Weight Loss

Language and Understanding
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2016
What is “weight?”

Mass that is affected by gravity
• Water – blood, intracellular, extracellular fluid
• Bones
• Muscles
• Organs
  – Heart
  – Intestines
  – Adipose tissue

It is sloppy language to interchange “Weight” with “Adipose Tissue”
What part of “Weight” is Fat?

Estimates/surrogates of proportionality of adipose tissue include:

- BMI
- Waist circumference
- Skin fold thickness
- Neck size
- Waist/hip ratio

How to tell if you may have excess adipose tissue -  
   - ? A mirror ?
Change in Weight

How to make the number on the scale different:
• Change water balance – takes minutes/ hours
• Change adipose tissue – takes days
• Change muscle mass – takes weeks
• Change bones – takes years
A theoretical ideal model of weight distribution
But – you are not just a mass or a lump of matter with “weight”

• You are alive! (which is an energy consuming process)

• This involves concepts of metabolism, energy intake, homeostasis, growth, repair, energy expenditure, motion.

• You consume energy when you are absolutely still (and still alive) – a lot of energy!
Most people think energy is used by:

- Exercising
- Working
- Gathering
- Playing
- Feasting
- Fighting
- Planting
- Breeding, raising offspring
- Thinking/creating
- Going to CME conferences

But most is used by just BEING
Unlike a bacteria in a pond, we have Inconstant Energy Intake

• Our Intake of nutrients is intermittent, but resting energy needs are constant
• We store energy between intake episodes as:
  Glycogen – short term, meal to meal
    • Made from glucose
  – Fat/Adipose tissue – long term, season to season
    • Made from glucose and from fatty acids
When you take energy in...

Used for one of three things:

• Creation of ATP for immediate energy
• Glycogen – a form of energy storage - glucose
• Creation of adipose tissue as fat - for longer term energy storage – fatty acids

Each step is generally sequential, dependent on oversupply of energy
Glycogen

- The short term glucose energy overflow – a finite amount, stored and released from liver, kidneys, muscles - (metabolically active tissues)
- Carries a lot of water molecules with it
- Endurance fitness training means learning to make more glycogen - which does have some weight/mass
- The more you use glycogen energy, the less you use fat energy.

- Glucose is a preferred fuel over fatty acids and is essential, so much so that your body will make glucose from protein when necessary
Why Fat/Adipose Tissue??

• An energy storage device
• An insulation strategy
• Positioned in an evolutionary way linked to species attraction for mating? (Sex differences in location of adipose reserves on the human frame).

• May have a survival/propagation benefit
It takes an Einstein...

• $E = mc^2$

Expresses the interchangeable nature of mass and energy

• The Mystery of the Theory of Relativity:
  – A Calorie is a measure of Energy – which has NO weight/mass
  – Fat is stored calories/energy, and HAS weight/mass
• Calories -- in food – are not simply related to the weight/volume of food

  – In general,
  • 1 gram of protein has 4 calories of energy
  • 1 gram of carbohydrate has 4 calories of energy
  • 1 gram of fat has 9 calories of energy
  • To the extent that it is not protein, carbohydrate, or fat, a food would have no calories, but may have the weight of water giving it volume. Or, it may be indigestible for humans, and therefore free of useful calories (fiber)
The Central Question

• How much energy does it take for you to be a constant healthy adult size with a given activity level at a given age, understanding there are gender differences?

• Other variables include ambient temperature, altitude, race, stress....
For Astronauts

Astronauts need to eat just as much food in space as they do on Earth, and math can be used to calculate exactly how many calories they need. To find out how much food astronauts should consume in one day during space flight, we need to know their weight, height, and age. From this information, we can estimate their energy needs. Just as your height is measured in feet or inches, energy is measured in calories or kilocalories (kca). Here are two equations used to calculate energy needs for either males or females:

For males, total energy needs (in kca) =
\[ 66.5 + (13.8 \times W) + (5 \times H) - (6.8 \times A) \] x 1.6

For females, total energy needs =
\[ 655.1 + (9.6 \times W) + (1.9 \times H) - (4.7 \times A) \] x 1.6

where
\( W = \) your weight in kilograms (1 kilogram = 2.2 pounds)
\( H = \) your height in centimeters (1 inch = 2.54 centimeters)
\( A = \) your age in years

Did you know?

