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Gender Differences in the Effect of Obesity on Chronic Diseases among the Elderly Koreans

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The objective of this study is to investigate gender differences of obesity on major chronic diseases in elderly Korean males and females. This study applied a cross sectional design using the 2005 Korean National Health and Nutrition Examination Survey (KNHNES). We selected 508 elderly males and 830 elderly females who were 60 or more years old. Obesity was defined using Body Mass Index (BMI) (≥ 25) or Waist Circumference (WC) (≥ 90 for men and ≥ 85 for women). We applied a surveylogistic regression to determine gender differences in relation to the effect of obesity on eleven major chronic diseases. Using WC, 46.2% of females were obese compared to 34.3% for males. Similarly, using BMI, 42.2% of females were obese compared to 31.7% for males. While obese males and females had similar profiles for developing metabolic syndrome components including hypertension, dyslipidemia, and diabetes (odds ratios [ORs] were 1.8-2.6 for males and 1.7-2.5 for females), obese elderly females had additional risks for arthritis and urinary incontinence (ORs 1.5-1.8 for females) as well as higher prevalence for these diseases. A clearer understanding of gender differences in relation to the association between obesity and chronic diseases would be helpful for reducing the social burden of chronic diseases in the elderly.

Key Words: Aged; Obesity; Chronic Disease; Gender

INTRODUCTION

Elderly obesity worldwide has become a growing public-health concern in developed countries with aging populations. The global epidemic of elderly obesity could be a major risk factor not only for resurgent chronic diseases, such as hypertension, cardiovascular disease, or diabetes, but also for impairing one's quality of life (1). Despite the global importance placed on elderly obesity, studies focusing on this age group are few when compared with other groups. There is a continuing debate about the harm that obesity engenders in later life (2).

Obesity's prevalence and its effect on morbidity in the elderly seemed to differ quantitatively by gender. In general, female elderly showed a higher prevalence for obesity than male elderly (3, 4). Gender is a relevant consideration for the discussion of obesity and its effect on chronic diseases, by reason of gender differential fat distribution and the patho-physiology. In their middle ages, women are expected to carry excess fat in their hips and thighs while men carry it in their abdomen. Later on in life, after menopause, women's adipose tissue tends to be redistributed toward the abdomen. Abdominal fat accumulation may pose a higher risk in men than women for metabolic syndrome (i.e. cardiovascular disease and diabetes) when they reach middle age, but this trend may reverse in the elderly (2, 4). So far, few studies have examined these gender differential changes in obesity's patterns and its health impact.

Korea has become one of the world's fastest aging societies as rapid socio-economic development and environmental change has brought an increase in life expectancy, from 61.9 yr in 1970 to 79.6 yr in 2007, and a decrease in the fertility rate from 4.53 in 1970 to 1.25 in 2007 (5). The proportion of elderly people, aged 65 yr or more, was 7.2% in 2000 and is projected to reach roughly 20% by 2026 (6). Using data from the Korean National Health and Nutritional Examination Survey (KNHNES), obesity's prevalence increased among adults aged 20 yr or more from 1998 to 2005 (from 26.3% to 31.7%) and rose substantially among the elderly aged 60 to 70 years (men: from 20% to 31%; women: from 39% to 47%) (7). In Korea, the rapid, concomitant increase in the elderly population and obesity will possibly foster a deteriorating profile of chronic diseases and impose a serious economic

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burden on societal health. Be that as it may, the common myth that obesity is not a serious Asian problem has restricted the research on the impact of obesity among the elderly (8). The body mass index (BMI: a proxy for body fat), a non-invasive and easily quantifiable measurement, has generally been used to determine obesity (9). For the elderly, however, waist circumference (WC) is more likely to be recommended (10) because abdominal fat tends to accumulate with age, and elderly weight loss may be attributed to the loss of muscle mass, but not to fat reduction (2). Overall, gender specific fat redistribution as age progresses might be a contributing factor for the difference in the pattern of chronic diseases in the elderly. Therefore, the aim of this study is to investigate, in the Korean context, the relationship between obesity and chronic diseases in elderly men and women, based on the BMI and WC criteria respectively.

