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Study on White Rice Consumption and Metabolic Risk Factor in Korean Elderly: Focused on Muscle Mass

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ABSTRACT: White rice consumption, a staple food for the Korean influence the other food consumption and nutrition balance. The aim of this study was to investigate the association with rice consumption based dietary intake and muscle mass for the Korean elderly who are easily in mal-nutrition. A total of 1,433 subjects (658 male and 775 female) 60 years or older from the fifth Korea National Health and Nutritional Examination Survey 2010 participated in this study. One of the findings was that there was association white rice consumption and marital status (single/with/without spouse) as well as education for men. Other interesting finding was the member of highest white rice consumption group showed higher muscle mass in both sexes. The other finding was that the more white rice consumption group showed the less meat consumption as well as the less consumption of other grains, noodle & dumpling, and flours & bread in both sexes. We found the significant association between white rice consumption level and muscle mass and several metabolic syndrome related factors in the elderly. But the association with white rice consumption and glucose metabolism related factor had not shown consistently.

Keywords: white rice consumption, Korean elderly, nutrient, socio-demographic factors, metabolic risk factor

INTRODUCTION

The population of the elderly in Korea has increased rapidly by the advanced medicine and industrial development since 1970. The proportion of the population aged 65 years and over has increased approximately to four-fold over the past 40 years, from 3.1% in 1970 to 11% in 2010. It will be expected for Korea to enter the super-aged society in 2026 (Statistics Korea). Moreover, there have been changes in disease and diet patterns. Recently, nutritional research has considered epigenetics that nutrient factor mainly influence on preventing chronic diseases and contribute to the successful aging and longevity as well (Gaudreau P et al 2007; Ozaki A et al 2007). Because it has been known that the elderly population has been considered serious mal-nutrition group, recently, it has been started to research on the effect of dietary patterns and nutrition for the elderly in Korean. In the previous study, Korea elderly takes the Korean traditional diet characterized as a low-fat and low- calorie and consisted of white rice, soup and plant foods (Song Y et al 2005). There are several reports that white rice consumption has been affected to deteriorate glucose metabolism. The other hands, there are still conflictions whether there is association between elevated intakes of white rice and increased risks of metabolic disorder or not (Watanabe Y et al 2013). Especially, for the Korean elderly who are easily in mal-nutrition, white rice consump-

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tion, a staple food for the Korean could influences the other food consumption and increase nutrition balance. Aging causes many functional deteriorate and typically body composition changes such as a progressive muscle mass loss and an increased fat mass called sarcopenia (Zamboni M et al 2008). Reduced muscle mass influence to insulin sensitivity negatively which is associated with an increase of the risk of metabolic syndromes by fat infiltration in the skeletal muscle (Roubenoff R 2000). Muscle loss in the elderly causes metabolic syndrome, cardiovascular disease, and fracture, and cancer (Zamboni M et al 2008). Despite muscle loss could be much worsened in the future, it is often under-recognized and lack of data on muscle mass and nutrient in the elderly. There is research on the higher of rice consumption had significantly higher intakes of nutrients and lower waist circumference and triceps skinfolds (Kennedy E, Luo H 2015). By Jo N, Kim SY(2015). The Korean diet was nutritional imbalance because of excessive amounts of rice consumption in the 1970s. Since the 1980s, drastically decreased rice consumption has become a serious social problem. So far, the study regarding white rice consumption and health status is rare. According to dietary pattern, nutrient contents of diet are different, so to be performed the research on the rice consumption based dietary intake are so important and association with muscle mass for the Korean elderly. Developing an interactive and friendly information system could also change meal quality of catering menu in senior center or nursing home.

