

Original Article



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Breakfast Intake Effect on the Association between Fast-Food Consumption and the Risk of Obesity and Dyslipidemia in Korean Adults Aged 20–39 Years Based on the Korea National Health and Nutrition Examination Survey IV 2013–2014

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ABSTRACT

We investigated the association between fast-food (FF) consumptions and the risk of overweight/obesity and dyslipidemia in Korean adults (20–39 years) based on the Korea National Health and Nutrition Examination Survey (2013–2014). We also examined the effect of breakfast intake on the risk of overweight/obesity and dyslipidemia according to their frequencies of FF consumption. FF consumption was categorized into 3 groups: < 1 time/month (n = 79); 1–3 times/month (n = 1,173); and ≥ 1 time/week (n = 474). People consuming FF ≥ 1 time/week had unhealthy lifestyles, higher intake of total calorie, fat, and protein, and higher levels of blood pressure, total cholesterol (TC) and low-density lipoprotein (LDL)-cholesterol than those consuming FF < 1 time/month. Logistic regression analysis showed higher risk of overweight/obesity in people consuming FF 1–3 times/month (odds ratio [OR], 2.525; confidence intervals [CIs], 1.169–5.452; p = 0.018) and ≥ 1 time/week (OR, 2.646; CIs, 1.128–6.208; p = 0.025) than those consuming FF < 1 time/month after the adjustment. The risk of dyslipidemia was also higher in people consuming FF ≥ 1 time/week than those consuming FF < 1 time/month after the adjustment (OR, 2.444; CIs, 1.047–5.704; p = 0.039). Furthermore, among people consuming FF ≥ 1 time/week, irregular breakfast consumers (≤ 2 times/week, n = 215) had significantly higher levels of triglyceride, TC, and LDL-C than regular breakfast consumers (5–6 times/week, n=180). Irregular breakfast consumers also showed a higher risk of dyslipidemia than regular breakfast consumers after the adjustment (OR, 2.913; CIs, 1.463–5.801; p = 0.002). In conclusion, frequent FF consumption increases the risk of obesity and dyslipidemia in Korean adults aged 20–39 years. Particularly among

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Conflict of Interest

The authors declare that they have no competing interests.

the frequent FF consumers, irregular breakfast intake may contribute to the increased risk of dyslipidemia. It may provide an evidence for proper dietary education to reduce the risk of overweight/obesity and dyslipidemia in Koreans adults aged 20–39 years.

Keywords: Fast foods; Breakfast; Obesity; Dyslipidemia; Nutrition Survey

INTRODUCTION

The prevalence of obesity has been continuously increasing and doubled in the past three decades and become a worldwide problem [1,2]. Increased weight gain and large waist circumference are main causes of metabolic dysfunction such as impaired blood pressure (BP), glucose intolerance, and dyslipidemia (i.e., low levels of high-density lipoprotein [HDL]-cholesterol, and high levels of triglyceride, total cholesterol or low-density lipoprotein [LDL]-cholesterol) [3,4], all of which are strongly associated with the increased prevalence of type 2 diabetes (T2D) and cardiovascular disease (CVD) [5-8].

Dietary factors are important contributors to the incidence of obesity and related metabolic disorders [3,9]. For example, an imbalance between energy intake and expenditure, excessive intake of certain nutrients (i.e., trans-fats, saturated fats, simple sugars, and salty sources), and unhealthy eating habits (i.e., irregular meal time, overeating and starvation) lead to a rapid rise of obesity, which contributes to the increase of cardiovascular risk through energy-independent and independent mechanisms [10,11].

According to the 2017 National Health Statistics reported by the Korean Center for Disease Control and Prevention (KCDC, Cheongju, Korea) based on data from the Korean National Health and Nutrition Examination Survey (KNHANES), two-fifth of Korean adults had body mass index (BMI) $\geq 25\text{kg/m}^2$, one-fifth had dyslipidemia, a third had hypertension, and a tenth had diabetes, and of which the incidences have been gradually rising; the rates of unhealthy and irregular dietary habits such as skipping breakfast and eating-out have been increasing every year which were highly observed in 20s (52.0% and 39.1%, respectively) and 30s (37.1% and 39.1%, respectively) among the all age group (29.8% and 30.1% respectively); and fast-food (FF) consumption is also increasing in adolescents as well as young adults. According to the report by the Ministry of Education (Seoul, Korea), more than 70% of adolescent are consuming FF ≥ 1 time/week. Particularly, Western-style FF consumption has been considered a potentially important dietary factor [12,13]. FF is defined as a type of mass-produced food prepared and served very quickly in self-service or take-out eating places [12,13]. FF includes burgers, fries, hamburgers, pizza, fried chicken, patties, and nuggets [14,15], which are characterized by a portion size served as a single large meal often exceeding the individual daily energy requirements, high energy density, high glycemic load, and palatability, with added sugar, salt, and fat [9,16]. Several studies have demonstrated that frequent FF intake might increase the risk of obesity and several chronic diseases such as T2D and CVD [17-19]. A study also reported that intake of unhealthy foods (i.e., insufficient micronutrients and energy-dense foods) is positively associated with the number of FF restaurants in a neighborhood [20]. Accordingly, the community exposed to FF restaurants had a positive relationship with an elevated BMI and abdominal obesity [21]. The World Cancer Research Fund and American Institute for Cancer Research also recommend a decrease in FF intake to reduce the risk of chronic diseases [22,23].

As mentioned above, FF consumption has increased worldwide and was associated with weight gain and metabolic abnormalities, but their associations were rarely studied among Korean adults. Therefore, this study aimed to examine if the frequency of FF consumption is associated with the risk of obesity and related metabolic disorders in Korean adults aged 20 to 39 years who have relatively unhealthy dietary habit (i.e. higher rates of skipping breakfast and eating-out) among the adults, and also if breakfast intake regularity can contribute to the risk of obesity and related metabolic disorders among frequent FF consumers using data from the KNHANES (2013–2014).

