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Vascular risk factors for stroke among urban community dwelling adults in Ansan city, Korea

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Abstract

Background & Objective: The number of ischemic stroke is increasing steadily. The recent stroke prevention strategies have targeted risk factors for preventing ischemic stroke. Community-based data that quantify the prevalence of these risk factors are needed to develop effective stroke prevention strategies. This study was performed aiming to establish customized prevention strategies by investigating vascular risk factors of ischemic stroke among the healthy adults in an urban population in Korea. *Methods:* The Prevention of Stroke and Dementia (PRESENT) survey collected data associated with stroke risk factors between 2007 and 2009 in Ansan city, Korea. Of 46,537 people, 2,843 were selected by random sampling, and final population included 358 men and 422 women over 50 years old. We checked modifiable risk factors, such as hypertension, diabetes mellitus, smoking, hyperlipidemia, atrial fibrillation, cardiovascular disease, obesity, and physical inactivity. *Results:* The mean age of study subjects was 60.1±8.2 years; 55.5% had hypertension, 18.6% had diabetes mellitus, 17.7% were current smoker, 44.9% had hyperlipidemia, 1.7% had atrial fibrillation, and 4.5% had cardiovascular disease. Men had more risk factors for stroke, and higher rates of diabetes mellitus and current smoking. However, women had higher cholesterol and obesity rates and lower physical activity. The proportion of individuals with >1 risk factor for stroke increased with age. Hypertension, diabetes mellitus, and cardiovascular diseases also increased with age, but low-density lipoprotein levels and current smoking decreased.
Conclusions: This study provides valuable information to develop customized strategic policies for primary and secondary stroke prevention.

INTRODUCTION

The remarkable decline in stroke mortality in the recent years is one of the great public health achievements, although stroke remains to be one of the leading cause of death in Korea.[1] It also results in significant morbidity with functional impairment among the survivals.[2] To overcome stroke, prevention is considered to be the most effective strategy. Effective strategic planning for the primary and secondary prevention of stroke relies on identifying the prevalence of widely known risk factors, the rate of stroke occurrence caused by risk factors within the corresponding population can be analyzed via population attributable risk (PAR). PAR can be used to prioritize policies and establish more effective strategies to prevent stroke.

First-time strokes represent 75% of all strokes. A healthy lifestyle and the management of modifiable risk factors are important for primary and secondary stroke prevention.[3] Known modifiable risk factors for stroke include hypertension (HT), diabetes mellitus (DM), smoking, hyperlipidemia, obesity, atrial fibrillation (AF), cardiovascular disease, and physical inactivity. Of these, the top 3 risk factors based on PAR are HT, DM, and smoking.[3]

While there have been several similar studies associated with prevention of stroke[4-7], there was none which analysed risk factors of ischemic stroke by limiting the subjects to healthy adults in an urban area. This study was performed to investigate the prevalence of vascular risk factors for stroke among community-dwelling adults in an urban area in Korea. It aimed to form the basis for establishing healthcare policies and prevention

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strategies for stroke among healthy adults in urban Korea.

METHODS

Study design

The Prevention of Stroke and Dementia (PRESENT) survey is an ongoing community-based project in Korea that has been funded by the regional government since 2007. The inclusion criteria were subjects who were healthy, over 50 years old, not diagnosed with stroke and dementia, and who consented to the study.

The study area was Ansan city Gyeonggi-do, South Korea, and sampling was made through a systematic random sampling after receiving data about the residents over 50 years old in Ansan City through administrative support from the City Hall. Their participation was confirmed by conducting direct interviews and phone calls with the subjects selected based on the resident data offered by the City Hall. Those who refused to participate, those who had the medical history of stroke or dementia, and those suspected to have neurological disease by neurologists were excluded.

The baseline cohort included 46,537 people recruited over 3 years. Of these 46,537 people, 2,843 were selected by random sampling: 1,119 could not be contacted, 779 did not agree to participate in the survey, 100 had moved to another area, 49 experienced previous stroke or dementia, and 16 died before we were able to collect data. The final population included 358 men and 422 women who were surveyed between 2007 and 2009 in Ansan-si, Gyeonggi-do, Korea (Figure 1).

