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The Relation of Body Mass Index to Dietary Intake and Blood Lipid Levels in Korean Adults

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ABSTRACT

This study was designed to investigate the relationship between body mass index (BMI) and dietary intake, and the relationship between BMI and plasma lipid levels in Korean adults. This study was conducted from January 1 to December 31 of 1997. It consisted of 3781 subjects (men : 2402, women : 1379) with the majority between the ages of 40 and 59. The dietary assessment was based upon a twenty-four-hour food record. Subjects were classified into one of four reference BMI groups : underweight ($\leq$20 kg/m^2), normal (20.1 - 25.0 kg/m^2), overweight (25.1 - 30.0 kg/m^2), and obese ($>$30 kg/m^2). The biochemical assessment included measurements of plasma total cholesterol (TC), HDL-cholesterol (HDL-C), LDL-cholesterol (LDL-C), triglyceride (TG), lipoprotein (a), and plasminogen activator inhibitor-1 (PAI-1). The BMI study showed that 60.5% of the men measured were normal and 32.6% of the men were overweight and/or obese subjects. Sixty-four percent of the women were normal and 20.3% of the women measured were overweight and/or obese subjects. With respect to the daily energy intake of the men and women subjects, the levels of daily energy intake appeared to increase as values of BMI increased. Men of the overweight group had significantly higher protein, fat and cholesterol intake than those of the normal or the underweight groups. The alcohol intake of the men in the overweight group was also significantly higher than that of the men in the underweight group. With respect to percent energy intake of macronutrients, there was no significant difference between the four BMI groups and percent energy intake for all the subjects in the study. The ratio of percent energy intake of carbohydrates : protein : fat : alcohol of the normal women group was 62 : 17 : 20 : 1, respectively. Women apparently had a higher intake of carbohydrates than men (52 : 17 : 19 : 10). With respect to the levels of plasma TC, LDL-C, TG, and HDL-C, the levels of plasma TC, LDL-C and TC appeared to increase as the values of BMI increased, while the level of HDL-C appeared to decrease as values of BMI increased. Levels of lipoprotein (a) appeared to be inversely related to the values of BMI, and levels of PAI-1 appeared to increase as values of BMI increased. The results of this study demonstrate that there is a relationship between dietary intake and BMI, and that there is a relationship between BMI and blood lipids levels.

KEY WORDS : blood lipids · body mass index (BMI) · dietary intake · obesity.

INTRODUCTION

The nutritional status in Korea has improved as a result of the country's economic growth. Although nutritional status has improved, other health problems have appeared. For example, the occurrence of obesity has increased very rapidly. In 1995, the Korean national nutrition survey[1] reported that 20.5% of people who were over 20 years old had a BMI of $>$25 kg/m^2. The Korean national nutrition surveys of 1991 and 1992 reported that 17.1%[2] and 19.6%[3] of the people in those surveys, respectively, had BMI levels of $>$25 kg/m^2. Obesity appears to be increasing in the young population in Korea. The problem seems to be caused by the increasing intake of western food. A growing number of people are being classified as overweight or obese. Being overweight is a condition where body weight is above a standard defined amount in relation to height. Obesity is a condition where there is an abnormally high percentage of body fat. Both the extent of being overweight and fat distribution may be useful predictors of health risks associated with obesity.[4][5] Numerous studies have shown that cardiovascular diseases, diabetes, and hypertension are related to obesity and increase the death rate.[6][7] Ahn *et al.* demonstrated that an overweight or obese condition increases the serum TC, LDL-C and TG levels and that an overweight or obese condition is inversely related to HDL-C levels.[8]

A number of studies have shown that the composition of diet might influence energy metabolism in humans.[9-13] Some animal studies have shown that a high-fat diet induced obesity.[14][15] The purpose of this study was to investigate the relationship between BMI and dietary intake , and the relationship between BMI and blood lipids, lipoprotein (a), and PAI-1 levels in Korean men and women.

SUBJECTS AND METHODS

1. Subjects

This study was composed of 3781 subjects (men : 2402,

women : 1379) with the majority between the ages of 40 and 59. The men and women in the study were selected from healthy subjects who had a physical examination at the Health Promotion Center of the Samsung Medical Center during the period from January 1 to December 31 of 1997.

