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Diet and Lifestyle Factors Affecting Obesity: A Korea National Health and Nutrition Survey Analysis

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Abstract

This study investigated potential causes of obesity by examining diet and lifestyle factors. The data from the 2008 Korea National Health and Nutrition Survey were statistically analyzed to determine the relative importance of causes of obesity. Because the factors affecting obesity for males and females were significantly different, binary choice logistic models of the male and female subjects were built and estimated separately. Our results show that stress, the irregularity of eating breakfast, and frequency of eating out had the three greatest impacts on male obesity, respectively, and stress, employment status, and age had the greatest impacts on female obesity, in that order.

Key words: obesity, diet, lifestyle, Korea National Health and Nutrition Survey, logistic model

INTRODUCTION

Obesity is a common metabolic disease worldwide and South Korea has reported that its occurrence rate has sharply increased. The analysis of 2008 health examination data revealed that out of the 9.88 million people participating in the examination, 3.24 million were found to be obese, with a body mass index (BMI) of 25.0 or higher. In other words, one out of three in the Korean population is classified as obese (1), which is a serious situation for the nation. According to the 2008 Korea National Health and Nutrition Survey, prevalence rates of obesity were 26.5% and 35.6% in females and males, respectively (2). OECD (Organization for Economic Co-operation and Development) reported that although the population rate with a BMI of over 30 is relatively low in Korea, it is a country in which the number of people with a BMI of over 25 is expected to increase at the fastest rate. While obesity is already an issue of great concern in Korea, it is expected to become an even greater problem in the future (3).

Obesity provokes negative effects on self-esteem (4), relationships (5), and salary (6), and seriously affects health as a cause of hypertension, diabetes, heart disease, and specific cancers at the individual level. In addition, since obesity-related diseases are covered by public health insurance, the resulting medical costs become a large social burden (7); therefore, Korea must also deal with obesity at the social level.

Because the issue of obesity has drawn so much attention in various academic disciplines, it is not possible to discuss each report individually. Studies on correlations between obesity and diseases and studies related to obesity and dietary intake have been performed by the medical sector and the nutritional science sector, respectively, and even social scientists have been interested in obesity. The psychological sector has examined psychological effects and behaviors following obesity, and economists have conducted studies on causes of obesity and estimations of the social burden of obesity, among other related topics.

In particular, most research on lifestyle and obesity in Korea involves collecting data through questionnaire surveys with a specific small group and analyzing causes of obesity. For example, there are studies on lifestyle and recognition of obesity in male office workers (8), on factors of obesity according to the lifestyle of adult women (9), and on recognition of weight control, lifestyle, and dietary habits according to obesity index in female college students (10). These studies had advantages of determining causes of obesity in specific groups and establishing measures to cope with the disease, but physical characteristics such as height and body weight were analyzed using response data rather than by actual measurement, provoking issues about accuracy. Moreover, data gathered on dietary habits and lifestyle were not inclusive in terms of the number of samples or range of life style-related data compared to data obtained from the Korea National Health and Nutrition Survey.

Although obesity is caused by an imbalance of calo-

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ries, with excessive calorie intake compared to calorie expended, dietary habits and other lifestyle factors make it more complex, so studies on patterns and causes of this imbalance are still insufficient. Actually, much data on causes of obesity at experimental or clinical stages have been reported, but statistical testing is necessary to use the results as basic data to establish policies to eradicate obesity.

The purpose of this study was to test the obesity effects of diet, lifestyle, and personal characteristics and to determine the relative impacts of those variables on obesity. The data was taken from the Korea National Health and Nutrition Survey, the most comprehensive collection of data on health, diet, and lifestyle factors of the Korean population.

SUBJECTS AND METHODS

Data used in this study are from the 2008 Korea National Health and Nutrition Survey, in which 7,178 subjects over the age of nineteen provided 9,744 items of raw data that included demographic characteristics and diet and lifestyle factors, as well as obesity-related data. The questionnaire consisted of 3 sections that were used by this study: i) demographic profile of respondents, ii) diet factors affecting obesity, and iii) lifestyle factors affecting obesity.

All statistical analyses were conducted with SPSS WIN 17.0. ANOVA and cross-tabulation analyses were performed with the demographic characteristics as well as diet and lifestyle factors that can affect obesity, and obesity variables and the influence on obesity were estimated with odds ratios (OR) by using the binary choice logistic regression model.

