The day-time patterns of carbohydrate intake in the UK adults - results from the NDNS RP (2008-16)

Chaochen Wang [1,2] Suzana Almoosawi [3] Luigi Palla [1]

[1]Dept Medical Statistics, LSHTM, London, UK; [2]Dept Public Health, Aichi Medical University, Aichi, Japan
[3]Brain, Performance and Nutrition Research Centre Northumbria University, Newcastle, UK

Introduction

The importance of the circadian rhythms has been recognized for long, while its impact on nutrition is still largely unknown. Meal timing has been found to be associated with a wide variety of physiological processes as well as health outcomes:

- Skipping breakfast is associated with a higher risk of developing type 2 diabetes (T2D) [1];
- While replacing fat at breakfast with carbohydrate is associated with lower risk of T2D incidence [2];
- Evening intake of energy is positively associated with incidence of hypertension, and overweight/obesity [3, 4];

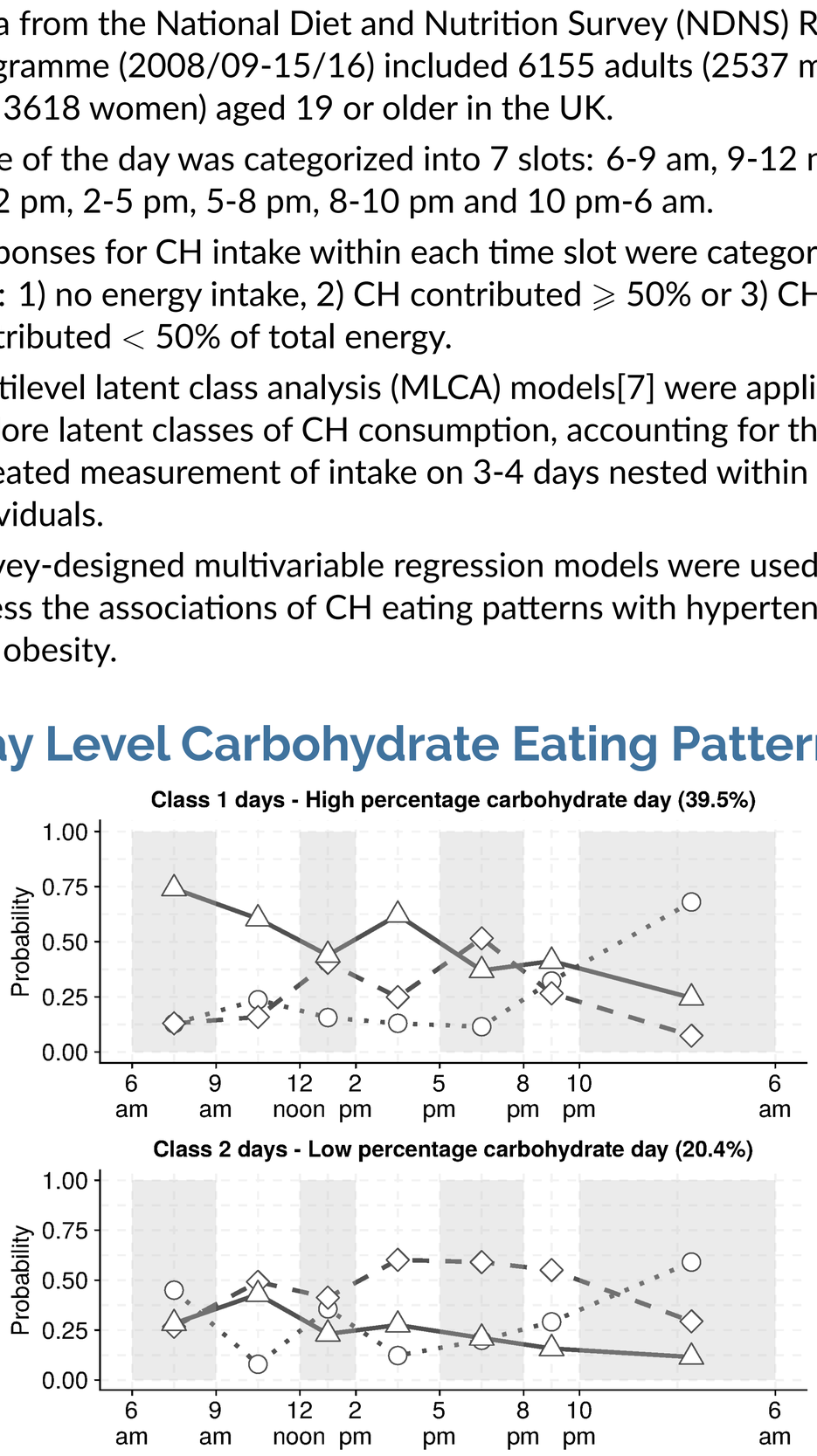
Recent evidence suggested that there are three types of eaters **(grazers, early eaters, and later eaters)** according to the timing of energy consumption [5, 6]. However, the temporal eating patterns were based only on averaging the total energy intake measured by one or two 24-hour dietary recalls and therefore **could not capture the day-to-day variation in eating patterns**, and **neither could it provide any clue of the temporal patterns specifically for nutrient intake**. This is mainly due to limitations in the dietary assessment methods (the questionnaires) often used in observational studies and the lack of understanding of statistical techniques that can capture and analyse the complexity of eating patterns across the day.