Definition of risk factors and terminology

1) HT was defined as those with at least one blood pressure measure of ≥ 140/90 mmHg at rest or those on medication for hypertension.
2) DM was defined as those with either a blood glucose level > 200 mg/dL for at least 2 hours after an oral glucose challenge (75 g),[8] or a fasting blood glucose level > 126 mg/dL[9] or those on medication for DM.
3) Current smokers were defined as those who reported a current smoking habit.
4) Hyperlipidemia was defined as those with a venous low-density lipoprotein (LDL) cholesterol concentration > 160 mg/dL or those on medication for hyperlipidemia (eg. statin). Individuals with high total cholesterol (TC) were defined as those with a total venous cholesterol concentration > 240 mg/dL. Individuals with high triglyceride (TG) were defined as those with a total venous blood triglyceride concentration > 200 mg/dL. All three definitions were based on levels after more than 12 hours of fasting.

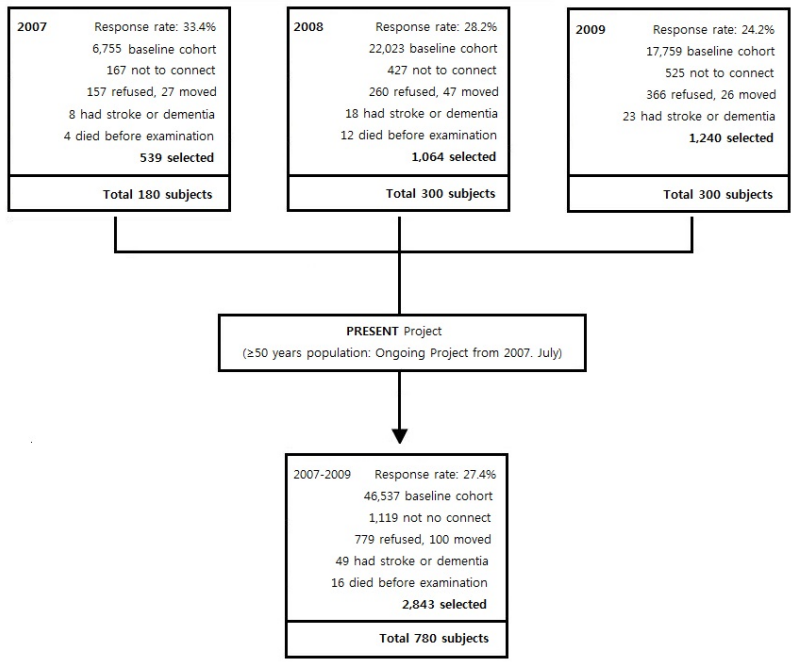

Figure 1. A flow diagram of the systematic random sampling used in the study cohort.

5) AF were defined as those who were diagnosed by a doctor based on electrocardiographic findings.
6) Cardiovascular disease was defined as those with myocardial infarction, a history of cardiovascular surgery, or evidence of coronary artery disease on electrocardiography.
7) Obesity was defined as those with a body mass index (BMI) ≥ 25 kg/m^2.
8) Individuals were considered to be physically inactive if they reported the absence of any exercise or leisure activity.
9) Awareness rate (AR) was the percentage of people who were aware that they had a disease, treatment rate (TR) represented the percentage of people who have been diagnosed with a disease and were receiving treatment, control rate (CR) represented the percentage of people with medication that controlled a disease.

Statistical analysis

The data were analyzed using SPSS software (version 13.0; SPSS Inc., Chicago, IL, USA). Two-way ANOVAs, Tukey's tests, Chi-square tests, and linear-by-linear associations were used for group comparisons; $p < 0.05$ was considered statistically significant. Clinical characteristics were compared according to sex using the Chi-square test, Fisher's exact test, and ANOVA as appropriate (Table 1). We also used the Chi-square test, Fisher's exact test, and ANOVA to compare characteristics according to age groups (Table 2). A 2-sided p value of < 0.05 was considered statistically significant.

