Original Article

Current Status and Characteristics of Hypertension Control in Community Resident Elderly Korean People: Data from a Korean Longitudinal Study on Health and Aging (KLoSHa Study)

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Hypertension is a common disease that greatly impacts the health of the elderly. However, the status of blood pressure (BP) control in the elderly Korean population has not yet been investigated. Subjects aged 65 years or older livings in Seongnam city, a suburb of Seoul, Korea, were included in this study. All subjects were evaluated by a physician, and medication was reviewed by a nurse. Seated BPs were measured by a trained nurse using standard methods. A total of 995 subjects were included in the current analysis (mean age: 76.3±8.7 years). The prevalence of hypertension was 68.7% in the study population, and this value increased with age, peaked in the 75–84 age group, and decreased thereafter. Only 66.1% of hypertensive patients had taken any antihypertensive medication, among which calcium channel blockers (64.2%) were most commonly used. Among the patients on antihypertensive medication, 46% were on combination drug therapy. BP was controlled in 38.5% of hypertensive patients, with systolic BP less controlled than diastolic BP, especially in the oldest-old population. The BP control rate was lower in high-risk patients of diabetes and renal disease. In conclusion, in community resident elderly populations, the BP control rate remains unsatisfactory, especially in high-risk patients. The benefit and optimal level of BP control in oldest-old population must be investigated because a lot of elderly hypertensive patients are currently being managed without definite evidence of related benefits. (*Hypertens Res* 2008; 31: 97–105)

***Key Words*: hypertension, epidemiology, cardiovascular disease, elderly**

Introduction

As more people live to advanced ages, it is important to understand the individual diseases that are prevalent and have great impacts on the health statuses of elderly subjects. Hypertension, one of the most common diseases in the elderly, is an important but modifiable risk factor for cardiovascular and cerebrovascular diseases, which are the leading causes of death in most developed countries (*1*).

Preventive strategies toward earlier detection of elevated blood pressure (BP) and its control are likely to offer the greatest promise for reducing hypertension-related morbidity and mortality. Nevertheless, hypertension control rates are

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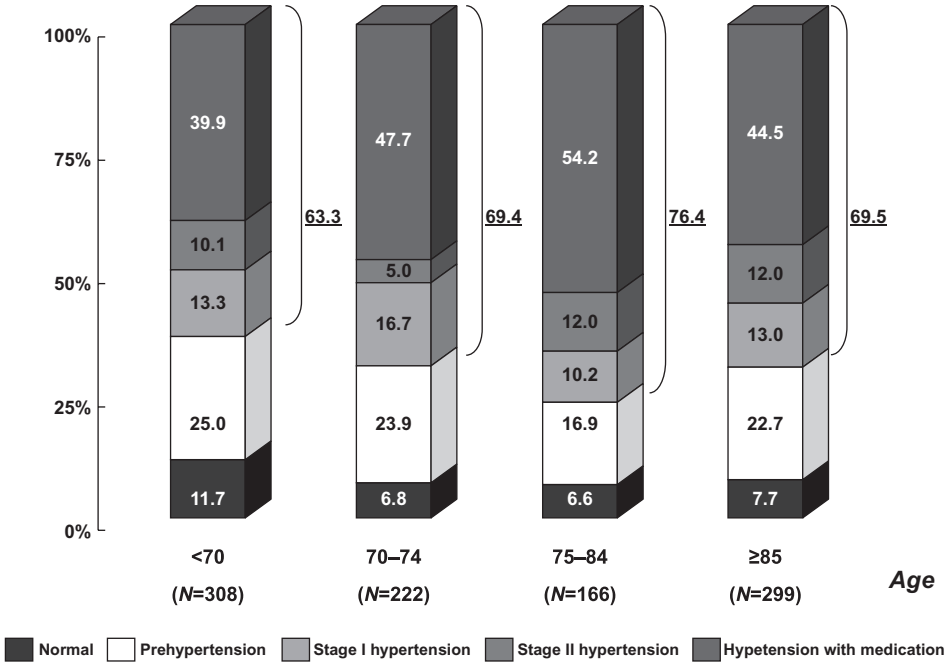

Fig. 1. *The prevalence of prehypertension and hypertension (stages I, II, and hypertension with medication) by age group in the study subjects. Blood pressure was classified according to JNC 7 reports for each age group.*

unacceptably low in the elderly population, and the prevalence of hypertension-related cardiovascular disease remains high.

