Speakers, talk titles and abstracts

Energy Stress Meeting, 15th September 2022

Order of speakers is outlined following the order of talks on the day of the meeting.

Speaker	Talk title
Prof. James Betts (University of Bath)	*Nutrient Timing & Metabolic Regulation*
Prof. Jose Calbet (University of Las Palmas, Spain)	*Endocrine and physiological responses to a severe energy deficit in overweight and obese individuals: The Östersund walking study*
Dr. Eimear Dolan (University of São Paulo, Brazil).	*Energetic trade-offs within athletes with low energy availability*
Dr. Jose L Areta (Liverpool John Moores University)	*The effect of energy deficit with concomitant exercise on skeletal muscle phenotype shift.*
Dr. Mark Hopkins (University of Leeds)	*The effect of diet and exercise-induced energy deficit on appetite responses in overweight/obese and athletic populations.*
Dr. Carl Langan-Evans (Liverpool John Moores University)	*The psychophysiological effects of low energy availability during weight making and subsequent recovery in combat sport athletes.*
Prof. Karsten Koehler (Technical University of Munich, Germany).	*Elite athletes and overweight individuals – parallels and differences in the metabolic response to energy deprivation at the opposite ends of the exercise spectrum*
Prof. John Speakman (University of Aberdeen, Scotland & Chinese Academy of Sciences, China)	*Did reductions in physical activity energy expenditure help to fuel the obesity epidemic?*

Abstracts

Order of abstracts is outlined following the order of talks on the day of the meeting.

Nutrient Timing & Metabolic Regulation.

Prof. James Betts, University of Bath. Profile link**, here.**

Dietary approaches that emphasise temporal feeding patterns bring together two fascinating topics within the broad fields of nutrition and physiology – namely, fasting and circadian rhythms. There has been a long history of research examining metabolism in the absence of nutrient intake and a recent resurgence of interest into whether fasting at particular times may impart metabolic benefits. This talk will present the findings of recent investigations involving the manipulation of nutrient availability over 24 hours. Specifically, this will include current understanding of how sequential eating occasions can exhibit carry-over effects from one to the next, how continuous *versus* intermittent delivery of nutrients can affect biological rhythms within tissues, and how alternating 24-h periods with and without food can influence weight loss and metabolic health. Regarding the latter, it has been proposed that there may be health benefits that are peculiar to intermittent fasting, which cannot be explained by weight-loss but instead operate via fasting-specific mechanisms. This hypothesis, however, was not supported by data from recent experiments that isolated the separate and combined effects of extended fasting and negative energy balance. The implications of these findings will be considered in terms of when we should and when we should not consume certain nutrients on a daily basis.

Endocrine and physiological responses to a severe energy deficit in overweight and obese individuals: The Östersund walking study.

Prof. Jose Calbet, University of Las Palmas, Spain. Profile link**, here.**

The neuroendocrine response to severe energy deficit in humans has been only studied through prolonged caloric restriction. In a recent study ("The Östersund walking study"), we determined the effects of a severe energy deficit of 5500 kcal/day for four days. We assessed the molecular mechanisms by which muscle contractions may counteract some of the signalling events produced by the severe energy deficit in fifteen overweight men who were evaluated before (PRE), after four days of caloric restriction (3.2 Kcal/kg BW/day) in combination with prolonged exercise (CRE) (8h walking + 45min single-arm cranking/day), and following three days of control diet (isoenergetic) and reduced exercise (CD). During CRE, the diet consisted solely of whey protein (n=8) or sucrose (n=7) (0.8 g/kg BW/day). Muscle biopsies were obtained from the exercised and the non-exercised deltoid muscles and the vastus lateralis. From PRE to CRE, serum glucose, insulin, leptin and testosterone were reduced, while cortisol increased. Several metabolic genes were regulated after the intervention, indicating a shift from carbohydrate to fat metabolism. Nicotinamide N-methyltransferase (NNMT) was the most consistently upregulated gene following the energy deficit and was accompanied by increased protein expression in skeletal muscle. Circulating levels of N(1)-methylnicotinamide (MNA), the product of NNMT activity, were doubled after the intervention. Leptin receptor expression was augmented in all examined muscles associated with increased maximal fat oxidation, accompanied by up-regulation of fatty acid transport proteins and PDK4. NRF2 and NFκB signalling were also upregulated and associated with an increased expression

