

Clinical characteristics of metabolic syndrome in Korea, and its comparison with other Asian countries

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ABSTRACT

Metabolic syndrome is referred to as syndrome X or insulin resistance syndrome, and is primarily composed of abdominal obesity, diabetes, glucose intolerance, dyslipidemia and high blood pressure. Asians have a lower frequency of obesity than Caucasians, but have an increasing tendency toward metabolic syndrome. Thus, metabolic syndrome poses a major challenge for public health professionals, and is set to become a social and economic problem in Asian populations. Most data on metabolic syndrome are based on studies from Western countries with only limited information derived from Asian populations. Recently, several studies were carried out on a large scale that represents the general Korean population. The prevalence of metabolic syndrome in Korean adults has varied depending on the study designs and different criteria, but shows a distinct increasing trend of metabolic syndrome driven by an increase in abdominal obesity and dyslipidemia. Given the rapid economic progression of Korea over the past 30 years along with a rise of the aged population, it is expected that the prevalence of metabolic syndrome will further increase. Therefore, a proactive strategy at the governmental level for metabolic syndrome prevention should be implemented, reducing abdominal obesity and dyslipidemia. Healthy dietary habits and regular exercise should be emphasized as a part of such a strategy.

INTRODUCTION

Metabolic syndrome is a collection of metabolic risk factors, which increases cardiovascular morbidity and mortality, as well as all-cause mortality¹. Metabolic syndrome is also associated with the development of diabetes mellitus. In a community-based prospective study with 4,975 men and women, a cluster of factors related with metabolic syndrome were found to be associated with increased risk of coronary artery disease². As a combination or individually, components of metabolic syndrome, such as abdominal obesity, hyperglycemia, dyslipidemia and high blood pressure, all predispose the subject to developing type 2 diabetes and cardiovascular disease³.

The number of individuals with metabolic syndrome is increasing worldwide. More than 40 million adult Americans are affected by metabolic syndrome⁴, and an increasing trend

has been observed in Asian countries^{5,6}. In the USA, 23.7% of the population (24.0% of men and 23.4% of women) were classified as having metabolic syndrome by the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) definition when the third National Health and Nutrition Examination Survey (NHANES) data were used⁴. Furthermore, Asian-Americans were found to have a higher prevalence of metabolic syndrome than Caucasian-Americans, after adjusting for age, body size, body composition, smoking, alcohol and exercise⁷. These results imply that the prevalence of metabolic syndrome differs between ethnic groups.

In addition, the prevalence of metabolic syndrome is dependent on the definitions and criteria used. Before the announcement of the NCEP-ATP III definition of metabolic syndrome, several studies were carried out on the prevalence of insulin resistance syndrome in Korea^{8,9}. However, in an early study using data of the Korea Medical Insurance Corporation, dyslipidemia and obesity were not included in the criteria of

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metabolic syndrome⁸. In another study, the criteria of high triglycerides levels were much higher than in other studies, and obesity was not included⁹. Thus, comprehensive studies on metabolic syndrome in Koreans are relatively sparse.

DEFINITION OF METABOLIC SYNDROME USED IN KOREAN STUDIES

The World Health Organization (WHO) proposed a working definition for metabolic syndrome in 1998. The WHO criteria requires fasting glucose ≥ 110 mg/dL (>6.1 mmol/L; impaired fasting glucose or diabetes mellitus) or homeostasis model assessment of insulin resistance¹⁰ in the top quartile of the non-diabetic population, plus at least two of the following: (i) obesity, defined as a high body mass index (BMI; ≥ 25 kg/m²) and/or a high waist-to-hip ratio (≥ 0.9 in men and ≥ 0.85 in women); (ii) dyslipidemia (triglycerides ≥ 150 mg/dL and/or low high-density lipoprotein [HDL]-cholesterol < 35 mg/dL in men and < 39 mg/dL in women); and (iii) blood pressure $\geq 140/90$ mmHg or medication.

