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Compliance With Home Blood Pressure Monitoring Among Middle-Aged Korean Americans With Hypertension

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Abstract

The primary objective of this study was to investigate the factors affecting the level of compliance of home blood pressure monitoring (HBPM) and its relation to blood pressure (BP) control among hypertensive adults in a community setting. A total of 377 middle-aged Korean Americans with high BP participated in this study. Along with structured behavioral education, the participants were instructed to measure their BP 3 times in a row upon waking and thrice again at bedtime, at least 2 or more times a week for 48 weeks. Using multivariate logistic regression, the authors examined the patterns and factors affecting HBPM and its relation to BP control status. The analyses revealed that older participants were more compliant with the HBPM instruction than were younger participants (adjusted odds ratio [OR], 5.29; 95% confidence interval [CI], 1.77–15.81) and those with more depressive symptoms were less compliant (OR, 0.19; 95% CI, 0.04–0.88). Participants who were more compliant to HBPM instruction were 4 times more likely than those who were noncompliant to have controlled their BP by the end of the intervention period (OR, 4.28; 95% CI, 1.79–10.23). These results suggest that the participants who checked their BP regularly at home had a stronger tendency to achieve BP control.

Home blood pressure monitoring (HBPM) is an emerging self-care strategy for people with high blood pressure (BP), and many experts are recommending HBPM with various instructions regarding optimal frequency of the measure.[1–5] However, clear practice guidelines based on evidence is still lacking. For example, the European Society of Hypertension (ESH) suggested the optimal frequency of HBPM, which was tested along with its sensitivity and specificity using masked hypertension[4]; however, these studies failed to address issues concerning clinical utility—the patient's perspective. In particular, essential information regarding the characteristics of the patients who complied with the recommended guidelines as well as the adequate level of adherence for obtaining optimal BP is largely unavailable.

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Some clinical trials for pharmacologic intervention reported a decrease in compliance of HBPM after the baseline time point in the clinical study.[6] Furthermore, since HBPM was followed by a drug trial in pharmacologic studies, it is difficult to define the characteristics of persons who comply with recommended HBPM guidelines.

Some studies investigate the characteristics of individuals who are currently measuring BP at home.[7,8] However, the self-report of these studies lack objective monitoring data with BP outcomes and thus impose serious limitations in the interpretation of data.

Therefore, in order to fill these critical gaps in our knowledge regarding HBPM, we have analyzed HBPM data obtained from a recently completed behavioral intervention clinical trial. The objectives of the analysis were to: (1) identify the patterns of compliance with HBPM, (2) determine the individual characteristics related to compliance with HBPM, and (3) examine the association between compliance with HBPM and BP control.

METHODS

Study Design and Sample

The study was part of a community-based, prospective trial, and study procedures were approved by the institutional review board. Data used from this analysis came from the baseline data of 377 middle- aged (40–64 years) individuals from a pool of 445 Korean Americans who participated in a community-based high BP intervention trial in which year-long HBPM was integrated as an intervention component.[9] The intervention consisted of 3 components: (1) 2 hours per week for 6 weeks of high BP education that included basic knowledge about high BP, exercises, patient-physician communication, and high BP medication; (2) HBPM through a telephone transmission system; and (3) telephone counseling conducted by a bilingual nurse.

We used a stratified sampling scheme based on the participant's age and sex to create comparable groups of Korean Americans in the Baltimore–Washington metropolitan area. The eligibility criteria for entry into this intervention study consisted of: age between 40 and 64 years; systolic BP (SBP) ≥140 mm Hg or diastolic BP (DBP) ≥90 mm Hg on 2 separate occasions or taking antihypertensive medication, including participants with controlled BP; and self-identification as a Korean American.

When the participant received high BP education, they were randomly assigned to different groups: in-class or mail-based high BP–related education. At 3 months (ie, at the end of the 6-week high BP education and 6-week BP transmission test period), telephone counseling was used for the participants who were again randomly assigned to either the more intensive or less intensive telephone counseling groups.

