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# Obesity and Metabolic Syndrome in Korea

Sang Woo Oh

Center for Obesity, Nutrition, and Metabolism, Department of Family Medicine, Dongguk University Ilsan Hospital, Dongguk University College of Medicine, Goyang, Korea

In Korea, a person with a body mass index (BMI) ≥25 kg/m$^2$ is considered obese, and a person with a BMI ≥30 kg/m$^2$ is classified as severely obese. Central obesity is defined as a waist circumference ≥90 cm for Korean men and ≥85 cm for Korean women. Recent epidemiologic data show that the prevalence of severe obesity and metabolic syndrome is steadily increasing. These epidemics increased morbidity and mortality of type 2 diabetes, cardiovascular diseases, and obesity-related cancers such as breast, colorectal, and other cancers in Korea. Decreased physical activity, increased fat and alcohol consumption, heavy smoking, and stress/depressed mood are the primary modifiable life-style risk factors for Koreans. Recently, public health interventions to encourage life-style changes have shown promising results in reducing the prevalence of severe obesity and metabolic syndrome.

**Keywords:** Cut-point; Definition; Intervention; Lifestyle; Metabolic syndrome; Obesity; Prevalence; Risk factor

## INTRODUCTION

In recent decades, marked environmental and lifestyle changes have occurred in Korea and led to rapid increases of morbidity and mortality due to type 2 diabetes and cardiovascular diseases [1,2]. Cancer has steadily increased during this period and became the most common cause of death in Korea. Obesity-related cancers such as breast and colorectal cancer are now some of the most widespread cancers in Korea [3]. A large number of Koreans now suffer from metabolic syndrome (MS) and obesity, and control of these is one of the main targets of public health intervention [4,5]. This review focuses on these recent epidemics in detail, presenting their risk factors and related comorbidities.

## DEFINING OBESITY AND METABOLIC SYNDROME IN KOREA

International Obesity Task Force (IOTF) and the World Health Organization (WHO) Regional Office for the Western Pacific Region recommend defining obesity in Asians as those with a BMI ≥25 kg/m$^2$ [6]. The Korean Society for the Study of Obesity (KSSO) adopted this definition and now the Korea Centers for Disease Control and Prevention (CDC) and other government organizations officially use this definition when calculating the prevalence of obesity in Korea. Koreans with a BMI ≥30 kg/m$^2$ are classified as severely obese.

There are various anthropometric measures used in clinical practice for defining obesity, such as waist circumference (WC), waist-hip ratio (WHR), body impedance analyzer (BIA), dual-emission X-ray absorptiometry (DEXA), and computed tomography (CT). Determining which anthropometric measurement is the best indicator of obesity-related complications for Koreans is an important issue when defining obesity. We compared these measures using representative samples of Koreans (the Korea National Health and Nutritional Examination Survey [KNHANES] 2008-2009). The outcome variable of this analysis was set as having more than two components

Corresponding author: Sang Woo Oh
Center for Obesity, Nutrition, and Metabolism, Department of Family Medicine, Dongguk University Ilsan Hospital, 814 Siksa-dong, Ilsandong-gu, Goyang 410-773, Korea
E-mail: osw6021@yahoo.co.kr

of MS, except WC. Total body fat percentage (TBFP) was measured by DEXA. When comparing the area under curves (AUC) of receiver operating characteristic (ROC) analyses, the order of predictive capacity for men (aged ≥19 years, *n*=1,424) is WC (AUC=0.719)>BMI (0.680)>TBFP (0.669). The order of predictive capacity for women (aged ≥19 years, *n*=1,965) is WC (AUC=0.753)>BMI (0.711) >TBFP (0.654). There are no representative data for visceral fat area (VFA) in Koreans, so data were gathered from hospital-based sampling and the same analysis was performed (*n*=238, both men and women). The order of predictive capacity was VFA (0.821)≥WC (0.791)>BMI (0.736)>TBFP (0.651, measured by BIA). These results show that, in Korean men and women, WC has a higher AUC value and is significantly more predictable than other anthropometric measurements. Similar results were observed for one or more and three or more components.

