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A Cross-sectional Study of Nutrient Intake for Korean Women with Menopause and Metabolic Syndrome

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한국여성의 폐경에 따른 대사증후군과 영양섭취에 대한 단면 연구

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Abstract

Menopausal status and hormonal changes are important factors related to the prevalence of metabolic syndrome in women. Nutrient intake is also a risk factor for metabolic syndrome. Although, postmenopausal status and hormonal changes result in a 60% increased risk for metabolic syndrome, there has been no method to elucidate the effects of nutrient intake on metabolic syndrome following menopause. This study was conducted to evaluate the effects of nutrient intake by menopausal women on the prevalence of metabolic syndrome. All data were obtained from the Korean National Health and Nutrition Examination Survey 2007–2009. Menopausal women showed a 1.8-fold increase in the prevalence of metabolic syndrome. Metabolic syndrome group showed significantly lower values in calcium, iron, vitamin A, carotin, retinol and riboflavin intake than those of normal group in premenopausal women. In postmenopausal women, there are significant differences in crude fiber, calcium, iron, potassium, riboflavin and niacin. Indeed, different patterns of nutrient intake were observed by menopausal status and metabolic syndrome. As menopause cannot be controlled, a diet with adequate nutrient intake may be useful to control the rapid increase in the prevalence of metabolic syndrome due to menopause.

Key words: nutrient intake, menopause, metabolic syndrome

Introduction

In an early study on insulin resistance, metabolic syndrome was named “syndrome X” to define a patient group that was concurrently glucose intolerant, dyslipidemic, and had high blood pressure and coronary heart disease (Reaven GM 1988). In 1999, the World Health Organization defined these symptoms as metabolic syndrome (Alberti & Zimmet 1998). The guide lines for metabolic syndrome were suggested by the International Diabetes Federation (Zimmet et al. 2005) and the National Cholesterol Education Program (NCEP) with the Asia-Pacific standard of waist circumference (Grundy et al. 2005; Pan et al. 2008). However, the cause of metabolic syndrome remains unknown. It is assumed that metabolic syndrome can be influenced by factors related to coronary heart disease and diabetes (Arnlov et al. 2010; Jialal et al. 2010).

Regulating food intake is the most common therapeutic method to prevent metabolic syndrome. The food intake pattern hypothesis is a major subject in many studies on the relationship between metabolic syndrome and food intake. It is difficult to

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eliminate confounding factors and obtain restricted nutritional intake data making it difficult draw conclusion (Gittelsohn et al. 1998). In the NHANES III cross-sectional study, men with excess carbohydrate intake showed an increased prevalence of metabolic syndrome (Zhu et al. 2004). Furthermore, low fat and high protein food intake has been suggested by the NCEP as a way to decrease total cholesterol, low density lipoprotein cholesterol and triglyceride concentrations in the blood (Yu-Poth et al. 1999). A low fat diet induces weight loss (Astrup et al. 2000). However, Willett WC (2002) reported that a low fat diet induces little loss of weight in the short term, but that there was no difference in a long term study. Reports have indicated that calcium and vitamin D intake are related to the prevalence of metabolic syndrome (Liu et al. 2005).

Menopause is defined as occurring 12 months after last menstrual period and marks the end of menstrual cycles in women. Menopause is relation to metabolic syndrome through direct effects on sex steroid hormones. Many reports have shown that menopause increases the prevalence of metabolic syndrome in women (Park et al. 2003; Park et al. 2004). They reported increased prevalence of metabolic syndrome in postmenopausal women due to hormonal changes that occur during the menopause transition. These changes are considered the main reason for the shift in prevalence (Regitz-Zagrosek et al. 2007). The Korean National Health and Nutrition Examination Survey (KNHANES) showed a rapid increase in the prevalence of metabolic syndrome in women vs. gradual increase in men (Kim et al. 2007). In particular, a change in estrogen level is a major factor in the relationship between metabolic syndrome and menopause. The transition contributes to increase the prevalence of metabolic syndrome with an accumulation abdominal and intra-abdominal fat in postmenopausal women (Lobo RA 2008). The changes in estrogens due to menopause are related to type II diabetes and insulin resistance as estrogen therapy improves lipid metabolism and insulin sensitivity (Rossi et al. 2004; Khoo & Perera 2005).