Since 1998, several definitions have been proposed for clinical diagnosis of metabolic syndrome. Among them, the NCEP-ATP III definition has been most widely used¹¹. As Koreans generally have smaller body size than Caucasians, lower cut-off of waist circumference criteria has been applied for abdominal obesity. Thus, modified NCEP-ATP III criteria with lower cut-off waist circumference (≥ 90 cm in men and ≥ 80 cm in women) has been used in many studies published in Korea; metabolic syndrome was diagnosed as the presence of three or more of the following criteria: (i) waist circumference: ≥ 90 cm in men and ≥ 80 cm in women (in accord with the International Obesity Task Force criteria for the Asian-Pacific population); (ii) triglycerides ≥ 150 mg/dL; (iii) HDL-cholesterol < 40 mg/dL in men and < 50 mg/dL in women; (iv) blood pressure $\geq 130/85$ mmHg or antihypertensive medications; and (v) fasting blood glucose ≥ 110 mg/dL (fasting blood glucose ≥ 100 mg/dL revised in 2005) or antidiabetic medications.

In 2005, the International Diabetes Federation (IDF) formulated a new, clinically accessible worldwide definition of metabolic syndrome in a global consensus statement¹² built on earlier definitions¹¹. According to the IDF definition, abdominal obesity was an essential component of metabolic syndrome, which must be determined by ethnicity- and sex-specific cut-off values for waist circumference. The IDF also lowered the cut-off value for raised fasting glucose level at 100 mg/dL.

Using the NCEP-ATP III and IDF definition, several studies on metabolic syndrome have been carried out in Korea by using large-scale data that represent the general Korean population; that is, Korea National Health and Nutrition Examination Surveys (KNHANES) and Korean Genome Epidemiology Study (KoGES). In the present review, we introduce major Korean cohort studies that focus on metabolic syndrome: KNHANES, KoGES and others. Furthermore, we include a discussion of issues on the definitions of metabolic syndrome, and a comparison with results from other Asian studies.

PREVALENCE OF METABOLIC SYNDROME IN KOREA KNHANES

Background

During the period between 1970 and 1980, Korea experienced an epidemiological switchover from infectious diseases to chronic degenerative diseases¹³. A Westernization of diet and a reduction in physical activity because of modern conveniences seem to have evoked metabolic imbalance, obesity, and an explosive increase in cardiovascular disease and diabetes. In particular, Korea experienced an economic crisis between 1997 and 1998 as a result of a collapse in the value of the currency, which was followed by an increase in the death rate¹⁴. Interestingly, in 1998 when the Korean economy was in a crisis, and in 2001, when it recovered, two KNHANES were carried out. A change in the prevalence of metabolic syndrome between KNHANES 1998 and 2001 with an application of the NCEP-ATP III definition was investigated¹⁵. Six years later, changes in the prevalence of metabolic syndrome from 1998 to 2007 in Korea were published with the KNHANES data of the next generation¹⁶. Details of the surveys have been previously published¹⁶.

Prevalence of Metabolic Syndrome in the Adult Population in KNHANES

A total of 6,907, 4,536, 5,373 and 2,890 Koreans aged ≥ 20 years participated in KNHANES in 1998, 2001, 2005 and 2007, respectively. By applying the revised NCEP criteria³, the age-adjusted prevalence of metabolic syndrome was found to have significantly increased from 24.9% in 1998, 29.2% in 2001 and 30.4% in 2005 to 31.3% in 2007 ($P < 0.01$). Of the five components comprising metabolic syndrome, low HDL-cholesterolemia showed the greatest increase (13.8%) over the 10 years. High waist circumference and high triglycerides levels followed, showing 8.7 and 4.9% increases, respectively. Conversely, the prevalence of high blood pressure and high glucose decreased (both $P < 0.05$). Table 1 shows that the prevalence of metabolic syndrome in men and women in 1998 differed by 5.5% (22.4 vs 27.9%). In KNHANES 2007, this difference was 3.9% (29.0% in men vs 32.9% in women). Men aged 20–49 years had a higher prevalence of metabolic syndrome than women in the same age group in all KNHANES surveys. However, women showed a rapid increase just around perimenopause, and a higher prevalence than men thereafter. Dyslipidemia and abdominal obesity were major contributing factors for increased metabolic syndrome in Korea for this 10-year period.

