Casual Friday Series

Troubleshooting Weight Loss Resolutions

A Biogenetix Clinical Presentation

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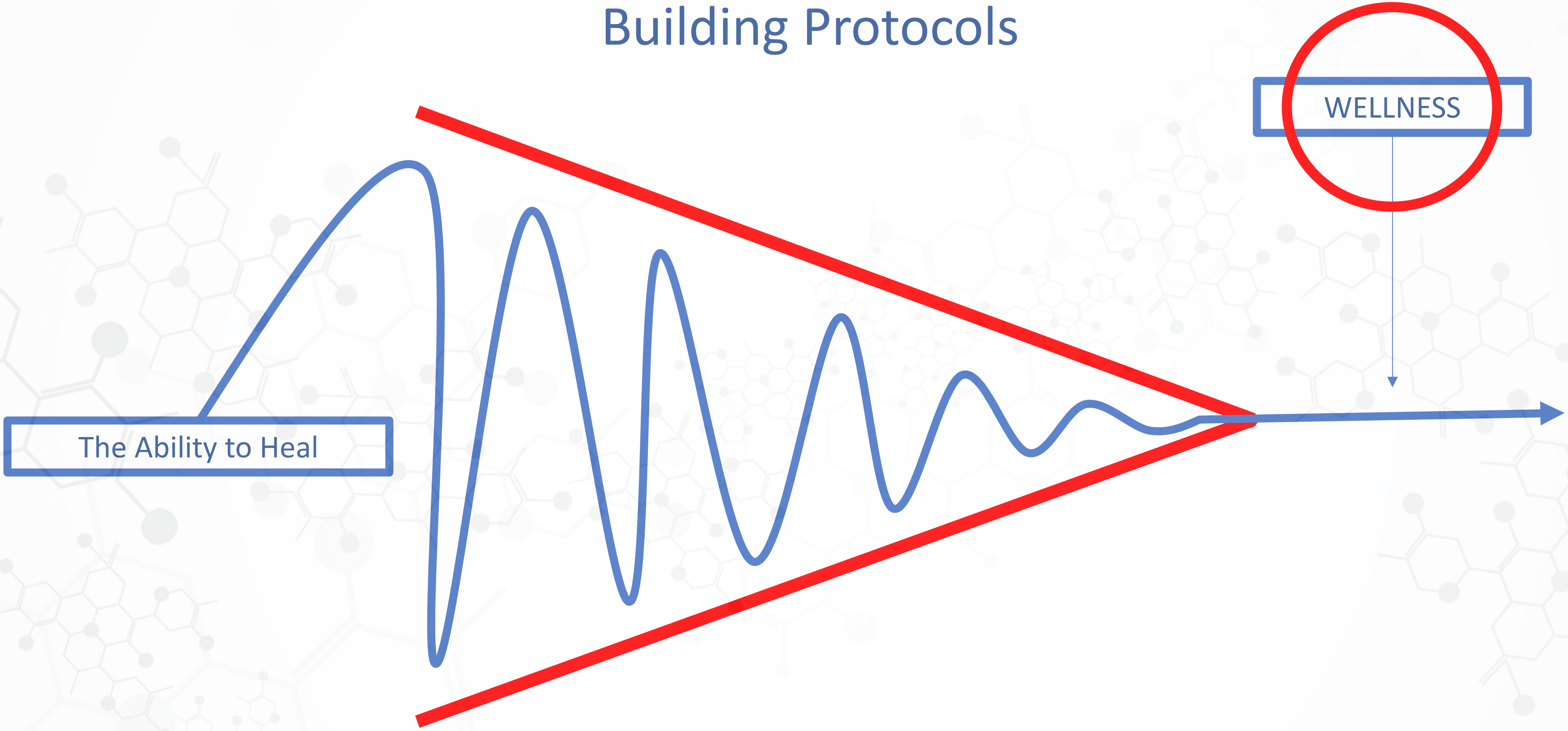
Lifestyle + Genetics = Chronic Health IMPROVEMENT

Building Protocols



January Decisions…

Exercise, no wedge.