As described above, metabolic syndrome, menopause and the nutrient transition interacts with each other. Thus, this study was conducted to elucidate the changes in the prevalence of metabolic syndrome following the menopausal transition by investigating the relationship among risk factors for metabolic syndrome, menopausal status, and nutrient intake.

Materials and Methods

1. Subject

This was a cross-sectional study using KNHANES data from the Korean Ministry of Health and Welfare. Study subjects were selected for the KNHANES by age and sex from 2007 to 2009. The selected subjects were women (age, 40–60 years) who participated in a health interview, medical examination, and nutrition examination. The subjects included 1,865 women who had neither hormonal treatment nor signs of ovarian dysfunction.

2. Assessment of nutritional intake

Food intake was estimated from 1 day intake by the 24 hr recall method. Foods were divided into 18 groups according to those shown in the report of the 2009 KNHANES (Ministry of Health and Welfare 2009). Nutrient intake was calculated from food intake using the National Standard Food Composition Table (Rural Development Administration 2009). The assessment of nutrient adequacy ratio (NAR) was evaluated with Korean Dietary Reference Intakes (KDRIs) for twelve nutrients (protein, crude fiber, calcium, phosphorus, iron, sodium, potassium, vitamin A, C, B_1, B_2 and niacin) (The Korean National Society 2009). And, the NAR was calculated with different nutrient requirements between 40 and 50 yrs by KDRIs. Mean adequacy ratio (MAR) was also calculated.

NAR = nutrient intake / nutrient requirement
MAR = sum of NAR / number of nutrients

3. Definition of metabolic syndrome

Diagnostic criteria of the NCEP-ATPIII were adapted to determine the prevalence of metabolic syndrome. The criteria indicate metabolic syndrome as the presence of three or more of the criteria below:

Waist circumference: men $\geq$ 90 cm, women $\geq$ 80 cm
Triglyceride: $\geq$ 150 mg/dL
HDL-cholesterol: men < 40 mg/dL, women < 50 mg/dL
Blood pressure: systolic blood pressure $\geq$ 130 mgHg or diastolic blood pressure $\geq$ 85 mmHg
Fasting plasma glucose: $\geq$ 100 mg/dL

4. Statistical analyses

The statistical analysis was conducted using SPSS 20.0K (SPSS, Inc., Chicago, IL, USA). The comparison of menopausal status between the metabolic syndrome and normal groups was

analyzed by Student's *t*-test. The analysis of general characteristics was conducted with the chi-square test. Regression analysis was performed to calculate odd ratio of NAR and MAR.

Results and Discussion

1. Characteristics of the study population

Demographic data of the study population are shown in Table 1. The incidence of metabolic syndrome was 21%. A total of 1,534 premenopausal and 740 postmenopausal women were included in this study. The prevalence of metabolic syndrome was 16.9% (260 women) in the premenopausal group and 30.7% (227 women) in the postmenopausal group. Menopausal status is an independent risk factor that increases the prevalence of metabolic syndrome (Hidalgo et al. 2006; Geum et al. 2008). The relationship between metabolic syndrome and menopause has been investigated in various race (Hidalgo et al. 2006; Ainy et al. 2007; Kim et al. 2007; Eshtiaghi et al. 2010). However, the results of investigation between menopause and metabolic syndrome are not consistent even though menopause is related to some risk factors for metabolic syndrome (Carr MC 2003). Furthermore, studies of Asian and Caucasian do not show significant differences in triglyceride and HDL-cholesterol levels around menopause (Fukami et al. 1995; Torng et al. 2002). These conflicting results may be due to limitations of cross-sectional studies ethnic homogeneity (Santoro et al. 2005; Ainy et al. 2007). Nevertheless, changes caused by menopause do not clearly explain the increased prevalence of metabolic syndrome as the menopausal transition induces alterations in a women's whole constitution including hormonal characteristics, dietary patterns and metabolism.

