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The Prevalence and Awareness of Hypertension and the Relationship between Hypertension and Snoring in the Korean Population

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Background: *Hypertension is the most important, and yet modifiable, risk factor for cardiovascular diseases. But in many countries, hypertension remains poorly controlled. Moreover, sleep apnea syndrome has shown that it is correlated with hypertension. The purpose of this study was to investigate the prevalence, awareness and control of hypertension among the Korean people and to evaluate the relationship between hypertension and snoring.*

Methods: *A total of 640 subjects living in Ansan, a regional city in Korea, were selected randomly, and trained nursing students investigated their age, sex, medical history, blood pressure, body mass index (BMI) and snoring score. Blood pressures were measured three times with a 10-minute interval and then averaged. The degree of snoring was estimated using a questionnaire. We divided the subjects into hypertensive (BP≥140/90 mmHg) versus normotensive group and snorer versus non-snorer group, and correlated hypertension with snoring.*

Results: *Of 640 subjects, 311 were male. The mean age was 39.7±14.6 years (18-77 years), the mean BMI (body mass index) was 22.4±3.0 kg/m^2. The mean systolic and diastolic blood pressure was 121±15.7 mmHg and 79.5±11.6 mmHg. The prevalence and awareness of hypertension were 22.2% and 16.9%, respectively, and the prevalence of snoring was 35.2%. With the increment of age, in the male, the prevalence of hypertension and snoring were higher, and the snorer group showed a higher risk of hypertension than the non-snorer group (Odds ratio 2.32, CI=1.56-3.39, p=0.0001).*

Conclusion: *In Korea, the prevalence of hypertension was similar to that in the western countries, but the awareness of hypertension was much lower compared with western countries. The prevalence of hypertension was higher in the snorer group, so more research on the correlation between the two conditions should be advanced in the future.*

Key Words: *Hypertension; Prevalence; Awareness; Snoring*

INTRODUCTION

Although hypertension is one of the most common diseases in adults, and it can be diagnosed easily, it is mostly asymptomatic until complications appear. However, if it is not treated effectively or left untreated, hypertension in its early stage may develop into such cardiovascular complications as coronary heart disease and stroke and, as a result, they can increase morbidity and mortality. As noted, hypertension is the most important, and yet modifiable, risk factor for cardiovascular diseases, because of its high prevalence in the general population and the associated high risk of cardiovascular and renal diseases[1-4].

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Mortality from cardiovascular diseases, such as coronary heart disease and stroke, has decreased progressively in North America and other western countries during the last several decades[5] because those countries have make efforts to treat and manage hypertension strategically and effectively. For example, in the USA, the National High Blood Pressure Education Program (NHBPEP) of NIH (National Institute of Health) was established in 1972 and, according to the report from the National Health and Nutrition Examination Survey (NHANES) which was Based on changes of recognition and control of hypertension among the U.S. population over the past 20 years, awareness of hypertension improved from 51% in 1976-1980 to 73% in 1988-1991, and the percentage of patients with hypertension and receiving treatment rose from 31% to 55%, and patients whose blood pressures, was controlled to less than 140/90 mmHg also increased from 10% to 29%[6].

These changes contributed to the rapid decrease of morbidity and mortality resulting from cardiovascular diseases. For example, according to the study results mentioned above, mortality from coronary heart disease and stroke declined to 53% and 60%, respectively[7].

However, in many developing counties, the mortality resulting from cardiovascular diseases has dramatically increased in the past few years[8] and, according to the reports on management and control of hypertension, over 70% of the patients with hypertension have incomplete to no control over their blood pressure[9]. Also, in the case of United States, according to the NHANES (phase 2) conducted between 1991 and 1994, the percentage of awareness, treatment and control rate of hypertension was 68.4%, 53.6% and 27.4%, respectively, which was lower compared to the survey from the period 1988-1991. Since the year 1993, the occurrence of cerebrovascular accidents has shown a tendency to increase after the adjustment of the age factor, and also the mortality of age-corrected CHD has been decreasing[10]. Therefore, in order to lower the morbidity and mortality resulting from CHD and cerebrovascular disease, high blood pressure needs adequate treatment.

Sleep apnea syndrome, one of the sleep-related breathing disorders, is usually associated with loud snoring and nocturnal arousals which result in sleep fragmentation[11-13]. Snoring, a particularly important clinical feature, is one of the cardinal symptoms. A pattern of intermittent loud snoring, with periods of silence lasting more than 10 seconds, suggests the presence of sleep apnea[14-16].