Wedge, no exercise.

Exercise + wedge.

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Energy compensation and adiposity in humans

Vincent Careau,[1,~#] Lewis G. Halsey,[2,~*] Herman Pontzer,[3,4,#] Philip N. Ainslie,[5] Lene F. Andersen,[6]

Understanding the impacts of activity on energy balance is crucial. Increasing levels of activity may bring diminishing returns in energy expenditure because of compensatory responses in non-activity energy expenditures[1–3]. This suggestion has profound implications for both the evolution of metabolism and human health. It implies that a long-term increase in activity does not directly translate into an increase in total energy expenditure (TEE) because other components of TEE may decrease in response–energy compensation. We used the largest dataset compiled on adult TEE and BEE (*N* = 1,754) of people living normal lives to find that energy compensation by a typical human averages 28% due to reduced BEE; this suggests that only 72% of the extra calories we burn from additional activity translate into extra calories burned that day. Moreover, the degree of energy compensation varied considerably between people of different body composition. This association between compensation and adiposity could be due to among-individual differences in compensation: people who compensate more may be more likely to accumulate body fat. Alternatively, the process might occur within individuals: as we get fatter, our body might compensate more strongly for the calories burned during activity, making losing fat progressively more difficult. Determining the causality of the relationship between energy compensation and adiposity will be key to improving public health strategies regarding obesity.

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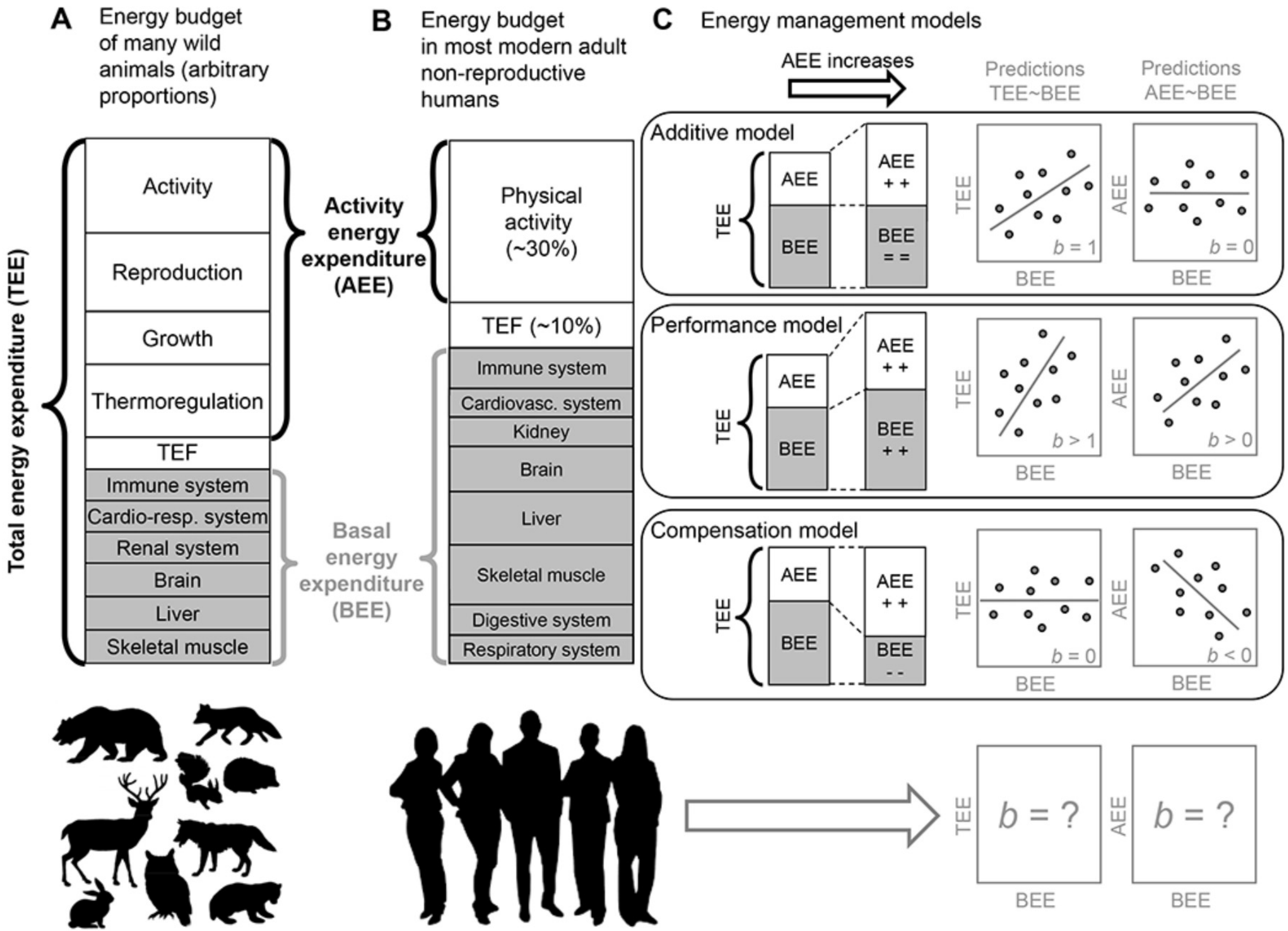
The contexts within which energy compensation occur, the extent to which it occurs [4, 5] and the processes involved are far from resolved [2, 6–8]. Using the largest dataset on human energy expenditure ever assembled, by estimating the relationships between TEE, AEE, and BEE we test the mutually exclusive predictions from the three energy expenditure models (Figure 1) for individuals with unremarkable lifestyles generating natural variation in total energy expenditures over time, and without food restriction. Determining which of these energy expenditure models apply to humans under typical, free-living conditions, and quantifying its effects, will progress our understanding of the evolution and control of metabolism, and may provide key physiological information for management strategies for weight control.