Table 1. General characteristics of the study population

		Normal		MS	
Age	40 – 50	1,258	83.20	254	16.80
	51 – 60	529	69.42	233	30.58
	Total	1,787	78.58[1)]	487***	21.42
Menopausal status	Pre-menopause	1,274	83.05	260	16.94
	Post-menopause	513	69.32	227	30.68
	Total	1,787	78.58	487***	21.42

1) %

***$p<0.001$; *p*-values were calculated using the χ^2 test between the normal and metabolic syndrome groups

2. Nutrient intake and menopausal status

Nutrient intake was decreased in most categories in postmenopausal women with metabolic syndrome (Table 2). Premenopausal women with metabolic syndrome showed a significantly decreased intake of calcium, iron, vitamin A, carotin, retinol and riboflavin. Indeed, postmenopausal women in the metabolic syndrome group showed decreased crude fiber, calcium, iron, potassium, riboflavin, and niacin intake.

Ratios of 55 – 70% carbohydrate, 7 – 20% protein and 15 – 25% fat are recommended by the KRI. Premenopausal women showed an adequate C:P:F ratio (Table 3). However, postmenopausal women had significantly higher carbohydrate and lower fat intake than recommended by the KDRs. Indeed, postmenopausal women in the metabolic syndrome group had lower protein intake than that in the normal group significantly ($p<0.05$).

Nutrient intake is a major factor related to metabolic syndrome. Dietary patterns are related to homeostasis and disease in humans including metabolic syndrome and changes due to menopausal status. In studies of Korean women, high carbohydrate intake was related to waist circumference and metabolic syndrome (Park et al. 2008; Yoo & Kim 2008). High carbohydrate and low fat intake occurs significantly more often in postmenopausal women (Moon & Kong 2010). Thus, menopause could be considered an independent factor inducing a change in nutrient intake regardless of metabolic syndrome. Vitamin A, carotin and riboflavin were consumed significantly less often in premenopausal women with metabolic syndrome than those in postmenopausal women. These results are consistent with a previous report that vitamins have a preventive effect on oxidative stress which is a major characteristic of metabolic syndrome (Zimmermann & Aeberli 2008; Roberts & Sindhu 2009).

3. Assessment of NAR and MAR

NAR and MAR were estimated in menopausal women in the metabolic syndrome and normal groups (Table 4). Although the presence of metabolic syndrome was not considered, the NAR and MAR values in postmenopausal women were lower than those in premenopausal women except iron, sodium and potassium. Indeed, premenopausal women in metabolic syndrome group significantly lower NAR in protein, calcium, iron, vitamin A, B_1 and B_2. Postmenopausal women in the metabolic syndrome group had significant differences in most NAR except protein, iron and phosphorus. Metabolic syndrome group showed a significant decrease in MAR.

Table 2. Comparison of nutrient intake between the normal and metabolic syndrome groups of menopausal women