These issues might be associated with concern regarding the hazardous effects of BP control. It has been reported that drug treatment may be less effective or even harmful in patients with hypertension aged 80 years or older (*2*, *3*). Furthermore, isolated systolic hypertension, a typical characteristic of elderly hypertension, has been considered not a treatment target but rather a physiologic change related to aging.

However, more data are now available to support the indication and intensity of antihypertensive medication in the elderly population. Major randomized, controlled trials clearly showed that active treatment was associated with a significant reduction in stroke rates, major cardiovascular disease, and mortality in elderly people (*4*–*7*).

However, oldest-old subjects were not included in most of the clinical trials that evaluated the efficacy and safety of antihypertensive medications. Therefore, very little evidence has been reported that supports the benefits of treating hypertension in this subgroup of the elderly population.

Recent clinical trials clearly showed the benefits of strict BP control in certain high-risk patients. The risks of hypertension-related morbidity and mortality increase as patients age. Moreover, cardiovascular risk factors such as diabetes, insulin resistance, dyslipidemia, and obesity are frequently associated with hypertension in elderly patients.

Therefore, the elderly are considered a high-risk population. Actually, in a previous clinical trial, the absolute rate of events was much higher in elderly people than in younger people, yet the antihypertensive treatment was very effective in reducing cardiovascular events. This means that the absolute risk reduction per mmHg of BP decrease was higher among elderly hypertensive patients (*8*). However, it is not clear that strict BP control is beneficial in elderly populations, especially the oldest-old population (*9*).

While there are a lot of uncertainties in managing hypertension in the elderly, the number of elderly hypertensive patients that require treatment is expected to increase because of the aging of the population. As a result, epidemiologic knowledge regarding the characteristics and statuses of elderly hypertensive patients is needed in order to determine the optimal management.

The Republic of Korea is the home of the most rapidly aging population in the world. With the increase of the elderly population, especially the oldest-old population, special consideration regarding medical treatment for elderly people must be emphasized.

Considering the prevalence of hypertension, optimal treatment of elderly hypertension will become an important medical issue. However, no community-based epidemiologic study has yet been conducted to evaluate hypertension treatments, control rates, and usage of antihypertensive medications in hypertensive elderly Korean patients.

Therefore, we sought to investigate the current prevalence, patterns, treatment, control, and risks of hypertension in community-dwelling, elderly Korean people.