Currently, there is no consensus on a universal definition for central obesity. Various academic societies recommend using ethnicity-specific definitions. The U.S. National Heart, Lung, and Blood Institute (NHLBI) recommends cut-off points of ≥102 and ≥88 cm for men and women in the United States. The International Diabetes Federation (IDF) adapted cut-off points of ≥94 and ≥80 cm for European men and women. China, Hong Kong, and some other Asian countries propose cut-off points of ≥90 and ≥80 cm for central obesity. However, Japanese researchers recommend cut-off points of ≥85 cm for Japanese men and ≥90 cm for Japanese women based on VFA measurements. In addition, more recent study results from Asian researchers suggest yet another cut-off point for their own countries (Table 1). An Asian collaboration study with 155,122 subjects (86% Asian; 52% female) from ten countries indicated that the optimal cut-off point for predicting type 2 diabetes for Asians is ≥85 cm for men and ≥80 cm for women [7]. Our research group analyzed cohort and representative cross-sectional data in Korea. Various methods were used for exploring an optimal cut-off point for central obesity. Based on this review, it appears that the optimal cut-off points for central obesity are ≥85 cm for men and ≥80 cm for women, and that the optimal difference between genders is 5 cm [8]. Using this criterion, the prevalence of central obesity is 47% in men and 41.3% in women (based on an analyses of KNHANES 2008 data). This criterion indicates that approximately one of every two Koreans has central obesity. Because of the possibility of unnecessary burdens from this high prevalence, KSSO recommended cut-off points of ≥90 cm for men and ≥85 cm for women [9].

The IDF [10] and the American Heart Association (AHA)/NHLBI [11] propose similar clinical definitions of MS except that, according to the IDF, abdominal obesity is a prerequisite for the diagnosis of metabolic syndrome. This single difference has evoked some confusion. In Korea, there is no need to use different WC cut-off points based on the IDF and revised National Cholesterol Education Program (NCEP) criteria. Therefore, all metabolic syndrome patients who meet the IDF criteria also meet the revised NCEP criteria, but not vice versa. The discrepant cases that satisfy the revised NCEP criteria but not

**Table 1.** Proposed cut-off points for defining central obesity, as suggested by various Asian researchers

| Authors | Nation | Cut-off point (Men) | Cut-off point (Women) | Journal, year |
|---|---|---|---|---|
| Lee et al. [20] | Korea | 90 | 85 | Diabetes Res Clin Pract, 2007 |
| Hyun et al. [21] | Korea | | 88 (Premeno) | Circ J, 2008 |
| Seo et al. [22] | Korea | 86.5 | 86.5 | BMC Public Health, 2009 |
| Park et al. [23] | Korea | 85 | 80 | Yonsei Med J, 2010 |
| Koh et al. [24] | Korea | 86-87 | 82-83 | J Korean Med Sci, 2010 |
| Hara et al. [25] | Japan | 85 | 80 | Diabetes Care, 2006 |
| Oka et al. [26] | Japan | 89.8 | 82.3 | Diabetes Res Clin Pract, 2008 |
| Kashihara et al. [27] | Japan | 90 | 85 | Circ J, 2009 |
| Yang et al. [28] | China | 78.9 (20-30 yr) | 65.8 (20-30 yr) | Clin Nutr, 2006 |
| | | 82.4 (31-45 yr) | 71.4 (31-45 yr) | |
| Li et al. [29] | China | 85 | 80 | Circ J, 2008 |
| Wang et al. [30] | China | 86.95 | 79.95 | Diabetes Res Clin Pract, 2010 |
| Lin et al. [31] | Taiwan | 86.5 | 82.1 | Int J Obes Relat Metab Disord, 2002 |

the IDF criteria are classified as the Metabolically Obese Normal Waist Circumference group. This discrepant group has significantly more adverse metabolic profiles than the MS-free group. It was also found that some metabolic profiles in the discrepant group were more adverse than those with MS satisfying both sets of criteria. From these reasons, when calculating the prevalence of MS in Korea, the revised NCEP definition is preferred to the IDF definition [12].

## CHANGES IN THE PREVALENCE OF OBESITY AND METABOLIC SYNDROME IN KOREA

From 1998 to 2005 there was a significant increase in the number of obese patients, as defined by those with a BMI ≥25 kg/m$^2$ (Table 2). There was an annual increase of approximately 1% during this period. However, recent KNHANES data show that the prevalence of obesity has recently stopped increasing, and that there is a decreasing tendency in women. The prevalence of abdominal obesity shows similar trends.

The prevalence of severe obesity (BMI ≥30 kg/m$^2$) has been steadily increasing, particularly in the younger generation (Fig. 1). This may be explained by the fact that fast food restaurants have been quickly gaining popularity in Korea since the mid-1980s, selling unhealthy foods such as hamburgers, fried chicken, and pizza. In addition, market dissemination of the automobile greatly increased during the same period. The children and adolescents of that time are now adults in their 20s and 30s. This paper proposes that the dramatic increase in fast food consumption and automobile use are two of the most important factors contributing to the recent severe obesity epidemic in younger generations.

Under the definition of the revised NCEP, the prevalence of MS in Korea is above 30% and rapidly increasing.

