Culinary Science & Hospitality Research. 2016;22(1):32-41.
https://cshr.jams.or.kr/

ISSN 2466-0752 (Print)
ISSN 2466-1023 (Online)

Metabolic Syndrome and Its Related Factors among Korean Elderly in Urban and Rural Areas

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ABSTRACT: The accelerated aging population may lead to the prevalence of metabolic syndrome and increase in medical costs as well. The aim of this study is to investigate the association with prevalence of metabolic abnormalities and its components in urban/rural area among Korean elderly. We examined the association between metabolic abnormalities and urban/rural area with data from the 2009 Korean National Health and Nutrition Examination Survey. The subjects were 1,622 elderly aged 65 years or over. The sixty percent of Korean elderly reside in urban and 40 % in rural. Rural residents were significantly lower income and less educated than urban residents. But there was no significant different in nutritional factors. They showed significantly 26% lower likelihood of having metabolic syndrome (0.578-0.950, p=0.018) compared with urban residents. Urban residents were associated with higher prevalence of metabolic syndrome than rural residents. This results will contribute to develop strategy for prevention metabolic syndrome for Korean elderly according to urban/rural area.

Keywords: urban and rural area, korean elderly, nutrient, socio-demographic factors, metabolic abnormality

INTRODUCTION

Rapid advances in medicine, and economic development have increased aging population in Korea. The proportion of the aged 65 or over elderly have expected to increase 7.3 % in 2000, 10.3 % in 2008, and will be 45 % in 2026 [1]. It has been known that they has been considered to need seriously practical and accessible programmes to healthy aging. Aging occurs many metabolic abnormality include typically body composition changes like loss of muscle mass with an increased fat mass [2]. In particular, the prevalence of metabolic syndrome has been increasing and it is likely to be accompanied by an increased demand for health care system and increased medical costs in the older population [3]. People with metabolic syndrome are at increased risk of developing cardiovascular disease and diabetes [4]. Since the World Health Organization defined cluster of metabolic abnormality known as metabolic syndrome, numerous studies have been released different criteria of metabolic syndrome [5]. The consist of metabolic abnormalities are included wait circumference abonormaility, impaired glucose metabolism, dyslipidemia, and high blood pressure has been used in Korea [6] and it has been released by Third Report of the National Cholesterol Education Program (NCEP) in 2001.

Its prevalence has rapidly increased over the past three decades [7] and it is both a clinical and public health problem in Korea. Recently, it has been started to research on metabolic related factors to lower morbidity. In addition, prior studies have documented that it is varied by multi-faceted factors including

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biological, physical, psychological, nutritional and socioeconomic factors [8]. The prevalence of the metabolic syndrome are different from country, race, region, sex and life style as well [9]. In the study with Chinese adults by Weng [10], the prevalence of metabolic syndrome for men in urban areas was 12.7 %, in rural areas was 1.7 %. For women, it was 10.1 % in urban areas, and 9.7 % in rural areas. However, the opposite result that it was higher in rural areas (52.2 %) compared to urban areas (39.7 %) in other study [4].

Health care needs for elderly are greatly different according to region, thus, in other countries, studies on the comparison with metabolic syndrome and urban-rural residents has been performmed [4,10,11]. But little is researched on metabolic syndrome related factors in urban and rural differences as well as socioeconomic and nutrition factors in Korean elderly. There are studies focused on socioeconomic factors in urban and rural area [12], health status include nutrition status [13], prevalence of metabolic syndrome [10]. One study investigated difference in prevalence of metabolic syndrome in urban and rural community with aged 20 or over in Korea [14].

It is necessary to find more effective prevention and control of metabolic syndrome by understanding of differences between urban and rural areas. This results will be possibly provide a basic data to establish the metabolic syndrome prevention and health-related policies for the elderly in Korea.

