NUTRITIONAL STATUS, EXERCISE, AND INSULIN SENSITIVITY

A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Public Health.

Massey University, Manawatu,

New Zealand.

Jackson George Green

2011

Abstract

The insulin-glucose system in lean-healthy people adapts its normal function in the face of challenging metabolic conditions. To improve understanding of these adaptations, I exposed subjects to periods of starvation, high-protein-low-carbohydrate diet (HPLC) and overfeeding.

In six lean-healthy men, dietary carbohydrate was eliminated but gluconeogenic substrate supply was maintained by three-day HPLC diet, compared with three-day starvation and three-day mixed-carbohydrate diet. Insulin sensitivity, *vastus lateralis* intramyocellular lipid (IMCL) and fasting glucose were unaffected by HPLC diet, although they were significantly altered after starvation. These results indicate that dietary carbohydrate restriction does not trigger metabolic adaptations, although total metabolic carbohydrate supply remains likely to be important.

Six lean-healthy men underwent two three-day periods of starvation with either no exercise or daily endurance exercise (80 min.day^{-1} at 50% VO_{2Max}) and a three-day mixed diet without exercise. Compared to mixed diet, starvation elevated fasting FFA and IMCL and decreased insulin sensitivity and fasting glucose. Exercise during starvation prevented the elevation of IMCL but did not prevent other metabolic disruption, in contrast with exercise during lipid infusion.

Maintaining high physical-activity may prevent the metabolic disruption associated with overfeeding, while insulin sensitivity may predict partitioning of fuel between tissues during overfeeding. Nine endurance-trained athletes maintained their normal physical-

activity while consuming a diet providing 90 kJ.(kg body mass)$^{-1}$.day^{-1} above their normal dietary intake for four weeks. Subjects' body-mass, fat-mass and body fat% increased while insulin sensitivity tended to decrease (14.5 ± 5.9 to 9.5 ± 4.1 min^{-1}.mU.l^{-1}, $p = 0.08$). Change in insulin sensitivity was correlated with change in body fat % ($r = -0.77$, $p < 0.023$). Initial insulin sensitivity was correlated with change in body fat% ($r = 0.90$, $p < 0.009$) and the proportion of mass gained as lean tissue ($r = 0.86$, $p < 0.024$). Maintenance of already high physical-activity cannot prevent metabolic disruption associated with overfeeding. These results also suggest that insulin sensitivity influences energy partitioning between tissues.

The results in this thesis suggest important interaction effects between exercise and diet. I propose that carbohydrate availability is a key modulator of the effects of exercise on metabolism in lean-healthy men.

Acknowledgements

The completion of this thesis would not have been possible without the generous assistance of many people. First and foremost I would like to thank my wife, Rose, for providing loving support and a sympathetic ear. I am also particularly indebted to my primary supervisor, Dr Stephen Stannard, who guided me away from many scientific pitfalls and made available whatever resources were needed. My co-supervisor Dr Chris Cunningham provided sage advice on the doctoral study process and co-supervisors Dr Nathan Johnson and Dr Peter Snell who provided physiological advice. I have enjoyed the collegial support of my fellow post-graduate students: Jon Hughes, Matt Barnes, Zac Schlader, Bob Stewart, Rachel Mason and Aaron Raman; and of Massey University staff Dr Jane Coad and Dr Toby Mundel. None of my research would have been possible without the technical assistance that was provided by Matt Barnes, Dr Pat Ruell, Dr Toos Sachinwalla, Chris Booth and Dr David Simcock. Perhaps most importantly, I am grateful to the subjects who endured unusually unpleasant interventions with stoic determination.

All the experiments presented in this thesis were approved by the local human ethics committee at the institution where they were performed, and complied with the Declaration of Helsinki.

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