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The association between mHealth wearables and hypertension self-management in African-born immigrants from medically underserved areas in the United States: a causal-comparative study

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ABSTRACT

Background

Hypertension remains a major global health concern, increasing the risk of heart disease and stroke. It affects over 1.3 billion adults globally and nearly half the US adult population (47.3%), or 116 million individuals. African-born immigrants (40.2%) are disproportionately affected compared to 30% for other ethnic groups. A significant portion of Americans (67 million) have uncontrolled hypertension. Using mHealth interventions, especially wearable devices, has shown some potential in improving hypertension control and treatment compliance in ethnic minorities.

Methods

This causal-comparative study conducted in 2024 aimed to determine if there is an association between using mHealth wearable devices and improving hypertension control in African-born immigrant groups. The inclusion and exclusion criteria consisted of having a hypertension diagnosis, being 45-75 years old, reading at a third-grade level, and living in a medically underserved primary care area (MUA). A t-test was used to compare the mean arterial pressure data in two groups.

Results

All 100 participants from nine MUAs were randomly divided into two equal groups. Group 1 used a smart watch (the mHealth group) to measure their blood pressure, whereas Group 2 (the usual care group) used an automated blood pressure monitor. The study yielded two statistically significant results, including 1) the mean arterial pressure at the end of six weeks was lower in the mHealth group than in the usual care group ($p < 0.001$) with a -4 mmHg difference. The mHealth group participants achieved a better mean arterial pressure with a -3 mmHg reduction in mean arterial pressure ($p = 0.005$).

Conclusions

The study suggested that African-born immigrants can benefit from using mHealth wearable devices to improve hypertension management. It contributed to the understanding of factors associated with the higher prevalence of hypertension among African-born immigrants. It aligns with ongoing efforts to uncover novel approaches for assisting minority populations in low-resource settings to control hypertension using mHealth wearable devices.

Keywords: African-born immigrants, digital health, hypertension control, mHealth wearable devices, smart watch.

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INTRODUCTION

Hypertension remains a major global health concern, significantly increasing the risk of heart disease and stroke. Globally, over 1.3 billion adults suffer from hypertension.[1,2] In the United States, hypertension affects nearly half of the adult population (47.3%), equating to 116 million individuals.[1] Hypertension disproportionately affects African Americans.[2] Furthermore, in the U.S., the prevalence of hypertension is notably high among African-born immigrants (45%), compared to 30% for other ethnic groups, including 32% for non-Hispanic Caucasian Americans and 30% for Hispanics.[3] Effective hypertension management includes lifestyle modifications as part of prevention and treatment, pharmacotherapy, and working closely with healthcare team members with the common aim of achieving the recommended BP below 130/80.[4]

The Centers for Disease Control and Prevention defines hypertension as having a blood pressure (BP) that is consistently higher than normal BP <120/80 mmHg.[1,3] This study referred to hypertension control in African-born immigrants as achieving the recommended treatment goal of BP <130/80 based on the recent American College of Cardiology/American Heart Association 2017 hypertension practice guideline.[5,6] Over the last decade, 67 million Americans (73%) did not achieve BP control.[2] Only 39% of African Americans achieved hypertension control compared to 49% of their non-Hispanic Caucasian counterparts.[3,7] The most common risk factors for hypertension include a sedentary lifestyle, an unhealthy diet, obesity, cigarette smoking, physical inactivity, excessive alcohol consumption, and genetics.[8]

Innovative approaches, such as mHealth interventions, can help achieve hypertension control in minority groups, including African-born immigrants, who are among the fastest-growing populations owning smartphones.[9] Mobile health (mHealth) is a medical and public health practice technology in which mobile devices and applications, including smartwatches, promote chronic disease treatment compliance. mHealth is a recently adopted strategy to help manage chronic health conditions, such as hypertension.[10] Despite the lack of access to mHealth wearable devices for two-thirds of the United States population, using such devices could help address cardiovascular health disparities in ethnic minority communities.[11] One in two Americans was diagnosed with hypertension, and only 35% of them use mHealth wearable devices to monitor their blood pressure.[11] While there are no significant gender differences in using mHealth wearable devices between women and men, ethnic differences exist between African Americans and other ethnicities.[12]

African-born immigrants are less likely to use mHealth wearable devices for hypertension self-monitoring than Caucasian Americans. Such devices are especially valuable in providing tailored education resources for vulnerable populations diagnosed with hypertension.[13] mHealth can also facilitate lifestyle changes for African-born immigrants in the U.S. Twenty-four percent of African-born immigrants in Arizona face other challenges in hypertension self-monitoring, including low English proficiency levels and limited health literacy, which imply limited aptitude in reading, speaking, writing, or understanding the English language to navigate the healthcare systems.[14] The study's target population was African-born immigrants residing in medically underserved primary care areas in Maricopa County, Arizona. The participants were males and females aged 45-75, born outside the United States, Puerto Rico, or other U.S. territories. The study participants used the Dafit smartwatch with a mobile application to monitor their blood pressure (BP).

