

The Relationship between Lifestyles and Obesity of Office Workers in Korea

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Abstract

The purpose of this study was to investigate the relationships of lifestyle factors, including energy intake and expenditure, to body mass index in male office workers. A total of 84 male office workers voluntarily participated in the study, and the participants' lifestyle factors, which included body fat indicators such as body mass index, percent body fat, waist circumference, and waist-to-hip ratio, were measured. They also answered questionnaires recording their daily dietary intakes and average daily walking and sedentary time. For group analysis, the subjects were classified into normal weight (n=30) or overweight (n=54) groups based on a BMI cut-off point of 23.0kg/m². Energy intake results showed that the overweight groups had significantly higher values for volume of dinner (p=.001), fat intake (p<.001), and frequency of skipping breakfast (p=.020) than the normal weight group. In terms of energy consumption, the overweight group had significantly lower values for commute time (p<.001) and significantly higher values for working hours (p=.017) and sedentary work time (p<.001) than the normal weight group. Pearson correlation analysis showed that dinner intake (p=.007) and sedentary work time (p<.041) were significantly related to BMI in both groups. Multiple linear regression analysis showed that dinner intake and sedentary work time were two independent predictors of BMI in office workers who participated in this study. In conclusion, the current findings of the study suggest that adopting healthy dietary habits, including dieting and regular meal times, as well as increased physical activity and reduced sitting time should be promoted as key components of lifestyle intervention for the prevention of body fatness in office workers.

Keywords: *Office workers, Energy intake, Energy consumption, Body mass index, Lifestyle factors*

1. Introduction

According to the Ministry of Health and Welfare's Korea National Health & Nutrition Examination Survey, 2011[1], the prevalence of obesity in adults over 19 years of age (BMI>25kg/m²) has been steadily increasing from 25.8% in 1998 to 31.4% in 2008 and 31.4% in 2010, and 3 out of 10 adults are obese. Decreasing physical activity and changes in dietary habits due to the comfortable and abundant life offered by the rapid development of modern civilization along with economic development are the main causes of this effect [2].

Physical activity has steadily decreased up to the present time, which is reported as the

main cause of death due to cardiovascular and other chronic diseases [3]. According to previous studies, insufficient physical activity due to the sedentary lifestyle seen in industrial societies is related to obesity [4], [5]. According to Yoo[6] and Lallukka et al. [7], the risk of obesity decreases as job activity increases, and more risk factors related to obesity, such as metabolic syndrome, hyperlipidemia and cardiovascular diseases were discovered in office workers than in production workers. In other words, modern people's sedentary lifestyle and life habits could be correlated to obesity, and the majority of daily activity, i.e. physical activity, is largely influenced by the activity time [6].

Office workers assist managers, professionals and semi-professionals to draw up business plans and carry out business according to those plans [8], and a majority of their duties are sedentary tasks. According to previous studies, office workers face nutritional imbalance from frequent drinking and eating out due to excessive work and stress; in particular, frequent drinking, eating out, skipping breakfast, indigestion, and nutritional imbalance [9-11]. Such unbalanced eating habits lead to high exposure to causes of obesity and various adult diseases.

In this way, people's lifestyle, including physical activities and eating habits, is highly correlated to their jobs. Although the kind of lifestyle, including physical activities and eating habits, is connected to metabolic diseases related to obesity, the levels of awareness of it, education, and practice remain insufficient. Since the number of office workers and professionals compared to blue-collar and production workers is currently increasing due to Korea's industrial structure, educational development, and improvement in education [12], the increase in the number of office workers that already takes up a large part of Korea's economically active population could lead to increases in groups at risk of obesity. Office workers in particular are at a higher risk of obesity due to sedentary work, stress, drinking, smoking, lack of exercise and irregular meals, and require substantial understanding and improvement.

However, studies related to obesity that evaluate energy intake and consumption mostly concern obesity prevention for children, adolescents, or middle-aged women, who are the most exposed to obesity, while there is a serious lack of studies about male office workers. Therefore, the objective of this study was to investigate the lifestyles of male office workers, who are at a high risk of obesity, to discover the behavioral factors that cause obesity, and to study the correlation between body mass index and lifestyle factors.

2. Method

2.1. Subjects

Subjects of this study were male office workers in inactive research & development businesses (n=84). Information on the study and data collection procedure was explained to all participants verbally and in writing, and participation consent was obtained. Out of a total of 90 participants in the study, 84 were selected as the final subjects, while 6 participants with poor responses were excluded. Based on measured data, body mass index below 23.0kg/m² was categorized as normal weight and anything over that as overweight, and each group's dietary intake and lifestyle habits related to energy consumption were compared. Subjects' physical characteristics are seen in Table 1.