LITERATURE REVIEW

Metabolic Syndrome

Since the World Health Organization (WHO) defined cluster of metabolic derangements known as metabolic syndrome, numerous studies have been performed on the criteria of diagnosis. Metabolic syndrome consists of waits circumference, impaired fasting glucose, dyslipidemia, and high blood pressure [6]. The core components of metabolic syndrome are insulin resistance, impaired glucose tolerance and it is related to increased risks of developing chronic diseases include sarcopenia and even mortality. There are different criteria of Metabolic syndrome. The criteria released by Third Report of the National Cholesterol Education Program (NCEP) in 2001 has been used in Korea [6]. In addition, the components of metabolic syndrome are related and inflammatory state, fat mass and muscle mass as well as cardiovascular disease risk factors. Among them, combined more than 3 components can cause up to a 1.5～2.6 fold increase metabolic diseases [15, 16]. The prevalence of Metabolic syndrome are different from country to country and has been increased 24.9 % in 1998, 31.3 % in 2007 [17]. Therefore, it is necessary to determine the related factors of metabolic syndrome and for prevention and management strategy.

The Prevalence Metabolic Syndrome and Rural/ Urban Areas

The prevalence of metabolic syndrome are different from country, race, region, sex and life style as well. In the study with Chinese adults by Weng [10], for men in urban areas, it was 12.7 %, and 1.7 % in rural areas. For women, it was 10.1 % in urban areas, and 9.7 % in rural areas [10]. However, there are opposite result that it is higher in rural areas (52.2 %) compared to urban areas (39.7 %) in other study [4]. Rural residents are more likely to be obese and less physically active [18,19], poorer diet, lower socioeconomic status than urban residents [19]. The study by Kim [14], it is higher in rural area (29.0 %) than in urban area (23.4 %) and rural residents show higher prevalence of abnormality (rural vs urban= 29.9 % vs 38.5 %), high blood pressure (31.3 % vs 38.5 %), elevated blood glucose (24.3 % vs 28.4 %) than urban community. Different variables are related with metabolic syndrome prevalence between urban and rural area. In urban residents, the related factors are age, marital status, alcohols consumption, obesity and age, marital status alcohols consumption, regular exercise, obesity in rural residents [14]. In Palestian West Bank, urban residents show higher prevalence of elevate blood sugar, low HDL cholesterol, obesity, smoking, but abdominal obesity in rural area [20]. Contrary, it is higher prevalence of obesity and metabolic syndrome in urban in India [21].

METHODS

Subjects

This study was based on data obtained from the

KNHANES 2009, a nationally representative survey conducted by the Korean Ministry of Health and Welfare. The survey's target population included non-institutionalized Korean civilians. Sampling units consisted of households selected through a stratified, multistage, probability-sampling design based on geographic area, sex, and age group using household registries. KNHANES 2009 consisted of four components: a health interview survey, a health behaviors survey, a health examination survey, and a nutrition survey. These surveys were completed by 8,473 (77.5% of the total target population of 10,938) participants in 2009. A total of 1,622 subjects aged 65 years or older who participated in biochemical test, dietary and DXA data were included in this study. We excluded subjects who had implausible energy intakes (< 500 or > 5,000 kcal/day) and those who did not have data on oral daily nutrition intake, and had not undergone blood tests.

Data Collection

Details of the measurement have been described as follow. In brief, health examination, dietary measurement, height, and weight were obtained using standardized techniques and calibrated equipment. Information on socio-demographic factors, such as region, gender, age, level of education, income, and marital status. Body mass index (BMI) was calculated by dividing weight (kg) by height (m^2). Blood pressure was measured using a sphygmomanometer with the subject in a sitting position. Three measurements were taken at 5-min intervals in the morning after having fasted for at least 8 h, and the average of the second and third measurements was used. Fasting glucose, fasting insulin, homeostasis model assessment of insulin resistance (HOMA-IR), total cholesterol, triglycerides (TG), and high-density lipoprotein (HDL) were analyzed in a central, certified laboratory. A dual-energy X-ray absorptiometry (DXA) scan was performed to measure body composition using fan-beam technology (Lunar Corp, Madison, WI). A general questionnaire was administered to assess basic demographic and health-related information. Nutrients intake were measured by the single 24-h dietary recall method and trained staff instructed the respondents to recall and describe all the foods and beverages they had consumed in the previous day.