The problem addressed by the study was the underutilization of mHealth wearable devices, which results in inadequate blood pressure control among African-born immigrants in Arizona. Despite developing and applying several hypertension management guidelines and tools in clinical practice, limited studies have investigated how mHealth wearable devices can improve BP management in African-born immigrants.[4] Several studies recommend making mHealth research more inclusive to manage hypertension and achieve digital health equity.[2,15] Hypertension research in African Americans often focuses on the native-born African American population, with less attention on African-born minority groups.[16] There is still a lack of evidence about the causal association between using mHealth wearable devices and improving blood pressure control in African-born immigrants.[2,16]

The purpose of this study was to investigate the association between using mHealth wearable devices with the Dafit mobile application and automated BP monitors in improving BP self-monitoring among African-born immigrants. The target groups were males and females aged 45-75 living in Maricopa County, Arizona. The study was guided by the following null hypotheses:

$H_0$1: There is no statistically significant difference in hypertension control between African-born immigrants who use the Dafit mHealth wearable device with a mobile application compared to those who use automated BP monitors (as measured by MAP, MSBP, and MDBP).

$H_0$2: There is no statistically significant difference in hypertension control between pre- and post-BP measurements in African-born immigrants who use the Dafit mHealth wearable device with a mobile application (as measured by MAP).

METHODS

Study Design

This non-experimental study used a causal-comparative research design to evaluate the effect of using mHealth wearable devices on the management of hypertension. A causal-comparative design enabled the investigator to examine the association between the independent variable (use of the Dafit mHealth wearable device) and the dependent variables: differences in mean arterial pressure (MAP), mean systolic blood pressure (MSBP), and mean diastolic blood pressure (MDBP).[17] A between-subjects subtype of a causal-comparative design helped to expose both groups to different conditions. The study was approved by Liberty University's Institutional Review Board (IRB-FY23-24-253) (see Appendix G).

Study Setting and Participants

The study was conducted in Maricopa County, Arizona, United States in 2024. Maricopa is Arizona's most populous county, with a population of 4.58 million, constituting 62% of the total population of Arizona.[14] The target population was distributed across nine medically underserved primary care areas (MUAs) in Maricopa County.[18] An MUA is a geographical area whose residents lack or have limited access to primary healthcare services.[19] The designation of MUAs helps maintain community health and promotes access to essential health services.[19] The study referred to such areas as strata, which included the cities and towns of Buckeye, El Mirage, Glendale, Guadalupe, Laveen, Tolleson, Peoria, Phoenix, and Tempe. The target participants for the study were male and female African-born immigrants aged 45 - 75 years, with a diagnosis of hypertension.

The study focused on an age group with a higher prevalence of hypertension compared to younger populations.[20] It is estimated that 2,698 (64%) of these African-born immigrants with hypertension live in Maricopa County.[18] The study used the following inclusion and exclusion criteria.

Inclusion criteria: The main criterion for inclusion was being an African-born immigrant, between the ages of 45 and 75 years, diagnosed with hypertension within the last 3 years preceding this study with the cutoff BP <130/80 mmHg. Other inclusion criteria were:

- Having a reading level of third grade to answer the study questions,
- Living in Maricopa County's specific medically underserved primary care area[14]
- Owning and actively using an automated blood pressure monitor to check BP independently, and
- Owning a smart mobile device on which to download the Dafit mobile application.

Exclusion criteria: The main exclusion criterion was the lack of hypertension diagnosis, the inability to measure blood pressure independently using an automated BP monitor, or being outside the age range of 45 to 75 years. Additional exclusion criteria were:

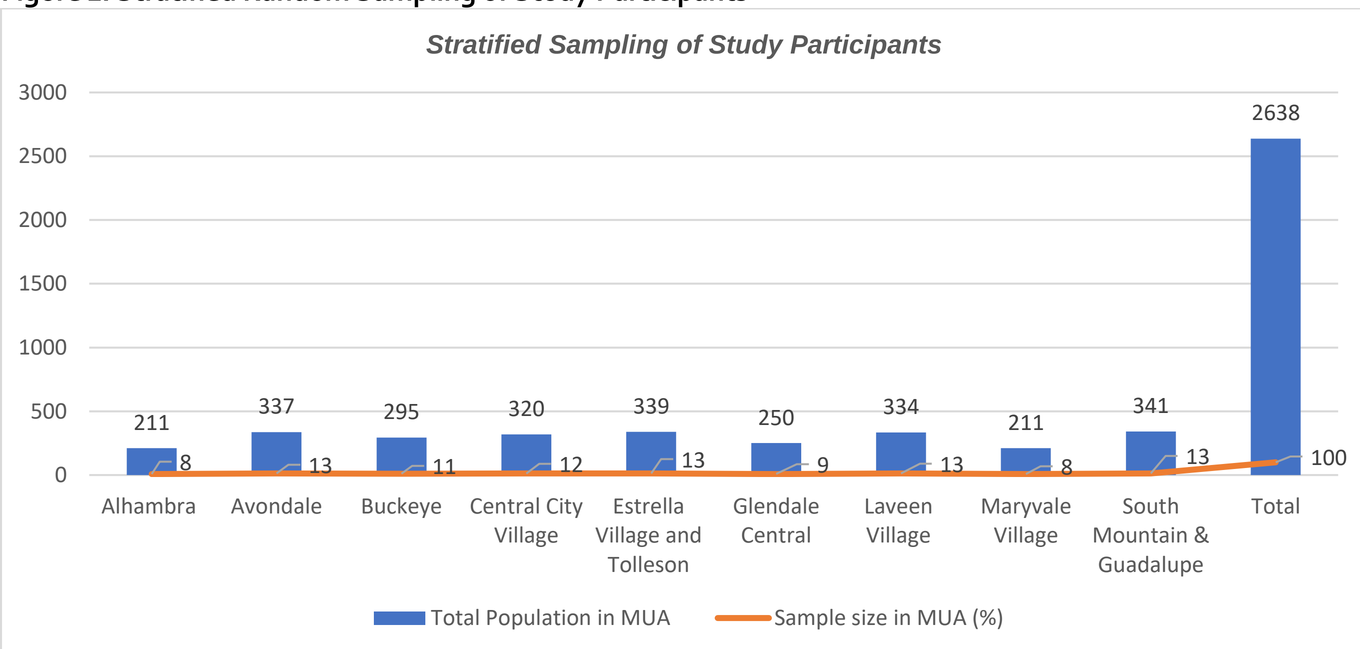
- The inability to read at a third-grade level to complete the questionnaire independently,
- The lack of a personal smart mobile device, and
- Relocating outside Maricopa MUAs during the data collection period.
-

Study Procedures

Recruitment and informed consent: The process of recruiting 100 participants consisted of reaching out to African-born immigrants' associations and agencies and attending their events. Permission was sought from these agencies to display the recruitment posters/flyers (see Appendix A). This attracted 124 target participants who signed the electronic consent form, using the QR code provided, to participate in the study (see Appendix B).

Procedure: Participants were randomly selected from 2,698 African-born immigrants in nine medically underserved primary care areas.[18] The investigator used the Piface sample size estimator to determine the sample of 100 participants was based on the statistical power of 0.08 at the alpha level of 0.05 and 95% confidence.[21] Therefore, the required minimum sample size was 99.74. The study used stratified random sampling to select 100 participants who met the inclusion criteria from 124 participants who signed the electronic consent form.[22]

Figure 1: Stratified Random Sampling of Study Participants



The investigator used the following formula to determine the target strata sample size (n_h) in each MUA (stratum):

$$n_h = \left(\frac{N_h}{N}\right) * n$$

N_h denotes the sample size, N denotes the population size, and n denotes the stratum size. A desired sample of 100 participants was divided by the total number of target participants who met the inclusion criteria (2638) times the total population number in each MUA (stratum). Figure 1 illustrates the distribution of eligible participants across the MUAs. Four MUAs (Avondale, Estrella Village and Tolleson, Laveen Village, and South Mountain and Guadalupe) had the highest number of eligible participants, with 337, 339, 334, and 341 participants, respectively. Each of these MUAs received 13% of the total sample size (N = 13 participants). The remaining five MUAs (Central City Village, Buckeye, Glendale Central, Alhambra, and Maryvale Village) had 320, 295, 250, 211, and 211 eligible participants, respectively. Their corresponding sample proportions were 12% (N = 12), 11% (N = 11), 9% (N = 9), 8% (N = 8), and 8% (N = 8), respectively. Half (N = 50) of the study participants were randomly assigned to the mHealth group (group 1), and the other half (N = 50) to the usual care group (group 2).

Data Collection Measures

The study used the investigator-designed BP form and a questionnaire to collect information from participants in mHealth and the usual care groups. Each group received a different form and questionnaire with predetermined questions. All participants recorded their BP levels on blood pressure forms daily for six weeks (see Appendix C for the mHealth group and Appendix D for the usual care group). Participants also completed an electronic questionnaire via encrypted Google Forms (see Appendix E) for the mHealth group and (see Appendix F) for the usual care group. All participants transferred the BP information from forms to questionnaires. The questionnaire consisted of 21 questions for group 1 and 17 questions for the usual care group and took approximately 20 minutes to complete. Data collection was done between January and April 2024.

Interventions

Half of the 100 research participants (the mHealth group or group 1) received a free Dafit smart watch with access to a mobile application from the primary investigator, equivalent to a $55 value. The mHealth group participants used a Dafit smart watch to measure and record their BP electronically and on BP forms for six weeks (12 hours a day from 8 a.m. to 8 p.m.). The other half of the participants (the usual care group or group 2) used different brands of automated BP monitors to measure and record their BP values on BP forms twice daily for six weeks. Participants in the usual care group were instructed on proper BP measurement techniques, including calibrating their BP monitors, and encouraged to seek clarification as needed throughout the study. The usual care group participants checked their BP once in the morning around 8 a.m. and once in the evening around 8 p.m. Also, a free Dafit smart watch ($55 value) was randomly given as a prize drawing at the end of the study to a select 25 out of 50 participants in the usual care group to motivate them to sign up for the study. No financial incentives or payment was given to participate in the study.