2. Anthropometric measurement

Height and weight were measured conventionally, percent body fat was measured with bioelectric impedance analyzer (TBF-202 TANITA) in both men and women. and BMI was calcurated based upon these parameters. Subjects were classified into one of four BMI reference groups, underweight, normal, overweight and obese. BMI value ≤ 20 kg/m^2 was regarded as indicative of an underweight condition, 20.1~25.0 kg/m^2 was regarded as a normal condition, 25.1~30.0 kg/m^2 was regarded as an overweight condition, and >30 kg/m^2 was regarded as an obese condition.[16] Data and relevant variables were then analyzed by BMI group.

3. Dietary assessment

Dietary assessment was done by twenty-four-hour food records. The dietary intake, nutrients and percent energy intake were analyzed by computer data analysis program. The computer data analysis system consisted of food composition data including cholesterol content.[17]

4. Laboratory measurements

Measurements included biochemical analysis of plasma total cholesterol (TC), HDL-cholesterol (HDL-C), LDL-cholesterol (LDL-C), triglyceride (TG), lipoprotein (a), plasminogen activator inhibitor-1 (PAI-1). TC, TG, and HDL-C were analyzed by automatic chemical analyzer (Hitachi-747). LDL-C was calculated by the Friedwald method.[18] Lipoprotein (a) was determined by the kinetic nephelometry method, using a protein system kit (Beckman). PAI-1 was measured by enzyme-linked immunosorbent assay (ELISA).[19]

5. Clinical assessment

Physical examinations were taken to ensure that the subjects were free of serious disease.

6. Statistical analysis

Statistical analysis was performed with a Statistical Analysis System (SAS). A General Linear Model procedure was done to determine the effects of the four classified BMI groups on daily macronutrients intake, daily nutrient intake as percentages of recommended dietary intakes with adjustment for age, blood lipids, Lp (a), and PAI-1 levels. Any group mean giving a significant F value ($p<0.05$) was further tested to distinguish which means were statistically different by use of Scheffe's multiple range test for groups of equal/unequal size. Pearson's product-moment correlation coefficient test was used to determine the relationship between nutrient intake, plasma lipids and BMI.

RESULTS AND DISCUSSION

1. Age and anthropometric characteristics of men and women

The mean age of men was 47.1±1 years, and the mean age of women was 46.0±8.3 years (Table 1). As shown in Table 1, the mean height of men was 170.5±5.4 cm, and the mean height of women was 158.3±4.7 cm. The mean weight of men was 69.6±8.0 kg, and the mean weight of women was 57.0±7.4 kg. The mean BMI of men was 24.0±3.3 kg/m^2 which is a normal BMI, and the mean BMI of women was 22.8±4.7 kg/m^2 which is also a normal BMI. The mean percent body fat of the men was 22.7±5.9%, and the mean percent body fat of the women was 29.0±5.9%.

2. BMI

The BMI classification system developed by the Health and Welfare Canada (1988) was used. Based on this classification, the results of measurement was analyzed. Of the men, 1452 subjects (60.5%) were in the normal range, and 784 (32.6%) were considered overweight and/or obese (Table 2). Of the women, 882 subjects (64.0%) were in the normal range, and 280 subjects (20.3%) were overweight

Table 1. Age and anthropometric characteristics of men and women

	Men (n=2402)		Women (n=1379)	
	Mean±SD	Range	Mean±SD	Range
Age (yr)	47.1±8.5	21 - 81	46.0±8.3	23 - 72
Height (cm)	170.5±5.4	52.9 - 193.3	158.3±4.7	142.8 - 176.8
Weight (kg)	69.6±8.0	42.6 - 113.8	57.0±7.4	35.5 - 87.7
BMI (kg/m^2)[1)]	24.0±3.3	13.6 - 68.7	22.8±4.7	10.0 - 52.9
Percent of body fat	22.7±5.0	15.0 - 42.5	29.0±5.9	11.0 - 56.5

1) Body Mass Index

Table 2. Distribution of men and women in the four references BMI group[1)] N (%)

BMI (kg/m^2)	Underweight ≤20	Normal 20.1 - 25.0	Overweight 25.1 - 30.0	Obesity >30	Total
Men	166	1452	729	55	2402
	(6.9)	(60.5)	(30.3)	(2.3)	(63.5)
Women	217	882	255	25	1379
	(15.7)	(64.0)	(18.5)	(1.8)	(36.5)

1) Modified classifications of the BMI by Health Analysis Canada (1988)

and/or obese. This result of overweight and/or obese was 32.6% of the men which showed higher than that of the Korean national nutrition survey (20.5%) of over 20 years old men in 1995.[1] At the same period of time, there was no significant difference (20.3% of >25 kg/m^2 in BMI) in women.

