Prediction Model for Non-pharmacological Treatment Implement of Hypertension based on Residential Area

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ABSTRACT

Hypertension management is most effective when pharmacological and non-pharmacological treatments are combined. However, there are differences in the implementation of non-pharmacological treatment depending on the region of residences, so research is urgently needed to reduce regional disparities in non-pharmacological treatment. This study aimed to construct a predictive model for the non-pharmacological treatment of hypertension according to residential areas using the 2021 CHS. This study analyzed the data of 48,662 individuals diagnosed with hypertension. A decision tree analysis was conducted to create a predictive model. Multiple logistic regression analysis was conducted to identify the factors related to the implementation of non-pharmacological treatment. The prediction model identified that subjects who lived in a "rural" area, did not complete hypertension management education, and did not respond to the written health information literacy question showed the lowest probability of performing non-pharmacological treatment at 10.2%. Conversely, those who lived in a "city", had completed hypertension education, and had above-average life satisfaction most likely to implement the program (45.0%). Multiple logistic regression results showed that those who live in a city, have a good subjective health level, quit smoking, have a high level of understanding of written health information, participate in hypertension management education, engage in economic activities, and have a high level of education or of life satisfaction had a high possibility of implementing non-pharmacological treatment of hypertension. Providing customized hypertension management education and ensuring their comprehension of written medical information will be effective in improving the rate of non-pharmacological treatment of hypertension.

Keywords: hypertension; non-pharmacological treatment; decision trees; CHS

INTRODUCTION

The prevalence of hypertension is increasing globally. In 2019, 2.28 billion people had hypertension (NCD Risk Factor Collaboration (NCD-RisC), 2021). In Korea, 33.2% of adults aged >30 years are affected by hypertension. Among the elderly population, more than half of those aged >65 years have hypertension, with a prevalence rate of 62.3% (Statistics Korea, 2023c). Analysis of the annual medical utilization status of chronic diseases such as hypertension, diabetes, and hyperlipidemia in Korea showed that hypertension had the highest number of hospitalizations per person per year, longer length of stay per case, and more outpatient cases per person than diabetes and hyperlipidemia (Moon, Shin, & Kim, 2021), Thus, the high prevalence of hypertension is expected to create a significant socioeconomic burden.

Uncontrolled hypertension can cause complications such as angina, heart failure, stroke, renal failure, and premature death (World Health Organization(WHO), 2023a). A systematic review of multiple risk factors for the international burden of disease revealed that hypertension was the leading cause of mortality and disability-adjusted life-years (DALYs), indicating the importance of hypertension management (GBD 2019 Risk Factors Collaborators, 2020). Adult hypertension management guidelines suggest pharmacological and non-pharmacological interventions to control blood pressure (Whelton et al., 2018). Antihypertensive drug therapy can control blood pressure, whereas non-pharmacological treatments involve correcting unhealthy lifestyle habits to prevent and manage hypertension. The drug treatment and control rates for hypertension in Korea are relatively high compared with those in other countries (NCD-RisC, 2021). According to a recent study, 63.6% of patients with hypertension in Korea receive drug treatment, with 72.0% achieving appropriate hypertension control (Kim et al., 2021). However, managing hypertension with drug treatment alone

is challenging because some individuals do not receive or respond to treatment (Lamirault, Artifoni, Daniel, Barber-Chamoux, & Nantes University Hospital Working Group On Hypertension, 2020). Therefore, combining lifestyle changes such as non-pharmacological treatment with drug therapy is recommended to prevent hypertension in all populations (WHO,2023a).

The hypertension guidelines (Whelton et al., 2018) propose non-pharmacological treatment strategies to correct hypertension-causing factors such as overweight or obesity, unhealthy diet (excessive sodium intake), physical inactivity, and excessive alcohol consumption. Restricting sodium intake and regular physical activity are highly effective in preventing and managing hypertension (Valenzuela et al., 2021). However, a previous study (Yu, Huh, & Sung, 2023) found that 61.1% of patients with hypertension in Korea lacked physical activity and their average daily sodium intake of approximately 3,326 mg exceeded the recommended level of 2000 mg (WHO,2023b), indicating inadequate non-pharmacological treatment of hypertension in Korea.