The subjects consisted of 41.7% males and 58.3% females, and subjects in their 20s, 30s, 40s, 50s, 60s, and 70s accounted for 13.2%, 20.8%, 19.5%, 16.7%, 15.9%, and 13.9%, respectively. When income level was divided into four groups, 24.7%, 24.8%, 25.3%, and 25.2% were in the lowest, the lower, higher, and highest income groups, respectively. For marital status, 71.1% were married but 15.2% did not have spouses due to divorce or some other reason and 13.7% were never married. In addition, unemployed and employed subjects accounted for 59.0% and 41.0%, respectively.

RESULTS AND DISCUSSION

Demographic characteristics of subjects

The obese males with BMIs of over 25 consisted of 34.3% of the total male subjects, whereas the rate of obese females was relatively lower at 29.4%. The obesity of the males was more severe than that of the females. The lowest recorded rate of obesity was 20.8% for subjects in their 20s, and the highest level was 38.9% for those in their 60s. The rate of obese subjects increased gradually up to the 60s age group, and then declined largely in the 70s age group to 29.9%. Since the rates of obese subjects with and without spouses were 33.4% and 35.6%, respectively, the rate of obesity was found to be relatively lower in married subjects. For employment status, the rates of obesity were 32.0% and 30.4% among employed and unemployed subjects, respectively. The general characteristics of the subject are shown in Table 1.

Diet factors affecting obesity

Energy intake surpassing energy consumption is the cause of obesity, and this imbalance of calories is known to be augmented by an irregular diet, excessive calorie intake, eating out frequently, frequent snacking, and skipping breakfast. Therefore, correlations between these diet patterns and obesity were examined through statistical analysis (Table 2).

Total calorie intake: A continuous calorie intake that exceeds energy expenditure through daily activity and exercise can cause obesity, so total calorie intake can be one of the most important factors of obesity. Therefore, total calorie intake is easily expected to be related to one's degree of obesity such as underweight with a BMI of 'less than 18.5', normal with a BMI of '18.5 to 25', obese with a BMI of '25 to 30', or highly obese with a BMI of 'over 30'. Although analysis on this correlation requires data collected over a long period, the Korea National Health and Nutrition Survey examined foods consumed the day before the survey by depending on the memory of subjects. Thus, the Korea National Health and Nutrition Survey has a limitation in that it examined calorie intake only for one day, but with the assumption that this 'calorie intake for a day' could represent the general calorie intake patterns of the subjects, ANOVA was conducted by dividing the subjects into males and females.

The underweight, normal, obese, and highly obese male groups as classified by BMI consumed 1,892 kcal, 2,089 kcal, 2,182 kcal, and 2,358 kcal of energy per day on average, respectively. The null hypothesis that these averages would be the same was rejected with a significance level of 0.000. Scheffe's post-hoc tests revealed that this result was mainly caused by differences in average calorie intake between the obese and underweight groups and between the normal and highly obese groups. Actually, the differences in average calorie intake between the underweight and normal weight groups

Table 1. The general characteristics of the subjects according to BMI

Variables		BMI<18.5	18.5≤BMI<25	25≤BMI<30	BMI≥30	Total	X^2 value
Gender (N=6774)	Male	112 (4.0%)	1746 (61.8%)	874 (30.9%)	95 (3.4%)	2827 (41.7%)	28.755**
	Female	217 (5.5%)	2572 (65.2%)	1009 (25.6%)	149 (3.8%)	3947 (58.3%)	28.755**
Age (years) (N=6774)	20～29	95 (10.7%)	611 (68.6%)	146 (16.4%)	39 (4.4%)	891 (13.2%)	232.159**
	30～39	86 (6.1%)	942 (66.9%)	324 (23.0%)	57 (4.0%)	1409 (20.8%)	232.159**
	40～49	39 (3.0%)	852 (64.5%)	385 (29.1%)	45 (3.4%)	1321 (19.5%)	232.159**
	50～59	15 (1.3%)	689 (60.8%)	386 (34.1%)	43 (3.8%)	1133 (16.7%)	232.159**
	60～69	31 (2.9%)	626 (58.2%)	382 (35.5%)	37 (3.4%)	1076 (15.9%)	232.159**
	≥70	63 (6.7%)	598 (63.3%)	260 (27.5%)	23 (2.4%)	944 (13.9%)	232.159**
Income level (N=6557)	Lowest	79 (4.9%)	1011 (62.4%)	467 (28.8%)	63 (3.9%)	1620 (24.7%)	11.292
	Lower	80 (4.9%)	1013 (62.3%)	459 (28.2%)	74 (4.6%)	1626 (24.8%)	11.292
	Higher	73 (4.4%)	1084 (65.4%)	452 (27.3%)	49 (3.0%)	1658 (25.3%)	11.292
	Highest	84 (5.1%)	1070 (64.7%)	447 (27.0%)	52 (3.1%)	1653 (25.2%)	11.292
Marital status (N=6746)	Married to spouse	206 (4.3%)	3035 (63.3%)	1390 (29.0%)	163 (3.4%)	4794 (71.1%)	82.768**
	Married but separated	42 (4.1%)	618 (60.3%)	326 (31.8%)	39 (3.8%)	1025 (15.2%)	82.768**
	Never married	78 (8.4%)	648 (69.9%)	161 (17.4%)	40 (4.3%)	927 (13.7%)	82.768**
Employment (N=6731)	Employed	181 (4.6%)	2518 (63.4%)	1142 (28.7%)	133 (3.3%)	3974 (59.0%)	7.448*
	Unemployed	148 (5.4%)	1771 (64.2%)	728 (26.4%)	110 (4.0%)	2757 (41.0)	7.448*