Definition of Urban and Rural

There were categorized by urban and rural area. Among the 16 administrative districts in this survey, urban resident were Seoul, Gyeonggi and 6 other metropolitan cities such as Busan, Daegu, Incheon, Gwangju, Daejeon and Ulsan. The remain were as rural resident.

Definition of Metabolic Syndrome and Sarcopenia

We has used the original criteria for metabolic syndrome proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III and ethnicity-specific WC values, as proposed by the International Diabetes Federation (IDF) [22]. The criteria of metabolic syndrome were defined as waist circumference >90 cm in males and >80 cm in females; hypertriglyceridemia as triglycerides ≥150 mg/dL; low HDL cholesterol as <40 mg/dL in males and <50 mg/dL in females; hypertension as blood pressure ≥130/85 mmHg; and hyperglycemia as fasting plasma glucose ≥110 mg/dL [22]. Appendicular skeletal muscle mass (ASM, kg) was defined as the sum of lean soft tissue mass in the arms and legs following the method of Heymsfield et al [23] and we modified methods by [24].

Statistical Analysis

All statistical analyses were conducted using SPSS version 20.0 (SPSS, IBM, NY, USA). The generalized linear model was used to compare numerical variables such as anthropometric measurements, metabolic risk factors, and nutrient intakes by urban and rural areas. Adjustments for income and education level. Data are presented as means±SE. Chi-square test for categorical variables. Logistic regression models were used to calculate odds ratios (ORs) with 95% confidence intervals (CIs) for the association between urban/rural areas and metabolic syndrome risk factors. The level of significance was set at $p<0.05$.

RESULTS

Table 1 presents sociodemographic characteristics according to urban and rural area. 60 % of the elderly has resided in urban and 40 % in rural. Members residing in rural were significantly lower income and less educated than members residing in urban area. The percentage of primary school was 66.3 % in urban, 84.9 % in rural, $p<0.001$). There was not significantly different age and marital status in urban and rural, members residing in rural were more likely to be older (72.96±0.26 vs 73.01±0.31, $p=0.889$), and more likely to have spouse (60.1 % vs 65.8 %, $p=0.218$).

Tables 2 shows anthropometric and metabolic risk factors of the elderly in urban and rural area. BMI were significantly higher in member of residing in urban area (urban vs rural=23.92±0.15 vs 23.29±0.23, $p=0.003$) after adjusting for age, education level, marital status. Waist circumference, serum total cholesterol, serum triglyceride, fasting glucose, and HOMA-IR were slightly higher in urban group and HDL-cholesterol levels were slightly lower in urban group.

Tables 3 shows nutrition factors of the elderly in urban and rural area. Sodium (mg) were significantly higher in member of residing in rural area (4,443.85±160.87 vs 4,954.30±2.86, $p=0.024$) after adjusting for age, education level, marital status. Energy (kcal), carbohydrates (g), protein (g), fat (g), dietary fiber (g), phosphorus (mg), potassuim (mg), and thiamin (mg) intakes were slightly higher in rural group. However, most of micro nutrients such as calcium (mg), iron (mg), vitamin A (gNE), riboflavin (mg), niacin (mg), vitamin C (mg), water (g) and carbohydrates (g) (%kcal), protein (g) (%kcal), and fat (g) (%kcal) intakes were slightly higher in urban group.