- Fat has more than twice as many calories, per unit weight, as carbohydrate and protein.
- In October 2004, the Expedition 10 crew will launch to the International Space Station, and the Expedition 9 crew will return to Earth.
- Two new planets have been found outside of our solar system. They are about the size of the planet Neptune.
- A kilocalorie is equal to 1000 calories.

The Challenge:
Let’s pretend that you are in charge of an astronaut’s nutritional needs for a day.

1. Write the equation you would use to calculate the total energy needs for a male astronaut who is 35 years old, weighs 180 pounds, and is 72 inches tall. What are his total energy needs (in kca)?

2. What are YOUR total energy needs?

Are you up for another challenge? Check out our website at the bottom of this page for more math problems relating to this topic.

http://www.nasa.gov/centers/johnson/pdf/511989main_vol4iss2.pdf
Formulas for basal calorie expenditure

Harris Benedict – the original formula

• For men,
  \[\text{B.E.E.} = 66.5 + (13.75 \times \text{kg}) + (5.003 \times \text{cm}) \times (6.775 \times \text{age})\]

• For women,
  \[\text{B.E.E.} = 655.1 + (9.563 \times \text{kg}) + (1.850 \times \text{cm}) \times (4.676 \times \text{age})\]

• Total Caloric Requirements equal the B.E.E. multiplied by the sum of the stress and activity factors. Stress plus activity factors range from 1.2 to over 2.

Military Standards

• Man - 174 lb 69 inches (50th%)
  – Light activity 3000 cal/day, heavy activity 3950
• Woman - 136 lb 64 inches (50th%)
  – Light activity 2200 cal/day, heavy activity 2700

• Protein 0.36 – 0.68 gm/lb (men 91, women 72 gm/day)
• Cold temperature 32 – 57 F can increase energy needs
• Altitude adjustment over 6000 feet increases needs

Interesting side commentary: Some army people are obese...
• Military reduced calorie plan: 3 meals of 500 – 700 cal daily
  • 30% or less from fat, 10 % saturated
Improved formula for resting energy expenditure

Mifflin – St. Jeor 1990

• \( \text{REE (males)} = 10 \times \text{weight (kg)} + 6.25 \times \text{height (cm)} - 5 \times \text{age (y)} + 5; \)
• \( \text{REE (females)} = 10 \times \text{weight (kg)} + 6.25 \times \text{height (cm)} - 5 \times \text{age (y)} - 161 \)

And other formulas and refinements are available.

Problem....

• Despite these predictive formulas, which give averages for metabolic rate, different people of the same height, weight, age, gender can vary in their metabolic rate by 20 – 30 %

• How do you know whether YOUR metabolic rate as an individual is right on the formula for BMR or above or below the formula?
Answer...

- By whether you easily accrue excess adipose tissue/fat energy reserves or not

Said another way...

- Unintentionally, your calorie intake has repetitively exceeded your calorie needs and you have stored the excess energy as fat/adipose tissue while you were eating “normal” probably means you are MORE efficient, ie, lower BMR
Obesity

• A medical condition of being less healthy (with less survival/ less longevity/ more illness) as a result of mismatch of calorie intake exceeding calorie output over an extended period of time, associated with an excess of adipose tissue/fat energy reserves
ICD 10 codes

• E66 Overweight and obesity
  – E66.0 obesity due to excess calories
    • E66.01 morbid obesity
The Problem of Constancy of Weight

- One Ritz cracker has 16 calories
- One lb. of human adipose tissue has about 3500 calories of stored energy
- One Ritz cracker a day for 365 days equals 5840 calories
- If you eat one cracker a day for one year you accrue 1.67 lb. of fat reserve energy from the excess Ritz cracker calories over your baseline.
Constancy – Darn it!!

• The fact that your weight can keep a constant fat energy reserve/weight for a year implies that your body picked a daily amount of food intake constant within 2/3 Ritz crackers a day over that year. . . .

