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Fewer than 25% of individuals in the United States with hypertension have controlled blood pressure (Centers for Disease Control and Prevention, 2021). Hypertension Management Program (HMP) adopted the Health Coaches for Hypertension Control© (HCHC©) curriculum and adapted it for delivery by Extension agents. Eight lessons with intermittent health coaching calls were delivered. Pre/post-participation surveys determined changes in knowledge and self-reported weight, systolic (SBP), and diastolic blood pressure (DBP). The pandemic forced a shift in methodology from in-person to virtual delivery, and results were compared. In both traditional and virtual programs, significant differences were found in weight, knowledge scores, and SBP from pre- to post-participation. Mean reduction in weight for in-person and virtual programs was 1.9 lb ($p = 0.0047$) and 3.5 lb ($p = 0.043$) respectively. Knowledge scores increased significantly for in-person ($p = 0.000$) and virtual program ($p = 0.0006$) participants. Mean reduction in SBP of 5.5 mmHg ($p = 0.0009$) and 1.9 ($p = 0.0338$) was observed in in-person and virtual participants, respectively. DBP significantly decreased by a mean of 8.5 mmHg ($p = 0.0421$) for virtual HMP participants and approached significance in traditional programs (decrease of 5.5 mmHg, $p = 0.0649$). Results suggest that participation in HMP, whether in-person or virtual, could help participants reduce their risk of cardiovascular events through blood pressure self-management.

Keywords: health education, virtual, hypertension, Extension, health coaches for hypertension control, hypertension management program, blood pressure, self-management

Introduction

It is estimated that 1.28 billion adults worldwide have been diagnosed with hypertension (World Health Organization [WHO], 2021). The prevalence of self-reported hypertension in all age groups in the United States is 47% (Centers for Disease Control and Prevention [CDC], 2021) and increases with age: from 7.5% in 18 to 39-year-old adults to 63.1% in adults over the age of 60 (Fryar et al., 2018). The state of South Carolina (SC) is in the top 10 states with the highest rates of self-reported hypertension in the country (CDC, 2021), with one in three adults reporting hypertension (SC Department of Health and Environmental Control, 2019). Hypertension is a significant risk factor for cardiovascular disease (CVD), and it is associated with stroke, heart attack, and kidney failure resulting in more than half a million deaths annually (CDC, 2021).

Blood pressure is the amount of pressure that blood places against the walls of the arteries (Unger et al., 2020). Blood pressure can vary widely throughout the day, but it is called hypertension if it remains high over time. Hypertension is diagnosed when a person's systolic blood pressure (SBP) is ≥140 mmHg and/or their diastolic blood pressure (DBP) is ≥90 mmHg. While blood pressure can be successfully managed, only about a quarter (24%) of individuals in the United States with hypertension have their blood pressure under control (Fryar et al., 2018; CDC, 2021). This statistic remains true despite evidence to suggest that relatively small differences in BP are associated with significant differences in cardiovascular risk (Appel, 1995, 2003; Dahlöf et al., 2005; Hardy, 2015; Wei et al., 2020). Healthy lifestyle choices are an important part of hypertension management and can prevent or delay the onset of high BP, enhance the effects of antihypertensive treatment, and reduce cardiovascular risk (Unger et al., 2020).

In the 2017 Guidelines for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults, recommendations are outlined for the care of patients at risk of developing heart disease because of hypertension (Whelton et al., 2017). These recommendations are based on published scientific evidence that is available for pharmacological and nonpharmacological strategies. Strong evidence supports the use of lifestyle interventions that use techniques like goal setting, self-monitoring, motivational interviewing, provision of feedback, and promotion of self-sufficiency in the management of hypertension. While lifestyle modification is the first line of antihypertensive treatment (Unger et al., 2020), lifestyle modifications require using motivational strategies to promote adherence to healthy behaviors (Whelton et al., 2017).

Tam et al. (2020) reviewed existing literature to evaluate the effect of individual and group educational intervention on blood pressure control and adherence to lifestyle modification in patients with hypertension. Meta-analysis showed that individual or group education with additional support strategies like phone calls, reminders, and written materials resulted in a moderate to large effect on adherence to lifestyle modifications and blood pressure control.

Researchers concluded that education with additional support methods could improve and reinforce adherence behavior to medications and lifestyle modifications in patients with hypertension.

Whelton et al. (2017) suggest that lifestyle behavior change strategies with the most significant evidence for lowering blood pressure include proper and consistent blood pressure monitoring, reduced salt intake with a diet like the Dietary Approaches to Stop Hypertension (DASH), and weight control. A study by Rice et al. (2018) showed that individuals who monitored their blood pressure at home and shared the results with their doctor had better control than those who did not monitor their blood pressure at home. Whelton et al. (2017) suggested that self-monitoring of blood pressure could be used with other lifestyle modification interventions to improve blood pressure control in patients with hypertension.