MATERIALS AND METHODS

Study population

This study was based on data from the KNHANES VI (2013–2014) (KCDC, Cheongju, Korea). Data for all participants were accumulated from home-based and individual interviews via self-administration or face-to-face interview methods. The KNHANES VI (2013–2014) included the data of 15,568 individuals who completed interviews, surveys, and examinations. Among the 15,568 participants, the analyses for this study were limited to adults aged 20–39 years. A total of 8,485 subjects were excluded as they did not satisfy the criteria for age. In addition, subjects were excluded if they had missing data for nutrition survey including the food frequency questionnaire (FFQ) and 24-hour dietary recall ($n = 3,029$), and had a diagnosis of chronic disease including vascular disease, diabetes mellitus, hyperlipidemia, hypertension, cancer, renal disease, and liver disease or were taking the related medications ($n = 2,288$). Furthermore, 40 subjects were excluded as the total calorie intake per day was greater than 5,000 calories or less than 500 calories per day. Thus, a total of 1,726 subjects (689 male and 1,037 female subjects) were finally included for the statistical analysis (**Figure 1**). In this study, subjects were categorized into three groups according to the frequency of FF consumption: those with FF intake < 1 time/month ($n = 79$), those with FF intake 1–3 times/month ($n = 1,173$), and those with FF intake ≥ 1 time/week ($n = 474$). Particularly, people with FF intake ≥ 1 time/week ($n = 474$) were additionally subcategorized into three group according to breakfast intake frequency: 5–6 times/week ($n = 180$), 3–4 times/week ($n = 79$) and ≤ 2 times/week ($n = 215$). The procedures for conducting the KNHANES were approved by the Institutional Review Board of the KCDC (2013-07CON-03-4C, 2013-12EXP-03-5C), and written informed consent was obtained from all survey participants.

Definitions of obesity, and dyslipidemia

Obesity was defined as a BMI greater than or equal to 25 kg/m^2 , in agreement with the guidelines from the Korean society for the study of obesity. Dyslipidemia was defined as the level of triglycerides greater than or equal to 150 mg/dL , HDL-cholesterol less than or equal to 60 mg/dL , LDL-cholesterol greater than or equal to 130 mg/dL , or total cholesterol greater than or equal to 200 mg/dL , according to the guidelines of the Korean society of lipid and atherosclerosis (3rd Ed. 2015).

Data information

Anthropometric, lifestyle, sociodemographic data, biochemical parameters, and dietary information were obtained from the KNHANES (2013–2014). As anthropometric parameters, body weight, height, waist circumference, BPs were collected, and BMI was calculated as weight per height squared (kg/m^2). Lifestyle and sociodemographic data include physical activity, cigarette smoking, alcohol consumption, household income, and education level.

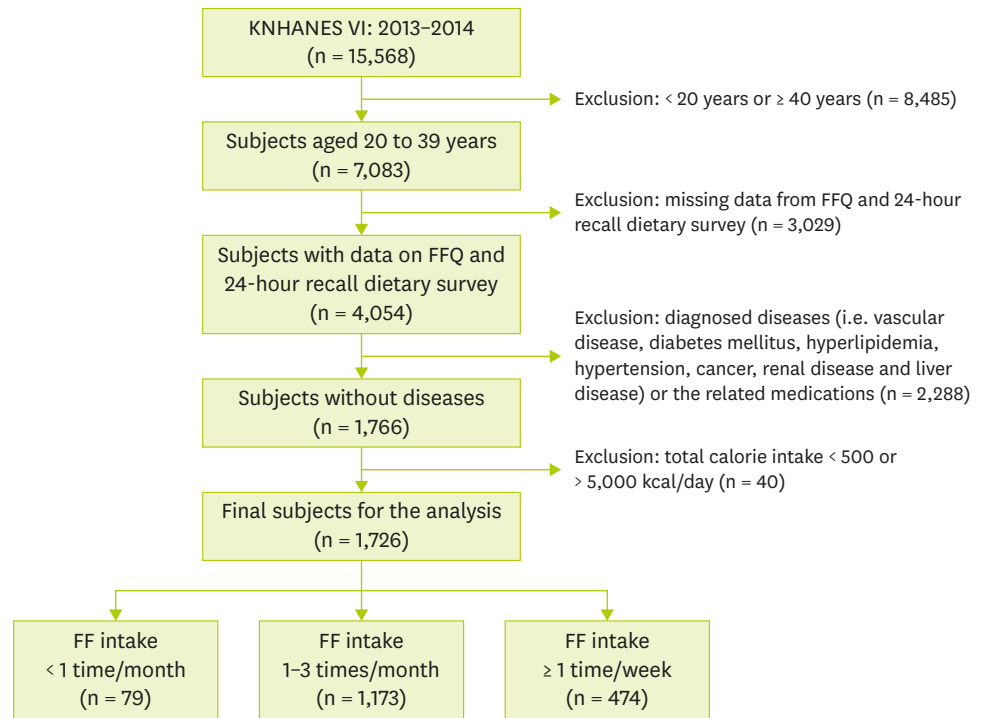


Figure 1. Flow chart of the study population.

KNHANES, Korean National Health and Nutrition Examination Survey; FFQ, food frequency questionnaire; FF, fast-food.