Tables 4 shows prevalence of metabolic related disease of the elderly in urban and rural area. The

Table 1. Sociodemographic characteristics of the elderly in urban and rural area

		Old (N=1,622)				
		Urban (N=973)		Rural (N=649)		p[a]
		N	Percentage	N	Percentage	
Sex	Men	398	40.9	253	39.4	0.585
	Women	541	59.1	379	60.6	
Age		72.96[b]	0.26[b]	73.01	0.31	0.889[c]
Income	Low	466	47.0	406	61.7	0.004
	Mid-low	202	22.0	127	20.5	
	Mid-high	100	10.7	29	4.7	
	High	151	20.3	65	13.0	
Education level	Primary school	620	66.3	526	84.9	<0.001
	Middle school	116	13.4	51	8.0	
	High school	117	12.2	26	4.6	
	College	72	8.0	15	2.5	
Marital statusd	Single	3	0.3	2	0.7	0.218
	Married	591	60.1	419	65.8	
	Widowed/divorced	343	39.6	211	33.5	

[a.] p from chi-square test; [b.] mean±SE; [c.] p from t-test.

Table 2. Anthropometric and metabolic risk factors of the elderly in urban and rural area

	Old (N=1,622)				
	Urban(N=973)		Rural(N=649)		p^a
	Mean	SE	Mean	SE	
Height	160.7	0.33	161.53	0.58	0.161
Weight	61.94	0.46	60.97	0.66	0.128
BMI	23.92	0.15	23.29	0.23	0.003
Waist circumference	84.59	0.46	83.76	0.73	0.246
Systolic blood pressure	132.31	1.18	132.21	1.65	0.950
Diastolic blood pressure	79.68	0.60	79.79	0.67	0.867
Serum total cholesterol	186.73	2.24	185.14	2.66	0.516
Serum triglyceride	147.42	4.51	143.21	7.03	0.537
Serum HDL-cholesterol[b]	48.78	0.62	49.55	0.92	0.390
Fasting glucose	106.87	1.29	104.48	1.96	0.230
HOMA-IR[c]	2.86	0.11	2.51	0.18	0.128

[a.] p was obtained from linear regression model after adjusted for income, and education level; [b.] Serum HDL-cholesterol, High-density lipoprotein; [c.] HOMA- IR was calculated by fasting insulin concentration (μU/L) × fasting blood glucose (mmol/L)÷22.56.

Table 3. Nutrition of the elderly in urban and rural area

	Old (N=1,622)				
	Urban(N=973)		Rural(N=649)		p^a
	Mean	SE[b]	Mean	SE	
Energy (kcal)	1717.34	37.2	1,810.71	54.83	0.057
Carbohydrates (g)	302.36	5.78	316.99	8.22	0.076
Protein (g)	60.16	1.42	62.22	2.58	0.368
Fat (g)	26.63	1.1	26.78	1.43	0.907
Dietary fiber (g)	7.72	0.28	8.08	0.34	0.226
Calcium (mg)	498.45	22.14	465.13	30.74	0.407
Phosphorus (mg)	1,083.74	25.88	1,111.75	36.79	0.392
Iron (mg)	15.65	0.94	14.59	0.92	0.257
Sodium (mg)	4,443.85	160.87	4,954.30	2.86	0.024
Potassuim (mg)	2,933.83	71.66	2,944.35	101.53	0.914
Vitamin A (gNE)	797.34	54.07	728.54	69.84	0.266
Thiamin (mg)	1.10	0.032	1.13	0.04	0.473
Riboflavin (mg)	1.02	0.02	0.98	0.03	0.233
Niacin (mg)	14.14	0.49	14.12	0.59	0.966
Vitamin C (mg)	100.12	3.87	97.42	4.98	0.571
Water (g)	852.24	36.92	807.03	41.79	0.175
Carbohydrates (g) (%kcal)	72.18	59.19	72.08	0.96	0.912
Protein (g) (%kcal)	13.89	0.17	13.55	0.32	0.275
Fat (g) (%kcal)	13.44	0.35	12.65	0.52	0.143

[a.] p from generalized linear model; All models were adjusted income, and education level.