The DASH diet is a low sodium diet often prescribed by physicians to help individuals manage their high blood pressure through lifestyle modification (American Heart Association [AHA], 2021a). Since its inception, studies have shown that following the DASH diet results in lowered blood pressure readings for people with high blood pressure (Appel, 1997). Blood pressure improves if sodium is restricted to less than 2300 mg a day and goes down even more when restricted to 1500 mg sodium. Since dietary salt serves as a significant source of sodium (400 mg of sodium in 1 gram of salt), WHO suggests that reducing population-wide dietary salt intake from average levels of 9-12 mg (3,600-4,800 mg sodium) to the recommended 5-6 mg (2,000-2,400 mg sodium) will help to decrease the number of deaths from hypertension, cardiovascular disease, and stroke (Ha, 2014). The AHA also suggests that losing as little as five to 10 pounds for people who are overweight may help lower blood pressure; losing weight, eating well, and moving more are keys to success (AHA, 2016a).

Combined, the findings above suggest that a comprehensive program that educates individuals with hypertension on strategies like at-home blood pressure monitoring, the adoption of a low-sodium DASH diet, and physical activity for weight and stress management can impact blood pressure. By including strategies focused on goal setting and motivational interviewing, efforts to adopt these lifestyle behaviors will be maximized (Rhodes & Sui, 2021). Health Coaches for Hypertension Control© (HCHC©) is an evidence-based education and support program created to address these and other lifestyle behavior change strategies for managing hypertension (Dye et al., 2015).

The HCHC© program was developed and pilot tested in a rural community in SC (Dye et al., 2015). The small-group educational program provides participants with the knowledge and skills to successfully manage their hypertension. Details of the original study can be found in previous publications (Dye et al., 2015). In brief, volunteer health coaches were recruited from the communities in which they lived and were given a total of 30 hours of training by the program creator (training described in methods section below). Eight educational modules were

developed for lesson delivery and were based on recommendations from the Joint National Committee's seven guidelines (the most recent guidelines available at the time of the pilot study; Chobanian et al., 2003). Participants were enrolled in the program, and pre-program health-risk assessments were completed (health-risk assessment was the Personal Wellness Profile™ by Wellsource, Inc.).

The trained volunteers used scripted modules to educate participants on hypertension and community resources that could support participant self-management. Module topics included: 1) development of personal action plans, 2) basics of hypertension control, 3) physical activity, 4) nutrition, 5) stress management, 6) tobacco cessation, 7) medication management, and 8) long-term action plan development. Participants were offered eight additional lessons providing comprehensive content in nutrition, cooking skills, and physical activity. Table 1 provides an overview of the HCHC© program structure and topics addressed during group sessions.

Pilot testing of HCHC© showed that delivery of hypertension self-management programming by trained volunteers yielded positive results. Participants showed statistically significant increases in hypertension knowledge, positive trends in "readiness to change" measures, increased consumption of fruits and vegetables, and improvements in SBP, body weight, and fasting blood glucose (Dye et al., 2015). While 40% of participants at baseline met the Healthy People 2020 recommendations for blood pressure control, 51% met blood pressure recommendations after participation (2015). These positive results supported the approval of HCHC© as an evidence-based program by the National Council on Aging in 2018 (Department of Health and Human Services, 2018).

In SC, prevalence of hypertension is higher in individuals with less than a high school degree and incomes less than $15,000 per year. These communities can be characterized as "at-risk" or "distressed" based on socioeconomic factors identified by the Distressed Community Index measure (DCI; Benzow et al., 2020; Economic Innovation Group; 2020). Cooperative Extension in SC has a proven track record of enrolling community members from "at-risk" or "distressed" zip codes into Extension health and nutrition programs (Dietz et al., 2018; Graham et al., 2021; Parisi et al., 2022; Stancil et al., 2018; White et al., 2021). Delivering a hypertension education and self-management program through the Extension workforce with a specified scope of practice (Parisi et al., 2020) is an appealing strategy for reaching individuals with hypertension in hard-to-reach communities. To our knowledge, in SC, HCHC© has not been delivered by degree-prepared Extension agents through the land-grant university system.

Purpose: The project objective was to determine if implementing a modified version of the HCHC© program (Hypertension Management Program [HMP]), when delivered by Extension agents through the Cooperative Extension System, would demonstrate similarly positive results as those obtained in the pilot study. Two years into program delivery, the COVID-19 pandemic forced a change in methodology from in-person program delivery to online delivery using a

videoconferencing platform. This disruption in service resulted in an additional research question: does an online, virtual version of the program have results that are similar to the in-person program? Method variations are noted, results are presented separately, and comparisons are made between in-person groups and virtual groups.