Other factors which help to increase the BMI are economic status and age.[20][21] Kim and Im's[20] study showed that 18.4% of college students had a BMI of >25 kg/m^2. Kim's *et al.*[21] study indicated that 14.5% of adolescent girls had a BMI of >25 kg/m^2. The incidence of obesity seems to increase with age. Obesity also seems to occur more frequently among those Koreans belonging to middle or upper economic classes.

3. The relationship between intake of nutrients and BMI of men and women

The nutrients intake in four BMI groups is shown in Table 3. The mean energy intake levels of men and women appeared to increase with BMI levels. The daily intake of energy of men in the normal group was 2176.8±620.9 kcal/day and of women in the normal group was 1774.1±454.3 kcal/day. The energy intake of the obese men group (2626.7±618.7 kcal/day) was significantly higher than that of the overweight (2387.3±623.2 kcal/day), the normal (2178.6±620.9 kcal/day) and the underweight groups (1957.2±622.9 kcal/day) at $\alpha=0.05$. Of the women, the energy intake of the obese (1863.2±446.9 kcal/day) and overweight groups (1884.5±465.3 kcal/day) were significantly higher than that of the normal (1774.1±454.3 kcal/day) and the underweight groups (1688.2±468.8 kcal/day) at $\alpha=0.05$.

The carbohydrate intake of the obese group (292.1±71.2 g/day) of men was significantly higher than that of the underweight group (259.6±71.9 g/day), and the protein intake of the obese (106.4±29.3 g/day) and overweight groups (102.1±29.6 g/day) was significantly higher than that of the normal (92.3±26.6 g/day) and underweight group (80.9±29.5 g/day) at $\alpha=0.05$. The daily intakes of fat, alcohol and cholesterol of the men appeared to increase with BMI values. The daily intakes of fat of the men, the obese (58.0±27.1 g/day) and overweight groups (53.1±26.9 g/day) was significantly higher than that of the normal (47.4±26.6 g/day) and underweight groups (44.9±26.9 g/day) at $\alpha=0.05$. The daily intakes of cholesterol of the men, the obese (317.8±178.5 g/day) and overweight groups (299.2±178.0 g/day) was significantly higher than that of the normal (265.4±179.0 g/day) and underweight groups (241.2±179.8 g/day) at $\alpha=0.05$.

Of the women, carbohydrate intake of the obese (290.0±70.0 g/day) and overweight groups (286.5±71.7 g/day) was significantly higher than that of the underweight (258.1±73.4 g/day) group, and the protein intake of the overweight group (78.6±25.4 g/day) was significantly higher than that of the normal (73.1±23.7 g/day) and underweight groups (68.9±24.9 g/day) at $\alpha=0.05$. The daily intakes of fat of the women, the overweight group (41.9±19.1 g/day) was significantly higher than that of the underweight group (34.7±20.5 g/day) at $\alpha=0.05$. The four women groups of the BMI showed no significant differences in alcohol and cholesterol consumption.

The energy intake of young Koreans, a number of investigators reported that there was no significant difference between the obese and the non-obese groups in energy intake.[4][21][22] With respect to the mean daily energy intake of the men and women in this study, the levels of daily energy intake appeared to increase as values of BMI increased. This results showed that high energy intake is an important factors associated with overweight problems and obesity in both men and women.

