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

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Introduction

The importance of circadian rhythms has long been recognised. However, it remains uncertain whether timing of energy or macro-nutrient intake has an impact on health or disease. 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];
- 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 on averaging the total energy intake measured in the questionnaires and therefore **could not capture the day-to-day variation in eating patterns**. Furthermore, most previous studies have focused on describing temporal patterns of energy intake, **providing little data on the timing of macro-nutrient intake**.

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.

Results

Day Level Carbohydrate Eating Patterns

Three CH eating day patterns emerged from 24483 observation days **(Fig. 1)**.

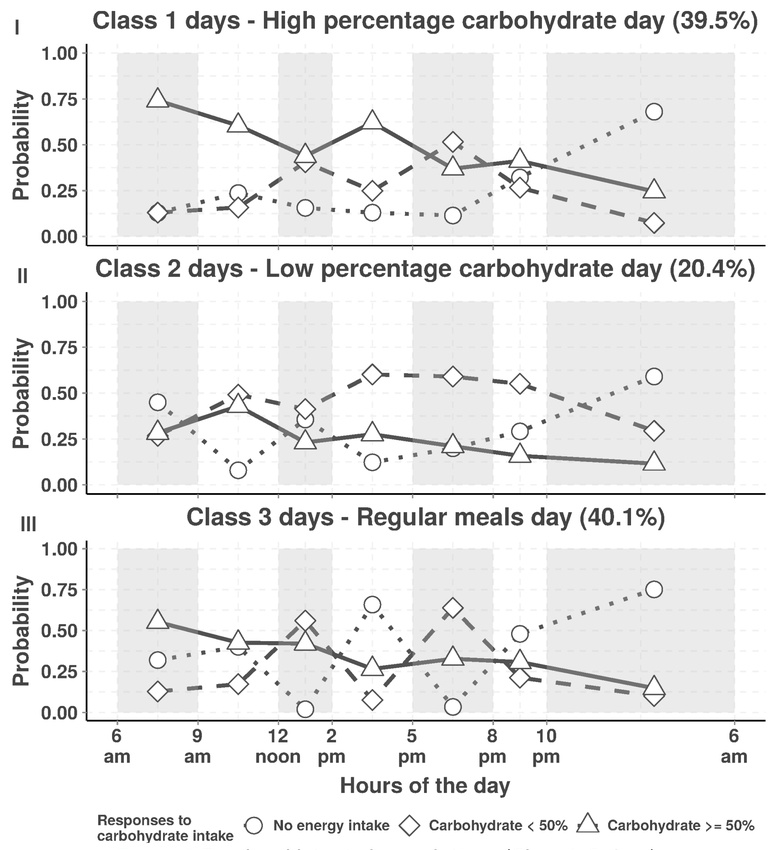

Figure 1:Day level latent class solutions (Class 1-3 days).

Individual Level Latent Class Solution

Based on the distribution of CH day patterns among the individuals, three types of CH eaters were defined which could be broadly labelled as low (28.1%), moderate (28.8%), and high (43.1%) CH eaters **(Fig. 2)**.

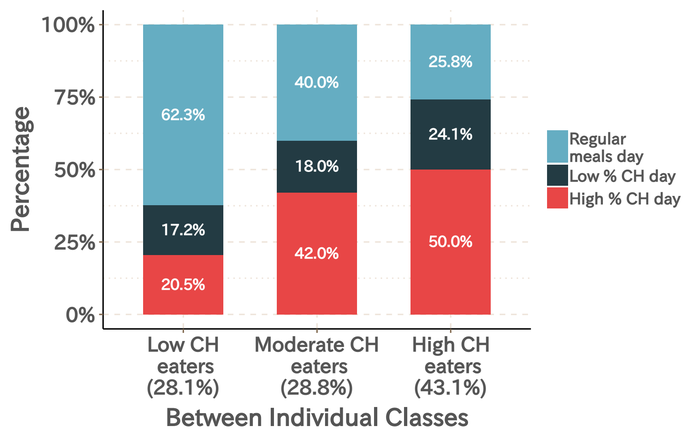

Figure 2:Multilevel Latent Class Solution, 3 classes in day level, 3 classes in individual level.

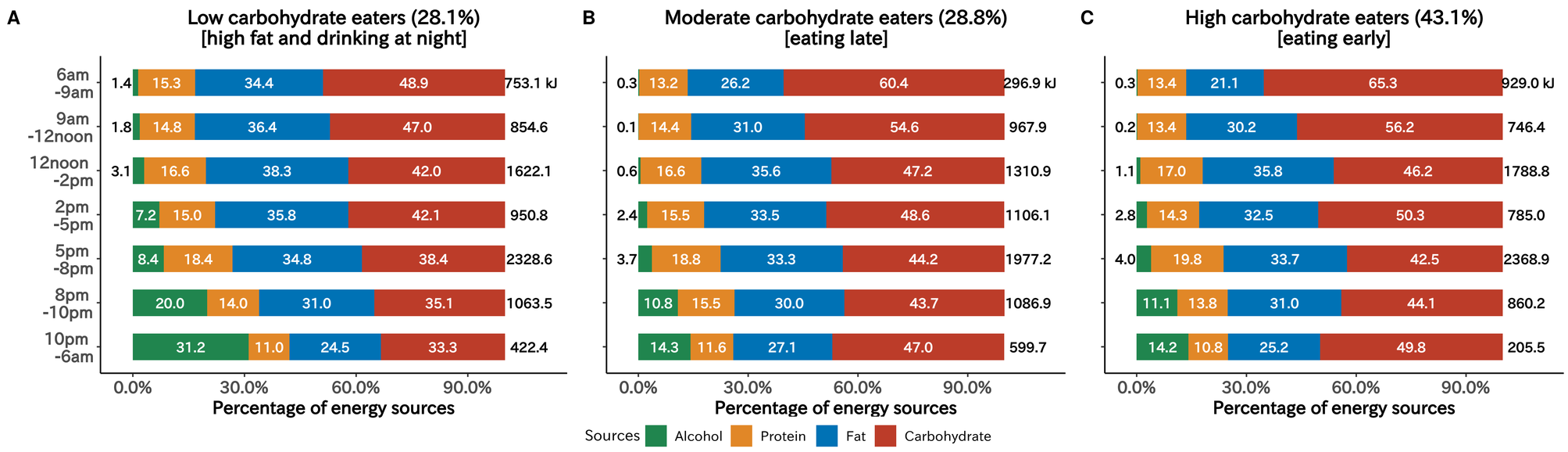

Figure 3:The compositions of energy consumption within each time slot by CH eaters.

On average, low-CH eaters **(Fig. 3-A)** consumed the highest amount of total energy intake (7985.8 kJ, $p < 0.001$), and they had higher percentages of energy contributed by fat and alcohol, especially after 8 pm. Moderate-CH eaters **(Fig. 3-B)** consumed the lowest amount of total energy (7341.8 kJ) while they had the tendency of eating later in the day. High-CH eaters **(Fig. 3-C)** consumed most of their CH and energy within time slots of 6-9 am, 12-2 pm, and 5-8 pm.

Discussion

The high-CH eaters profile seemed to be the healthiest. Low-CH eating which was crudely associated with higher prevalence of hypertension and obesity may have resulted from health/weight concerns, leading to fat or alcohol as replacements for CH. To ascertain the direction of causality in the association of CH patterns with blood pressure and obesity, prospective longitudinal studies are warranted.

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