Methods

Extension Agent Training

The Extension Health Program Team adopted and implemented the HCHC© curriculum as our approved curriculum for the overarching Hypertension Management Program (HMP). Specific goals for implementing the curriculum were to increase participants' knowledge related to home blood pressure monitoring, the DASH diet, and physical activity strategies for weight and stress management. Extension agents attended an in-person training, "Health Coaching Bootcamp," offered through SC Department of Health and Environmental Control. They completed an additional 30 hours of in-person training with the program creator and trainer. Training sessions provided instruction on the curriculum and standardized program delivery methods that included scripted lesson plans. Topics on behavior change theory and framework, communication strategies, motivational interviewing techniques, and goal-setting strategies were presented. Background education was provided on hypertension, the DASH diet, smoking cessation, physical activity, yoga and meditation, and using home blood pressure monitoring devices. Agents were also trained on the assessment strategies and tools used for pre-and post-program data collection.

The HCHC© program was developed to be facilitated by lay audience volunteers using tightly scripted lessons to account for the variation in health/clinical knowledge among the educators. Adaptations were made during training that tailored the program for facilitation by degreed Extension agents. Like the volunteers facilitating the program in the pilot study, Extension agents are intentionally hired from within the counties they live in and are embedded members in their communities. However, Extension agents have college degrees in related fields like Public Health Science, Health Promotion, and Nutrition. They are paid professionals compared to the lay audience volunteers in the pilot study. Extension agents were therefore encouraged to use their formal education and professional training to deliver a more conversational, interactive version of the pilot-study scripts originally developed for HCHC© lesson delivery.

To ensure adequate training, Extension agents completed a pre and post-test to ensure knowledge comprehension. Additionally, agents participated in role-playing scenarios to demonstrate mastery of the skills required for health coaching of program participants.

Method Adaptations of HCHC© to HMP

Adaptations of HCHC© to HMP are outlined in Table 1.

Table 1. Comparison of Health Coaches for Hypertension Control (HCHC©) pilot program to Hypertension Management Program (HMP), a modified version of HCHC©

Pilot study HCHC© (Dye et al., 2015)	Modified to HMP
Facilitated by lay audience, peer-educator volunteers	Facilitated by degreed, professional Extension agents
8 HCHC© group lessons + 8 optional lessons	8 HCHC© group lessons with intermittent health coaching calls
Paper surveys	Qualtrics electronic surveys
Core lessons	**Intermittent structure**
1) Personal action plan	1) Personal action plan + introduction to Check, Change, Control app + introduction of "Ask it basket"
2) Basics of hypertension control	1a. Individualized health coaching call
3) physical activity	2) Basics of hypertension control
4) Nutrition	2a. Individualized health coaching call
5) Stress management	3) physical activity
6) Tobacco cessation	3a. Individualized health coaching call
7) Medication management	4) Nutrition
8) Long-term goal planning/ graduation	4a. Individualized health coaching call
Optional lessons	5) Stress management
9) Reading food labels	5a. Individualized health coaching call
10) Plan, shop, save	6) Tobacco cessation
11) Cooking skills – cutting fresh vegetables	6a. Individualized health coaching call
12) Cooking skills – cutting fresh fruits	7) Medication management
13) Meal planning using MyPlate	7a. Individualized health coaching call
14) Cooking skills – going lean with protein	8) Long-term goal planning/graduation
15) Personalized activity plan	
16) Preventing injury	

The HCHC© curriculum originally included eight core lessons and eight optional lessons that provided a "deeper dive" into nutrition and physical activity topics. The original program delivered these lessons in 1.5 to 2-hour segments weekly. In the HMP, the core lessons were adapted to address key objectives in 1-hour increments delivered every other week. The group sessions were administered with intermittent individual health coaching sessions facilitated by phone calls. Extension agents discussed barriers to meeting personal health goals and objectives and assisted participants with navigating healthcare and social service resources during these calls.

Another adaptation to HCHC© was related to the eight optional nutrition and physical activity lessons outlined in Table 1. Instead, participants in HMP were referred to other nutrition and health programs offered through the Cooperative Extension System's Health and Nutrition

Program. Also, the HCHC© curriculum incorporates educational materials developed by the National Heart, Lung, and Blood Institute, utilizes principles from *Community Health Worker's Sourcebook: A Training Manual for Preventing Heart Disease and Stroke* (Centers for Disease Control and Prevention, 2010), and encourages adoption of the DASH Diet Eating Plan. The HMP used existing materials and worked with the program creator to update materials based on the most recent practice guidelines (example – updated from food pyramid to MyPlate). Additional materials from the AHA's *Check. Change. Control* toolkit were also adopted as a support method. *Check. Change. Control* toolkit included an infographic on reference blood pressure levels which was transferred onto a refrigerator magnet and distributed at session 2. Instructions for electronically logging blood pressure checks through the *Check. Change. Control* mobile app were provided in session 1 as an alternative to the paper data log.

The final alteration from the original HCHC© program to HMP was the addition of an "Ask it Basket." At the completion of each session, participants were invited to submit clinically based questions about blood pressure, blood pressure medications, and other topics. The questions were sent to our clinical partners (nurse practitioners), who answered the questions and returned the answers to the Extension agent. Through this mechanism, the Extension agent could stay within their scope of practice (Parisi, 2020) and provide an important link between the community and the local or regional health systems.