When examining the factors that influence non-pharmacological treatment practices for patients with hypertension, factors related to physical activity include sex, marital status, use of antihypertensive drugs (beta-blockers), and quality of life (Nakarmi et al., 2023; Nascimento, Belo, Araújo, Silva, & Barros, MDFFN, Figueirêdo, 2021; Zhang, Qiu, Zheng, Zang, & Zhao, 2020). Various factors related to dietary control have been identified, including educational level, religious affiliation, subjective health status, cognitive function, quality of life, and family function (Jung & Moon, 2023; Nakarmi et al., 2023; Zhang et al., 2020). A review on factors influencing the self-management of hypertension (Konland & Shin, 2023) found that demographic factors such as sex, age, socioeconomic status, and education level affect self-management in patients with hypertension. Factors affecting hypertension treatment include treatment duration, drug characteristics, and medication adherence. Knowledge regarding hypertension and its management also affects the self-care of hypertension. However, research on non-pharmacological treatment factors related to hypertension in Korea is lacking (Jung & Moon, 2023), and further research is required to obtain more conclusive results.

A total of 82% of the global population with hypertension resides in low-and middle-income countries (NCD-RisC, 2021), indicating that the prevalence of hypertension may be affected by regional characteristics. The prevalence of hypertension differs based on the size of the residential areas. The prevalence of hypertension in rural areas was higher than that in urban areas (42% and 25.4%, respectively) (Statistics Korea, 2023c). Although hypertension management is effective when both pharmacological and non-pharmacological treatments are implemented simultaneously, the compliance rate of non-pharmacological hypertension treatment in Korea is low at 45-57%. Specifically, it has been reported that rates of awareness, treatment, and management for hypertension are significantly lower in rural areas of Korea compared to urban areas (Ahn,2018). For example, the prevalence of regular physical activity for aerobic exercise differed with 47.0% in urban areas and 33.4% in rural areas (Statistics Korea, 2023a). The rate of healthy eating habits exhibited a gap between urban (47.3 %) and rural areas (39.6 %) (Statistics Korea, 2023b), indicating that the region largely influences hypertension rates and healthy behaviors. Therefore, not only the onset of hypertension but also its management differed depending on the region of residence. Although the importance of non-pharmacological hypertension management is emphasized and regional disparities in the implementation of non-pharmacological hypertension management are clear, most studies are limited to pharmacological treatment compliance and there are few studies that reflect the region of residence. To fill this gap, this study aimed to investigate the factors influencing non-pharmacological treatment behaviors in patients with hypertension by considering local characteristics.

METHOD

Study Design and Participants

This study aimed to predict the implementation of non-pharmacological treatments in subjects with hypertension based on their residential area. We conducted an empirical analysis using cross-sectional data from the 2021 Community Health Survey (CHS). The CHS is an annual cross-sectional study that has been conducted by public health centers across the country to establish and evaluate local health care plans. The survey period was from August 16 to October 31, 2021, and targeted adults aged 19 and above. The survey was conducted by trained investigators who visited selected household and conducted one-on-one interviews using Computer Assisted Personal Interviewing(CAPI). In the 2021 CHS, data was collected from 229,242 individuals. The average interview time was 28 minutes per household members, and the total survey time including physical measurement was 40 minutes (Korea Disease Control and Prevention Agency(KDCA), 2022). This study included 48,662 individuals diagnosed with hypertension who reported experiencing hypertension. Among the participants, 11,353 (23.3%) were classified into the "Yes" group and underwent non-pharmacological treatment. Conversely, 76.7% (n = 37,309) of the total number of subjects who did not receive non-pharmacological treatment were included in the "No" group.

Variables

The description of the tools used in this study was extracted and cited from the "2021 Guidelines for using raw data from the CHS" (Korea Disease Control and Prevention Agency (KDCA), 2022). The CHS provides demographic characteristics, health-related behaviors, and health conditions. Data were collected from August 16th to October 31st, 2021, targeting 2021 CHS adults aged 19 years and older. Trained interviewers conducted the in-person surveys using electronic devices.

General Characteristics

The general characteristics of the study participants include age (in years), sex (male, female), residential areas (city or province), education level (high school graduate or below, college graduate or above), basic livelihood recipients (yes or no), household income (monthly, 10,000 won) (<50, 50–99, 100–199, 200–299, 300–399, 400–499, 500–599, >600), life satisfaction (happiness index), economic activity (yes, no), and marital status (single, married).

Age was classified into four categories: youth (19–29 years old), middle-aged (30–49 years old), elderly (50–64 years old), and senior (≥65 years). Residential areas were divided into "city" for "dong" and "province" for "eup/myeon". The education level of the subjects was reclassified as "high school graduation or below" for those with no education, those who attended a private school or a traditional Korean school, elementary school, middle school, and high school. Those who attended a college, university, or graduate school were reclassified as "graduate of college or higher."