Sleep apnea syndrome has close relationships with cardiovascular complications and, especially, it is often regarded as a more common, reversible cause of hypertension in that not only does it raise the blood pressure (BP) but also it complicates the control of hypertension[17-19]. However, a causal link between these two conditions is still a subject of controversy[20,21].

In the present study, we investigated the prevalence, awareness and control of hypertension in the Korean population and evaluated the relationship between hypertension and snoring as one of sleep-related breathing disorders.

MATERIALS AND METHODS

As this is a cross-sectional study, a total of 640 subjects in Ansan City in Korea was randomly selected, interviewed and evaluated according to their age, gender, measurement of BP, degree of snoring and BMI (body mass index) by well-trained nursing students.

Measurements of BP were taken from the left arm of the seated subject, with a mercury-column sphygmomanometer with cuff-size adjustment based on arm circumference. Prior to measuring, the subject rested for more than 5 minutes in a quiet place and smoking or consumption of coffee was not allowed for at least 30 minutes. BP was measured three times with a 10-minute interval in between and the average value was calculated after taking all three measurements.

Hypertension, in line the JNC (Joint National Committee) IV report and the World Health Organization/International Symposium of Hypertension (WHO/ISH) in 1999, was defined as systolic BP (SBP) over 140 mmHg and diastolic BP (DBP) over 90 mmHg, or the use of antihypertensive medications. Classification of hypertension was made also based on the JNC IV report and the principles of WHO/ISH (1999) and the subjects with hypertension were divided into 3 groups: stage 1 (mild; SBP between 140-159 mmHg, DBP 90-99 mmHg), stage 2 (moderate; SBP between 160-179 mmHg, DBP 100-109 mmHg) and stage 3 (severe; SBP over 180 mmHg, DBP over 110 mmHg) hypertension. Also investigated were the awareness of hypertension among the subjects, whether or not they were taking antihypertensive medications, and whether their BP was being controlled to an adequate range.

The degree of snoring was obtained from the answers to a questionnaire given to each subject. That is, all subjects were asked how often they heard from

people that they snore in their sleep -'How often have you been told you snore?'- and, afterwards, the answers were quantified and scored (snoring score) as follows: 1-never, 2-very infrequently, 3-occasionally, 4-often, 5-always or almost always. We defined the subjects with a snoring score greater than 3 as the snorer group.

With respect to the two variables, namely BP and snoring, we divided the subjects into hypertensive vs. normotensive groups, and snorer vs. non-snorer groups, respectively, to obtain the prevalence of hypertension and that of snoring, and tried to correlate them with age, gender and other variables. Then, we evaluated the relationship between these two conditions, and also measured the comparative risk of snoring subjects to hypertension.

All the data was summarized by mean±SD (standard deviation) for the continuous variables and by frequency (percentage) for the categorical variables. Wilcoxon's rank sum test was performed for two-sample comparison of continuous variables, and Chi-squared test was used for categorical variables. We considered the statistical significance as 5%. All data was analyzed using SAS (v.6.12).

RESULTS

1. Population Characteristics

Of the 640 subjects, 311 (48.6%) were male and 329 (51.4%) were female (Table 1). The mean age was 39.7± 14.6 years [18-87 years], the mean BMI was 22.4±3.0 kg/m^2 and the mean SBP and DBP were 121± 15.7 mmHg and 79.5± 11.6 mmHg.

The differences between genders were that the SBP and DBP in men were 125.7± 16.4 mmHg and 82.8± 11.9 mmHg, respectively, while those in women were 117.9± 13.9 mmHg and 76.4± 10.4 mmHg, respectively. Although these differences between genders were of statistical significance, BPs in both groups were within a normal range.

Table 1. Clinical Characteristics of Study Population (N=640)

	Male	Female	Total	*p* value
Number (%)	311(48.6%)	329(51.4%)	640(100%)	
Age (years)	41.5±14.7	38.1±14.3	39.7±14.6	0.002
BMI[1] (kg/m^2)	22.9±2.8	22.0±3.2	22.4±3.0	0.001
Systolic BP[2] (mmHg)	125.7±16.4	117.9±13.9	121.7±15.7	0.0001
Diastolic BP (mmHg	82.8±11.9	79.4±10.4	79.5±11.6	0.0001

[1] Body mass index. [2] Blood pressure.

