Response

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Impact of Meal Frequency on Insulin Resistance in Middle-Aged and Older Adults: A Prospective Cohort Study (*Diabetes Metab J* 2025;49:311-20)

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We sincerely thank Dr. Ja Young Jeon for her thoughtful and constructive comments regarding our article, entitled 'Impact of meal frequency on insulin resistance in middle-aged and older adults' [1]. We greatly appreciate her emphasis on evolving dietary patterns among Koreans and the implications for metabolic health, particularly highlighting the role of breakfast consumption and changes in meal patterns, which align well with the public health inferences of our findings. We fully agree with the suggestion that adjusting for macronutrient composition in addition to total energy intake could provide a more comprehensive interpretation of the relationship between meal frequency and insulin resistance. Previous research based on the Korean Genome and Epidemiologic Study (KoGES) dataset reported that the carbohydrate-to-protein or fat intake ratio was associated with mortality, suggesting that reducing excessive carbohydrate intake while increasing protein and fat consumption may contribute positively to longevity and cardiovascular health [2]. Furthermore, recent analyses of the Korea National Health and Nutrition Examination Survey (KNHANES) data from 2010 to 2020 showed a trend toward decreasing total energy intake among Korean adults, accompanied by a lower proportion of energy from carbohydrates and higher proportions from protein and fat [3]. These findings reinforce the idea that not only total calorie intake but also dietary composition significantly affects metabolic health. As Dr. Ja Young Jeon insightfully pointed out, when we adjusted for total calories plus fat (%) in our analysis, the hazard ratio (HR) for insulin resistance in participants consuming ≥3 meals compared to <3 meals per day was 0.880 (95% confidence interval [CI], 0.782 to 0.990; $P=0.033$), a significant association. However, when we further adjusted for the proportions of carbohydrate, fat, and protein simultaneously, the HR was 0.889 (95% CI, 0.789 to 1.002; $P=0.054$), and the significance was slightly attenuated. Initially, we adjusted for total caloric intake only, because the sum of carbohydrates, fat, and protein equals total energy intake, and simultaneously adjusting for all can lead to a saturated model. As described in the literature, adjusting for total energy and energy contributions from carbohydrates, protein, and fats at the same time can be statistically inappropriate and may lead to over-adjustment bias [4].

Regarding the suggestion to further subdivide participants into those who consumed more than three meals, exactly three meals, and fewer than three meals per day, we appreciate this valuable recommendation. Unfortunately, in our current study, we were limited by the available sample size, as only 23 participants reported consuming more than three meals per day. This small number made it difficult to achieve meaningful statistical power for subgroup analyses. However, we agree that future

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studies with larger sample sizes could allow for more detailed stratification and might better clarify the potential linear relationship between meal frequency and metabolic health outcomes. In an era where irregular eating patterns and meal-skipping regimens are increasingly common, maintaining a regular meal frequency may represent a simple yet effective strategy to mitigate insulin resistance. Tailoring dietary recommendations based on sex, metabolic status, and cultural eating patterns could further enhance preventative strategies for metabolic disease.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Ryu HE, Lee JH, Park B, Heo SJ, Kwon YJ. Impact of meal frequency on insulin resistance in middle-aged and older adults: a prospective cohort study. Diabetes Metab J 2025;49:311-20.
2. Son GH, Lee HS, Kwon YJ, Lee JW. Association between carbohydrate to protein or fat ratio and mortality: a prospective cohort study. Clin Nutr ESPEN 2024;63:805-12.
3. Chun DW, Kwon YJ, Heo SJ, Lee JW. Secular trends in dietary energy, carbohydrate, fat, and protein intake among Korean adults, 2010-2020 KHANES. Nutrition 2024;121:112360.
4. Tomova GD, Arnold KF, Gilthorpe MS, Tennant PWG. Adjustment for energy intake in nutritional research: a causal inference perspective. Am J Clin Nutr 2022;115:189-98.