4. The relationship between daily intake of % energy and BMI of men and women

Underweight (54.8±12.8%) and normal men (52.4±11.4%) consumed significantly higher carbohydrates in their

Table 3. Mean intake of energy, macronutrients, alcohol, and cholesterol by men and women in the four BMI[1] groups

BMI (kg/m^2)	Men (n=2402)				Women (n=1379)			
Nutrient intake/day	Underweight (n=166)	Normal (n=1452)	Overweight (n=729)	Obesity (n=55)	Underweight (n=217)	Normal (n=882)	Overweight (n=255)	Obesity (n=25)
Energy (kcal)	1957.2±622.9^d	2178.6±620.9^c	2387.3±623.2^b	2626.7±618.7^a	1688.2±468.8^b	1774.1±454.3^b	1884.5±465.3^a	1863.2±446.9^a
Carbohydrate (g)	259.6± 71.9^b	275.2± 68.5^{ab}	277.1± 70.1^{ab}	292.1± 71.2^a	258.1± 73.4^b	270.8± 71.2^{ab}	286.5± 71.7^a	290.0± 70.0^a
Protein (g)	80.9± 29.5^c	92.3± 26.6^b	102.1± 29.6^a	106.4± 29.3^a	68.9± 24.9^b	73.1± 23.7^b	78.6± 25.4^a	77.0± 24.4^{ab}
Fat (g)	44.9± 26.9^b	47.4± 26.6^b	53.1± 26.9^a	58.0± 27.1^a	37.4± 20.5^b	39.4± 17.8^{ab}	41.9± 19.1^a	40.8± 19.6^{ab}
Alcohol (g)	115.2±366.0^b	189.4±365.6^b	260.8±366.9^a	310.2±363.7^a	33.4±126.3^a	25.6±121.7^a	16.0± 65.9^a	7.3± 40.8^a
Cholesterol (mg)	241.2±179.8^b	265.4±179.0^b	299.2±178.0^a	317.8±178.5^a	216.4±169.0^a	218.8±163.3^a	228.4±167.3^a	192.0±162.0^a

1) Modified classifications of the BMI by Health Analysis Canada (1988)

^{abc} Means within the same row with different superscipt differ significantly by scheffe's multiple range test ($\alpha=0.05$) in men and women

diets than that of the overweight (48.9±10.7%) and obese groups (46.3±12.4%) counterparts at $\alpha=0.05$ (Table 4). Of the men, the percent energy intake of the protein showed that the overweight (17.6±2.6%) group was significantly higher than that of the underweight (16.5±3.8%) group at $\alpha=0.05$. The percent energy intake of alcohol showed that the obese (15.8±13.9%) and overweight men (12.4±13.4%) was significantly higher than that of the normal (9.7±11.4%) and underweight men (6.9±14.1%) at $\alpha=0.05$.

Four groups of BMI showed no significant differences in percent energy intake of carbohydrate, protein, fat or alcohol of the women. This result appears to be consistent with the findings of the Davies[9] and Summerbell *et al.*,[23] in which they indicated that there is no relationship between feeding pattern and BMI. On the other hand, Ortega *et al.*[13] demonstrated that the percent energy ratio of fat and protein of an obese group was higher than that of a non-obese group. Some of the studies in developed countries showed that obese subjects ingested about the same amount of energy as normal and underweight subjects but their percent energy intake of fat was higher in obese subjects than that of normal and underweight subjects.[8-12] Therefore, further research in this area is needed.

In this study, the ratio of the percent energy intake of carbohydrates, protein, fat, and alcohol by the normal group of men was 52 : 17 : 20 : 10, respectively. The ratio of women was 62 : 17 : 20 : 1 respectively (Table 4). This results shows that women had a higher intake of carbohydrate than men. Korean people had higher intake of carbohydrate than any other countries where such measurements have been taken, and a lower intake of fat than western people. Kim's[21] study showed that the ratio of percent intake of carbohydrate : protein : fat was 62 : 14 : 24 in an obese group of high school girl students and 63 : 14 : 24 in a normal group. The percent energy intake of fat by high school girl students was higher than that of the Korean RDA (Recommended Dietary Allowance)[24] which suggested 20%. Recently, Kim's[25] study showed that the ratio of percent energy intake of carbohydrate : protein : fat was 71 : 12 : 17 in obese men and 64 : 14 : 22 in normal men of university students. The percent energy intake of fat appeared to increase in young age groups.

