Risk factors of Metabolic Syndrome and Lifestyle in Early Adulthood in Korea

Seo, Yoo-jin, Byun, Young Soon

Abstract— **The objective of this study was to identify risk factors of metabolic syndrome in early adulthood which has currently shown an increase in Korea, due to a westernized lifestyle. Health medical examination data collected from a total of 5801 participants, gathered by the National Health Insurance Service(NHIS) in 2013, was used to proceed with the study. NCEP ATP-III was used as diagnostic criteria for determining metabolic syndrome. The prevalence rate for metabolic syndrome totaled 32.8%, 29.7% for men and 3.1% for women. Among the subjects, 21.5% of men were found to have abnormal waist circumferences compared to a percentage of 2.3% for women. However, the HDL-cholesterol levels for both men and women were very similar, at 13.6% and 13.3% respectively. There were statistically significant differences in their BMIs, family histories of diabetes, smoking periods, smoking frequencies, alcohol consumption, drinking frequencies, and intense physical activities for the metabolic syndrome group and the normal group. The factors influencing metabolic syndrome were BMI(OR=1.645, 95% CI, 1.599-1.692), a high risk of diabetes(OR=8.818, 95% CI, 4.493-17.306), drinking frequency(OR=1.151, 95% CI, 1.074-1.233), smoking period(OR=1.037, 95% CI, 1.010-1.064), whereas the family history of diabetes, smoking frequency, and physical activity showed no significance. The factors attributing to a high risk in diabetes were BMI(OR=1.021, 95% CI, 1.008-1.035), family history of diabetes(OR=1.835, 95% CI, 1.045-3.225), smoking period(OR=1.125, 95% CI, 1.050-1.206), presence of metabolic syndrome(OR=8.519, 95% CI, 4.876-14.885). The result from the data illustrates the necessity in developing programs and management education for such factors (BMI, smoking, drinking) that influence metabolic syndrome in early adulthood. Promotion of the environment and social awareness of metabolic syndrome is also required to make possible improvements in lifestyle.**

Keywords-component; Metabolic Syndrome, Early Adulthood, Lifestyle, Risk Factors

I. INTRODUCTION

Metabolic syndrome, one of the expected causes of chronic disease, is a combination of obesity, diabetes, high triglyceride levels, low HDL-cholesterol levels, and hypertension. There has been a steady increase in prevalence of metabolic syndrome reaching a percentage of 23.2% in 2012 [1], [2]. Westernized lifestyle combined with an aging population, smoking, high fat diets and lack of exercise are the causes of this increasing trend in metabolic syndrome which is expected to further increase consistently due to the spreading of a changed lifestyle [3]. Metabolic syndrome is closely associated with metabolic disease, and it increases the mortality rate by elevating the risk and complications of diabetes and hypertension [4], [5], [6].

Seo, Y. J., is with the National Health Insurance Service, 328, Teheran-ro, Gangnam-gu, Seoul, Korea. (e-mail: yujin3321@nhis.or.kr).

Byun, Y. S., is with the College of Health Sciences, Division of Nursing Science, Ewha Womans University, 52, Ewhayeodae-gil, Seodaemun-gu, Seoul, Korea. (e-mail: ysbyeon@ewha.ac.kr).

Metabolic syndrome shows no noticeable symptoms and it is often mistaken for other lighter problems. Furthermore, it reduces the quality of life, affecting the mental health by causing stress [7], [8]. Lifestyle factors such as age, gender, BMI, smoking, drinking, family history, exercising are said to have a relation with metabolic syndrome. However, only the drinking habits, alcohol consumption, smoking habits, and physical activities were found to have any effect on it [9], [10]. People in their early adulthood were also found to be influenced by factors including a sedentary lifestyle, age, physical activity, family history, and BMI [11], [12], [13]. The prevalence of the metabolic syndrome among men in their 30's has sharply increased, but they are often unaware of the state of their health, and overlook in the treatment or management of what could turn into chronic diseases. Many in their early adulthood who have contracted chronic disease often cannot manage themselves properly and show high smoking and drinking rates as a high risk lifestyle [2], [14]. Hence, it is necessary to identify metabolic syndrome itself and the risk factors that influence it by having people in their early adulthood as subjects of research.