MATERIALS AND METHODS

Design and study population

The data were derived from the 2005 KNHNES, which is a nationally representative survey (11). Using two-stage stratified cluster sampling methods, 600 national districts were selected for the Health Interview Survey, and 200 national districts were selected for the Health Examination Survey and Health Behavior Survey. Approximately 20-26 households were included in each district. The weighted sample for the 2005 KNHNES reflected the sampling fraction and non-response bias adjustments. Additional weight adjustments reflected the structure of the 2005 sex-age-specific population. We selected 508 men and 830 women who were aged ≥ 60 yr.

The KNHNES consisted of four comprehensive questionnaires, including a Health Interview Survey, a Health Examination Survey, a Health Behavior Survey, and a Nutrition Survey. Our study variables were collected from the first three surveys. In the Health Interview and Behavior Survey, data were collected by well-trained interviewers interviewing respondents. In the Health Examination Survey, data were gathered by direct clinical and physical examinations, including anthropometric measurements, administered by highly trained medical personnel.

Chronic disease definition

For our analysis, we specified eleven major chronic diseases: 1) arthritis, 2) osteoporoses, 3) disk disorder, 4) cardiovascular diseases; 5) pulmonary disease, 6) thyroid, 7) anemia, 8) incontinence, 9) hypertension, 10) diabetes, and 11) dyslipidemia.

Firstly, we categorized eleven chronic diseases from the health interview: "Have you experienced any chronic diseases during the past year?" "Was the chronic disease diagnosed by a physician?" "Chronic diseases" were defined as diseases lasting at least three months. Only cases diagnosed by a physician were included in the definition of eleven diseases.

Secondly, for the definition of hypertension, dyslipidemia, and diabetes, we combined information from the health interview and clinical examination: Hypertension was defined as having a diastolic blood pressure of ≥ 90 mm Hg, a systolic blood pressure of ≥ 140 mm Hg, or self-reported hypertension, as suggested by the National Cholesterol Education Program (NCEP) (12). Diabetes was defined as having a glucose level of ≥ 126 mg/dL or self-reported diabetes, as suggested by the American Diabetes Association (13). Dyslipidemia was defined as having a total cholesterol level of ≥ 240 mg/dL, a LDL-cholesterol level of ≥ 160 mg/dL, a HDL-cholesterol level of < 40 mg/dL, a triglyceride level of ≥ 200 mg/dL, or self-reported dyslipidemia, as suggested by the NCEP (12).

Main independent variables

Obesity was defined as BMI or WC. The anthropometric index for height, weight, and waist circumference was measured by well-trained medical personnel. Respondents were measured for weight and height while wearing light clothing and no footwear. WC was measured at the narrowest point between the lower borders of the rib cage and the iliac crest. Body weight and WC were measured to the nearest 0.01 kg and 0.1 cm respectively. BMI was calculated as weight in kilograms divided by height in meters squared. In accordance with WHO criteria for Asian people (9), BMI obesity was defined as a BMI of 25 or more (BMI ≥ 25 kg/m^2).

The cut-off points of WC obesity is different depending on ethnicity and countries (14). For Asian, investigators recommended a cut-off of 80 cm for women and 90 cm for men as the WC obesity due to a higher prevalence of hypertension and diabetes in these areas. For Caucasians, WC obesity criteria is usually defined as 88 cm for women and 102 cm for men as higher co-morbidities risk in Caucasians (9). In our study, WC obesity was defined as a WC of ≥ 90 cm for men and ≥ 85 cm for women, based on the study conducted using representative Korean population (15), which were line with the country specific guidelines by international diabetes federation (14).

Covariables included age, sex, marital status, and socioeconomics position (education, equalized house income), and health behaviors (smoking, alcohol drinking, exercise). Marital status was divided into two categories: married or single/divorced/widow/separate. Education was categorized under middle school and high school and over. Equalized income (= total household income per family $size^{0.5}$) was classified into three-quintile. Smoking status was classified into three groups (current smoking, ex-smoking, and non-smoking). Drinking and exercise status were classified, based on current habits (no or yes).

Statistical analysis

All the analyses were divided by gender. Descriptive statistics

were calculated with chi squire procedure. After stratification by obesity and gender, the age-adjusted prevalence and 95% confidence interval of chronic disease was calculated with age adjustment for 5-yr age groups. Considering the complex survey sample design and unequal weights, surveylogistic regression was applied to estimate the odds ratio and 95% confidence interval (95% CI) in order to examine the association between obesity and 11 major chronic diseases, after adjusting for age, socioeconomic position (education, income, and marital status), and health behaviors (smoking, alcohol, and exercise). All statistical analyses were conducted using SAS, version 9.1.