*p<0.1, **p<0.05.

Table 2. The results of statistical tests on dietary patterns

	Variables	Male		F-stat (p-value)	Female		F-stat (p-value)
		Mean	SE		Mean	SE	
Level of obesity[1)]	Underweight	1,892	803	F(3,2269) =6.29 (0.000)	1,560	644	F(3,3610)=5.23 (0.001)
	Normal	2,089	823		1,584	609	
	Obese	2,182	840		1,500	602	
	Highly obese	2,358	1,121		1,464	541	
Frequency of food consumption away home[2)]	Rarely	22.95	2.98	F(4,2270) =12.00 (0.000)	23.98	3.59	F(4,3608)=18.70 (0.000)
	1～3 times per month	23.69	3.01		23.60	3.28	
	1～6 times per week	24.12	3.12		23.08	3.28	
	Once a day	24.32	3.20		22.57	3.22	
	At least twice a day	24.09	2.95		22.00	3.06	
Frequency of snacks[2)]	Rarely	23.81	3.29	F(4,2266) =0.58 (0.675)	23.54	3.67	F(4,3606)=5.83 (0.000)
	Once every other day	24.03	2.99		23.99	3.58	
	Once a day	23.96	2.98		23.38	3.27	
	Twice a day	23.73	3.16		23.02	3.21	
	At least 3 times a day	23.88	3.14		23.09	3.24	
Skipping breakfast[2)]	Skipped all breakfasts	24.27	3.63	t[3)](2,256) =2.362 (0.021)	23.04	3.59	t (2.632)=5.58 (0.018)
	Had breakfast at least once	23.82	3.01		23.43	3.33	

[1)]Calorie intake (kcal). [2)]BMI. [3)]t-value.

and between the obese and highly obese groups were not statistically significant.

The average calorie intakes of the four female groups according to the degree of obesity were 1,560 kcal, 1,584 kcal, 1,500 kcal, and 1,464 kcal, respectively, and the females with a higher degree of obesity consumed fewer calories on average. The null hypothesis that these averages would be the same was rejected with a significance level of 0.001. Post-hoc tests showed that this finding was caused by differences in average calorie intake between the normal and obese groups. In addition, when ANOVA was conducted on average calorie intake according to degree of obesity based on BMI by dividing the ages of the female subjects into groups from the 20s to 70s, there were no significant differences in calorie intake according to the degree of obesity within the five age groups, except for those in their 70s, with a significance level of 0.05. Therefore, differences in average calorie intake by females according to degree of obesity were thought to follow differences in age.

While males had a relatively considerable difference in calorie intake according to obesity, females did not show any significant difference. This means that the calorie intake data obtained from the Korea National Health and Nutrition Survey are not sufficient to represent daily calorie intake patterns in females.

Eating out: Although eating out has been noted as a main cause of obesity by inducing overeating, a previous study insisted that simple eating out replacing regular meal did not provoke obesity (10,11). In addition, a study by Suh et al. (12) in Korea also reported that eating out was not related to obesity. Not considering gender, the total subjects were classified by frequency of eating out into groups of 'rarely', 'one to three times per month', 'one to six times per week', 'once a day', and 'at least twice per day', and ANOVA was performed. According to the analysis, the average BMIs of the groups divided by the frequency of eating out were 23.67, 23.63, 23.49, 23.60, and 23.44, respectively, and there were no significant differences in the averages; thus, this study seems to support the findings of Suh et al. (12). However, when the subjects were divided by gender and then ANOVA was conducted by classifying them according to frequency of eating out, the average BMIs of the males increased with more frequent eating out, presenting values of 22.95, 23.69, 24.12, 24.32 and 24.09, in order of frequency of eating out. Since the null hypothesis which stated that the averages would be the same was rejected with a significance level of 0.000, average BMI was found to be different in the male subjects according to frequency of eating out. For the females, average BMI decreased with more frequent eating out, presenting indices of 23.98, 23.60, 23.08, 22.57, and 22.00 in order of eating out frequency. The differences were also statistically significant.

