DTN2PNU Principles of Human Nutrition: Lecture: Energy from Food and Macronutrients

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Today

Key questions to be covered:

- Biological energy
- Chemical reactions in the body
- The energy value of food
- Human energy needs
- Measurement of energy expenditure
- Mechanisms for regulating energy balance
- Introduction to body composition & anthropometry

Required readings

- Whitney, E., Rolfes, SR, Crowe, T., Cameron-Smith, D. & Walsh, A. (2011). Understanding Nutrition: Australia and New Zealand Edition. South Melbourne, Australia: Cengage Learning Australia.

- CHAPTERS 7 AND 8

Energy

- Energy is required by the body to function
- Cannot be created or destroyed
- Energy used by the body is ultimately derived from the energy contained in macronutrients
- When released may be:
  - Expressed as heat OR
  - Stored as chemical energy

Nutrients to Energy

- Glucose and fatty acids are primarily used for energy, amino acids to a lesser extent.
- Glucose is made from all carbohydrates, most amino acids and the glycerol portion of fat.
- Protein is made from amino acids.
- Glucose can be made into nonessential amino acids if nitrogen is present.
- All energy-yielding nutrients consumed in excess can contribute to fat storage.

Nutrients to Energy

- The kJ/g we derive from food:
  - Carbohydrate = 4 kcal/g (17 kJ/g)
  - Protein = 4 kcal/g (17 kJ/g)
  - Fat = 9 kcal/g (37 kJ/g)
  - Fat provides more energy because the bonds in fat molecules are easily oxidized and result in more ATP.

Alcohol

- Not a nutrient
- Yields energy – 7 kcal/g (29 kJ/g)

Energy Balance

- When energy intake exceeds energy output, there is a gain in weight.
- Excess energy can come from protein, fat or carbohydrate.
- Fat is the most efficient in being stored as fat.
- One kilogram of body fat contains approximately 30 000 kJ of energy.

Energy In

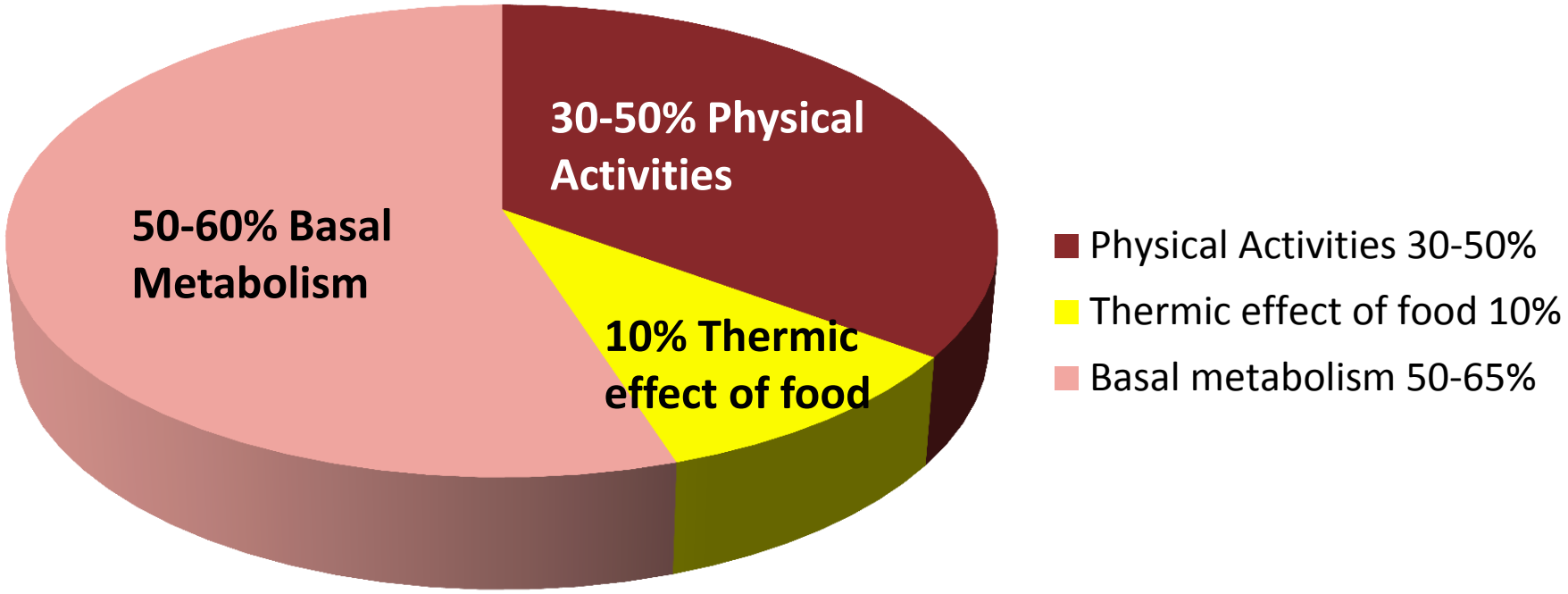
How can we find out food composition or how many kJ we get?