The 640 subjects were divided into 5 age groups as follows; 146 (22.8%) in the group <30 years of age, 211 (33%) in 30 to 39 years of age, 162 (25.3%) in 40 to 49 years of age, 51 (8%) in 50 to 59 years of age, and 70 (10.9%) in ≥60 years of age. The respective number of male and female in each age group was 61 and 85 in the <30 year-old group, 96 and 115 in the 30 to 39 year-pld group, 78 and 84 in the 40 to 49 group, 37 and 14 in the 50 to 59 year-old group, and 39 and 31 in the (60 group.

2. The Prevalence of Hypertension and Snoring and Awareness of Hypertension

Among the 640 subjects, 142 had hypertension and 225 were snorers with the prevalence of 22.2% and 35.2%, respectively. Of the 142 subjects in the hypertensive group, 102 were classified as stage 1 (mild), 17 as stage 2 (moderate) and 19 as stage 3 (severe) hypertension (Figure 1).

Of the 106 subjects with mild hypertension, only 11 (10.4%) were aware of the fact that they had hypertension and the remaining 95 (89.6%) subjects were not. But, in moderate and severe hypertension groups, the results showed that the subjects had a higher level of awareness. 4 (23.5%) out of 17 subjects with moderate hypertension and 9 (47.4%) of 19 subjects with severe

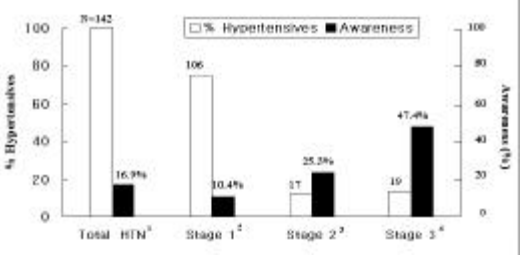

Figure 1. Hypertension Awareness. Percentages and number of subjects with hypertension (HTN) aware of the severity of HTN.

[1] Mild Hypertension: SBP 140-159 mmHg or DBP 90-99 mmHg

[2] Moderate Hypertension: SBP 160-179 mmHg or DBP 100-109 mmHg

[3] Severe Hypertension: SBP (180 mmHg or DBP (110 mmHg

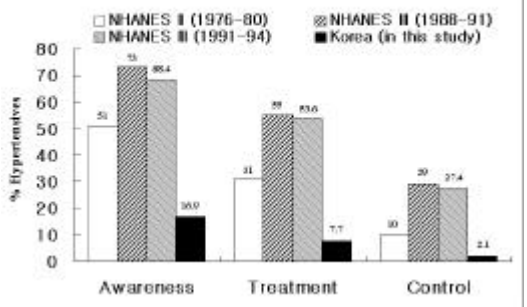

Figure 2. Awareness, treatment and control of Hypertension. Percentages of NHANES and Korean population (in this study) with hypertension (defined as a blood pressure of 140/90 mmHg or more on one or two examinations) who were aware of the condition, receiving treatment and whose hypertension was being controlled (NHANES: National Health and Nutrition Examination Surveys).

who were aware of their condition, 11 (7.7%) were taking antihypertensive medications and 3 (2.1%) were maintaining their blood pressure in a tolerable range (Figure 2).

3. The Correlation Between Hypertension and Snoring By Age and Gender Group

When we looked at the prevalence of hypertension and snoring with respect to age, of the 142 subjects in the hypertensive group, 101 were male and 41 were female with the prevalence 32.5% and 12.5%, respectively, and in the case of snoring, there were 153 males and 72 females with the prevalence of 49.2% and 21.9%, respectively. We can easily observe that the prevalence of hypertension and snoring is higher in men (Table 2). Also, when these results were compared with the different age and gender groups, the prevalence of hypertension and snoring were higher in the male population and older age groups. With the increment of age, the prevalence of hypertension obviously tended to increase as follows: the prevalence in subjects less than 30 years of age was 13.7% (male: 24.6%, female: 5.9), whereas it was 39.2% (male: 40.5%, female: 35.7%) in the 50 to 59 age group and 50% (male: 53.9%, female: 45.2%) in the <60 age group. The prevalence of snoring showed similar results as those in the case of hypertension but, distinct from hypertension, snoring had a decrement of prevalence in the ≥60 years of age group (Figure 3). The prevalence of BMI also tended to increase until the age of <60 years, but showed decrement in the ≥60 years age group as seen in the snorer group (Figure 4).