Cross-tabulation analysis revealed between frequency of eating out and obesity according to BMI including both males and females did not show any correlation between them with x^2 (12) = 11.279 and an asymptotical p-value of 0.505. However, gender difference analyses showed high correlations between frequency of eating-out and obesity according to BMI for both the males and females with x^2 (12) = 53.813 and x^2 (12) = 69.383, respectively, and p-values of 0.000. Therefore, when gender was taken into account, the frequency of eating out and the degree of obesity were highly correlated. More frequent eating out led to higher BMI in the males, which was not found in the female subjects. The reason the BMIs of the females who ate out more frequently were not as high is because these women were likely to have jobs, and employed females paid relatively more attention to their body weight and appearance.

Snack: Snacking is another main calorie source besides of regular meals. The Korea National Health and Nutrition Survey investigated the frequency of snacking by dividing it into groups of 'rarely', 'once every other day', 'once a day', 'twice a day', and 'at least three times per day'. ANOVA was conducted on average BMI according to frequency of snack intake by considering the gender. The average BMIs of the males who ate snacks 'at least three times a day' was higher than that of those who rarely ate snacks with values of 23.88 and 23.81, respectively, but the difference was statistically insignificant. However, for the females, average BMIs by frequency of snacking were 23.54, 23.99, 23.38, 23.02, and 23.09, respectively, and the average BMI of the group who consumed snacks more frequently was observed to be lower. The difference was found to be significant with a p-value of 0.000. Similar to the eating out variable, when the gender of the subjects was considered, the males and females showed different results according to ANOVA.

From cross-tabulation analysis on the frequency of snacking and the degree of obesity based on BMIs by gender, the males showed no correlation between the two items but the females had a significant correlation with x^2 (12) = 26.772 and a significance level of 0.008.

Skipping breakfast: The following question on the irregularity of breakfast was given in the Korea National Health and Nutrition Survey with the question: "Did you have breakfast for the last two days?" The average BMI of the total subjects responding to the question was

23.57. The average BMIs of the subjects answering 'I had it at least once' or 'I skipped breakfast for two days' were 23.58 and 23.50, respectively, but the difference was not statistically significant. However, when the responses were analyzed through ANOVA by dividing the subjects according to gender, differences in average BMI in the males and females were both significant. The males who answered they 'skipped breakfast for two days' recorded higher BMIs and this finding supports the view that persons eating meals irregularly tend to be obese. The average BMIs of the females who answered 'skipped breakfast for two days' were significantly lower than the BMIs of those who answered 'ate at least one breakfast', recording 23.04 and 23.43, respectively. These results were considered to be due to the males consuming additional energy through other meals or snacks when they did not eat breakfast. However, in the females, skipping breakfast was used as an active weight control measure or to lose weight. Moreover, after classifying the subjects by gender, cross-tabulation analysis between skipping breakfast and degree of obesity based on BMI was conducted and a correlation was found between the two factors in both the males and females with significance level of 0.002 and 0.066, respectively.

Lifestyle factors affecting obesity

Alcohol consumption: Obesity is known to be influenced by lifestyle factors such as alcohol consumption, smoking, exercise, and stress, as well as dietary factors (13). In particular, for males who consume alcohol frequently due to gatherings at work or for other reasons, alcohol-drinking is known to be a main cause of obesity; thus the correlations between the frequency of alcohol consumption and obesity were analyzed. Out of 2,812 males responding to the frequency of alcohol-drinking, only 5.6% were non-drinkers and 94.4% were drinkers. The frequency of alcohol-drinking was classified into groups of 'almost never', 'less than once a month', '2～4 times a month', '2～3 times a week', and '4 or more than 4 times a week'. By dividing the subjects according to various frequency criteria (ex. into 'almost never' and 'alcohol-drinking' groups, into 'almost never', 'less than once a month' and 'once or more than once a month' groups and into '4 or more than 4 times a month' and 'never or less than 4 times a month', etc.), ANOVA and *t*-tests were conducted on average BMIs. ANOVA on the average BMIs of the five groups by frequency of alcohol-drinking showed that average BMIs were significantly different according to frequency with a significance level of 0.001. However, post-hoc tests showed that the difference in average BMI was significant only between the 'almost never' and '2～3 times a week' groups with a significance probability of 0.02, and there was no significant difference among the other groups. Moreover, cross-tabulation analysis found no significant correlation between the frequency of alcohol-drinking and obesity by BMI in the males with a significance level of 0.05. This result shows that the effect of alcohol consumption on obesity was greatly exaggerated in the males. In particular, considering the possibility of under-reporting the frequency of drinking, the effects of alcohol-drinking on obesity may be further limited.