Ethics statement

We used de-identified data on 2005 KNHNES which open to the public through the websites and informed consent was obtained for all persons who participated for the blood sampling before this survey (11). This study was reviewed by IRB (2010.10.08).

RESULT

Table 1 shows the demographic characteristics of the elderly aged 60 yr or over, stratified gender and obesity (WC and BMI obesity). For elderly males, the proportion was 34.3% in WC obesity and 31.7% in BMI obesity. The proportion of WC and BMI obesity appeared to be greater among elderly females than among elderly males (46.2%, 42.2% respectively). The proportion of obesity seemed to increase with age for elderly males: the oldest being more obese. The opposite result was observed among elderly females: the oldest being less obese. Well-educated elderly males had more obesity than low-educated elderly males (38.9% vs 31.7% for WC obesity; 37.2% vs 28.7% for BMI obesity, respectively) whereas uneducated elderly females had greater obesity than educated elderly females (47.0% vs 36.8% for WC obesity; 42.6% vs 36.8% for BMI obesity, respectively). In terms of incomes, a higher proportion of only WC obesity among elderly males with low and middle incomes than among those with high incomes was observed. Married men and women had a higher proportion of obesity when compared to those who were single, widowed, or divorced. Currently smoking elderly males had a lower proportion of obesity than nonsmoking elderly males, but the differences were not substantial for elderly females. Male and elderly females who currently consume alcohol seemed to have a higher proportion of obesity whereas only elderly females who exercised had a higher proportion of obesity than the non-exercising group.

Tables 2 and 3 present the age-adjusted prevalence of chronic diseases in the elderly after being stratified by gender and WC/BMI obesity. Gender differences in the pattern of specific chronic diseases related to obesity were observed. For elderly males, the WC and BMI obese group, when compared to the non-obese group, had a higher prevalence of hypertension, dyslipidemia and diabetes. For elderly females, a greater prevalence of arthritis, hypertension, dyslipidemia, pulmonary, diabetes, and incontinence were observed among the BMI and WC obese groups

Table 1. Weighted percentage of demographic, aged 60 yr or over (n = 1,238), stratified by waist circumference (WC) and body mass index (BMI), using 2005 Korean National Health and Nutrition Examination Survey (KNHNES)

Characteristics	Men			Women		
	No.	WC ≥ 90 cm No. (%)	BMI ≥ 25 No. (%)	No.	WC ≥ 85 cm No. (%)	BMI ≥ 25 No. (%)
Obesity	508	174 (34.3)	161 (31.7)	730	337 (46.2)	308 (42.2)
Age (yr)						
60-69	352	115 (32.7)	110 (31.3)	420	201 (47.9)	196 (46.7)
70-	156	59 (37.8)	51 (32.7)	310	136 (43.9)	112 (36.1)
Education						
High school & over	180	70 (38.9)	67 (37.2)	57	21 (36.8)	21 (36.8)
Under middle school	328	104 (31.7)	94 (28.7)	673	316 (47.0)	287 (42.6)
Equalized household income						
Q3 (high)	202	62 (30.7)	63 (31.2)	247	113 (45.8)	99 (40.1)
Q2 (middle)	172	65 (37.8)	58 (33.7)	237	114 (48.1)	111 (46.8)
Q1 (low)	134	47 (35.1)	40 (29.9)	246	110 (44.7)	98 (39.8)
Marital status						
Married	452	156 (34.5)	146 (32.3)	353	163 (46.2)	163 (46.2)
Single, Widowed, Divorced, Separated	56	18 (32.1)	15 (26.8)	377	145 (38.5)	145 (38.5)
Smoking						
Never smoker	77	31 (40.3)	35 (45.5)	622	286 (46.0)	267 (42.9)
Former smoker	256	97 (37.9)	83 (32.4)	47	23 (48.9)	19 (40.4)
Current smoker	175	46 (26.3)	43 (24.6)	61	28 (45.9)	22 (36.1)
Drinking						
No	392	131 (334)	121 (30.9)	718	329 (45.8)	302 (42.1)
Yes	116	43 (37.1)	40 (34.5)	12	8 (66.7)	6 (50.0)
Exercise						
No	177	113 (34.1)	102 (30.8)	563	253 (44.9)	228 (40.5)
Yes	331	61 (34.5)	59 (33.3)	167	84 (50.3)	80 (47.9)