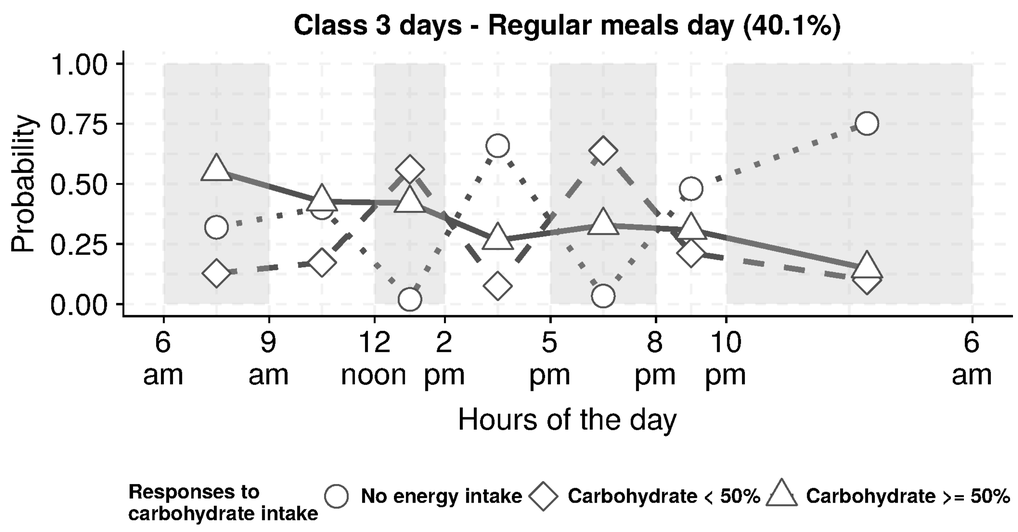
This study aims at finding both time and quantity eating patterns specifically for carbohydrate (CH) intake in UK adults.

Data and Methodology

- Data from the National Diet and Nutrition Survey (NDNS) Rolling Programme (2008/09-15/16) included 6155 adults (2537 men and 3618 women) aged 19 or older in the UK.
- Time of the day was categorized into 7 slots: 6-9 am, 9-12 noon, 12-2 pm, 2-5 pm, 5-8 pm, 8-10 pm and 10 pm-6 am.
- Responses for CH intake within each time slot were categorised into: 1) no energy intake, 2) CH contributed $\geqslant$ 50% or 3) CH contributed $<$ 50% of total energy.
- Multilevel latent class analysis (MLCA) models[7] were applied to explore latent classes of CH consumption, accounting for the repeated measurement of intake on 3-4 days nested within individuals.
- Survey-designed multivariable regression models were used to assess the associations of CH eating patterns with hypertension and obesity.

Day Level Carbohydrate Eating Patterns





Note:
Grey, and white shades indicate the 7 time slots;
Carbohydrate < 50% indicates CH contributed less than 50% total energy intake;
Carbohydrate >= 50% indicates CH contributed higher or equal to 50% total energy intake.

Figure 1:Day level latent class solutions (Three types of CH eating days).