	Premenopause		Postmenopause	
	Normal	Metabolic syndrome	Normal	Metabolic syndrome
Energy (kcal)	1,654.92 ± 572.14[1)]	1,606.65 ± 591.82	1,638.71 ± 585.00	1,624.14 ± 598.64
Protein (g)	59.22 ± 25.77	57.96 ± 27.52	57.00 ± 26.43	53.47 ± 26.55
Fat (g)	31.25 ± 20.43	28.88 ± 20.21	24.93 ± 17.01	24.32 ± 19.53
Carbohydrate (g)	286.31 ± 106.89	274.78 ± 95.81	302.34 ± 113.78	299.37 ± 108.09
Crude fiber (g)	7.61 ± 5.24	7.19 ± 5.01	7.83 ± 5.06**	6.74 ± 4.71
Calcium (mg)	471.47 ± 300.16*	432.01 ± 261.99	456.50 ± 271.20*	408.95 ± 263.09
Phosphorus (mg)	1,030.73 ± 401.30	1,000.70 ± 403.37	1,033.07 ± 430.70	965.70 ± 431.93
Iron (mg)	14.09 ± 10.00*	12.70 ± 8.02	14.01 ± 9.31**	12.09 ± 8.99
Sodium (mg)	4,494.15 ± 3,459.78	4,621.45 ± 2,980.95	4,008.13 ± 2,223.95	4,252.78 ± 2,611.42
Potassium (mg)	2,902.95 ± 1,402.45	2,749.71 ± 1,304.93	2,973.62 ± 1,525.95*	2,694.05 ± 1,481.96
Vitamin A (μg/RE)[2)]	843.60 ± 879.78**	708.15 ± 707.97	779.99 ± 811.48	683.34 ± 851.40
Carotin (μg)	4,445.95 ± 5,009.11*	3,722.00 ± 4,064.10	4,274.76 ± 4,700.45	3,678.93 ± 4,881.93
Retinol (μg)	88.38 ± 185.37*	72.57 ± 90.57	62.33 ± 146.77	61.46 ± 185.90
Thiamine (mg)	1.11 ± 0.55	1.07 ± 0.56	1.06 ± 0.57	1.03 ± 0.57
Riboflavin (mg)	1.06 ± 0.53**	0.97 ± 0.51	0.97 ± 0.52*	0.88 ± 0.53
Niacin (mg)	13.94 ± 6.42	13.60 ± 6.57	13.66 ± 6.85*	12.45 ± 6.33
Vitamin C (mg)	107.76 ± 86.78	102.17 ± 85.49	113.91 ± 107.11	105.86 ± 108.60

1) Mean±S.D., 2) retinol equivalent, RE
*p<0.05, **p<0.01; comparison between the normal and metabolic syndrome groups

Table 3. Comparison of the carbohydrate:protein:fat (C:P:F) ratio between the normal and metabolic syndrome groups of menopausal women

	Premenopause		Postmenopause	
	Normal	Metabolic syndrome	Normal	Metabolic syndrome
Carbohydrate	69.67 ± 11.31[1)]	69.74 ± 10.92	74.08 ± 10.22	74.58 ± 10.25
Protein	14.34 ± 3.84	14.44 ± 4.60	13.87 ± 3.83**	12.99 ± 3.56
Fat	16.57 ± 7.83	15.55 ± 7.20	13.39 ± 6.70	12.84 ± 7.10

1) Mean±S.D.
**p<0.001; p-values were calculated between the normal and metabolic syndrome groups

The odd ratios for the normal and metabolic syndrome groups according to NAR and MAR in menopausal women are shown in Table 5. A significant difference in calcium, iron, vitamin A and vitamin B_2 was observed in the premenopausal group with 1.3 and 1.4 odd ratios. However, the postmenopausal group showed a significant difference in iron, vitamin A, vitamin B_2, and niacin. The odds ratio in the postmenopausal group was higher in the premenopausal group except that for that of vitamin A. Indeed, the results of MAR comparison showed that the odds ratio for the incidence of metabolic syndrome was 1.725 in the postmenopausal group and 1.484 in the premenopausal group.