2.2. Measuring Instruments

This study was a correlation study to examine the factors that influence office workers' body mass index. For the body composition, subjects' body mass index, percent body fat, waist circumference, and waist-to-hip ratio were measured, and their daily dietary intake and average daily walking and sedentary time were investigated through the questionnaires and recorded.

Table 1. Physical Characteristics of Office Worker Participated in Study

variable	Normal weight(n=30)	Over weight(n=54)	P
Age(yr)	40.60±9.81	35.67±9.45	.026
Height(cm)	173.10±5.93	174.93±5.86	.175
Weight(kg)	66.19±5.62	83.98±16.30	.001**
Percent body fat(%)	16.61±3.86	25.33±5.86	.001**
Waist circumference(cm)	79.67±4.40	91.26±11.71	.001**
Waist-to-hip ratio	0.86±0.02	0.90±0.03	.001**

Values are means±SD **P<.001

A. Body Composition Measurements

Height (cm) and weight (kg) were obtained using an automatic measuring instrument (DS-102, Jenix, Korea), and the body mass index was calculated using a weight (kg)/height (m²) formula: body fat percentage was measured using InBody 230. Waist circumference was measured from the half-way point of the lower part of the ribs to the upper part of iliac crest, and hip circumference was measured at the most convex part seen from the side; each was measured twice and the average values were recorded. Waist-to-hip ratio was calculated by dividing waist circumference (cm) by hip circumference (cm).

B. Lifestyle Habits

Questionnaires were used to investigate the lifestyle factors related to dietary intake and energy consumption. Questionnaire items were obtained by revising the items in a previous study about office workers' health, exercise and eating habits (Park, Yeon Ok, 2001; Kim, Mi Kyung 2004) accordingly. Questionnaire items consisted of employment period, working hours, commute hours, means of transportation, exercise frequency, exercise time, meal time, regularity in eating, meal skipping, overeating, eating-out, drinking, snacks, and intake frequency of favorite food.

C. Dietary Intake

A 24-hour recall method was used to investigate the dietary intake (kcal), energy nutrition intake ratio and contribution rate of each dietary group, and subjects' total daily dietary activities were recorded, including name of food, ingredients, and quantity or weight. Due to the difference in eating habits between weekdays and weekends, the dietary activities for 2 weekdays and 1 weekend day were recorded and their average value was used. This was analyzed using Can Pro (ver3.0, Korea Nutrition Society).

D. Energy Consumption

In order to calculate total daily energy consumption and sedentary time, subjects were instructed to record all activities from waking up to sleeping in 10-minute intervals; these records were taken for 2 weekdays and 1 weekend day and their average value was used. R

Recorded activities were substituted into a formula for energy consumption per activity (kcal/kg/min) by Choi, et al. [14], and activity metabolism was calculated in kcal. Total energy expenditure (TEE) was calculated by adding energy consumption, which was calculated using a formula, and diet-induced thermogenesis, and the following formulas were used:

- A. Basal metabolism rate + activity metabolism rate
= Energy consumption per activity (kcal) × weight (kg) × duration of activity (min)
- B. Diet-induced thermogenesis
= A (Basal metabolism rate + activity metabolism rate) / 0.9 × 0.1
- C. Total energy expenditure
= A + B kcal

3. Data Processing

All collected data was processed using SPSS Statistics (ver. 18), and all values were indicated as average and ± standard deviation. In order to study the subjects' physical characteristics based on body mass index and lifestyle factor differences related to dietary intake and energy consumption, independent T-tests and χ^2 tests were performed. The correlation of body mass index with each factor was analyzed using Pearson's correlation coefficient. In addition, multiple regression analysis was performed to ascertain which factors influence body mass index. All statistical significance levels were set at $\alpha=.05$.

3. Results

3.1. Correlation of Body Mass Index to Lifestyle Factors

A. Comparison of Macronutrient Intake and Dietary Intake between Groups

Table 2 compares the macronutrient intake and dietary intake of the two groups. There was no statistically significant difference in the total dietary intake between groups, but the carbohydrate intake of the normal weight group was significantly higher than that of the overweight group ($p=0.001$). Fat intake was significantly higher in the overweight group ($p<0.001$) than in the normal weight group, but there was no difference in protein intake ($p=0.912$) between groups. The normal weight group showed a significantly lower dinner intake rate ($p=0.001$) than the overweight group.

