Myter og fakta om trening og forbrenning av kalorier!
-
NIH Aktiv Convention 2021

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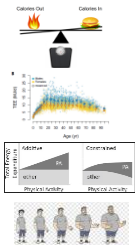
'Myths' or 'facts'

- **ENERGY BALANCE** - Reducing energy intake by 500 kcal per day equals about 0.5 kg weight loss per week
- **METABOLIC RATE** - Weight gain during adulthood is mainly explained by slowing down metabolic rate
- **ENERGY COMPENSATION** – Increasing physical activity will increase total energy expenditure
- **WEIGHT GAIN PREVENTION** – Higher levels of physical activity prevent weight gain



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A small negative energy balance produces substantial weight loss over time

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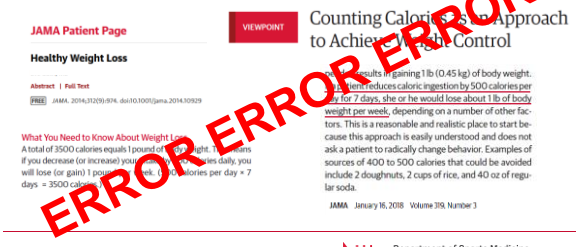
Weight loss and calories


JAMA Patient Page

Healthy Weight Loss

What You Need to Know About Weight Loss

A total of 3500 calories equals 1 pound of body weight. If you decrease (or increase) your daily calories by 500 calories daily, you will lose (or gain) 1 pound per week. (500 calories per day × 7 days = 3500 calories)

VIEWPOINT

Counting Calories as an Approach to Achieve Weight Control

...results in gaining 1 lb (0.45 kg) of body weight. ...patient reduces caloric ingestion by 500 calories per day for 7 days, she or he would lose about 1 lb of body weight per week, depending on a number of other factors. This is a reasonable and realistic place to start because this approach is easily understood and does not ask a patient to radically change behavior. Examples of sources of 400 to 500 calories that could be avoided include 2 doughnuts, 2 cups of rice, and 40 oz of regular soda.

JAMA January 16, 2018 Volume 319, Number 3

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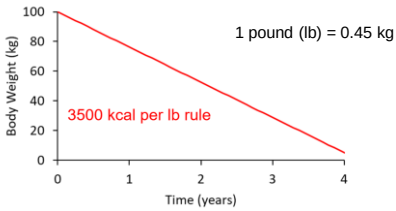
Erroneous weight loss projections



1 pound (lb) = 0.45 kg

(Hall et al, *Lancet* 2011)

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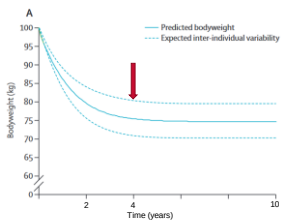
A dynamic energy balance model



- Predicted weight loss by reducing energy intake by 500 kcal per day in a man of 100 kg
- ~12-13 kg weight loss within 1 year
- ~25 kg weight loss achieved within 4 years
- No further weight loss despite energy deficit
- https://www.niddk.nih.gov/bwp

(Hall et al, *Lancet* 2011)

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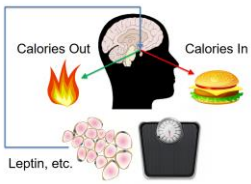
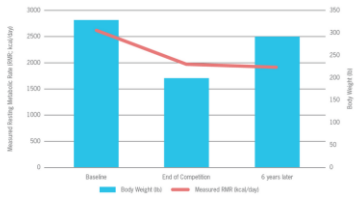
The body fight against weight loss but not weight gain



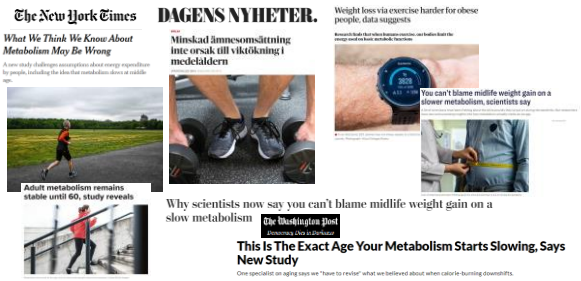
Why Weight loss is difficult

- Homeostasis – maintenance
- Evolution – store energy
- Metabolism slows down - storing fat
- Hormones (leptin) - increase drive to eat
- Neural reward systems (dopamine) 'kick in'

Weight regain



(From Hall et al, *Obesity* 2016)



METABOLISM

Daily energy expenditure through the human life course

Pontzer *et al.*, *Science* **373**, 808–812 (2021)

Total daily energy expenditure ("total expenditure") reflects daily energy needs and is a critical variable in human health and physiology, but its trajectory over the life course is poorly studied. We analyzed a large, diverse database of total expenditure measured by the doubly labeled water method for males and females aged 8 days to 95 years. Total expenditure increased with fat-free mass in a power-law manner, with four distinct life stages. Fat-free mass–adjusted expenditure accelerates rapidly in neonates to ~50% above adult values at ~1 year; declines slowly to adult levels by ~20 years; remains stable in adulthood (20 to 60 years), even during pregnancy; then declines in older adults. These changes shed light on human development and aging and should help shape nutrition and health strategies across the life span.

