Relationships between food groups, eating time slots and diabetes status in adults from the UK National Diet and Nutrition Survey (2008–2017)

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Short running head: Time of eating

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**Abbreviations:**

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## ABSTRACT

**Background:**

**Objective:**

**Design:**

**Results:**

**Conclusions:**

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## INTRODUCTION

The timing of energy intake has been shown to be associated with obesity and diabetes. (1)

We aimed to decribe the relationship between food groups and the time of day when they were consumed, and how such relationships may vary by status of type 2 diabetes.

## METHODS

6802 adults (2810 men and 3992 women) and 749,026 food recordings collected by the UK National Diet and Nutrition Survey Rolling Programme (NDNS RP 2008-17) were analyzed (2). The sample was randomly drawn from a list of all addresses in the UK, clustered into postcode sectors. Further details of the rationale, design and methods of the survey can be found elsewhere (3,4). Time of the day was categorized as 7 slots: 6-9 am, 9-12 noon, 12-2 pm, 2-5 pm, 5-8 pm, and 10 pm - 6 am. Foods recorded were also classified into 60 standard food groups with 1 to 10 subgroups each: the details are given in Appendix R of the NDNS offical report (5). We focused on the 60 standard food groups.

### Other variables and analyses

Computer-assisted personal interviews were undertaken by trained interviewers to collect background information of the participants on smoking habits (current, ex-smoker, and never), ethnicity (white, non-white), education level (lower than degree/degree or above level), living with a partner or not, and other socio-demographic variables. Participants also had their height, weight, blood pressure, and waist circumferences (WC) measured by the nurses during the visit of the interview. A self-completion questionnaire - the Recent Physical Activity Questionnaire (RPAQ) (6) was used to estimate physical activity. Blood samples were taken from the participants. Serum total, high-density lipoprotein (HDL), and low-density lipoprotein (LDL), cholesterol, triglycerides (TG), fasting blood glucose, hemoglobin A1c (HbA1c) were measured. HbA1c of 6.5% was used as the cut off value for diagnosing diabetes. Hypertension was defined as with systolic blood pressure of 140 mmHg or above, or diastolic blood pressure of 90 mmHg or above, or taking any medication specifically to reduce blood pressure. Body mass index (BMI), was calculated as weight in kilograms divided by height in square meters. BMI was then categorized into less than 25 kg/m2 (normal weight), 25 to 30 kg/m2 (overweight), and higher or equal to 30 kg/m2 (obese).

Individual-level point estimates and 95% confidence intervals (CIs) were estimated by applying individual, nurse visiting, and blood sample weights accordingly to adjust for differences in sample selection and the clustered survey design. Descriptive statistics of participants were presented as weighted means (95% CI) or weight percentages (95% CI). After examining the distribution of the data, the following variables were log-transformed to improve normality: fasting blood glucose, HbA1c, TC, LDL, HDL, TG and average physical activity duration per day. Weighted geometric mean (95% CI) were used for all log-transformed variables. Weighted estimates of nutrients consumption across the 7-time slots of the day were calculated for each individual-level latent class. Contributions (%) of the average energy intake within time slots were evaluated by determining the percentages of energy coming from carbohydrate, fat, protein, and alcohol intake.

For continuous variables, the *F* test was used to determine differences between latent classes with Bonferroni correction to account for multiple testing across > 2 classes when applicable. For categorical variables, differences between latent classes were assessed using the adjusted Pearson test for survey data. Survey-designed multivariable logistic regression (for hypertension), linear regression models (for BMI and WC) were used to test for associations between individual-level latent classes of carbohydrate eating patterns and WC/BMI. Since diabetic participants may or may not modify their carbohydrate eating habits, we also fitted all the above-mentioned regression models restricted to those without diabetes. All statistical analyses were performed with svyset command as implemented in Stata software version 15.1 (7).

## RESULTS

## DISCUSSION

### Conclusions

## ACKNOWLEDGEMENT

## CONFLIT OF INTEREST (COI) STATEMENT

The authors declared no conflicts of interest.

## AUTHOR’S CONTRIBUTIONS

CW, SA, and LP: designed research and had primary responsibility for final content; CW and LP performed statistical analysis; and all authors: wrote the manuscript, read and approved the final manuscript.

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