It’s not uncommon to hear both lay persons and professionals matter-of-factly refer to the “starvation response” (also called metabolic adaptation) and “set-point theory” as if they were accepted facts. The supposition of these theories is that the body reacts to reduced energy intake, or weight loss, by lowering its basal metabolic rate in an attempt to maintain the current weight or return to a higher weight. If this were the case the data would show a suppressed resting metabolic rate (RMR) per kilogram of fat free mass (FFM) after weight loss.

These theories however, have not survived sound scientific investigation, and those researchers who are familiar with this area of medical literature have known that for almost 20-years. Three comprehensive reviews of the literature in 1992, 1994, and 1995\textsuperscript{1,2,3} all reached the same conclusions that:

\begin{itemize}
  \item Dieting does not lead to an abnormal decrease in basal metabolic rate. \textit{A lower body weight does mean a lower BMR, however it is not abnormal to the new reduced weight level.}
  \item Dieting does not lead to an abnormal loss of lean body mass, or redistribution of body fat. \textit{When people gain weight part of their weight gain is lean body mass (muscle). When they lose weight they tend to lose the same ratio of fat and muscle that they originally gained.}\textsuperscript{4}
  \item Dieting does not affect the future ease/difficulty of regaining/losing weight (at least from a physiological basis).
\end{itemize}

While those three reviews looked at the literature regarding people who were \textit{trying to lose weight}, other research has looked at \textit{chronically undernourished} populations expecting to find proof of metabolic adaptation, but the data simply do not support the theory.\textsuperscript{5,6,7}

Shetty’s paper\textsuperscript{5} was a review of existing literature regarding “metabolic adaptation,” or set-point theory, which he presented as the keynote lecture at a scientific meeting of the Nutrition Society in July 1992. Shetty reported that many studies on malnourished subjects, have failed to demonstrate any significant decrease in metabolic rate when adjusted per kg/FFM. In fact, most recent measurements show an increased RMR kg/FFM in undernourished individuals. Finding a higher RMR kg/FFM makes sense due to changes within the \textit{lean body mass} compartment, which result in a higher proportion of organ tissue (and less skeletal muscle), and therefore a higher RMR per Kg/FFM. The author summarizes, “\textit{It would then appear that an increase in metabolic efficiency in the RMR component of the energy expenditure, which has been hitherto considered to be the cornerstone of the beneficial metabolic adaptation to energy inadequacy, is of doubtful existence.”}

The author goes on to discuss the literature, and finally concludes that the data do not demonstrate adaptive responses in RMR, thermogenesis, or physical activity, in chronically undernourished subjects.

One of the early problems with this area of literature was with the statistical analysis of the follow-up measurement of RMR per Kg/FFM. Researchers must adjust for changes in fat mass and LBM correctly to determine if any differences between the baseline and follow-up RMR remain. Some older studies (that seemed to support the notion of metabolic adaptation)\textsuperscript{8,9} used a ratio method to normalize the follow-up RMR for changes in FFM, which led to the follow-up RMR \textit{appearing falsely lower} than it actually was. Well done studies use analysis of covariance (ANCOVA), which is the appropriate method for the \textit{curvilinear} relationship between RMR and FFM. The ratio method should only be used when adjusting factors that have a \textit{linear} relationship, which is not the case between fat and FFM.

Note that the paper by Leibel,\textsuperscript{9} which may be the most quoted among advocates of the set-point idea is one of the studies criticized for the above statistical error, ”\textit{Leibel et al, reported that weight loss caused a reduced ratio of RMR to FFM; however, when the authors adjusted RMR for changes in FFM and FM by using a regression-based analysis [ANCOVA], the changes in RMR were not significant...}”\textsuperscript{10}.

