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LETTERS TO THE EDITOR

Why is the 3500 kcal per pound weight loss rule wrong?

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We welcome the recent article by Thomas *et al.*[1] criticizing the commonly used 3500 kcal per pound weight loss rule. This echoes our research showing that the 3500-kcal rule leads to overestimation of weight loss in individuals and populations.[2,3] Despite our agreement with the spirit of the article, we believe it has the potential to generate confusion about exactly why the 3500-kcal rule is wrong.

The most serious error of the 3500-kcal rule is its failure to account for dynamic changes in energy balance that occur during an intervention. Unfortunately, we feel that this error is obscured by the equation of Thomas *et al.*[1] meant to represent the predictions of the 3500-kcal rule: $W(t) = W_0 + \Delta EB \times t/3500$, where the change in energy balance, ΔEB, was defined as the difference between the rates of energy intake and expenditure. What the authors failed to stress was that they calculated ΔEB as the initial difference between the energy intake and expenditure rates and assumed it to be a static quantity. In reality, ΔEB is dynamic and, if accurately estimated over time, then the above equation provides a reasonable estimate of weight change.

Mathematical models attempt to correct this deficiency by estimating the dynamic changes in ΔEB.[4] Thomas *et al.*[1] correctly demonstrated that the typical assumption of a static ΔEB leads to exaggerated weight loss predictions with no plateau. However, the static ΔEB assumption was not explicitly stated and the reader may be led to the erroneous conclusion that the deficiency of the 3500-kcal rule is the numerical value '3500'.

Conservation of energy requires that the cumulative energy deficit (that is, the integral of ΔEB) equals the energy lost from the body. The 3500-kcal rule was motivated by calculating that a pound of adipose tissue stores approximately 3500 kcal.[5] A more accurate accounting of body composition changes demonstrated that this value is appropriate for modest weight changes in overweight and obese people, but is an overestimate in others.[6] However, using a 'corrected' numerical value for the energy content of lost tissue does not repair the 3500-kcal rule without also accounting for the ΔEB dynamics.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Response to 'Why is the 3500 kcal per pound weight loss rule wrong?'

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We agree with Hall and Chow[1] that the 3500-kcal rule prediction is more accurate when the change in energy balance (ΔEB) includes the effects of a progressively decreasing weight loss over time. The proposed dynamic model allows for this complexity by making it possible to simulate the expected weight loss at any point in time under the new conditions prevailing at this particular time. However, the 3500-kcal rule in every instance that it is applied in the global obesity literature and in countless weight management programs assumes ΔEB is static (see citations in study by Thomas *et al.*[2]). For example, if an individual reduced their intake by 500 kcal per day, then at the end of 1 week, the 3500-kcal model would predict one lb of weight loss. The focus of our commentary was to demonstrate that applying the 3500 model, which relies on an assumption of static ΔEB, would result in a vast overestimation of weight loss. This has serious practical implications, as the 3500-kcal model is currently applied to guide individual patient weight loss, design and analyze experimental weight loss studies, and inform the public.

More complex thermodynamically based models, however, do include exactly the component mentioned by Hall and Chow[1] and, as demonstrated in our publication[2], greatly increase the accuracy of predictions. We have emphasized in our commentary and would like to emphasize again that any model that assumes constant ΔEB would be flawed in predicting accurate weight loss.

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Thus, we strongly advocate regular use of the available online calculators that simulate dynamic models for both single subject entry and multiple subjects as the prevailing energy intake and energy expenditure conditions change over time (web-site addresses are provided in the study by Thomas *et al.*[2]).

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