Smoking: There is a popular belief that 'smoking is effective in controlling body weight' or 'stopping smoking raises body weight' among females (14). To investigate the correlation between smoking and the degree of obesity, data on body weight before and after stopping smoking in persons who had currently ceased smoking were necessary, but the Korea National Health and Nutrition Survey did not include the appropriate data on smoking and therefore data on the current status of smoking and BMI were analyzed.

By dividing the male and female subjects into 'smoking', 'had smoked but quit', and 'never smoked' groups, the correlations between smoking and degree of obesity by BMI were investigated. Cross-tabulation analyses did not show any correlations between smoking and obesity in the males but found a significant correlation in the females, with an asymptotical significance probability of 0.000 (Table 3). When ANOVA was conducted on the average BMIs of males and females according to smoking status, the 'had smoked but quit' groups recorded the highest BMI levels of 24.02 and 23.70, respectively, and the 'smoking' groups showed the lowest BMIs of 23.80 and 22.67, respectively. Although there was no statistical significance in the average BMIs of the males according to smoking status, the average BMIs of the females were different according to smoking status with a significance probability of 0.001. Therefore, ANOVA on the average BMI of the females who smoked confirmed the popular belief regarding the influence of smoking on female weight.

Exercise: Walking is recommended most frequently as the aerobic exercise for weight control. When average BMIs were measured by dividing the male subjects into 'almost never', 'once a week', 'twice a week', 'three times a week', 'four times a week', 'five times a week', 'six times a week', and 'everyday' groups according to the frequency of walking, the average BMIs of each group were 24.04, 24.14, 24.64, 24.05, 24.25, 24.02, 24.09, and 23.62, respectively, and the null hypothesis that they would be the same was rejected with a sig-

Table 3. The results of statistical tests on lifestyle

Variables		BMI					
		Male		F-stat (p-value)	Female		F-stat (p-value)
		Mean	SE		Mean	SE	
Frequency of drinking	Almost never	23.69	3.21	F(4,2803) =4.88 (0.001)	23.66	3.36	F(4,3926) =4.58 (0.001)
	Less than once a month	23.81	3.12		23.26	3.40	
	2～4 times a month	23.93	2.97		23.14	3.51	
	2～3 times a week	24.31	3.02		23.16	3.33	
	More than 4 times a week	23.60	3.29		22.97	3.57	
Smoking status	Smoking	23.80	3.23	F(2,2808) =1.80 (0.165)	22.67	3.86	F(2,3926) =6.92 (0.001)
	Had smoked but quit	24.02	2.91		23.70	3.93	
	Never smoked	24.02	3.18		23.42	3.33	
Frequency of walking	Almost never	24.04	2.96	F(7,2802) =4.31 (0.000)	23.51	3.62	F(7,3923) =3.25 (0.002)
	Once a week	24.14	2.94		22.94	3.37	
	Twice a week	24.64	2.97		23.43	3.36	
	3 times a week	24.05	3.13		23.68	3.48	
	4 times a week	24.25	3.31		23.10	3.28	
	5 times a week	24.02	3.11		23.00	3.39	
	6 times a week	24.09	3.44		22.76	3.14	
	Everyday	23.62	3.09		23.53	3.38	
Level of stress	Very high level of stress	24.51	3.42	F(3,2808) =2.64 (0.048)	23.74	3.79	F(3,3926) =6.78 (0.000)
	High level of stress	24.07	3.14		23.41	3.63	
	Moderate level of stress	23.83	3.06		23.20	3.22	
	Little stress	23.85	3.11		23.84	3.47	

nificance probability of 0.000 by ANOVA. In particular, the group that walked 'for over 30 minutes per one time five times a week' and those that did not showed average BMIs of 23.72 and 24.13, respectively, and the difference was statistically significant with a significance level of 0.000. However, when the average BMIs of the groups conducting 'intense physical activity' for over 20 minutes per one time 'three times a week' and 'not doing it at all' were compared, the average BMI (24.12) of the intense exercise group was significantly higher than that of the other group (23.87); thus intense exercise tended to increase BMI by raising muscle mass. The average BMIs of the 'moderate physical activity' group, practicing moderate activity for over 30 minutes per one time for five or more days a week, and 'the other group' were not significantly different.