• When your “weight” has been steady for 2 – 3 years (in spite of the amount of your weight that represents energy reserve as fat), your body seems to “want” to be that weight and your BMR is linked to that weight.

• Why? - unknown. Blame it on homeostasis?
No one “loses weight”

• This term should be banned from medical and scientific discussion as entirely missing the point.
• It is short-sighted and promotes recidivism
• It is metabolically inaccurate

• If you have excess stored energy as fat, you need to create an energy deficit to force your body to use the reserves in your adipose tissue, instead of maintaining your present homeostasis.

There is energy “re-sourcing” but not “loss.”
Problem: Increased efficiency from calorie restriction

• When you reduce calories, the body initially becomes more efficient – reduces BMR.

• OUCH!!

• BUT – it can only do this by about 10 %
SO... hypothetically

• You eat 2800 calories, your metabolic rate is x, you use/expend 2800 calories a day. You weigh 220 lbs (of which 40 lbs is unnecessary excess stored energy/fat).

• You eat 10 % less (2520 calories), your metabolic rate becomes 0.9x, you use 2520 calories a day. You weigh 220 lbs (of which 40 lbs is excess stored energy/fat)
But what if...

• You eat 25% less ??

• You eat 2100 calories a day, your metabolic rate shifts to 0.9x and you use 2520 calories a day. Your weight has to change because you have to use energy reserves to make up 420 calories a day deficit

• (but for a long time it will “WANT” to be 220 lbs and maintain homeostasis BMR)
Bariatric surgery

• Is **anything** more assured of results to change weight/adipose tissue/energy reserve than bariatric surgery?
  – NO

• Does a bariatric surgeon remove one ounce of adipose tissue during the operation, whichever operation it is?
  – NO
How does bariatric surgery work?

• It physically forces people to consume an amount of calories closer to the amount their more slender body would need, given their unusually efficient metabolic rate and low basal energy needs.

• Post-op you reach a new equilibrium.
• ERGO: if a person consumes enough less than their baseline, they will utilize fat reserves eventually
Recidivism

• The result of trying to “lose” weight?

• Linked to the phenomenon of “Constancy”

• Explains why efforts and plans to LOSE WEIGHT are ill conceived and short sighted and metabolically inaccurate
Beware: Fat has a mind of its own for self-preservation

• White adipose tissue (WAT) secretes a number of peptide hormones, including leptin, several cytokines, adipsin and acylationstimulating protein (ASP), angiotensinogen, plasminogen activator inhibitor1 (PAI1), adiponectin, resistin etc., and also produces steroid hormones

• Your fat is alive…..It does things, it protects itself

What about Exercise?

• If you work 40 hours a week, it will be almost impossible to permanently use up fat energy adipose reserves by adding exercise to your week.

• It takes 3500 calories of exercise (over your baseline) to consume a pound of fat energy
• The more you exercise, it eventually costs you less energy to do the same exercise – you become fit/efficient.
• Muscles consume relatively little energy
• Endurance exercise can reduce your BMR, resistance training may increase it a bit
Thermogenesis, 10%

Sedentary Individual
- Resting metabolic rate, 60-75%
- Exercise, 10-25%

Active Individual
- Resting metabolic rate, 60%
- Exercise, 30%
Exercise energy expenditure

Calories per pound per hour:
• 1.13 – Hatha yoga
• 1.27 – walking 2 mph
• 1.3 – Tai Chi
• 1.81 – cycling <10 mph
• 1.95 – walking 3.5 mph
• 2.27 – resistance weight training
• 2.27 – elliptical trainer, moderate
• 2.27 – low impact aerobics
More energy expenditures

Calories per pound per hour:
• 2.5 – water aerobics
• 2.63 – swimming laps, moderate
• 2.72 - stationary rowing
• 3.31 - aerobics, high impact
• 3.7 – running 5 mph
• 5.35 – running 8 mph, rope jumping
Do the math...