Table 4. Prevalence of metabolic related disease of the elderly in urban and rural area

	Old(N=1,622)				
	Urban(N=973)		Rural(N=649)		p^a
	N	Percentage	N	Percentage	
Diabetes	179	17.7	83	15.0	0.270
Hypertension	471	50.0	282	47.5	0.446
Hyperlipidemia	91	9.7	39	6.8	0.123
Stroke	40	3.8	27	4.7	0.493
Cardiac infaraction	48	5.0	19	3.1	0.097
Hypercholesteremia	146	18.5	77	12.3	0.010
Low-HDL cholesterol[b]	300	35.0	162	30.3	0.098
Hypertriglyceridemia	147	20.2	90	17.8	0.422
Sarcopenia_1sd[c]	422	50.3	225	39.4	0.034
Sarcopenia_2sd[d]	110	13.1	47	7.9	0.013

[a.] p from χ^2 test; [b.] HDL, High-density lipoprotein; [c.] Sarcopenia_1sd, sarcopenia defined by ASM/Wt (%) of < 1 SD; [d.] Sarcopenia_wt_2sd, sarcopenia defined by ASM/Wt (%) of < 2SD.

prevalence of hypercholesteremia, Sarcopenia_wt_1sd, and Sarcopenia_wt_2sd were significantly higher in urban area. The elderly residing in urban showed slightly higher prevalence of metabolic related disease except stroke.

The majority of the metabolic related disease were hypertension, followed by sarcopenia, low HDL cholesterol, hypertriglyceridemia, hypercholesteremia, diabetes symptoms in turn.

The Odds Ratios (95% CI) for metabolic syndrome abnormality in urban and rural area are presented in Table 5. Members of the rural group showed significantly 26 % lower likelihood of having metabolic syndrome (0.578~0.950, p=0.018) compared with

Table 5. The odds ratios (95% CI) for metabolic syndrome abnormality according to urban and rural area

	Old (N=1622)				
	Urban	Rural			p^a
	OR	OR	95% CI		
Abdominal obesity (M > 90, F > 80)	1	0.810	0.619	1.058	0.122
Low HDL-cholesterol (M < 40, F < 50 mg/dL)	1	0.925	0.726	1.178	0.526
Elevated blood pressure (≥130/85 mmHg)	1	1.079	0.792	1.471	0.628
Elevated triglyceride (≥150 mg/dL)	1	0.873	0.633	1.203	0.405
Elevated fasting blood glucose (≥110 mg/dL)	1	0.733	0.530	1.014	0.061
Metabolic syndrome (3 or more)	1	0.741	0.578	0.950	0.018

[a.] Multivariate adjusted logistic regression was used to estimate ORs (95% CIs) and p after adjustment for income, and education level.

the urban group. There were associated with metabolic syndrome urban/rural area in the elderly. We applied definitions of metabolic syndrome abnormalities as proposed by IDF (ATP III).

DISCUSSION

The results of this study reveal urban-rural area differences in Korean elderly' metabolic syndrome abnormality and related factors include socioeconomic, nutritional factors and prevalence of metabolic related diseases. Furthermore, we examined the association between metabolic syndrome factors and urban-rural area. We found that more than half of Korean elderly reside in urban area. The aging rate is higher in rural than urban area in Korea [25] because of outflow of young generation to metropolitan and city for education, economic activity.

In particular, the elderly in urban area differed significantly from in rural area in terms of higher income and educational level. And they were slightly younger, more male, more residing alone than the elderly in rural area. There are similar results in other countries. For instance, the study with Taiwan elderly aged 65 or older showed rural participants had significantly less educational level, lower income, higher dependency of medication, poorer nutritional status than urban residing elderly [12,25]. However, recent reports show that there are many elderly in urban who are suffering from lack of regular social participation, lower socioeconomic status and poor nutrition [26,27]. There is sometimes perception of a better health in rural due to green countryside, fresh air. Some studies suggest that there are no overall urban-rural differences in morbidity [28]. Another finding in present study was that there were not significant different nutrient factors between urban and rural. For urban residents were slightly higher consumption of micro nutrients such as calcium (mg), iron (mg), vitamin A (gNE), riboflavin (mg), niacin (mg), vitamin C (mg), water (g). For rural residents, sodium consumption was significantly higher and slightly higher in macro nutrients such as energy (kcal), carbohydrates (g), protein (g), fat (g), dietary fiber (g). High education level and income consumed more of the micro-nutrient rich foods, such as vegetables and fruit [29]. Generally, most of the elderly have rack of knowledge on the micro-nutrients. Our finding also supported that the elderly in urban had high education level and it could be influenced the intake of micro-nutrients. Higher socioeconomic status had more intakes of fiber, and most micro-nutrients.