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Table 2. Age-adjusted prevalence (%) (95% confidence intervals)* of chronic conditions diagnosed by physician among the elderly aged 60 yr or over (n = 1,238), stratified by waist circumference (WC) using the 2005 Korean National Health and Nutrition Examination Survey (KNHNES)

Chronic disease	Men		Women	
	WC < 90 cm	WC ≥ 90 cm	WC < 85 cm	WC ≥ 85 cm
Arthritis	22.6 (20.8-24.5)	21.7 (19.9-23.4)	63.3 (61.2-65.4)	71.5 (69.2-73.8)
Osteoporosis	3.0 (2.3-3.6)	0.6 (0.3-0.9)	30.8 (29.3-32.3)	30.1 (28.6-31.6)
Disk	12.6 (11.2-14.0)	11.0 (9.7-12.0)	17.9 (16.8-19.1)	17.7 (16.5-18.8)
Hypertension	45.3 (42.7-47.9)	68.3 (65.1-71.5)	52.5 (50.5-54.4)	66.6 (64.4-68.8)
Dyslipidemia	53.5 (50.7-56.4)	67.3 (64.2-70.5)	55.5 (53.5-57.5)	70.4 (68.2-72.7)
Cardiovascular†	8.5 (7.3-9.6)	7.7 (6.6 -8.7)	9.9 (9.0-10.7)	10.5 (9.7-11.4)
Pulmonary‡	14.2 (12.7-15.6)	11.2 (9.9-12.5)	7.7 (6.9 -8.4)	10.0 (9.2-10.9)
Diabetes	12.0 (10.7-13.3)	21.5 (19.7-23.2)	11.9 (11.0-12.8)	18.1 (16.9-19.2)
Thyroid	0.8 (0.5-1.1)	1.0 (0.6-1.4)	2.9 (2.4-3.3)	4.3 (3.7-4.8)
Anemia	6.3 (5.3-7.3)	4.5 (3.7-5.3)	19.0 (17.9-20.2)	15.3 (14.3-16.4)
Incontinence	2.4 (1.7-3.0)	0.6 (0.3-0.9)	50.0 (48.1-51.9)	59.0 (56.9-61.1)

*Age-standardized prevalence (95% CI) of chronic disease were calculated with age adjustment to 5-yr age groups according to the direct method with the distribution of total sample as reference; †Cardiovascular diseases include stroke, angina pectoris, myocardial infarction; ‡Pulmonary diseases include asthma, chronic lower obstructive pulmonary disease.

Table 3. Age-adjusted prevalence (%) (95% confidence intervals)* of chronic conditions diagnosed by physician among the elderly aged 60 yr or over (n = 1,230), stratified by body mass index (BMI) using the 2005 Korean National Health and Nutrition Examination Survey (KNHNES)

Chronic disease	Men		Women	
	BMI < 25	BMI ≥ 25	BMI < 25	BMI ≥ 25
Arthritis	21.5 (19.7-23.2)	23.6 (21.7-22.5)	61.8 (59.7-63.9)	74.5 (72.2-76.8)
Osteoporosis	2.4 (1.8-3.0)	1.2 (0.8-1.6)	32.1 (30.5-33.6)	29.6 (28.1-31.1)
Disk	12.2 (10.9-13.6)	11.6 (10.3-12.9)	16.2 (15.1-17.2)	21.2 (20.0-22.5)
Hypertension	46.3 (43.6-48.9)	67.3 (64.2-70.5)	51.4 (49.4-53.3)	69.0 (66.8-71.3)
Dyslipidemia	54.3 (51.5-57.2)	66.1 (63.0-69.3)	54.9 (52.9-56.9)	72.2 (69.9-74.5)
Cardiovascular†	8.9 (7.7-10.0)	7.5 (6.4-8.5)	10.3 (9.4-11.1)	9.4 (8.6-10.3)
Pulmonary‡	14.6 (13.1-16.0)	10.2 (9.0-11.5)	7.0 (6.3-7.7)	11.2 (10.3-12.1)
Diabetes	16.3 (14.8-17.9)	25.8 (23.8-27.7)	16.8 (15.7-18.0)	19.4 (18.3-20.6)
Thyroid	1.0 (0.6-1.4)	0.6 (0.3-0.9)	3.7 (3.2-4.2)	2.7 (2.3-3.1)
Anemia	5.9 (5.0-6.8)	4.9 (4.1-5.8)	19.0 (17.9-20.2)	15.6 (14.6-16.7)
Incontinence	2.2 (1.6-2.7)	0.4 (0.2-0.6)	52.5 (50.5-54.4)	60.0 (55.0-59.0)

*Age-standardized prevalence (95% CI) of chronic disease were calculated with age adjustment to 5-yr age groups according to the direct method with the distribution of total sample as reference; †Cardiovascular diseases include stroke, angina pectoris, myocardial infarction; ‡Pulmonary diseases include asthma, chronic lower obstructive pulmonary disease.