To summarize the differences between HCHC© and HMP, alterations included: facilitation by Extension agents with health-related degrees and training compared to lay-audience volunteers, shortened group sessions from 1.5 hours to 1 hour each, weekly group education sessions to bi-weekly sessions, lesson delivery using conversational dissemination versus scripts, referral to other programs after eight core sessions instead of continued optional lessons in HCHC©, updated and additional handouts and materials, introduction to the American Heart Association *Check. Change. Control* mobile app, the addition of the "Ask it Basket" end-of-session activity, and the addition of individual health coaching calls between group lessons. The Institutional Review Board obtained approval for all methods and materials described.

In-Person HMP

In-person HMP participants were recruited from the community through health professional referrals and promotion of the program in local senior centers. A Memorandum of Understanding (MOU) was established with the regional Councils of Government to deliver HMP in partnering senior centers. These agreements included reimbursement for Extension agent services on a per participant basis utilizing Title III-D funds for the delivery of HMP in county senior centers. Title III-D funds are Older Americans Act funds provided to states with the understanding that they are to be used for evidence-based programs to improve the health and well-being of older Americans by reducing disease and injury. As an evidence-based program recognized by the National Council on Aging, the HCHC© curriculum delivered in HMP meets these standards

and therefore qualified for Title III-D fund reimbursement. This reimbursement supported participant notebooks, participation supplies such as stretch bands, and assistance obtaining home blood pressure monitors for participants.

Recruitment into the in-person programs targeted adult residents of Greenville, SC, over 18 with a verbal or written diagnosis of hypertension by their healthcare provider. Individuals with a history of kidney disease or congestive heart failure were excluded. Promotional flyers were distributed at local organizations like community centers, senior centers, churches, and health fairs. Blood pressure screenings were offered to attract interest during health fairs and other recruitment events. Contact information was collected from those who expressed interest. Extension agents made follow-up calls, screened interested participants to ensure they met inclusion/exclusion criteria, received informed consent, and enrolled individuals into scheduled, in-person, small-group sessions.

Participants committed to in-person attendance at eight group sessions and intermittent health coaching calls upon enrollment. The first session established rapport, allowed for introductions and networking, and collected pre-program data. In this session, participants were provided with a participant notebook that contained educational materials and interactive learning pages that helped to guide and engage participants during educational sessions. Additionally, supplies that allowed participants to engage in lessons fully were provided at the first session and included stretch bands, cookbooks, and home blood pressure monitors if needed. Home-grade blood pressure monitors donated by the SC Department of Health and Environmental Control were provided for those who requested a monitor. Participants were also introduced to the *Check. Change. Control* mobile application in session 1. We planned to teach those interested in the tool to download the mobile app to a smartphone. No participants adopted this method of logging blood pressure, so this portion of the program was discontinued after being introduced to the first two groups of participants.

The second session covered a discussion of hypertension, and enrollees were taught how to take their own blood pressure using an at-home blood pressure monitoring device. Participants were provided with a personal health diary and instructed on how it should be used. The facilitator instructed enrollees to track blood pressure readings, servings of fruits and vegetables, steps of physical activity, sodium intake in mg, participation in stress management activities, and adherence to blood pressure medications as prescribed.

Session 3 was dedicated to nutrition and covered MyPlate, lowering sodium with “go,” “slow,” “whoa” foods, serving sizes, nutrition labels, and the DASH eating plan. Session 4 included information on smoking cessation, and the fifth session targeted physical activity. During session 5, participants learned about BMI and were encouraged to maintain appropriate energy balance for weight loss or maintenance depending on their BMI value. The lesson on physical activity

also covered the use of stretch bands for strength training, and participants were provided with several stretch band exercises that could be implemented at home.

The sixth session covered the basics of blood pressure lowering medications with a discussion of different kinds of medications and how they work. Participants were encouraged to talk with their doctors to ensure their medication prescriptions were up to date. Session 7 provided an overview of stress and depression and their associated effects on the body. At the end of sessions 1-7, participants worked through the development of a personal action plan that would be used to keep enrollees on track between sessions. Extension agents maintained copies of the completed action plans and used these for discussion during individual health coaching sessions. The final session 8 guided participants in setting long-term action plans for sustained behavior change beyond the program's life. During this session, Extension agents introduced other health programs in which participants could enroll, such as the Walk SC walking program, the CDC National Diabetes Prevention Program, and our Health Extension for Diabetes self-management program.