Health-related Characteristics

The health-related characteristics include subjective health status (good, fair, poor), smoking (yes, no), amount of smoking (number of cigarettes), alcohol consumption (yes, no), frequency of alcohol consumption per year (none, less than once a month, two to three times a week, four or more times a week), duration of alcohol consumption, amount of alcohol consumed at once (glasses: 1–2, 3–4, 5–6, 7–9, 10 or more), body mass index (BMI, kg/m2) (underweight, normal, overweight, obese) (CDC, 2016), self-perceived body shape (thin, average, obese), ability to understand medical information (easy, difficult), ability to understand health information in writing (easy, difficult), subjective stress level (none, low, high), experience of cognitive impairment (yes, no), awareness of blood pressure (yes, no), hypertension management education (yes, no), blood pressure management (medication) (yes, no), and average sleep time (average of weekday and weekend).

Subjective health status was reclassified as follows: "very good" and "good" as "good" and "bad" and "very bad" as "bad". The self-perceived body shape was reclassified as "thin" for very thin" and "slightly thin" and "obese" for "slightly obese" and "very obese." The ability to understand explanations of medical staff and written health information was reclassified into two categories: "easy" ("very easy" and "somewhat easy") and "difficult" ("somewhat difficult" and "very difficult"). For the variable of subjective stress levels, "feeling a lot" and "feeling quite a bit" were reclassified as "high".

Statistical analysis

Data analysis was conducted using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to compare the general and health-related characteristics. Decision tree analysis was used to execute the predictive model, which was identified as the most suitable method (Jung & Kim, 2022); decision tree analysis is a data-mining technique used to classify or predict large amounts of data into subgroups according to certain rules. Research results are presented in a tree structure consisting of nodes, and to interpret predictions for new objects, the process can be visually analyzed by following the root node to the end node (Kim & Kim, 2010). In this study, decision tree analysis could easily identify the path to predict non-pharmacological treatment implementation by various combinations of factors related to non-pharmacological treatment implementation in hypertension. For this reason, decision tree analysis enables the simple identification of the path to predict the execution of non-pharmacological treatment for hypertension using various combinations of factors (Seo & Kim, 2021). For the tree analysis setting, Chi-square Automatic Interaction Detection (CHAID) algorithm was used and performs X2-tests for nominal variables and F-tests for continuous variables because this study included variables that contain both nominal and continuous types (Choi, Han, Kang, & Kim, 1998; J. Seo & Kim, 2021). To form the model, the maximum level was set to 3, with 100 parent and 50 child nodes (Choi & Seo, 1999; Seo & Kim, 2019). We used a split-sample validation test to analyze the validity of the final model (Choi et al., 1998; Seo & Kim, 2021). Multiple logistic regression analysis was conducted to identify the general and health-related variables that affected the implementation of non-pharmacological treatments for hypertension. The significance level was set at $p < 0.05$.

RESULTS

General Characteristics

Table 1. General Characteristics

Characteristics	No Group (n=37,309, 76.7%)		Yes Group (n=11,353, 23.3%)		p-value
	Frequency	Percentage	Frequency	Percentage	
Age (in years)					<0.001
19-29	223	0.6	119	1.0	
30-49	2,928	7.8	1,379	12.1	
50-64	10,860	29.1	4,195	37.0	
Over 65	23,298	62.4	5,660	49.9	
Sex					<0.001
Male	16,133	43.2	5,418	47.7	
Female	21,176	56.8	5,935	52.3	
Residential areas					<0.001
Rural	21,334	57.2	4,856	42.8	
City	15,975	42.8	6,497	57.2	
Education level					<0.001
≤High school	31,438	84.3	8,257	72.8	
≥College	5,844	15.7	3,091	27.2	
Basic livelihood recipient					<0.001
No	35,052	94.0	10,844	95.5	
Yes	2,251	6.0	509	4.5	
Household income (month, won)					0.008
<50	37	14.5	3	3.3	
50-99	48	18.8	10	11.1	
100-199	35	13.7	17	18.9	
200-299	30	11.7	6	6.7	
300-399	25	9.8	10	11.1	
400-499	14	5.5	11	12.2	
500-599	14	5.5	7	7.8	
≥600	53	20.7	26	28.9	
Life satisfaction					<0.001
No	15,816	42.4	3,876	34.1	
Yes	21,493	57.6	7,477	65.9	
Economic activity					0.002
No	17,087	45.8	5,007	44.1	
Yes	20,220	54.2	6,346	55.9	
Marital status					<0.001
Single	13,476	36.1	3,383	29.8	
Married	23,819	63.9	7,967	70.2	
Total	37,309	100.00	11,353	100.00	