Table 1. General Characteristics of the Study Population

	Normotensive (*N*=311)	Hypertensive (*N*=684)	*p*-value
Mean age (years)	75.7±8.9	76.5±8.5	0.157
Male sex (%)	47.3	42.7	0.178
Systolic BP (mmHg)	119.1±9.38	138.6±17.6	<0.0001
Diastolic BP (mmHg)	76.3±6.4	85.7±10.9	<0.0001
Pulse pressure (mmHg)	42.8±6.8	52.9±13.4	<0.0001
Pulse rate (/min)	72.1±10.1	72.0±9.6	0.876
BMI (kg/m^2)	23.3±3.2	24.3±3.3	<0.0001
Waist (cm)	85.0±9.8	87.6±8.8	<0.0001
Hip (cm)	92.5±7.0	93.7±7.0	0.02
Current smoker (%)	37.2	39.5	0.494
Alcohol consumption (%)	26.1	21.9	0.085
Regular exercise (%)	51.0	50.1	0.792
DM (%)	23.8	36.3	<0.0001
CKD (%)	42.5	50.1	0.028
Albuminuria (%)	4.3	10.0	0.003
BUN (mg/dL)	15.9±4.6	17.2±6.0	0.001
Creatinine (mg/dL)	1.08±0.21	1.13±0.38	0.002
GFR (mL/min/1.73 m^2)	63.1±11.6	60.0±13.3	<0.0001
LVH (%)	18.6	27.4	0.004
Cholesterol (mg/dL)	198.7±38.7	204.4±37.4	0.027
TG (mg/dL)	119.5±68.1	141.3±85.8	<0.0001
HDL-cholesterol (mg/dL)	60.5±14.9	59.5±15.6	0.372
LDL-cholesterol (mg/dL)	114.5±33.3	117.7±33.5	0.165
Glucose (mg/dL)	104.1±21.7	110.3±26.7	<0.0001
HbA1c (%)	5.91±0.74	6.07±0.88	0.002
γGT	23.9±24.4	28.5±36.6	0.020
ESR (mm/h)	19.8±14.7	20.9±14.2	0.279
hsCRP (mg/L)	2.53±6.34	2.49±7.19	0.930

BP, blood pressure; BMI, body mass index; DM, diabetes mellitus; CKD, chronic kidney disease; BUN, blood urea nitrogen; GFR, glomerular filtration rate; LVH, left ventricular hypertrophy; TG, triglyceride; HDL, high density lipoprotein; LDL, low density lipoprotein; γGT, γ-glutamyl transferase; ESR, erythrocyte sedimentation rate; hsCRP, high sensivity C-reactive protein.

Methods

Study Population

This is a baseline study of the Korean Longitudinal Study on Health and Aging (KLoSHa), which is a population-based, prospective cohort study on health, aging, and common geriatric diseases of elderly Koreans aged ≥65 years. The baseline study was conducted from September 2005 through September 2006 in Seongnam, a city near Seoul in Kyeongi province. The total population of Seongnam was 931,019 as of August 1, 2005. Approximately 6.6% (61,730) of the population was aged 65 or older, from whom random and selected oldest-old samples (age ≥85 years) were recruited. Of the 1,000 participating subjects, 5 were excluded from this analysis due to inadequate BP measurement or uncertainty of hypertension history. This study was approved by the Institutional Review Board of Seoul National University Bundang Hospital.

Subject Evaluation and Laboratory Study

In the KLoSHA baseline study, a physician evaluated all of the participants, and nurses carried out an extensive interview using standardized questionnaires, including a review of medication, lifestyle, and comorbidity. Standard 12-lead ECGs were recorded in all subjects at 25 mm/s and 1-mV/cm calibration. Body weight and height were measured with the subjects wearing light clothing without shoes. The body mass index (BMI) was calculated as weight in kg divided by height in m squared. The waist circumference was measured from the narrowest point between the lower borders of the rib cage and the iliac crest. After at least 10 h of overnight fasting, blood samples were obtained in the morning. A random early morning urine sample was collected and analyzed in a semi-