Postmenopausal women in the metabolic syndrome group showed the lowest nutrient intake values and NAR. Postmenopausal women also showed similar patterns with lower vitamins and essential nutrients, which are related to metabolic syndrome. Indeed, the results of the odds ratio analysis for metabolic syndrome showed that postmenopausal women have a higher risk for metabolic syndrome due to nutrient deficiency. Thus, these results indicate that the difference in nutrient intake pattern is related to metabolic syndrome and menopausal status. However,

Table 4. Comparison of nutrient adequacy ratio and mean adequacy ratio between the normal and metabolic syndrome groups of menopausal women

Variable		Premenopause		Postmenopause	
		Normal	Metabolic syndrome	Normal	Metabolic syndrome
NAR[2)]	Protein	0.92 ± 0.15*	0.90 ± 0.18[1)]	0.90 ± 0.17	0.88 ± 0.19
	Calcium	0.60 ± 0.26*	0.56 ± 0.26	0.55 ± 0.26**	0.49 ± 0.27
	Phosphorus	0.96 ± 0.12	0.95 ± 0.15	0.95 ± 0.13	0.93 ± 0.15
	Iron	0.78 ± 0.23*	0.75 ± 0.25	0.88 ± 0.19	0.82 ± 0.25
	Sodium	0.99 ± 0.08	0.98 ± 0.09	0.98 ± 0.11**	0.99 ± 0.05
	Potassium	0.59 ± 0.23	0.57 ± 0.23	0.60 ± 0.24**	0.55 ± 0.25
	Vitamin A	0.77 ± 0.28**	0.71 ± 0.30	0.74 ± 0.31*	0.68 ± 0.32
	Vitamin B_1	0.82 ± 0.21*	0.80 ± 0.23	0.80 ± 0.22*	0.76 ± 0.23
	Vitamin B_2	0.76 ± 0.24**	0.71 ± 0.26	0.71 ± 0.26***	0.64 ± 0.27
	Niacin	0.83 ± 0.21	0.81 ± 0.22	0.80 ± 0.21*	0.76 ± 0.22
	Vitamin C	0.75 ± 0.28	0.71 ± 0.30	0.75 ± 0.29*	0.69 ± 0.31
MAR[3)]		0.80 ± 0.16*	0.77 ± 0.17	0.79 ± 0.17**	0.74 ± 0.18

[1)] Mean±S.D., [2)] Nutrient adequacy ratio, NAR, [3)] Mean adequacy ratio, MAR
*p<0.05, **p<0.01, ***p<0.001; p-values were calculated between the normal and metabolic syndrome groups

Table 5. Odds ratios of nutrient intake using the NAR and MAR for the normal and metabolic syndrome groups of menopausal women