Energy compensation and adiposity in humans

Careau et al. Current Biology 31, 1–8, October 25, 2021

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.[1–7] 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 basal energy expenditure (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 translates into extra calories burned that day. Moreover, the degree of energy compensation varied considerably between people of different body compositions. 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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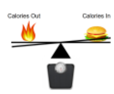
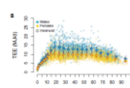
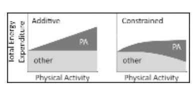
'The Myths'



- **ENERGY BALANCE** - Reducing energy intake by 500 kcal per day equals about 0.5 kg weight loss per week



- **METABOLIC RATE** - Weight gain during adulthood is mainly explained by slowing down metabolic rate



- **ENERGY COMPENSATION** – Increasing physical activity will increase total energy expenditure

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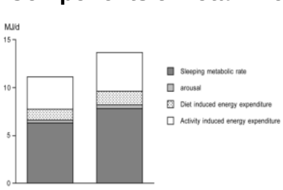
Components of Total Energy Expenditure



- **Basal (Resting) Energy Expenditure**
- **Diet-induced energy expenditure – 10% of TEE**
- **Physical Activity Energy Expenditure (AEE) – TEE (x 0.9) minus REE**

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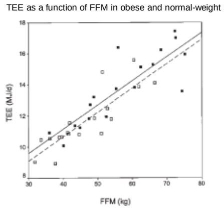
Physical activity but not energy expenditure is reduced in obese adolescents: a case-control study[1–3]

TEE as a function of FFM in obese and normal-weight



- **FFM explains 71% of the variation in TEE**
- **The association between FFM and TEE is similar in obese and normal-weight**
  - **Same slope**
  - **Different intercept**
- **TEE should be adjusted for FFM and FM when comparing groups/individuals with different body composition**

(Ekelund et al, *AJCN* 2002)

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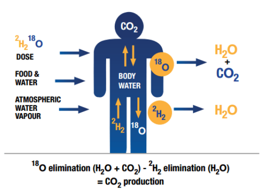
Measurement of TEE by The Doubly Labelled Water Method



$H_2{}^{18}O + C^{16}O_2 \leftrightarrow H_2C^{18}O^{16}O_2 \leftrightarrow H_2{}^{16}O + C^{16}O^{18}O$

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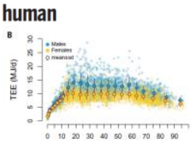

6421 individuals (62% women) aged 8 days to 95 years

- TEE (MJ/d) increases linearly between birth and adolescence
- TEE (MJ/d) is stable between 20 and 60 years
- TEE (MJ/d) decline after age 60 years
- TEE (MJ/d) higher in men compared with women after adolescence

(Pontzer et al, *Science* 2021)

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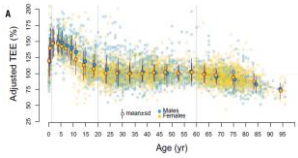
TEE adjusted for FM and FFM



- Body size adjustment by residuals and converted to 'adjusted' TEE - 100% match the expected TEE given FM and FFM
- TEE highest in 1 year olds
- Decline throughout childhood and adolescence
- Stable between 20 and 60 years
- Decline by 0.7% after 60 years
- No sex difference

(Pontzer et al, *Science* 2021)

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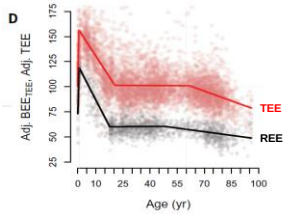
Similar pattern for TEE and REE by age



- **Adjusted for FFM and FM**
- **REE starts declining before the decline in TEE**
- **Steeper decline in TEE compared with REE - explained by lower physical activity**

(Pontzer et al, *Science* 2021)

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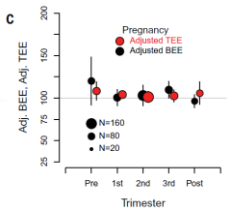
No difference in TEE and REE during pregnancy and lactation



(Pontzer et al, *Science* 2021)

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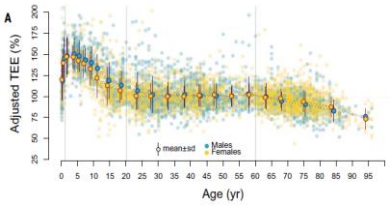
Body weight gain in adulthood – Intake or Expenditure?



