Meal pattern validation: associations of meal size and meal timing with glucose concentrations in a population-based cohort

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Meal patterning encompassing time, quantity and frequency of eating has been associated with diet quality, cardiovascular risk factors and coronary heart disease (1). In observational studies, underreporting is common and might be time-of-day dependent (2). Underreporting may bias associations between meal patterns and disease. Glucose concentrations have circadian variation corresponding to food intake (3,4). We aimed to validate reported meal patterns by associating meal size with glucose concentrations over the day.

The Norfolk-based European Prospective Investigation into Cancer and Nutrition (EPIC-Norfolk) recruited 25,636 men and women, aged 39-79 y from GP practices between 1993-1998 (5). At a health visit, anthropometry was measured and non-fasting blood samples were collected (08:00-19:00); serum glucose concentrations were analysed (n = 18,631). Participants using glucose and lipid lowering medication were excluded as well as those who reported <4 days, illness or nightshifts in their 7-day diet diary (7dDD). The pre-structured 7dDD had eight recording sections: before breakfast (BB), breakfast (B), midmorning (MM), lunch (L), tea (T), dinner (D), evening (E) and ‘unknown time’ (U). We calculated mean reported energy intake (MJ/d) for each section, representing ‘meal size’. Analysis of covariance was adjusted for: daily energy intake (DEI), hour of blood sampling, hours fasted, eating frequency, season, sex, age, physical activity, smoking, alcohol, education and BMI (N = 15,506). Adjusted means of glucose (Y-axis) were graphed by hour of blood sampling (X-axis) for zero, 25th, 50th and 75th centiles of average meal size (lines). The significance of the interaction between meal size and sampling time was determined by the F-test (P < 0.05).

Mean (SD) DEI was 9.53 (2.10) and 7.23 (1.58) MJ/d in men and women respectively (with 4.0, 0.3 and 0.2 % skipping B, L, D respectively). Mean daily glucose was 4.23 (1.49) and 4.16 (1.32) mmol/L respectively, with approximately 0.5 mmol/L interval between mean peak and trough over the day (P < 0.001). Significant interactions between blood sampling time and lunch size were observed (P < 0.001), but not for breakfast or dinner.

Glucose concentrations measured at morning appointments had no dose-response association with breakfast, whereas such associations were observed for afternoon and lunch size, in addition to afternoon insulin resistance (5). Evening blood samples were lacking. In this free-living population, meals were not iso-caloric, but represent gradual increments of meal sizes over the day (the latter more clearly observed for triglycerides (6)). Verifying meal skipping, and therefore meal frequency, may help elucidate meal pattern-disease associations.