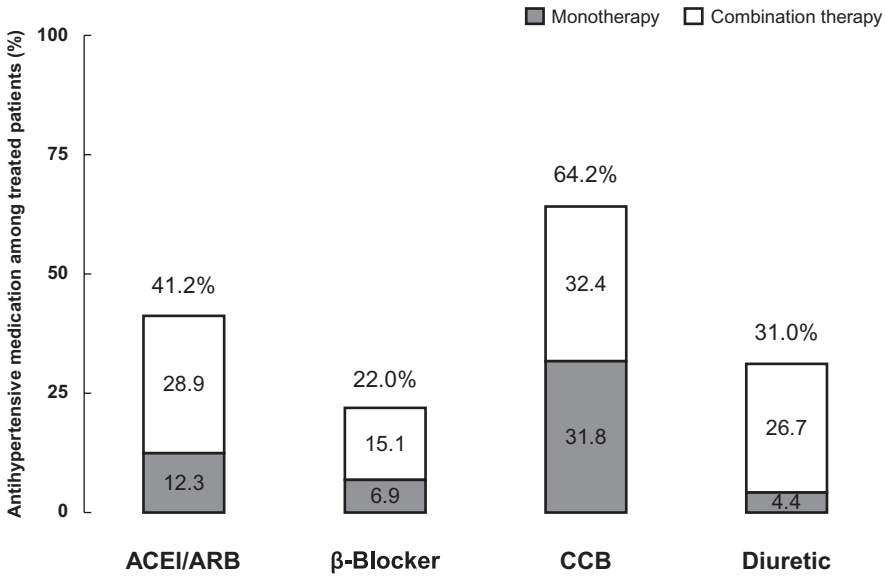

Fig. 2. *Antihypertensive medication use among treated elderly hypertensive patients by drug class. Monotherapy is the use of one active antihypertensive medication, and combination therapy is the use of more than one active antihypertensive medication at the same time. Of the study patients, 9 hypertensive male patients (2.0%) were treated with α-blockers, and 8 of them were also taking one or more other antihypertensive medications.*

quantitative manner using a dipstick. All of the assessments were performed at Seoul National University Bundang Hospital in Seongnam.

BP Measurement

BP was measured in the left arm by a trained nurse, using a mercury sphygmomanometer with an appropriately sized cuff after the subject had been seated for at least 10 min. During the measurement period, the subject's feet remained on the floor and the left arm was supported at heart level. The average of two consecutive measurements with a 5-min interval was used for analysis.

Definitions

Hypertension was defined as BP >140/90 mmHg or taking antihypertensive medications. Hypertension was classified according to the JNC 7 guidelines (*10*).

Participants were considered to have diabetes if they were receiving insulin or oral diabetes medications, or if their fasting blood glucose levels exceed 126 mg/dL (*11*). The glomerular filtration rate (GFR) was calculated using the Cockroft-Gault equation, and chronic kidney disease was defined if the estimated GFR was less than 60 mL/min per 1.73 m^2 (*12*, *13*). Left ventricular hypertrophy (LVH) was determined using Romhilt-Estes point score criteria (*14*). Alcohol consumption was defined as having 12 or more standard drinks during the previous 12 months. One standard drink contains about 15 g of ethanol (*15*). Physical activity was classified as light, moderate, or vigorous. Regular exercise was defined as spending >30 min in moderate or vigorous physical activity at least three times a week (*16*). Albuminuria was defined if any positive result (>1+) of urinary albumin was observed.

Statistical Analysis

All statistical analyses were performed using SPSS 12 (SPSS, Chicago, USA). Continuous variables were expressed as mean±SD, and were compared by either the unpaired Student's *t*-test or analysis of variance (ANOVA). Discrete variables were expressed as counts and percentages, and the χ^2 or Fisher's exact test was used to compare proportions. All statistical analyses were two-tailed, and *p*-values <0.05 were considered statistically significant.

Results

The average age of the study population was 76.3±8.7 years, and 438 of the subjects (44.1%) were male. Among the 995 included subjects, 8.5% were classified as normotensive, 22.7% were prehypertensive, and 68.7% were hypertensive (stage I: 13.5%; stage II: 9.8%; patients with medication: 45.4%). The prevalence of hypertension increased with age, peaked in the age group of 75–84, and decreased thereafter (63.3%, 69.4%, 76.4%, and 69.5% in the <70, 70–74, 75–84, and ≥85 years age group, respectively; $p=0.029$) (Fig. 1). Normotensive and hypertensive subjects were compared (Table 1). Hypertensive patients had more cardiovascular disease risk factors, including dyslipidemia, obesity, diabetes,