Precisely, physical activity was based on exercise experience: the exercise group comprised 2 main types: 1) vigorous physical activity was defined as exercise for at least 20 minutes a day for at least 3 days per week, 2) moderate physical activity was defined as exercise for at least 30 minutes a day for at least 5 days per week. Regarding cigarettes smoking, subjects who had smoked more than 100 cigarettes during their lifetimes and were presently smoking were considered as current smokers. Drinking habit was surveyed on frequency, alcoholic drink type, and length of alcohol consumption patterns. Subjects who consumed alcohol more than once a month were considered as current alcohol drinkers. Household income was categorized into four levels: lowest, lower middle, upper middle, and highest. In addition, education level was classified into ≤ 12 or > 12 years according to the number of years of schooling. As biochemical parameters, serum concentrations of fasting glucose, total cholesterol, triglyceride, HDL-cholesterol, LDL-cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine and hemoglobin A1C (Hb_{A1C}) were collected. Dietary Information was obtained from a FFQ and a 24-hour recall method. In this study, FF includes burgers, fries, pizza, or fried chicken, which was investigated from the FFQ data. The FFQ assessed how often subjects consumed each of the 63 food items based on one portion size per time during the last year according to a 10-point scale (9 points, 3 times per day; 8 points, 2 times per day; 7 points, once per day; 6 points, 4–6 times per week; 5 points, 2–3 times per week; 4 points, once per week; 3 points, 2–3 times per month; 2 points, once per month; 1 point, 6–11 times per year; and 0 point, almost never). The scales were revised to units per week. Among the items in the FFQ, selected food items were categorized following previous report [24] as follows: 1) grains (rice, whole grains, noodles, bread, and rice cake), 2) meat, fish, and eggs (beef, pork, fish, poultry, and eggs), 3) vegetables (white radish, soybean sprout, spinach, cucumber, hot pepper, carrot, pumpkin, cabbage, and tomatoes),

4) fruits (mandarin orange, persimmon, pear, watermelon, oriental melon, strawberry, grapes, peach, apple, banana, and orange), 5) milk and dairy products, and 6) soft-drinks. Daily total calorie intake (TCI) (kcal/day) and macronutrient content such as proportion of dietary carbohydrates, proteins, and fats derived from TCI estimated using Computer Aided Nutritional analysis program (Can-Pro 2.0 software; Korean Nutrition Society, Seoul, Korea) were collected. The frequency of breakfast intake assessed by self-reporting questionnaire was categorized into three group such as 5–6 times/week, 3–4 times/week and ≤ 2 times/week.

Statistical analysis

All statistical analyses were performed using SPSS software, version 23.0 (SPSS Inc., Chicago, IL, USA) for Windows. The complex sampling design recommended in the guidelines for the using raw data of the KNHANES was employed in the analysis. Categorical variables were presented as the number (percentage) and tested by the χ^2 method. Continuous variables were presented as the mean \pm standard errors for the descriptive, and were tested using one-way analysis of variance (unadjusted) or general linear model (adjustment for confounding factors) with the Bonferroni correction. The distribution of continuous variables was inspected to detect outliers and non-normal distribution before statistical analysis. The skewed variables were tested after log-transformation. The odds ratios (ORs) and 95% confidence intervals (CIs) for the risk of obesity and dyslipidemia according to the frequency of FF consumption in whole population (reference group: FF consumption < 1 time/month) or according to the frequency of breakfast consumption among frequent FF consumers (reference group: breakfast consumption 5–6 times/week) were calculated using a logistic regression model. Briefly, model 1 indicates non-adjustment (P0); model 2 indicates the adjustment for age, sex, TCI, alcohol drinking, cigarette smoking, household income, education levels, and physical activity (P1); and model 3 indicates further adjustment for specific food group consumptions that were significantly different among the three FF consumer groups (P2). Model 4 indicates further adjustment for breakfast intake frequency (P3). The p values of less than 0.05 were considered as statistically significant.

RESULTS

General characteristics of participants according to the frequency of FF consumption

Table 1 shows the general characteristics of Korean adults aged 20–39 years without diagnosed disease according to the frequency of FF consumption. People consuming FF ≥ 1 time/week or 3–4 times/month were younger than those consuming FF < 1 time/month. The proportions of male participants, current smokers, current alcohol drinkers, those with longer education period, and those with relatively higher household income were significantly higher in people consuming FF ≥ 1 time/week than in those consuming 3–4 times/month or < 1 time/month. However, the proportion of physical activity was not significantly different among the three groups. People consuming FF ≥ 1 time/week showed more irregular breakfast intake and had higher amount of total calorie, fat and protein, and lower amount of carbohydrate (P0) compared with those consuming FF < 1 time/week. In addition, those consuming FF ≥ 1 time/week showed higher intakes in grains, meat, fish, and eggs, vegetables, and soft drinks, but not in fruits, and milk and dairy products compared with those consuming FF < 1 time/month or 3–4 times/month (data not shown). The statistical significance for dietary carbohydrate intake and selected food group consumptions were still maintained after the adjustment

Table 1. General characteristics and dietary intake according to the frequency of FF intake among Korean adults aged 20–39 year (n = 1,726)