KoGES

Comparison of Metabolic Syndrome Between Urban and Rural Areas

In 2001, the Korean government organized a large-scale community-based prospective cohort study, KoGES. Two communities representing a rural (*Ansung*) and an industrial (*Ansan*) area were selected to investigate the difference in obesity, glucose regulation, lipid profiles, and blood pressures between the

rural and urban communities, as lifestyle and diet patterns are very different between these two communities¹⁷. The first survey was carried out in 2001, and follow-up surveys have been undertaken biennially until 2012. As a baseline study, the prevalence of metabolic syndrome was estimated in accordance to region and sex by applying the modified NCEP-ATP III definition¹⁸.

In 2001, a total of 10,044 Korean men and women, aged 40–69 years, participated in KoGES (5,024 people in rural *Ansung*; 5,020 people in urban *Ansan*). The age-standardized prevalence of metabolic syndrome was 25.6% using the Korean standard population. Age- and sex-adjusted metabolic syndrome prevalence rates were 29.3 and 22.3% in the rural and urban communities, respectively ($P < 0.01$). Abdominal obesity (46.9%) and high blood pressure (45.2%) were major

components in the rural *Ansung*, whereas hypertriglyceridemia (37.6%) and low HDL-cholesterolemia (37.0%) were the major factors in the urban *Ansan*. Age-adjusted prevalence of the components of metabolic syndrome is shown in Table 2.

Among the five components, a high blood pressure criterion was more prevalent in the rural population. A high-salt diet in the rural community is likely to have had an influence on this difference¹⁹. Considering that the levels of HDL-cholesterol are determined by insulin resistance and physical activity²⁰, the higher prevalence of low HDL-cholesterolemia in women living in the rural community might be due to the high levels of obesity and low levels of exercise. In terms of the fasting glucose criterion, men residing in the urban area had a higher prevalence than those in the rural area. This seems to have been affected by the preference and easy accessibility of a

Table 1 | Age-adjusted comparison of the prevalence of metabolic syndrome components (according to the revised National Cholesterol Education Program-Adult Treatment Panel III definition) in the Korea National Health and Nutrition Examination Surveys 1998, 2001, 2005 and 2007

Variables	Men					Women				
	1998	2001	2005	2007	<i>P</i>	1998	2001	2005	2007	<i>P</i>
Abdominal obesity*										
≥90 cm for men, ≥80 cm for women	20.4 (1.2)	22.4 (1.1)	26.6 (1.3)	27.5 (1.6)	–	42.2 (1.3)	43.4 (1.5)	41.7 (1.2)	51.2 (2.1)	–
High triglycerides										
≥150 mg/dL	36.1 (1.4)	43.0 (1.5)	39.7 (1.8)	40.8 (1.8)	–	22.1 (1.6)	26.0 (1.7)	22.6 (1.9)	27.8 (2.0)	–
Low HDL-cholesterol										
<40 mg/dL for men, <50 mg/dL for women	25.5 (1.5)	32.6 (1.9)	35.2 (1.9)	34.7 (1.9)	–	47.9 (1.7)	60.1 (1.8)	61.2 (1.7)	59.3 (2.3)	–
High blood pressure										
≥130/85 mmHg or medication	48.0 (1.3)	44.3 (2.1)	46.6 (1.2)	40.6 (1.6)	–	35.3 (1.6)	31.7 (1.9)	30.7 (1.4)	30.1 (1.5)	–
High fasting glucose										
≥100 mg/dL or medication	25.1 (1.3)	26.7 (1.8)	29.3 (1.3)	31.8 (2.1)	–	22.9 (1.5)	24.5 (1.6)	18.8 (1.9)	22.3 (2.5)	–
Metabolic syndrome	22.4 (1.3)	26.9 (1.2)	31.7 (1.5)	29.0 (1.6)	<0.01	27.9 (1.2)	31.8 (1.4)	29.5 (1.5)	32.9 (1.8)	<0.01

HDL, high-density lipoprotein. Data presented as percentage (standard error). *The Asian-Pacific guideline was used for abdominal obesity.