Variables		Premenopause			Postmenopause			Total		
		Metabolic syndrome	Normal	OR[1)] (95%CI)	Metabolic syndrome	Normal	OR (95%CI)	Metabolic syndrome	Normal	OR (95%CI)
MAR[2)]	mar≤0.8	138(20)[4)]	551(80.0)	1.484	129(36.8)	222(63.2)	1.725	267(25.7)	773(74.3)	1.592
	mar>0.8	122(14.4)	723(85.6)	(1.136-1.940)**	98(25.2)	291(74.8)	(1.259-2.365)***	220(17.8)	1,014(82.2)	(1.301-1.947)***
Protein	nar[3)]≤0.8	50(19.2)	210(80.8)	1.206	63(35.2)	116(64.8)	1.315	113(25.7)	326(74.3)	1.354
	nar>0.8	210(16.5)	1,064(83.5)	(0.857-1.698)	164(29.2)	397(70.8)	(0.920-1.878)	374(20.4)	1,461(79.6)	(1.063-1.725)*
Calcium	nar≤0.8	206(18.1)	934(81.9)	1.389	188(31.7)	405(68.3)	1.285	394(22.7)	1,339(77.3)	1.417
	nar>0.8	54(13.7)	340(86.3)	(1.004-1.921)*	39(26.5)	108(73.5)	(0.857-1.927)	93(17.2)	448(82.8)	(1.104-1.820)**
Phosphorus	nar≤0.8	27(19.1)	114(80.9)	1.179	33(36.3)	58(63.7)	1.334	60(25.9)	172(74.1)	1.319
	nar>0.8	233(16.7)	1,160(83.3)	(0.758-1.835)	194(29.9)	455(70.1)	(0.843-2.112)	427(20.9)	1,615(79.1)	(0.965-1.804)
Iron	nar≤0.8	133(19.1)	565(80.9)	1.314	80(37.2)	135(62.8)	1.524	213(23.3)	700(76.7)	1.207
	nar>0.8	127(15.2)	709(84.8)	(1.006-1.717)*	147(28.0)	378(72.0)	(1.089-2.132)*	274(20.1)	1,087(79.9)	(0.986-1.478)
Sodium	nar≤0.8	11(23.9)	35(76.1)	1.564	6(20.7)	23(79.3)	0.578	17(22.7)	58(77.3)	1.078
	nar>0.8	249(16.7)	1,239(83.3)	(0.784-3.121)	221(31.1)	490(68.9)	(0.232-1.440)	470(21.4)	1,729(78.6)	(0.622-1.869)
Potassium	nar≤0.8	213(17.5)	1,006(82.5)	1.207	186(32.2)	391(67.8)	1.416	399(22.2)	1,397(77.8)	1.266
	nar>0.8	47(14.9)	268(85.1)	(0.856-1.702)	41(25.2)	122(74.8)	(0.954-2.100)	88(18.4)	390(81.6)	(0.979-1.636)
Vitamin A	nar≤0.8	132(19.8)	534(80.2)	1.429	118(34.3)	226(65.7)	1.375	250(24.8)	760(75.2)	1.425
	nar>0.8	128(14.7)	740(85.3)	(1.094-1.867)**	109(27.5)	287(72.5)	(1.005-1.881)*	237(18.8)	1,027(81.2)	(1.166-1.743)**
Vitamin B_1	nar≤0.8	115(19.2)	485(80.8)	1.290	115(34.3)	220(65.7)	1.367	230(24.6)	705(75.4)	1.374
	nar>0.8	145(15.5)	789(84.5)	(0.985-1.689)	112(27.7)	293(72.3)	(0.999-1.871)	257(19.2)	1,082(80.7)	(1.123-1.680)**
Vitamin B_2	nar≤0.8	149(19.5)	617(80.5)	1.429	153(34.2)	295(65.8)	1.528	302(24.9)	912(75.1)	1.566
	nar>0.8	111(14.5)	657(85.5)	(1.092-1.871)**	74(25.3)	218(74.7)	(1.101-2.121)*	185(17.5)	875(82.5)	(1.276-1.923)***
Niacin	nar≤0.8	107(18.2)	481(81.8)	1.153	119(35.3)	218(64.7)	1.491	226(24.4)	699(75.6)	1.348
	nar>0.8	153(16.2)	793(83.8)	(0.879-1.513)	108(26.8)	295(73.2)	(1.089-2.041)*	261(19.4)	1,088(80.6)	(1.101-1.649)**
Vitamin C	nar≤0.8	133(18.0)	607(82.0)	1.151	118(34.0)	229(66.0)	1.343	251(23.1)	836(76.9)	1.210
	nar>0.8	127(16.0)	667(84.0)	(0.881-1.503)	109(27.7)	284(72.3)	(0.982-1.836)	236(19.9)	951(80.1)	(0.990-1.479)

[1)] Odds ratio, [2)] Mean adequacy ratio, MAR, [3)] Nutrient adequacy ratio, NAR, [4)] N (%)
*p<0.5, **p<0.1, ***p<0.001; p-values were calculated between the normal and metabolic syndrome groups

estimating nutrient intake should be considered for all dietary intake including food, medicine, supplements, and vitamin D directly synthesized from human skin (Pittas et al. 2007).