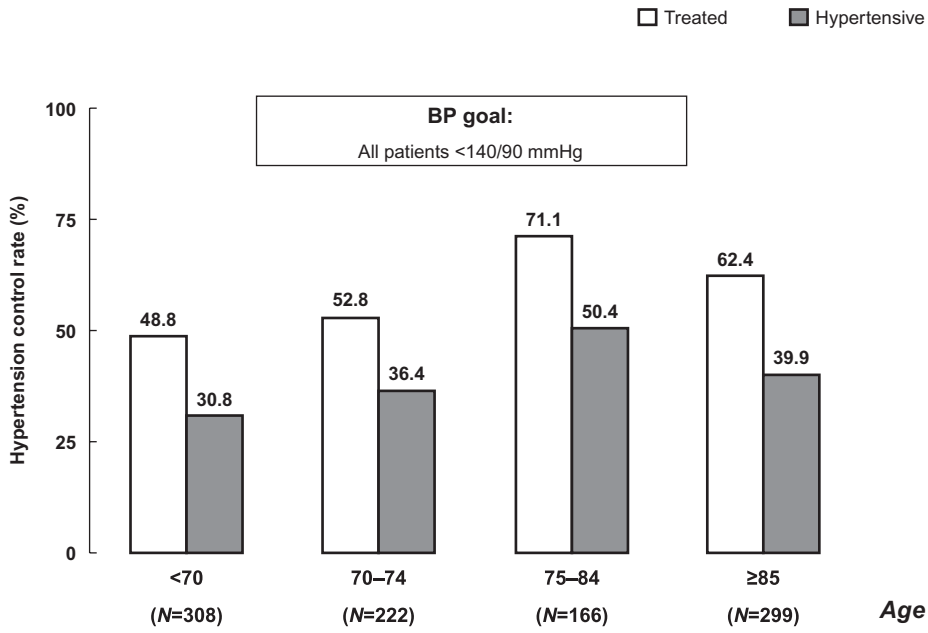

Fig. 3. *Hypertension control rate in hypertensive and treated patients according to the subject's age.*

and chronic kidney disease.

Of the 684 hypertensive patients, 452 patients (66.1%) took antihypertensive medication. However, the treatment rate did not differ significantly with the age of the subject. Among treated individuals, the average number of antihypertensive medications was 1.58±0.04, and the number of antihypertensive medications used was similar across age groups. Of the patients on antihypertensive medication, 54% took one drug, 33% took two drugs, and 13% took three or more drugs. Of the antihypertensive medications, calcium channel blockers were most commonly used in the study population (64.2%), and half of the patients were treated with single drug therapy. In contrast, most of the diuretics were used in combination therapy (Fig. 2).

Of the hypertensive patients, 476 (69.6%) had diabetes or chronic kidney disease. The proportion of patients with diabetes or chronic kidney disease did not increase with age (p=0.798). Current available guidelines recommend stricter BP control (<130/80 mmHg) in patients with diabetes or chronic kidney disease. However, the guidelines contain no specific comment regarding optimal BP control in elderly patients.

Therefore, we analyzed our data with two different standards for BP control in the study population. Applying the goal of 140/90 mmHg to all of the study population, the control rates were 58.2% and 38.5% among treated patients and hypertensive patients, respectively. The control rate increased with age, peaking in the 75–84 age group (71.1% of treated and 50.4% of hypertensive patients) (Fig. 3). Interestingly, the control rate of diastolic BP (DBP) was higher than that of systolic BP (SBP). In addition, the DBP control rate increased with age, while the SBP control rate decreased in the oldest-old group (Fig. 4). However, according to the JNC 7 guidelines, the BP control rate decreased to 24.8% in treated patients and 16.4% in all hypertensive patients. In other words, more than half of the patients with diabetes or chronic kidney disease did not attain the strict goal of BP control.