LITERATURE REVIEW

White rice consumption and matabolic risk factors

Traditional Korean diet composed of rice and several side dishes containing a variety of nutrients are known to be effective in the prevention of metabolic diseases (Ahn JY, Ha TY 2010). Central obesity, hypertension, blood sugar, and abnormal serum lipid levels that lead to an increased likelihood of cardiovascular disease (CVD) are the major causes of early death in both sexes in developed countries include Korea. (Graham I et al 2007 & Kadowaki T et al 2005). In the prevention of metabolic risk, dietary pattern approaches are more cost-effective, much safer, and more proper than medical approaches (Graham I et al 2007 & Azadbakht L et al 2011). There are many studies on the effects of the white rice consumption to metabolic risk factors in western country but not in asian, especially, focused on muscle mass. By Watanabe (Watanabe Y et al 2013), there were positive correlations with rice intake and metabolic disease in the 40–9 and 50–9 age groups, whereas in the 60 such as BMI, waist circumference and metabolic disease decreased with increasing rice consumption in the aged 60–4 yrs men. Many researcher suggest that older individuals have undergone easily mal-nutrition, so they advised rice consumption by three times a day in reasonable quantities could increase other nutrients as well (Watanabe Y et al 2013). Recently, evidence displayed that rice intake could protect against risk of mortality from cardiovascular diseases(Eshak ES et al 2011). So, the association between carbohydrate intake from refined grains, such as white rice and CVD risk factors still remain uncertain (Eshak ES et al 2011).

METHODS AND MATERIALS

Subjects

This study was based on data obtained from the KNHANES 2010, 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 (Oh C et al 2015). KNHANES 2010 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 8473 (77.5% of the total target population of 10,938) participants in 2010 (Oh C et al 2015). A total of 1,687 subjects (748 male and 939 females) 60 years or older who participated in the health examination and nutrition surveys were included in this study. We excluded 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 gender, age, level of education, income, drinking, smoking and marital status, and more specific information regarding sex and white rice consumption were obtained by a personal interview with a structured questionnaire. 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 total body fat mass, total body fat percentage, and lean mass using fan-beam technology (Lunar Corp, Madison, WI). A general questionnaire was administered to assess basic demographic and health-related information. Dietary intake was 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. Food models and measuring bowls, cups, and spoons were used to assist in estimating portion sizes. Subjects were further classified into four groups based on daily energy intake from white rice consumption - quartiles (Q1–Q4): Q1 (≤542.90 Kcal), Q2 (542.91 Kcal～801.26 Kcal), Q3 (801.27 Kcal～1,080.56 Kcal), Q4 (1,080.57 Kcaly～3807.34 Kcal).

Definition of Appendicular Skeletal Muscle Mass and Obesity

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 (Heymsfield SB et al 1990). We calculated ASM as a percentage of body weight (Wt), modifying methods published by Janssen et al (2002) and Lim S et al (2010), respectively. Obesity classification was determined according to the BMI criteria established by the Obesity Task Force (IOTF), World Health Organization (WHO) and the Korean Society for the Study of Obesity (KSSO) (Oh SW 2011).

Definition of Metabolic Syndrome Risk Factors

We employed the original criteria for metabolic syndrome proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III. However, we used ethnicity-specific WC values, as proposed by the International Diabetes Federation (IDF) (Oh C et al 2015). Obesity was assessed based on the BMI cut-offs proposed by the World Health Organization (WHO). Metabolic syndrome were defined as having three or more of the following five criteria: Abdominal obesity was 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 (Oh C et al 2015).

Statistical Analyses

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 among the four groups classified by white rice consumption quartile. Adjustments for age, sex. 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 relationships between white rice consumption and metabolic syndrome risk factors. The level of significance was set at $p<0.05$.

