



Association between frequency of breakfast consumption and insulin resistance using triglyceride-glucose index

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INTRODUCTION

- Diabetes mellitus is an important chronic disease causing economic and social burden. Insulin resistance is a determinant of diabetes, and regular eating patterns are an important factor in blood sugar control.
- In modern society, eating habits have become of increased interest and many people are focused on high-quality meals and numerous dietary patterns. Many studies have investigated the relationship between skipping breakfast and health status.
- The findings that skipping breakfast is associated with an increased risk of T2DM in both men and women are in agreement across studies. Furthermore, skipping breakfast has been suspected to be a risk factor for T2DM, but the associations are not entirely consistent across ethnicities or sexes, and the issue has not been adequately addressed in the Korean population.
- The purpose of this study was to investigate the link between the frequency of weekly breakfast consumption and insulin resistance calculated by the TyG index in the Korean population.

MATERIALS AND METHODS

- Data source:** We used data from a cross-sectional, nationally representative survey — Korea National Health and Nutrition Examination Survey (KNHANES) VII(2016-2018) — conducted by the Korea Centers for Disease Control and Prevention.
- Study population:** The initial study population comprised 24,269 individuals. From among them, we excluded patients who were diagnosed with diabetes from a physician or had used medication for diabetes and had HbA1c levels greater than 6.5% (48 mmol/mol) or blood glucose values greater than 126.0 mg/dL, in order to conduct a study on people without diabetes. The subjects with missing data for all covariates were excluded from the study. Finally, data on 12,856 participants were included in the study.
- Outcome variables:** The main objective of this study was an assessment of insulin resistance using the TyG index, which is a product of the fasting levels of triglycerides and fasting glucose, which is a useful indicator for assessing insulin resistance. The TyG index was calculated as the $\ln(\text{triglycerides (mg/dL)} \times \text{fasting blood glucose (mg/dL)})/2$ [14]. The TyG index is expressed by a logarithmic scale. . Insulin resistance was divided into the following groups according to the median TyG index (8.5): low insulin resistance group (<8.5) and high insulin resistance group (≥8.5).
- Interesting variables:** The interesting variables, frequency of breakfast consumption, were based on following questions: “How many breakfasts did you have per week in the last year?”. There are four responses to the question: 5–7 times per week, 3–4 times per week, 1–2 times per week, and rarely (0 times per week). Based on responses to this survey, we reclassified groups of independent variables to 5–7 times per week, 1–4 times per week, and 0 times per week. The group having breakfast 5–7 times per week was set as the reference.
- Covariates:** The covariates were socioeconomic (gender, age, marital status, education attainment, household income, region, occupation), health-related (BMI, waist circumference, subjective health status, smoking status, frequency of alcohol consumption, physical activity), and nutritional variables (frequency of lunch and dinner consumption per week, macronutrients and calorie intake per day).
- Statistical analysis:** We used χ^2 -tests to examine the general characteristics of the participants. We also used multiple logistic regression analysis to estimate odd ratios (ORs) and 95% confidence intervals (CIs). Sampling weights were applied in all data analyses. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA). The level for statistical significance was 0.05.

RESULTS

Table 1. General characteristics of the study population.

Variables	Insulin Resistance (TyG Index)						p-Value ⁴
	Total		Low (<8.5)		High (≥8.5)		
	N	%	N	%	N	%	
Breakfast per week							<0.0001
0 times	1761	13.7	919	52.2	842	47.8	
1–4 times	2960	23.0	1626	54.9	1334	45.1	
5–7 times	8135	63.3	4039	49.6	4096	50.4	

- The total number of participants was 12,856, of which 6584 were considered to have low insulin resistance and 6272 were considered to have increased insulin resistance. In both groups, the frequency of breakfast consumption was 5–7 times per week for most of the participants.

Table 2. Odds ratio for insulin resistance.

Variables	Insulin Resistance		
	OR ¹	95% CI	p-Value ⁷
Breakfast per week			
0 times	1.42	(1.24–1.64)	<0.0001
1–4 times	1.17	(1.03–1.32)	0.0153
5–7 times	1.00		

- The group without breakfast had the greatest risk for increased insulin resistance. Compared with the reference group (breakfast 5–7 times per week), the odds ratios (95% CIs) for high insulin resistance were as follows: OR = 1.42 (95% CI 1.24–1.64) for breakfast 0 times per week; OR = 1.17 (95% CI 1.03–1.32) for 1–4 times per week.

RESULTS

Table 3. Results of subgroup analysis for the association between weekly breakfast frequency and insulin resistance according to different factors.