A Dafit smart watch was used for the study. Given the target population's limited financial resources, participants received a free non-U. S. Food and Drug Administration (FDA)-approved Dafit smart watch instead of more expensive FDA-approved models like the Omron HeartGuide.[23] The minimum required model was the 2023 Dafit smart watch. The Dafit smart watch has a free mobile application (also known as KW17 Pro) in Google Play for Android devices and the App Store for iOS (Apple) products. Dafit smart watch transmits BP data wirelessly to the mobile application. The study participants were required to have a smartphone or another smart device to download the Dafit application.

The investigator calibrated all the Dafit smartwatches before distributing them to study participants.[24] Calibration increased the internal and external validity. The investigator completed the validation process in October 2023 and reviewed the data from the validation process to ensure their accuracy and consistency. Participants were instructed to measure and record their BP twice daily (morning and evening) at the same time for six weeks. The investigator advised participants to sit comfortably in an upright position for at least five minutes before each BP measurement, rest their arms on a table, and ensure the BP cuff or the Dafit smartwatch was about the same height as their heart level.[25,26]

Data Analysis

Data analysis was done using IBM SPSS 29.0 statistical software. This study used an independent sample t-test to compare the mean arterial pressure (MAP), mean systolic blood pressure (MSBP), and mean diastolic blood pressure (MDBP). Two independent samples t-test were helpful in deciding whether there were differences between the means of the two groups of participants.[27] A paired samples t-test was used to analyze data comparing MAP measurement in the mHealth group participants related to pre- vs. post-study MAP results.This study's findings provide valuable insights into the association between using mHealth wearable devices and improved hypertension self-management, specifically highlighting the potential benefits of increased awareness and frequent BP monitoring.

RESULTS

Demographic Characteristics

All 100 participants (N = 100) completed the study. Table 1 shows demographic characteristics, such as gender, age group, African region of origin, and the medically underserved primary care areas.

Table 1. Demographic Statistics of Study Participants

Demographic Characteristics	***mHealth Group*** ***N_1 (%)***	***Usual Care Group N_2 (%)***	***Total*** ***N (%)***
Gender			
Male	23 (46)	24 (48)	47 (47)
Female	27 (54)	26 (52)	53 (53)
Age group			
45-55	30 (63)	31 (62)	61 (62)
56-65	12 (25)	13 (26)	25 (26)
66-75	6 (12)	6 (12)	12 (12)
African Region of Origin			
Central Africa	9 (18)	10 (20)	19 (19)
Eastern Africa	19 (38)	18 (37)	37 (37)
Northern Africa	7 (14)	8 (16)	15 (15)
Southern Africa	8 (16)	8 (16)	16 (16)
Western Africa	7 (14)	6 (12)	13 (13)
Medically Underserved Primary Care Area (MUA)			
1. Alhambra Village	4 (8)	4 (8)	8 (8)
2. Avondale	7 (14)	6 (12)	13 (13)
3. Buckeye	5 (10)	6 (12)	13 (11)
4. Central City Village	6 (12)	6 (12)	12 (12)
5. Estrella Village & Tolleson	6 (12)	7 (14)	13 (13)
6. Glendale Central	5 (10)	4 (8)	9 (9)
7. Laveen Village	7 (14)	6 (12)	13 (13)
8. Maryvale Village	4 (8)	4 (8)	8 (8)
9. South Mountain & Guadalupe	6 (12)	7 (14)	13 (13)

Table 1 shows that more female respondents (N = 53) participated in the study than male participants (N = 47). The percentage of female participants was 53% vs. 47% for male participants. The number of participants by gender was slightly equal in both groups. The most common age group of research participants was between 45 and 55 years old (N = 61, 62.2%), followed by 56-65 with the second highest participation rate (N = 25, 26%). The older adult age group (66-75) had the lowest number of participants in the study (N = 12, 12%). Two participants (N_1 = 2) did not disclose their age in the mHealth group.

Table 1 also shows that most research participants (N = 37, 37%) were born in the Eastern African region. The Southern African regions consisted of 16 participants (N = 16, 16%), while the Northern region had 15 research participants (N = 15, 15%). The Western African region had the lowest number of participants (N = 13, 13.1%). Four MUAs, including Avondale, Estrella Village and Tolleson, South Mountain and Guadalupe, and Laveen Village, had the most research participants (N = 13, 13%) each. Alhambra and Maryvale villages had the lowest number of participants (N = 8, 8%) each. The number of participants in each MUA was equal or slightly equal.

Hypertension Outcomes

Overall Hypertension Control Outcomes

Unless otherwise noted in this study, all values of mean arterial pressure (MAP), mean systolic blood pressure (MSBP), and mean diastolic blood pressure (MDBP) resulted from the means of a millimeter of mercury (mmHg). Such values were indicated by mean (*M*) and standard deviation (*SD*). The significance level (p-value) was set at $p < 0.05$ (alpha value), and the confidence interval (CI) was calculated at 95%. The MAP values were rounded to the nearest whole number to simplify data presentation and to keep numbers close to their original values. N_1 denotes the number of participants in the mHealth group, whereas N_2 denotes the number of participants in the usual care group. N denotes participants in both groups.

