

The BASES Expert Statement on The Role of Breakfast-Physical Activity Interactions for Energy Balance and Metabolic Health

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Javier Gonzalez, Prof Emma Stevenson, Dr Lewis James, Dr James Betts and Dr David Clayton.

Introduction

Physical activity can maintain and improve metabolic health, but the efficacy of physical activity can be altered by nutrition. Health guidelines make recommendations about total energy intake and diet composition, but *when* to eat is rarely considered, particularly in the context of physical activity. The time of the day when eating behaviours tend to differ most between people is the morning (at least in developed countries). Therefore, if benefits are to be obtained by altering meal-physical activity timing, the first meal of the day (i.e. breakfast) provides a logical opportunity to achieve these benefits.

A primary means by which meal timing and physical activity alter metabolic health is via energy balance (see Figure 1). These two components (physical activity and energy intake) are the two most variable components of energy balance. Therefore, they not only make the largest contribution to changes in energy balance but are also most likely to be amenable to interventions. Moreover, a rarely considered aspect is the *interaction* between energy balance components. For example, many people skip breakfast when attempting to lose body mass. This may seem logical as less energy intake can be expected in that morning period. However, this could stimulate appetite and increase energy intake later in the day, and/or reduce spontaneous physical activity. These compensatory behaviours may diminish, or even supersede, the initial energy deficit, and therefore energy balance could be neutral (and body mass change negligible). However, a neutral energy balance does not necessarily mean that metabolic health is unaffected, since physical activity can also impact health independent from energy balance. Accordingly, the aim of this statement is to summarise the evidence regarding breakfast consumption in relation to physical activity, and the effects on energy balance and metabolic health.

Background and evidence

Energy intake (Appetite)

There is a general belief, at least amongst lay people, that skipping breakfast will augment appetite and food intake later in the day, thereby driving positive energy balance and weight gain. This has propagated the idea that breakfast is “the most important meal of the day” and skipping breakfast should be avoided. Indeed, observational studies would support this; people who regularly consume breakfast are more likely to be leaner than people who regularly skip breakfast (Clayton & James, 2016). However, these observations do not necessarily represent a cause-and-effect relationship. Observations that breakfast consumers are leaner than breakfast skippers could be due to confounding factors (breakfast consumers tend to follow other health guidelines) or reverse causation (heavier people skip breakfast in attempts to lose body mass).

Acute intervention studies consistently show that breakfast omission leads to lower overall daily energy intake. This is because whilst breakfast decreases appetite and energy intake at the next meal (lunch), this small decrease does not offset the energy consumed at breakfast (Clayton *et al.*, 2015; Gonzalez *et al.*, 2013). The effects of breakfast on appetite and energy intake are transient and are confined to the time between breakfast and the next meal. Appetite responses to subsequent meals are similar, independent of breakfast consumption. Thus, a single exposure to breakfast omission decreases total daily energy intake (Clayton *et al.*, 2015). Semi-chronic randomised controlled trials corroborate these findings. Six weeks of either consuming or omitting breakfast had no effect on fasting appetite-related hormones, and free-living assessments of energy intake suggest daily energy intake is reduced when breakfast is omitted (Betts *et al.*, 2016). Foregoing breakfast will therefore likely lead to a reduction in daily energy intake,

although implications for other elements of energy balance and metabolic health need consideration.

Energy expenditure (Physical activity)

Since breakfast omission can reduce energy intake, it is understandable why many would expect morning fasting to favour reductions in body mass. However, reductions in body mass or adiposity will depend on the sustained difference between both sides of energy balance. Therefore, a consideration of energy expenditure is required.

Most weight-loss diets operate on the principle that energy restriction can result in an energy deficit with little consideration of energy expenditure. This is presumably because individual components of energy expenditure are thought to be relatively fixed. This view may be justified in relation to resting metabolic rate and diet-induced thermogenesis, largely dictated by (lean) body mass and macronutrient intake, respectively (Betts *et al.*, 2016). In contrast, physical activity is the component of energy expenditure that is most variable,