To identify the underlying factors associated with poor BP control in elderly patients, the controlled and uncontrolled groups were compared (Table 2). Old age, regular alcohol consumption, and regular exercise were associated with BP control. In contrast, LVH was more common in uncontrolled patients. However, the number of antihypertensive medications was not different (1.58±0.05 and 1.59±0.06 in the controlled and uncontrolled groups, respectively, p=0.900). Accordingly, uncontrolled hypertension was not due to a lack of antihypertensive medication.

Discussion

In this study, we observed the prevalence of hypertension in an elderly Korean population living in an urban community. The prevalence increased with age through the 75–84 age group, then slightly decreased. The reason for the decreasing prevalence after age 84 might be related to frailty. Some reports have indicated that low BP in elderly patients can be used to predict mortality and functional decline (*17*). In addition, subjects with hypertension may not survive to very old age, so selection bias might be the reason for the decreasing prevalence of hypertension in the extremely elderly subgroup.

In this study, hypertensive patients had more cardiovascular risk factors and comorbidity. Because elderly patients usu-

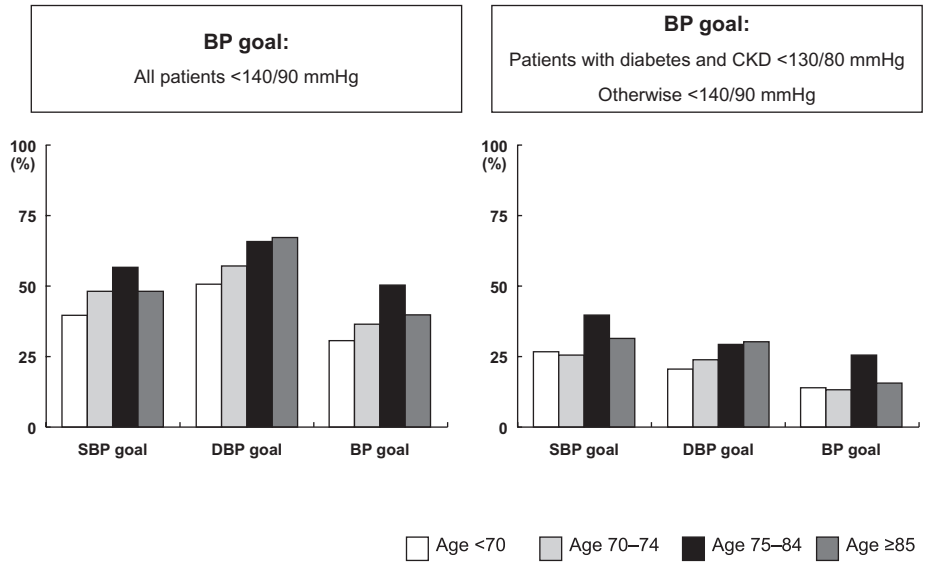

Fig. 4. *Control rate of systolic vs. diastolic blood pressure in hypertensive patients.*

ally experience multiple comorbidities, such as diabetes, renal impairment, lung disease, cognitive impairment, and depression, comorbidity must be considered, as it is important for the proper management of hypertension. Considering the multiple comorbidities and aging-related functional decline in elderly populations, the risk profile seems to be higher in elderly hypertensive subjects than in younger subjects. All of these findings suggest that a more aggressive investigation to identify subjects' global risk is very important for the proper management of hypertension in elderly patients. A previous report demonstrated the superiority of global risk assessment and management for individual risk management (*18*). Especially in elderly hypertensive patients, by taking multiple risk factors into account, global risk evaluation will provide a more effective measure on which to base treatment decisions than single risk factor measurements.

