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 mortality. 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 disease. 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 disease.

The number of individuals with metabolic syndrome is increasing worldwide. More than 40 million adult Americans are affected by metabolic syndrome, and an increasing trend has been observed in Asian countries. 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 used. 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 exercise. 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. However, in an early study using data of the Korea Medical Insurance Corporation, dyslipidemia and obesity were not included in the criteria of...
metabolic syndrome\(^8\). In another study, the criteria of high triglycerides levels were much higher than in other studies, and obesity was not included\(^9\). 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 require fasting glucose \(\geq 110\) mg/dL (\(\geq 6.1\) mmol/L; impaired fasting glucose or diabetes mellitus) or homeostasis model assessment of insulin resistance\(^10\) 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; \(\geq 25\) kg/m\(^2\)) and/or a high waist-to-hip ratio \((\geq 0.9\) in men and \(\geq 0.85\) in women); (ii) dyslipidemia (triglycerides \(\geq 150\) 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 used\(^11\). As Koreans generally have smaller body size than Caucasians, lower cut-off levels of waist circumference criteria has been applied for abdominal obesity. Thus, modified NCEP-ATP III criteria with lower cut-off waist circumference (\(\geq 90\) cm in men and \(\geq 80\) 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: \(\geq 90\) cm in men and \(\geq 80\) cm in women (in accord with the International Obesity Task Force criteria for the Asian-Pacific population); (ii) triglycerides \(\geq 150\) 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 \(\geq 110\) mg/dL. (fasting blood glucose \(\geq 100\) mg/dL revised in 2005) or antidiabetic medications.

In 2001, the International Diabetes Federation (IDF) formulated a new, clinically accessible worldwide definition of metabolic syndrome in a global consensus statement\(^12\) built on earlier definitions\(^11\). 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 diseases\(^13\). 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 rate\(^14\). 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 investigated\(^15\). 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 generation\(^16\). Details of the surveys have been previously published\(^16\).

**Prevalence of Metabolic Syndrome in the Adult Population in KNHANES**

A total of 6,907, 4,536, 5,373 and 2,890 Koreans aged \(\geq 20\) years participated in KNHANES in 1998, 2001, 2005 and 2007, respectively. By applying the revised NCEP criteria\(^3\), 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 higher 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 communities\textsuperscript{17}. 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 definition\textsuperscript{18}.

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 difference\textsuperscript{19}. Considering that the levels of HDL-cholesterol are determined by insulin resistance and physical activity\textsuperscript{20}, 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

| 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 | \(P\) | 1998 | 2001 | 2005 | 2007 | \(P\) | 1998 | 2001 | 2005 | 2007 | \(P\) |
| Abdominal obesity\* | 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) | – | 25.5 (1.5) | 32.6 (1.9) | 35.2 (1.9) | 34.7 (1.9) | – |
| High triglycerides \(\geq 150\) 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) | – | 25.5 (1.5) | 32.6 (1.9) | 35.2 (1.9) | 34.7 (1.9) | – |
| 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) | – | 25.5 (1.5) | 32.6 (1.9) | 35.2 (1.9) | 34.7 (1.9) | – |
| High blood pressure \(\geq 130/85\) 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) | – | 48.0 (1.3) | 44.3 (2.1) | 46.6 (1.2) | 40.6 (1.6) | – |
| High fasting glucose \(\geq 110\) 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) | – | 25.1 (1.3) | 26.7 (1.8) | 29.3 (1.3) | 31.8 (2.1) | – |
| Abdominal obesity* | 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 (\(n=4,763\)) | | | | | | Women (\(n=5,281\)) | | | | | |
|-----------|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|           | Ansung | Ansan | \(P\)* | Ansung | Ansan | \(P\) | 1998 | 2001 | 2005 | 2007 | 1998 | 2001 | 2005 | 2007 |
| Abdominal obesity† | 23.9 | 20.7 | 0.008 | 69.1 | 41.7 | <0.001 |
| High blood pressure \(\geq 130/85\) mmHg or medication | 46.8 | 40.2 | <0.001 | 43.6 | 30.0 | <0.001 |
| High fasting glucose \(\geq 110\) mg/dL or medication | 11.3 | 14.8 | <0.001 | 10.0 | 8.7 | NS |
| High triglycerides \(\geq 150\) 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 \(\chi^2\)-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 Korea. 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, respectively. 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. Nevertheless, the prevalence of metabolic syndrome in the Chongup study was similar to those in Western countries.