• If you weigh 195 lbs. and walk at 3.5 mph for an hour you use 380 calories. If you only have half an hour, you use 190 calories. If you can only do it 4 days a week for an hour, you use 1500 calories (less than half the 3500 calories of energy stored in a pound of adipose fat)

• If you are going to exercise for adipose/energy tissue, plan on A LOT of exercise
To Review

• Your weight on the scale is:
• Molecules
  – Inorganic
  – Water
  – Organic compounds
  – Proteins

Represents calories that are made from energy and turned into mass and come can go back into energy again
On a good day for the human animal:

• You take in as much energy and water as you need,
• You put out water with wastes + excess intake
• You are energy neutral
• You are fat reserve neutral
• Your glycogen has gone up and down during the day but basically stayed the same average - if you eat carbohydrates

• Your weight on the scale is the same from day to day
Mystery - and Apparent Fact

• You will not make extra ATP – you ordinarily will make as much as you need in the moment
• You will not make extra Glycogen - you make as much as you have habituated/trained yourself to make
• You can make and store an infinite amount of fat energy as Adipose tissue.
Socio/Cultural/economic aspects of obesity

Thesis:
• Obesity can only occur where excess calories are consistently available to the organism, and where non-homeostatic mechanisms* exert influence on caloric intake

* Bad habits, your mother, school lunches, search for “value,” unit dosing of foods by industry/restaurants, emotions, boredom, society norms, feast days
3 Step Program

• Acknowledge that you live in a world where more calories are available every day than you need.
• Acknowledge that you have grown accustomed to consuming enough calories to maintain an excess energy reserve called fat/adipose tissue – the present “YOU”
• Believe that there IS an amount of calories that will maintain a different (healthier) homeostasis – the “YOU” you could be forever.
Corollaries

• Anything you do toward a different calorie homeostasis should be thought of as permanent.
  – If you start a “diet,” will you do this for life?
  – If you take a pill to influence leptin/ghrelin, will you do this for life?
  – If you plan on increasing calorie expenditure by exercise, will you do this for life?
Summary

• Given that we live where calorie availability is in excess of needs, each of us can choose a caloric intake to carry any amount of reserve calories we wish to carry, or none at all.

• Our challenge is to learn how to BE a weight, not to LOSE weight.
Evolutionary corollaries:

• Because adipose tissue is self protective, it will complain as a hunger signal when it is being utilized for energy, instead of being kept in reserve.

• Hunger primarily results from falling glucose levels in a body not trained to utilize fatty acids as fuel.
A Bit of Philosophy for you and your patients

Is the goal of your life:
• Longevity
• Happiness
• Good memories
• Adventure
• Propagation
• Experience of pleasure
• Avoidance of discomfort/pain
• A BMI 18 – 24.9?
• A BP near 120?
• Watching good TV Programs?
Hunger and eating can be reduced to chemical commands: leptin, ghrelin, insulin, dopamine, ADH, estrogen

• Every minute of every day we as a civilized species deal with our instincts/hormonal/chemical commands:
  – Is that person in my territory? adrenalin
  – Should I empty my bladder here? acetylcholine
  – I like the taste of salt. ADH, cortisol
  – I’m thirsty, should I drink now or later? ADH
  – Is there an opportunity for breeding? Sex hormones
  – I’d like a nap. Melatonin?
  – Cookie monster wants a cookie. Ghrelin
It is never about Weight Loss!

The question is:
• In your life priorities, what is the BMI you would like to be for the rest of your life?

Other similar questions for us and our patients:
• How will you balance your need to make money and your need to exercise?
• How much sleep will you get each day?
• How much fun will you have each day?
• What will you do to keep your BP near 120?
• To what extent are you ruled by instinct or by intention?
• In the typical style of 21st century medicine, we state that a BMI over 30.0 is a surrogate for the likelihood of adverse health outcomes.

• BMI over 30 does not guarantee that bad health will be your lot in life, but there is a lot of data that there is a survival benefit to being 18 – 24.9 BMI.
Summary

• It is not “Obesity” – it is an energy management issue.
• No one should “Lose Weight” – they should manage their energy differently for the rest of their life.
• Given a surplus of available food, given sociocultural influences on eating behavior, we need to consciously choose an energy intake that is healthily apportioned and quantified to our individual needs.
• P.S. – Regular exercise is never a bad idea
Questions?