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NUTRITIONAL STATUS, EXERCISE, AND
INSULIN SENSITIVITY

A thesis presented in partial fulfilment of the requirements for
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New Zealand.

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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 ($80 \text{ min} \cdot \text{day}^{-1}$ at $50\% \text{ VO}_{2\text{Max}}$) 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-

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activity while consuming a diet providing $90 \text{ kJ} \cdot (\text{kg body mass})^{-1} \cdot \text{day}^{-1}$ 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 $9.5 \pm 4.1 \text{ min}^{-1} \cdot \text{mU} \cdot \text{l}^{-1}$, $p = 0.08$). 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.

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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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