messages increase adherence and behavioral changes in patient with hypertension. JKKI: Jurnal Kedokteran Dan Kesehatan Indonesia [Internet] 2016 Jan 20;7(3):87–94. Available from: https://doi.org/10.20885/jkki.vol7.iss3.art3

25. Bhandari B, Narasimhan P, Jayasuriya R, Vaidya A, Schutte AE. Effectiveness and acceptability of a mobile phone text messaging intervention to improve blood pressure control (TEXT4BP) among patients with hypertension in Nepal: A feasibility randomised controlled trial. Global heart [Internet] 2022 Feb 23;17(1):13. Available from: https://doi.org/10.5334/gh.1103

26. Buis LR, Hirzel L, Dawood R, Dawood K, Nichols LP, Artinian NT, et al. Text messaging to improve hypertension medication adherence in African Americans from primary care and emergency department settings: results from two randomized feasibility studies. Jmir Mhealth and Uhealth [Internet] 2017 Feb 1;5(2):e9. Available from: https://doi.org/10.2196/mhealth.6630

27. Gutierrez MM, Sakulbumrungsil R. Factors associated with medication adherence of hypertensive patients in the Philippines: a systematic review. Clinical Hypertension [Internet] 2021 Oct 1;27(1). Available from: https://doi.org/10.1186/s40885-021-00176-0

28. Kim MT, Hill MN, Bone LR, Levine DM. Development and testing of the Hill-Bone compliance to high blood pressure therapy scale. Progress in Cardiovascular Nursing [Internet] 2000 Jun 1;15(3):90–6. Available from: https://doi.org/10.1111/j.1751-7117.2000.tb00211.x

29. Song Y, Han HR, Song H, Nam S, Nguyen TH, Kim MT. Psychometric evaluation of Hill-Bone medication adherence subscale. Asian Nursing Research [Internet] 2011 Sep 1;5(3):183–8. Available from: https://doi.org/10.1016/j.anr.2011.09.007

30. Ogedegbe G, Mancuso CA, Allegrante JP, Charlson ME. Development and evaluation of a medication adherence self-efficacy scale in hypertensive African-American patients. J Clin Epidemiol [Internet] 2003 Jun 1;56(6):520–9. Available from: https://doi.org/10.1016/s0895-4356(03)00053-2

31. Mafutha GN, Wright SCD. Compliance or non-compliance of hypertensive adults to hypertension management at three primary healthcare day clinics in Tshwane. Curationis [Internet] 2013 Jan 8;36(1). Available from: https://doi.org/10.4102/curationis.v36i1.52