Table 4. Adjusted odds ratios (95% confidence intervals)* for chronic conditions diagnosed by physician according to body mass index (BMI) or waist circumference (WC) among the elderly aged 60 yr or over (n = 1,238), stratified by gender using the 2005 Korean National Health and Nutrition Examination Survey (KNHNES)

Chronic disease	Men		Women	
	WC ≥ 90 cm	BMI ≥ 25	WC ≥ 85 cm	BMI ≥ 25
Arthritis	0.77 (0.45-1.33)	1.06 (0.58-1.93)	1.53 (1.06-2.21)	1.81 (1.27-2.56)
Osteoporosis	0.15 (0.02-1.32)	0.54 (0.11-2.68)	1.01 (0.69-1.49)	0.93 (0.61-1.40)
Disk	0.69 (0.34-1.39)	1.00 (0.51-1.97)	1.26 (0.83-1.92)	1.55 (1.00-2.43)
Hypertension	2.22 (1.36-3.63)	2.44 (1.48-4.01)	1.77 (1.19-2.61)	2.03 (1.38-3.0)
Dyslipidemia	1.80 (1.17-2.77)	1.75 (1.10-2.81)	2.34 (1.65-3.31)	2.52 (1.79-3.54)
Cardiovascular†	0.85 (0.40-1.84)	0.92 (0.43-1.95)	1.51 (0.85-2.66)	1.16 (0.67-2.01)
Pulmonary‡	0.63 (0.30-1.33)	0.68 (0.31-1.50)	1.25 (0.68-2.29)	1.49 (0.85-2.61)
Diabetes	2.56 (1.45-4.53)	2.19 (1.20-4.01)	2.34 (1.46-3.74)	1.66 (1.05-2.63)
Thyroid	0.56 (0.09-4.24)	0.37 (0.03-5.09)	2.15 (0.84-5.50)	0.79 (0.30-2.09)
Anemia	0.56 (0.22-1.42)	0.60 (0.22-1.61)	0.76 (0.48-1.20)	0.69 (0.43-1.11)
Incontinence	0.17 (0.02-1.84)	0.23 (0.03-2.21)	1.53 (1.10-2.14)	1.25 (0.90-1.74)

Model: Odds ratios (95% CI) adjusted for age, educational qualification (uneducated, middle school, and beyond high school), equivalent household income (low, middle, and high), marriage status, and health behaviors (smoking, drinking, and exercise). *Odds ratio (95%CI) were calculated using multiple logistic regression analysis among the elderly aged 60 yr or over; †Cardiovascular diseases include stroke, angina pectoris, myocardial infarction; ‡Pulmonary diseases include asthma, chronic lower obstructive pulmonary disease.

than the non-obese group. In particular, the prevalence of thyroid disease was higher for the female WC obese group than the female non-obesity group while a higher prevalence of disk disorder was observed only for the female BMI obese group, when

compared to the non-obese group. The prevalence of chronic diseases between the WC and BMI obese groups was similar.

Table 4 presents the association between chronic diseases and obesity (BMI and WC obesity) using multiple surveylogistic regression, after controlling for demographics, equalized household income, education level, and health behaviors (smoking, drinking, and exercise). A gender-differential was observed in the association between specific chronic diseases and obesity. Elderly males with BMI or WC obesity had a 1.8-2.6 times greater risk for developing hypertension, dyslipidemia, and diabetes when compared to non-obese elderly males. For elderly females, the obese group was significantly associated with hypertension, dyslipidemia, diabetes, arthritis, and incontinence (with a 1.5-2.5 times higher odds ratio) including marginal significance of disk disorder. Although both WC and BMI measurements were highly sensitive at detecting an excessive risk for developing several chronic diseases, a different pattern between the WC and BMI measurement was found for elderly females. The WC criteria were likely to be a more sensitive method of detecting the association between obesity and incontinence in the elderly while the BMI criteria were sensitive at detecting obesity's excessive risk for arthritis.