RESULT

The prevalence of metabolic syndrome and metabolic abnormality according to sex among the elderly are presented in Table 1. Age adjusted prevalence of metabolic syndrome was 20.4% in men and 27.0% in women. There were significantly different between

Table 1. Metabolic risk factors by sex

Metabolic syndrome and metabolic abnormality	Men (n=748)	Women (n=939)	p[1)]
Waist circumference (Male≥90, Female≥80)	217(30.9)[2)]	393(43.4)	0.001
Blood pressure (≥130/85 mmHg)	160(22.8)	206(22.3)	0.856
Fasting blood glucose (≥110 mg/dL)	304(39.5)	288(31.4)	0.004
Triglyceride (≥150 mg/dL)	557(31.6)	347(13.2)	0.784
HDL cholesterol (male≤40, female≤50 mg/dL)	171(23.4)	401(40.4)	0.001
Metabolic syndrome (≥3 or more of the risk factors)	153(20.4)	257(27.0)	0.006

1) *P* from chi-square test. $p<.05$.
2) Categorical variables are given as numbers and percentages.

sex and the prevalence of metabolic syndrome, WC, fasting blood glucose and HDL abnormality. The prevalence of WC (30.9% in men vs 43.4 in women, $p<.001$) and HDL (23.4% in men vs 40.4 in women, $p<.001$) abnormality was higher in women than in the men. The fasting blood glucose (39.5% in men vs 31.4 in women, $p=0.004$) was contrary. Table 2 and Table 3 present demographic characteristics and white rice consumption by sex. There were significantly different between white rice consumption and age, education level, marital status in men and education level only in women. Men showed that there were significantly different other grain, flour bread, vegetable, legumes, meat, oils, alcohols among 24 food groups were categorized. And for wo- men, other grain, noodle & dumpling, flour & bread, fruits, beverage, and alcohols. Members of the highest white rice consumption group were more likely to be older, and subject with spouse. In women, members of the highest white rice consumption group were more likely to have fewer intakes of meat, other grain, noodle, and flour as well. The rice consumption in women was higher than men. The anthropometric and metabolic risk factors according to white rice consumption adjusted age, sex, smoking, diabetics are presented in Table 6. There were significantly different between white rice consumption and ASM related muscle mass, fasting blood glucose, vitamin D in men and ASM only in women. There was significantly increased muscle mass, depending on the increased rice consumption in both sexes.

DISCUSSION

In this study, we explore the association between white rice consumption level and metabolic risk factors and food/nutrient intake as well. There is believe that white rice consumption has been affected to deteriorate glucose metabolism because refined rice is negative for insulin sensitivity, but brown rice is positive. However, the association between increased white rice consumption and increased risks of developing metabolic disorder remains unclear. We found that the member of highest white rice consumption group showed to have higher muscle mass in both sexes. White rice, which is a staple food for the Korean elderly, contributes major energy source of meal and for last 10 year, and it has been the top of the ranking of favorite food, and pork, kimchi stew ins next (Ahn EM et al 2011). Despite the changes in the westernization of diet, ages 6 and over of Korean still showed white rice is kept the top of favorite food (Ahn EM et al 2011). The rice consumption began to decline steadily since the 1970s (Lee GL & Kim MJ 2003) but annual per capita consumption of meat is increasing to 30.5kg in 1998 and 35.6kg in 2008 (Statistics Korea). The westernized diet and the increased the replacement food is affecting the reduced consumption of rice (Yoon HS et al 2005). After introduced the westernized diet, rice consumption in Korean decreased and at the same time, alternative food like flour product, bread, and noodle increased (Ryu HK 2003). Due to this phenomenon, flour consumption as a main ingredient has been in-

Table 2. The relationship between socio-demographic factors and white rice consumption for men