II. METHODS

A. Study Design and Population

This descriptive correlation study is one which utilized secondary analysis study that re-analyzed the 2013 health medical examination data from NHIS and proceeded to identify BMI, diabetes, family history and lifestyle factors that affect the onset of metabolic syndrome in subjects in their early adulthood. There was a total of 894,570 participants who were over the age of 20's and had received a general health examination from NHIS in 2013. Out of the aforementioned group of participants, excluding those that had no anthropometry and blood test data or health questionaire data related to their lifestyle, 163,975 subjects were first selected. The subjects' selection was finalized by having both men and women whose age ranged in the 20's to 40's and had not been previously diagnosed with diabetes. In total, 5,801 subjects were chosen, of which 4,027(69.4%) were men and 1,774(30.6%) were women.

B. Data Collection and Metabolic syndrome Diagnosis

This study proceeded to carry on its research after receiving the approval that the health examination data from NHIS will only be used for academic purposes. After the approval was made we received anonymous data where it was impossible to identify personal information. NCEP ATP-Ⅲ guidelines were used to diagnose metabolic syndrome and specific/detailed diagnostic criteria are as follows: 1) triglyceride level: > 150mg/dL 2) HDL-cholesterol level: < 40mg/dL in men, < 50mg/dL in women 3) fasting plasma glucose: > 100mg/dL 4) blood pressure: >

DOI: 10.5176/2345-718X_1.2.43

130/85mmHg 5) waist circumference: > 90cm in men, > 85cm in women. The study proceeded by categorizing the subjects who meet three or more of the five criteria above into a metabolic syndrome group and the rest into a normal group.

C. Ethical Consideration

This study is a secondary analysis study that re-analyzed the 2013 health medical examination data from NHIS and no other personal information about the subjects were gathered and recorded as we were provided with an anonymous data from the organization. Thus, it meets the exemptions to IRB approval as there is no need to obtain the subjects' consent.

D. Statistical Analysis

Analysis of data was conducted using the SPSS WIN 21.0 Program to fit the purpose of this study and was set to be determined at a 0.05 level of significance. Detailed statistical analysis is as follows: (1) Percent, mean, and standard deviation were used to determine general and disease related characteristics. (2) T-test and x^2-test were performed to examine the difference between diagnostic criteria and risk factors associated with the presence of metabolic syndrome. (3) Logistic regression was performed to examine the risk factors that affect diagnosis of metabolic syndrome and high risk individuals with diabetes.

III. RESULTS

A. General and disease related characteristics of subjects

The gender of subjects was pivoted to men as there were 4,027(69.4%) men and 1,774(30.6%) women. The average age of subjects was 31.39 and there were more subjects in their 30's than in their 20's, 3,888(67%) and 1,913(33%) respectively (Table Ⅰ). The characteristics related to metabolic syndrome that can be examined are as follows. The average BMI was 23.77kg/m² and 32.2% of subjects were classified as obese. The average of waist circumference for men was 83.3cm and was 71.55cm for women, the men had more abnormal waist circumferences at 21.5% while the women were only at a mere 2.3%. The systolic blood pressure average was in the normal range at 117.75mmHg, which was lower than the diagnostic criteria for metabolic syndrome of 130mmHg, with the abnormal group taking up 22.9% of the group. The average of diastolic blood pressure was also in the normal range at 73.81mmHg, which had a comparatively smaller abnormal group than the aforementioned systolic blood pressure at a percentage of 11.2%. The average of fasting plasma glucose was 91.27mg/dL, which was in the normal range when taking into the account that the diagnostic criteria for metabolic syndrome was over 100mg/dL and there was a percentage of 17.6% corresponding to the abnormal group. The average of triglyceride levels was 127.71mg/dL, which also was in the normal range but of which 20.5% were in the abnormal group. The average of HDL-cholesterol levels for men was 53.42mg/dL and for women 66.03mg/dL, where both sexes were in the normal range as their levels for diagnostic criteria were over 40mg/dL and 50mg/dL respectively. The abnormal group of HDL-cholesterol levels was similar in that it was 13.6% for men and was 13.3% for women but was comparatively higher when compared to the 2.3% of abnormalities in waist circumference for women. Additionally there were 1,902 subjects from 5,801 in total who were diagnosed with metabolic syndrome and out of those who were, 1,723(29.7%) were men and 179(3.1%) were women according to the health examination results (Table Ⅱ, Ⅲ).