DISCUSSION

Our findings indicated that women have a higher prevalence of obesity than men in a representative Korean population, aged 60 yr and over. The results also highlighted that elderly women are exposed to a significantly higher risk of obesity on additional diseases such as arthritis and urinary incontinence, in comparison to their male counterparts. On the other hand, diabetes, hypertension, and dyslipidemia showed a similar level of positive associations with obesity in both genders.

In line with previous studies, elderly Korean women showed a higher prevalence of obesity than elderly men in BMI and WC measurements (3, 4). These levels of elderly obesity may be explained by biological gender differences; after menopause, decreased estrogen levels lead to reduced metabolic activity and may accelerate the development of female obesity. Even though the decrease in fat free mass is greater for elderly men (2.0% increase/10 yr among men, not among women) (16), women possess relatively greater fat mass and less lean mass when compared with men (17). This association could also be attributed to societal determinants, such as economic growth, media advertisements, the stress of a fast-paced society, gender discrimination, and the family structure. For example, Korea's recent change from a kinship to a conjugal family and its adoption of modern kitchen appliances may decrease the physical labor that burns off calories for elderly women. Furthermore, the increase in purchasing power, that economic growth brings, and widespread market advertising grants them an ease of access to food. However, studies show varying gender differences for obesity's prevalence. In a recent empirical research from Hungari and Canada, obesity is more prevalent among elderly males (18, 19). Country by country, the prevalence of elderly obesity differs according to gender since various risk factors such as ethnicity, socioeconomics, healthy behaviors, and place of birth, intertwine in a complicated manner (19). A further study should be conducted to investigate this phenomenon.

After adjusting for potential covariates in our study, obese elderly females appeared to have a greater vulnerability for arthritis and urinary incontinence when compared to non-obese females. These findings were not observed in elderly males. What is well known is that the aging process increases arthritis, and this prevalence is much higher in elderly women than in elderly men (20). Our data shows a three times higher prevalence for arthritis in older females than in their male counterparts, with the gap being wider in obese groups using BMI and WC measures. Gender differences of musculoskeletal diseases may be explained by psychological and biological factors. Women feel more stress (one of the major factors contributing to the development of musculoskeletal diseases) due to experiencing lower social equality and lower pain thresholds, which are arthritis related. Furthermore, a decrease in sex hormones (such as estrogen) in female elderly might lead to a weakening of their bone density (20). In regards to obesity's effect on musculoskeletal diseases, we found the association only among older women. Presumably, excess adipose tissue on weight bearing joints would be more burdensome on the weaker bones of females than males. These differing gender patterns for obesity-related musculoskeletal disorders were seen in some (21), but not all (22), previous studies.

Epidemiological and clinical studies have reported that obesity is related to a higher risk of incontinence in women (23, 24); anatomic changes during pregnancy, a short urinary tract, and postmenopausal hormonal changes may partly explain this. Additionally, women's excessive abdominal weight may also contribute to urinary incontinence by increasing intra-abdominal pressure on the bladder (24). Alternatively, the gender effect of obesity on the aforementioned diseases could be explained by a smaller prevalence of severe obesity among males than females (BMI ≥ 30: 1.6% for men vs 3.4% for women).

Our results are consistent with previous studies that addressed the relationship between obesity and metabolic syndrome in both genders (25, 26). Recent research has explained the mechanism by which obesity is linked to these diseases. Obesity is regarded as the chronic inflammation by adipocyte-secreted agents, and this may account for the development of the metabolic syndrome. In other words, pro-inflammatory cytokines, specific hormones, and free fatty acids that are secreted by adipose tissue, increase hypertension by affecting the renin-angiotensin aldosterone system. These agents also affect dyslipidemia

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and insulin resistance (27).

Metabolic syndrome is a well-known predictor of cardiovascular diseases (CVD); however, our results did not confirm a relationship between obesity and CVD (stroke, myocardial infarction, and angina). Nonetheless, by using rigorous cutoff value for WC obesity (women, 90 cm WC; men, 102 cm WC), we detected a relationship with CVD (result not shown). An empirical study observed that severe obesity in the elderly increases the risk of CVD even though the effect of obesity on CVD may be much smaller among the elderly than among an adult population (3). By using BMI ≥ 30, however, we were unable to prove any association, which was similar to a previous Korean finding that used BMI (28). Consequently, BMI may not be a reliable measure for elderly obesity and CVD in Korean context. Another possibility is that an 'obesity paradox'–the issues of "survival bias" and "reverse causation"–may have influenced our result (29). Survival bias proposes that whereas obese CVD patients tend not to live long, obese patients who live longer may be less vulnerable to CVD. Also, the lack of relationship could attribute to reverse causation because undiagnosed chronic diseases may bring weight-loss of the elderly, which seemed to attenuate the association between BMI and CVD.