Conclusions

This study was conducted to investigate the cause for the increased prevalence of metabolic syndrome in menopausal women from a nutritional perspective. As previous studies described, a change in estrogen level around menopause is a major risk factor for metabolic syndrome. Our findings did not suggest a causal relationship between these hormone changes at menopause and nutrient intake. However, nutrient intake related to the prevalence of metabolic syndrome showed significant differences with menopausal status. Thus, the control of vitamin and essential nutrient intake is suggested as an effective way to decrease the prevalence of metabolic syndrome during menopause. In particular, deficiency of nutrients was observed more in comparison with menopausal status than that in metabolic syndrome. Therefore, control of nutrient intake is necessary to decrease the prevalence of metabolic syndrome as well as other diseases that occur during menopause.

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References

Ainy E, Mirmiran P, Zahedi Asl S, Azizi F. 2007. Prevalence of metabolic syndrome during menopausal transition Tehranian women: Tehran Lipid and Glucose Study (TLGS). *Maturitas* 58:150-155

Alberti KG, Zimmet PZ. 1998. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus: provisional report of a WHO consultation. *Diabet Med* 15:539-553

Arnlov J, Ingelsson E, Sundstrom J, Lind L. 2010. Impact of body mass index and the metabolic syndrome on the risk of cardiovascular disease and death in middle-aged men. *Epidemiology and Prevention* 121:230-236

Astrup A, Grunwald GK, Melanson EL, Saris WH, Hill JO. 2000. The role of low-fat diets in body weight control: a meta-analysis of *ad libitum* dietary intervention studies. *Int J Obes Relat Metab Disord* 24:1545-1552

Carr MC. 2003. The emergence of the metabolic syndrome with menopause. *J Clin Endocrinol Metab* 88:2404-2411

Cho GJ, Lee JH, Park HT, Shin JH, Hong SC, Kim T, Hur JY, Lee KW, Park YK, Kim SH. 2008. Postmenopausal status according to years since menopause as an independent risk factor for the metabolic syndrome. *Menopause* 15:524-529

Eshtiaghi R, Esteghamati A, Nakhjavani M. 2010. Menopause is an independent predictor of metabolic syndrome in Iranian women. *Maturitas* 65:262-266

Fukami K, Koike K, Hirota K, Yoshikawa H, Miyake A. 1995. Perimenopausal changes in serum lipids and lipoproteins: a 7-year longitudinal study. *Maturitas* 22:193-197.

Gittelsohn J, Wolever TMS, Harris SB, Harris-Giraldo R, Hanley AJG, Zinman B. 1998. Specific patterns of food consumption and preparation are associated with diabetes and obesity in a Native Canadian community. *Journal of Nutrition* 128:541-547

Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F. 2005. Diagnosis and management of the metabolic syndrome an American Heart Association/ National Heart, Lung, and Blood Institute Scientific Statement. *Circulation* 112:2735-2752

Hidalgo LA, Chedraui PA, Morocho N, Alvarado M, Chavez D, Huc A. 2006. The metabolic syndrome among postmenopausal women in Ecuador. *Gynecol Endocrinol* 22:447-454

Jialal I, Devaraj S, Singh U, Huet BA. 2010. Decreased number and impaired functionality of endothelial progenitor cells in subjects with metabolic syndrome: Implications for increased cardiovascular risk. *Atherosclerosis* 211:297-302

Khoo CL, Perera M. 2005. Diabetes and the menopause. *J Br Menopause Soc* 11:6-11

Kim HM, Ryu SY, Park J, Kim J. 2007. The effect of menopause on the metabolic syndrome among Korean women. *Diabetes Care* 30:701-706

Liu S, Song Y, Ford ES, Manson JE, Buring JE, Ridker PM. 2005. Dietary calcium, vitamin D, and the prevalence of metabolic syndrome in middle-aged and older US women. *Diabetes Care* 12:2926-2932

Lobo RA. 2008. Metabolic syndrome after menopause and the role of hormones. *Maturitas* 60:10-18