However, the average BMI of the female subjects increased according to the frequency of walking, from 22.94 in the 'once a week' group to 23.68 in the 'three times a week' group. BMI was lowered from 23.10 in the 'four times a week' group to 23.00 in the 'five times a week' group and to 22.76 in the 'six times a week' group, and then increased again to 23.53 in the 'everyday' group. The null hypothesis that BMI averages would be the same according to the frequency of walking was rejected with a significance probability of 0.002. However, when average BMIs were compared by the frequency of walking in the females by dividing them into 'less than three times a week' and 'three or more than three times a week' groups and into 'less than four times a week' and 'four or more than four times a week' groups, no statistically significant differences were observed.

Stress: Psychological factors and stress have been noted as factors provoking obesity by stimulating appetite. When t-tests on average BMIs were conducted by dividing the subjects into groups undergoing relatively high stress and undergoing low stress by considering gender, the average BMIs of the high stress and lower stress groups were 24.15 and 23.84, respectively, and the difference was statistically significant with a significance level of 0.02. However, the average BMI of the female group undergoing high stress was higher than that of females undergoing less stress, presenting values of 23.50 and 23.34, respectively, but the difference was not statistically significant. While stress tended to increase BMI among the males, it did not among the females. Meanwhile, cross-tabulation analyses on the four degrees of obesity by BMI and stress revealed significant correlations in both the males and females with significance levels of 0.046 and 0.034, respectively.

Personal characteristics affecting obesity

Age: When ANOVA was performed on average BMIs by dividing the ages of subjects into groups from the 20s to 70s, the null hypothesis that average BMIs would not be different by age was rejected with a significance level of 0.000. For the males, average BMI increased continuously from the 20s and reached its highest level of 24.34 among subjects in their 50s, and then declined

to the lowest level of 22.82 among those in their 70s. According to Scheffe post-hoc tests on average BMI, the average BMIs of males in their 30s, 40s, and 50s were not significantly different, but there were statistically significant differences with other age groups. Meanwhile, the average BMIs of the females were clearly different by age group as compared to the males. The lowest average BMI for the females was 21.73 among subjects in their 20s; it grew continuously to the highest level of 24.60 among those in their 60s and was reduced to 23.68 among those in their 70s. According to post-hoc tests, the increases in average BMI with increasing age from the 20s to 50s was significant. However, the difference in average BMI was not significant between the 50s and 60s age groups and the average of the 70s age group was reduced to that of the 40s age group.

Marital status: A US study reported that married people had higher body weights than unmarried people (15). Marriage is considered to affect body weight since it triggers mental stability and offers the care of a spouse and regular dietary habits following cohabitation. To determine whether the hypothesis between marital status and body weight could be applied to Koreans, cross-tabulation analysis investigating the effect of marital status on body weight or degree of obesity was conducted and a significant correlation was found between them with a significance level of 0.05.

Probability of being obese according to dietary habits and lifestyle

This study found that dietary habits, lifestyle factors, and personal characteristics affected degree of obesity. However, this finding meant only a partial correlation of each factor with the degree of obesity and could not explain how other factors influenced the degree of obesity when one affected it. Therefore, we investigated how each factor influenced degree of obesity when various other factors were being presented. For this, a binary choice model or a logistic model assuming the log normal distribution was built and the effects of factors influencing obesity were analyzed. Here, the binary choice model is a model with a dependent variable of 0 or 1, and this study designated BMIs of over 25 and less than 25 as 1 and 0, respectively.

$$\text{logit}\ (P) = \ln P/(1-P) = X'B + \epsilon i \quad (1)$$

P is the rate of obesity, X is a vector of personal characteristics and diet and lifestyle factors of a subject, and B is an estimated parameter vector and ϵi is an error term.

Since the pattern with which personal characteristics and diet and lifestyle factors influenced the degree of obesity was considerably different between males and females, the obesity models of males and females were built and estimated separately. For explanatory variables, variables like dietary habits were redefined differently from those of the Korea National Health and Nutrition Survey by utilizing the results of the partial correlation analysis. For example, while the Korea National Health and Nutrition Survey divided the frequency of walking into eight groups from 'almost never' to 'everyday', the frequency of walking or an explanatory variable was classified into two groups of walking for less than five days and for five or more days, which provoked a significant difference in the average BMI. Although this redefinition could lose some information, it can avoid multicollinearity following the use of too many dummy variables (16).

$$\begin{aligned} OBSTY = {} & b0 + b1AGE + b2AGE{**}2 + b3INC\_low + \\ & b4UEMPL + b5MAR\_with + b6CAL + \\ & b7FCAFH\_1\text{-}6 + b8SKBF + b9SNCK + \\ & b10WLK\_5\text{-}7 + b11DRNK\_2\text{-}3 + b12SMK \\ & + b13STRSS \end{aligned} \quad (2)$$

The explanation of each variable is presented at Table 4.