The BP monitoring began 2 weeks after the high BP education component and continued for an additional 48 weeks. Each study participant received a BP unit with built-in capability for transmission of BP data via telephone. After participants received appropriate cuff-sized BP machine, they were instructed to measure their BP 3 times in a row upon waking (am

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reading) and to do the same before retiring to bed at night (pm reading). Both sets of triplicate measurements were to be measured ≥2 a week.[10]

The measurements were automatically saved on the telephone device. The patients were then instructed to send the BP measurements from home via their telephone at least once a week. During the 48-week period of home monitoring and BP transmission, participants were provided with bilingual nurse telephone counseling monthly (for the less intensive group) or biweekly (for the more intensive group). In this study, 377 participants received the education component and were given machines for HBPM in their homes. To assess the relationship between HBPM and BP control, we analyzed the BP results for the participants who sent their BP measurements during the last 2 months of the follow- up period.

Study Instrument and Variables

The dependent variable for this study was the HBPM. This variable consisted of the BP measurements made by the participants in their homes using the machines provided by the research team. Because of the lack of availability of a well-established definition of compliance to BP monitoring, we followed the recommended frequency of HBPM as defined by ESH recommendations,[11] with a total of 12 readings recorded during the course of a given week being defined as the minimum number of measurements to be performed each week. Participants were considered compliant if they had transmitted ≥24 weeks of HBPM recordings (ie, half or more of the 48-week follow-up period using HBPM, with ≥12 readings per week). The participants' level of compliance was further categorized in order to examine the relationship between compliance level and BP control. Specifically, we categorized our sample according to their level of compliance when logistic analysis was performed in order to investigate the relationship between compliance and BP control: level 1 (<8 weeks of HBPM), level 2 (8–23 weeks of HBPM), and level 3 (≥24 weeks of HBPM). The BP value analyzed in this study was the mean BP that the participant transmitted. BP control was defined as the mean value of BP of <135/85 mm Hg that was transmitted during last 2 months.

Demographic variables (sex, age, marital status, education, and work status), high BP characteristics (medication, period of high BP, comorbidity, family history, and body mass index [BMI]), and psychosocial variables (depression and knowledge) were used as predicting factors. We asked about heart failure, heart attack, stroke, and diabetes, and the participants who answered "yes" to any other questions were categorized as the comorbidity group.

We used BMI categories for Asians, as recommended by the World Health Organization (WHO).[12] According to the WHO recommendation, the BMI cutoff points were as follows: 18.5 kg/m^2 to 22.9 kg/m^2 (acceptable risk); 23 kg/m^2 to 27.4 kg/m^2 (high risk); and ≥27.5 kg/m^2 (higher high risk).[12]

Depression was measured using the Kim Depression Scale for Korean Americans (KDSKA), a self-reported 21-item instrument.[13] Its 4-point Likert-type scale ranges from 0 to 63, with higher scores indicating more depressive symptoms. In this study, the reliability of this scale proved to be strong, with an α coefficient of 0.94, and a Cronbach's α

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measurement of 0.93. Because this scale has no established cut-off point for depression, the 90th percentile and above was used as the criterion for identifying participants with depressive symptoms.

Knowledge regarding high BP measurement was evaluated using 12 items developed by the National High Blood Pressure Education Program of the National Heart, Lung, and Blood Institute (1994), with the addition of 18 literature review-based items. High BP–related knowledge scores were calculated by summing the number of items with correct responses to statements such as "Young adults don't get high BP" and "High BP is life-threatening." Scores ranged from 0 to 30. We chose the upper 90th percentile to represent higher high BP knowledge.