5. The relationship between blood lipids variables and BMI of men and women

1) Total cholesterol (TC)

In Table 5, plasma TC levels of the obese (5.36±0.85 mmol/L) and overweight groups of men (5.26±0.86 mmol/L) were significantly higher than that of the normal (5.10±0.79 mmol/L) and the underweight group (4.78±0.83 mmol/L) at $\alpha=0.05$. Plasma TC levels of the overweight group of women (5.15±0.82 mmol/L) was significantly higher than that of the normal (4.93±0.84 mmol/L) and the underweight group (4.84±0.84 mmol/L) at $\alpha=0.05$.

Table 4. Composition of percent energy intake by men and women in the four BMI[1] groups

BMI (kg/m^2)	Men				Women			
% energy intake/day	Underweight (n=166)	Normal (n=1452)	Overweight (n=729)	Obesity (n=55)	Underweight (n=217)	Normal (n=882)	Overweight (n=255)	Obesity (n=25)
Carbohydrate (%)	54.8±12.8^a	52.4±11.4^a	48.9±10.7^b	46.3±12.4^b	61.8±8.8^a	61.6±8.9^a	61.5±8.0^a	62.5±8.7^a
Protein (%)	16.5± 3.8^b	17.1± 3.8^{ab}	17.6± 2.6^a	16.8± 3.6^{ab}	16.2±2.9^a	16.5±3.2^a	16.7±3.1^a	16.3±3.3^a
Fat (%)	19.8± 6.4^a	19.1± 3.8^a	19.6± 5.3^a	19.6± 7.3^a	19.4±5.8^a	19.5±5.9^a	19.3±6.3^a	19.3±6.2^a
Alcohol (%)	6.9±14.1^b	9.7±11.4^b	12.4±13.4^a	15.8±13.9^a	1.2±2.9^a	1.0±2.9^a	0.9±3.1^a	0.2±3.8^a

1) Modified classifications of the BMI by Health Analysis Canada (1988)
^{abc} Means within the same row with different superscipt differ significantly by scheffe's multiple range test ($\alpha=0.05$) in men and women

Table 5. Plasma lipids, lipoprotein (a), and PAI-1 levels of men and women in the four BMI[1] groups

BMI (kg/m^2)	Men				Women			
Blood variables	Underweight	Normal	Overweight	Obesity	Underweight	Normal	Overweight	Obesity
Total cholesterol (mmol/L)	4.78± 0.83^b	5.10± 0.79^b	5.26± 0.86^a	5.36± 0.85^a	4.84± 0.84^b	4.93± 0.84^b	5.15± 0.82^a	4.82± 0.82^b
HDL-cholesterol (mmol/L)	1.48± 0.26^a	1.24± 0.26^b	1.16± 0.26^c	1.17± 0.25^c	1.60± 0.30^a	1.44± 0.30^b	1.37± 0.33^c	1.29± 0.32^c
LDL-cholesterol (mmol/L)	2.75± 0.76^b	3.06± 0.69^a	3.15± 0.77^a	3.15± 0.78^a	2.76± 0.76^b	2.93± 0.69^b	3.13± 0.74^a	2.86± 0.72^b
Triglyceride (mmol/L)	1.16± 1.03^c	1.77± 1.03^b	2.06± 1.04^a	2.33± 1.03^a	1.02± 0.46^c	1.22± 0.83^b	1.44± 0.86^a	1.42± 0.62^a
Lipoprotein (a) (mg/dl)	22.0 ±17.9^a	20.1 ±19.0^a	17.5 ±18.8^b	15.5 ±19.1^b	22.0 ±20.5^a	21.7 ±17.8^a	21.3 ±20.7^a	18.5 ±18.6^a
PAI-1 (ng/ml)	19.6 ±19.2^d	30.7 ±19.0^c	40.3 ±18.8^b	55.4 ±19.8^a	18.4 ±11.6^d	25.1 ±14.8^c	35.7 ±17.5^b	45.1 ±16.7^a

1) Modified classifications of the BMI by Health Analysis Canada (1988)
^{abc} Means within the same row with different superscipt differ significantly by scheffe's multiple range test ($\alpha=0.05$) in men and women

2) HDL-Cholesterol

In Table 5, of the men, plasma HDL-C levels of the obese (1.17±0.25 mmol/L) and overweight groups (1.16±0.26 mmol/L) was significantly lower than those of the normal (1.24±0.26 mmol/L) and the underweight groups (1.48±0.26 mmol/L) at $\alpha=0.05$. Of the women, plasma HDL-C levels of the obese (1.29±0.32 mmol/L) and overweight groups (1.37±0.33 mmol/L) was significantly lower than those of the normal (1.44±0.30 mmol/L) or underweight group (1.60±0.30 mmol/L) at $\alpha=0.05$.