Table 4. Definition of variables

Variables	1	0
OBSTY	If BMI is greater than or equal to 25	Otherwise
INC_low	If income level belongs to 25 percentile	Otherwise
UEMPL	If currently unemployed	Otherwise
MAR	If married to spouse	Otherwise
FCAFH_1-6	If frequency of food consumption away from home exceeds 1～6 times a week	Otherwise
SKBF	If skipped breakfast twice in a row	Otherwise
SNCK	If snacking more than once a day	Otherwise
DRNK_2-3	If drinking 2～3 times per week	Otherwise
SMK	If smoker	Otherwise
WLK_5-7	If walking 5 times or more per week	Otherwise
STRSS_higher	If stress level is very high	Otherwise
STRSS_high	If stress level is high or very high	Otherwise
AGE	Number of years living	
CAL	Total calorie intake	

Out of the explanatory variables, age was included in the first and second order term because ANOVA revealed that average BMI increased with age between years 20 and 60; however, it was reduced starting in the 60s and 70s for both males and females, respectively. Therefore, b1 was expected to be positive and b2 was expected to be negative. The correlation between income (INC) and obesity is known to have a different sign according to gender, such that the degree of obesity is reduced with higher income in male subjects and the degree of obesity is increased with higher income level in female subjects (17). The estimated parameter of employment (UNEMPL) is expected to be negative as females with jobs have a lower possibility of being obese compared to those without jobs. Caloric intake (CAL) was expected to be positively related to obesity, while food consumption away from home (FCAFH) and obesity have not shown any consistent correlation in previous studies. Although the frequencies of snacking (SNCK), alcohol-drinking (DRNK), and stress (STRSS) were also expected to have a positive correlation with obesity, the practice of walking (WLK) for over 5 times per week was expected to be negatively related to obesity.

The estimation results of equation 2 are presented in Table 5. First, in the estimation of the males, the null hypothesis, all parameters were 0, was rejected by Log Likelihood Ratio test with a significance level of 0.000. In addition, the rate that dependant variables were expected by using the estimated parameters was the same as for the actual variables, was reaching 66.2%. And adjusted R**2 was 0.06. Of the characteristics of the subjects, the estimation of age parameters showed that the first order and the second order were positive and negative, respectively, as expected. The males in the lowest of the four income groups had a higher possibility of being obese by 6% (odds ratio: OR) than those in relatively higher income groups with a significance probability of 0.062. Marital status and employment status, defined as being married and having no job, respectively, were expected to be positively related to obesity, but there were no statistically significant effects. The OR is defined as $OR_i = \frac{P_i^1 (1-P_i^1)}{P_i^0 (1-P_i^0)} = \exp(b_i)$, where P_i^1 and P_i^0 means probability of being obese and of not being obese due to a variable at i in the order, respectively and bi is an estimated parameter of a variable at i in the order.

Although among the diet-related variables of total calorie intake and frequency of snacking were found not to be related significantly with obesity, the frequency of eating out (FCAFH) and the frequency of skipping breakfast had significant correlations with the degree of obesity with significance levels of 0.025 and 0.059, respectively. Particularly in the males, the possibility of being obese with eating out 1～6 times a week was assumed to be higher by 29.9% as compared to other eating out frequency groups. Also, the possibility of males being obese with skipping breakfast was assumed to be higher by 31.6% than in males who ate breakfast. According to the estimation of male obesity with the logistic model, the statistical significance of lifestyle var-

Table 5. Logistic regression estimation results regarding obesity

Variables	Male			Female		
	Parameter	SE	OR	Parameter	SE	OR
AGE	0.109**	0.023	1.12	0.131**	0.019	1.14
AGE**2	-0.001**	0.000	1.00	-0.001**	0.000	1.00
INC_low	0.058*	0.112	1.06	-0.229**	0.089	0.82
UEMPL	0.105	0.131	1.11	0.150*	0.081	1.16
MAR_to	0.028*	0.144	1.03	0.059	0.099	1.06
CAL	0.062	0.057	1.06	-0.135*	0.072	0.82
FCAFH_1-6	0.262**	0.117	1.30	-0.116	0.086	0.89
SKBF	0.275*	0.146	1.32	0.199	0.129	1.22
SNCK	-0.062	0.097	0.94	-0.041	0.089	0.96
WLK_5-7	-0.184**	0.093	0.83	0.035	0.078	1.04
DRNK_2-3	0.167*	0.098	1.18	-0.208	0.148	0.81
SMK	-0.200**	0.099	0.82	-0.193	0.178	0.83
STRSS_higher	0.440**	0.203	1.55	–	–	–
STRSS_high	–	–	–	0.218**	0.086	1.24
Constant	-3.207**	0.562	0.04	-4.479**	0.473	0.01
-2Log Likelihood ratio	87.429 (p-value=0.000)			211.546 (p-value=0.000)		
R**2	0.06			0.09		
Correct predicted (%)	66.2			70.8		