Moon HK, Kong JE. 2010. Assessment of nutrient intake for

middle aged with and without metabolic syndrome using 2005 and 2007 Korean National Health and Nutrition Survey. *Korean J Nutr* 43:69-78

Pan WH, Yeh WY, Weng LC. 2008. Epidemiology of metabolic syndrome. *Asia Pac J Clin Nutr* 17:S37-42

Park HS, Oh SW, Cho SI, Choi WH, Kim YS. 2004. The metabolic syndrome and associated lifestyle factors among South Korean adults. *Int J Epidemiol* 33:328-336

Park SY, Park MS, Ko JA. 2008. The association between carbohydrate intake and waist circumference. *Korean J Obesity* 17:175-181

Park YW, Zhu S, Palaniapan L, Heshka S, Carnethon MR, Heymsfield SB. 2003. The metabolic syndrome: Prevalence and associated risk factor findings in the US population from the Third National Health and Nutrition Examination Survey. *Arch Intern Med* 163:427-436

Pittas AG, Lau J, Hu FB, Dawson-Hughes B. 2007. The role of vitamin D and calcium in type 2 diabetes. *J Clin Endocrinol Matab* 92:2017-2029

Reaven GM. 1988. Role of insulin resistance in human disease. *Diabetes* 37:1495-1607

Regitz-Zagrosek V, Lehmkuhl E, Mahmoodzadeh S. 2007. Gender aspects of the role of the metabolic syndrome as a risk factor for cardiovascular disease. *Gend Med* 4:S162-S177

Roberts CK, Sindhu KK. 2009. Oxidative stress and metabolic syndrome. *Life Sci* 22:705-712

Rossi R, Origliani G, Modena MG. 2004. Transdermal 17-β-estradiol and risk of developing type 2 diabetes in a population of healthy, nonobese postmenopausal women. *Diabetes Care* 27:645-649

Santoro N, Torrens J, Crawford S, Allsworth JE, Finkelstein JS, Gold EB, Korenman S, Lasley WL, Luborsky JL, McConnell D, Sowers MF, Weiss G. 2005. Correlates of circulating androgens in mid-life women: the Study of Women's Health Across the Nation. *J Clin Endocrinol Metab* 90:4836-4845

The Korean Nutrition Society. 2005. Korean dietary reference intakes. http://www.kns.or.kr [cited 2009 Jan 5]

Torng PL, Su TC, Sung FC, Chien KL, Huang SC, Chow SN, Lee YT. 2002. Effects of menopause on intraindividual changes in serum lipids, blood pressure, and body weight: the Chin-Shan Community Cardiovascular Cohort Study. *Atherosclerosis* 161:409-415

Willett WC. 2002. Dietary fat plays a major role in obesity: no. *Obes Rev* 3:59-68

Yoo HJ, Kim YH. 2008. A study on the characteristics of nutrient intake in metabolic syndrome subjects. *Korean J Nutr* 41: 510-517

Yu-Poth S, Zhao G, Etherton T, Naglak M, Jonnalagadda S, Kris-Etherton PM. 1999. Effects of the National cholesterol Education Program's Step I and Step II dietary intervention programs on cardiovascular disease risk factors: a meta-analysis. *Am J Clin Nutr* 69:632-646

Zhu S, St-Onge MP, Heshka S, Heymsfield SB. 2004. Lifestyle behaviors associated with lower risk of having the metabolic syndrome. *Metabolism* 53:1503-1511

Zimmermann MB, Aeberli I. 2008. Dietary determinants of subclinical inflammation, dyslipidemia and components of the metabolic syndrome in overweight children: a review. *Int J Obes* 32:S11-18

Zimmet PZ, Alberti KG, Shaw J. 2005. International Diabetes Federation: the IDF consensus worldwide definition of the metabolic syndrome. *Diabetes Voice* 50:31-33

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