Table 2. MAP, MSBP, and MDBP Results at the End of the Study

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p			Lower	Upper
MAP after 6 weeks	Equal variances assumed	.058	.811	-4.035	94	<.001	<.001	-4.1122	1.0191	-6.1356	-2.0887
	Equal variances not assumed			-4.025	92.120	<.001	<.001	-4.1122	1.0216	-6.1412	-2.0832
MSBP after 6 weeks	Equal variances assumed	.095	.759	-3.955	94	<.001	<.001	-4.0462	1.0232	-6.0777	-2.0147
	Equal variances not assumed			-3.946	92.321	<.001	<.001	-4.0462	1.0253	-6.0825	-2.0098
MDBP after 6 weeks	Equal variances assumed	.053	.819	-4.070	94	<.001	<.001	-4.1462	1.0188	-6.1691	-2.1233
	Equal variances not assumed			-4.059	92.106	<.001	<.001	-4.1462	1.0214	-6.1747	-2.1177

Table 2 shows a statistical difference for MAPs between groups 1 and 2 by the end of six weeks of their participation in the study based on p-values from independent samples t-test data. The MAP was lower in the mHealth group (*M* = 99, *SD* = 5.1) than in the usual care group (*M* = 103, *SD* = 4.8), $t(94) = -4$, *p*

< 0.001. Lavene's test for equality of variance was tested to determine if variances were equal for the two group samples. The Lavene statistic was based on the MAP's mean at the end of the study, $F(1,94) = 0.058$, $p = 0.81$ was > 0.05 (alpha value). As the p-value of the Lavene test was greater than $p > 0.05$, the homogeneity assumption of the variance for both groups was met.[28] A significant difference was also noted in the MSDB and MDBP. The MSBP for the mHealth group ($M = 125$, $SD = 5.1$) was lower than in the usual care group ($M = 129$, $SD = 4.18$), $t(94) = -3.9$, $p < 0.001$. Also, the MDBP was lower in the mHealth group ($M = 85$, $SD = 5.1$) than in the usual care group ($M = 89$, $SD = 4.8$), $t(94) = -4$, $p < 0.001$. Both groups had a difference of 4 mmHg MAP. Therefore, the null hypothesis (H_01) was rejected as the difference in MAP ($p < 0.001$ was < 0.05 than alpha value) was unlikely to happen if such hypotheses were true.

Table 3. Comparison of MAP, MSBP, and MDBP assessments at the Baseline and at the End of the Study

		Baseline			After 6 weeks		
	Grouping Variable	N	Mean	Std. Deviation	N	Mean	Std. Deviation
MAP	mHealth Group (N_1)	50	101	7.8089	46	99	5.1391
	Usual Care Group (N_2)	49	103	8.289	50	103	4.8456
MSBP	mHealth Group (N_1)	50	128	7.8089	46	125	5.1391
	Usual Care Group (N_2)	49	130	8.289	50	129	4.8847
MDBP	mHealth Group (N_1)	50	88	7.8089	46	85	5.1391
	Usual Care Group (N_2)	49	89	7.4744	50	89	4.8429

Six weeks before both groups participated in the study, their MAP was predominantly high (101 mmHg for the mHealth group vs. 103 mmHg for the usual care group). The post-study results showed a significant statistical difference for MAPs between groups 1 and 2 at the end of six weeks of the study ($p < 0.001$). Accordingly, the results implied that the participants (the mHealth group) who used mHealth wearable devices achieved a better MAP with a significant difference of 4 mmHg than the usual care group participants who did not use smartwatches. The MAP was critical to determine such a difference. The mean blood pressure differences were also noted in the systolic (MSBP) and diastolic (MDBP) measurements. The mHealth group achieved a lower MSBP (125) than the usual care group (129) with a mean difference of 4 mmHg reduction in mean systolic blood pressure (Table 3). The mHealth group also achieved a lower MDBP than the usual care group, with a mean difference of 4 mmHg reduction in MAP.

Figure 2. Comparison of Mean Arterial Pressure Differences by African Region of Origin

