Health-Related Quality of Life in Adults with Metabolic Syndrome: The Korea National Health and Nutrition Examination Survey, 2007–2008

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Key Words

Metabolic syndrome • Quality of life • Obesity • Comorbidity

Abstract

Background/Aims: An association between metabolic syndrome and impaired health-related quality of life (HRQoL) is still controversial. We investigated the association between metabolic syndrome in itself and HRQoL in the Korean adult population. **Methods:** The study is a cross-sectional analysis of 8,941 adults ≥ 19 years of age who participated in the 2007 and 2008 Korean National Health and Nutrition Examination Survey. EuroQoL five-dimension (EQ-5D), the EQ-5D index and the EQ visual analogue scale (EQ VAS) were used to assess HRQoL. **Results:** The prevalence of metabolic syndrome was 26.2%. Compared to the participants without metabolic syndrome, those with metabolic syndrome were older and comprised a higher proportion of men. Moreover, participants with metabolic syndrome were more likely to have a lower education level, to be current smokers, to have activity limitation and to have more frequent metabolic abnormalities and comorbidities. Metabolic syndrome was associated with HRQoL based on EQ-5D and EQ VAS in simple regression analysis. However, metabolic syndrome was not signifi-

cantly associated with HRQoL after adjusting for age, sex, smoking status, income, education level, marital status, obesity, diabetes mellitus, stroke, history of heart disease and chronic kidney disease for EQ-5D, and in addition history of depression for EQ VAS. **Conclusion:** Metabolic syndrome in itself was not associated with impaired HRQoL after adjusting for confounding variables such as socio-demographic factors, medical comorbidities and obesity.

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Introduction

Metabolic syndrome is a combination of abnormalities including abdominal obesity, high blood pressure (BP), dyslipidemia and impaired glucose metabolism [1]. People with metabolic syndrome have an increased risk of developing diabetes and cardiovascular disease [2]. In addition, metabolic syndrome has been associated with other adverse outcomes such as chronic kidney disease (CKD), fatty liver disease and Alzheimer disease [3–5]. Several components of metabolic syndrome and metabolic syndrome-related adverse events such as diabetes and cardiovascular disease have been associated with decreased health-related quality of life (HRQoL) [6–8]. Im-

paired HRQoL has been associated with increased mortality and disease progression [9, 10]. Although several studies have reported that metabolic syndrome is associated with impaired HRQoL [11–14], another study suggests that metabolic syndrome itself is not associated with impaired HRQoL [15]. Therefore, the impact of metabolic syndrome on HRQoL is less predictable and has not been clearly defined.

Obesity has been associated with the increase of various comorbidities, depression, worse physical functioning and a decreased HRQoL [8, 16, 17]. Thus, obesity may modify the relationship between metabolic syndrome and HRQoL. In Korea the prevalence of metabolic syndrome has been increased by significant socioeconomic and demographic changes and it has become an important public health problem. Here we assessed whether metabolic syndrome is associated with HRQoL regardless of medical comorbidities and obesity in the Korean adult population. We hypothesized that metabolic syndrome in itself would be associated with impaired HRQoL.

Patients and Methods

Study Population

The data were derived from the 2007 and 2008 Korean National Health and Nutrition Examination Survey (KNHANES), a population-based cross-sectional survey that was conducted with a stratified multistage sampling design according to age, gender and geographic area to select a representative sample of the civilian, noninstitutionalized Korean population. We used data from the health interview survey and medical examination. The health interview survey was completed by 8,941 adults aged 19 years and older. The response rates were 93.2%. KNHANES was approved by the Korea Center for Disease Control and Prevention (KCDC) Institutional Review Board, and all participants signed a written informed consent form.

Data Collection

Trained interviewers interviewed participants face-to-face using a structured questionnaire. Participants were asked whether they had ever been told by a physician that they had hypertension, diabetes mellitus, stroke, heart disease, osteoporosis, osteoarthritis or depression. Participants were also asked whether they had a history of backache and took any medication for hypertension, diabetes mellitus or hyperlipidemia. Socio-demographic data were also collected, including age, sex, marital status, education, income, smoking status, alcohol consumption and activity limitation.

Anthropometric Measurement, Biochemical Parameters and Health-Related Quality of Life

Waist circumference was measured at the midpoint between the lowest rib and the iliac crest at minimal respiration. BP was

measured three times at 30-second intervals and we used the mean of the three measured values for systolic and diastolic BP. Fasting venous blood from participants was sampled for measurements of plasma glucose, triglycerides and high-density lipoprotein cholesterol (HDL-C) by an ADVIA 1650 Chemistry Analyzer (Siemens, Deerfield, Ill., USA). Estimated glomerular filtration rate (eGFR) was calculated with the abbreviated modification of diet in renal disease equation, corrected to a body surface area of 1.73 m², using the following equation for men:

$$\text{eGFR (ml/min/1.73 m}^2\text{)} = 186 \times \text{serum creatinine (mg/dl)}^{-1.154} \times \text{age}^{-0.203}.$$

For women, the result derived with the same formula was multiplied by 0.742. Body mass index (BMI) was calculated as body weight (kg) divided by the square meter of height.