- A bomb calorimeter is an instrument that measures the heat energy released when foods are burned.
- Direct calorimetry measures the heat energy released.
- Indirect calorimetry measures the amount of oxygen consumed and carbon dioxide expelled.

Energy Out

- Energy expenditure includes basal metabolic activities, physical activity, thermic effect of food and adaptive thermogenesis.
- These energy requirements differ from person to person and are affected by age, gender, weight and height.
- The intensity and duration of physical activity also make a difference.

Components of Energy Expenditure



Adapted from: Whitney, E., Rolfes, SR, Crowe, T., Cameron-Smith, D. & Walsh, A. (2011). Understanding Nutrition: Australia and New Zealand Edition. South Melbourne, Australia: Cengage Learning Australia. Pg.246

How is energy expenditure determined?

Total daily energy expenditure can be

- measured in the laboratory or
- estimated using prediction equations.

Three categories of methods

- indirect calorimetry
- direct calorimetry
- non-calorimetric methods.

Non-calorimetric methods

Factorial method

- *Estimated Energy Requirements (EER) (kJ/d) = BMR x Activity Factor (PAL)*

Examples of PAL

Lifestyle	PAL (Expressed as a ratio to BMR)
Bed rest or bed bound	1.2
Predominantly standing or walking at work	1.8-1.9

Source: NHMRC et al. 2006

Australian reference standards for energy

There are no RDIs for energy

The Australian nutrient reference values have a new standard for energy called the

- EER = estimated energy requirement (NHMRC et al. 2006)
- Values are available for
  - age, sex, pregnancy and lactation and are based on a standard reference weight
  - Different PAL levels
- Limitations
  - TEF, AT, spontaneous activity, genetics, ethnicity, environment, individual adaptation are not accounted for.

Source: NHMRC et al. 2006

Calculating EER

2 Most common Equations for Adults:

- Schofield
- Harris-Benedict

Enable you to calculate BMR and then multiply by an activity/stress factor

Eg. Schofield- Men 18-29 yrs

BMR= (74 x weight in kg) + 2754

Moderately active activity factor = 1.8

So EER= BMR x 1.8

Schofield's equation for measuring BMR (MJ/d) for adults

Sex	Age (yr)	Equation
Males	18-30 30-60 Over 60	(0.063 x wt) + 2.896 = BMR (0.048 x wt) + 3.653 = BMR (0.049 x wt) + 2.459 = BMR
Females	18-30 30-60 Over 60	(0.062 x wt) + 2.036 = BMR (0.034 x wt) + 3.538 = BMR (0.038 x wt) + 2.755 = BMR

Source: Schofield (1985)

Mechanisms for regulating energy balance

- Energy balance is dynamic
- Positive during meals, negative during intervals
- Balances out over time (except during intentional growth etc)
- Regulation achieved by hypothalamus
  - Receives neural & endocrine signals from body,
  - Integrates these through complex network of neural pathways and
  - Follows by sending efferent neural signals to regulate appetite and energy expenditure

Energy balance

Short term signals indicating energy sufficiency:

- Blood glucose, amino acid, fatty acid levels
- Stomach & gut derived hormones
- Vagal signals from liver

Long-term signals:

- Hormones secreted by adipose tissue: to fat stored there- leptin
- Leptin- directly proportional to fat stores- body's fuel gauge

During weight loss/starvation BMR can drop by ~20%

Factors affection energy requirements

- Gender – men generally have a higher BMR.
- Growth – BMR is high in people who are growing.
- Age – BMR declines as lean body mass decreases.
- Physical activity – activities are clustered by intensity and vary considerably.
- Body composition and body size – taller people have more surface area and heavier people have higher BMRs.

Hence body size and composition are very important ie. tall, young male athletes may have very high requirements

BMI

- Body mass index (BMI) measures relative weight for height.
  - Underweight is a BMI below 18.5 kg/m^2.
  - Overweight is a BMI above 25 kg/m^2.
  - Obese is a BMI above 30 kg/m^2

Summary

Energy is required by the body to function

Energy used by the body is ultimately derived from the energy contained in macronutrients

- Carbohydrate
- Fat
- Protein
- Alcohol

The energy value of food varies based on its composition

Human energy needs are based on BMR, TEF, Physical activity and other factors

A number of tools exist for the measurement of energy expenditure- direct and indirect calorimetry, non-calorimetric methods

Mechanisms for regulating energy balance is complex

Body composition will impact on BMR, hence it is important to know how to assess it

Image Sources

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Thank you