Table 2. Characteristics of the Subjects in the Normotensive Group, Hypertensive Group, Non-Snorer Group and Snorer Group.

		Normotensive	Hypertensive	*p* value
Gender	Male	158 (50.8%)	101 (32.5%)	0.001
	Female	257 (78.1%)	41 (12.5%)	
Mean age (years)		38.6±15.4	47.5±16.9	0.0001
BMI (kg/m^2)		21.8±2.9	23.8±3.1	0.0001
Systolic BP (mmHg)		119.7±15.7	141.3±17.5	0.0001
Diastolic BP (mmHg)		77.7±11.2	95.5±10.5	0.0001

		Non-snorer	Snorer	*p* value
Gender	Male	158 (50.8%)	153 (49.2%)	0.001
	Female	257 (78.1%)	72 (21.9%)	

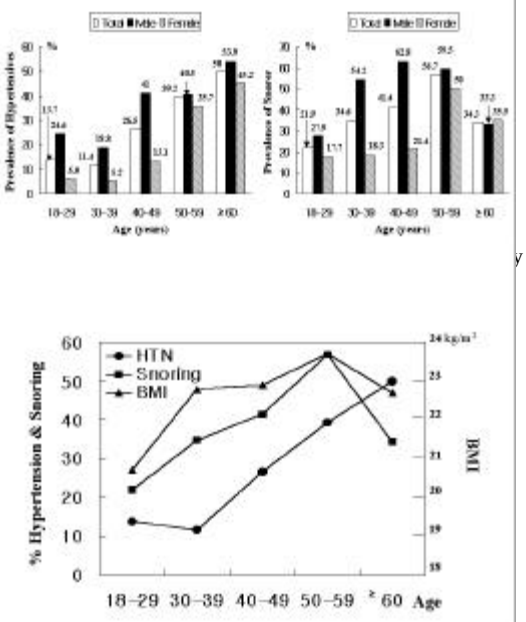

Figure 4. Prevalence of Hypertension and Snoring, BMI by Age Group.

Of the 225 snorers, 72 (32%) were hypertensive patients and the remaining 153 (68%) were normotensives whereas, among the 415 non-snorers, hypertensives and normotensives were 70 (16.9%) and 345 (83.1%), respectively. So, the Odds ratio of hypertension to snoring was 2.32 (CI: 1.56-3.39, p=0.0001) and we can infer that the snorer group is at a higher risk of hypertension compared to the non-snorer group.

DISCUSSION

This study found that the prevalence and awareness of hypertension in the Ansan area were 22.2% and 16.9%, respectively, and these results are not much different from the recent prevalence results reported in the NHANES III (24% and 73%, respectively)[1]. However, in the case of awareness, there was a great difference between the two studies, indicating a serious lack of awareness of hypertension in the Korean population (Figure 2). Of the 106 subjects with mild hypertension, only 11 (10.4%) were aware that they had the disease, whereas 4 (23.5%) among the 17 moderate hypertensive patients and 9 (47.4%) of the 19 severe hypertensive patients were aware of their disease, showing that there is a noticeable difference between groups of different severity of hypertension in the level of awareness the patients had of their disease, i.e. the awareness of hypertension declined as the severity of hypertension reduced (Figure 1). Also, the percentages of subjects who were receiving treatment and whose hypertension was being controlled were 7.7% and 2.1%, respectively, which were markedly lower than the results from the NHANES III (phase 2) with 53.6% of treatment rate and 27.4% of control rate (Figure 2).

With the increment of age, the prevalence of hypertension tended to increase (Figure 3). In the (30 years of age group the prevalence of hypertension was 13.7% as compared with 50% in the (60 year-old group. From the results, we could easily see that the prevalence of hypertension increases with age and similar results were reported by the NHANES, showing a prevalence of less than 10% in the 18 to 29 age group and a 50 to 70% prevalence in the 50 to 60 age group.

The prevalence of hypertension also showed difference between sexes. As a whole, the prevalence of hypertension was higher in the male than in the female with statistical significance (32.5% vs. 12.5%, p=0.001; see Table 2). When the age factor was adjusted, however, we could observe that the prevalence was higher in male in the younger age groups, whereas, with increasing age, the prevalence in female enormously increased, and, as a result, there was little difference in prevalence between genders from the (50 age group and onward (Figure 3).