Characteristics	FF intake			p value		
	< 1 time/month (n = 79)	1–3 times/month (n = 1,173)	≥ 1 time/week (n = 474)	P0	P1	P2
Age (yr)	33.4 ± 0.55 ^a	31.3 ± 0.17 ^b	29.38 ± 0.26 ^c	< 0.001	-	-
Male sex	25 (31.6)	434 (37.0)	230 (48.5)	< 0.001	-	-
Physical activity	20 (25.3)	328 (28.0)	140 (29.5)	0.681	-	-
Current smoker	11 (13.9)	215 (18.3)	114 (24.1)	0.013	-	-
Current drinker	24 (41.4)	591 (64.0)	279 (74.8)	< 0.001	-	-
Education levels				0.047	-	-
≤ 12 yr	22 (32.4)	244 (23.8)	81 (19.8)			
> 12 yr	46 (67.6)	783 (76.2)	329 (80.2)			
Household income status				0.036	-	-
Lowest	6 (7.6)	70 (6.0)	31 (6.6)			
Lower middle	32 (40.5)	303 (25.9)	113 (23.9)			
Upper middle	15 (19.0)	410 (35.1)	167 (35.4)			
Highest	26 (32.9)	385 (33.0)	161 (34.1)			
Breakfast intake				0.002	-	-
≤ 2 times/week	21 (26.6)	440 (37.5)	215 (45.4)			
3–4 times/week	12 (15.2)	221 (18.8)	79 (16.7)			
5–6 times/week	46 (58.2)	512 (43.6)	180 (38.0)			
Total calorie and macronutrients intake (per day)						
Total calorie intake	1,949.2 ± 79.9 ^a	2,060.3 ± 24.6 ^a	2,295.4 ± 41.1 ^b	< 0.001	-	-
Carbohydrate (%)	62.4 ± 1.36 ^a	59.7 ± 0.32 ^b	55.6 ± 0.53 ^c	< 0.001	< 0.001	0.004
Protein (%)	14.4 ± 0.48	14.4 ± 0.13	15.1 ± 0.22	0.014	0.616	0.417
Fat (%)	21.7 ± 1.08	22.4 ± 0.25	24.0 ± 0.41	0.003	0.003	0.407

Values are presented as mean ± standard error (SE) or number (%). Statistical differences were determined using the χ^2 test for categorical variables. Statistical significances of biochemical markers and food group consumption frequency were determined by one-way analysis of variance (unadjusted: P0) or by general linear model followed with Bonferroni multiple correction after adjustment for age, sex, total calorie intake, drinking, smoking, household income, education levels, and physical activity (P1), with further adjustment for breakfast intake frequency (P2). FF, fast-food.

Sharing the same alphabet indicates no statistical significant differences in the same raw.

for age, sex, TCI, alcohol drinking, cigarette smoking, household income, education levels, physical activity and breakfast intake frequency.

Anthropometric and biochemical parameters according to the frequency of FF consumption

Table 2 presents anthropometric and biochemical parameters according to the frequency of FF consumption. As the frequency of FF consumption increases, people were heavier, had larger waist circumferences and high BPs (P0). The statistical significance was still maintained after adjustment for age, sex, TCI, alcohol drinking, cigarette smoking, household income, education levels, physical activity, and breakfast intake frequency (P1–P3). Regarding biochemical parameters, people consuming FF ≥ 1 time/week showed higher levels of total cholesterol, and LDL-cholesterol than those consuming FF < 1 time/month after adjustment (P1–P3). Serum triglyceride levels were also significantly higher in people consuming FF ≥ 1 time/week than the other two groups before and after adjustment (P0 and P1), but the significance disappeared after further adjustment for specific food group consumption and breakfast intake frequency (P2 and P3). On the other hand, serum levels of fasting glucose, Hb_{A1C}, HDL-cholesterol, AST, ALT, and creatinine were not significantly different among the 3 groups before and after adjustment.

Association between the frequency of FF consumption and the risk of obesity and dyslipidemia

Based on the results shown in **Tables 1** and **2**, the association between the frequency of FF consumption and the risk of obesity and dyslipidemia were evaluated by comparison of OR

Table 2. Anthropometric and biochemical parameters according to the frequency of FF intake among Korean adults aged 20–39 year (n = 1,726)

Parameters	FF intake			p value			
	< 1 time/month (n = 79)	1–3 times/month (n = 1,173)	≥ 1 time/week (n = 474)	P0	P1	P2	P3
BMI (kg/m ²)	21.8 ± 0.34 ^a	23.1 ± 0.12 ^b	23.18 ± 0.19 ^b	0.017	0.002	0.002	0.001
Waist (cm)	73.6 ± 0.99 ^a	77.8 ± 0.32 ^b	78.43 ± 0.50 ^b	< 0.001	< 0.001	< 0.001	< 0.001
Systolic BP (mmHg)	104.0 ± 1.34 ^a	108.8 ± 0.36 ^b	110.2 ± 0.59 ^b	< 0.001	< 0.001	< 0.001	< 0.001
Diastolic BP (mmHg)	69.5 ± 1.18 ^a	72.2 ± 0.30 ^b	73.23 ± 0.48 ^b	0.010	0.003	0.002	< 0.001
Fasting glucose (mg/dL)*	93.0 ± 2.75	91.6 ± 0.48	92.1 ± 0.95	0.848	0.004	0.753	0.714
Hemoglobin _{A1c} (%)	5.61 ± 0.13	5.50 ± 0.02	5.52 ± 0.03	0.279	< 0.001	0.111	0.134
Total cholesterol (mg/dL)	173.9 ± 4.23 ^a	179.7 ± 0.98 ^{ab}	183.1 ± 1.81 ^b	0.058	< 0.001	0.001	0.010
Triglyceride (mg/dL)*	96.8 ± 8.58 ^a	113.0 ± 3.02 ^{ab}	127.3 ± 6.01 ^b	0.030	< 0.001	0.191	0.146
LDL-cholesterol (mg/dL)*	100.5 ± 3.89 ^a	104.7 ± 0.86 ^b	105.6 ± 1.38 ^b	0.263	< 0.001	0.003	0.006
HDL-cholesterol (mg/dL)	55.9 ± 1.21	55.0 ± 0.40	55.6 ± 0.59	0.658	0.070	0.185	0.885
AST (IU/L)	18.6 ± 1.12	19.5 ± 0.40	19.2 ± 0.38	0.810	0.928	0.290	0.874
ALT (IU/L)	16.6 ± 1.44	21.1 ± 0.92	19.9 ± 0.78	0.321	0.678	0.179	0.312
Creatinine (mg/dL)	0.77 ± 0.02	0.81 ± 0.01	0.83 ± 0.01	0.172	0.983	0.466	0.979

Values are presented as mean ± standard error or %.