TABLE Ⅰ

General Characteristics of subjects

Variable	separation	n(%)	M±SD
Sex	Male	4,027(69.4)	
	Female	1,774(30.6)	
Age	20's	1,913(33.0)	31.39±3.908
	30-40years	3,888(67.0)	
Having Metabolic syndrome	Male	1,723(29.7)	
	Female	179(3.1)	
	Total	1,902(32.8)	

TABLE Ⅱ

Disease related characteristics of subjects

Variable		n(%)		M±SD
		normal	Abnormal	
WC	M	3,163(78.5)	864(21.5)	83.30±8.62
	F	1,638(28.2)	136(2.3)	71.55±8.70
BMI		3,925(67.8)	1,876(32.2)	23.77±5.92
SBP		4,470(77.1)	1,331(22.9)	117.75±12.15
DBP		5,149(88.8)	652(11.2)	73.81±8.865
FBS		4,780(82.4)	1,021(17.6)	91.27±17.18
TG		4,350(75.0)	1,451(25.0)	127.71±120.53
HDL-C	M	3,480(86.4)	547(13.6)	53.42±12.56
	F	1,538(86.7)	236(13.3)	66.03±14.24

B. Difference of lifestyle factors according to the presence of metabolic syndrome

After examining the risk factors which included BMI, family history of diabetes, smoking, drinking, and physical activity, BMI($t=17.209$, $p<0.001$), family history of diabetes ($\chi^2=11.226$, $p<0.001$), history of smoking in the past ($\chi^2=79.127$, $p<0.001$), smoking period ($t=6.190$, $p<0.001$), smoking frequency ($t=6.923$, $p<0.001$), alcohol consumption ($t=8.254$, $p<0.001$), drinking frequency ($\chi^2=132.150$, $p<0.001$), and intense physical activity ($t=-2.901$, $p=0.004$), it showed a statistically significant difference in diagnosis of metabolic syndrome. In the case of 'Number of days during a week in which 20 minutes of intense activity was implemented that caused one to be out of breath for a lot more than usual', there was a statistically significant difference as the metabolic syndrome group had 1.25 days while the normal group had 1.12 days($t=-2.901$, $p=0.004$). It shows that the subjects who have metabolic syndrome, participate more in intense physical activity. However, there was no significant difference between participating in moderate physical activity, 'Number of days during a week in which 30 minutes or more of moderate activity was implemented that caused one to be out of breath for a little

while than usual' and participating in light physical activity with 'Number of days during a week in which a total of 30 minutes or more was spent on walking, this includes 10 minutes or more on walking at one go' (t=-1.841, p=0.066, t=-0.506, p=0.613) (Table Ⅳ).

C. Risk factors of metabolic syndrome

The risk factors affecting metabolic syndrome are as follows: BMI, high risk individuals with diabetes, smoking period, and drinking frequency. The odds ratio of BMI and metabolic syndrome was 1.645(95% CI, 1.599-1.692), high risk individuals with diabetes and metabolic syndrome was 8.818(95% CI, 4.493-17.306), smoking period and metabolic syndrome was 1.037(95% CI, 1.010-1.064), and drinking frequency and metabolic syndrome was 1.151(95% CI, 1.074-1.233). The result showed significant association between metabolic syndrome and risk factors which influence diagnosis of metabolic syndrome, BMI, high risk individuals with diabetes, smoking period, and drinking frequency. However there was no significant influence on metabolic syndrome with factors including family history of diabetes, smoking frequency, alcohol consumption, and physical activity(Table Ⅴ).

D. Risk factors of high risk individuals with diabetes

The factors that have influence on diagnosis of high risk individuals with diabetes are as follows: BMI and family history of diabetes, smoking period, and presence of metabolic syndrome. The odds ratio of BMI and high risk individuals with diabetes was 1.021(95% CI, 1.008-1.035), family history of diabetes and high risk individuals with diabetes was 1.835(95% CI, 1.045-3.225), smoking period and high risk individuals with diabetes was 1.125(95% CI, 1.050-1.206), and presence of metabolic syndrome and high risk individuals with diabetes was 8.519(95% CI, 4.876-14.885). However, there was no significant influence on diagnosis of high risk individuals with diabetes with smoking frequency, alcohol consumption, drinking frequency, and physical activity (Table Ⅵ).

