The Effect of Endurance Exercise on Energy and Protein Balance

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Abstract

Background

The energy cost of endurance exercise is significant and the ability to consume enough food to maintain energy balance is critical for success. In addition maintenance of body protein stores is also critical and there is a well known relationship between energy and protein balance. The establishment of any relationship between energy and protein balance and markers of overtraining in endurance athletes is also beneficial for endurance performance.

Purpose and Aims

The purpose of this thesis was to investigate the effects of endurance exercise on energy balance and protein balance. The aims were to establish accurate values for EI, EE and protein balance in two endurance sports, Road Cycling and Ironman. The rationale was to determine whether endurance athletes are able to maintain energy and protein balance over periods of increased EE and whether parameters of energy and protein balance related to markers of overtraining

Methods

Two research projects were conducted, the first at the Tour of Southland cycle event (5 high performance male cyclists) and the second at an Ironman training camp (7 male Ironman athletes). In both studies EE was determined by the DLW technique and EI by supervised weighed diet records. Protein balance was determined by an 18-hour primed continuous infusion of ^{13}C-leucine at the Tour of Southland and via the traditional 24-hour nitrogen balance technique at the Ironman camp. Both techniques were performed prior to and immediately after the given event. Nude body weight, blood overtraining parameters, urine samples and a mood questionnaire were collected in the mornings for analysis of daily parameters.

Results

The Tour of Southland: Subjects maintained energy balance with a mean EI of 27.3±3.8 MJ/day and a mean EE of 27.4 ± 2.0 MJ/day. There was no significant change in protein breakdown or parameters of overtraining. Ironman Training Camp: Athletes maintained energy balance with a mean EI of 20.27±2.91 MJ/day and a mean EE of 20.5±3.4 MJ/day and nitrogen balance was positive. There were indications of a relationship between energy and protein balance and markers of overtraining in both studies.

Conclusions

Endurance athletes are able to maintain energy balance when EE is high. When nutrients are sufficient to meet energy demands, protein stores are maintained.

Dedication

In memory of my grandparents

EDWARD RATIMA ROLLESTON

17 March 1912 – 23 August 1987

WILENA PARETIAKI ROLLESTON

18 June 1924 – 29 August 1993

ELIZABETH MARY HILDRETH

19 September 1920 – 28 October 2001

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%ΔPV	percent change in plasma volume	IRMS	isotope ratio mass spectrometry
αKIC	α-ketoisocaproate	kcal	kilocalorie
AA	amino acid	kJ	kilojoule
AGF	Atwater general factor	LBM	lean body mass
APE	atom percent excess	MJ	megajoule
AV balance	arteriovenous balance	MS	mass spectrometer
BCAA	branched chain amino acid	POMS	profile of mood state
BD	body density	R_a	rate of appearance
BF%	body fat percentage	R_d	rate of disappearance
CO_2	carbon dioxide	RMR	resting metabolic rate
DLW	doubly labelled water	RQ	respiratory quotient
DXA	dual energy x-ray absorptiometry	TBW	total body water
EE	energy expenditure	TDEE	total daily energy expenditure
EI	energy intake	TEF	thermic effect of food
FFM	fat free mass	ToS	Tour of Southland
FQ	food quotient	TUN	total urinary nitrogen
FSR	fractional synthesis rate	UUN	urine urea nitrogen
GC	gas chromatography	VO_2max	maximal oxygen consumption
Hct	haematocrit	VO_2peak	peak oxygen consumption
Hgb	haemoglobin	WBPT	whole body protein turnover