Table 2 | Age-adjusted prevalence of components of metabolic syndrome by the modified National Cholesterol Education Program Adult Treatment Panel III definition

Variables	Men (<i>n</i> = 4,763)			Women (<i>n</i> = 5,281)		
	<i>Ansung</i>	<i>Ansan</i>	<i>P</i> *	<i>Ansung</i>	<i>Ansan</i>	<i>P</i>
Abdominal obesity†						
≥90 cm for men; ≥80 cm for women	23.9	20.7	0.008	69.1	41.7	<0.001
High blood pressure						
≥130/85 mmHg or medication	46.8	40.2	<0.001	43.6	30.0	<0.001
High fasting glucose						
≥110 mg/dL or medication	11.3	14.8	<0.001	10.0	8.7	NS
High triglycerides						
≥150 mg/dL	43.7	45.5	NS	31.0	30.0	NS
Low HDL cholesterol						
<40 mg/dL for men, <50 mg/dL for women	24.3	25.3	NS	51.2	47.4	0.006

HDL, high-density lipoprotein; NS, not significant. Data presented as the percentage. *The χ^2 -test was used. †The Asian-Pacific guideline was used for abdominal obesity

Western diet in men living in the urban area. Based on these findings, abdominal obesity in rural communities and dyslipidemia in urban communities should be the main target of intervention aimed at reducing the prevalence of metabolic syndrome in Korea.

Chongup Study

Prevalence of Metabolic Syndrome in a Typical Rural Area of Korea
There was another study, *Chongup*, that assessed the prevalence and clinical characteristics of metabolic syndrome in a typical rural area in Korea²¹. A total of 1,108 residents aged over 40 years in the district of *Chongup* participated in the study. The prevalence of metabolic syndrome was 29.4 and 39.2% according to the original NCEP-ATP III and WHO criteria, respectively²². Of note, the prevalence of abdominal obesity defined by waist circumference ≥ 102 cm in men and ≥ 88 cm

in women was 0.2% in men and 27.3% in women in this population. This is much lower compared with those of Western ethnicities^{4,23}. Nevertheless, the prevalence of metabolic syndrome in the *Chongup* study was similar to those in Western countries^{4,23}.

Chongju Cohort

Characteristics of Metabolic Syndrome in a Middle-Aged Korean Population

The *Chongju* cohort is another population-based cohort that investigated the prevalence and clinical characteristics of metabolic syndrome in a middle-aged Korean population²⁴. A total of 5,330 subjects (2,197 men and 3,133 women) aged over 40 years participated in that study, from 2003 to 2004. Metabolic syndrome was defined based on both the original NCEP-ATP III and modified NCEP-ATP III criteria (waist