ANALYSIS

For the descriptive data concerning study participant characteristics, we used *t* tests, analysis of variance, and Scheffe tests to interpret differences in the characteristics according to HBPM frequency. HBPM compliance predictors were identified using multiple logistic regression analysis. Because interventions such as education and counseling did not affect the compliance to HBPM, intervention-related variables were not analyzed. We also examined the relationships between the levels of HBPM compliance as well as both SBP and DBP control. Following the recommendations from the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), we considered individuals with a mean value for home-measured BP of <135/85 mm Hg to have achieved BP control.[14] In the analysis, demographic variables (sex, age, marital status, education, and work status), high BP characteristics (medication, period of high BP, comorbidity, family history, and BMI), psychosocial variables (depression, knowledge), and intervention method (education method and counseling intensiveness) were adjusted.

RESULTS

Sample Characteristics

Table I shows the sample characteristics for the 377 participants included in the analysis. Korean Americans in the sample were first-generation immigrants who were born in Korea. The sample included essentially equal numbers of men and women (49.3% vs 50.7%, respectively), most of whom were married (93.9%) and in their 50s (63.7%). More than half (55.4%) had a college level of education or higher and were employed either full- or part-time (56.0%). A total of 56.7% of participants took their hypertensive medication, while more than two thirds (73.2%) reported a family history of high BP and 15.9% reported a diagnosis of high BP for >10 years; 14.1% had one or more comorbid conditions in addition to high BP. For BMI, 56.0% of patients were at increased risk, being in the high-risk category (BMI 23–27.4 kg/m^2), and 15.9% were in the higher high-risk category (BMI ≥27.5 kg/m^2).

On the KDSKA, 11.4% of the participants had scores higher than the 90th percentile; those with high BP knowledge scores above the 90th percentile were in the lower 17.0% for

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depressive symptoms. Of the 377 participants, 43.8% received in-class education and 50.1% received more intensive counseling.

From the results of the number of weeks that participants measured their BP more than 12 times a week, older participants were more persistent with regard to measuring their BP than were younger participants (F=5.802, P=.003), and less-educated participants had a tendency to continue HBPM for a longer period (t=2.622, P=.009). Participants who generally had higher depression scores had a tendency to use HBPM less persistently (t=−3.078, P=.003).

Patterns and Correlates of Compliance With HBPM

During the 48-week period, 91.0% of the participants had measured their BP more than 12 times at least once a week, but the curve describing the number of weeks that participants used HBPM was skewed to the left. Of the 377 participants, 204 (54.1%) used HBPM at level 1 (<8 weeks of HBPM), 113 (30.0%) at level 2 (8–23 weeks of HBPM), and 60 (15.9%) at level 3 (≥24 weeks of HBPM).

Compliance With HBPM

Demographic characteristics, clinical characteristics, and other psychosocial aspects of the sample were compared in two separate groups: the noncompliant and compliant groups. Multivariate analysis revealed that older participants were more compliant with HBPM (adjusted odds ratio [OR], 5.29; 95% confidence interval [CI], 1.77–15.81). We also assessed the relationship between a number of psychosocial factors and the patterns of observed HBPM compliance. Participants with higher depression scores (≥90th percentile) were not as compliant with BP measurements (OR, 0.19; 95% CI, 0.04–0.88) as those with lower depression scores (Table II).

Frequency of HBPM and BP Outcomes

Average frequency of HBPM per week, average BPs, and percentage of participants achieving BP control in the compliant group and noncompliant group were analyzed with the 317 participants who sent their BP during the first 2 months (from week 1 to week 8) and last 2 months (from week 41 to week 48) of the HBPM period. BP control was defined as a mean BP of <135/85 mm Hg that was transmitted during a designated period.[14] The average frequency of HBPM per week for the compliant group was higher than that of the noncompliant group (13.05 times vs 7.72 times, P=.000).

When the participants started monitoring their BP during the first 2 months, SBP and DBP were not significantly different; however, DBP during the last 2 months for the compliant group was lower than that of the noncompliant group (76.67 mm Hg vs 79.76 mm Hg, P=.008).

The results of mean BP in 225 (71.0%) participants among 317 persons who sent their BP during the last 2 months were below the desired level. The proportion of controlled BP during the last 2 months differed according to the compliance of HBPM, with the percentage of BP control being 86.4% for the compliant group and 67.4% for the noncompliant group (P=.004) (Table III).