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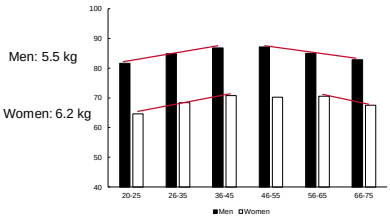
Body weight in adult Norwegians by age



(Anderssen SA et al, Fysisk aktivitet blant voksne og eldre i Norge Resultater fra en kartlegging i 2008 og 2009. Helsedirektoratet)

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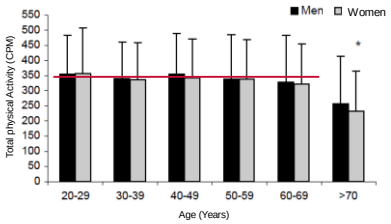
Physical activity in adult Norwegians



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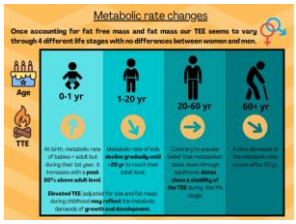
Summary



- **Four distinct phases of metabolism**
- **TEE stable throughout adulthood – suggesting body weight gain between 20 and 60 years is due to intake rather than expenditure**
- **Is the decline after 60 years inevitable?**

(Pontzer et al, *Science* 2021)

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'The Myths'

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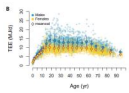

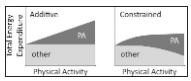

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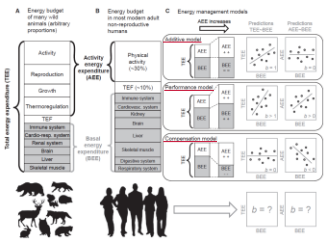
Energy compensation and adiposity in humans

- 1754 men and women aged 18 to 96 yrs.
- TEE by DLW and REE by indirect calorimetry
- FM and FFM derived from body water (deuterium dilution)



(Careau et al, *Curr Biol* 2021)

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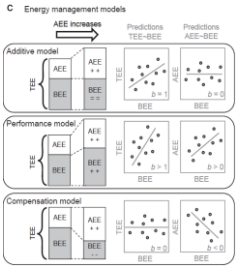

Additive model: assumes that AEE and BEE are independent and thus uncorrelated. The model predicts that **additional calories burned by undertaking extra activity results in an equivalent increase in TEE**

Performance model: assumes that a greater "metabolic machinery" is needed to support higher AEE due to increased assimilation of energy. The model predicts that the resultant total calories burned due to activity will be higher than just the calories expended during the activity because of **additional energy spent on subsequent physical recovery and maintenance**

Compensation model: assumes that energy budgets are somewhat constrained. The model predicts that **BEE decreases (compensation) when AEE increases**

(Careau et al, *Curr Biol* 2021)

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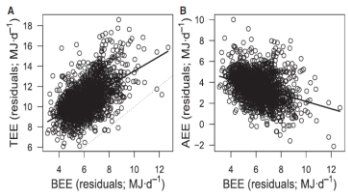
TEE and AEE as functions of REE - Compensation



TEE positively associated with BEE slope (b=0.72) **<1** partly supporting **compensation**

AEE negatively associated with BEE supporting **compensation**

When AEE increases BEE declines

No sex or age effect

(Careau et al, *Curr Biol* 2021)

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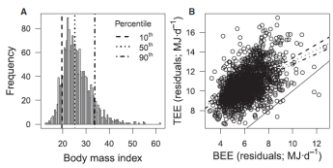
Compensation increases with fat mass



Compensation increases from 27% in those at 10th percentile of BMI to 49% in those at the 90th percentile

It is unknown if the greater compensation is due to;

1) Some are inherently stronger energy compensators

2) People become stronger compensators as they get fatter

(Careau et al, *Curr Biol* 2021)

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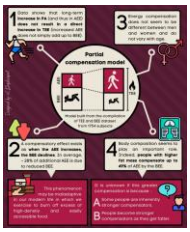
Higher AEE partly compensates TEE

- **Increase in AEE does not result in a direct increase in TEE**
- **When AEE increases REE declines**
- **Compensation is similar in men and women and do not vary by age**
- **Body composition is important – compensation is substantially higher in obese compared with lean individuals**



Factors driving energy compensation?

- **Energy intake** – obese people increases their food intake in response to increases AEE less than lean, they have fewer resources for other functions, and this could encourage the body to energy compensate – less likely?
- **Fidgeting** – decrease in response to increased AEE – Little evidence in the literature?
- **Uncoupling proteins?**
- **Genetic basis** – unknown but likely?

(Cureau et al, *Curr Biol* 2021)

Summary

- Data are cross-sectional – extrapolations to interventions may be wrong
- AEE may reflect other things (e.g. thermoregulation) in addition to physical activity
- Increased AEE through physical activity do not lead to a proportional increase in TEE
- Unclear whether fatter people are predisposed to higher fat mass ('thirfty phenotype') or whether they compensate more when getting fatter
- Unclear if a lowered BEE due to increased AEE is associated with comprised immune system and recovery from injury?