of antioxidant enzymes. The severe energy deficit stimulated autophagy signalling in skeletal muscle. However, this effect was blunted by high-volume exercise, contributing to preserving muscle mass in the more exercised limbs. The intake of proteins alone failed to maintain more muscle than ingesting only carbohydrates. The latter was explained by reduced pSer^{9}GSK3β levels making the skeletal muscle refractory to the anabolic effects of whey protein ingestion, regardless of contractile activity. Whole-body VO_2peak was reduced likely by a central mechanism since VO_2peak was increased during small muscle exercise (single arm cranking by the exercise arm). This investigation showed some of the molecular mechanisms by which exercise counteracts some adverse effects of caloric restriction on muscle mass and exercise performance in humans.

Energetic trade-offs within athletes with low energy availability.

Dr. Eimear Dolan, University of São Paulo. Profile link**, here.**

The energetic costs of athletic training can be substantial, and deficits arising from costs unmet by adequate intake can lead to a state of low energy availability, whereby less energy is available than is required to optimally sustain all biological processes. Energy is a finite resource, and so low availability can result in trade-offs between competing processes, with the nature and severity of these trade-offs dependent on the extent of deficit, along with the environment within which it occurs. Within this talk, I will discuss the concept of energetic trade-offs within athletes with low energy availability, and consider how an evolutionary perspective may enhance understanding of the body's response to periods of low energy availability, along with what this may mean for athlete health and performance.

The effect of energy deficit with concomitant exercise on skeletal muscle phenotype shift.

Dr. José L Areta, Liverpool John Moores University. Profile link**, here.**

Skeletal muscle is a key tissue for maintenance of metabolic health as well as for strength and endurance performance. Periods of energy deficit reduce skeletal muscle mass, particularly in the absence of a contractile stimulus and this may negatively affect physical capacity and health. Myofibrillar protein synthesis is reduced within days of exposure to dietary energy deficit, and this reduction can be mitigated by exercise and dietary interventions. While the effect of energy deficit on muscle size have been well-characterised, the effect of energy deficit on skeletal muscle oxidative capacity and phenotype remain poorly characterised. This talk will explore this topic while presenting preliminary findings of research on the effect of short-term (5 days) pronounced energy deficit (~20% of energy required to achieve energy balance) in humans, on endocrine and physiological responses, with a focus on skeletal muscle proteome changes.

The effect of diet and exercise-induced energy deficit on appetite responses in overweight/obese and athletic populations.

Dr. Mark Hopkins, University of Leeds. Profile link**, here.**

The control of appetite and energy balance is thought to be asymmetric, with physiological and behavioural compensation stronger following energy deficit than surfeit. The mechanisms that oppose chronic energy deficits are inter-related, individually subtle, and difficult to quantify. Sustained energy deficit and weight loss is often associated with an increase in orexigenic drive, with changes in appetite-related hormones thought to act as cues for increased hunger and energy intake. However, changes in hunger with weight loss are inconsistent, with some studies reporting no change or even weight loss-induced reductions in hunger. These discrepancies may relate to the characteristics of weight loss (rate, extent and composition), weight loss modality (diet vs exercise), or type of dietary energy restriction. There is also renewed interest in integrative models of energy balance that consider the relationships between body composition, energy expenditure and physiological function, and the way in which these relationships influence appetite and energy intake. There is little evidence that increased fat mass exerts strong negative feedback on longer-term appetite and energy intake, but during chronic energy deficit, fat-free mass loss may act as an orexigenic signal that promotes increased energy intake and subsequent weight regain. However, studies are limited in number and often employ extreme energy deficits.