3) LDL-Cholesterol (LDL-C)

The plasma LDL-C levels of the obese (3.15±0.78 mmol/L) and overweight men (3.15±0.77 mmol/L) was significantly higher than that of the underweight group (2.75±0.76 mmol/L) at $\alpha=0.05$. Of the women, plasma LDL-C levels of the overweight group (3.13±0.74 mmol/L) was significantly higher than those of the normal (2.93±0.69 mmol/L) and underweight groups (2.76±0.76 mmol/L) at $\alpha=0.05$ (Table 5).

4) Triglyceride (TG)

The plasma TG levels of the obese (2.33±1.03 mmol/L) and overweight men groups (2.06±1.04 mmol/L) was significantly higher than those of the normal (1.77±1.03 mmol/L) and the underweight group (1.16±1.03 mmol/L) at $\alpha=0.05$. Of the women, plasma TG levels of the overweight group (1.44±0.86 mmol/L) was significantly higher than those of the normal (1.22±0.83 mmol/L) and underweight groups (1.02±0.46 mmol/L) at $\alpha=0.05$(Table 5).

These data show that the levels of plasma TC, LDL-C, HDL-C and TG appeared to increase as the values of the BMI increased, while levels of plasma HDL-C appeared to decrease as values of the BMI increased. This agrees with the findings of Thelle's *et al.*[26]

5) Lipoprotein (a) (Lp (a))

In Table 5, the underweight (22.0± 17.9 mg/dl) and normal men groups (20.1±19.0 mg/dl) showed that their plasma Lp (a) levels were significantly higher than that of the overweight (17.5±18.8 mg/dl) and obese groups (15.5±19.1 mg/dl) at $\alpha=0.05$. There was no significant difference of the Lp (a) levels of the women in the study. Lp (a) levels was affected by various factors, such as alcohol drinking, BMI, and age, and is not only correlated with lipid levels but also with hemostatic factors such as fibrinogen and PAI-1.[27] Duell[28] suggested the possibility that serum concentration of Lp (a) may be modulated by a complex interplay between obesity, insulin action and exercise. Lecerf *et al.*[29] found that Lp (a) levels were lower in upper-body-obese women. They suggested that Lp (a) is a better indicator of body fat distribution than HDL-cholesterol or apo-A1. Therefore, Lp (a) has been used as an independent risk factor for cardiovascular disease (CVD), whose incidence is greater in obese subjects.[30]

6) Plasminogen activator inhibitor-1 (PAI-1)

In Table 5, plasma PAI-1 levels in the obese men group (55.4±19.8 ng/ml) was significantly higher than that of the overweight (40.3±18.8 ng/ml), normal (30.7±19.0 ng/ml) and underweight groups (19.6±19.2 ng/ml) at $\alpha=0.05$. Plasma PAI-1 levels in the obese women group (45.1±16.7 ng/ml) was significantly higher than that of the overweight (35.7±17.5 ng/ml), normal (25.1±14.8 ng/ml) and underweight groups (18.4±11.6 ng/ml) at $\alpha=0.05$. High PAI-1 activity is frequently found in obesity, and both PAI-1 and obesity are risk factors for cardiovascular disease (CVD). Several studies[31-35] observed the significant correlation between PAI-1 levels and BMI. Juhan-Vague[36] reported that PAI-1 activity was positively correlated with BMI, insulin and triglyceride.