	White rice consumption - quartile				$p^{2)}$
	Q1[1)]	Q2	Q3	Q4	
Men (N=748)					
Age	69.54±0.47[3)]	69.77±0.72	69.02±0.54	67.96±0.49	0.027
Income(monthly)					0.699
1,000,000 won	26(17.3)[4)]	30(21.6)	51(23.2)	71(26.2)	
–2,000,000 won	36(26.2)	40(26.8)	42(23.1)	65(27.1)	
–3,000,000 won	35(21.1)	41(25.0)	57(25.6)	54(22.3)	
≥3,000,000 won	44(35.2)	45(26.6)	52(28.1)	48(22.3)	
Education level					0.005
Elementary	42(29.0)	58(45.8)	82(42.1)	119(51.3)	
Middle school	30(21.7)	28(17.9)	42(17.2)	49(21.9)	
High school	42(30.8)	49(26.5)	49(17.2)	49(21.6)	
College or more	28(18.5)	17(9.8)	29(15.9)	19(5.2)	
Smoking	46(27.0)	38(28.4)	45(23.8)	61(30.8)	0.609
Drinking	92(66.0)	90(59.5)	131(65.7)	138(58.2)	0.431
Marital status					0.030
Living w/ spouse	130(91.3)	139(84.0)	188(94.4)	215(89.4)	
Living w/o spouse	11(6.5)	17(15.0)	12(5.0)	23(10.6)	
Unmarried	3(2.2)	1(1.0)	2(0.6)	0(0.0)	

All model were adjusted by sex and age.

1) Energy from white rice consumption (Q1～Q4): Q1(≤542.90), Q2(542.91～801.26), Q3(801.27～1080.56), Q4(1,080.57～3,807.34),

2) *P* from chi-square test for categorical variables. Differences were tested using generalized linear model for numerical variables. $p<.05$.

3) Numerical variables are given as means±SE.

4) Categorical variables are given as numbers and percentages.

creased continuously, but rice consumption tend to reduce relatively (Statistics Korea). By Baxter et al (2006), diet rich in whole-grains, vegetables, fruits and dairy has influenced against metabolic syndrome. The Korean diet based rice rich and various vegetables include kimchi is traditionally high in carbohydrate, low in fat, and abundant in vegetables and legumes. This means adequate white rice consumption is especially important for Korean elderly to maintain their healthy aging for the advantages of Korean traditional diet. Centenarians in many regions of the world have in common likely very much physical activity, non-obese, consumed a lot of plant foods than animal foods (Hausman DB et al 2011). By Oh C et al(2014), traditional diet pattern has much positive part like low calorie, fat intake, and more plant food intake but considering the body composition, consumption of protein, calcium and vitamin D should be increased for the Korean elderly. Rice consumption in the US is much lower compared to Asian countries such as Korea, Japan, and China (Batres-Marquez SP et al 2009), but the consumption is in-

Table 3. The relationship between socio-demographic factors and white rice consumption for women

	White rice consumption - quartile				$P^{2)}$
	Q1[1)]	Q2	Q3	Q4	
Women (N=939)					
Age (yr)	69.21±0.54[3)]	70.35±0.57	71.03±0.59	71.11±0.75	0.066
Income(monthly) (%)					0.166
1,000,000 won	48(18.3)[4)]	61(24.3)	61(29.1)	57(28.8)	
–2,000,000	62(20.6)	63(24.8)	53(25.5)	47(25.4)	
–3,000,000	75(29.2)	68(27.6)	48(25.4)	45(26.8)	
3,000,000	83(31.9)	62(23.3)	48(20.0)	27(26.8)	
Education level					<.001
Elementary	183(74.5)	197(83.8)	183(89.7)	157(93.2)	
Middle school	30(10.1)	28(8.9)	16(7.1)	11(4.3)	
High school	42(10.6)	23(6.1)	10(3.0)	4(2.0)	
College or more	11(4.7)	4(1.1)	1(0.2)	1(0.5)	
Smoking	12(5.2)	7(3.1)	8(3.0)	6(3.7)	0.723
Drinking	49(18.9)	52(18.7)	40(21.1)	38(21.9)	0.889
Marital status					0.845
Living w/ spouse	146(48.7)	143(47.5)	119(48.4)	102(53.9)	
Living w/o spouse	126(50.9)	115(52.1)	95(51.6)	75(45.7)	
Unmarried	2(0.5)	1(0.4)	0(0.0)	1(0.4)	

All model were adjusted by sex and age.