**Table 3**

| Study             | Design                | Year   | No. participants | Age (years) | Criteria                              | Prevalence (%) |
|-------------------|-----------------------|--------|------------------|-------------|---------------------------------------|----------------|
| Hwang et al.      | Healthcare center     | 1997   | 2,435 (M 1,761/F 674) | 20–78       | NCEP + WC*                            | M 21.7/F 11.4  |
| Lim et al.        | Nationwide survey      | 1998   | 6,147 (M 2,731/F 3,416) | 25–79       | NCEP + WC*                            | M 22.1/F 27.8  |
| Lim et al.        | Nationwide survey      | 1998   | 7,945 (M 3,592/F 4,353) | >20 (M 43.1/F 43.8) | NCEP + WC*                            | M 28.6/F 27.8  |
| Lim et al.        | Nationwide survey      | 2001   | 5,703 (M 2,423/F 3,280) | >20 (M 45.0/F 45.4) | NCEP + WC*                            | M 21.5/F 25.4  |
| Lim et al.        | Nationwide survey      | 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) | Revised NCEP + WC*                     | M 26.9/F 31.8  |
|                   |                       | 2005   | 5,373             | >20 (mean age 47.1) | Revised NCEP + WC*                     | M 31.7/F 29.5  |
|                   |                       | 2007   | 2,890             | >20 (mean age 49.9) | Revised NCEP + WC*                     | M 29.0/F 32.9  |
| Park et al.       | Nationwide survey      | 1998   | 6,824 (M 3,057/F 3,767) | 20–80       | IDF + WC†                             | M 13.5/F 15.0  |
| Park et al.       | Healthcare center      | 2001   | 40,698 (M 26,528/F 14,170) | 20–82       | NCEP                                 | M 5.2/F 9.0  |
| Choi et al.       | Healthcare center      | 2001   | 1,230 (M 627/F 603) | 30–79       | WHO + BMI§                            | M 9.8/F 12.4  |
| Lim et al.        | Community-based survey (KoGES) – Rural | 2001 | 5,024 (M 2,240/F 2,784) | 40–69       | NCEP + WC§                            | M 21.8/F 19.4  |
|                   | Community-based survey (KoGES) – Urban | 2001 | 5,020 (M 2,523/F 2,497) | 40–69       | NCEP + WC§                            | M 34.2/F 38.7  |
| Choi et al.       | Nationwide survey      | 2001   | 5,964 (M 2,583/F 3,381) | >20 (M 44.8/F 45.1) | Revised NCEP + WC*                     | M 17.8/F 20.5  |
| Kim et al.        | Nationwide survey      | 2001   | 4,452 (M 1,883/F 2,569) | >20 (M 45.0/F 45.4) | Revised NCEP + WC*                     | M 15.0/F 23.9  |
| Kim et al.        | Chongup cohort         | 2002   | 1,108 (M 419/F 689) | >40 (mean age 61.1) | Revised NCEP + WC*                     | M 17.6/F 30.0  |
| Kwon et al.       | Chongju cohort         | 2003–2004 | 5,330 (M 2,197/F 3,133) | >40         | NCEP + WC§                            | 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 $\geq 90$ cm in men, $\geq 80$ 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 syndrome. In fact, the prevalence of abdominal obesity exceeds 50% using this cut-off value in Korean postmenopausal women. Based on this, the Korean Society for the Study of Obesity (KOSO) recommends to use the cut-off values of waist circumference for abdominal obesity in Koreans as $\geq 90$ cm for men and $\geq 85$ cm for women. Using these cut-off values, the prevalence of abdominal obesity was 19.8% in men and 24.5% in women. However, the KOSO 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 adults. 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 et al.1 | China    | Cross-sectional survey  | 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 et al.2 | China    | Nationwide survey       | 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 et al.3 | 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 et al.4 | 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 et al.5 | Vietnam  | Community-based survey  | 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 et al.6 | India    | Community-based survey  | 2005       | 4,535             | $\geq 30$    | Revised NCEP + WC*               | Total 24.6 (M 28.6/F 20.4) |
| Deepa et al.7 | South India | Cross-sectional survey | 2006       | 2,350             | $\geq 20$ (Mean 40) | WHO + WHR†                       | Total 23.2 (M 27.3/F 19.7) |
| Sy et al.8 | Philippines | Cohort study         | 2009       | 3,072 (M 1,329/F 1,743) | 20–50        | IDF + WC*                        | Total 19.7 (M 16.1/F 22.4) |

CHNS, China Health and Nutrition Survey; CURES, Chennai Urban Rural Epidemiology Study; F, female; IDF, International Diabetes Federation; LIFE-CARE, 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 $\geq 90$ cm (male) and $\geq 80$ cm (female); WHR, waist-to-hip ratio; WHO, World Health Organization; WC, waist circumference; †WHR, waist-to-hip ratio $\geq 0.9$ (male) and $\geq 0.85$ (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 data. 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). 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%, respectively.

**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. 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 abnormalities, 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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