Table 1 presents a comparison of the general characteristics based on the implementation of non-pharmacological treatment in subjects diagnosed with hypertension. Regarding age, the highest proportion was ≥65 years in both groups. However, the ratio was 62.4% in the "No" group and 49.9% in the "Yes" group, showing a significant difference ($p < 0.001$). Both groups had a high proportion of females, and the proportion of the "No" group was significantly higher than that in the "Yes" group (56.8% and 52.3%, respectively, $p < 0.001$). In terms of the residential area, the proportion living in the rural areas was high at 57.2% in the "No" group. However, in the case of the "Yes" group, the proportion of living in the city was 57.2%, which was a significant difference between the groups ($p < 0.001$). Both groups had a high percentage of people who graduated from high school or lower, but the "No" group had a higher percentage than the "Yes" group (84.3% and 72.8%, respectively). The proportion of basic livelihood recipients was significantly higher in the "No" group (6.0%) than that in the "Yes" group (4.5%) ($p < 0.001$). For monthly household income, a high percentage earning >6 million won was

observed in both groups, although these significantly differed at 20.7% in the "No" group and 28.9% in the "Yes" group (p = 0.008). For life satisfaction, the percentage of individuals who answered that they were satisfied was highest in both groups. The "Yes" group showed a higher rate than that of the "No" group (65.9% and 57.6%, respectively). For economic activity, the "Yes" group showed a significantly higher rate of economic activity than that in the "No" group (55.9% and 54.2%, respectively, p=0.002). Both groups had a high proportion of married people with the percentage in the "Yes" group being significantly higher than that in the "No" group (70.2% and 63.9%, respectively, p = 0.002).

Health-related Characteristics

The results of the comparison of health-related characteristics of participants diagnosed with hypertension with implementation of non-pharmacological treatment are shown in Table 2. Both groups had a high proportion of the average level of subjective health status, but the "Yes" group showed a significantly higher rate than that of the "No" group (46.1% and 26.8%, respectively, p < 0.001). Regarding smoking, the non-smoking rate was high in both groups but was significantly higher in the "Yes" group than in the "No" group (70% and 63.8%, respectively). For the amount of smoking, the "No" group smoked significantly more cigarettes than the "Yes" group (average of 15.26 and 14.18 cigarettes, respectively, p < 0.001). Both groups had a high rate of drinking, but the "Yes" group had a higher rate (73.1%) than the "No" group (68.2%) (p < 0.001). For the drinking period, the "No" group showed a longer period than the "Yes" group (39.92 and 37.57 years, respectively, p < 0.001). For BMI, both groups had a high rate of obesity, but the "Yes" group showed a significantly higher rate than the "No" group (50% and 37.6%, respectively p < 0.001). The "Yes" group had the highest percentage of people who felt they were fat at 45.1%, and the "No" group had the highest percentage of people who felt they were normal at 42.7% (p < 0.001). For the variable in understanding verbal explanations of medical staff (p < 0.001) and written health information (p < 0.001), both groups showed a high proportion of answers for easy, but the "Yes" group showed a significantly higher rate than the "No" group. Both groups showed a high rate of responding that they had less stress, but the "Yes" group had a higher proportion (66.0%) than the "No" group (48.6%) (p < 0.001). For cognitive impairment, both groups had a high percentage of none, but the "Yes" group showed a higher rate than the "No" group (70.6% and 67.2%, respectively, p < 0.001). The proportion of people in the "Yes" group who were aware of their blood pressure levels was 87.9%, which was higher than the rate of 76.3% of the "No" group, and 34.2% of the "Yes" group completed hypertension management education, which was significantly higher than the 16.9% of the "No" group (p < 0.001). Both groups had a high rate of taking hypertension medication, but the "No" group had a higher rate than the "yes" group (95.8% and 93.3%, p < 0.001). No significant differences were present between the two groups for the amount of alcohol consumed (p = 0.283) and sleep time (p = 0.489).

Table 2. Health-related Behaviors Characteristics

Characteristics	No Group (n=37,309, 76.7%)		Yes Group (n=11,353, 23.3%)		p-value
	Frequency or Mean	Percentage or SD	Frequency or Mean	Percentage	
Subjective health status					<0.001
Good	9,999	26.8	3,906	3,906 (34.4)	
Average	16,621	44.6	5,234	5,234 (46.1)	
Bad	10,688	28.6	2,213	2,213 (19.5)	
Smoking					<0.001
No	8,267	63.8	2,912	2,912 (70.0)	
Yes	4,697	36.2	1,249	1,249 (30.0)	
Amount of smoking	15.26	7.51	14.18	14.18±6.84	<0.001
Drinking					<0.001
No	11,865	31.8	3,049	3,049 (26.9)	
Yes	25,433	68.2	8,304	8,304 (73.1)	
Frequency of drinking					<0.001
No	9,231	36.3	2,614	2,614 (31.5)	
<1/month	3,501	13.8	1,250	1,250 (15.1)	
1/month	2,110	8.3	776	776 (9.3)	
2-4/month	4,216	16.6	1,664	1,664 (20.0)	
2-3/week	3,803	14.9	1,358	1,358 (16.4)	
≥4/week	2,580	10.1	642	642 (7.7)	
Duration of drinking	39.92	13.78	37.57	37.57±13.07	<0.001