1) Energy from white rice consumption (Q1–Q4): Q1(≤542.90), Q2(542.91～801.26), Q3(801.27～1,080.56), Q4(1,080.57～3,807.34).

2) P from chi-square test for categorical variables. Differences were tested using generalized linear model for numerical variables. $p<.05$.

3) Numerical variables are given as means±SE.

4) Categorical variables are given as numbers and percentages.

creasing rapidly. According to the data from U.S. Department of Agriculture 2009 (Food and Nutrient Database for Dietary Studies), more than 70% of rice consumed is white rice as well as increased rice consumption. Some researchers are concerned that refined rice has negative effect on insulin related disease. Replace white rice to brown rice may lower risk of type 2 diabetes (Sun Q et al 2010). However, different perspective for white rice consumption is needed to remind for the healthy elderly. Even though the elderly are exposed to nutritional problems such as loss of appetite, bad teeth etc, increased white rice consumption which is most favorable food in Korean elderly may have benefit for them to reduce malnutrition rate (Park MY et al 2006). One of findings was the more white rice consume and the less meat consume and other grains, noodle & dumpling, flours & bread in both sexes as well. Nutrients intake varies according to the type of dietary patterns (Ryu HK 2003). Some researchers have suggested that the most important environmental factors affecting longevity are proper nu-

Table 4. The relationship between white rice consumption and nutrient intake for men

	White rice consumption - quartile				p[2]
	Q1[1]	Q2	Q3	Q4	
Men (N=748)					
White rice	23.7±1.46[3]	39.36±1.39	50.0±51.14	62.26±1.31	<.001
Other grain	14.24±1.51	11.37±1.05	8.86±0.70	8.55±0.69	<.001
Noodle & dumling	18.63±2.15	19.34±2.29	14.23±2.20	16.19±4.20	0.378
Flour & bread	14.31±2.79	10.57±1.83	9.57±2.42	4.51±0.54	<.001
Vegetable	3.44±0.26	3.39±0.19	3.35±0.22	2.78±0.13	0.021
Legumes	4.66±0.63	5.10±0.62	5.54±0.72	3.52±0.31	0.001
Kimchi	1.56±0.15	1.84±0.24	2.10±0.21	1.93±0.18	0.196
Fruits	8.93±1.18	6.57±0.61	6.65±0.76	7.31±0.86	0.240
Meat	13.90±2.73	11.72±1.12	8.57±0.74	8.48±0.77	0.031
Egg	2.80±0.37	2.95±0.62	3.08±0.50	2.96±0.59	0.976
Fishes	4.37±0.63	4.07±0.47	4.19±0.53	3.95±0.35	0.592
Milk & dairy	3.55±0.83	4.02±0.98	6.89±1.32	6.32±2.26	0.170
Oils	0.28±0.31	2.85±0.26	2.57±0.27	1.97±0.18	0.011
Beverage	4.27±0.52	3.63±0.43	3.53±0.32	3.61±0.28	0.662
Alcohols	18.03±2.07	19.60±3.06	12.81±1.42	10.1±10.83	<.001
Energy	1,943.96±86.60	1,952.01±97.49	2,035.07±99.13	2,363.31±75.25	<.001
Protein	73.23±5.03	67.66±5.03	70.99±3.92	74.91±3.14	0.343
Fat	42.86±4.83	34.44±3.19	31.43±2.71	28.50±2.12	0.014
Carbohydrate	299.82±18.47	303.79±15.87	349.22±14.37	435.20±13.95	<.001
Calcium	497.35±37.95	489.36±35.5	559.71±38.50	597.26±31.50	0.006

All model were adjusted by sex and age.

1) Energy from white rice consumption (Q1～Q4): Q1(≤542.90), Q2(542.91～801.26), Q3(801.27～1,080.56), Q4 (1,080.57～3,807.34).

2) Differences were tested using generalized linear model for numerical variables. $p<.05$.

