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Comparison of Hypertension Prediction Analysis Using Waist Measurement and Body Mass Index by Age Group

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ABSTRACT

Objectives: The purpose of this study was to evaluate hypertension with simple anthropometry data related to obesity in Korean adults and identify whether age specific waist circumference (WC) may be a useful screening tool for determining hypertension.
Methods: Subjects (n = 571) were classified into 3 groups by age; young (18–39 years), middle aged (40–64 years), and old aged (≥ 65 years). Correlations between demographic and anthropometric parameters and hypertension were performed using Spearman correlation analysis. Logistic regression analysis and ROC (receiver operating characteristics) curves were also analyzed for correlations with hypertension.
Results: Spearman correlation analyses, age, gender, WC, and body mass index were positively correlated with hypertension. When logistic regression analysis was performed, increased age and increased WC was associated with a higher incidence of hypertension, although gender and body mass index were not significantly related to hypertension. In ROC analysis of WC for hypertension demonstrated that patients in the old age group showed higher WC cutoff value than patients in the young and middle aged groups.
Conclusion: The findings of this study demonstrate that WC may be a useful predictor of hypertension incidence among demographic and anthropometric factors in Korean adults. In addition, WC in the young population was more sensitive to the incidence of hypertension than in the elderly population.

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Introduction

Hypertension is a common disease affecting the cardiovascular system and indirectly impacts human health. The prevalence of hypertension in 2003–2004 in US was 29.3%, and 7.3±0.9%, 32.6±2.0%, and 66.3±1.8% in the 18 to 39, 40 to 59, and ≥60 age groups, respectively. The age is important factor for prevalence of hypertension [1]. Thus, analysis of age-related hypertension is necessary.

There are 2 main causes of hypertension: secondary hypertension, resulting from another medical condition, and essential hypertension, which has no identifiable cause. Essential hypertension is the most common form of hypertension [2].

The specific causes for essential hypertension have not yet been identified, but there are risk factors that increase the incidence of hypertension, for example, alcohol consumption, stress, poor diet, lack of physical activity, smoking, etc. A combination of these factors may cause obesity, with a high correlation between obesity and hypertension [3, 4].

Generally, measuring body mass index (BMI) and waist circumference (WC) are used as simple, economical and easily accessible measurements to predict obesity. These methods predict hypertension based upon the correlation between obesity and hypertension [4-7]. In addition, prevalence of

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Table 1. Demographic and anthropometric characteristics in young, middle aged and old subjects.

	Variable	Young (18-39 years)		Middle (40-64 years)		Old (≥ 65 years)	
Male (n = 337)	*WC (cm)	085.98	(08.56)	082.82	(08.76)	84.68	(9.53)
	*BMI (cm/kg)	023.60	(03.06)	023.38	(02.98)	24.22	(2.99)
	*SBP (mmHg)	118.69	(14.10)	119.09	(14.00)	119.08	(11.90)
	*DBP (mmHg)	076.95	(11.49)	078.36	(10.37)	79.03	(10.51)
	Hypertension / normal (number)	17/47		72/163		13/25	
	Total (number)	64		235		38	
Female (n = 234)	*WC (cm)	083.49	(07.82)	083.3	(7.33)	085.97	(09.43)
	*BMI (cm/kg)	023.70	(02.88)	023.51	(2.56)	024.09	(03.08)
	*SBP (mmHg)	122.28	(12.5)	122.54	(12.89)	122.32	(12.54)
	*DBP (mmHg)	079.23	(11.83)	079.99	(10.52)	081.42	(08.91)
	Hypertension / normal (number)	25/32		57/89		5/16	
	Total (number)	57		146		31	

*Mean ± (SD)
BMI = body mass index; DBP = diastolic blood pressure; SBP = systolic blood pressure; WC = waist circumference.

hypertension increases as people become elderly [7] and the prevalence of hypertension may also depend on gender differences [8]. Thus, understanding the results of these simple measurements according to age and gender is essential for improving public health.

The purpose of this study was to find the risk factors (WC, BMI, gender) most associated with hypertension for Korean adults. In addition, using receiver operating characteristics (ROC) curve analysis, this study aimed to determine how cutoff values changed with increasing age in the population.