225 of 640 subjects had the tendency to snore with a prevalence value of 35.2%. The prevalence in the male was 49.2%, which was higher than 21.9% in the female, showing similarity with the outcomes on hypertension (Table 2). According to the first large-scale study on habitual snoring by Lugaresi E. et al. in 1980, the prevalence of habitual snoring in the male and female population was 25% and 15%, respectively, and it increased significantly with age[22]. Similarly, this present study found that the prevalence of snoring increased significantly with age and also that the mean age in the snorer group was higher compared to the non-snorer group. Howeer, we could observe the prevalence of snoring and BMI decline again in the (60 year-old group (Figure 3, 4).

In the correlation between sleep apnea and hypertension, it is found that sleep apnea is more common in patients with hypertension[23-26] and, conversely, patients with obstructive sleep apnea have a high prevalence of hypertension[27-29]. Gislason[30] et al. reported that hypertension is perhaps 3 times more common among habitual loud snorers, who frequently have sleep apnea, than among non-snorers. Several studies of patients with hypertension reported a prevalence ranging from 26% to 49%, which is significantly higher compared with the prevalence varying from 0% to 12% as found in the control groups[31-34].

Also, some of undiagnosed sleep apnea patients with hypertension showed difficulty in controlling blood pressure and, in some but not all studies, it is reported that the human subjects treated for obstructive sleep apnea with tracheostomy or nasal continuous positive airway pressure (nasal CPAP) experienced a decline in blood pressure[35, 36].

In this study, we investigated the prevalence of hypertension and snoring, and also the correlation between the two conditions. We observed that the risk of hypertension was significantly higher in the snoring group (Odd ratio: 2.32, CI: 1.56-3.39, p=0.0001).

The cardiovascular effects of sleep apnea syndrome have a multi-factorial pathogenesis. The risk of cardiovascular complications, including hypertension, appears to be mediated by the complex interaction between the mechanical and chemical effects (hypoxia, hypercapnia) or repetitive upper airway closure and its effect on the autonomic nervous system. During the normal sleep cycle, the parasympathetic tone is high. However, in patients with moderate-to-severe sleep apnea, there is strong sympathetic activation with peripheral vasoconstriction and high plasma cathecholamine levels due to hypoxemia and frequent arousals (apnea termination)[11, 17-19, 37, 38]. In the vessel wall, localized hypoxemia and hypercapnia lead to acidosis which is followed by the release of many vasoactive agents, such as

prostacyclin, thromboxane, endothelin and arginine-vasopressin[18, 19, 38, 39]. Consequently, there is a likelihood of development of cardiovascular complications, such as pulmonary or systemic hypertension and cardiac arrhythmia[11, 17-19, 37, 38]. Also, chronic stimulation of the sympathetic nervous system leads to down-regulation of the baroreceptor reflex, and to autonomic dysfunction[11, 18, 38]. Together, the activation of the rennin-angiotensin-aldosterone system and decreased sensitivity of the kidney to atrial natriuretic peptidemay lead to fixed hypertension and other cardiovascular complications.

In conclusion, through this study we observed that (1) the awareness of hypertension and the percentage of patients with hypertension and receivingtreatment was markedly lower in the Korean population than those in western countries, and (2) the prevalence of hypertension is higher in the snoring population. Therefore, in managing patients with hypertension, more intensive education and aggressive treatment for hypertension are needed to reduce the morbidity and mortality of hypertension-induced cardiovascular complications. Furthermore, it is highly important to evaluate the patient's history of snoring. In addition, more research on the correlation between snoring and hypertension must be advanced in the future.

Limitations: First, our study was limited to the population in the Ansan area, Korea. So, the results from this study may not represent the prevalence and awareness of hypertension in the general Korean population. However, we consider that the population sample in this study is relatively large (640 subjects), and it was chosen in a random manner, so that the results given by this study have some validity. Second, we defined the snoring population as those with a snore score greater than 3. However, the sleep apnea syndrome, of which snoring is the cardinal symptom, has a broad spectrum of clinical conditions from simple snoring to obstructive sleep apnea and polysomnography is still regarded as the most standard diagnostic method. For in this reason, the definition of snoring used this study is quite subjective and we should keep in mind that the snoring group defined in this study may actually include patients with sleep-related breathing disorders other than sleep apnea syndrome. Therefore, a caution must be taken when discussing the correlation between hypertension and snoring.

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