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Thus, humans living typical modern lives – not undertaking exceptional levels of activity or experiencing chronic food shortages – exhibit a fairly strong compensation between the energy they expend on activity and that expended on basal metabolic processes; over the long term more than a quarter of the extra calories burned by people during activity do not translate into extra calories expended that day. Presumably, such compensation would have been adaptive for our ancestors because it minimised food energy demands and hence reduced the time needed for foraging, the advantages of which may include reducing exposure to predation. However, it is potentially maladaptive for modern-living humans exercising to try to burn off excess food consumption, given the chain of association linking high-density foods to greater energy intake [14], obesity [15] and its related diseases [16].

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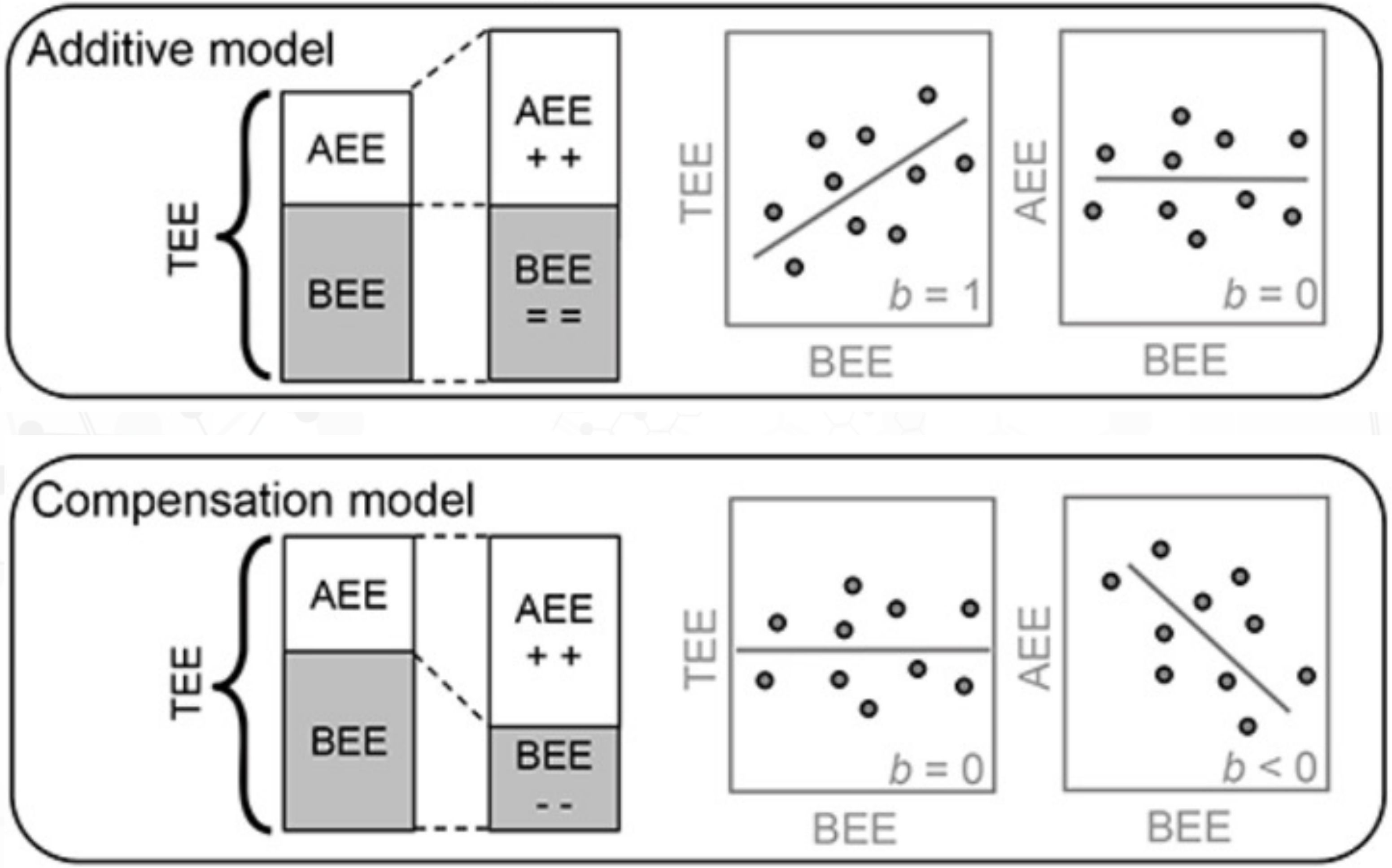
If energy compensation has an underlying genetic basis, in the future it might be possible to screen individuals to ascertain whether exercise would be a valuable fat loss intervention because they are 'weak compensators', or a fruitless fat loss intervention because they are strong compensators (while recognising other benefits to exercise including protecting against weight regain [22, 23]). Moreover, we need to understand whether there are costs to reducing BEE. If there are, such as for example a compromised immune system or slowed recovery from injury [24, 25], then for some individuals the point at which exercise levels reach a detrimental level will be considerably lower than for others.

The ever growing and diversifying range of fat loss plans and fads available to the public reflects the reality, well known to researchers, that prescribed exercise programmes for weight reduction rarely result in substantive or long-term changes in body mass [26]. The few national guidelines that have been published converge on the recommendation of a 500-600 kcal/d deficit through exercising and dieting to instigate fat loss [27]. These guidelines are general for the population and do not factor in the variation in energy compensation exhibited by people with different levels of fat mass, as demonstrated in the current study. Public health strategies for fat loss should be revised to recognise energy compensation as our understanding progresses about which individuals compensate and by how much. In this vein, more research is needed on the potentially substantial diversity of energy compensation between sub-populations. In the future, personalised exercise plans targeting fat loss might be developed partly based on an individual's genetic propensity for energy compensation.



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Energy compensation. Reduced BEE accounts for an energy compensation of 28%.

Translation: A body with excess fat will protect the excess fat.