Individual Level Latent Class Solution

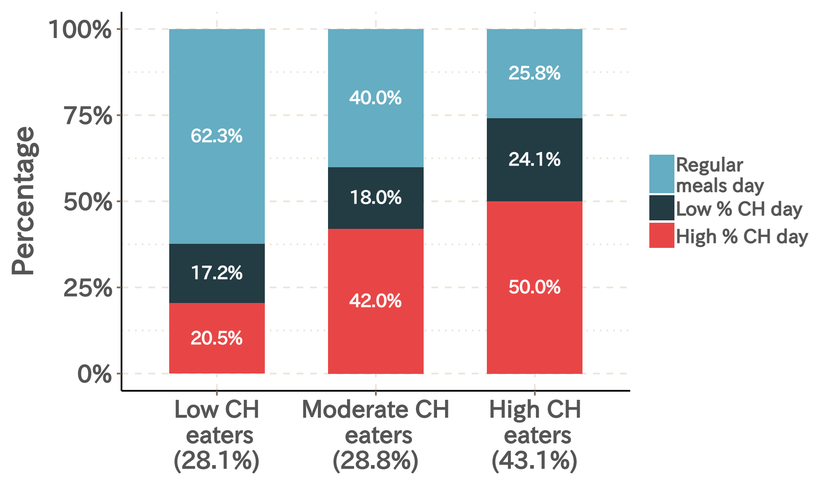


Figure 2:Multilevel Latent Class Solution, 3 classes in day level, 3 classes in individual level.

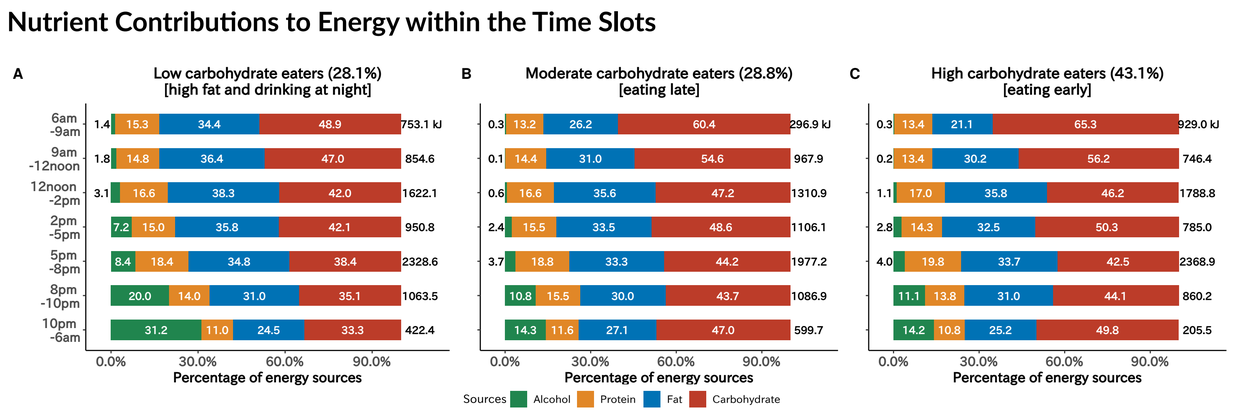


Figure 3:The compositions of energy consumption within each time slot by CH eaters.

References

[1] M. Uemura, H. Yatsuya, E. H. Hilawe, Y. Li, C. Wang, C. Chiang, R. Otsuka, H. Toyoshima, K. Tamakoshi, A. Aoyama, Breakfast skipping is positively associated with incidence of type 2 diabetes mellitus: evidence from the aichi workers' cohort study, Journal of Epidemiology 25 (5) (2015) 351--358.

[2] S. Almoosawi, C. Prynne, R. Hardy, A. Stephen, Diurnal eating rhythms: association with long-term development of diabetes in the 1946 british birth cohort, Nutrition, Metabolism and Cardiovascular Diseases 23 (10) (2013) 1025--1030.

[3] S. Almoosawi, C. J. Prynne, R. Hardy, A. M. Stephen, Time-of-day of energy intake: association with hypertension and blood pressure 10 years later in the 1946 british birth cohort, Journal of hypertension 31 (5) (2013) 882--892.

[4] S. Almoosawi, S. Vingeliene, L. Karagounis, G. Pot, Chrono-nutrition: a review of current evidence from observational studies on global trends in time-of-day of energy intake and its association with obesity, Proceedings of the Nutrition Society 75 (4) (2016) 487--500.

[5] R. M. Leech, A. Worsley, A. Timperio, S. A. McNaughton, Temporal eating patterns: a latent class analysis approach, International Journal of Behavioral Nutrition and Physical Activity 14 (1) (2017) 3.

[6] R. Mansukhani, L. Palla, Investigating eating time patterns in uk adults from the 2008--2012 national diet and nutrition survey, Proceedings of the Nutrition Society 77 (OCE1).

[7] W. H. Finch, J. E. Bolin, Multilevel modeling using Mplus, Chapman and Hall/CRC, 2017.