The EuroQoL (EQ) instrument was used for evaluating HRQoL. EQ consists of the EQ five-dimension (EQ-5D) descriptive system and the EQ visual analogue scale (EQ VAS). The EQ-5D descriptive system is made up of the following five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Participants are asked to select one of three levels (no problem, some problems and extreme problems) representing the most appropriate health state in each of the five dimensions. The EQ-5D is converted into a single summary index in which 1 indicates no problem in any of the five dimensions and zero indicates death. The EQ VAS records the participant's self-rated health on a vertical, visual analogue scale where a value of 0 means the 'worst imaginable health state' and a value of 100 means the 'best imaginable health state'. The Korean version of the EQ-5D had already been made and evaluated for its validity and reliability [18].

Definition

Obesity was defined as a BMI ≥ 25 . According to the National Cholesterol Education Program Adult Treatment Panel Guideline III [19] and central obesity criteria for Korean [20], participants who had three or more of the following criteria were considered to have the metabolic syndrome: (1) abdominal obesity (waist circumference ≥ 90 cm in men or ≥ 85 cm in women); (2) high triglycerides (≥ 150 mg/dl) or drug treatment for elevated triglycerides; (3) low HDL-C (<40 mg/dl in men or <50 mg/dl in women) or drug treatment for reduced HDL-C; (4) elevated fasting glucose (≥ 100 mg/dl) or drug treatment for elevated glucose, and (5) high BP (systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg) or drug treatment for hypertension. CKD was defined as an eGFR of <60 ml/min/1.73 m² or proteinuria by a dipstick urine analysis score of +1 or more.

Statistical Analysis

Data analyses were performed using the SAS software for survey analysis. The baseline data were presented as mean $\pm$ standard error and percentage. Rao-Scott modified χ^2 test for complex sampling design using PROC SURVEYFREQ in SAS was used to compare the frequency of comorbidities and categorical variables in participants with and without metabolic syndrome. Regression analysis for complex sampling design using PROC SURVEYREG in SAS was used to compare the mean value of continuous variables. We used linear regression for complex sampling design using PROC SURVEYLOGISTIC in SAS to evaluate the effect of metabolic syndrome on EQ-5D index and EQ VAS, adjusting for

sex, age, smoking status, income, educational level, marital status, obesity, diabetes mellitus, stroke, history of heart disease and CKD for EQ-5D, and in addition history of depression for EQ VAS. p values were corrected by Bonferroni's method due to multiple testing. We also used logistic regression analysis for complex sampling design implemented in PROC SURVEYLOGISTIC in SAS to evaluate the effect of metabolic syndrome on dimensions of EQ-5D after adjusting for sex, age, smoking status, income, educational level, marital status, obesity, diabetes mellitus, stroke, history of heart disease and CKD. p values and 95% CIs for ORs were corrected by Bonferroni's method.

Results

The overall study sample was comprised of 6,107 non-obese participants and 2,834 obese participants. The prevalence of metabolic syndrome was 26.2%. Of the nonobese and obese participants, 13.8 and 52.9% met criteria for metabolic syndrome, respectively. The socio-demographic characteristics of participants with and without metabolic syndrome are shown in table 1. Compared to the participants without metabolic syndrome, those with metabolic syndrome were older (52.8 ± 0.40 and 40.8 ± 0.30 , respectively) and comprised a higher proportion of men (56.0 and 47.7%, respectively). As expected, participants with metabolic syndrome had higher BMI, serum glucose levels, BP and triglyceride levels, and lower HDL-C levels than those without metabolic syndrome. In addition, participants with metabolic syndrome were more likely to have a lower level of education, to be current smokers and to have activity limitation. Compared to participants without metabolic syndrome, those with metabolic syndrome had more frequent comorbid disorders, including stroke, angina or myocardial infarction, osteoporosis, osteoarthritis, lumbar pain and CKD. However, the prevalence of depression did not differ between participants with and without metabolic syndrome (12.68 and 11.01%, respectively, $p = 0.055$).