RESULTS

Among the 780 participants, no difference in age was observed by gender. Among individuals with risk factors for stroke, men had a higher incidence than women of one or more risk factors and three or more risk factors. In addition, education level, body weight, and physical activity were higher in men than women (Table 1).

Hypertension

HT incidence was not significantly different between men and women, but significantly increased with age (Table 1, 2). When we compared these data to data from the same collection period in the Korea National Health and Nutrition Examination Survey (KNHANES)

Table 1: Baseline characteristics of study subjects.

Characteristics	Total (n = 780)	Men (n = 358)	Women (n = 422)	*p*-value
Age	60.1 ± 8.2	59.6 ± 8.1	60.4 ± 8.2	*0.177*
50–59	429 (55.0)	202 (56.4)	227 (53.8)	
60–69	224 (28.7)	104 (29.1)	120 (28.4)	*0.467*
≥ 70	127 (16.3)	52 (14.5)	75 (17.8)	
Number of risk factors				
≥ 3	89 (11.4)	61 (17.0)	28 (6.6)	*<0.001**
≥ 1	630 (80.8)	304 (84.9)	326 (77.3)	*0.007**
Hypertension	433 (55.5)	204 (57.0)	229 (54.3)	*0.447*
Diabetes Mellitus	145 (18.6)	81 (22.6)	64 (15.2)	*0.008**
Current smoking	138 (17.7)	118 (33.0)	20 (4.7)	*<0.001**
Hyperlipidemia	350 (44.9)	146 (40.8)	204 (48.3)	*0.034**
High TC	249 (31.9)	84 (23.5)	165 (39.1)	*<0.001**
High TG	179 (22.9)	92 (25.7)	87 (20.6)	*0.093*
Atrial fibrillation	13 (1.7)	9 (2.5)	4 (0.9)	*0.089*
Cardiovascular disease	35 (4.5)	19 (5.3)	16 (3.8)	*0.308*
Obesity				
BMI (Kg/m^2)	24.6 ± 3.2	24.5 ± 2.9	24.7 ± 3.4	*0.404*
BMI ≥ 25	323 (41.6)	148 (41.7)	175 (41.5)	*0.95*
BMI ≥ 30	42 (5.4)	13 (3.7)	29 (6.9)	*0.049**
Education (years)	9.3 ± 4.5	11.0 ± 4.1	7.9 ± 4.4	*<0.001**
Physical inactivity	109 (14.0)	26 (7.3)	83 (19.7)	*<0.001**

* P < 0.05: difference by Chi-square test. The values represent the mean ± standard deviation (SD), n (%). TC = total cholesterol; TG = triglycerides; BMD = body mass index.

Table 2: Comparison of risk factors by age.

Characteristics	50–59	60–69	≥ 70	*p*-value
Number of risk factors	1.3 ± 1.0	1.5 ± 0.9	1.4 ± 0.9	*0.004*
≥ 3	45 (10.5)	26 (11.6)	18 (14.2)	*0.515*
≥ 1	332 (77.4)	192 (85.7)	106 (83.5)	*0.026**
Hypertension	198 (46.2)	147 (65.6)	88 (69.3)	*<0.001**
Diabetes Mellitus	64 (14.9)	48 (21.4)	33 (26.0)	*0.008**
Current smoking	86 (20.0)	36 (16.1)	16 (12.6)	*0.116*
Hyperlipidemia	196 (45.7)	110 (49.1)	44 (34.6)	*0.029**
High TC	134 (31.2)	82 (36.6)	33 (26.0)	*0.11*
High TG	107 (24.9)	51 (22.8)	21 (16.5)	*0.141*
Atrial fibrillation	2 (0.5)	4 (1.8)	7 (5.5)	*<0.001**
Cardiovascular disease	10 (2.3)	12 (5.4)	13 (10.2)	*0.001**
Obesity				
BMI ≥ 25	175 (41.1)	99 (44.2)	49 (38.6)	*0.564*
BMI ≥ 30	15 (3.7)	16 (8.5)	8 (6.3)	*0.026**
Physical inactivity	48 (11.2)	32 (14.3)	29 (22.8)	*0.004**