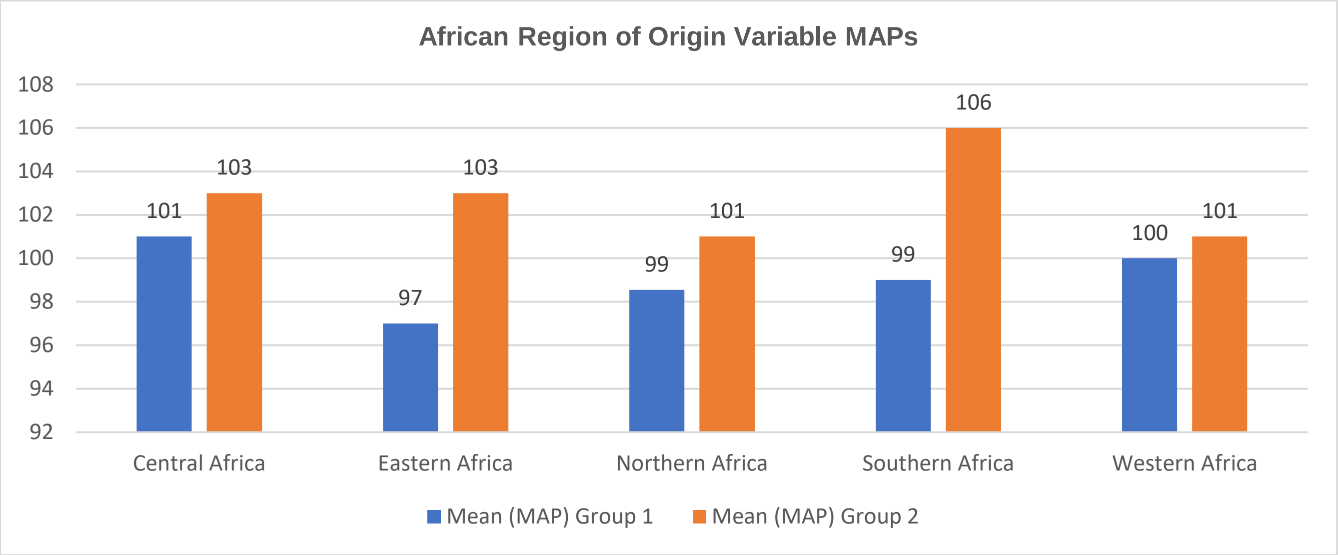


Figure 2 compares the differences between research participants' MAPs in groups 1 (the mHealth group) and 2 (the usual care group) based on the African region of origin. It shows that the research participants who originated from the Eastern African region achieved a better MAP of 97 in the mHealth group than in the usual care group, which achieved a MAP of 103. All other African regions of origin, including Central, Northern, Southern, and Western Africa, also achieved better MAPs in the mHealth group than in the usual care group. Such findings supported the study result for H_01, which showed that MAP differences exist in both groups (Table 2).

Figure 3. Comparison of Mean Arterial Pressure Differences by MUA

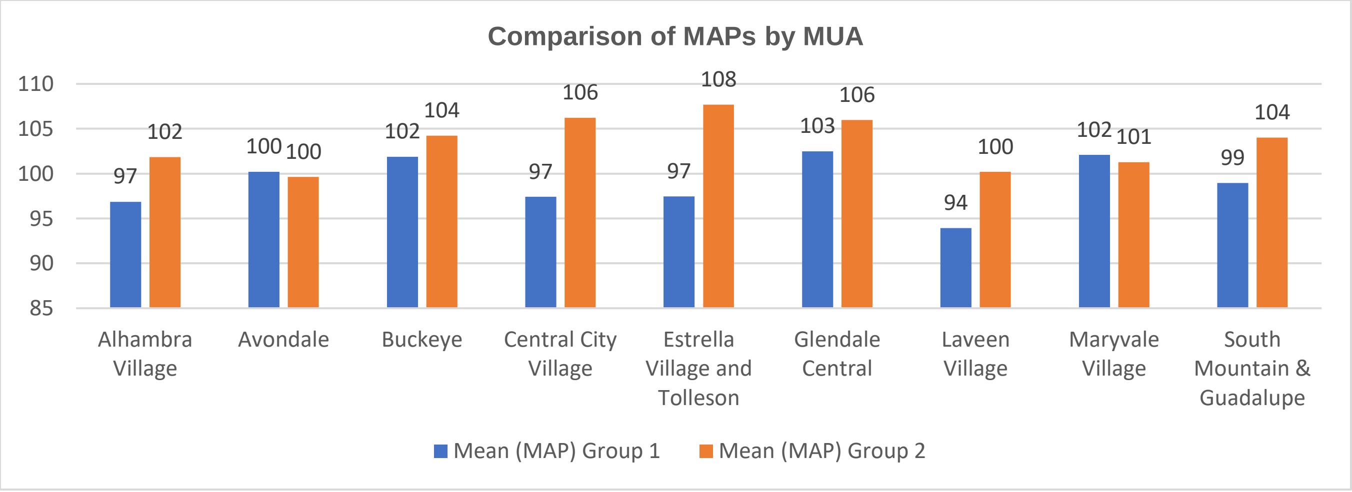


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Figure 3 illustrates the variation in MAPs between research participants in the mHealth group (Group 1) and the usual care group (Group 2) across nine different MUAs. In seven MUAs (Alhambra Village, Buckeye, Central City Village, Estrella Village and Tolleson, Glendale Central, Laveen Village, and South Mountain and Guadalupe), the mHealth group demonstrated lower MAP values, ranging from 97 to 103 mmHg, compared to the usual care group (100-108 mmHg). However, in the Avondale MUA, both groups exhibited identical MAPs of 100 mmHg. Interestingly, in Maryvale Village MUA, the usual care group achieved a slightly lower MAP (101 mmHg) than the mHealth group (102 mmHg).