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Logistic regression models were used to examine the frequency of HBPM in relation to the ultimate BP outcomes in this sample of middle-aged Korean Americans with high BP. The percentage of BP outcomes was calculated with the average BP transmission results during the last 2 months. The category for the compliance of HBPM in the logistic regression was determined by the total period over which the measurements performed at the recommended frequency, and the levels of compliance were categorized as level 1 (<8 weeks of HBPM), level 2 (8–23 weeks), and level 3 (≥24 weeks). Table IV shows the probability of BP control for each HBPM group. Participants who were more compliant (level 3, or ≥24 weeks of HBPM) were 4 times more likely than those who were not compliant (level 1, or <8 weeks of HBPM) to achieve BP control by the end of the intervention period (OR, 4.28; 95% CI, 1.79–10.23).

DISCUSSION

In our study, approximately 91.0% of the 377 hypertensive, middle-aged Korean-Americans who were given home BP monitoring machines monitored their BP in their home at least once during the 48-week study period. Because the participants received BP machines from the research team during the high BP education period and were also encouraged through bilingual nurse telephone counseling to use HBPM, the number of participants who used HBPM in our study was substantially higher than that in previous community-based descriptive studies.[7,8]

The unique contribution of this study was that we were able to obtain real-time BP data via teletransmission. Unlike other studies of HBPM that have often relied on self-report of HBPM,[7,8,15,16] we were able to follow the pattern of HBPM usage during a 48-week period with real-time BP data, including frequency and time of each measurement. Thus, the study design enabled us to observe the natural pattern of compliance to HBPM recommendations after accessing the BP machines.

The participants who were more likely to be compliant with the HBPM instructions were generally older and had lower levels of depressive symptoms. The relationship between age and HBPM has not been unequivocal. While some studies have demonstrated a significant association between younger age and HBPM,[17] others have revealed that age is not associated with a higher likelihood of HBPM.[8,16] In our study, older Korean Americans might have been more compliant because they could afford more time to engage in HBPM as compared with their younger counterparts. In fact, the older age group was less likely than the younger group to be employed full- or part-time ($P<.05$). Another explanation may be different life priorities for different age groups. For example, in other studies of Korean Americans, older Korean Americans tended to adopt healthier lifestyle behaviors (eg, smoking cessation, regular exercise) than their younger counterparts.[18,19]

Researchers have previously reported that hypertension knowledge and physician's recommendations are strongly associated with HBPM usage.[7] In our study, the level of high BP knowledge was not significantly correlated with HBPM compliance. The results reported here may have been due, in part, to the characteristics of our sample, which included a large proportion of highly educated individuals, with 68% scoring 80 or higher on the high BP

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knowledge test when transformed into a 100-point scale. Therefore, future research on a sample with a more diverse demographic background is warranted.

We also found a significant correlation between higher levels of depressive symptoms and lower levels of HBPM compliance. The relationship between depressive tendency and self-care behaviors, such as high BP medication adherence, is well-known.[20] In earlier studies, the level of depression was an important predictor of critical self-care behavior with regard to high BP, such as adherence to treatment recommendations, including HBPM.[21] Together, these findings have significant clinical implications, because we now have empirical evidence to suggest that depression is an important predictor of a lack of compliance with high BP treatment recommendations. The findings of this present study also contribute to the growing evidence that depression has a negative impact on self-monitoring of BP, an essential self-care behavior with regard to managing BP. Because our study findings underscore the importance of HBPM in BP control, more vigilant effort is needed to screen for depression among patients with high BP levels.