Objective measurements of weight and blood pressure were taken at group sessions 1 and 8. Participants were asked to weigh themselves on a standard electronic scale, take a blood pressure reading using a home blood pressure monitor, and submit the readings to the instructor at the first in-person session. Additionally, knowledge at baseline and post-program was assessed using a 22-item paper survey. The survey tool contained questions adopted from the survey instruments described in the pilot study by Dye et al. (2015). Questions about hypertension, physical activity, nutrition, stress management, tobacco use, and medication management were completed by each participant. Surveys were self-administered and completed in real-time. The Extension agent remained available to assist with question clarification and survey completion as needed.

Virtual HMP

After two years of delivering the HMP in face-to-face environments, the pandemic demanded a change in delivery strategy. Objective data collection was self-reported from home, and informed consent was completed with electronic signatures or mail correspondence. The survey tool was adapted from a paper survey to a Qualtrics electronic survey. The health coaching sessions continued to be delivered by phone, and the lessons remained synchronous, with participants attending Zoom calls instead of presenting in person. Institutional Review Board approval was obtained for amendments in all program methodology.

Recruitment strategies for the virtual program required creative methods to reach and enroll participants. Weekly virtual DASH Diet Cooking classes/demonstrations and a weekly virtual yoga class, "Yoga for Every-Body," were offered to the public in the evenings and over the traditional lunch hour through the Zoom platform to attract potential participants. The HMP, Yoga for Every-Body, and DASH Diet Cooking classes were added to Eventbrite and the

Clemson University “Events” calendar, and the links were shared on the Extension website, through Extension social media, and through list-serves with partner organizations.

Extension agents contacted respondents to recruitment for inclusion/exclusion screening, informed consent, and program enrollment. At that time, they were taught how to use the Zoom platform and directed to the survey link for baseline data collection. Participants were asked to self-report weight and blood pressure readings, and those who needed a blood pressure monitor were provided with the necessary equipment through regular mail shipping. Additional materials like notebooks and stretch bands were mailed to virtual program participants prior to the first session to encourage maximum participation. Because most participants found the virtual program online, technology was not a significant barrier for those who participated in the virtual HMP. Consistent with the in-person delivery program, individual health coaching sessions were provided intermittently between group education sessions.

For both the in-person and virtual HMP, demographics were collected at baseline and included age, gender, ethnicity/race, and zip code. Zip codes were evaluated using the Distressed Community Index (DCI) measure, which determines if participants enrolled were residents in at-risk or distressed communities (Benzow et al., 2020; Economic Innovation Group; 2020). The DCI is a measure of economic well-being at the zip-code level (Benzow et al., 2020). It evaluates seven metrics of well-being to describe five tiers of communities: prosperous, comfortable, mid-tier, at-risk, and distressed. Factors that impact which quintile a zip code is in include adults with a high-school diploma, poverty rate, prime-age adults not in work, housing vacancy rates, median household income, change in employment, and change in establishment (number of companies/establishments housed in the geographic region). According to the DCI, 22.5% of the population of SC resides in zip codes that are described as distressed communities (Benzow et al., 2020).

Descriptive statistics were used for demographic analysis. Mean change in weight, SBP, DBP, and knowledge scores from pre- to post-program participation was determined separately for the in-person and virtual groups. Wilcoxon signed ranks test determined significant differences within groups from baseline to post-participation and between groups (in-person HMP compared to virtual HMP) for mean changes in weight, knowledge scores, SBP, and DBP.

Table 2. Demographics of In-person and Virtual Hypertension Management Program Graduates

	In-person HMP (n=39)	Virtual HMP (n=29)	Pilot HCHC© (Dye et al, 2015) (n=146)
Age			
Mean in years	68	59	71
Range	59-80	27-77	59-89
Sex			
Male	6 (15%)	7 (24%)	46 (31%)
Female	17 (43%)	22 (76%)	100 (69%)
No response	16 (41%)	0 (%)	0 (0%)
Ethnicity			
Black	4 (10%)	8 (28%)	15 (10%)
White	19 (49%)	20 (69%)	125 (86%)
Hispanic	0 (0%)	1 (3%)	1 (.7%)
No response	16 (41%)	0 (0%)	5 (3.5%)
Distressed Community Index			
At-Risk or Distressed	3 (8%)	4 (14%)	
Comfortable or Prosperous	20 (51%)	25 (86%)	N/A
No response	16 (41%)	0 (0%)	

Results from In-person Program Delivery

There were 75 people recruited to participate in the in-person HMP. Nine people attended one or fewer sessions and were dropped from the program. Sixty-six participants attended two or more sessions. Of these, 39 participants graduated from the program (graduation = at least six of the eight sessions completed), resulting in a 59% graduation rate. For in-person programs, demographic data was incomplete, with only 10 of 39 participants reporting age. Twenty-three of 39 participants reported race/ethnicity and gender demographic questions. For the in-person sample, 10% were black, (n = 4), 49% white (n = 19), and 41% (n = 16) provided no response. Participants were 43% female (n = 17), and 41% (n = 16) provided no response. In-person programs reached 12 different zip codes representing one county. Of the 12 zip codes, 8% of participants came from at-risk or distressed zip codes as defined by the Distressed Community Index. Table 2 summarizes demographic information for the in-person HMP with comparisons to virtual HMP and the pilot HCHC© program.

