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

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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];
- Shift workers have a higher risk of developing T2D[5].

Recent evidence suggested that there are three types of eaters **(grazers, early eaters, and later eaters)** according to the timing of energy consumption [6, 7]. 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 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[8] 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.

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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] A. Pan, E. S. Schernhammer, Q. Sun, F. B. Hu, Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women, PLoS Medicine 8 (12) (2011) e1001141.

[6] 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.

[7] 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).

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