Hypertension self-management outcome before and after participating in the study

The results showed a significant statistical difference for MAPs in the mHealth group (group 1) before and after participating in the study (pre and post) using mHealth wearable devices based on the paired samples' p-values. The post-study data showed a more remarkable improvement in MAP ($M = 99$, $SD = 5.1$) than the pre-study MAP ($M = 101$, $SD = 7.7$), $t(45) = 2.9$, $p = 0.005$. A reduction in MAP of -2 mmHg was observed. The differences in group means were statistically significant in achieving a better MAP at the end of six weeks than on the first day of using mHealth wearable devices. Based on such results, the null hypothesis (H_02) was rejected as $p = 0.005$, which was < 0.05 than the alpha value, suggesting a significant difference in MAP values for the mHealth group at the end of the study.

DISCUSSION

This causal-comparative study investigated the association between utilizing mHealth wearable devices and improved blood pressure control among African-born immigrant groups living in medically underserved Arizona primary care areas. It revealed that differences in MAPs, MSBP, and MDBP exist between the mHealth and the usual care groups. The most crucial finding from the research was that the MAP at the end of the study was lower in the mHealth group than in the usual care group, with a -4 mmHg difference (Table 3). The MAP for the mHealth group was ($M = 99$, $SD = 5.1$), whereas the MAP for the usual care group was ($M = 103$, $SD = 4.8$), $t(94) = -0.4$, $p < 0.001$. Similar findings were noted, indicating a more significant improvement in MAP, MSBP, and MDBP for minority groups who use mHealth wearable devices than the control groups who do not use such devices.[29] Previous research has demonstrated that the population with disparities in digital health resources who used self-management equipment with mobile applications achieved an MSBP difference of -4 mmHg with 95% CI.[29] Another study revealed that at the end of different time intervals ranging from months one, three, six, and nine, the MSBP for 54 study participants who used mHealth devices was lower in the experimental group than in the control group.[30] The MSBP was 125 vs. 140 mmHg (month one), 120 vs. 137 mmHg (month 3), 121 vs. 146 mmHg (month 6), and 122 vs. 145 mmHg (month 9) with ($p < 0.01$).[30]

In several other studies, 2607 African Americans and 1631 Hispanics aged between 46 and 71 years old with hypertension who used digital health interventions experienced significant improvements in MSBP and MDBP after six months.[31] The MSBP changes between intervention and control groups ranged from 1.90 mmHg to −13.70 mmHg (95% CI), while the MDBP changes ranged from 1.50 mmHg to -6.70 mmHg (95% CI) over six months.[31] These results suggest that digital health interventions, including mHealth, are crucial for effectively managing hypertension, particularly among populations facing health disparities. The intervention group participants experienced significantly greater reductions in blood pressure compared to the usual care group participants.[32] The results highlight the potential of personalized digital health approaches to improve hypertension outcomes and promote greater health equity.

Current study findings align with the results from previous studies that reported a greater impact of mHealth wearable devices on MSBP in which participants achieved a reduction of -3 mmHg.[32] The same participants also achieved the MDBP with a mean reduction of -1 mmHg compared to participants who used traditional strategies.

Similar studies noted a substantial reduction of -4 mmHg in MSBP and -2 mmHg in MDBP in a subgroup using mHealth wearable devices.[33] The above findings align with current study results and support the association between using mHealth wearable devices and achieving better hypertension control.

In contrast, this study noted that one MUA (Maryvale Village) in the usual care group achieved a slightly lower MAP (101 mmHg) than the mHealth group (102 mmHg). Additionally, both groups exhibited identical MAPs of 100 mmHg in the Avondale MUA. Some researchers have suggested that adherence to study protocols in mHealth studies may decline among participants in some underserved communities over time due to factors, such as advanced age, limited technological literacy, employment status, place of residence, and privacy concerns.[34] This potential lack of adherence and geographical and socioeconomic disparities are frequently prevalent within these communities and could potentially explain the lack of significant differences in MAPs observed between the mHealth and usual care groups in Maryvale and Avondale villages MUAs.

Some studies noted that despite a reduction of -4 mmHg in MSBP, seven randomized clinical trials found no statistical significance in MSBP reduction at 6-month intervals between the intervention and control groups ($p = 0.48$).[29] Such results contradict current study findings. This disparity in results may be attributed to differences in sample size and/or duration of study. In this study, groups 1 and 2, with 50 participants each, took part in the study for six weeks. The results of this study showed how African-born immigrants, a segment of the African American population often not represented in major health research, can benefit from mHealth wearable devices.[35] Nevertheless, lifestyle changes, including a healthy diet and physical activity, would significantly contribute to better hypertension management. The research contributes to existing knowledge on how to improve patient involvement and its positive impact on the management of hypertension in African-born immigrants in Maricopa County, Arizona.