Materials and Methods

1. Study subjects

This study enrolled 1032 adults aged 20 years to 80 years, who visited the health center in the general hospital between April 2010 and March 2012. Subjects were included in the study after all study procedures were explained and written informed consent obtained. Subjects who had diseases of the parathyroid gland, and/or diabetes mellitus, were pregnant or who had received drug therapy for hypertension, hyperlipedema or metabolic syndrome were excluded from this study. Finally, 571 subjects (337 male, 234 female) were included in this study and were classified into 3 groups, young (18–39 years), middle aged (40–64 years), and old aged (≥65 years) (Table 1).

2. Procedure

After subjects had completed the questionnaire containing information on demographic data and medical history, they underwent an anthropometric evaluation and blood investigations. The evaluation was conducted by well-trained examiners. Height (cm) and weight (kg) were measured in light clothing with no shoes using an automatic scale (HM-300, Fanics co. Ltd, Busan, South Korea), that measured to 1 decimal point (0.1 cm and 0.1 kg respectively). BMI was calculated as weight (kg) divided by height squared (m^2). WC was measured midway between the lowest rib and the iliac crest with a flexible anthropometric tape on the horizontal plane, in standing position as described in a previous study [8]. Blood pressure (BP) was measured using an automatic BP monitor (BP-203 RVⅡ Colin Corp Aichi, Japan). Hypertension was defined as systolic blood pressure (SBP) above 140 mmHg and diastolic blood pressure (DBP) above 90 mmHg according to the guidelines of the NIH [9]. This protocol was conducted in accordance with the ethical standards of the Declaration of Helsinki.

Table 2. The logistic regression analysis of variables on hypertension incidence.

Variable	B	SE	*p*	OR
Waist	0.07	0.01	0.00**	1.07
Age	0.02	0.01	0.03*	1.02
Constant	-8.34	1.30	0.00**	0.00

*$p < 0.05$; **$p < 0.01$
OR = odds ration; SE = standard error.

Table 3. Optimal cutoff values for prediction of hypertension incidence in waist and BMI risk factors in different age groups.

		Age Group (years)	Cutoff	SS	SP	AUC (95% CI)
Waist	Men	Young (18-39)	92.50	0.53	0.85	0.74 (0.58 - 0.90)*
		Middle (40–64)	87.50	0.51	0.76	0.68 (0.61 - 0.75)*
		Old (≥ 65)	82.50	0.85	0.56	0.74 (0.59 - 0.90)*
	Women	Young (18-39)	82.50	0.84	0.63	0.71 (0.58 - 0.85)*
		Middle (40–64)	81.50	0.83	0.56	0.70 (0.61 - 0.78)*
		Old (≥ 65)	94.50	0.27	0.94	0.51(0.30 - 0.72)
BMI	Men	Young (18-39)	23.05	0.88	0.47	0.74 (0.58 - 0.89)*
		Middle (40–64)	23.25	0.75	0.58	0.68 (0.61 - 0.75)*
		Old (≥ 65)	23.95	0.54	0.60	0.64 (0.44 - 0.84)
	Women	Young (18-39)	23.65	0.84	0.75	0.76 (0.64 - 0.89)*
		Middle (40–64)	21.85	0.93	0.40	0.68 (0.59 - 0.76)*
		Old (≥ 65)	20.95	0.93	0.25	0.50 (0.30 - 0.71)

*$p < 0.05$
AUC = area under the curve; BMI = body mass index; CI = confidence interval; SS = sensitivity; SP = Specificity.

3. Statistical analysis

This study used logistic regression analysis to evaluate the correlations of age, gender, WC, and BMI with hypertension. Before the logistic regression analysis, correlations between these factors and hypertension were investigated through Spearman correlation analysis to remove the factors not associated with hypertension. Forward stepwise selection was used to find the factors most significantly associated with hypertension amongst those factors identified through logistic regression analysis.

After finding the factor most associated with hypertension, subjects were divided into young (18–39 years), middle aged (40–64 years), and old aged (≥ 65 years) groups. Cutoff values were analyzed using ROC curve. SPSS for Windows (version 20.0) was used to analyze the data. The statistical significance level was set to $\alpha = 0.05$.

Results

General demographic and anthropometric characteristics of the subjects are shown in Table 1., The results demonstrated that age, gender, WC, and BMI had correlations with hypertension ($p < 0.05$). In logistic regression analysis, increased age and WC were significantly correlated with a higher incidence of hypertension ($p < 0.05$). However, gender and BMI did not affect the incidence of hypertension ($p > 0.05$). Interestingly, WC was significantly associated with the incidence of hypertension more than age ($p < 0.05$, Table 2). Analysis of the WC impact upon hypertension using the ROC curve, showed that the old age group (≥ 65 years) had a higher cutoff value than the young (18–39 years) and the middle aged (40-64 years) groups (p <0.05) (Table 3).