3) Numerical variables are given as means±SE.

trition and eating habits (Takeda S et al1998). By research with Tokyo area Centenarians by Shimizu K et al (2003), reported higher dairy intake associated with longevity. In present study, the highest white rice consumption group showed that highest calorie intake and muscle generation related nutrient such as protein, calcium intake is highest while lowest fat intake. So the member of highest white rice consumption group showed to have higher muscle mass in both sexes in the present research. The keeping balance of body composition like high muscle mass and low fat mass is important for the elderly. The research with 1,433 subjects (658 men and 775 women) who were 60 years or older by Oh C et al(2015) reported that the prevalence of sarcopenic obesity, muscle mass loss and increased fat mass, is related with metabolic syndrome and more in women (31.3%) than in men (19.6%). Individuals with sarco-

Table 5. The relationship between white rice consumption and nutrient intake for women

	White rice consumption - quartile				$p^{2)}$
	Q1[1)]	Q2	Q3	Q4	
Women (N=939)					
White rice	34.54±1.43[3)]	52.98±1.28	61.47±1.23	69.50±1.24	<.001
Other grain	18.53±0.99	13.65±0.98	10.29±0.76	9.57±0.97	<.001
Noodle & dumpling	22.45±1.98	13.7±12.60	16.79±1.73	10.91±2.39	0.001
Flour & bread	12.53±1.62	8.19±0.98	5.77±0.80	4.38±0.52	<.001
Vegetable	3.31±0.25	3.00±0.22	2.87±0.19	3.12±0.24	0.540
Legumes	5.39±0.47	4.46±0.51	5.16±0.55	4.51±0.49	0.371
Kimchi	1.69±0.15	1.78±0.18	1.56±0.10	1.60±0.16	0.785
Fruits	10.27±0.96	9.33±0.84	6.46±0.60	6.01±0.67	<.001
Meat	9.79±1.49	8.14±0.65	7.30±0.71	6.140±.91	0.133
Egg	2.92±0.34	2.55±0.42	3.44±0.55	1.98±0.39	0.057
Fishes	3.41±0.53	3.19±0.33	2.75±0.24	2.24±0.23	0.066
Milk&Dairy	10.84±7.00	5.37±1.28	6.22±1.48	9.39±3.36	0.607
Oils	2.17±0.20	2.18±0.29	2.14±0.18	1.64±0.20	0.198
Beverage	5.55±0.51	4.48±0.39	4.32±0.52	3.20±0.30	<.001
Alcohols	6.78±1.59	3.45±1.08	5.37±1.64	6.65±0.55	0.029
Energy	1,223.63±55.82	1,410.66±54.17	1,610.36±55.39	1,953.86±46.77	<.001
Protein	42.86±2.52	45.28±1.92	50.05±2.14	55.58±1.67	<.001
Fat	20.19±1.40	18.02±1.34	19.42±1.47	18.61±1.13	0.396
Carbohydrate	224.00±10.95	269.75±10.64	310.00±10.55	389.77±1.13	<.001
Calcium	375.49±36.04	381.72±34.58	399.55±35.26	474.49±29.50	0.035

All model were adjusted by sex and age.

1) Energy from white rice consumption (Q1～Q4): Q1(≤542.90), Q2(542.91～801.26), Q3(801.27～1,080.56), Q4 (1,080.57～3,807.34).

2) Differences were tested using generalized linear model for numerical variables. p<.05.