The mean value of the EQ-5D index in participants with and without metabolic syndrome was 0.89 and 0.93, respectively, which was statistically significant ($p < 0.0001$). The mean value of EQ VAS was 71.0 and 75.1, respectively, in participants with and without metabolic syndrome, which was also statistically significant ($p < 0.0001$). On simple linear regression, metabolic syndrome was significantly associated with the EQ-5D index (table 2). However, after adjusting for socio-demographic factors and medical comorbidities, including age, sex, smoking status, income, education level, marital status, obesity, diabetes mellitus, stroke, history of heart disease

Table 1. Baseline characteristics of nonobese participants with and without metabolic syndrome among KNHANES 2007–2008 participants (n = 8,941)

	Metabolic syndrome absent (n = 6,306)	Metabolic syndrome present (n = 2,635)	p value
Sex male, %	47.7	56.0	<0.0001
Age, years	40.8 ± 0.30	52.8 ± 0.40	<0.0001
Current smoker, %	25.7	29.1	0.0138
Marital status			<0.0001
Married, %	67.4	75.8	
Other (single, separated, widowed, divorced), %	32.6	24.2	
Education			<0.0001
High school and above, %	78.2	53.1	
Monthly income			0.0403
USD 3,000 and more, %	52.4	49.4	
Hypertension, %	6.9	39.0	<0.0001
Diabetes, %	2.09	17.0	<0.0001
Obesity, %	20.2	64.1	<0.0001
BMI	22.7 ± 0.05	26.1 ± 0.08	<0.0001
Serum glucose, mg/dl	91.4 ± 0.26	110.4 ± 0.75	<0.0001
SBP, mm Hg	110.4 ± 0.27	126.2 ± 0.49	<0.0001
DBP, mm Hg	73.0 ± 0.21	81.4 ± 0.28	<0.0001
Heart rate, beats per minute	69.8 ± 0.18	70.8 ± 0.28	0.0001
Waist circumference, cm	78.5 ± 0.18	89.9 ± 0.21	<0.0001
Triglyceride, mg/dl	105.1 ± 1.10	215.5 ± 3.60	<0.0001
HDL-C, mg/dl	51.3 ± 0.37	40.9 ± 0.32	<0.0001
Activity limitation, %	11.7	21.8	<0.0001
Stroke, %	0.87	3.46	<0.0001
Angina or myocardial infarction, %	1.16	3.70	<0.0001
Osteoporosis, %	3.20	6.50	<0.0001
Osteoarthritis, %	9.20	21.25	<0.0001
Lumbar pain, %	19.81	24.92	<0.0001
Depression, %	11.01	12.68	0.0551
CKD, %	9.65	20.2	<0.0001
EQ-5D	0.93 ± 0.002	0.89 ± 0.003	<0.0001
EQ VAS	75.1 ± 0.3	71.0 ± 0.5	<0.0001

SBP = Systolic BP; DBP = diastolic BP.

Table 2. Simple linear regression analysis to evaluate the associations between metabolic syndrome and HRQoL based on the EQ-5D index and EQ VAS

	Estimate	SE	t value	p value
EQ-5D index				
MS	-0.036	0.003	-10.78	<0.0001
EQ VAS				
MS	-4.104	0.495	-8.3	<0.0001

SE = Standard error; MS = metabolic syndrome.

Table 3. Multiple linear regression analysis to evaluate the associations between metabolic syndrome and HRQoL based on the EQ-5D index and EQ VAS

	Total			Men			Women		
	estimate	SE	p value	estimate	SE	p value	estimate	SE	p value
EQ-5D index									
MS	0.001	0.003	1.000	0.009	0.004	1.000	−0.009	0.005	1.000
Abdominal obesity	0.001	0.003	1.000	0.012	0.004	0.139	−0.013	0.005	0.515
High BP	−0.002	0.003	1.000	0.003	0.003	1.000	−0.009	0.005	1.000
IFG	−0.005	0.003	1.000	−0.011	0.004	0.471	0.002	0.004	1.000
High triglyceride	−0.012	0.003	0.006	−0.013	0.003	0.011	−0.007	0.005	1.000
Low HDL-C	0.005	0.002	1.000	0.006	0.003	1.000	0.005	0.003	1.000
EQ VAS									
MS	−1.282	0.549	0.123	−1.454	0.613	0.222	−1.029	0.937	1.000
Abdominal obesity	−1.714	0.566	0.016	−1.842	0.708	0.118	−1.400	0.854	1.000
High BP	−1.281	0.495	0.061	−0.639	0.550	1.000	−2.297	0.864	0.099
IFG	0.396	0.535	1.000	0.314	0.722	1.000	0.518	0.780	1.000
High triglyceride	0.685	0.498	1.000	0.570	0.586	1.000	0.909	0.849	1.000
Low HDL-C	−1.250	0.405	0.013	−1.374	0.529	0.118	−1.149	0.572	0.545

p values were corrected by Bonferroni's method due to multiple testing. EQ-5D variables adjusted for age, sex, smoking status, income, educational level, marital status, obesity, diabetes mellitus, stroke, history of heart disease and CKD. EQ VAS variables adjusted additionally for depression. SE = Standard error; MS = metabolic syndrome; IFG = impaired fasting glucose.