Table 3 | Prevalence of metabolic syndrome in Korean adults

Study	Design	Year	No. participants	Age (years)	Criteria	Prevalence (%)
Hwang <i>et al.</i> ³⁷	Healthcare center	1997	2,435 (M 1,761/F 674)	20–78	NCEP + WC*	M 21.7/F 11.4
Kim <i>et al.</i> ³⁸	Nationwide survey (KNHANES)	1998	6,147 (M 2,731/F 3,416)	25–79 (M 44.6/F 46.5)	NCEP + WC* NCEP + WHR†	M 22.1/F 27.8 M 28.6/F 27.8
Lim <i>et al.</i> ¹⁵	Nationwide survey (KNHANES)	1998	7,945 (M 3,592/F 4,353)	>20 (M 43.1/F 43.8)	NCEP + WC*	M 21.5/F 25.4
Lim <i>et al.</i> ¹⁵	Nationwide survey (KNHANES)	2001	5,703 (M 2,423/F 3,280)	>20 (M 45.0/F 45.4)	NCEP + WC*	M 26.0/F 29.3
Lim <i>et al.</i> ¹⁸	Nationwide survey (KNHANES)	1998	6,907	>20 (mean age 45.0)	Revised NCEP + WC*	M 22.4/ F 27.9
		2001	4,536	>20 (mean age 45.5)		M 26.9/F 31.8
		2005	5,373	>20 (mean age 47.1)		M 31.7/F 29.5
		2007	2,890	>20 (mean age 49.9)		M 29.0/F 32.9
Park <i>et al.</i> ³⁹	Nationwide survey (KNHANES)	1998	6,824 (M 3,057/ F 3,767)	20–80 (M 44.3/F 44.6)	IDF + WC‡	M 13.5/F 15.0
Park <i>et al.</i> ²⁵	Healthcare center	2001	40,698 (M 26,528/ F 14,170)	20–82 (M 41.4/F 41.1)	NCEP NCEP + WC*	M 5.2/F 9.0 M 9.8/F 12.4
Choi <i>et al.</i> ³¹	Healthcare center	2001	1,230 (M 627/F 603)	30–79 (M 51.3/F 53.5)	WHO + BMI§ NCEP + WC*	M 21.8/F 19.4 M 34.2/F 38.7
Lim <i>et al.</i> ¹⁸	Community-based survey (KoGES) – Rural	2001	5,024 (M 2,240/F 2,784)	40–69 (M 55.5/F 55.5)	NCEP + WC*	Total 29.3 (M 21.8/F 36.6)
	Community-based survey (KoGES) – Urban	2001	5,020 (M 2,523/F 2,497)	40–69 (M 48.6/F 49.6)	NCEP + WC*	Total 22.3 (M 19.9/F 24.5)
Choi <i>et al.</i> ⁴⁰	Nationwide survey (KNHANES)	2001	5,964 (M 2,583/F 3,381)	>20 (M 44.8/F 45.1)	Revised NCEP IDF + WC*	M 17.8/F 20.5 M 15.0/F 23.9
Kim <i>et al.</i> ³³	Nationwide survey (KNHANES)	2001	4,452 (M 1,883/F 2,569)	>20 (M 45.0/F 45.4)	Revised NCEP + WC* Revised NCEP + WC‡ IDF + WC* IDF + WC‡	M 24.6/F 28.1 M 24.6/F 23.0 M 16.5/F 28.8 M 16.5/F 18.2
Kim <i>et al.</i> ²¹	<i>Chongup</i> cohort	2002	1,108 (M 419/F 689)	>40 (mean age 61.1)	NCEP	Total 29.4 (M 19.3/F 35.6)
Kwon <i>et al.</i> ²⁴	<i>Chongju</i> cohort	2003–2004	5,330 (M 2,197/F 3,133)	>40	NCEP NCEP + WC*	M 17.6/F 30.0 M 26.3/F 40.1

F, female; IDF, International Diabetes Federation; KNHANES, Korea National Health and Nutrition Examination Survey; KoGES, Korean Genome Epidemiology Study; M, male; NCEP, National Cholesterol Education Program; WHO, World Health Organization; WC, waist circumference; WHR, waist-to-hip ratio. NCEP, original NCEP ATP III criteria; Revised NCEP, fasting plasma glucose ≥ 100 mg/dL (≥ 5.6 mmol/L); *WC, WC ≥ 90 cm (M), ≥ 80 cm (F); †WHR, WHR ≥ 0.9 (M), ≥ 0.85 (W); ‡WC, WC ≥ 90 cm (M), ≥ 85 cm (F); §BMI, BMI ≥ 25.0 kg/m².

circumference ≥ 90 cm in men, ≥ 80 cm in women). The age-adjusted prevalence of metabolic syndrome was 24.8% (17.6% in men; 30.0% in women) using the original NCEP-ATP III criteria, whereas it increased to 34.3% (26.3% in men; 40.1% in women) with the modified NCEP-ATP III criteria. In the present study, metabolic syndrome in men was most prevalent in those aged 40–49 years, which then decreased with aging. Conversely, there was a steep increase of metabolic syndrome in women aged 50 years and older.

COMPARISON OF METABOLIC SYNDROME WITHIN KOREAN STUDIES

In addition to the aforementioned studies, there are a few more studies that examined the metabolic syndrome in Korea (Table 3). Taken together, the prevalence of metabolic syndrome in Korean studies has varied widely, being 5.2–34.2% in men and 9.0–40.1% in women. This large variance might be due to the lack of uniformity in study designs and criteria. These different studies used their own criteria for metabolic syndrome²⁵. In addition, the study participants were mostly confined to small numbers of restrictive groups²⁶.