Despite increasing interest in minority groups using mHealth wearable devices to manage chronic conditions, digital health disparities persist in making eHealth and mHealth intervention research more inclusive.[36] Most studies conducted on mHealth wearable devices and their relationship with hypertension management were limited to Caucasian, Hispanic, and Asian population groups.[37] Even the limited studies about the use of mHealth wearable devices in minority groups to improve hypertension management considered African Americans and African-born immigrants as a homogenous population.[3] Notwithstanding significant advancements in eHealth technology, mHealth's contribution to hypertension management among minority groups, such as African Americans, American Indians, and Pacific Islanders, remains largely underexplored.[38]

As a result, the gap in digital health disparities was not closed in earlier literature.[38] Therefore, some experts suggest that more studies are necessary to determine how mHealth wearable devices' interventions can address social determinants of health and explore different approaches to increasing the use of these devices.[4] mHealth interventions can foster behavior change and create relationships that support this change over time. Additionally, they can enhance the alignment between users' needs and sociodemographic factors, particularly within minority groups.[39]

STUDY LIMITATIONS

Some limitations were noted in this study. They included using a free non-FDA-approved smartwatch and the potential bias in BP recordings reported by nonmedically trained participants. At the time of the study, the only FDA-approved smartwatch, Omron HeartGuide, was unaffordable due to the limited financial resources of research participants.[23] To mitigate the threat of using a non-FDA-approved smartwatch on internal and external validity, the investigator provided a free, calibrated, and validated Dafit smartwatch for all participants in the mHealth group.[24] The potential bias in blood pressure recordings and other data was a significant limitation.

There was a possibility that some self-reported blood pressure readings and data from non-medically trained research participants might not be accurate. This inaccuracy could be attributed to the lack of fundamental training in blood pressure measurement, resulting in potentially biased results.[40] Some participants might not have adhered to the recommended times and intervals for monitoring their blood pressure nor recorded accurate readings on blood pressure forms or electronic questionnaires. Reporting biased blood pressure readings could affect the study's internal validity and reliability.[41] The mitigation strategy for potential bias in BP recordings consisted of simplifying the steps and highlighting instructions while checking BP and completing the BP forms and questionnaires. Research participants were instructed to measure their BP twice daily, once in the morning and once in the evening, at the same time each day. They were also advised to sit comfortably for at least two minutes before each measurement.[42]

RECOMMENDATIONS

Further research would expand the findings of this study to include different types of mHealth wearable devices. With potentially limited empirical research on causal relationships between using mHealth wearable devices and the improvement of hypertension management in African-born immigrants, more avenues of research need to be uncovered. African-born immigrants would potentially benefit from further studies lasting longer than six months. Such a timeframe would include several virtual or in-person follow-ups to ensure participants comply with research protocols consistently. The investigator recommends using FDA-approved smartwatches. The investigator hopes the study findings will provide insights to public health practitioners, primary care providers, cardiologists, nurse practitioners, clinical nurses, physician assistants, and academics to develop effective strategies for improved management of hypertension in African-born immigrants using mHealth wearable devices. The study results have the opportunity to encourage state and local government officials in the United States to support African-born immigrants who want to use mHealth wearable devices for hypertension control but cannot afford them.

CONCLUSION

This causal-comparative study investigated the association between the use of mHealth wearable devices and improved hypertension control among African-born immigrants in Maricopa County, Arizona. The study found significant differences in MAP, MSBP, and MDBP between participants in the mHealth group, who utilized Dafit smartwatches, and those in the usual care group, who used automated blood pressure monitors. The study findings demonstrated a significant reduction in MAP among participants in the mHealth group compared to the usual care group, with a mean difference of -4 mmHg ($p < 0.001$) at the end of the study. However, the study also highlighted a limited awareness of poorly controlled hypertension among research participants. This research provides valuable insights into the potential of mHealth wearable devices to improve hypertension management among African-born immigrants.

This research contributes to the existing body of knowledge by investigating the impact of enhanced patient involvement in hypertension management outcomes among African-born immigrants in Maricopa County, Arizona. The study results entail that ongoing educational programs led by primary care providers, nurse practitioners, and nurses within clinical settings could significantly enhance hypertension management among African-born immigrants in Arizona through the effective utilization of mHealth wearable devices. While this study's findings are specific to Maricopa County, Arizona, they offer valuable insights for enhancing hypertension self-management among African-born immigrant populations across Arizona and the United States. This study aligns with the growing research efforts exploring innovative and tailored digital health strategies to address health disparities and promote health equity in hypertension management within underserved and minority populations, particularly those with limited access to healthcare resources.[43]

Authors' contribution:
The corresponding author (NMB) contributed solely to this manuscript's conceptualization, methodology, data analysis, review, and editing.

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Protection of Research Participants
Ethics approval and consent to participate
The study was approved for ethics compliance by the Institutional Review Board of Liberty University (IRB-FY23-24-253) (see Appendix G).All participants signed a written consent before participating in the study (see Appendix C). They agreed to participate voluntarily with no coercion.

Availability of data and materials:
The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

List of abbreviations

BP	Blood Pressure
DBP	Diastolic Blood Pressure
MAP	Mean Arterial Pressure
MSBP	Mean Systolic Blood Pressure
MDBP	Mean Diastolic Blood Pressure
MUA	Medically Underserved Areas
SBP	Systolic Blood Pressure

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