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Characteristics	No Group (n=37,309, 76.7%)		Yes Group (n=11,353, 23.3%)		p-value
	Frequency or Mean	Percentage or SD	Frequency or Mean	Percentage	
Amount of drinking					0.283
1-2cups	5,970	36.8	2,030	2,030 (35.7)	
3-4cups	3,526	21.8	1,264	1,264 (22.2)	
5-6cups	1,879	11.6	687	687 (12.1)	
7-9cups	3,177	19.6	1,089	1,089 (19.1)	
≥10cups	1,658	10.2	620	620 (10.9)	
Body Mass Index(kg/m2)					<0.001
Underweight	1,169	3.3	199	1.8	
Normal	11,644	32.4	3,328	29.8	
Overweight	9,619	26.8	3,088	27.7	
Obesity	13,498	37.6	4,552	40.8	
Self-awareness of body shape					<0.001
Thin	6,600	17.7	1,325	11.7	
Normal	15,946	42.7	4,906	43.2	
Obesity	14,756	39.6	5,122	45.1	
Difficulty of understanding medical staff's verbal explanations					<0.001
Easy	25,795	69.2	8,584	75.6	
Difficult	11,475	30.8	2,763	24.4	
Difficulty of understanding explanation by writing					<0.001
Easy	18,160	66.4	7,188	73.9	
Difficult	9,201	33.6	2,538	26.1	
Stress level					<0.001
Rare	12,048	32.3	3,141	27.7	
Little	18,116	48.6	6,110	66.0	
Much	6,104	16.4	1,848	16.3	
Experience of cognitive impairment					<0.001
No	24,505	67.2	7,715	70.6	
Yes	11,941	32.8	3,212	29.4	
Cognition of blood pressure value					<0.001
No	8,811	23.7	1,368	12.1	
Yes	28,441	76.3	9,976	87.9	
Education of hypertension management education					<0.001
No	30,991	83.1	7,470	65.8	
Yes	6,298	16.9	3,883	34.2	
Hypertension medication					<0.001
No	1,560	4.2	755	6.7	
Yes	35,748	95.8	10,598	93.3	
Sleeping time	6.57	1.41	6.56	1.30	0.489
Total	37,309	100.00	11,353	100.00	

Prediction Mode of Non-pharmacological Treatment Implementation in Hypertension

Figure 1 shows the predictive model for non-pharmacological treatment in individuals with hypertension, which comprised zero nodes. The implementation of non-pharmacological treatment was significantly affected by residential area (F = 727.125, p < 0.001). For individuals residing in a "city" (Node 1), the implementation of non-pharmacological treatment according to their hypertension management education experience (F = 674.316, p < 0.001). For those who received hypertension management education, a significant difference was present in non-pharmacological treatment based on life satisfaction (F = 51.916, p < 0.001). For individuals who did not receive hypertension management education, the implementation of non-pharmacological treatment varied according to their understanding of written health information (F = 192.760, p < 0.001).

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A significant difference was found in the implementation of non-pharmacological treatment for hypertension in rural areas (eup/myeon) depending on the experience of hypertension management education (F = 656.172, p < 0.001). Furthermore, a significant difference in non-pharmacological treatment based on education level was present among those who had received hypertension management education (F = 27.807, p < 0.001). For those who did not receive hypertension management education, a significant difference was present in the implementation of non-pharmacological treatment based on their understanding of written health information (F = 309.749, p < 0.001).