B. Comparison of Lifestyle Factors Related to Energy Consumption between Groups

Table 3 compares the energy consumption and energy consumption-related activity times of the two groups. Energy consumption was significantly higher in the overweight group than in the normal weight group ($p<.001$). Within activity time, the normal weight group's commute time was significantly longer than that of the overweight group ($p<.001$), and work hours ($p=.017$) and sedentary time ($p<.001$) were significantly longer in the overweight group than in the normal weight group. However, there was no significant difference in sleeping hours between the two groups ($p=.309$).

Table 2. Comparison of Macronutrient Intake, Dietary Intake and Ratio of Intake Group Contribution between Groups

variable	Normal weight(n=30)	Over weight(n=54)	P
Dietary intake(kcal/day)	1730.81±362.25	1880.61±384.82	.085
Macronutrient intake ratio(%)			
Carbohydrate	59.33±8.93	52.67±8.76	.001**
Fat	24.00±8.15	30.48±7.37	.001**
Protein	16.77±2.83	16.89±5.60	.912
Intake group contribution ratio(kcal)			
Breakfast	352.69±206.87	239.65±232.45	.029*
Lunch	604.02±145.92	621.97±189.39	.657
Dinner	605.37±145.92	846.04±378.62	.001**
snack	168.75±224.27	157.00±172.16	.356

*p<.05, **p<.01

Table 3. Comparison of Energy Consumption and Lifestyle Factors Related to Energy Consumption between Groups

variable	Normal weight(n=30)	Over weight(n=54)	P
energy consumption(kcal/day)	2845.37±391.79	3391.14±631.95	.001**
sleeping hours(min)	391.00±47.22	377.78±61.26	.309
commute time(min)	55.50±21.63	35.61±24.40	.001**
working hours(min)	556.00±90.42	614.44±112.32	.017*
sedentary time(min)	687.83±87.41	804.91±104.02	.001**

*p<.05, **p<.01

C. Correlation of Body Mass Index, Dietary Intake and Energy Consumption

Table 4 shows the correlation between body mass index and lifestyle factors related to dietary intake. Body mass index and macronutrient intake ratio did not show a significant correlation, and neither did breakfast, lunch and snack intakes. In comparison, dinner intake amount showed a significant correlation ($r=.339$, $p=.002$).

Table 5 shows the correlation between body mass index and lifestyle factors related to energy consumption. Body mass index and commute showed a significant negative correlation ($r=-.350$, $p=.001$), while sedentary time showed a significant positive correlation ($r=.291$, $p=.007$). However, sleeping hours and working hours did not show any correlation.

Table 4. Correlation Analysis of Body Mass Index and Dietary Intake Lifestyle Factors

	Macronutrient intake ratio(%)		Intake group contribution ratio(kcal)				
	carbohydrate	fat	protein	breakfast	lunch	dinner	snack
Body mass index	-.118 (p=.287)	.125 (p=.257)	.008 (p=.939)	-.124 (p=.262)	.105 (p=.344)	.339* (p=.002)	-.034 (p=.756)

*p<.01

Table 5. Correlation Analysis of Body Mass Index and Energy Consumption Lifestyle Factors

	Sleeping hours	Commute time	Working hours	Sedentary time
Body mass index	.058 (p=.603)	-.350* (p=.001)	.003 (p=.975)	.291* (p=.007)

*p<.01

2. Effects of Lifestyle Factors Related to Dietary Intake and Energy Consumption on Body Mass Index

Multiple regression analysis was performed in order to find out the effects of lifestyle factors related to dietary intake and energy consumption on body mass index. Lifestyle factors related to dietary intake (carbohydrate, fat, protein, breakfast/lunch/dinner, snack intake amount) and factors related to energy consumption (sleeping hours, commute time, working hours, sedentary time) that are thought to affect body mass index were set as independent variables. In terms of multicollinearity among independent variables, macronutrient intake ratio and total dietary intake appeared to be related, causing collinearity, and were eliminated from the final analysis Table 6.

Results showed that dinner intake appeared to significantly affect body mass index (p=.007, t=2.749) while breakfast and lunch intake did not have any effect.

Table 6. Effects of Lifestyle Factors Related to Dietary Intake and Energy Consumption on Body Mass Index

variable	Non-coefficients B	Standardized SE	Standardized coefficients β	t	p	VIF
constant	16.453	5.834	-	2.820	.006	-
Breakfast intake	.001	.002	.002	.020	.984	1.157
Lunch intake	.002	.003	.088	.842	.403	1.108
Dinner intake	.004	.001	.293	2.749	.007*	1.153
Snack intake	.001	.002	.027	.247	.806	1.173
Sleeping hours	.004	.008	.057	.550	.584	1.088
Commute time	-.034	.019	-.199	-1.801	.076	1.240

Working hours	-.006	.005	-.149	-1.238	.220	1.469
Sedentary time	.010	.005	.272	2.076	.041*	1.740

R²=.259. p=003, F=3.279, * p<.05

Among lifestyle factors related to energy consumption, only sedentary time affected energy consumption in a positively significant direction (p=.041, t=2.076) while commute time showed a negative tendency, although this was not statistically significant. Ultimately, the lifestyle factor that influenced body mass index the most was dinner intake (β =.293), followed by sedentary time (β =.272) and commute time (β =-.199).