3) Numerical variables are given as means±SE.

penic obesity had significantly higher fasting insulin, homeostasis model assessment of insulin resistance, and triglycerides (Oh C et al 2015). Other interesting finding was that the member of highest white rice consumption group showed insulin abnormality related factors like fasting glucose, HOMA IR, and weight became reduced. As consider with result of food group intake according to white rice consumption, we could presume that their rich in protein, calcium intake and low in fat diet reduced inflammation which could degrade muscle by cytokine. Additionally, less consumed simple sugars such as flour & bread and noodle & dumpling or alcohol which could cause metabolic abnormality in the highest white rice consumption group. On the other hand, other results on effect of white rice/ rice consumption and CVD (Izadi V & Azadbakht L 2015 & Muraki I et al 2015 & Khosravi-Boroujeni H et al 2013

Table 6. The relationship between white rice consumption and metabolic risk measurement by sex

	White rice consumption - quartile				$p^{2)}$
	Q1[1)]	Q2	Q3	Q4	
Man					
ASM[4)]	33.39±3.46	33.16±2.71	33.41±3.42	34.38±3.35	0.029
Wc[5)]	84.23±1.22	84.29±0.66	83.75±0.91	84.31±0.82	0.478
BMI	22.84±0.44	22.74±0.20	22.39±0.31	22.55±0.26	0.899
Glucose	111.20±2.81	105.72±2.64	105.22±2.39	101.89±2.12	0.047
TG[6)]	145.24±11.88	146.02±7.56	149.40±11.16	146.31±8.88	0.213
Total cholesterol	195.54±2.65	195.67±2.95	201.15±3.12	196.41±3.21	0.468
Vitamin D	17.93± 0.72	19.68± 0.72	19.51 ±0.73	20.51± 0.78	0.038
HDL[7)]	3.16±0.15	3.12±0.21	3.11±0.23	2.79±0.13	0.144
HOMA-IR[8)]	3.16±0.15	3.12±0.21	3.11±0.23	2.79±0.13	0.547
Woman					
ASM	25.86±3.10	26.00±3.76	26.42±4.06	27.11±4.06	0.002
Wc	81.82±1.9	83.36±2.11	82.14±2.03	82.07±2.07	0.540
BMI	22.91±0.77	23.26±0.82	22.65±0.78	22.57±0.80	0.355
Glucose	106.91±2.94	109.57±3.32	110.57±2.90	107.18±2.92	0.277
TG	133.02±10.85	137.20±15.28	127.98±14.02	148.27±16.92	0.384
Total cholesterol	205.04±8.00	200.37±8.12	200.50±8.28	200.74±8.29	0.606
Vitamin D	16.64±1.74	16.40±1.80	16.56±1.81	16.60±1.80	0.988
HDL	53.14±1.80	51.99±1.54	51.84±1.66	51.52±1.61	0.630
HOMA-IR	2.80±0.14	3.11±0.28	2.87±0.21	2.81±0.16	0.575

All model were adjusted by sex, age, smoking and diabetes.

1) Energy from white rice consumption (Q1～Q4): Q1(≤542.90), Q2(542.91～801.26), Q3(801.27～1,080.56), Q4 (1,080.57～3,807.34).

2) Differences were tested using generalized linear model for numerical variables. $p<.05$.

3) Numerical variables are given as means±SE. d. Appendicular skeletal muscle mass (ASM) was measured by DXA.

4) Wc; waist circumference(cm) 5) TG; triglycerides(nmol/l) 6) HDL; high-density lipoprotein(nmol/l) 7) HOMA-IR; homoeostasis model assessment of insulin resistance.

& Eshak ES 2014) showed that it seems that there is no significant correlation between white rice consumption and incidence of CVD, metabolic disease and its mortality. Meta-analysis by Vajihe Izadi (Izadi V & Azadbakht L 2015) showed a positive association between white rice intake and risk factors of CVD including metabolic syndrome and type 2 diabetes. In present study, the rice consumption of elderly women was higher than men. We found that for men, white rice consumption and marital status having spouse have affected rice consumption but education for women. In several researches, nutritional status of the elderly is different by gender rather than age (Choe JS et al 2004). Generally, the elderly has been a typical poor nutrition in rural areas of Korea, elderly women, elderly people living alone, and low-