* P < 0.05: difference by linear-by-linear association. The values represent the mean ± SD, n (%). TC = total cholesterol; TG = triglycerides; BMD = body mass index.

cohort, the prevalence of HT was higher in both men and women among our cohort across all ages; the prevalence generally increased with age in both cohorts (Table 3). In addition, the AR was lower in our cohort compared with the KNHANES cohort in both men and women across all age groups. The overall values of the TR were lower than the AR in both the KNHANES and PRESENT cohorts. In addition, the TR increased with age in both genders. The CR was highest among men in their sixties. The CR decreased with age among women (Table 4).

Diabetes mellitus

The incidence of DM was higher in men than women, and increased with age (Table 1, 2). The prevalence of DM was higher in men than women in most age groups in our cohort compared with the KNHANES cohort. In contrast, DM was less prevalent in women in our cohort compared with the KNHANES cohort, but the prevalence increased in women with age (Table 3). Men with DM had a lower AR in our cohort compared with the KNHANES cohort, but the pattern was similar. The AR increased slightly among women with DM as age increased, and then increased significantly after age 69. The TR exhibited a similar pattern to that of AR. Overall the CR is low across the age and gender, from 20% to 50%. The CR increased with age in the KNHANES cohort in both genders. The CR pattern in our cohort was similar to that of the KNHANES cohort among men, but different among women such that women in our cohort had the highest CR between the ages of 60 and 69 (Table 4).

Smoking

The prevalence of smoking among men decreased from 45% to 24.7% with age and remained the same from 5.2% to 5% in women in the KNHANES cohort. In the PRESENT cohort, the prevalence of smoking was also higher in men than women (p<0.001). The prevalence of smoking decreased with age (Table 1, 2). The number of men who smoked decreased with age in our cohort as in the KNHANES cohort (Table 3). However, among women, the prevalence of smoking decreased from 50–59 to 60–69 (Table 3). Thus, the pattern of smoking across age-groups differed by gender.

Hyperlipidemia

Hyperlipidemia and high TC were more common in women than men. The prevalence of both conditions increased with age, with the highest prevalence observed between 60 and 69 followed by a sharp decline thereafter. High TG was slightly more common among men, and its prevalence gradually decreased with increasing age (Table 1, 2). The prevalence of high TC in both genders was higher in our cohort compared with the KNHANES cohort. The prevalence of high TG was similar to that observed in the KNHANES cohort (Table 3).

Table 3: Comparison of stroke risk factors between the Korea National Health and Nutrition Examination Survey (KNHANES) and the Prevention of Stroke and Dementia Survey (PRESENT) from 2007-2009

	KNHANES		PRESENT	
Variables	**Men**	**Women**	**Men**	**Women**
Hypertension (%)				
50-59	41	33.7	47.5	44.9
60-69	52.5	58.3	69.2	62.5
≥70	50.1	68.2	69.2	69.3
Diabetes Mellitus (%)				
50-59	17.7	8.6	20.3	10.1
60-69	16	19.1	26	17.5
≥70	24.5	22.7	25	26.7
Current smoking (%)				
50-59	45	5.2	36.1	5.7
60-69	30.8	2.9	30.8	3.3
≥70	24.7	5	25	4
High TC (%)				
50-59	18.7	23.3	24.3	37.4
60-69	13.3	29.5	27.9	44.2
≥70	10.6	27.5	11.5	36
High TG (%)				
50-59	27.6	14.2	27.7	22.5
60-69	20	17.2	27.9	18.3
≥70	17.5	20.1	13.5	18.7
Obesity (%)				
50-59	36.8	33.8	42.7	39.6
60-69	37.8	43.3	45.2	43.3
≥70	24.5	34.4	30.8	44

Obesity = BMI≥25 Kg/m^2; TC = total cholesterol; TG = triglyceride; BMI = body mass index

Arrhythmia and cardiovascular disease

Arrhythmia was uncommon, but was more prevalent among men than women and increased with age (Table 1, 2). Cardiovascular disease was slightly more prevalent in men, but no significant difference was observed across genders. Cardiovascular disease also increased gradually with age (Table 1, 2).