The core component of metabolic syndrome is obesity. BMI ≥ 30 kg/m² or waist circumference ≥ 102 cm in men and ≥ 88 cm in women are commonly recommended as the cut-off for obesity in predicting metabolic syndrome and obesity-related disorders. There is an abundance of evidence showing that Asians suffer from the metabolic complications of obesity at a lower BMI than Caucasians²⁷. For this reason, it

has been suggested that lower cut-offs for obesity would be more suitable in Asians. Although there is limited prospective data to validate these findings, a study from Singapore proved that a lower cut-off used to define abdominal obesity (≥ 90 cm in men and ≥ 80 cm in women) is associated with increased risk of cardiovascular disease and diabetes²⁸.

However, the criteria of waist circumference (≥ 80 cm) for women seemed to be unsuitable for Asian ethnic groups, including Koreans. When this cut-off value was applied to the Korean population, the prevalence of metabolic syndrome in women was higher than men by approximately 1.5-fold^{15,16}. In fact, the prevalence of abdominal obesity exceeds 50% using this cut-off value in Korean postmenopausal women¹⁶. Based on this, the Korean Society for the Study of Obesity (KOSSO) recommends to use the cut-off values of waist circumference for abdominal obesity in Koreans as ≥ 90 cm for men and ≥ 85 cm for women²⁹. Using these cut-off values, the prevalence of abdominal obesity was 19.8% in men and 24.5% in women³⁰. However, the KOSSO cut-off values were not based on prospective data; hence, further study results are required to find the optimal cut-off values for abdominal obesity in Korea.

Interestingly, there was a study comparing the prevalence of metabolic syndrome according to the criteria by WHO and modified NCEP-ATP III in Korean adults³¹. The study included 1,230 participants (627 men and 603 women) aged 30–79 years, who underwent a health-screening test in 2001 in the Korean Association of Health. The prevalence of metabolic

Table 4 | Prevalence of metabolic syndrome in Asian countries

Study	Country	Design	Year	No. participants	Age (years)	Criteria	Prevalence (%)
Gu <i>et al.</i> ⁴¹	China	Cross-sectional survey (InterASIA study)	2000–2001	15,838 (M 7,684/ F 8,154)	35–74 (M 50.1/ F 50.2)	NCEP + WC*	Total 13.7 (M 9.8/F 17.8)
Xi <i>et al.</i> ⁴²	China	Nationwide survey (CHNS)	2009	7,488 (M 3,485/ F 4,003)	>18 (M 51.3/ F 51.1)	Revised NCEP + WC*	Total 21.3 (M 20.9/F 21.7)
Lao <i>et al.</i> ⁴³	South china	Cross-sectional survey	2010	3,561 (M 1,604/ F 1,957)	>20 (Mean 50.4)	IDF + WC*	Total 24.5 (M 16.3/F 30.9)
Podang <i>et al.</i> ⁴⁴	Thailand	Cross-sectional survey	2009	2,544 (M 1,875/ F 669)	–	Revised NCEP + WC*	Total 16.6 (M 18.2/F 10.3)
Binh <i>et al.</i> ⁴⁵	Vietnam	Community-based survey – Rural	2011	2,443 (M 849/ F 1,594)	40–64 (M 52/ F 51)	Revised NCEP + WC*	Total 16.3 (M 13.9/F 18.5)
Chow <i>et al.</i> ⁴⁶	India	Community-based survey – Rural	2005	4,535	≥ 30	Revised NCEP + WC*	Total 24.6 (M 28.6/F 20.4)
Deepa <i>et al.</i> ⁴⁷	South India	Cross-sectional survey (CURES study)	2006	2,350	≥ 20 (Mean 40)	WHO + WHR†	Total 23.2 (M 27.3/F 19.7)
Sy <i>et al.</i> ⁴⁸	Philippines	Cohort study (LIFECARE study)	2009	3,072 (M 1,329/ F 1,743)	20–50	IDF + WC* Revised NCEP + WC*	Total 19.7 (M 16.1/F 22.4) Total 25.6 (M 26.6/F 24.8)