Table Ⅴ

Risk factors of metabolic syndrome

Variable	Wals	*p*	OR	CI
BMI	1,205.837***	<.001	1.645	1.599-1.692
High risk DM	40.040***	<.001	8.818	4.493-17.306
DM Family Hx.	.065	.798	.969	.763-1.231
Smoking				
Duration	7.297**	.007	1.037	1.010-1.064
Amount	.844	.358	1.009	.990-1.028
Drinking				
Amount	3.679	.055	1.016	1.000-1.032
Frequency	15.808***	<.001	1.151	1.074-1.233
Physical Activity				
Hard Activity	.096	.757	.991	.934-1.051
Moderate Activity	.551	.458	.978	.923-1.037
Light Activity	<.001	.985	1.000	.968-1.033

p<.*01*** p<.*001****

TABLE Ⅳ

Difference of lifestyle factors according to the presence of metabolic syndrome

Variable	separation	n(%) or M±SD		t or χ^2(*p*)
		Met	Normal	
BMI		28.62±3.94	23.42±5.89	17.209***(<.001)
DM Family Hx.	Yes	214(3.6)	332(5.7)	11.226***(.001)
	No	1,688(29.1)	3567(61.5)	
Smoking				
Smoking Hx.	No	114(29.1)	2812(52.0)	79.127***(<.001)
	Yes. But don't smoking now	72(18.4)	582(10.8)	
	Yes. smoking now	206(52.6)	2015(37.3)	
Smoking duration	Past	1.51±3.645	0.85±2.826	4.327***(<.001)
	Present(Total)	6.26±6.702	4.27±6.129	6.190***(<.001)
Smoking Amount	past	2.59±6.334	1.23±4.143	6.017***(<.001)
	Present(Total)	7.82±8.977	5.06±7.490	6.923***(<.001)
Drinking				
Drinking Amount	Amount per day	7.10±5.194	4.97±4.912	8.254***(<.001)
Drinking Frequency	0	491(8.5)	1478(25.5)	132.150*** (<.001)
	1	645(11.1)	1362(23.5)	
	2	449(7.7)	660(11.4)	
	More than 3	317(5.5)	399(7)	
Physical Activity	Hard	1.25±1.555	1.12±1.514	-2.901**(.004)
	Moderate	1.41±1.677	1.33±1.646	-1.841(.066)
	Light	2.97±2.409	2.93±2.409	-.506(.613)

- *p*<.01** *p*<.001***

TABLE Ⅲ

Difference of diagnostic criteria according to the presence of metabolic syndrome

Variable		M±SD		t(*p*)	n(%)		$\chi^2(p)$
		Met.S	Normal		Met.S	Normal	
Age		32.41±3.725	30.89±3.897				
BMI	Normal	27.282±6.050	2.062±5.040	32.524***(<.001)	412(7.1)	3.474(59.9)	2,629.112***(<.001)
	Abnormal				1490(25.7)	425(7.3)	
SBP	Normal	26.64±11.524	13.41±9.871	42.978***(<.001)	856(14.8)	3,614(62.3)	1.644.174***(<.001)
	Abnormal				1,046(18.0)	285(4.9)	
DBP	Normal	79.63±8.845	70.97±7.362	36.903***(<.001)	587(10.1)	3,834(66.1)	1,092.239***(<.001)
	Abnormal				1315(22.7)	65(1.1)	
FBS	Normal	97.93±23.577	8.02±11.650	17.319***(<.001)	702(12.1)	3,580(61.7)	727.430***(<.001)
	Abnormal				1200(20.7)	319(5.5)	
TG	Normal	89.71±166.869	97.47±72.421	23.071***(<.001)	890(15.3)	3,460(59.6)	1,199.304***(<.001)
	Abnormal				1,012(17.4)	439(7.6)	
WC	Normal(M)	88.62±8.836	75.36±7.679	55.934***(<.001)	893(22.2)	2270(56.4)	1,275.550***(<.001)
Abnormal(M)					830(20.5)	34(0.8)	
	Normal(F)				79(4.5)	1,559(87.9)	653.413***(<.001)
Abnormal(F)					100(5.6)	36(2.0)	
HDL-C	Normal(M)		60.01±14.449	22.869***(<.001)	212(5.3)	2.079(51.6)	6.566*(.012)
Abnormal(M)		51.66±12.307			1,511(37.5)	225(5.6)	
	Normal(F)				29(1.6)	1,421(80.1)	4.448*(.046)
Abnormal(F)					150(8.5)	174(9.8)	

IV. CONCLUSION

This study is a descriptive correlation study which was performed to analyze BMI, family history of diabetes and lifestyle factors by utilizing NCEP ATP-Ⅲ guideline to identify risk factors that influence metabolic syndrome through 5801 subjects who were aged in the 20's to 40's and were currently living in Seoul and had received a health examination proceeded by the NHIS in 2013. The results of the study are as follow:

1. Out of the test group, 69.4% were men and 30.6% were women, and the average age of subjects was 31.39. Out of the subjects 33% were in their 20's and 67% were in their 30's. The prevalence of metabolic syndrome was 32.8%, 29.7% for men and 3.1% for women.