and CKD, metabolic syndrome and its components, with the exception of high triglycerides, were not significantly associated with the EQ-5D index (table 3). When some/extreme problems in dimensions of EQ-5D were used as cut-off points for determining impaired HRQoL, metabolic syndrome and its components were also not associated with EQ-5D dimensional problems in multiple logistic regression analysis (data not shown). Metabolic syndrome was significantly associated with EQ VAS in simple regression analysis (table 2). In a multiple linear regression analysis, metabolic syndrome and its components, with the exception of abdominal obesity and low HDL-C, were not significantly associated with EQ VAS after adjusting for age, sex, smoking status, income, education level, marital status, history of depression, obesity, diabetes mellitus, stroke, history of heart disease and CKD.

Discussion

The purpose of the present study was to determine the association between metabolic syndrome in itself in Korean adults and impaired HRQoL. We found that metabolic syndrome was not significantly associated with

HRQoL based on EQ-5D and EQ VAS after adjustments were made for confounding variables in this population. Metabolic syndrome was associated with definitive impairment of HRQoL based on EQ VAS after adjustments were made for only socio-demographic factors and obesity, even when p values were corrected by Bonferroni's method due to multiple testing (data not shown; $p = 0.004$). However, interestingly, this relationship was not significant when adjustments were additionally made for medical comorbidities. This finding suggests that medical comorbidities that are increased in metabolic syndrome contribute to an increased risk of impaired HRQoL.

Previous reports have shown a significant association between metabolic syndrome and HRQoL [11–14]. However, in all of these reports, only socio-demographic factors such as age, sex, income, marital status, education, occupational status or smoking status were considered as confounding factors. It has been shown that insulin resistance, which plays a pivotal role in pathophysiology of the metabolic syndrome, is associated with impaired HRQoL [21]. Some reports have shown that hypertension may also be associated with decreased HRQoL and that dyslipidemia may be associated with a decline in physical functioning [22, 23]. Obesity, which is a major risk factor for metabolic syndrome, is associated with insulin resis-

tance, often leading to type 2 diabetes mellitus [24, 25]. Obesity increases the risk for various comorbidities including hypertension, dyslipidemia, cardiovascular disease, stroke and CKD, which are also associated with worse HRQoL [26–31]. Obesity also increases the incidence of osteoarthritis, which may have adverse effects on physical functioning [32, 33]. Obese subjects may often be disadvantaged in education, employment and health care because of their size, and experience frequent depression, all of which can impair HRQoL [8, 16, 17, 34]. Therefore, obesity could directly or indirectly have an effect on a variety of clinical implications related to metabolic syndrome. In the case of HRQoL, obesity may lead to the stronger association between metabolic syndrome and HRQoL. Therefore, we considered additional medical comorbidities and obesity as confounding variables to exclude the impact that these factors have on metabolic syndrome and HRQoL. As a result, in this study, metabolic syndrome was not significantly associated with HRQoL, which is in contrast with previous studies.

In Asian populations, the risk for metabolic abnormalities including diabetes, hypertension and dyslipidemia tend to increase even at a low BMI [35]. According to the recommended classifications for BMI adopted by the National Institute of Health and World Health Organization, obesity is BMI ≥ 30 [36]. However, the definition of obesity varies by race. In Asians, a greater percentage of body fat is reached at a lower BMI than in other races. Therefore, for Asians, obesity is often defined as a BMI ≥ 25 [35]. In the present study it is reasonable to define obesity as BMI ≥ 25 .

Of the five components that define metabolic syndrome, abdominal obesity and low HDL-C was associated with HRQoL based on EQ VAS. There are some reports that have shown the association of abdominal obesity with impaired HRQoL [37]. It seems that abdominal obesity affects impaired HRQoL differently compared to obesity based on BMI. Little seems to be known about the relationship between dyslipidemia and impaired HRQoL. A study has reported that dyslipidemia was associated with lower scores in the physical and psychological domains [38].

The limitation of this study is that the causal relationship between metabolic syndrome and HRQoL was not assessed owing to this being a cross-sectional study. However, the strengths of the study are that a large number of participants and representative population data were used to evaluate the association between metabolic syndrome and HRQoL.

In summary, metabolic syndrome was not associated with the impairment of HRQoL based on EQ-5D and EQ VAS after adjusting for confounding variables such as socio-demographic factors, medical comorbidities and obesity. The prevention and management of medical comorbidities may be important for improvement of HRQoL in adults with metabolic syndrome.

Disclosure Statement

There are no conflicts of interest.

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