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Modelling changes in fat-free mass in response to severe energy restriction

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Very-low calorie diets (VLCD), providing ~450–800 kcal per day, are designed to promote rapid weight-loss, resulting in 15–25% weight-loss in 3–4 months[(1)]. While weight-loss is composed of both fat mass and fat-free mass (FFM), it has been suggested that larger energy deficits, such as that imposed by VLCDs, result in an accelerated loss of metabolically active FFM[(2)] i.e., skeletal muscle. As the primary determinant of resting energy expenditure (REE), FFM loss will subsequently reduce REE, which contributes 60–70% of total energy expenditure[(3)]. This will narrow the discrepancy between energy intake and energy expenditure, suggested to result in early weight plateau and reduced weight maintenance. Our main objective to determine the impact of severe energy restriction on FFM.

Firstly, data obtained from *The DROPLET Trial* was used to model changes in weight and FFM in response to a very-low calorie total-diet replacement program and a usual care protocol delivered for 12 weeks. From these findings, we tested an existing mathematical model of weight-loss, developed by our group, using baseline inputs of weight and calorie intake to convert energy deficit to weight- loss over time. Within our model, energy expenditure is subdivided into REE, physical activity energy expenditure and diet-induced thermogenesis. Additionally, the model accounts for obligatory changes in body composition and adaptive changes in energy expenditure observed in response to underfeeding. Mean model error was determined by calculating the discrepancy between actual weight-loss and weight-loss predicted by our model.

Degree of energy restriction was directly associated with rate of weight-loss, with a mean weight-loss of 12.23 ± 5.22% *vs.* 3.22 ± 3.78% observed in VLCD and usual care participants respectively. 71% of VLCD participants had >10% weight-loss compared to 3% of usual care. Greater absolute and percent weight-loss was observed in male participants, likely attributed to significantly higher baseline weight and FFM. Greater reductions in FFM were observed in VLCD participants (2.55 ± 4.90 kg *vs.*0.20 ± 4.37 kg), particularly in the first four weeks of the intervention. However, proportionally, VLCD resulted in a greater increase in FFM% at 12 weeks (5.8% *vs.* 2.12%). From these observations, our mathematical model of weight-loss was associated with a mean error of <1 kg at 4 weeks and 1–4 kg at 12 weeks.

We conclude that larger energy deficits result in significantly greater short-term weight-loss. While greater FFM loss is observed in VLCD, it appears proportional to overall weight-loss. Furthermore, VLCD has a more desirable effect on body composition, with large fat mass losses resulting in a greater increase in FFM%. By modelling FFM and energy expenditure changes in response to underfeeding, mathematical modelling may provide a more accurate method of weight-loss prediction.

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References

1. Tsai AG & Wadden TA (2006) *Obesity* **14**, 1283–93.
2. Vink RG, Roumans NJ, Arkenbosch LA *et al.* (2016) *Obesity* **24**(2), 321–7.
3. Leibel RL, Rosenbaum M & Hirsch J (1995) *N Engl J Med* **332**, 621–8.
4. Astbury NM, Aveyard P, Nickless A *et al.* (2018) *BMJ* **362**, k3760.