This study found that individuals who lived in a "province", did not receive education on hypertension management, and did not answer for written health information literacy had the lowest probability of implementing non-pharmacological treatment at 10.2%. Conversely, those who lived in a "city, received hypertension management education and had above average life satisfaction were the most likely to implement non-pharmacological treatment at 45.0%.
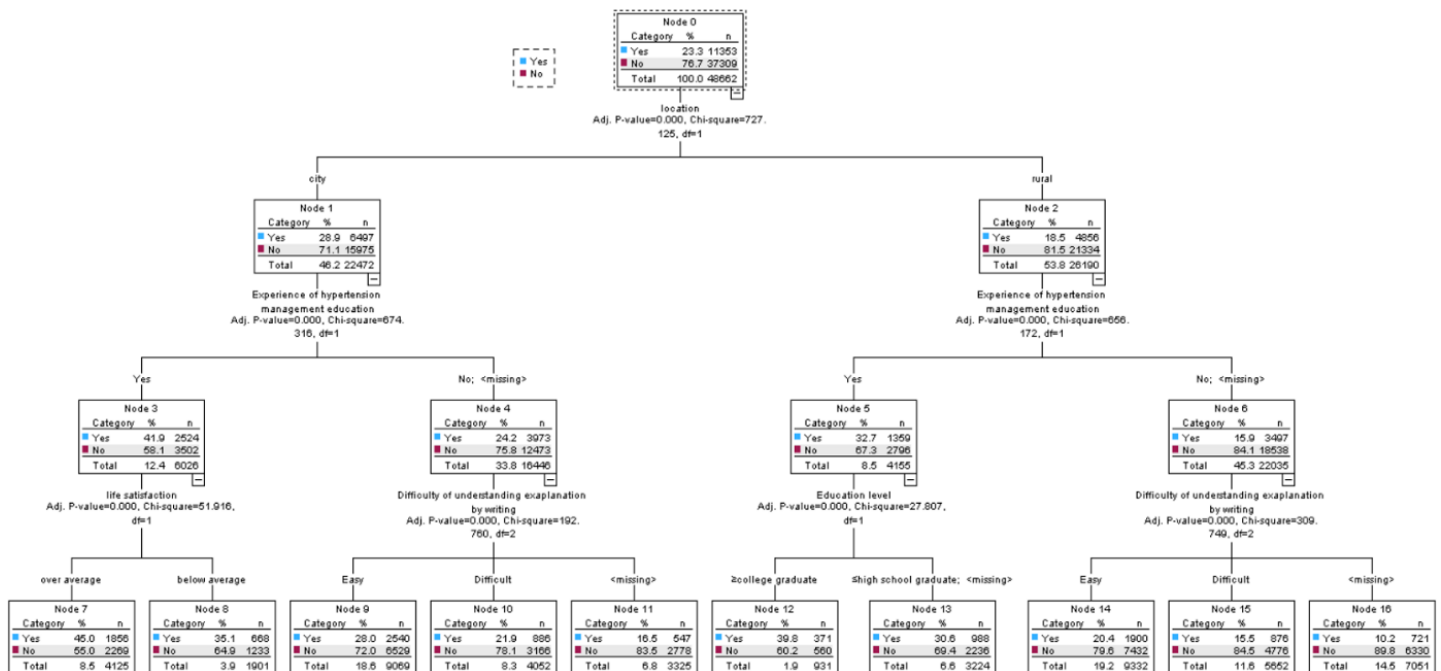

Figure 1. Prediction Model of Hypertension Non-drug Therapy

Validation of Decision Tree for Non-pharmacological Treatment in Hypertension

The results of the validation analysis of the decision tree model that predicted non-pharmacological treatment for subjects with hypertension are shown in Table 3. The risk estimate of this model was 0.24, confirming a classification accuracy of 76%.

Table 3. Validation Test of Prediction Model

Model	Risk Estimate (RE)	Standard Error (SE)
Training data	0.24	0.003
Test data	0.23	0.003

Factors Related to the Implementation of Non-pharmacological Treatment for Hypertension

The results of the analysis of factors affecting the implementation of non-pharmacological treatment among individuals diagnosed with hypertension are shown in Table 3.5. People residing in a "city" are 1.44-fold more likely than those living in residing in a "province" to implement non-pharmacological treatment. This study also found that subjective health status influenced the implementation of non-pharmacological treatments for hypertension management. Individuals in average or bad condition have a 0.66- and 0.83-fold lower likelihood of implementing non-pharmacological treatment for hypertension management, respectively, than those in good health.

Additionally, the likelihood of implementing non-pharmacological treatment decreased by 0.74-fold among smokers compared with non-smokers. Individuals who had difficulty understanding written health information were 0.89-fold less

likely to implement non-pharmacological treatment compared with those who could easily understand it. Those who knew their blood pressure had 1.54-fold higher likelihood of undergoing non-pharmacological treatment than those who did not, whereas people who completed hypertension education had a 1.88-fold higher likelihood of undergoing non-pharmacological treatment than those who did not.

Moreover, compared with those who do not engage in economic activities, individuals who do so are 0.89-fold less likely to adopt non-pharmacological treatment. People who have graduated from college or university are 1.27-fold more likely to implement non-pharmacological treatment than those who have a high school diploma or less. Individuals who are satisfied with their lives are 1.11-fold more likely to implement non-pharmacological treatments than those who are dissatisfied.

