

## Nutrition Discussion Forum

*The influence of the glycaemic index of breakfast and lunch on substrate utilisation during the postprandial periods and subsequent exercise – Comments by J. Galgani et al.*

Stevenson *et al.* (2005) recently assessed, in a group of athletes, the effect of high- and low-glycaemic-index meals (breakfast and lunch) on fuel utilization under resting and exercise conditions using a crossover design. Their research was based on the hypothesis that, following the ingestion of high-glycaemic-index meals, augmented postprandial hyperglycaemia and hyperinsulinaemia would promote carbohydrate oxidation at the expense of fat oxidation, thereby leading to body fat gain. Conversely, low-glycaemic-index diets would promote fat oxidation and protect subjects from body fat gain.

Their results seem to provide evidence in support of this hypothesis, but there are some aspects that justify further consideration. First, the authors did not find a difference in fuel oxidation after breakfast and during exercise. There was, however, significantly increased carbohydrate oxidation (+22%,  $P < 0.005$ ) and decreased fat oxidation (–28%,  $P < 0.01$ ) following the high-glycaemic-index lunch. Second, the accuracy and precision of the indirect calorimetry procedure was not reported – this information would allow an appreciation of the real meaning of the glycaemic index meal effects on fat oxidation. Third, the 3-h postprandial measurement period used after each meal is insufficient to describe the postprandial period appropriately.

In addition to these considerations, a more relevant aspect is related to the long-term impact of contrasting glycaemic index diets. Thus, if Stevenson *et al.*'s results were extrapolated to the long term, high-glycaemic-index diets would generate a metabolic paradox whereby a positive fat balance would have to be accompanied by a negative carbohydrate balance. Certainly, this does not happen under energy-balance conditions as it is known that macronutrient balance is needed to achieve energy balance (Flatt, 1987; Schrauwen & Westerterp, 2000). This means that the dietary macronutrient composition, particularly the dietary fat:carbohydrate ratio, determines the amount of macronutrient oxidized. This condition is represented by the equation  $FQ = RQ$  in 24-h, where FQ (food quotient) is the proportion of macronutrient present in the diet, and RQ in 24-h is the mean RQ during a day, which represents the proportion of macronutrient oxidized in 24 h (Black *et al.* 1986). This implies that dietary macronutrient intake and oxidative metabolism are perfectly matched. Hence, if energy balance is present, macronutrient balance will occur. This condition has been repeatedly demonstrated (Bobbioni-Harsch *et al.* 1997; Whitley *et al.* 1997; Schrauwen & Westerterp, 2000; Smith *et al.* 2000).

Considering the aforementioned, the changes in fuel partitioning reported by Stevenson *et al.* would be expected to be transient and compensated throughout the 24-h period. Given the short measurement period (3 h for each meal), it may have been that they were unable to observe this situation. Thus, after a longer time period, no differences in substrate oxidation would have been found, as recently reported

(Díaz *et al.* 2005). In our research, involving twelve obese women, we determined the influence of high- and low-glycaemic-index meals (breakfast and lunch) on fuel oxidation measured in a respiratory chamber for 10 h using a crossover design. No differences in fuel partitioning after breakfast and lunch were found even when significant differences in serum glucose and insulin response were induced. This evidence is supported by several studies in which no differences in fuel partitioning were observed (Würsch *et al.* 1988; Ritz *et al.* 1991; Howe *et al.* 1996; Kiens & Richter 1996; Sparti *et al.* 2000; Korach-André *et al.* 2004; Sloth *et al.* 2004), although an exception can be quoted (Bouche *et al.* 2002). The specific role of the glycaemic index on fuel partitioning have been recently reviewed (Díaz *et al.* 2006).

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## Response

We appreciate the interest that Dr Galgani and colleagues have shown in our recent publication on the influence of the glycaemic index of breakfast and lunch on substrate utilization during the postprandial periods and subsequent exercise (Stevenson *et al.* 2005).

Before addressing the points made in their letter, it is worth reiterating the two aims of the study. First, we aimed to describe the metabolic responses to high-glycaemic-index (HGI) and low-glycaemic-index (LGI) mixed meals: previous studies in this area have investigated only the metabolic responses to a single meal or to one portion of a single food.

The second aim of the study was to investigate the effects of the glycaemic index of breakfast and lunch on substrate utilization during a 60-min run at 70 % maximum  $\dot{V}O_2$ . In an earlier study, we showed that the calculated rate of fat oxidation was significantly higher during 60 min of exercise 3 h after the ingestion of an LGI rather than an HGI breakfast (Wu *et al.*, 2003). We therefore wanted to investigate whether this response to the LGI breakfast persisted after a second meal. The results of the present study clearly suggested that this was not the case, but there were differences in the calculated rate of fat oxidation during the postprandial period following the second meal.

Dr Galgani and colleagues are correct in drawing our attention to the comments we made about long-term

substrate partitioning in the Discussion section of our paper. We stated in the Discussion: ‘It is not possible to speculate on the chronic effects of an LGI diet from these data; however, the results of the present study provide evidence that changes in fuel partitioning and substrate oxidation can occur even over a single day when consuming LGI CHO [carbohydrate] instead of HGI CHO’. What follows is speculation based on the observation that LGI foods tend to result in a prolonged feeling of satiety and may therefore reduce hunger and hence food intake (Ludwig *et al.* 1999; Warren *et al.* 2003). Even so, we should in our speculation have been more explicit and included comments about the need to be in negative energy balance to help to promote fat loss.

Dr Galgani and colleagues raise the question of the accuracy and precision of the indirect calorimetry procedures described in our paper. We used active, healthy young men who were very familiar with the laboratory procedures described in our paper because they had been subjects in a range of previous studies. With these subjects, the CV for the indirect calorimetry, that is the oxygen uptake measurement, is approximately 4%. We agree with the comment by the correspondents that ‘the 3-h postprandial measurement period used after each meal is insufficient to describe appropriately the postprandial period’. What we were, however, trying to do was to observe the metabolic responses over a period of time that typically separates breakfast and lunch for most people in Northern Europe.

We are grateful to Dr Galgani and his colleagues for taking the time to provide us with their helpful and insightful comments.

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**Abbreviations:** CHO, carbohydrate; HGI, high glycaemic index; LGI, low glycaemic index.