FF, fast-food; BMI, body mass index; BP, blood pressure; ALT, alanine aminotransferase; AST, aspartate aminotransferase; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

*Tested after log-transformation. Statistical significances were determined by one-way analysis of variance (unadjusted: P0) or by general linear model followed with Bonferroni multiple correction after adjustment for age, sex, total calorie intake, drinking, smoking, household income, education levels, and physical activity (P1), with further adjustment for the food groups which were significantly different among the FF intake frequency status (grains; meat, fish, and eggs; vegetables; soft-drinks) (P2) and further adjustment for breakfast intake frequency (P3). Sharing the same alphabet indicates no statistical significant differences in the same raw.

(95% CIs) using a logistic regression model with adjustment for confounding factors (**Table 3**). The risk for obesity (BMI ≥ 25 kg/m²) was higher in those consuming FF 3–4 times/month (Model 1: OR, 2.064; 95% CI, 1.124–3.790; p = 0.020) and ≥ 1 time/week (Model 1: OR, 2.043; 95% CI, 1.091–3.825; p = 0.026) compared with people consuming FF < 1 time/month (reference group). The statistical significances were still maintained after the adjustment for age, sex, TCI, alcohol drinking, cigarette smoking, household income, education levels, physical activity, specific food group consumption, and breakfast intake frequency in those consuming FF 3–4 times/month (Model 2: OR, 2.449; 95% CI, 1.148–5.223; p = 0.020; Model 3: OR, 2.491; 95% CI, 1.156–5.369; p = 0.020; and Model 4: OR, 2.525; 95% CI, 1.169–5.452; p = 0.018) and in those consuming FF ≥ 1 time/week (Model 2: OR, 2.532; 95% CI, 1.124–5.701; p = 0.025; Model 3: OR, 2.871; 95% CI, 1.235–6.677; p = 0.014; and Model 4: OR,

Table 3. ORs and 95% CI for obesity and dyslipidemia by the frequency of FF intake among Korean adults aged 20–39 year (n = 1,726)

Variables	FF intake				
	< 1 time/month (n = 79) (reference)	1–3 times/month (n = 1,173)		≥ 1 time/week (n = 474)	
		ORs (95% CIs)	p value	ORs (95% CIs)	p value
Obesity					
Model 1	1.000	2.064 (1.124–3.790)	0.020	2.043 (1.091–3.825)	0.026
Model 2	1.000	2.449 (1.148–5.223)	0.020	2.532 (1.124–5.701)	0.025
Model 3	1.000	2.491 (1.156–5.369)	0.020	2.871 (1.235–6.677)	0.014
Model 4	1.000	2.525 (1.169–5.452)	0.018	2.646 (1.128–6.208)	0.025
Dyslipidemia					
Model 1	1.000	1.279 (0.694–2.357)	0.431	1.427 (0.758–2.688)	0.271
Model 2	1.000	1.372 (0.671–2.809)	0.386	2.460 (1.112–5.440)	0.026
Model 3	1.000	1.378 (0.671–2.828)	0.383	2.883 (1.255–6.626)	0.013
Model 4	1.000	1.354 (0.658–2.788)	0.411	2.444 (1.047–5.704)	0.039

OR (CIs), performed by logistic regression model. Reference: Low-FF consumers. Model 1: unadjusted; Model 2: adjusted for age, sex, total calorie intake, drinking, smoking, household income, education levels, and physical activity; Model 3: further adjustment for the food groups that were significantly different among the FF intake frequency status (grains; meat, fish, and eggs; vegetables; soft-drinks); and Model 4: further adjustment for breakfast intake frequency. Dyslipidemia is defined as triglyceride level greater than or equal to 150 mg/dL, high-density lipoprotein cholesterol less than or equal to 60 mg/dL, low-density lipoprotein cholesterol greater than or equal to 130 mg/dL, or total cholesterol greater than or equal to 200 mg/dL. Obesity is defined as BMI greater than or equal to 25 kg/m².

OR, odds ratio; CI, confidence interval; FF, fast-food; BMI, body mass index.

2.646; 95% CI, 1.128–6.208; $p = 0.025$). In addition, the risk of dyslipidemia was higher in people consuming FF ≥ 1 time/week than those consuming FF < 1 time/month after adjustment (Model 2: OR, 2.460; 95% CI, 1.112–5.440; $p = 0.026$; Model 3: OR, 2.883; 95% CI, 1.255–6.626; $p = 0.013$; and Model 4: OR, 2.444; 95% CI, 1.047–5.704; $p = 0.039$).

Based on the above results, frequent FF consumers (≥ 1 time/week) had higher risks of obesity and dyslipidemia, and showed more irregular breakfast intake compared with less frequent FF consumers (< 1 time/week). Therefore, we examined whether breakfast intake level affects metabolic parameters and is associated with the risk of obesity and dyslipidemia among the frequent FF consumers. People consuming FF ≥ 1 time/week were categorized into three groups by the frequency of breakfast intake: little or no breakfast (≤ 2 times/week, $n = 215$), breakfast on few days (3–4 times/week, $n = 79$), and breakfast everyday (5–6 times/week, $n = 180$).