Discussion

Although the risk factors associated with hypertension are different depending on race and culture, there is little research observing the relationship between simple anthropometric indicators and hypertension in Korea. Therefore, this study was conducted in Korean adults to determine a simple screening tool for determining hypertension using anthropometry data.

A total of 571 Korean adults participated in this study and we investigated the relationship with age, gender, WC, and BMI and hypertension, on the basis that hypertension is closely associated with obesity and age. In addition, we measured the age-specific cutoff points of WC which is thought to be the most effective prescreening factor for determining hypertension.

The results of the study indicated that WC and age are positively associated with hypertension and gender, and BMI has a weak association with hypertension according to the results of logistic analysis. When comparing the effect of age and WC on hypertension, WC had a greater effect on hypertension than age. These results are in agreement with other studies in Asia. Woo et al [10] reported that a positive association between WC and hypertension was noted for both men and women in the elderly Chinese population. In contrast, research carried out in Brazil [11] suggested that the risk of hypertension was directly associated with both BMI and WC, and that younger women with a WC ≥ 80 cm and BMI ≥ 30 kg/m^2 had an increased risk of hypertension. Furthermore, Janssen et al. [12] explained that the health risk was greater in normal-weight, overweight, and obese women with high WC values

compared with normal weight, overweight, and obese women with normal WC values, and that health effects of a high WC were more obvious in women than in men, which is in contrast to our findings that gender does not affect hypertension. This variance may be caused by the differences of race and culture.

It is noted that WC achieved the best indicator for prescreening hypertension amongst the anthropometric factors analyzed. Thus, we identified an age-specific, WC cutoff point. By comparing cutoff points of the 3 age groups, the young and middle aged groups had an 85.5cm threshold, and the elderly age group had an 87.5cm threshold in this study.

Previous study suggested, the WC value for predicting metabolic risk factors in Korean aged 20–80 years was about 85 cm for men and 80 cm for women. The odds ratio for the risk of two or more metabolic risk factors increased abruptly in men with WC ≥ 90 cm and women with WC ≥ 85 cm [14]. The other study reported the cut-off value of WC was 86cm in men and 82 cm in women in Korean aged 30~60 years and when the subjects were divided into 5 groups according to the WC, the cut-off value were 90cm in men and 85cm in women [15]. Thus, WC value over 85.5 cm could be a risk factor for hypertension in Korean.

The sensitivity and specificity values of cutoff points were highest in the younger group. This means, the young and middle age group has lower cutoff values than the elderly group, which may suggest that the WC of younger people was more sensitive as a marker for hypertension than in the elderly, and the predictive power is higher in younger group [16]. Woo et al. suggested that WC values for predicting health outcomes in elderly people aged 70 years and over, are different compared with younger subjects and WC and waist-to-height ratio values tended to be higher in the elderly population. Optimal sensitivity and specificity for these cutoff values was higher in the younger population than the older population, which are consistent with our findings. Other European studies [5] found that WC and waist-to-height ratios are better predictors of cardiovascular disease risk factors than BMI, not only in younger adult groups, but also in children. Park et al. [17] reported the area under ROC curve for waist-to-height ratio was higher than that for WC or BMI with respect to diabetes mellitus and hypertension in both men and women, whereas WC was a better predictor for low high-density lipoprotein cholesterol in men. Feng et al. [9] reported WC and BMI were good markers for metabolic syndrome, WC was a good marker for type 2 diabetes mellitus and dyslipidemia, and BMI was a good marker for hypertension in northern Chinese adults. There would be some differences in the results according to differences in age, race, lifestyle, and cultures. But the results suggested WC is more useful predictor for hypertension and cardiovascular diseases.

The possible limitations of this study were the, focus on the simple anthropometry data, the use of a relatively small sample size in the elderly group, the omission of children from the study, and lifestyle factors such as smoking or exercise patterns, were not investigated. Neither was blood serum data collected possibly limiting this work.

The findings of this study demonstrate that WC is the best predictor of hypertension incidence amongst Korean adults when assessing WC, BMI, age, and gender risk factors. Young people have the lowest threshold of WC value for incidence of hypertension, and WC data of the younger group had the highest predictive power for incidence of hypertension. This data suggests that the WC value of younger people is more indicative of hypertension than WC value in the elderly and so could be useful as a prescreening tool to monitor healthy cardiovascular function in the young.

Conflicts of Interest

The author has no conflicts of interest to declare.

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