4. Discussion

This study examined the correlation of body mass index and lifestyle factors by investigating the body mass index, lifestyle factors, eating habits, and energy consumption of office workers, who are at a high risk of obesity, for a practical understanding of obesity at a preventive level.

Office workers tend to be less physically active than production workers due to their inactive job [7], and have been reported to tend to lead sedentary lives at home as well [15]. Inactive and sedentary lifestyles cause obesity, hypertension, hyperlipidemia, diabetes, metabolic diseases and cardiovascular diseases. Body mass index (BMI), the traditional index to measure obesity, is the WHO's indicator to define obesity and classify its severity, and is used throughout the world. In addition, body mass index is also used as a risk factor to predict the risk of coronary artery diseases and cerebral infarction [16], but can't reflect abdominal obesity and body fat [17].

Waist circumference (WC) and Waist-to-hip ratio (WHR), which can evaluate abdominal obesity, are studied as factors that predict health risk across various age groups, races, and genders when compared to body mass index. Yoo et al. [17] reported a significant correlation between body mass index and waist circumference, and between waist circumference and systolic/diastolic blood pressure, neutral fat, HDL-C and LDL-C. Obesity indices including body mass index, body fat, waist circumference, and WHR have been reported to be correlated to calorie intake [18]. Kang [19] suggested a correlation between energy consumption and body mass index by obtaining positive changes in body mass index, percent body fat and waist-to-hip ratio through increased energy consumption from increased physical activities in daily life.

Obesity is closely related to individuals' lifestyles [20], and job, education, economic standard, social status, behavior patterns, and eating patterns affect obesity [21,-22]. The Korean Nutrition Society [23] calculated the odds ratio of risk factors of cardiovascular diseases according to the ratio of carbohydrates and fat intake to energy, and set dietary reference intakes at 55-70% carbohydrates, 15-25% fat, and 7-20% of protein. Reducing fat intake may be one of the ways to prevent and treat cardiovascular diseases, but its primary basis is that low-fat food has fewer calories than high-fat food and helps reduce calorie intake, however, since body fat reduction due to limited fat intake is not substantial and is not sustained, the roles of carbohydrate and protein should be considered as well [24]. Meals containing less than 20% of carbohydrate intake had a greater effect on weight loss than low-fat and low-calorie meals, and had positive effects on neutral fat, HDL and blood pressure [25]. In terms of protein, increasing the protein intake in low-carb and low-fat meals leads to weight loss, decreased risk factors for cardiovascular diseases and maintenance of lean body mass [26].

Maybe however, since increased animal protein intake lead to increased fat intake, high-protein meals ought to use vegetable protein [27]. In the results of this study, dietary intakes between groups did not show a statistically significant difference, but there were significant differences in carbohydrate (p<.001) and fat (p<.001) between the two groups Table 2, while there was no significant correlation between body mass index and macronutrient

t intake Table 4, whereas, underweight or normal weight adolescents showed significantly lower macronutrient intake of carbohydrates, fat and protein in a previous study [28]. Hong [29] did not see any difference in carbohydrate, fat and protein intake between the normal weight group and overweight group. Based on this study and previous studies, it can be suggested that meals to prevent obesity should be balanced in terms of carbohydrates, fat and protein, and that low-fat diets with increased protein intake, preferably vegetable protein, would help reduce body fat percentages.

Meanwhile, 42.5% of office workers have irregular meals [10], 52.3% eat out once or more per day, and 33.4% skip breakfast, which is higher than the average breakfast skipping ratio of 21.4% [30]. Causes of irregular meals include loss of appetite from stress due to insufficient time in the morning, excessive work the day before, and complex personal relations. Snacks or late-night meals as opposed to 3 regular meals contributes highly to office workers' nutritional intake [31] and late-night meals interfere with breakfast, causing irregular eating habits [32,-33]. Results of this study showed that the breakfast amount of the normal group was significantly higher than that of the overweight group ($p < .029$), while on the other hand, the dinner amount of overweight group was significantly higher than that of the normal weight group ($p < .001$) Table 2. Body mass index was positively correlated to dinner Table 4. This implies that meals focused on dinner, drinking, and late-night meals influence imbalances in dining patterns, and the energy imbalance through the intake is saved in the body and increases the accumulation of body fat, leading to obesity; thus, dinner could be the most influential factor from among all dietary intake lifestyle factors related to obesity.