Obesity

The prevalence of obesity did not differ significantly by gender. However, the age comparison revealed the highest prevalence of obesity among people between 60 and 69 (Table 1, 2). Extreme obesity, which was defined as a BMI ≥30 kg/m^2, was more common among women than men, and its prevalence was also highest between 60 and 69 (Table 1, 2). The prevalence of obesity was relatively high in both genders in our cohort compared with the KNHANES cohort.

Physical inactivity

Women were less physically active than men, and the rate of physical inactivity increased with age (Table 1, 2).

Table 4: Comparison of the awareness rate (AR), treatment rate (TR), and control rate (CR) by gender between the Korea National Health and Nutrition Examination Survey (KNHANES) and the Prevention of Stroke and Dementia Survey (PRESENT) from 2007-2009

	KNHANES						PRESENT					
	Men			Women			Men			Women		
	AR	TR	CR	AR	TR	CR	AR	TR	CR	AR	TR	CR
Hypertension												
50-59	66.9	59.9	45	76.6	69.1	48.8	53.1	46.9	44.4	66.7	60.8	50
60-69	78.5	74.5	53.1	85.3	81.5	57.8	66.7	61.1	47.7	80	74.7	42.9
≥70	76.7	72.8	49.1	82.3	79.4	51.8	69.4	63.9	34.8	76.9	75	41
Diabetes Mellitus												
50-59	75.8	59.5	29	72.7	59.5	19.6	58.5	46.3	36.8	60.9	60.9	14.3
60-69	85.6	72.3	31.2	85.9	76.1	27.8	66.7	59.3	37.5	66.7	57.1	33.3
≥70	72.3	61.7	40.4	80.8	70	32.5	61.5	46.2	50	85	70	21.4

AR = awareness rate (%); TR = treatment rate (%); CR = control rate (%).

DISCUSSION

The purpose of this study was to help establish and apply customized health policies of stroke prevention suitable for the urban area by determining the risk factors of ischemic stroke targeting healthy adults in a particular urban area. This study examined 780 subjects for three years and the mean age of subjects was 60.1 ± 8.2 years. The majority of subjects had hypertension (55.5%) and hyperlipidemia (44.9%), and various other risk factors (diabetes, smoking, atrial fibrillation, and cardiovascular disease were 18.6, 17.7, 1.7, and 4.5%). There was no statistical different in the disease distribution between genders. Male subjects had a higher vascular risk factor than female subjects. Although male subject had higher diabetes and smoking, female subjects had slightly more hyperlipidemia. Older age group had a higher proportion of hypertension, diabetes, arrhythmia, and cardiovascular disease. When the results were compared with those of KNHANES, which targeted the entire nation, this study showed relatively lower AR, TR, and CR of HT and DM in the 50s group. On the other hand, this study had more hyperlipidemia in all age groups than KNHNES results. As the age increased, subjects exercised less. However, the obesity rate was the highest in the 60s age group.

As stroke incidence increases with the aging population, related socio-economic costs are also expected to increase. The characteristics of stroke and its risk factors are changing, and healthcare providers need to adapt to these changes.[10] In addition, knowledge about PAR can provide information about the rates of particular risk factors within a population, which is more useful than a simple risk comparison in determining priorities for stroke prevention.[11]

The prevalence of HT among the PRESENT cohort was higher than that observed in the KNHANES cohort. The reason for this difference is that PRESENT was collected in a metropolitan area whereas KNHANES was collected in a rural area of Korea. Individuals residing in urban areas are less physically active due to westernization and urbanization; therefore, the prevalence of HT is more frequent in urban areas. This study confirmed our hypothesis that AR, TR, and CR would be lower among older individuals in this population (Table 4). One potential strategy involves increasing the awareness of risks associated with HT through education targeted to the elderly. According to the PAR reported by Park *et al*. in 2008,[11] the prevalence of HT increases with age, but the attributable risk is highest in both men and women in their fifties with a gradual decline thereafter. Effective prevention of HT to decrease the risk of stroke should therefore target people in their fifties and sixties as well as those in their seventies.[12]