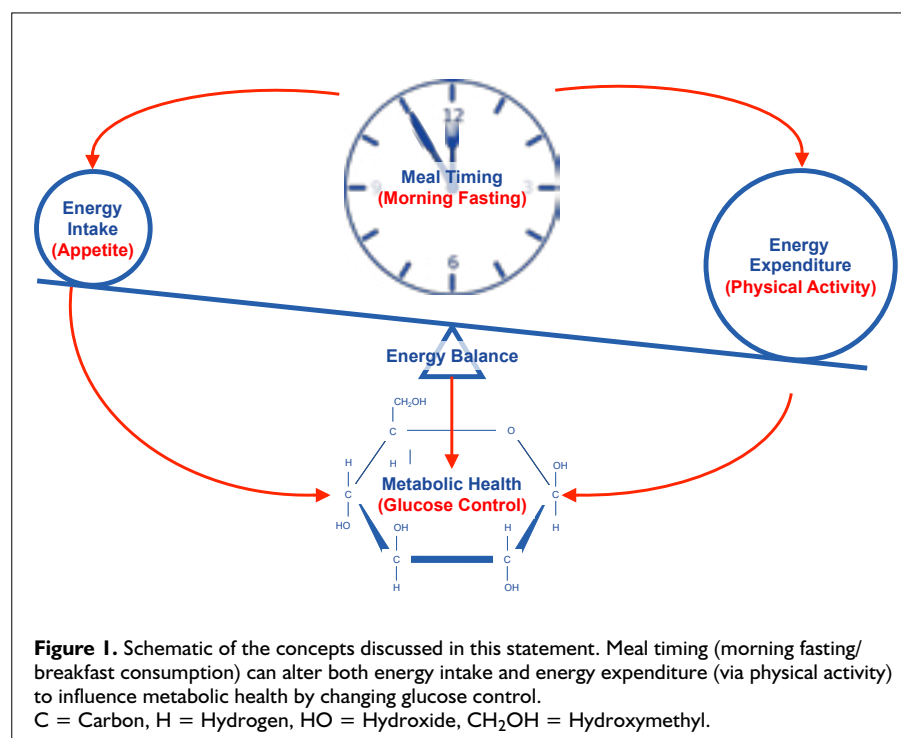


Figure 1. Schematic of the concepts discussed in this statement. Meal timing (morning fasting/breakfast consumption) can alter both energy intake and energy expenditure (via physical activity) to influence metabolic health by changing glucose control.
C = Carbon, H = Hydrogen, HO = Hydroxide, CH₂OH = Hydroxymethyl.

quantitatively important, and, as emerging evidence suggests, is responsive to feeding/fasting interventions (Betts *et al.*, 2016).

Cross-sectional surveys highlight that regular breakfast consumption is positively associated with self-reported physical activity. However, this correlational evidence suffers from many limitations, such as the (in)sensitivity of tools used to quantify diet and physical activity, and the inability to infer cause and effect. Further advancements in understanding have therefore been enabled by recent technologies, capable of objectively and reliably monitoring free-living energy expenditure. Specifically, relative to when omitting breakfast, randomised controlled trials have revealed that prescribed breakfast consumption results in higher overall energy expenditure due to spontaneous low-intensity physical activity in the morning; a finding now replicated in both lean and obese populations (Betts *et al.*, 2016). The magnitude of this increase in energy expenditure can be sufficient to offset the higher daily energy intake with breakfast consumption.

Metabolic health (Glucose control)

The changes in energy intake and expenditure with breakfast consumption/omission may have implications for components of metabolic health such as glucose control. Glucose control is characterised by the ability to maintain blood glucose homeostasis after meal ingestion. An inability to maintain stable blood glucose concentrations is the diagnosis for some metabolic diseases and high post-meal blood glucose concentrations are associated with increased mortality and morbidity (Pekkanen *et al.*, 1999). Whilst physical activity can improve glucose control and reduce the risk of developing metabolic diseases, there is accumulating evidence suggesting that the efficacy of physical activity in improving metabolic health may be dependent on meal timing, whereby exercising before breakfast may enhance metabolic health benefits (Edinburgh *et al.*, 2017).

Breakfast consumption can influence our metabolic response to meals consumed later in the day. Compared to breakfast omission, breakfast consumption at rest improves glucose control at lunch (Gonzalez, 2014; known as the "Second-meal Effect.") This effect is acute, but also persists chronically; 6 weeks of breakfast consumption was shown to reduce interstitial glucose variability in the afternoon and evening, compared to breakfast omission (Betts *et al.*, 2014). However, the metabolic health effects of breakfast consumption may differ in the context of physical activity.

Prior breakfast consumption alters metabolism during and after physical activity, with potential health implications. Breakfast consumption prior to moderate-intensity physical activity increases carbohydrate metabolism and suppresses fat metabolism in lean and overweight individuals (Chen *et al.*, 2017; Gonzalez *et al.*, 2013). Whereas breakfast consumption at rest appears to improve glucose control later in the day, consuming breakfast prior to physical activity does not appear to produce this effect (Gonzalez *et al.*, 2013). Furthermore, 6 weeks of aerobic exercise training performed in a fasted state improved glucose tolerance during high-fat overfeeding in healthy men, whereas consuming carbohydrate before and during aerobic exercise did not (Van Proeyen *et al.*, 2010). This suggests changing *when* people eat breakfast (after *versus* before undertaking physical activity) may provide metabolic health benefits for lean men. However, whether this is also true for people at increased risk of metabolic disease requires further assessment.

Conclusions and recommendations

- Consuming breakfast has consistently been shown to increase daily energy intake due to insufficient compensation at subsequent meals, although daily energy expenditure is also elevated by breakfast, leading to negligible effects on net energy balance and body mass.
- During conditions of low physical activity, breakfast improves glucose control in the afternoon and evening, though glucose responses to breakfast in exercising populations are less clear.

- When exercising, omitting breakfast before training can enhance some metabolic adaptations to aerobic exercise, but whether this strategy improves health in populations at increased risk of metabolic disease remains unknown.
- Individuals looking to gain the most adaptation from aerobic exercise training should consider performing some exercise sessions before breakfast. However, if skipping breakfast on a day when structured physical activity is not planned, one should be aware that spontaneous physical activity levels may decline, so a conscious decision to remain physically active on these days would be advisable. ■



Dr Javier Gonzalez

Javier is a Human Physiologist at the University of Bath interested in carbohydrate and fat metabolism.



Prof Emma Stevenson

Emma is Professor of Sport and Exercise Science at Newcastle University. Her research interests are in exercise, appetite regulation and metabolism.



Dr Lewis James

Lewis is a Senior Lecturer in Nutrition at Loughborough University, with research interests in diet, exercise and appetite regulation.



Dr James Betts

James is Reader in Nutrition and Metabolism at the University of Bath, interested in nutrient timing and health.



Dr David Clayton

David is a Lecturer at Nottingham Trent University, interested in energy restriction and appetite regulation.

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