The effect of breakfast intake on general and metabolic parameters among frequent FF consumers (FF intake ≥ 1 time/week)

Table 4 presents general characteristics and dietary intake according to the frequency of FF consumption among people consuming FF ≥ 1 time/week. The frequency of FF consumption per week was similar among the three groups (little or no breakfast [≤ 2 times/week]: 2.58 ± 0.10 , breakfast on few days [3–4 times/week]: 2.40 ± 0.14 , and breakfast everyday [5–6 times/week]: 2.47 ± 0.10 , $P_0 = 0.570$, $P_1 = 0.702$). People consuming little or no breakfast smoked more cigarettes than those consuming breakfast on few days or breakfast everyday (31.6%, 25.3%, and 14.4%, respectively). Regarding dietary intakes, people consuming breakfast everyday had relatively higher intake of dietary carbohydrate and lower intake of dietary fat than those consuming little or no breakfast before and after adjustment (P_0 and P_1). In addition, people consuming breakfast everyday showed higher intakes of grains and vegetables than those consuming little or no breakfast before and after the adjustment (data not shown). **Table 5** shows anthropometric and biochemical properties according to the

Table 4. General characteristics and dietary intake according to the frequency of breakfast intake in people consuming FF ≥ 1 time/week ($n = 474$)

Characteristics	Breakfast everyday: 5–6 times/week ($n = 180$)	Breakfast on few days: 3–4 times/week ($n = 79$)	Little or no breakfast: ≤ 2 times/month ($n = 215$)	p value	
				P_0	P_1
Male sex	83 (46.1)	39 (49.4)	108 (50.2)	0.707	-
Physical activity	50 (27.8)	26 (32.9)	64 (29.8)	0.703	-
Current smoker	26 (14.4)	20 (25.3)	68 (31.6)	< 0.001	-
Current drinker	89 (69.0)	46 (73.0)	144 (79.6)	0.101	-
Education levels				0.186	-
≤ 12 yr	22 (15.0)	17 (23.3)	42 (22.1)		
> 12 yr	125 (85.0)	56 (76.7)	148 (77.9)		
Household income status				0.782	-
Lowest	15 (8.4)	4 (5.1)	12 (5.6)		
Lower middle	38 (21.3)	20 (25.3)	55 (25.6)		
Upper middle	66 (37.1)	25 (31.6)	76 (35.3)		
Highest	59 (33.1)	30 (38.0)	72 (33.5)		
Total calorie and macronutrient intake (per day)					
Total calorie intake (kcal)	$2,307.1 \pm 66.0^b$	$2,358.8 \pm 101.1^a$	$2,262.4 \pm 61.8^a$	0.699	-
Carbohydrate (%)	57.7 ± 0.85^b	56.8 ± 1.19^b	53.4 ± 0.80^a	0.001	0.017
Protein (%)	15.0 ± 0.34	15.2 ± 0.45	15.0 ± 0.35	0.981	0.852
Fat (%)	23.1 ± 0.70^b	23.4 ± 0.94^{ab}	24.9 ± 0.59^a	0.110	0.016

Values are presented as mean \pm standard error or number (%). Statistical differences were determined using the χ^2 test for categorical variables. Statistical significances of biochemical markers and food group consumption frequency were determined by one-way analysis of variance (unadjusted: P_0) or by general linear model followed with Bonferroni multiple correction after adjustment for age, sex, total calorie intake, drinking, smoking, household income, education levels, and physical activity (P_1).

FF, fast-food.

Sharing the same alphabet indicates no statistical significant differences in the same row.

Table 5. Anthropometric and biochemical parameters according to the frequency of breakfast intake in people consuming FF ≥ 1 time/week (n = 474)

Parameters	Breakfast everyday: 5–6 times/week (n = 180)	Breakfast on few days: 3–4 times/week (n = 79)	Little or no breakfast: ≤ 2 times/week (n = 215)	p value		
				P0	P1	P2
BMI (kg/m ²)	22.9 \pm 0.27	22.8 \pm 0.38	23.6 \pm 0.30	0.134	0.271	0.358
Waist (cm)	77.3 \pm 0.79	77.9 \pm 1.05	79.5 \pm 0.79	0.118	0.261	0.428
Systolic BP (mmHg)	108.3 \pm 1.01	111.3 \pm 1.30	111.3 \pm 0.85	0.045	0.095	0.281
Diastolic BP (mmHg)	72.3 \pm 0.80	73.5 \pm 1.21	73.9 \pm 0.70	0.304	0.390	0.592
Fasting glucose (mg/dL)*	90.4 \pm 0.94	94.3 \pm 3.53	92.7 \pm 1.39	0.322	0.254	0.182
Hemoglobin A _{1c} (%)	5.49 \pm 0.03	5.58 \pm 0.10	5.51 \pm 0.04	0.534	0.125	0.071
Total cholesterol (mg/dL)	176.4 \pm 2.39 ^b	173.7 \pm 3.10 ^b	192.2 \pm 3.15 ^a	< 0.001	< 0.001	< 0.001
Triglyceride (mg/dL)*	111.4 \pm 7.35 ^b	110.9 \pm 8.56 ^b	146.6 \pm 11.2 ^a	0.013	0.003	0.008
LDL-cholesterol (mg/dL)*	100.6 \pm 2.03 ^b	100.3 \pm 2.75 ^b	111.8 \pm 2.26 ^a	< 0.001	< 0.001	< 0.001
HDL-cholesterol (mg/dL)	56.6 \pm 0.97	53.6 \pm 1.37	55.6 \pm 0.89	0.225	0.331	0.246
AST (IU/L)	18.8 \pm 0.55	19.0 \pm 0.70	19.7 \pm 0.64	0.523	0.749	0.738
ALT (IU/L)	17.5 \pm 0.93	20.0 \pm 1.91	21.8 \pm 1.35	0.042	0.052	0.221
Creatinine (mg/dL)	0.83 \pm 0.01	0.83 \pm 0.02	0.83 \pm 0.01	0.997	0.806	0.914

Values are presented as mean \pm standard error.

FF, fast-food; BMI, body mass index; BP, blood pressure; ALT, alanine aminotransferase; AST, aspartate aminotransferase; BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

*Tested after log-transformation. Statistical significances were determined by one-way analysis of variance (unadjusted: P0) or by general linear model followed with Bonferroni multiple correction after adjustment for age, sex, total calorie intake, drinking, smoking, household income, education levels, and physical activity (P1), with further adjustment for the food groups which were significantly different among the fast-food intake frequency status (grains; meat, fish, and eggs; vegetables; soft-drinks) (P2). Sharing the same alphabet indicates no statistical significant differences in the same raw.

frequency of breakfast intake among people consuming FF ≥ 1 time/week. People consuming little or no breakfast had significantly higher levels of total cholesterol, triglyceride, and LDL-cholesterol than those consuming breakfast on few days or breakfast everyday (P0, P1, and P2).