According to previous studies, workers' daily energy consumption differed depending on their job types and characteristics, but was lower in office workers than production workers [34]. Jung [35] reported that in a study of 312 middle-aged workers, job-related physical activity and total physical activity were highly correlated, and job-related physical activity made up almost all physical activity. According to the results of this study, the normal weight group showed a significantly higher energy consumption than the overweight group ($p < .001$). Results for commute time, work hours and sedentary time showed that the normal weight group's commute time was longer than that of the overweight group ($p < .001$) Table 3, and although this was not reflected in these results, they tended to use mostly public transportation. Also, the correlation analysis with body mass index showed a significant correlation with commute time ($p < .001$) and sedentary time ($p < .007$) Table 5. In a study by Kim et al. [36], which states that use of public transportation and bicycles is related to individual's obesity reduction, walking has been proven to control hypertension, diabetes, and hyperlipidemia, and to be effective in preventing heart disease and stroke and in treating obesity. Therefore, longer commute time leads to longer activity time, increasing the energy consumption, and using public transportation in particular helps increase energy consumption in daily life. On the other hand, work hours ($p < .017$) and sedentary time ($p < .001$) were longer in the overweight group than in the normal weight group. Bauman et al. [37] investigated sedentary time during the week including at work and home, and stated that the inactive group was 3 times more likely to be sitting more than 9 hours compared to the active group; a study by Jans et al. [15] stated that workers who sit for a prolonged time at work tend to not move at home either. A sedentary lifestyle is classified as the health risk factor [38], and Stamatakis et al. [39] insisted that a sedentary lifestyle is a cause of obesity and weight gain. Thus, a sedentary lifestyle is an independent risk factor for obesity and should be eliminated while physical activity is increased. In this regard, an increase in office workers' work hours would mean an increase in sedentary hours, and the long work hours of the overweight group are suspected to involve inactive activities such as using a computer or reading after work, as opposed to exercising. Furthermore, since the difference in sedentary time between the groups is greater than the difference in work hours, the overweight group probably spends more time sitting down in other places besides the office. Muscle activity required to stand is stopped during prolonged sitting and may have

negative effects in activity within the cells of skeletal muscles that control obesity risk factors [40,-41]. Prolonged sitting or lying down causes a 50% increase in fat in the pressure d area, the speed of preadipocyte cells turning into fat cells increases, and the blood vessels of body parts with little or no movement don't develop as well as the parts with lots of movement, facilitating fat accumulation. Therefore, longer sedentary hours are more likely to lead to weight gain, even with exercise and diet [21].

Finally, regarding the effects of lifestyle factors related to dietary intake and energy consumption on body mass index Table 6, results for commute time were most significant, followed by sedentary time ($p<.041$) and dinner intake ($p<.007$). Such results indicate that these are the major causes of obesity in office workers. The results showed that job-related physical activity affects total physical activity, and office workers have higher health risks due to imbalanced diets and less physical activity, implying that these risks are related to a sedentary lifestyle. Therefore, changes in work environment, such as having a place to work standing up or having time for light exercise during work hours, should be made to reduce sedentary time and increase energy consumption, which should also be increased through regular exercise.

5. Conclusion

Physical measurements and questionnaires were used in this study to examine lifestyle habits related to dietary intake and energy consumption along with a record of dietary and physical activity for 3 days from 84 male office workers. Subjects were classified into a normal weight group and an overweight group according to their body mass index, and the following results were obtained by comparing lifestyle habits related to dietary intake and energy consumption.

Firstly, there was no significant difference between the two groups' dietary intake, but fat intake, dinner intake, and breakfast skipping frequency were significantly higher in the overweight group than in the normal weight group.

Secondly, there was a significant difference in energy consumption between the two groups; commute time among energy consumption-related lifestyle habits was longer in the normal weight group than in the overweight group, and work hours and total sedentary time were higher in the overweight group than in the normal weight group.

Thirdly, in terms of lifestyle habits related to dietary intake and energy consumption, dinner intake and sedentary time influenced the office workers' body mass index and commute time was also related.

In summary, the eating habits focused on dinner and sedentary habits after work hours in male office workers seem to have the greatest influence on their obesity. For this reason, studies to induce regular eating habits and develop exercise programs for before and after work hours should be conducted, followed by a study to confirm the efficiency of the developed program.

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