WHY? What is the fat there *for?*

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High-Intensity Intermittent Exercise and Fat Loss

Stephen H. Boutcher*

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Most exercise protocols designed to induce fat loss have focused on regular steady state exercise such as walking and jogging at a moderate intensity. Disappointingly, these kinds of protocols have led to negligible weight loss [1, 2]. Thus, exercise protocols that can be carried out by overweight, inactive individuals that more effectively reduce body fat are required. Accumulating evidence suggests that high-intensity intermittent exercise (HIIE) has the potential to be an economical and effective exercise protocol for reducing fat of overweight individuals.

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HIIE protocols have varied considerably but typically involve repeated brief sprinting at an all-out intensity immediately followed by low intensity exercise or rest. The length of both the sprint and recovery periods has varied from 6 s to 4 min. Most commonly the sprints are performed on a stationary cycle ergometer at an intensity in excess of 90% of maximal oxygen uptake ($\dot{V}O_{2\,max}$). Subjects studied have included adolescents, young men and women, older individuals, and a number of patient groups [3–12]. The most utilized protocol in past research has been the Wingate test which consists of 30 s of all-out sprint with a hard resistance [13]. Subjects typically perform the Wingate test 4 to 6 times separated by 4 min of recovery. This protocol amounts to 3 to 4 min of exercise per session with each session being typically performed 3 times a week for 2 to 6 weeks. Insight into the skeletal muscle adaptation to HIIE has mainly been achieved using this type of exercise [13]; however, as this protocol is extremely hard, subjects have to be highly motivated to tolerate the accompanying discomfiture. Thus, the Wingate protocol is likely to be unsuitable for most overweight, sedentary individuals interested in losing fat. Other less demanding HIIE protocols have also been utilised. For example, we have used an 8-second cycle sprint followed by 12 s of low intensity cycling for a period of 20 min [5]. Thus, instead of 4 to 6 sprints per session, as used in Wingate protocol studies, subjects using the 8 s/12 s protocol sprint 60 times at a lower exercise intensity. Total sprint time is 8 min with 12 min of low intensity cycling. For the HIIE Wingate protocols, total exercise time is typically between 3 to 4 min of total exercise per session. Thus, one of the characteristics of HIIE is that it involves markedly lower training volume making it a time-efficient strategy to accrue adaptations and possible health benefits compared to traditional aerobic exercise programs. This review summarises results of research examining the effect of different forms of HIIE on fitness, insulin resistance, skeletal muscle, subcutaneous, and abdominal fat loss.

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Nevill et al. [25] examined the growth hormone (GH) response to treadmill sprinting in female and male athletes and showed that there was a marked GH response to only 30 s of maximal exercise and the response was similar for men and women but greater for sprint compared to endurance trained athletes. GH concentration was still ten times higher than baseline levels after 1 hour of recovery. Venous blood cortisol levels have also been shown to significantly increase after repeated 100 m run sprints in trained males [26], after five 15-second Wingate tests [27], and during and after brief, all-out sprint exercise in type 1 diabetic individuals [28].

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Chronic responses to HIIE training include increased aerobic and anaerobic fitness, skeletal muscle adaptations, and decreased fasting insulin and insulin resistance (Table 1). Surprisingly, aerobic fitness has been shown to significantly increase following minimal bouts of HIIE training. For example, Whyte et al. [45] carried out a 2-week HIIE intervention with three HIIE sessions per week consisting of 4 to 6 Wingate tests with 4 min of recovery. Previously, untrained males increased their $\dot{V}O_{2\,max}$ by 7%. Increases in $\dot{V}O_{2\,max}$ of 13% for an HIIE program also lasting 2 weeks have been documented [42]. HIIE protocols lasting 6 to 8 weeks have produced increases in $\dot{V}O_{2\,max}$ of 4% [37] and 6–8% [39]. Longer Wingate-type HIIE programs lasting 12 to 24 weeks have recorded large increases in $\dot{V}O_{2\,max}$ of 41% [40] and 46% [6] in type 2 diabetic and older cardiac rehabilitation patients. The less intense protocols (8 s/12 s) coupled with longer duration conducted over 15 and 12 weeks resulted in a 24% [5] and 18% increase [46] in $\dot{V}O_{2\,max}$. Collectively, these results indicate that participation in differing forms of HIIE by healthy young adults and older patients, lasting from 2 to 15 weeks, results in significant increases in $\dot{V}O_{2\,max}$ from between 4% to 46% (Table 1). Mechanisms underlying the aerobic fitness response to HIIE are unclear

Table 1

Effect of high-intensity intermittent exercise on subcutaneous and abdominal fat, body mass, waist circumference, $\dot{V}O_{2\,max}$, and insulin sensitivity.