It is well known that calcium channel blockers and thiazide diuretics are initial choices for the treatment of elderly hypertensive patients (*19*, *20*). Nevertheless, newly developed angiotensin-converting enzyme inhibitors (ACEI) or angiotensin II receptor blockers (ARB) also have clinical benefits in elderly hypertensive patients (*21*). Furthermore, a recently published clinical study clearly demonstrated that using newly developed antihypertensive medication had clinical benefits over older drugs such as β-blockers and diuretics, in terms of the reduction of cardiovascular and cerebrovascular events (*22*). Because elderly subjects usually have more cardiovascular risk factors than younger populations, the benefit of a new drug blocking the renin-angiotensin system might have an additional role besides reducing BP. In addition, pharmaceutical companies are attempting to increase the market share of new drugs that are more expensive than the older drugs. This atmosphere may have a clinical impact on the choice of antihypertensive medication. In this study, we observed that the major drugs used in the elderly were calcium channel blockers and renin-angiontensin blocking agents. The use of diuretics was minimal, but increased with age. The effects of the new drugs in elderly hypertensive patients must be evaluated, and their cost-effectiveness should also be assessed.

The overall control rate of hypertension was 38.5% in hypertensive patients, comparable to that of previous reports. As optimal BP control in elderly hypertensive patients with diabetes and chronic kidney disease has not yet been established, the control rate might be overestimated in the higher-risk group. Recent guidelines have emphasized stricter BP control in high-risk groups such as populations with diabetes and chronic kidney disease. Elderly patients more frequently have diabetes and renal impairment than younger patients. Moreover, the long duration of hypertension in elderly patients increases the risk of renal impairment, which also heightens their chance of chronic kidney disease. As a result, more elderly patients are the object of strict BP control (less than 130/80 mmHg) in light of comorbidity. In this study, among the 684 hypertensive patients, 476 (69.6%) were in the strict BP control group; *i.e.*, these patients had accompanying diabetes or chronic kidney disease.

In this study, the prevalences of diabetes and chronic kidney disease were 32.5% and 46.1%, respectively. Importantly, more than half of the diabetic patients (16.7%) were first diagnosed in this evaluation, and most of the patients with renal impairment were not aware of the status of their own renal function. Therefore, without extensive evaluation to identify a subject's risk, optimal care for hypertensive elderly patients can hardly be accomplished. In this study, we observed that only 112 of the treated patients (24.8%)

Table 2. Factors Associated with Blood Pressure (BP) Control (Target BP<140/90 mmHg)

	Controlled (*N*=263)	Uncontrolled (*N*=189)	*p*-value
Mean age (years)	77.19±8.16	75.48±8.35	0.030
Male sex (%)	45.2	39.2	0.196
BMI (kg/m^2)	24.54±3.29	24.81±3.18	0.416
Waist (cm)	88.22±8.88	88.01±9.45	0.827
Hip (cm)	94.59±6.75	93.94±7.42	0.357
Current smoker (%)	38.5	37.6	0.832
Alcohol consumption (%)	21.1	18.5	0.020
Alcohol amount (standard drink/month)*	66.00±10.92	45.37±10.56	0.203
Regular exercise (%)	56.9	45.0	0.013
DM (%)	38.8	39.7	0.240
CKD (%)	55.9	46.5	0.055
Albuminuria (%)	10.0	11.6	0.641
CAD (%)	59.4	42.4	0.107
CVA (%)	41.8	45.6	0.631
BUN (mg/dL)	18.14±6.30	17.39±6.95	0.228
Creatinine (mg/dL)	1.17±0.29	1.16±0.57	0.718
GFR (mL/min/1.73 m^2)	57.66±12.46	60.00±13.41	0.058
LVH (%)	20.4	37.5	<0.0001
Cholesterol (mg/dL)	200.97±38.27	203.51±37.90	0.486
TG (mg/dL)	140.10±86.78	147.09±85.56	0.396
HDL-cholesterol (mg/dL)	59.47±15.46	57.80±14.51	0.249
LDL-cholesterol (mg/dL)	114.26±33.17	117.92±33.95	0.260
Glucose (mg/dL)	110.03±21.70	111.71±28.73	0.500
Number of antihypertensive medication	1.58±0.05	1.59±0.06	0.900