income seniors. According to KNHANES 2005 (Choe JS et al 2004), 65 years and over elderly showed lack of intake of riboflavin, vitamin C, vitamin A as well as calcium, while over intake of sodium. For the elderly women, in general, energy (94.0%), calcium (63.9%), potassium (50.9%), thiamine (82.6%), riboflavin (68.3%), niacin (92.7%), and vitamin C (80.8%) to less than the DRIs reference was shown (Choe JS et al 2006). Data from Department of Health and Human Services 2007 reported that the elderly living alone have been increasing 18% of total elderly population and among them, skipping meals at least once a week to 17%, also more than five times the ratio to 9.8% (Park MY et al 2006). The lower levels of education and economic condition showed poor nutrition in the elderly (Choe JS et al 2006). There were several limitations in this study. First, the cross-sectional design of this study precluded our ability to identify on causal inference between white rice consumption and socio-demographic factors, metabolic risk factors and food/nutrient. Second, all participants in the present study were relatively healthy because those who were admitted to hospital or nursing homes were not included in KNHANES. Therefore, in the present study, the mean values of metabolic risk factors may have been underestimated. Third, at the population level, 24-h recall which might not represent accurate usual intake could be one of another limitation in our study. We could not control for all of epigenetic influence, thus, these results need to be confirmed by additional study with longitudinal data to make it possible to generalize the results. In conclusion, there are various health problems due to malnutrition in aging. Therefore, the study on diet pattern by white rice consumption which is staple food in Korean elderly and socio-demographic factors influenced the onset of chronic diseases like metabolic syndrome is very important. In Korea, improvement of nutrition policy and the transition of the management system in order to improve the quality of life of people by reduction of incidence and prevalence of various chronic diseases is need. We found the significant association between white rice consumption level and muscle mass and several metabolic syndrome related factors in the elderly. But results regarding white rice consumption and glucose metabolism related factor had not shown the consistent results. Thus, present study provides that justification for Korean elderly should be start early with modification of diet by adequate white rice consumption which could improve muscle mass by taking nutrient-rich foods intake.

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한국 노인의 쌀 섭취와 대사위험지표에 관한 연구: 근육량 중심으로

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국문초록

한국인의 주식인 쌀 중심의 식사패턴은 다양한 식품군의 섭취와 영양의 균형을 얻을 수 있는 장점을 가지고 있다. 따라서 본 연구에서는 노화과정에서 생리적 기능 저하에 따른 노인기 쉽게 야기될 수 있는 영양의 불균형으로 인한 영양결핍이 쌀을 중심으로 한 식사 패턴이 노인기 근육량에 미치는 영향에 대해 살펴보고자 하였다. 본 연구 대상자는 2010년 제5기 국민건강영양조사 자료를 이용한 60세 이상 노인 남녀 각각 658명, 775명을 대상으로 연구하였다. 연구 결과로 특히 남성의 경우, 결혼 및 배우자 유무 그리고 교육 수준에 따라 쌀의 섭취량에 유의적 차이가 있음을 알 수 있었다. 본 연구의 흥미로운 점은 노인기 남녀 모두 쌀 섭취량이 높을수록 더 높은 근육량을 보여주었다. 또한 쌀 섭취가 높을수록 육류 섭취가 낮았고, 다른 곡물, 면류, 만두류, 밀 및 빵에 대한 섭취가 남녀 모두 낮았다. 노인기의 식사패턴에서 쌀 섭취량의 증가가 근감소와 대사관련 위험 요인에 대한 위험도를 낮추어 주었다. 그러나 쌀 섭취량과 포도당 대사의 위험성에 대한 결과는 유의한 차이를 나타내지 않았다.

본 연구의 결과를 통해 노인기에 충분한 쌀 섭취를 통한 식사 패턴은 근감소와 대사증의 위험 지표에 영향을 미친다는 것을 살펴볼 수 있었다.

주제어: 쌀 섭취, 한국 노인, 영양, 사회인구통계학적 요인, 대사적 위험 요인