Study	Subcutaneous fat (kg)	Abdominal/ trunk fat (kg)	Body mass (kg)	Waist circumference (cm)	Type of HIIE	Length of intervention	$\dot{V}O_{2\,max}$ $ml \cdot kg \cdot min^{-1}$	Insulin sensitivity
Boudou et al. [8]	⇓18%	⇓44%	⇓1.9 kg (2%)	—	SSE + 5 × 2/3 min R	8 weeks	—	⇑58%
Burgomaster et al. [37]	—	—	⇔	—	4–6 Wingate/4.5 min R	6 weeks	⇑7%	—
Dunn [46]	⇓2.6 kg (8%)	⇓.12 kg (6%)	⇓1.9 kg (3%)	⇓3.5 cm (4%)	60 × 8 s/12 s R	12 weeks	⇑18%	⇑36%
Helgerud et al. [39]	—	—	⇓.8 kg (1%)	—	15 s/15 s R	8 weeks	⇑6%	—
Helgerud et al. [39]	—	—	⇓1.5 kg (2%)	—	4 × 4 min/4 min R	8 weeks	⇑7%	—
Mourier et al. [40]	⇓18%	⇓48%	⇓1.5 kg (2%)	⇓1.00 cm (1%)	SSE + 5 × 2/3 min R	8 weeks	⇑41%	⇑46%

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The majority of research examining HIIE has focused on short-term (2 to 6 weeks) programs on skeletal muscle adaptation [13]. However, some studies have utilized longer programs to determine the effect of HIIE on subcutaneous and abdominal fat loss. For example, Tremblay et al. [38] compared HIIE and steady state aerobic exercise and found that after 24 weeks subjects in the HIIE group lost more subcutaneous fat, as measured by skin folds, compared to a steady state exercise group when exercise volume was taken into account (Table 1). More recently, Trapp et al. [5] conducted an HIIE program for 15 weeks with three weekly 20-minute HIIE sessions in young women. HIIE consisted of an 8-second sprint followed by 12 s of low intensity cycling. Another group of women carried out an aerobic cycling protocol that consisted of steady state cycling at 60% $\dot{V}O_{2\,max}$ for 40 min. Results showed that women in the HIIE group lost significantly more subcutaneous fat (2.5 kg) than those in the steady state aerobic exercise program (Figure 2(a)). Dunn [46] used a similar HIIE protocol together with a fish oil supplementation and a Mediterranean diet for 12 weeks. In 15 overweight young women, the combination of HIIE, diet, and fish oil resulted in a 2.6 kg reduction in subcutaneous fat (8%) and a 36% increase in insulin sensitivity (Table 1). The amount of subcutaneous fat lost was similar to that observed in the Trapp et al. [5] study suggesting that shorter HIIE interventions (12 versus 15 weeks) are also effective for reducing subcutaneous fat.