Outcome indicators of in-person HMP success are included in Table 3. The HMP was not designed specifically as a weight loss program. However, 59% of the participants lost weight over the course of the program. At baseline, weight ranged from 98.4 to 333.2 pounds (M = 185 $\pm$ 42 pounds). At post-program, weights ranged from 94.5 to 333.2 pounds (M = 183 $\pm$ 42.3 pounds). Mean weight was significantly different from baseline to post-program (p = 0.0047) in the in-person sample, with an average participant weight loss of 1.9 pounds.

The knowledge test had a 22-point maximum score. Scores for the in-person group ranged from 4 to 22 at baseline ($M = 17.5 \pm 4.1$) and from 12 to 22 at program completion ($M = 20.5 \pm 4.1$). Seventy-seven percent of the participants significantly increased knowledge test scores with an average increase of 3.1 points. The difference in knowledge test scores from baseline to post-program was significantly different ($p = 0.0000$) for in-person program participants.

Normal SBP is a reading <130 mmHg, and hypertension is a reading >140 mmHg. SBP for the in-person sample ranged from 106 mmHg to 179 mmHg ($M = 142 \pm 16.4$ mmHg) at baseline. Eight percent of the sample had SBP $\leq$120 mmHg at baseline, and 41% had s SBP $\leq$140 mmHg. After participation, SBP ranged from 107 mmHg to 167 mmHg ($M = 135.2 \pm 17.1$ mmHg). Post-program, 23% of the sample had SBP $\leq$120 mmHg, and 62% had SBP readings <140 mmHg. At the completion of the program, 13% of the sample was able to reduce their SBP from high to normal. The average decrease in SBP was 13.12 mmHg, and these differences were statistically significant ($p = 0.0009$).

Normal DBP is $\leq$ 80 mmHg. DBP ranged from 60-102 mmHg ($M = 81 \pm 9.8$ mmHg) at baseline with 69% of participants reporting a DBP $\leq$80. Post-program, 72% of participants had a normal DBP, and readings ranged from 50-100 mmHg ($M = 75.5 \pm 10.1$ mmHg). While 21% of participants improved DBP from high to normal readings from baseline to post-program, change in mean DBP was not statistically significant for in-person program participants ($p = 0.0645$).

Results from Virtual Program Delivery

Fifty-nine participants were recruited into the virtual Hypertension Management Program. Of these, 38 participants completed two or more sessions for a 64% retention rate. Twenty-nine participants completed six of eight sessions for a graduation rate of 76.7%. Age ranged from 27 to 77 years old, with a mean age of 59 ($n = 29$). Twenty were white (69%), eight were black (28%), and one was Hispanic (3%). Twenty-two participants were female, representing 76% of the virtual program sample. In the virtual program, county residence eligibility requirements were lifted, resulting in the virtual program reaching 22 different zip codes in 12 different counties in the state by one Extension agent. Zip code data revealed that four participants were enrolled from at-risk or distressed zip codes, representing 14% of the sample.

For the virtual program, pre-program weight ranged from 122 pounds to 415 pounds ($M = 268.5 \pm 55.3$ pounds), and post-program weight ranged from 120 to 410 pounds ($M = 265 \pm 54.5$ pounds). Fifty-five percent of the sample lost weight ranging from 1 to 13 pounds, with an average weight loss of 3.5 pounds. Weight at baseline and post-program were significantly different ($p = 0.0047$). Six participants (20%) lost at least 5 pounds from pre- to post-participation. However, five people gained weight ranging from 1 to 4 pounds. The average weight gain was 1.7 pounds.

Nineteen of the 29 (66%) virtual participants improved knowledge scores from pre- to post-program participation, which was statistically significant ($p = 0.0006$). The mean increase was 3.9. Scores ranged from 12 to 22 (x = 17 $\pm$ 2.8) before participation and from 17 to 22 ($M = 22 \pm 1.9$) at completion. Four participants scored lower on the post-test than the pre-test (14%), and 6 participants showed no difference from pre- to post-program participation (21%).

Changes in SBP in the virtual program sample were significantly improved from baseline to post-program ($p = 0.0338$). Baseline SBP ranged from 104 mmHg to 168 mmHg ($M = 136 \pm 16.3$ mmHg) and 14% of the sample had a reading $\leq$120 mmHg. After participation, SBP ranged from 110 mmHg to 159 mmHg ($M = 134.5 \pm 12.4$ mmHg), 31% of the sample had a reading $\leq$120 mmHg, and 86% of participants had an SBP $\leq$140 mmHg. Seventeen percent of the sample decreased a high SBP to a normal SBP at program completion.

