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Divided consumption of late-night-dinner improves glucose excursions in young healthy women: A randomized cross-over clinical trial

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ABSTRACT

Aims: Our aim was to explore the acute effect of the late-night-dinner and the divided-dinner on postprandial glucose levels in young healthy women.

Methods: Fourteen women (22.6 ± 2.6 years, BMI 20.2 ± 1.5 kg/m²: mean \pm SD) were randomly assigned to this crossover study. Each participant wore a continuous glucose monitor for 5 days and consumed identical test meals from the second to the fourth day at home. Each participant consumed the test meals of breakfast at 0800 h, lunch at 1300 h, and the half of the participants consumed dinner at 2100 h (D21) on the second day, 1800 h (D18) on the third day, and divided dinner (DD: vegetable and rice at 1800 h, and vegetable and the main dish at 2100 h) on the fourth day. The rest of the participants consumed DD on the second day, and D21 on the fourth day.

Results: D21 demonstrated higher incremental glucose peak (IGP 2.74 ± 0.38 vs. 1.57 ± 0.23 mmol/L, $p < .05$, mean \pm SEM) and incremental area under the curve for glucose (IAUC) 2300–0800 h (271 ± 63 vs. 111 ± 37 mmol/L \times min, $p < .05$) than D18. On the other hand, DD ameliorated IGP (1.96 ± 0.29 mmol/L, $p < .05$), IAUC 2300–0800 h (80 ± 29 mmol/L \times min, $p < .001$), and the mean amplitude of glycemic excursion (DD 2.34 ± 0.25 vs. D21 2.91 ± 0.28 mmol/L, $p < .05$) than D21.

Conclusions: Consuming late-night-dinner increased postprandial glucose levels, compared to DD, suggesting DD could be a practical strategy for reduction of postprandial glucose levels in young healthy women.

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1. Introduction

Epidemiological research demonstrates that the shift work is associated with increased risk for obesity, diabetes, and cardiovascular diseases as the result of physiological maladaptation to sleeping and eating [1]. The circadian misalignment has also been revealed to reduce glucose tolerance and pancreatic β cell function observed in shift workers [2,3].

On the other hand, unhealthy dietary habits such as skipping breakfast and late-night meal have been shown to be associated with weight gain and obesity [4–7]. According to the National Health and Nutrition Survey in 2008, 11.7% of Japanese over 15 years old consume the dinner after 2100 h [8]. The consumption of carbohydrate-rich meals in the late evening was associated the glucose intolerance and decreased insulin sensitivity in both healthy people and people with impaired fasting glucose or impaired glucose tolerance [9,10]. However, it is not easy for people to improve their lifestyle, particularly eating habit, partly due to a lack of evidence-based method of lifestyle intervention and mechanisms to implement.

One of the early changes in the development of type 2 diabetes is the postprandial hyperglycemia, which increases the risk of cardiovascular diseases even before the onset of diabetes [11,12]. Therefore, reducing the postprandial glucose level is important to decrease the risk of type 2 diabetes and cardiovascular diseases in healthy people. We recently clarified that the consuming late-night-dinner increased both incremental glucose peak (IGP) and postprandial hyperglycemia in patients with type 2 diabetes, whereas divided dinner, eating carbohydrate in the early evening followed by eating vegetable and the main dish (protein) in the late night, significantly ameliorated IGP and postprandial hyperglycemia compared to those of the late-night-dinner [13].

We hypothesized that consuming late-night-dinners would increase postprandial glucose levels, and that consuming the dinner dividedly would ameliorate the postprandial glucose levels in young people without diabetes, which would contribute to the prevention of type 2 diabetes in young people. Therefore, in this randomized controlled, a within-participant, cross-over study, we assessed the effect of the late-night-dinner and the divided dinner on the postprandial glucose levels in individuals without diabetes.

2. Methods

2.1. Participants

A total of 16 female university students were volunteered and informed of study requirements from Osaka Prefecture University, Osaka, Japan. The following exclusion criteria were applied to select the participants; type 1 and type 2 diabetes, health complications including metabolic diseases, eating disorder, weight loss or other special diet in the past 6 months, and taking any drugs or supplementations. We included participants who were not engaged in night shift within the last 2 years and who did not cross time zones within the last 6 months prior to this study. The participants habitually woke up between 0600 h and 0800 h and went to

sleep between 2200 h and 2400 h and consumed dinner around 1800–1900 h. The study was recruited and conducted between September 2014 and September 2015.

2.2. Study design

This study was a randomized, open-label, cross-over, within-participant clinical trial. The study protocol and benefits of the study were explained to each participant and reinforced with a phone call during the study period by the dietitians of the clinic. The study was conducted according to the guideline laid down in the Declaration of Helsinki, and the study protocol involving human subjects was approved by the Ethics Committee of Osaka Prefecture University and Kyoto Women's University, and was registered at Clinical Trial gov. (UMIN 000015108). The written informed consent was obtained from all participants. Two weeks prior to the study, the anthropometric data and blood samples were collected in the morning after an overnight fast.

On the first day, participants arrived at the clinic at 1530 h, and divided to two groups, and were all fitted with a continuous glucose monitor (CGM, iPro2, Medtronic Japan, Tokyo) using an Enlite Sensor (Medtronic Japan, Tokyo) by clinic nurses for the following 5 days (Fig. 1). The participants per-

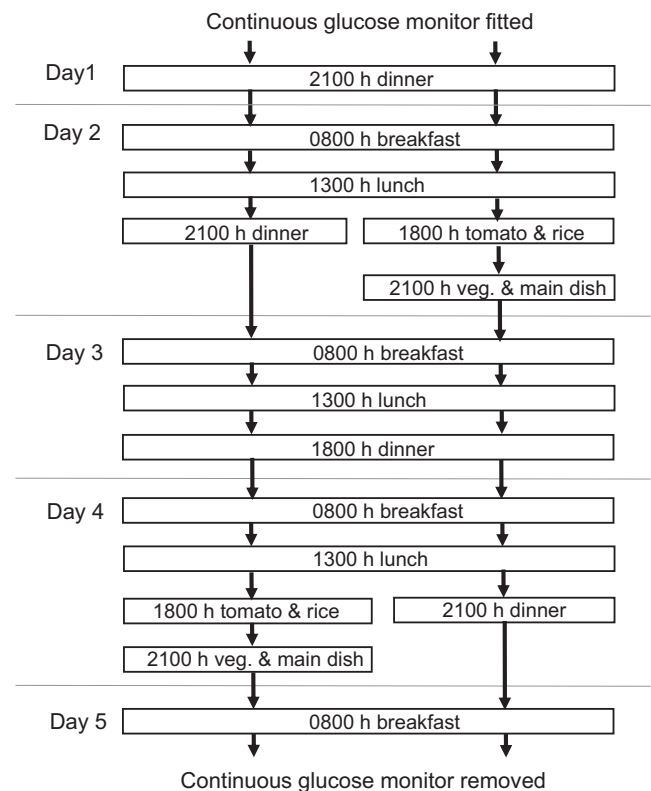


Fig. 1 – Study protocol. Participants consumed identical test meals for 3days during 5days with CGMs. Participants consumed test meals of breakfast at 0800h, lunch at 1300h, and dinner at 2100h or the divided dinner (tomatoes and rice at 1800h, and the spinach and the main dish at 2100h) on the second or the fourth day, and dinner at 1800h on the third day.

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