Variables	Insulin Resistance						
	5–7		0		1–4		p-Value ⁵
	OR ¹	OR ¹	95% CI	p-Value ⁵	OR ¹	95% CI	
Sex							
Male	1.00	1.47	(1.18–1.84)	0.0007	1.18	(0.96–1.44)	0.1214
Female	1.00	1.37	(1.14–1.64)	0.001	1.15	(0.98–1.35)	0.0805
Age							
<30	1.00	1.61	(1.16–2.25)	0.0048	1.16	(0.84–1.35)	0.3650
30–39	1.00	1.34	(0.99–1.80)	0.0582	1.18	(0.91–1.53)	0.2163
40–49	1.00	1.75	(1.28–2.38)	0.0004	1.42	(1.10–1.83)	0.0065
50–59	1.00	1.25	(0.88–1.76)	0.2096	0.84	(0.63–1.13)	0.2450
60–69	1.00	0.91	(0.54–1.56)	0.7385	1.20	(0.79–1.83)	0.4025
≥70	1.00	1.15	(0.50–2.63)	0.7453	1.01	(0.58–1.76)	0.9732
BMI ³							
Obese	1.00	1.70	(1.29–2.24)	0.0002	1.16	(0.93–1.46)	0.1926
Overweight	1.00	1.45	(1.08–1.94)	0.0137	0.90	(0.69–1.17)	0.4195
Underweight or Normal	1.00	1.31	(1.07–1.61)	0.0092	1.36	(1.14–1.64)	0.0009
Waist circumference ⁴							
Abdominal obesity	1.00	1.50	(1.14–1.97)	0.0040	1.15	(0.92–1.43)	0.2332
Normal	1.00	1.42	(1.20–1.68)	0.0001	1.19	(1.02–1.38)	0.0234
Physical activity							
Inactive	1.00	1.52	(1.26–1.84)	<0.0001	1.22	(1.04–1.43)	0.0172
Active	1.00	1.34	(1.08–1.66)	0.0073	1.12	(0.93–1.34)	0.2475
Lunch per week							
0 times	1.00	7.31	(1.50–35.7)	0.0141	1.59	(0.39–6.46)	0.5155
1–4 times	1.00	1.28	(0.76–2.13)	0.3508	1.13	(0.78–1.64)	0.5093
5–7 times	1.00	1.41	(1.21–1.63)	<0.0001	1.16	(1.02–1.32)	0.0296
Dinner per week							
0 times	1.00	– ²	–	–	– ²	–	–
1–4 times	1.00	1.24	(0.81–1.89)	0.3190	0.93	(0.66–1.33)	0.6966
5–7 times	1.00	1.45	(1.25–1.68)	<0.0001	1.20	(1.05–1.36)	0.0087

- Both men and women who reported “never eating breakfast” were more likely to be susceptible to a higher risk of insulin resistance compared to the breakfast 5–7 times per week reference group (men: OR = 1.47, 95% CI = 1.18–1.84; women: OR = 1.37, 95% CI = 1.14–1.64).
- The odds ratio of the overweight or obese group was significantly higher than those of the other groups. Individuals who did not eat breakfast at all were significantly more likely to be at higher risk (overweight: OR = 1.45, 95% CI = 1.08–1.94; obese: OR = 1.70, 95% CI = 1.29–2.24). In addition, individuals who had abdominal obesity showed higher ORs for high insulin resistance when they did not have breakfast at all each week compared with the normal group (OR = 1.50, 95% CI = 1.14–1.97).
- People without physical activity were more likely to have increased insulin resistance when skipping breakfast (OR = 1.52, 95% CI = 1.26–1.84) or having breakfast under 4 times per week (OR = 1.22, 95% CI = 1.04–1.43).

DISCUSSION

- The present study was designed to examine the association between weekly breakfast frequency and insulin resistance in the Korean population using the TyG index. We observed that decreased weekly breakfast frequency was associated with a higher risk of insulin resistance in people without diabetes. Additionally, not eating breakfast was significantly associated with the highest probability of insulin resistance.
- The subgroup analysis revealed that the association between the frequency of breakfast consumption and insulin resistance was more pronounced amongst participants with obesity and abdominal obesity (p-values for interaction were <0.05).
- Our study results support and extend the findings from previous studies by showing that having breakfast more than once a week can help prevent diabetes by lowering insulin resistance compared to not having breakfast at all.
- The present study is important for public health because it considers the preventive aspects of T2DM, which has a high disease burden. Moreover, it clarifies the association between breakfast frequency and insulin resistance; eating breakfast is a lifestyle habit that can be easily modified for the prevention of T2DM.
- This study has several limitations that should be considered when interpreting the results. First, as this study was a cross-sectional study, the results cannot infer a clear causal relationship between the frequency of breakfast and insulin resistance. Second, despite the efforts of the surveying agency to reduce bias, the original data we analyzed might have been affected by response bias. The data used in this study were mostly based on self-reported surveys. In addition, it was not possible to determine the items or calorie intake consumed for breakfast. Third, due to the nature of the data, we could not consider the frequency of breakfast divided into weekdays versus weekends in this study.

CONCLUSION

- This study demonstrated that breakfast skipping is negatively associated with insulin resistance, as indicated by TyG index in the Korean population. In addition, male sex, high BMI, abdominal obesity, and low physical activity tended to increase the risk of high insulin resistance.
- These findings indicate that regular breakfast consumption may effectively reduce the development of insulin resistance in the Korean population. Therefore, promoting the benefits of breakfast could be a simple and effective public health message to prevent diabetes.