2. Despite the statistically significant difference shown between the metabolic syndrome and normal group in BMI(t=17.209, p<.001), family history of diabetes(χ^2 =11.226, p<.001), smoking period(t=6.190, p<.001), smoking frequency(t=6.923, p<.001), alcohol consumption(t=8.254, p<.001), drinking frequency(χ^2 =132.150, p<.001), and intense physical activity(t=-2.901, p=.004), there seemed to be no significant difference in moderate and light physical activity.

3. Despite the statistically significant difference shown between the metabolic syndrome and normal group in BMI(t=17.209, p<.001), family history of diabetes(χ^2 =11.226, p<.001), smoking period(t=6.190, p<.001), smoking frequency(t=6.923, p<.001), alcohol consumption(t=8.254, p<.001), drinking frequency(χ^2 =132.150, p<.001), and intense physical activity(t=-2.901, p=.004), there seemed to be no significant difference in moderate and light physical activity.

4. Lifestyle factors that affect metabolic syndrome increases the risk of diagnosis by 1.645 times when BMI is high(95% CI, 1.599-1.692), 8.818 times for individuals with high risk of diabetes(95% CI, 4.493-17.306), 1.151 times when drinking frequency increases(95% CI, 1.074-1.233), and 1.037 times when smoking period expands(95% CI, 1.010-1.064). However, family history of diabetes, smoking frequency and degree of physical activity were found to have no significant influence.

5. The factors that affect high risk individuals with diabetes increased by 1.021 times when BMI is high(95% CI, 1.008-1.035), 1.835 times when there is a family history of diabetes(95% CI, 1.045-3.225), 1.125 times when smoking period is extended(95% CI, 1.050-1.206), and 8.519 times in the presence of metabolic syndrome(95% CI,

4.876-14.885).

TABLE VI

Risk factors of high risk individuals with diabetes

Variable	Wals	*p*	OR	CI
BMI	9.396**	.002	1.021	1.008-1.035
Metabolic syndrome	40.040***	<.001	8.818	4.493-17.306
DM Family Hx.	.065	.798	.969	.763-1.231
Smoking				
Duration	11.123**	.001	1.125	1.050-1.206
Amount	1.163	.281	1.025	.980-1.073
Drinking				
Amount	2.626	.105	.956	.905-1.009
Frequency	.043	.837	1.040	.792-1.207
Physical Activity				
Hard Activity	.222	.637	1.040	.884-1.222
Moderate Activity	2.784	.095	1.142	.977-1.335
Light Activity	11.123**	.001	1.125	1.050-1.206

p<.01** *p*<.001***

V. Discussion

The prevalence of metabolic syndrome in early adulthood has shown an escalation to 32.8% compared to a 23.2% prevalence rate in 2012 [2]. The prevalence of this study is higher than the 20.3% metabolic syndrome which is Ervin [15] reported in the USA as well as the 9.8% prevalence reported in Nepal [16], and the 8% prevalence in Kenya [17]. Furthermore, men had a higher prevalence rate than women, 29.7% and 3.1% respectively. This occurrence of men showing a higher prevalence rate are in accordance with the studies done by Gustafsson et al. [18], and Park & Lee [19]. We can presume people in their early adulthood to have a higher risk of metabolic syndrome as they live sedentary lives due to their work. According to a study done by Kim & Oh [20], lifestyle is the main reason for corporate workers as it causes problems in eating habits due to factors such as sedentary life and company dinner culture – which is common in South Korea. Employees are typically forced by their superiors to drink alcohol against their will at company dinners after work. Women on the other hand, are taking better care of themselves as they are interested in managing their weight in order to maintain their appearance in the workplace. Therefore we can see the relevance of this study that men have a larger abnormal group in the criteria of waist circumference. A study proceeded by Arimura et al. [21] emphasized the importance of waist circumference, and revealed the significant correlation existing between metabolic syndrome and waist circumference. Magnavita & Fileni [22] and Almadi et al. [23] also reported that work related stress and metabolic syndrome have a significant relationship. Thus a lifestyle and workplace stress management program for metabolic syndrome is needed within the workplace to actively intervene metabolic syndrome in early adulthood. In addition, the difference in triglyceride levels depending on the presence of metabolic syndrome was in accordance with Phillips et al.'s result [24]. Therefore factors such as eating habits need to be controlled in order to maintain low levels of triglyceride.