When examined in relation to BP control with multivariate logistic regression analysis, our data strongly demonstrated that the compliant group controlled their BP significantly better than the noncompliant group. In particular, individuals in the compliant group (>24 weeks of HBPM) were at least 4 times more likely to have achieved high BP control than were those in the least compliant group (<8 weeks of HBPM) during the 48 weeks. This result is consistent with previous studies demonstrating that HBPM is associated with higher levels of BP control.[22]

LIMITATIONS

It should be noted that because our study was limited to Korean Americans with high BP, our findings may not be generalizable beyond this specific population. There are potentially unforeseen cultural or contextual factors that may have played a role in the compliance-related behavior of this group with regard to HBPM that might not be transferrable to other populations of different cultural backgrounds. Another potential study limitation is the fact that we offered bilingual nurse counseling and education, which is unlikely to be offered outside a research study. Because the Korean Americans in our study were encouraged through telephone counseling to use HBPM as part of their intervention program, our sample may not serve as an exact representation of hypertensive patients outside of research settings. Thus, further research is needed to cross-validate and confirm our findings in other populations.

We recommended that participants measure their BP 12 times a week whether their BP was controlled or not, although the adequate frequency of HBPM should be cut back accordingly to BP level. Further HBPM intervention studies should be designed with inclusion of various frequencies of HBPM with a reasonable protocol.

CONCLUSIONS

The present study provides important empirical and clinical insights into HBPM practice, particularly as it relates to this ethnic minority population. Using follow-up BP data, we

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have clearly demonstrated the positive impact of HBPM on BP control in a community setting. In addition, we have identified and validated potential links between psychosocial factors and HBPM usage. Our findings particularly highlight the need for screening and adequate treatment of depressive patients with high BP. It is clear that optimal management of high BP should address the psychosocial needs of the individual patient in order to promote adequate self-care activities, including HBPM, ultimately leading to the achievement of adequate BP control.

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Table I

Sample Characteristics and HBPM Measurements (N=377)

Variable		No.	Mean (SD)[a]	*t* or *F* Score	*P* Value	Scheffe
Sex	Male	186	10.31 (11.57)	−0.495	.621	
	Female	191	10.87 (10.49)			
Age, y	40–49	137	8.48 (9.68) A	5.802	.003	AB<BC
	50–59	216	11.36 (11.15) B			
	>60	24	15.75 (14.51) C			
Marital status	Married	354	10.66 (11.09)	0.480	.632	
	Other	23	9.52 (10.13)			
Education	High school graduate	168	12.26 (11.52)	2.622	.009	
	College education or higher	209	9.25 (10.45)			
Work status	No job	166	10.99 (11.31)	−0.628	.530	
	With job	211	10.27 (10.81)			
Medication	Yes	214	11.22 (11.47)	1.269	.205	
	No	163	9.77 (10.39)			
Period of high BP, y	<10	317	10.42 (10.94)	0.709	.479	
	>10	60	11.52 (11.51)			
Comorbidity	No	324	10.26 (10.93)	1.463	.144	
	Yes	53	12.64 (11.45)			
Family history	No	101	10.52 (10.75)	0.071	.943	
	Yes	276	10.62 (11.14)			
BMI, kg/m^2	18.5–22.9	106	10.71 (11.06)	0.815	.443	
	23–27.4	211	11.00 (11.18)			
	27.5	60	8.95 (10.40)			
Depression	<90th percentile	334	11.04 (11.35)	−3.078	.003	
	≥90th percentile	43	7.14 (7.23)			
Knowledge	<90th percentile	313	10.85 (11.15)	1.019	.309	
	≥90th percentile	64	9.31 (10.38)			
Method	Mail	212	9.83 (11.14)	1.513	.131	
	In-class	165	11.56 (10.83)			

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	Variable	No.	Mean (SD)[a]	*t* or *F* Score	*P* Value	Scheffe
Counseling	More intensive	189	10.94 (10.85)	0.609	.543	
	Less intensive	188	10.24 (11.21)			

Abbreviations: BMI, body mass index; HBPM, home blood pressure (BP) monitoring.

[a]The number of weeks that participants measured their BP ≥12 times a week.