The prevalence of DM was higher and the AR and TR were lower in the PRESENT cohort compared with the KNHANES cohort. However,

the CR was similar or slightly higher in the PRESENT cohort. Regional promotion and screening of DM is needed to raise the AR and TR in urban areas; CR will naturally rise as a result of this strategy. This strategy will also be effective for stroke prevention. The prevalence of DM, like that of HT, increases with age, but it has been reported that the relative risk is reduced as age increases.[13,14] PAR is almost twice as high among women in their sixties or later compared with men. This finding suggests that well-controlled DM among elderly women will be particularly important for stroke prevention.[11,12]

The prevalence of smoking among men has decreased each year in Korea. In contrast, the prevalence of smoking in women has been increasing slightly each year despite being low overall.[15] The prevalence of smoking decreased among women until age 60–69 and increased thereafter. One possible reason for this rebound in smoking among elderly women is their longer life expectancy compared with men, which is associated with an increase in depression as women are left alone in their old age. The previously reported PAR revealed that the risk was ten times higher among men in their fifties, six times higher among men in their sixties, and almost two times higher among men in their seventies compared with women.[11] This result suggests that smoking cessation training and management is needed among young men.[16]

The prevalence of high TC was higher in both men and women in our cohort compared with the KNHANES cohort, due to westernized eating habits and decreased daily activity among those living in urban areas. PAR is higher among women than men across all ages; therefore, strategies to manage hyperlipidemia among those living in urban areas need to focus on women.[11,12]

The occurrence of AF increased with age and was more prevalent among men. This is thought to underlie the disparity in stroke prevalence between men and women. In addition, the prevalence of HT increases with age, and HT reduces the extension of the left ventricle and increases pressure on the left atrium. Therefore, HT can cause an increase in atrial fibrillation prevalence.[17] Further, PAR of atrial fibrillation increases with age.[11] The prevalence of ischemic heart disease was 7~8 times higher for individuals ≥ 70 compared with those ≤ 50 years old.[15] This increase may also be attributed to the increase in underlying diseases such as HT and atrial fibrillation. In our society, in which the elderly population is growing rapidly, effective diagnosis and treatment of cardiac problems in people over 60 years old is important for stroke prevention.

The prevalence of obesity has been increasing steadily due to the westernized diet. It is highest among individuals in their sixties and declines thereafter. This decrease may be due to the high mortality rate triggered by other diseases that accompany obesity such as metabolic syndrome; few obese people remain alive until their late seventies. Hence, PAR was low for individuals above 70 years old compared with younger age groups.[11] Therefore, obesity management strategies would be more effective among younger age groups. And also, increasing physical activity have a significant effect on reducing body weight and stroke incidence.[18]

Based on these findings, strategies for stroke prevention among individuals living in urban areas should be considered in the following order of priority: 1) increase the AR, TR, and CR of HT and DM among individuals in their fifties and sixties through institutional improvement strategies that have the highest prevention effects, such as education targeted at different ages, education in the workplace, and increases in the number of physical examinations; 2) smoking cessation education and management for young men as well as research into the reasons for the rebounded rates of smoking among women ≥ 70 years old; 3) greater attention to management of hyperlipidemia, atrial fibrillation, and cardiovascular disease among women and increase the early diagnosis rate through frequent electrocardiograms from age 60; and 4) systematic weight reduction management targeted to the younger population.

Our study has some limitations; it used a cross-sectional study design and was confined to only one urban area. Furthermore, there was small sample size and low response rate. The low response rate reflects that the Korean society's acceptance of research is yet to be fully developed. Nevertheless, there was no significant difference between age and sex of the participants and non-participants groups (Age: 60.1±8.2 vs. 61.4±6.9, Female: 54.1% vs. 55.3%).

Despite these limitations, the results of the PRESENT cohort were consistent with findings from the KNHANES cohort, and therefore these data are suitable for the development of stroke prevention strategies for the study area.

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DISCLOSURE

Conflicts of Interest: None

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