There is also some evidence to suggest that the appetitive responses to isoenergetic energy deficits may differ when induced by diet and exercise, with exercise-induced deficits potentially eliciting attenuated appetite compensation. Again however, studies are limited and often employ acute or short-term periods of energy deficit. When exercise (alone) is used to perturb energy balance, a weak coupling appears to exist between the energy expenditure of exercise and subsequent energy intake. However, studies suggest that this coupling becomes stronger when energy balance is systematically manipulated over time, or in those with high levels of habitual physical activity. Low levels of physical activity coincide with an ‘unregulated zone’ of appetite in which energy intake and energy expenditure are disassociated, promoting the overconsumption of food. At higher levels of habitual physical activity, appetite appears to be better regulated such that energy intake more closely matches energy expenditure.

The psychophysiological effects of low energy availability during weight making and subsequent recovery in combat sport athletes.

Dr. Carl Langan-Evans*,* Liverpool John Moores University. Profile link***, here.***

Combat sport athletes are classified into weight categories in order to promote fair competition between opponents of equal proportion. Despite this, these athletes often engage in a process known as ‘weight making’, by losing large volumes of body mass with the intent to compete in the lowest weight category possible, in an attempt to gain subsequent competitive advantages in stature, limb length and power-to-mass ratio over their competitors. Given this practice, it is purported that combat sport athletes may experience transient periods of low energy availability (LEA) when weight making for competition, which has been widely postulated as leading to potential sequelae of athlete triad (TRIAD) and Relative Energy Deficiency in Sports (RED-S). To that end, the aim of the presentation will be to outline the effects of these weight making practices and subsequent periods of recovery on both TRIAD and RED-S via

assessments of body composition, resting metabolism, cardiac function, maximal dynamic strength & power, cardiorespiratory capacity, psychological state and blood clinical chemistry across a series of case studies conducted on elite combat sport athletes.

Elite athletes and overweight individuals – parallels and differences in the metabolic response to energy deprivation at the opposite ends of the exercise spectrum

Prof. Karsten Koehler, (Technical University of Munich). Profile link, **here**.

Understanding the regulation of human energy balance is of foremost importance for the prevention and treatment of the current obesity pandemic. Elite athletes, and particularly those involved in endurance exercise, present a natural model of the extreme end of human energy balance. While some athletes are able to match the substantially elevated energy requirements of exercise by using targeted, energy-dense nutrition approaches, other fail to do so for a variety of reasons. For example, some athletes are restricted in time and food availability, while others use the resulting energy deficit for deliberate body weight reductions to maximize their performance. Energy deficits of prolonged duration and/or substantial magnitude are associated with various metabolic adaptations, which ultimately reduce energy expenditure and conserve energy for vital functions. Although these metabolic adaptations mimic energy conserving processes observed in individuals with overweight and obesity during weight loss, their impact on body composition, performance and health can vary substantially between these two populations. This presentation will provide real-world data from the extremes of human energy expenditure, discuss the relevance of metabolic adaptations for human performance, and highlight parallels and discrepancies in the adaptive responses to energy deficiency between elite athletes and mere mortals.

Did reductions in physical activity energy expenditure help to fuel the obesity epidemic?

Prof. John Speakman, (University of Aberdeen & Chinese Academy of Sciences). Profile link, **here**.

The obesity epidemic is a result of a gene by environment interaction, whereby changes in the environment over the past 70 years or so have interacted with the genetic make-up of a sub-section of society resulting in excessive fat storage for some individuals. A major question has been whether decreases in physical activity have been a major contributor to this problem. There is lots of anecdotal evidence supporting this idea. But there are also several reasons why changes in activity may not translate to changes in activity related energy expenditure, which would be necessary if the changed activity cased the epidemic. Using several sources of information, including analyses from a large database of doubly-labelled water measurements, this talk will attempt to answer whether changes in physical activity energy expenditure have been an important contributor to the obesity epidemic.