The effect of breakfast intake on the risk of dyslipidemia among frequent FF consumers (FF intake ≥ 1 time/week)

Table 6 presents the association between the frequency of breakfast intake and the risk of obesity, and dyslipidemia among people consuming FF ≥ 1 time/week, which were evaluated by comparison of the OR (95% CIs) using a logistic regression model with adjustment for confounding factors. The risk for dyslipidemia was higher in people consuming little or no breakfast compared with those consuming breakfast every day (reference group) (Model 1: OR, 2.037; 95% CI, 1.254–3.309; p = 0.004). The statistical significances were still maintained after the adjustment for age, sex, TCI, alcohol drinking, cigarette smoking, household income, education levels, physical activity, and specific food group consumption (Model 2: OR, 2.471; 95% CI, 1.348–4.529; p = 0.003; Model 3: OR, 2.913; 95% CI, 1.463–5.801; p = 0.002).

Table 6. ORs and 95% CI for obesity and dyslipidemia by the frequency of breakfast intake in people consuming FF ≥ 1 time/week (n = 474)

Variables	Breakfast 5–6 times/week (n = 180) (reference)	Breakfast 3–4 times/week (n = 79)		Breakfast ≤ 2 times/week (n = 215)	
		ORs (95% CIs)	p value	ORs (95% CIs)	p value
Obesity					
Model 1	1.000	0.950 (0.513–1.760)	0.870	1.510 (0.972–2.347)	0.066
Model 2	1.000	0.736 (0.343–1.581)	0.736	1.441 (0.837–2.480)	0.187
Model 3	1.000	0.724 (0.327–1.601)	0.425	1.554 (0.848–2.849)	0.154
Dyslipidemia					
Model 1	1.000	0.618 (0.279–1.368)	0.235	2.037 (1.254–3.309)	0.004
Model 2	1.000	0.900 (0.363–2.234)	0.821	2.471 (1.348–4.529)	0.003
Model 3	1.000	0.766 (0.289–2.027)	0.591	2.913 (1.463–5.801)	0.002

OR (CIs), performed by logistic regression model. Reference: low-FF consumers group. Model 1: unadjusted; Model 2: adjusted for age, sex, total calorie intake, drinking, smoking, household income, and education levels, and physical activity; Model 3: further adjustment for the food groups which were significantly different among the fast-food intake frequency status (grains; meat, fish, and eggs; vegetables; soft-drinks); Dyslipidemia is defined as triglyceride level greater than or equal to 150 mg/dL, high-density lipoprotein-cholesterol less than or equal to 60 mg/dL, low-density lipoprotein-cholesterol greater than or equal to 130 mg/dL, or total cholesterol greater than or equal to 200 mg/dL. Obesity is defined as body mass index greater than or equal to 25 kg/m². OR, odds ratio; CI, confidence interval; FF, fast-food.

On the other hand, there was no significant association between the frequency of breakfast consumption and the risk of obesity among people consuming FF ≥ 1 time/week.

DISCUSSION

The consumption of FF has been increasing worldwide because of its convenience to access and palatability, but it has been associated with the increased incidence of obesity and related metabolic disorders (i.e., dyslipidemia, metabolic syndrome, T2D, and CVD) [1-8]. This present study demonstrated that frequent FF consumption contributes to the increased risk of obesity and dyslipidemia in Korean adults aged 20–39 years. Furthermore, it shows that people who consume breakfast irregularly had a higher risk of dyslipidemia than those who consume breakfast regularly among frequent FF consumers (1 time \geq week). These outcomes may provide evidences for dietary education to prevent and manage the risk of obesity and related metabolic disorder in Koreans adults aged 20–39 years.

The results of the current study are partly in accordance with those obtained by previous community-based epidemiological, clinical, and intervention studies which showed a positive association between the Western-style FF consumption and the risk of obesity and metabolic diseases [11,18,19,22-27]. Anderson et al. [27] reported that the probability of being obese was higher in people consuming FF ≥ 1 time/week than in those consuming FF < 1 time/week. According to the study by Yeo et al. [24], high FF consumers (≥ 1 time/week) had higher adiposity and higher levels of LDL-cholesterol and inflammation than low FF consumers (< 1 time/week); particularly, interleukin-6 levels in the high FF consumers were positively correlated with the number of metabolic syndrome (MetS) risk factors. El-Seweidy et al. [26] also showed that higher expression of genes related to inflammation was caused by higher FF consumption. In addition, the Teheran Lipid and Glucose (TLG) study [28], a large-scaled cohort study showed that the frequency of FF consumption was positively correlated with weight gain in young adults (19–30 years) as well as in middle-aged adults (31–50 years), but the positive relationship between FF consumption and abdominal obesity was observed only in young adults. This study also shows that serum levels of LDL-cholesterol and triglyceride were positively associated with FF consumption in both age groups, but decreased levels of serum HDL-cholesterol were associated with increased FF consumption only in young adults [28]. Another report from the TLG study [23] demonstrated that children and adolescents (aged 6–18 years) living in Teheran showed undesirable effects of FF intake on the incidence of MetS, abdominal obesity, and hypertriglyceridemia during the 3.6-year follow-up period. Particularly, higher consumptions of sausages, French fries, and pizza were significantly associated with a higher risk of MetS. The Coronary Artery Risk Development in Young Adults study conducted for 15 years also reported that FF consumption is strongly and positively associated with weight gain and insulin resistance (IR) in young African-American and Caucasian adults [11]. In this study, people who frequently visited the FF restaurant (> 2 times/week) had an extra 4.5 kg weight gain and a 104% greater increase of IR for 15 years compared with those who infrequently visited the FF restaurant (< 1 time/week) during that period.