*Significant at $p<0.1$, **Significant at $p<0.05$.

iables was assumed to be higher than that of personal characteristics or diet variables. Walking exercise and smoking showed negative correlations with obesity with a significance level of less than 0.05. Males who walked for over 30 minutes per one time 5 times per week had a lower possibility of being obese by 16.8% than males who walked less. Males who smoked were assumed to have a lower possibility of being obese by 18.2% than males who did not smoke. However, males who consumed alcohol 2～3 or more times per week and males undergoing the highest level of stress among four stress levels were assumed to have higher possibilities of being obese by 18.2% and 55.3% with significance levels of 0.087 and 0.030, respectively.

The results for logistic regression estimations of the female subjects also showed that based on the Log Likelihood Ratio, the null hypothesis was rejected with a significance level of 0.000. The accuracy for dependent variable with estimated parameters was 70.8%, and R**2 was 0.09. For female obesity, personal characteristics were found to have more statistical significance than dietary habits or lifestyle variables. In particular, age had a strong correlation with obesity in the females similar to the males, and income and employment variables were also related to obesity with relatively high significance. The females in the lowest income group had a lower possibility of being obese by 18.3% than those in relatively higher income groups with a significance probability of 0.011, and unemployed females had a higher possibility of being obese by 15.7% than employed females with a significance probability of 0.064. Different BMI response by gender to income class variable is well documented in the previous studies, such as Lakdawalla and Philipson (17) and our result also confirmed such results. The reason that lower income class females are thinner than the higher income class is related with the distribution of foods and calories among family members. It is because more foods and calories are distributed to male family member in the lowest income class families.

According to the estimation of the logistic model in the females, with the exception of total calorie intake, food consumption away from home, skipping breakfast, and snack intake had no statistical significance among the dietary variables. This finding differed from our expectations, however this result was not an error in the estimation but is a reflection of the characteristics of the data of the Korea National Health and Nutrition Survey. As shown in the results of ANOVA on average calorie intake and degree of obesity based on BMI, the subjects with a higher degree of obesity consumed fewer calories. Another possible reason for this observation is that the only activity variable in equation 2, WLK5-7, was not enough to control the whole calorie expenditure, which means females are obese not because of the excess calorie intake but because of the lack of activity. This possibility requires further research.

The only lifestyle variable that was related with obesity was stress in the females. The influences on obesity of walking as exercise, alcohol drinking, and smoking were statistically insignificant. The females undergoing high or very high levels of stress were assumed to have a higher possibility of being obese by 24.4% than those undergoing a moderate level or less stress with a significance probability of 0.011.

CONCLUSIONS

This study statistically analyzed relationships between obesity and various factors affecting obesity to investigate the effects of personal characteristics as well as diet and lifestyle factors on the degree of obesity using data from the 2008 Korea National Health and Nutrition Survey.

First, ANOVA and cross-tabulation analyses on the degree of obesity and each factor were conducted. Age and stress variables were found to be significantly related to the degree of obesity in both sexes. For the male calorie intake, the frequency of eating out and skipping breakfast had close correlations with obesity, but for the females, the effects of these two factors on obesity were limited. From these results, how much and in what way each dietary factor influenced obesity was different between the male and the female subjects.

When various factors expected to affect obesity were presented together, logistic regression models were established to analyze the effects of the variables on male and female obesity. According to the odd ratio results, the variable showing the largest influence on obesity in the males was stress, and the males with very high levels of stress had a higher possibility of being obese by 55.3% than males with lesser stress levels. Next, the males who skipped breakfast and ate out 1～6 times a week were assumed to have higher possibilities of being obese by 31.6% and 29.9%, respectively. Females with relatively high levels of stress recorded higher possibilities of being obese by 24.4% compared to other stress levels, followed by the effects of unemployment, as unemployed females were 15.7% more likely to be obese than employed.

To conclude, we feel our main contributions from this study are; (1) males and females have different obesity mechanisms, so they should be analyzed separately, (2) the obesity of males was affected largely by personal

characteristics and lifestyle factors and was also influenced by dietary factors: stress, skipping breakfast and frequency of eating out in order, and (3) the calorie intake data obtained from the Korea National Health and Nutrition Survey are not sufficient to represent daily calorie intake patterns of females, and further research is needed to investigate the relationship between calorie intake and daily activity level at work and home.

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