Our study found differences between BMI and WC measurements for detecting the relationship between specific chronic diseases and obesity. For men, there were no differences between each type of measurement. For elderly females, however, the BMI scale was especially useful for detecting obesity-related musculoskeletal disorders while the WC was useful for detecting obesity-related urinary incontinence. BMI (a proxy for body fat) is used to identify obesity in epidemiological studies and clinical practices; this scale, however, is limited for measuring elderly obesity due to its lack of sensitivity regarding body fat (2, 10). Despite the same levels of BMI, the elderly have a greater proportion of fat than young adults mainly because fat body mass replaces lean body mass with age (30). Nonetheless, we found BMI to be an effective measure for detecting arthritis in elderly females, mainly because of the correlation between higher BMI and higher body weight, which increases stress on the joints.

On the contrary, WC obesity in our study was a more sensitive measure for detecting urinary incontinence than BMI obesity. Because the visceral and abdominal fat–important risk factors for developing morbidity and mortality–will accumulate steadily with increasing age, previous epidemiology studies have also relied on WC to predict obesity in the elderly (10). These measures are important indicators of the inflammatory process. As previously mentioned, intra-abdominal and bladder pressure, caused by obesity, could account for the effectiveness of the WC measurement in detecting women's urinary incontinence (24). Additionally, the association between diabetes and obesity can be strongly determined by WC over BMI measurements because WC effectively detects visceral fat (ORs for WC and BMI obesity: 2.34 vs 1.66 for female; 2.56 vs 2.19 for male, respectively).

To our knowledge, this might be the first study to examine the relationship between chronic diseases and obesity among a representative sample of Korean elderly. However, this study has some limitations, which are related to its design and survey methods. First of all, it is commonly theorized that cross-sectional design, using odds ratios, prevents the interpretation of any real causality between obesity and chronic diseases, but it is possible to examine the associations between risk factors and disease prevalence. Future prospective and clinical studies are needed to confirm this gender differential association in this study. Secondly, this survey used self-reported, physician-diagnosed chronic diseases, which could lead to an underestimation of their prevalence. For example, some diseases would go undetected if patients did not visit a physician. To reduce this potential bias, we used available, objective laboratory measurements for detecting chronic diseases, such as hypertension, dyslipidemia, and diabetes. Thirdly, it is possible that our study results were influenced by unmeasured confounding factors (e.g. physical activity) that are related to obesity or chronic diseases.

In summary, our study, using both BMI and WC measurements, detected a gender differential relationship between obesity and chronic diseases for Korean elderly men and women. Although an association between elderly obesity and metabolic syndrome components was observed in both genders, obesity's adverse risk for arthritis, and urinary incontinence was significant only in female elderly. Both WC and BMI were useful in detecting associations between elderly obesity and chronic diseases, especially among women. A clearer understanding of gender differences in relation to the association between obesity and chronic diseases would be helpful for reducing the social burden of chronic diseases in the elderly.

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AUTHOR SUMMARY

Gender Differences in the Effect of Obesity on Chronic Diseases among the Elderly Koreans

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The objective of this study is to investigate gender differences in obesity's effect on major chronic diseases among elderly Koreans. From the 2005 Korean National Health and Nutrition Examination Survey (KNHNES), we selected 508 elderly males and 830 elderly females who were 60 or more years of age. Using Waist Circumference (WC) ≥ 90 for men and ≥ 85 for women, 46.2% of females were obese in comparison to 34.3% of males. Similarly, using the Body Mass Index (BMI) ≥ 25, 42.2% of females were obese in comparison to 31.7% of males. Whereas obese males and females had similar profiles for developing metabolic syndrome components, including hypertension, dyslipidemia, and diabetes (ORs, 1.8-2.6 for males; 1.7-2.5 for females), obese elderly females had additional risks for developing arthritis and urinary incontinence (ORs, 1.5-1.8). A better understanding of gender differences in the association between obesity and chronic diseases would be helpful for reducing the social burden of chronic diseases in the elderly.