DBP ranged from 65 mmHg to 106 mmHg at baseline ($M = 85.5 \pm 8.4$ mm Hg) with 24% of the sample reporting a normal, $\leq$80 mmHg reading. Post-program, 48% of the sample had a normal DBP reading of $\leq$80 mmHg, and all participants had a diastolic blood reading of $\leq$90 mmHg. Readings post-program ranged from 64 mmHg to 90 mmHg ($M = 77 \pm 7.7$ mm Hg). Thirty-one percent of the sample changed their DBP reading from high to normal. This change was significantly different ($p = 0.0421$) for the virtual program.

Table 3. Baseline and Post-program Measurements for In-person Program Delivery and Virtual Program Delivery Methods of the Hypertension Management Program

Outcome Measurement	Baseline Mean (*SD*)	Post-program Mean (*SD*)	Significance *p*-value
In-person (*N* = 39)			
Weight (lb)	185.4 lb (42.0)	183.5 lb (42.3)	$p = 0.0047$*
Test Score	17.4 (4.0)	20.5 (2.1)	$p = 0.0000$*
SBP (mmHg)	142 mmHg (16.4)	135 mmHg (17.6)	$p = 0.0009$*
DBP (mmHg)	81 mmHg (9.8)	75.5 mmHg (10.9)	$p = 0.0649$
Virtual (*N* = 29)			
Weight (lb)	268.5 lb (55.3)	265 lb (54.5)	$p = 0.0430$*
Test Score	17 (2.8)	22 (1.9)	$p = 0.0006$*
SBP (mmHg)	136 mmHg (16.3)	134.5 mmHg (12.4)	$p = 0.0338$*
DBP (mmHg)	85.5 mmHg (8.4)	77 mmHg (7.7)	$p = 0.0421$*

Wilcoxon Signed Ranks conducted.

* indicates significant difference at $p \leq 0.05$ significance level.

Results Comparing In-person and Virtual Program Delivery

When comparing the results of the in-person program to the virtual HMP, there were no significant differences between changes in knowledge scores and SBP ($p = 0.394$ and $p = 0.107$, respectively). Significant differences were identified between groups for weight ($p = 0.021$) and

DBP (p = 0.022). Virtual program participants lost more weight than in-person participants (mean loss of 3.5 pounds versus 1.9 pounds, respectively) and had a greater decrease in SBP than in-person participants (mean decrease of 5.5 mmHg versus 8.5 mmHg, respectively). Table 4 summarizes the differences in results between in-person and virtual HMP and compares this with the findings from the HCHC© pilot study.

Table 4. Comparison of the Change in Measurements from Baseline to Post-program Participation in the Hypertension Management Program Delivered In-person and Virtually

Outcome Measurement	Mean Change In-person HMP (N = 39)	Mean Change Virtual HMP (N = 29)	Significance p-value	Mean Change Pilot HCHC© (Dye et al., 2015) (N = 146)
Weight (lb)	-1.9 lb	-3.5 lb	p = 0.021*	-2.48
SBP (mmHg)	-5.5 mmHg	-1.5 mmHg	p = 0.107	-5.78
DBP (mmHg)	-5.5 mmHg	-8.5 mmHg	p = 0.022*	-1.12

Wilcoxon Signed Ranks conducted.
* indicates significantly different at P≤0.05 significance level.

Discussion

While there was a high no-response rate for demographics for the in-person HMP, comparisons in demographics showed that in-person HMP and the pilot HCHC© study enrolled similar participants. Conversely, the virtual HMP participants were significantly younger by a mean age of 9 to 11 years than the in-person HMP and pilot HCHC© participants. Across the board, the participants were predominantly female, white, and non-Hispanic. However, there was a slightly higher percentage of black participants in the virtual HMP than in the in-person HMP. The difference in age between the in-person programs and the virtual HPM is likely a result of online recruiting strategies implemented in the virtual program. Very elderly participants are less likely to access social media and may not have been aware of or interested in a virtual hypertension education program (Parida et al., 2016). This difference in age ranges between the in-person and virtual HMP could have impacted the findings since blood pressure is known to increase with age (Fryar et al., 2018).

General guidelines for blood pressure management include weight management through the adoption of a low-sodium diet and exercise (American Heart Association, 2016a, 2016b; Rice et al., 2018; Unger et al., 2020). While weight loss was not a primary goal of the original program, the HCHC© pilot study reported small but significant changes in weight (2.48 pounds weight loss). HMP participants also demonstrated small, significant weight losses, but the virtual program had a greater mean weight loss than in-person HMP (x=3.5 and x=1.9, respectively, p=0.021). Findings related to weight loss are not surprising because the HCHC© curriculum strongly focuses on eating well and moving more which are keys to weight loss success (AHA, 2016a). Interestingly, the virtual HMP had a much higher mean weight at baseline than the in-person HMP (268+55.3 pounds versus 185.4+42 pounds, respectively). It is possible that the

virtual platform for HMP served as a better, less threatening option for those who are overweight or obese.