Table 4. Factors Affecting Hypertension Non-pharmacological Treatment

Variables	B	SE	Sig	Exp(B)	95% CI	
					Lower	Upper
Location (ref. rural)	0.366	0.041	<0.001	1.442	1.331	1.562
Subjective health status (ref. good, bad vs good)	-0.410	0.065	<0.001	0.664	0.585	0.753
Subjective health status (ref. good, average vs good)	-0.192	0.043	<0.001	0.825	0.759	0.898
Smoking (ref. No)	-0.296	0.043	<0.001	0.743	0.684	0.808
Difficult to understand explanation by writing (ref. Easy)	-0.123	0.049	0.013	0.885	0.803	0.974
Cognition of blood pressure value (ref. No)	0.432	0.071	<0.001	1.541	1.341	1.769
Experience of hypertension management education (ref. No)	0.632	0.043	<0.001	1.882	1.730	2.047
Economic activity (ref. No)	-0.117	0.044	0.009	0.890	0.816	0.971
Education level (ref. ≤high school graduate)	0.237	0.044	<0.001	1.268	1.163	1.382
Life satisfaction (ref. below average)	0.101	0.043	0.019	1.106	1.016	1.203
Constant	-1.594	0.087	<0.001	0.203		

DISCUSSION

Approximately one billion people worldwide are diagnosed with hypertension, which is a major cause of premature death and an important international health issue. According to a report by the Korean Society of Hypertension, in 2022, 12 million people, or approximately 30% of the Korean adult population, were diagnosed with hypertension (Lim, 2022). As premature deaths and complications caused by hypertension increase, efforts are required to systematically manage hypertension. Regular and continuous medication use is important, but the importance of concurrent non-pharmacological treatment to manage risk factors for hypertension has also been emphasized (Chun & Shin, 2011). Non-pharmacological treatment for hypertension refers to improving lifestyle habits, such as an unhealthy diet, insufficient physical activity, drinking, smoking, and obesity, which are risk factors (Eum & Lee, 2013; M. Jung & Kim, 2022). According to a previous study, the lifestyle improvement practice rate of people with hypertension was identified to be 45–57%, and was reported to be especially low for rural residents (Ahn, 2018). The results of a study on the management of complex chronic diseases, including hypertension, showed that living in rural areas with relatively low levels of healthcare infrastructure and accessibility to healthcare services compared with living in cities increased the difficulty for residents to manage their health (Joo & You, 2018). Disparities in the implementation of non-pharmacological treatments for hypertension were observed based on residential location. Residents in a "city" had a higher rate of non-pharmacological treatment implementation (28.9%) compared with those living in a "province" (18.5%). These findings are consistent with those of previous studies.

Many studies on hypertension have focused on medication adherence, but research is limited on lifestyle improvements, particularly among community-dwelling individuals (Ahn, 2018). Therefore, this study aimed to use decision tree analysis to create a decision tree model that could predict non-pharmacological treatment for hypertension management based on the patient's place of residence. This study found that the proportion of patients with hypertension who received non-pharmacological treatment was low at only 23.3%. Both groups had a high compliance rate (approximately 95%) with hypertension medications. This indicates that most subjects rely on medication to manage their hypertension rather than opting for non-pharmacological treatment in the long term. However, effective management of hypertension requires both medication and non-pharmacological treatment, highlighting the need for continuous education.

During the 2021 CHS, level 4 distancing measures were implemented because of the COVID-19 pandemic. Unfortunately, confirmed cases have continued to occur (Ministry of Health and Welfare, 2021), making it difficult for

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individuals to continue exercising, and limiting their choice of exercise location. Consequently, physical activity decreased while the consumption of delivery food, snacks, emotionally driven and irregular meals, and high-calorie food increased, which was challenging for following a controlled diet (Bracale & Vaccaro, 2020). Therefore, individuals with hypertension may have struggled to engage in physical activity (Jurak et al., 2020; Vancini et al., 2021).

According to the predictive model presented in this study, the path with the lowest rate of non-pharmacological treatment implementation was among subjects who lived in a "province", had no experience in hypertension management education, and did not respond to a question about their understanding of written health information. Conversely, the group of participants with the highest rate of non-pharmacological treatment implementation were those who lived in a "city"," had completed hypertension management education, and reported above-average life satisfaction.