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Table II

Factors Predicting Compliance With HBPM (N=377)

Variable	Category	Odds Ratio	95% CI	*P* Value
Sex	Male			
	Female	0.84	0.45–1. 55	.577
Age, y	40–49			.012
	50–59	1.68	0.84–3.36	.146
	>60	5.29	1.77–15.81	.003
Marital status	Married	1.07	0.32–3.60	.910
	Other			
Education	High school graduate			
	College education or higher	0.58	0.32–1.06	.078
Work status	No job			
	With job	0.95	0.52–1.73	.869
Medication	Yes	0.98	0.52–1.85	.939
	No			
Period of high BP, y	<10			
	>10	1.22	0.55–2.69	.620
Comorbidity	No			
	Yes	1.36	0.62–3.01	.444
Family history	No			
	Yes	1.48	0.73–2.99	.272
BMI, kg/m^2	18.5–22.9			.873
	23–27.4	0.83	0.42–1.66	.607
	27.5	0.85	0.33–2.20	.736
Depression	<90th percentile			
	≥90th percentile	0.19	0.04–0.88	.033
Knowledge	<90th percentile			
	≥90th percentile	0.58	0.23–1.46	.249
Constant		0.17		.002

Abbreviations: BMI, body mass index; CI, confidence interval; HBPM, home blood pressure (BP) monitoring. The reference group is the noncompliant group (HBPM <24 of the 48 weeks). The intervention method (education method and counseling intensiveness) was not adjusted for because there was no significant effect on HBPM.

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Table III

HBPM Results According to Compliance (N=317[a])[b]

	Compliant (n=59)	Noncompliant (n=258)	Total (N=317)	*t* or χ^2 Test	*P* Value
Frequency of HBPM per wk, mean (SD), mm Hg	13.05 (1.66)	7.72 (2.32)	8.55 (3.22)	20.528	.000
BP during first 2 months, mean (SD), mm Hg					
Systolic BP	129.47 (12.17)	126.49 (11.91)	127.05 (11.99)	1.160	.086
Diastolic BP	80.20 (8.91)	80.66 (8.04)	80.57 (8.20)	−0.384	.701
BP during last 2 months, mean (SD), mm Hg					
Systolic BP	122.31 (9.86)	124.91 (11.57)	124.43 (11.30)	−1.601	.110
Diastolic BP	76.67 (8.17)	79.76 (7.97)	79.18 (8.08)	−2.679	.008
BP during first 2 months, No. (%)					
Controlled	39 (66.1)	165 (64.0)	204 (64.4)	0.097	.756
Uncontrolled	20 (33.9)	93 (36.0)	113 (35.6)		
BP during last 2 months, No. (%)					
Controlled	51 (86.4)	174 (67.4)	225 (71.0)	8.414	.004
Uncontrolled	8 (13.6)	84 (32.6)	92 (29.0)		

Abbreviation: HBPM, home blood pressure (BP) monitoring.

[a]Participants who sent their BP during the first 2 months and last 2 months were analyzed.

[b]Frequency and BP analyzed in this study was the mean value that participants transmitted.

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Table IV

BP Control and Compliance With HBPM (n=317)[a]

Variable	Category[b]	Odds Ratio	95% CI	*P* Value
HBPM	Level 1 (<8 wks)			.004
	Level 2 (8 wks–23 wks)	1.56	0.86–2.83	.146
	Level 3 (≥24 wks)	4.28	1.79–10.23	.001
Constant		1.26		.700

Abbreviations: BP, blood pressure; CI, confidence interval; HBPM, home blood pressure monitoring. BP control: systolic BP <135 mm Hg and diastolic BP <85 mm Hg. Demographic variables (sex, age, marital status, education, and work status), high BP characteristics (medication, period of high BP, comorbidity, family history, and body mass index), psychosocial variables (depression, knowledge), and intervention method (education method and counseling intensiveness) were adjusted in the analysis.

[a] BP data reflect only the BP transmission results during the last 2 months.

[b] The category was determined by the total period over which the measurements were performed at the recommended frequency, and the levels of compliance were categorized as level 1 (<8 weeks of HBPM), level 2 (8–23 weeks), and level 3 (≥24 week).