As mentioned above, FFs are popular for their convenience to access and palatability, but contain relatively unbalanced nutrient values compared with other foods and dishes [9,16]. These characteristics may contribute to the incidence of obesity, dyslipidemia, and other metabolic disorders [3,9]. Some FFs contain trans-fats partially and large amounts of

saturated fats that are known to cause IR and increase the risk of T2D [29]. FF also contains large amounts of highly refined grains and starchy sources and added sugars which have a high glycemic index [30]. Diets with a high glycemic index or high glycemic load were reported to increase the risk for T2D through observational, clinical, and experimental studies, but the conclusion still remains controversial [31-36].

In the present study, the frequent FF consumers (≥ 1 time/week) had relatively unhealthy life habits such as higher consumption of cigarette smoking and alcohol drinking, higher TCI, and an irregular breakfast intake compared with less frequent FF consumers. Interestingly, among the frequent FF consumers, those who had breakfast irregularly had unhealthier life habits and more increased risk of dyslipidemia than those who consumed breakfast everyday. The current study results are in accordance with those of several previous studies [37-40]. Higher proportions of current smoking and drinking were observed among the Irish people frequently consuming FF [37], and US people skipping breakfast intake [38]. Poti et al. [39] demonstrated that FF consumers had unhealthier dietary patterns outside the FF restaurant based on the data from the NHANES 2007–2010. Another study also showed that people with a negative attitude about healthy eating behavior consumed greater amounts of alcohol, white bread, meat products, and sugars than those with a positive attitude did [40]. Our present study reveals that socioeconomic status and demographic factors were also associated with the frequency of FF consumption: people who spent longer education period (> 12 years) more frequently consumed FF compared with those who spent education period ≤ 12 years, and also those with a higher household income status more frequently consumed FF than those with a lower household income status. These results are similar to the those shown in previous studies [41,42]. However, a cross-sectional study showed that young adults frequently consumed burgers and sandwiches when they had low-income levels [43].

In our study, we additionally examined whether regular breakfast intake affects metabolic parameters and is associated with the risk of obesity and dyslipidemia among the frequent FF consumers (≥ 1 time /week). Among the frequent FF consumers, those consuming little or no breakfast showed a significantly higher risk of dyslipidemia (approximately 3-fold increase) than those consuming breakfast almost everyday after adjusting for all confounding factors. Furthermore, frequent FF consumers who had little or no breakfast had relatively unhealthy life habits such as smoking more cigarettes and consuming lesser amounts of vegetables and grains than those who had a breakfast on few days or everyday. Several studies have examined the association of the breakfast-eating pattern with blood cholesterol levels and body weight [38,44-46]. Irregular breakfast consumption plays a significant role in cardiometabolic risk including elevated levels of triglyceride, total-, and LDL-cholesterol, or reduced levels of HDL-cholesterol, as well as overweight or abdominal obesity [38,44,45,47]. Irregular breakfast intake may lower the thermic effect of foods, and consequently contributes to the weight gain in the long-term [46] and then affects metabolic abnormality such as IR and dyslipidemia [29-36]. According to the study by Farshchi et al. [46], women who had an irregular meal consumption pattern showed relatively lower insulin sensitivity than those who had a regular meal consumption pattern. Another study by Farshchi et al. [44] demonstrated that people skipping breakfast had significantly higher postprandial insulin levels than those consuming breakfast regularly. On the other hand, no significant association between obesity and regular breakfast consumption was observed among Swedish women [47]. Furthermore, TCI was significantly higher in those who ate breakfast regularly than in those who ate breakfast irregularly among normal-weight adults [38], but it was not influenced by the irregular breakfast intake in healthy adults, according to

the NHANES data [44]. In our study, no significant differences were observed in BMI, waist circumference, and the risk of obesity according to the frequency of breakfast intake among the frequent FF consumers, even though the values seemed to be higher in those consuming little or no breakfast than among those consuming breakfast everyday. It may be due to that the observation was performed in the frequent FF consumers who already had higher levels of BMI and waist circumferences and a higher risk of obesity.

We have some limitations in this study. The sample size for examining the effect of breakfast intake on the risk of obesity and dyslipidemia among frequent FF consumer was relatively small ($n = 471$). It is needed to confirm in large sample size in the future. In addition, the information of alcohol consumption used in this study was the proportion of current drinkers, but not the amount of alcohol consumed. Lifestyle and dietary habits, and the risk of chronic disease might be associated with the amount of alcohol drinking. Further study considering the amount of alcohol drinking is needed to elucidate the effect of breakfast on the risk of obesity or dyslipidemia among frequent FF consumers. Further analysis for the interaction effect of breakfast intake and FF frequency on the risk of obesity and dyslipidemia also needs to be performed among the all subjects in order to determine whether breakfast intake pattern strongly affect the outcome.

Nevertheless, this study is a first study to show the effect of breakfast intake on the risk of obesity and dyslipidemia among frequent FF consumers from the Korean adults aged 20–39 years. It may provide an important evidence to establish optimal dietary guideline for young Korean adults aged 20–39 years who have relatively unhealthier habits (i.e. frequent eating-out and irregular breakfast intake).

CONCLUSION

This study demonstrated that frequent FF consumption may increase risk of obesity and dyslipidemia in Korean adults aged 20–39 years, and also presents that irregular breakfast intake may contribute to the increased risk of dyslipidemia among frequent FF consumers. It may suggest evidence for proper dietary education to prevent and manage the risk of overweight/obesity and dyslipidemia in Korean adults aged 20–39 years.

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