6. Correlation coefficients between nutrient intake, plasma lipids and PAI-1, and BMI of men and women

In Table 6, of the men, BMI significantly and positively correlated with energy ($r=0.191$ at $p<0.001$), cholesterol ($r=0.071$ at $p<0.001$), carbohydrate ($r=0.047$ at $p<0.001$), protein ($r=0.163$ at $p<0.001$), fat ($r=0.100$ at $p<0.001$), and alcohol intake ($r=0.117$ at $p<0.001$), and also percent energy intake of alcohol ($r=0.116$ at $p<0.001$). However, of the men, BMI significantly and negatively correlated with % energy intake of carbohydrate ($r=-0.133$ at $p<0.001$) and percent energy intake of carbohydrate/fat ratio ($r=-0.069$ at $p<0.001$). Of the men, BMI significantly and positively correlated with the plasma TC ($r=0.135$ at $p<0.001$), LDL-C ($r=0.112$ at $p<0.001$), TG ($r=0.201$ at $p<0.001$) and PAI-1 levels ($r=0.290$ at $p<0.001$), and negatively correlated with plasma HDL-C ($r=-0.211$ at $p<0.001$) and plasma Lp (a) ($r=-0.063$ at $p<0.01$).

In the Table 6, BMI of the women significantly and positively correlated with energy ($r=0.126$ at $p<0.001$), carbohydrate ($r=0.125$ at $p<0.001$), protein ($r=0.109$ at $p<0.001$), and fat intake ($r=0.058$ at $p<0.05$). Of the women, BMI significantly and positively correlated with the plasma TC ($r=0.100$ at $p<0.001$) , LDL-C (r=

Table 6. Correlation coefficients between nutrient intakes, plasma lipids with BMI

Variables	Men	Women
Nutrient variables		
Energy (kcal)	0.191***	0.126***
Cholesterol (mg)	0.071***	0.007
Carbohydrate (g)	0.047***	0.125***
Carbohydrate (%)	-0.133***	0.001
Protein (g)	0.163***	0.109***
Protein (%)	0.034	0.024
Fat (g)	0.100***	0.058*
Fat (%)	0.014	-0.007
CHO (%)/Fat (%)	-0.069***	0.025
Alcohol (g)	0.117***	-0.050
Alcohol (%)	0.116***	-0.027
Blood variables		
Total cholesterol	0.135***	0.100***
HDL-cholesterol	-0.211***	-0.215***
LDL-cholesterol	0.112***	0.135***
Triacylglycerol	0.201***	0.164***
Lipoprotein(a)	-0.063**	-0.018
PAI-1	0.290***	0.338***

*p<0.05, **<0.01, ***<0.001

0.135 at $p<0.001$), TG ($r=0.164$ at $p<0.001$) and PAI-1 levels ($r=0.338$ at $p<0.001$), and significantly negatively correlated with plasma HDL-C levels ($r=-0.215$ at $p<0.001$).

The plasma TC, LDL-C, TG, and PAI-1 levels showed positive correlation with BMI in both men and women. These data suggest that BMI may be a useful predictor of health risk associated with obesity and CVD, in which BMI is associated with high PAI-1 activity, and TC and TG levels. Plasma HDL-C levels in both men and women negatively correlated with BMI. It is well known that the obese subjects may have a greater risk of developing CVD than non-obese subjects. However, through this study, it was confirmed that Koreans in the upper and middle socioeconomic classes are also facing the same obesity problem that was once regarded as unique to western society.

CONCLUSION AND RECOMMENDATION

The increased energy intake of the Korean upper and middle socioeconomic class is resulting in an increased overweight and obese sector of the population. The BMI study showed that 1452 (60.5%) of the men measured were normal and 784 (32.6%) were overweight and/or obese subjects. The study results suggest that the levels of mean energy intake appear to increase as values of BMI increase. The carbohydrate and protein intakes of the obese and overweight groups were significantly higher than those of the underweight groups. The daily intake of fat, cholesterol, and alcohol of the men obese and overweight groups was significantly higher than that of the normal and underweight groups. There was no significant differences in the percent energy intake of fat in men, or the percent energy intake of carbohydrate, protein, fat and alcohol in women. The percent energy intake of fat was not directly correlated to the incidence of obesity in this study.

The levels of plasma TC, LDL-C, and TG appear to increase as values of BMI increase, while levels of HDL-C decrease as values of BMI increase. The plasma lipids and PAI-1 levels were positively associated with BMI.

This study shows that there is a correlation between dietary intake and BMI, and also shows that there is a relation of BMI to blood lipids and PAI-1 levels. However, a more detailed study is needed to establish the relationship between percent body fat and dietary intake.

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