A comparison of the blood pressure results shows that those who participated in the HCHC© pilot study had a mean reduction of 5.78 mmHg and 1.12 mmHg in SBP and DBP, respectively (Dye et al., 2015). In the current study, HMP showed a significant mean reduction in SBP of 5.5 mmHg for the in-person program and 1.9 for the virtual HMP. Comparisons of DBP showed a greater decrease of 5.5 mmHg and 8.5 mmHg for in-person and virtual HMP, respectively, than the 1.12 mmHg reduction in HCHC©. It's possible that the difference in significance for DBP resulted from the intermittent health-coaching calls and/or the "Ask it Basket" activity that linked clinical questions to clinical healthcare personnel.

Historically, findings from the National Health and Nutrition Examination Survey (NHANES) and Framingham Heart Study showed that a decrease of as little as 2-3 mmHg in mean SBP can reduce cardiovascular events (Cook et al., 1995; Halm & Amouka, 2008; Nicoll & Henein, 2010; Walsh et al., 2006). Another assessment found that a 10% proportional reduction in blood pressure could lead to cardiovascular event reduction (Hardy et al., 2015). Most recently, Wei et al. (2020) reported that a 10/5 mmHg reduction in blood pressure can significantly reduce the incidence of stroke, cardiovascular events, and cardiovascular death. For our in-person HMP, 53% decreased SBP by at least 10 mmHg, and 44% decreased DBP by at least 5 mmHg. In the virtual program, 34% decreased SBP by at least 10 mmHg, and 38% decreased DBP by at least 5 mmHg. If a 10/5 mmHg reduction in blood pressure leads to a reduction in cardiovascular events, as suggested by Wei et al. (2020), results from this study suggest that participation in HMP, whether in-person or virtual, resulting in decreased blood pressure could help participants decrease their risk of cardiovascular events through blood pressure self-management.

Finally, using virtual platforms as an alternative method of program delivery was an unforeseen modification resulting from the COVID-19 pandemic. However, delivery through a virtual platform proved to be an efficient and effective method for educating people with hypertension on self-management of their chronic condition. While it took two years to graduate 39 participants from the in-person program in one county, the virtual program graduated 29 participants in 6 months from 12 different counties in the state. Offering the HMP through a virtual platform also increased program delivery efficiency because it allowed for one Extension agent to reach a much larger geographic area than can be reached through face-to-face delivery. The virtual program reached at-risk and distressed communities similar to the in-person program. Also, the virtual platform for the HMP allowed for agent flexibility with less impact on work-life balance when expanding offerings to evening and lunchtime classes. Finally, a virtual platform may appeal to overweight, obese individuals who may not be comfortable attending in-person classes.

Limitations

While we were able to recruit 134 people into the combined programs (in-person and virtual HMP), the attrition rate was high at 44% resulting in a small sample size of 68 (39 in-person, 29 virtual). The COVID-19 pandemic interrupted several in-person HMP groups, contributing to the attrition rate. Another limitation is the change in program delivery method from in-person to virtual. All efforts were made to maintain the established methodology, and programs were delivered using the same lesson plans and activities completed in person. However, this change in methodology impacted how people were recruited and enrolled, likely impacting the age and weight at baseline of the virtual participants. Prior to the pandemic, the in-person program was delivered extensively in local senior centers resulting in higher mean age for in-person HMP participants. Lastly, COVID-19 stay-at-home orders could have impacted access to healthy foods, physical activity options, and socialization in the virtual program sample.

Another challenge was the change in program supply funds because of the inability to deliver HMP in senior centers. Without this delivery avenue, we could not bill for services (through Title III-D funds) that were supporting the program materials and supplies. Additionally, the program cost increased because materials had to be shipped to participants. Because of this, we could not provide new blood pressure monitors to all participants (something we tried to do during the in-person program) and could only distribute monitors to those who did not already have one available.

Finally, using self-reported weights and blood pressure readings was a limitation of the current study. The pilot study had research assistants and a team dedicated to data collection. It was impractical, however, for Extension agents who were delivering the program alone to take these direct measurements. When the program was transitioned to virtual HMP, only self-reported weights and blood pressures were available. Both the in-person HMP and virtual HMP collected self-reported weights and blood pressures. While this maintained our study methodology, differences due to human error or failure to report accurate readings when taking blood pressures cannot be ruled out.

Conclusion

Positive results from the current study suggest that hypertension self-management educational programs like HMP can be delivered successfully by Extension agents through the Cooperative Extension Service network. Using the evidence-based HCHC© curriculum allows for financial support of the program through Title III-D funds, and partnerships with senior centers offer a steady pool of participants. Also, virtual program delivery was an effective strategy during the COVID-19 pandemic, and the results justify continued program delivery through both in-person and virtual platforms for maximized reach. Finally, expanding this program to additional counties and Extension systems in other states could help more individuals lower their blood

pressure with lifestyle behavior changes facilitated through an educational program and potentially reduce their risk for cardiovascular events.

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