CHNS, China Health and Nutrition Survey; CURES, Chennai Urban Rural Epidemiology Study; F, female; IDF, International Diabetes Federation; LIFECARE, LIFE course study in CARdiovascular disease Epidemiology; M, male; NCEP, National Cholesterol Education Program (original National Cholesterol Education Program-Adult Treatment Panel III criteria); Revised NCEP, original National Cholesterol Education Program-Adult Treatment Panel III criteria with fasting plasma glucose >100 mg/dL; *WC, waist circumference ≥ 90 cm (male) and ≥ 80 cm (female); WHR, waist-to-hip ratio; WHO, World Health Organization; WC, waist circumference; †WHR, waist-to-hip ratio ≥ 0.9 (male) and ≥ 0.85 (female).

syndrome by the modified WHO criteria was 21.8% in men and 19.4% in women. In contrast, the prevalence increased to 34.2% in men and 38.7% in women using the modified NCEP-ATP III. This finding suggests that the WHO definition is stricter than the modified NCEP-ATP III in assessing metabolic syndrome in Koreans.

There is insufficient data regarding the prevalence of metabolic syndrome according to the new worldwide definition proposed by the IDF. There was a report assessing the prevalence of metabolic syndrome in accordance to the IDF criteria with the Korean national data³². Using the IDF criteria with abdominal obesity defined as waist circumference ≥ 90 cm for men and ≥ 85 cm for women, the age-adjusted prevalence of metabolic syndrome was 13.5% in men and 15.0% in women, with abdominal obesity of 19.4% in men and 22.5% in women.

In another report, the prevalence of metabolic syndrome was compared according to the NCEP-ATP III and IDF definition, using either the KOSSO waist circumference criteria (≥ 90 cm in men, ≥ 85 cm in women) or WHO criteria (≥ 90 cm in men, ≥ 80 cm in women)³³. The prevalence of metabolic syndrome estimated by NCEP-ATP III, NCEP-ATP III with KOSSO waist circumference criteria, IDF and IDF with KOSSO waist circumference criteria were 26.7, 23.7, 23.8 and 17.5%, respectively³³.

COMPARISON OF METABOLIC SYNDROME AMONG DIFFERENT ASIAN ETHNIC GROUPS

The prevalence of metabolic syndrome among different Asian ethnic groups is shown in Table 4. The overall prevalence of metabolic syndrome in these countries widely varies, from 13.7 to 25.6% (9.8–28.6% in men and 10.3–30.9% in women). Although it is difficult to directly compare the prevalence of metabolic syndrome in different countries because of varying criteria, study designs and study numbers, it appears to increase with age, especially above 50 years-of-age, in both men and women.

The increase in the population with overweight or obesity after rapid industrialization and urbanization in Asian countries seems to contribute to an increase of metabolic syndrome. Increasing consumption of an energy-dense diet, decreasing physical activity, and elevated psychosocial stress by economic development and urbanization are associated with not only obesity, but also impaired glucose regulation, high blood pressure and dyslipidemia, resulting in an increased risk of metabolic syndrome^{34,35}. Because the increasing prevalence of metabolic syndrome leads to future cardiometabolic disorders, appropriate health policies for prevention of metabolic syndrome need to be created in Asian countries.

CONCLUSIONS

The prevalence of metabolic syndrome in Korea has varied widely, depending heavily on the different criteria used in previous studies. Thus, further studies are necessary to define the appropriate criteria of metabolic syndrome for Korean

adults, which is also the case in other Asian countries. Aside from the cut-off issue, the issue of an increasing population of older generations in Asian countries contributing to the increased prevalence of metabolic syndrome will continue. Furthermore, the increases in metabolic syndrome and its constituent factors are contributing to the increasing rates of cardiovascular diseases, as well as diabetes. As a recent study has proven, a modest modification of lifestyle can be the most effective way to manage metabolic abnormalities³⁶, which in turn, will play a role in reducing the cardiometabolic disease burden.

DISCLOSURE

The authors declare no conflict of interest.

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