BMI, body mass index; DM, diabetes mellitus; CKD, chronic kidney disease; CAD, coronary artery disease; CVA, cerebrovascular accident; BUN, blood urea nitrogen; GFR, glomerular filtration rate; LVH, left ventricular hypertrophy; TG, triglyceride; HDL, high density lipoprotein; LDL, low density lipoprotein. *One standard drink contains about 15 g of ethanol.

achieved the target BP when a goal of 130/80 mmHg was applied in diabetic and chronic kidney disease patients. In other words, more than half of the treated patients would indeed be considered under-treated if stricter BP control were also applied to elderly patients. Accordingly, the significance of strict BP control in elderly patients needs to be established because a considerable proportion of the elderly population may be under-treated in terms of the strict BP control goal.

Predictors of BP control have been investigated in various studies, and the presence of target organ damage, healthy lifestyle including moderate alcohol consumption and regular exercise, renal disease, and diabetes invariably figure among the best predictors of poor BP control; these findings were replicated in our study.

Although alcohol consumption was significantly associated with hypertension control, there was no dose-response relationship between alcohol consumption and BP control. Further studies are required to confirm the effect of alcohol consumption and level of alcohol drinking that optimizes the benefits of BP control in elderly patients.

In this study, high-risk patients displayed lower BP control rates than low-risk patients. This has also been observed in other studies (*23*), and the reason for this may be that high-risk patients tend to include those with higher pretreatment BP, which is inherently more difficult to control. In addition, 54% of treated patients took a single antihypertensive medication to control BP. Recent data show that over-reliance on monotherapy is one of the most important factors responsible for the persistently low rates of hypertension control. To improve BP control, an increase in the use of combination therapy needs to be emphasized. Recent studies have documented that physicians are often willing to accept BP values higher than the guideline BP goals as a result of an antihypertensive treatment perceived to be "effective."

It is unclear whether poor rates of hypertension control are due to a lack of control over SBP, DBP, or both. Until recently, greater clinical emphasis was placed on the control of elevated DBP. However, SBP was less controlled than DBP, especially in older hypertensive patients, despite SBP's major role as an independent cardiovascular risk factor. The control of DBP might be related to vascular aging, which would lead to a decrease in DBP in the elderly population. Indeed, in this study, the DBP control rate was found to significantly increase with age. In contrast, the control rates of

SBP in the elderly population are suboptimal compared to the DBP control rate. However, if the goal of strict BP control is applied, the SBP control rate is much higher than the DBP control rate. This may be related to concerns about decreasing DBP in elderly patients due to the fear of coronary ischemia.

Cardiovascular and cerebrovascular diseases are important causes of death in the Republic of Korea, as well as in many other countries. The most recent Korean National Health and Nutrition Examination Survey (KNHNES) showed that 22.9% of known hypertensive patients are now using antihypertensive medication, but hypertension is being adequately controlled in only 10.7% of those individuals (*24*). The control rate in the elderly population seems to be better than that in the general population. This might be associated with specific characteristics of the study population. The city of Seongnam is located near Seoul, the capital, and a lot of wealthy people have migrated to Seongnam for their retirement. Considering the socioeconomic status of the study population, the treatment and control rates found in this study might not be applicable to the general population of elderly Korean people.

In conclusion, hypertension is common in the elderly Korean population, and its prevalence increases with age. Furthermore, global risk evaluation is very important because elderly subjects tend to have more cardiovascular risk factors. In other words, it seems that it is not enough to treat only hypertension in elderly hypertensive subjects. In a community resident elderly population, the BP control rate remains unsatisfactory, especially in higher-risk patients. The goal of optimal BP control and the benefit of BP control in the most aged of the elderly population must be investigated, because a lot of elderly hypertensive patients are currently being managed without definite evidence of benefit.

Limitations

This study has some limitations. Since the KLoSHa study does not include institutionalized adults, some of the sickest members of the population were excluded from these analyses. In addition, because of the cross-sectional design of this study, a causal relationship is difficult to draw from these observations.

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