**Table 2.** Changes in the prevalence of obesity and metabolic syndrome in Korea

| | | 1998 KNHANES | 2005 KNHANES | 2007-2009 KNHANES |
|---|---|---|---|---|
| Obesity (BMI ≥25 kg/m$^2$) | Men | 25.9 | 34.8 | 35.8 |
| | Women | 27.5 | 28.3 | 26.1 |
| | All | 26.7 | 31.5 | 30.9 |
| Severe obesity (BMI ≥30 kg/m$^2$) | Men | 1.72 | 3.42 | 3.88 |
| | Women | 3.08 | 3.60 | 3.92 |
| | All | 2.41 | 3.52 | 3.90 |
| Central obesity | Men | 20.6 | 24.0 | 24.8 |
| | Women | 24.1 | 23.8 | 23.5 |
| | All | 22.4 | 23.9 | 24.1 |
| Metabolic syndrome | Men | 16.8 | 33.8 | 35.0[a] |
| | Women | 21.9 | 26.8 | 30.1[a] |
| | All | 19.6 | 30.2 | 32.4[a] |

KNHANES, Korea National Health and Nutritional Examination Survey; BMI, body mass index.
[a]The prevalence of metabolic syndrome was calculated using only 2007-2008 KNHANES data because 2009 KNHANES blood pressure data was not yet released.

## OBESITY-RELATED COMORBIDITIES

We demonstrated that obesity is closely related to type 2 diabetes, hypertension, and hypercholesterolemia in Koreans using 812,251 data with eight years of follow-up [4]. Other Korean researchers have demonstrated a clear dose-dependent relationship between obesity, ischemic heart disease [13] and stroke [14].

During recent decades, there has been a marked increase of colorectal, breast, renal cell, thyroid, and prostate cancer in Korea, all of which are proven to be associated with obesity in Koreans [15]. Less than 20 years ago, these obesity related-cancers were uncommon and the most prevalent cancers in Korea were gastric, lung, and cervical cancers. Recently, the prevalence of these obesity-related cancers has rapidly increased, which has also impacted public health care costs in Korea.

All-cause mortality shows a U-shaped relationship with BMI in Korean men and women [4]. This curve is similar to

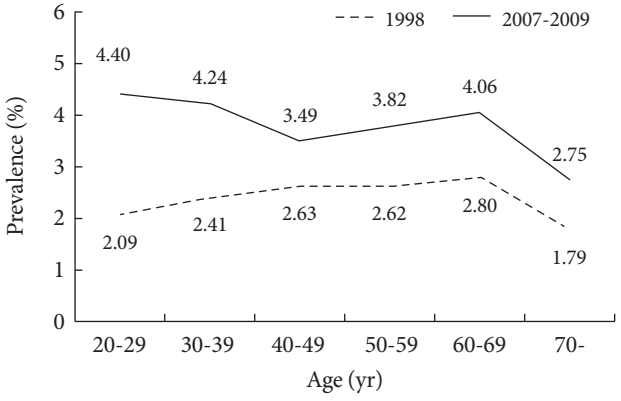


**Fig. 1.** Distribution of the prevalence of severe obesity by age group.

those from western societies. Subjects who never smoked had a stronger dose-dependent relationship with BMI.

## RISK FACTORS FOR OBESITY AND METABOLIC SYNDROME, AND LIFE-STYLE INTERVENTION IN KOREA

Smoking can reduce body weight and quitting smoking may increase body fat. However, we demonstrated that smoking increases risks of central obesity and metabolic syndrome in Koreans [16]. Increased alcohol intake among Koreans is associated with increased risk of central obesity and metabolic syndrome and its components (except high density lipoprotein cholesterol) [17]. Although stress might be classified as a risk factor for obesity and metabolic syndrome, it is difficult to prove this association because there is no established tool for measuring stress in Koreans. However, a depressive mood is associated with visceral adipose tissue and not with subcutaneous adipose tissue in overweight premenopausal women [18]. During recent decades there has been a marked increase in fat consumption, especially in younger Koreans [19], as well as a decrease in physical activity.

Recently, the Korean government and the Korean National Assembly have passed laws related to the promotion of health and disease preventions. The Korean Ministry of Health constructed the Health Plan 2020 with the primary goal of obesity prevention. These laws and the Health Plan 2020 include life-style interventions, food safety, and public education about healthy eating behaviors and physical activity.

Seoul is the capital of Korea, with a population greater than ten million. Seoul recently started a well-organized program for preventing MS in its citizens. Medical check-ups focused on diagnosing MS are offered free of charge. If any medical risks are detected, life-style interventions are also offered free of charge, with the goal of reducing the following five risk factors: smoking, alcohol, unhealthy nutrition, physical inactivity, and stress. Because this project just began two years ago, it is not yet clear if the program is effective, although data collected thus far shows promising results [5].

## CONCLUSION

The prevalence of severe obesity (BMI $\geq$30 kg/m$^2$) and metabolic syndrome is rapidly increasing in Korea. These epidemics have resulted in increased type 2 diabetes, coronary heart disease, and breast, colorectal, and other cancers in Korea. All-cause mortality showed a U-shaped association with BMI, which is similar to results of studies conducted in Western countries. Public interventions were recently initiated, focusing on life-style changes.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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