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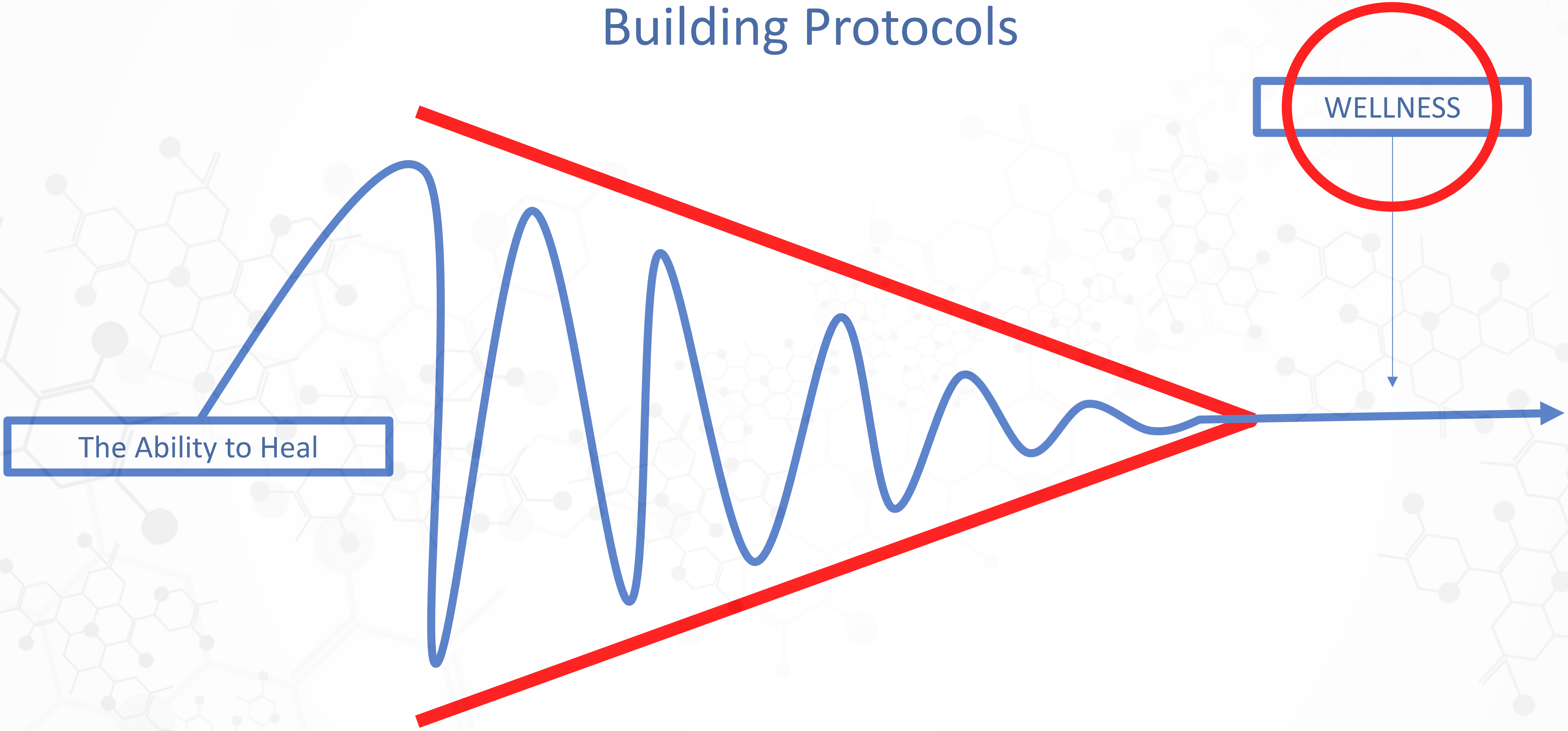
A summary of the results of studies examining the effects of HIIE on subcutaneous and abdominal fat, body mass, and waist circumference is illustrated in Table 1. As can be seen studies that carried out relatively brief HIIE interventions (2 to 6 weeks) only resulted in negligible weight loss. However, the majority of subjects in these short-term Wingate test studies have been young adults with normal BMI and body mass. Studies that used longer duration HIIE protocols with individuals possessing moderate elevations in fat mass [5] have resulted in greater weight/fat reduction. Interestingly, the greatest HIIE-induced fat loss was found in two studies that used overweight type 2 diabetic adults (BMI > 29 kg/m^2) as subjects [8, 40]. Given that greater fat loss to exercise interventions has been found for those individuals possessing larger initial fat mass [54], it is feasible that HIIE will have a greater fat reduction effect on the overweight or obese. Thus, more studies examining the effects of HIIE on obese or overweight individuals are needed.

Building Protocols



Biogenetix: 833-525-0001

bruno@biogenetix.com

kim@biogenetix.com