Another finding was that the elderly in rural had significantly lower morbidity such as hypercholesteremia, sarcopenia than urban area. Moreover, the elderly residing in urban showed slightly higher prevalence of metabolic related disease such as high blood pressure, HDL cholesterol abnormality, diabetes etc. In Palestian West Bank, urban residents show higher prevalence of elevate blood sugar, low HDL cholesterol, obesity, smoking, but abdominal obesity in rural area [20]. Contrary, it is higher prevalence of obesity and metabolic syndrome in urban in India [21]. This finding was very interesting because there were many reports that people with a lower socioeconomic status have lo level of health related factors in British [30]. Rural residents are more likely to have disadvanageous health outcomes due to their more aged, less educated, and lower income population. Likewise, evidence from several studies have documented that low socioeconomic status is associated with metabolic abnormalities [31,32] and a low education level links metabolic abnormalities with obesity [33,34]. There were several studies on association with metabolic syndrome and urban-rural area [11,12,14]. We found that the elderly in rural area showed significantly 26 % lower likelihood of having metabolic syndrome (0.578～0.950, p=0.018) compared with the urban residents. Our findings suggest that the differences in some sociodemographic characteristics and nutrients factors provided possible explanations of this difference in metabolic syndrome by urban-rural areas. However, even though there are associated with the prevalence of metabolic syndrome and urban/rural area, there are opposite results as well. For example, it was higher in rural than urban residents (39.9% vs 32.8%) and OR for metabolic syndrome in rural residents was 23 % (95% CI, 1.02～1.49) after adjusting age and sex than urban residents [11].

Our results have several implications on prevention metabolic disease for the elderly. First of all, there are still conflicting results between the preva-

lence of metabolic syndrome and geographical location. Social and cultural characteristics of the members might be influenced more prevalence of metabolic syndrome than region. Therefore, it is necessary to consider interventions of metabolic syndrome by more multifaceted aspects to understand their related factors. In order to develop the metabolic syndrome intervention program, it is important investigation on the prevalence of metabolic syndrome in urban areas and in rural areas. Secondly, the elderly aged 65 year and over resides in urban and their morbidity were higher than rural. But opposite results also were revealed. Therefore, definition of urban and rural or region should be considered and more studied because, there are many migration between urban and rural. Recently, rural areas have social change with migration from urban which is highly socially selective and gentrification. Our findings suggest that future research should target low sociodemographic elderly among rural or urban residents for prevention of metabolic syndrome. Health care needs for the elderly are greatly different according to other factors such as lifestyle and eating behaviors [35,36].

Some limitations existed in present study. First, the cross-sectional design of KHANES data did not allow us to study causal relationships among metabolic syndrome abnormality and its risk factors include sociodemographic and nutrient factors in rural and urban areas. Second, assessing dietary variables based on a single day 24-hour diet recall may not capture day-to-day variations within an individual"s dietary intake, thus limiting our ability to evaluate the relationship between diet and metabolic syndrome.

Findings of this study contribute to know- ledge about the association of metabolic syndrome and its related factors of Korean elderly in urban and rural. This is identified high metabolic syndrome or risk groups according to region and has been attempted to provide a basis data for developing intervention plans of metabolic syndrome.

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Received: 21 DEC, 2015
Revised: 8 JAN, 2016
Accepted: 19 JAN, 2016