Weinsier, regarding his 4-year study comparing post-obese women to controls, concluded that exogenous factors contributed to weight regain, rather than any inherent set-point. Over the four years, some women regained as little as 2 kg and others as much as 26 kg. “\textit{Overall our data suggest that this tendency to weight regain among obesity prone women is more likely to}...”}

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be due to maladaptive responses to the environment in terms of physical inactivity or excess energy intake than to reduced energy requirements."\(^\text{11}\)

De Groot’s findings are not surprising since it takes 7- to 14-days on maintenance level calories (appropriate for current body weight) for a subject’s RMR to normalize following energy restriction.\(^\text{15}\)

Taking the follow-up RMR measurement before patients were stabilized is another example of how some studies have provided misleading follow-up RMRs kg/FFM. If a study doesn’t specify when the reading was taken it makes it difficult to conclude anything from the data without contacting the study authors for clarification.

When it does occur, the suppression in RMR secondary to ongoing negative energy balance is believed to be due to several factors the greatest probably being the suppression of both active thyroid hormone (T\(_3\)) and sympathetic nervous system (SNS), in addition to changes in insulin, glucagon, growth hormone and glucocorticoids. Weinsier suggested that normalized T\(_3\) could be used as an indicator of weight stabilization that researchers could look for before attempting to measure the post weight loss RMR.

Untreated hypothyroidism can lower REE 30\% \pm 10\%, while subclinical hypothyroidism is estimated to lower REE 15\% \pm 5\%.\(^\text{16,17,18}\) Approximately 10\% and 7.5\% of the population has either frank or subclinical hypothyroidism respectively, with around 80\% of cases being in females. Some data indicate that about 40\% of treated hypothyroid cases may not be properly adjusted, and may still exhibit various symptoms of hypothyroidism (low body temperature, dry skin, hair loss, depression, low REE, etc.).\(^\text{19}\)

Evaluating thyroid status, as well as RMR, before energy restriction commences would provide valuable information for all involved.

The set-point, starvation-response, and lately the popular metabolic-adaptation theories have evolved over the years as their advocates attempt to maintain a viable theory. Are there physiological changes associated with energy restriction? Yes. Do they prevent weight loss, or maintenance of weight loss? No. The danger with these theories is how they are applied by the public and some professionals. If you believe you have no control over your weight that will become a self-fulfilling prophesy. One could argue that these notions have done as much to promote the obesity epidemic as the cultural and environmental changes that clearly encourage it.

2 NIH National Task Force on the Prevention and Treatment of Obesity. Weight Cycling. JAMA Oct. 19, 1994;272(15):1196-1202. This study was conducted by an expert panel at the National Institutes of Health, which consisted on experts in the fields of nutrition, obesity, and epidemiology.


The author notes that normalizing BMR, for either body weight or FFM, by analysis of covariance abolished all difference in BMR between well-nourished and chronically-undernourished subjects. The author concludes: “These findings suggest the absence of an enhanced metabolic response in weight-stable chronically undernourished adults. This is in contrast with earlier reports, and supports more recent views.”

In further discussion the author notes that her data, and that of previous reports (Gambian men and women, Ethiopian women, and malnourished Colombian school-aged boys and girls), found a higher BMR per unit of body weight or FFM, compared to well-nourished controls. This finding is consistent with the loss of tissues that are less metabolically active (adipose tissue, and skeletal muscle), vs. highly metabolically active tissues (organs).


7 Soares MJ, et al. Basal metabolic rates and metabolic efficiency in chronic undernourished. Euro J Clin Nutr. 1991;45:363-373. “A large number of measurements made, over the last decade, in chronically energy deficient (CED) subjects do not confirm the existence of an enhanced metabolic efficiency as indicated by a reduce O\textsubscript{2} consumption per unit FFM. On the contrary, it has now been observed that the BMR expressed per kg/FFM was significantly higher in CED subjects than in well-nourished subjects.”


11 Weinsier RL, et al. Metabolic predictors of obesity. J Clin Invest 1995;95:980-985.. There was no significant difference in REE between the obese and post-obese states after adjusting for FFM and FM. The average value for TEF was lower in the obese subjects compared to controls (P < 0.05); however, it rose after weight loss such that there was no longer a significant difference in TEF between the post-obese and never-obese controls.