A previous study found that counseling and education provided by health-related organizations or doctors can affect the implementation of non-pharmacological treatments for hypertension (Bae, Kim, Min, Kwon, & Han, 1999). Similarly, the provision of hypertension management projects in the community was reported to be effective in improving health behaviors to control hypertension (William, Poulter, Brown, Davis, & McInnes, 2004). Education in hypertension management projects was confirmed to be essential for the effective management of hypertension, particularly in rural areas (Lee et al., 2011). To promote the implementation of effective non-pharmaceutical treatments for hypertension, customized education programs that reflect the subject's diet, exercise, medication, and lifestyle habits should be developed (Ko et al., 2007; Son & Yoo, 2004). Long-term individualized education was found to be more effective. Additionally, motivation and psychological support should be provided to help patients adopt non-pharmacological treatments as part of their daily routine and as long-term practice (Ko et al., 2007). Active monitoring is necessary to determine whether non-pharmacological treatments are consistently implemented or incorrect methods are applied (Ko et al., 2007).

Most programs are conducted through direct visits to public health centers or clinics, and participation is inevitably limited for those with disabilities visiting the training site (Sim, Go, & Yoo, 2007). This study also found that the rate of non-pharmacological treatment implementation was low in those who lived in rural areas and did not receive education on hypertension management. Therefore, hypertension management policies in rural areas should be examined. One study reported that accessibility is the most urgent problem when using public health centers that usually provide hypertension management programs (Sim et al., 2007). Additionally, problems in providing hypertension-related services to rural residents must be identified and a hypertension management program designed that is suitable for rural areas (Joo & You, 2018). This study showed that the ability to understand written health information also affected the rate of non-pharmacological treatment implementation. A previous study showed that understanding health information is strongly linked to health behaviors (Sorensen, Van den Brouchek, Pelikan, Fullam, & Doyle, 2013). Individuals with low health literacy exhibit poor health behaviors and increased mortality rates (Baker et al., 2007). Therefore, the health literacy levels of patients are important and should be assessed to provide appropriate education (Oh & Park, 2017). In this study, above-average life satisfaction was associated with non-pharmacological treatment of hypertension. At present, analysis needs to be included on how the life satisfaction of patients influences the non-pharmacological treatment of hypertension, making comparison of the results difficult. Further research is required to investigate the impact of life satisfaction on the implementation of non-pharmacological treatments in patients with hypertension.

It is difficult to establish clear relationships between factors due to the lack of previous studies. However, rural areas are expected to have relatively fewer opportunities for hypertension management education compared to urban areas. In rural areas, the level of education is low, which makes it difficult for people to understand medical professionals' explanations. Consequently, the rate of implementing non-pharmacological treatment for hypertension is expected to be low in these areas. On the other hand, cities often provide not only hypertension management education but also health management education. As subjects manage their hypertension through these educations, their life satisfaction and subjective health level improve, making them more likely to practice non-pharmacological treatments.

This study provides valuable data on non-pharmacological treatment for hypertension based on residential area, but certain limitations should be considered in future research. First, the CHS only includes information related to exercise and diet therapy regarding the implementation of non-pharmacological treatments and does not consider weight management, smoking, or alcohol consumption as in previous studies. Second, this study used a secondary data set; thus, not all factors affecting non-pharmacological treatment were considered. Third, the unequal distribution of the participants between the two groups may have affected the interpretation of the study results. Fourth, it was difficult to determine whether non-pharmacological treatment was being continuously implemented because this was a cross-sectional study. Since the continuous implementation of non-pharmacological treatments is important, a prospective study on this matter will be necessary in the future. Finally, residential areas were classified into urban and rural areas. However, it is unreasonable to say that the characteristics of the urban or rural areas of each subject were fully reflected.

CONCLUSION

To effectively manage hypertension, systematic analyses of regional variations and the factors that affect them must be performed. Therefore, this study aimed to develop a model that predicts the use of non-pharmacological treatments based on the place of residence of patients with hypertension. The results showed that urban residents were more likely to use non-pharmacological treatments than rural residents. Furthermore, factors such as completion of hypertension management, education level, understanding of health information, life satisfaction, economic activity, smoking, awareness of blood pressure, and subjective health status were related to non-pharmacological treatment of hypertension. Residents in rural areas may have less access to hypertension management education, therefore, customized education considering their educational level and ability to understand health information is urgently needed. It is recommended to identify individuals who have a lower level of life satisfaction or are unemployed, in order to encourage the implementation of non-pharmacological treatment for hypertension. It is important to educate people on the significance of measuring their blood pressure frequently. Projects such as renting portable blood pressure monitors should be implemented to promote this practice. Regular monitoring of blood pressure can increase the chances of implementing non-pharmacological treatments by raising awareness of the need to manage hypertension. The most crucial aspect is ongoing education about the importance of non-pharmacological hypertension treatment and methods. Additionally, community nurses should actively monitor to ensure proper implementation. However, as research on these topics is insufficient, further studies are necessary to identify more accurate factors that affect the implementation of non-pharmacological treatment for hypertension.

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