Due to the significant difference in BMI, family history of diabetes, smoking frequency and period, alcohol consumption and drinking frequency depending on the presence of metabolic syndrome, we were able to see relationship that exists between differences in lifestyle factors and metabolic syndrome. It was also seen that the level of physical activity had no significant influence on metabolic syndrome in accordance to Im et al. [25] and Yoo et al. [26] but the insignificance of the data could be attributed to the fact that it was limited to the question: 'number of days in which the activity has been carried out recently within a week'. Therefore, a study should be performed after specific criteria related to exercise and physical activity has been established in order to collect significant data relevant to those areas.

BMI and smoking periods were the ones that appeared as the common risk factors for metabolic syndrome and high risk individuals with diabetes. The result of studies done by Kim et al. [27] and Chun et al. [28] were a match with metabolic syndrome being influenced by smoking and drinking. Smoking and drinking affects the body in many ways and thus a cohort study into the changes in complications that follow metabolic syndrome when smoking and drinking were to be continued. Moreover, emphasis on education and practice on quitting smoking and drinking in early adulthood are essential, and especially those who have been classified as having metabolic syndrome need active intervention. Additionally BMI affects both metabolic syndrome and individuals with a high risk of diabetes [29]. Crawford et al. [30] and Jahangiri Noudeh et al. [31] found that BMI does have effect on diabetes and individuals with high risk of diabetes. Therefore both the recognition of managing one's weight and development of weight managing programs are needed. Furthermore, social support is needed in order to maintain one's weight at an optimal level.

A proposal was made based on the results of this study and the discussions are as follow:

1. Due to the high prevalence of metabolic syndrome in early adulthood, early detection and management of individuals with high risk of metabolic syndrome are needed by enhancing the health examination rate. 2. Environmental support such as running counseling program for eating habits to maintain proper weight and support for fitness facility is needed within the workplace as BMI is the influential factor of metabolic syndrome and individuals with a high risk of diabetes. 3. Smoking periods and drinking frequencies are found to be the influential factors from this study. Therefore development of programs for intervention education regarding smoking and drinking are needed for people in their early adulthood. 4. Additional studies for the relationship between drinking and smoking with metabolic syndrome can be suggested due to smoking frequency and alcohol consumption having had no effect on metabolic syndrome while both smoking period and drinking frequency did. 5. Furthermore, another study should be implemented on the relationship between degree of exercise and amount of exercise with metabolic syndrome as this study displayed no significance in such

relationship between exercise with metabolic syndrome and high risk individuals with diabetes while existing studies have reported a decrease in risk of getting metabolic syndrome and diabetes.

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First Seo, Yoo Jin was born in Seoul, Korea, in 1987. She received B.S. degree in Nursing from Ewha Womans University, Seoul, Korea, in 2010. She also received M.S. degree in nursing from Ewah Womans University, Seoul, Korea, in 2014.

From 2010 to 2013, she worked as a registered nurse in the Pediatric Intensive Care Unit at Asan Medical Center in Seoul, Korea. Since 2013, she has been work for the National Health Insurance Service(NHIS).

Second Byun, Young Soon, a Professor at Ewha Womans University, College of Health Sciences, Division of Nursing Science, is involved in education and research related to basic nursing science. She received her PhD from Yonsei University and her scholarship focuses on metabolic syndrome, osteoporosis, and symptom management. She

has served as a president of Korean Academy of Fundamental Nursing as well as Korean Society of Biological Nursing Science. She was also a board of director for Korean Society of Nursing Science, Korean Nurses Association and Korean Accreditation Board of Nursing Education and now serving as an editorial board member for International Journal of Nursing Science (IJNS).

Dr. Byun has published almost 80 articles in academic journals and published the textbook of Fundamental Nursing, Human Anatomy & Physiology, Pathophysiology, Health Assessment, Clinical Nutrition & Nursing, and Clinical Pharmacology.