Energy Requirements of Man

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The human body needs continuous regulated supply of nutrients. Energy is required for all body process, growth and physical activity. Even at rest body the body requires energy for contraction, active transport of molecules and ions, and synthesis of macromolecules and other biomolecules from simple precursors. In most process the energy is supplied by adenosine triphosphate (ATP). Energy is liberated when ATP is hydrolysed to adenosine diphosphate (ADP) and inorganic phosphate. Arresting human consumes about 40 kg of ATP in 24 hr. The amount of ATP in the body tissues is limited but is generated continuously from the fuel stores to supply the required energy. These fuel stores must be replenished via food intake.

The energy requirements of individuals are dependent on four variables :

1. physical activity.
2. body size and composition (weight & height)
3. age and sex.
4. climate and environment.

There are also extra needs for growth in children and adolescents, also during pregnancy and lactation.

Components of Energy Expenditure

The total energy expended by an individual supports three essential energy uses, and these called the components of energy expenditure are :

1. Basal metabolic needs (basal energy expenditures (BEE), or resting energy
   expenditures (REE).
2. Thermic effects of food or called (food intake effect).
3. Physical activity.

Basal Metabolic Needs

Basal Metabolic Rate (BMR) or resting metabolic rate is the metabolism of the body at rest. It is defined as the heat production of the body when in a state of complete mental and physical rest and in the post absorptive state. The basal metabolic reflects the energy requirements for maintenance and conduct of the cellular and tissue processes which are fundamental to the continuing activities of the organism.

Certain small, but vitally active tissues: - brain, liver, GIT, heart and kidneys together make up less than (5%) of the total body weight, but they contribute about (60%) of the total basal metabolic processes.

The resting metabolic rate is the largest component of energy expenditure in humans, constituting about (60%) to (70%) of the daily energy expenditure of individuals.

To calculate BMR, use the general formula:

For woman ---------- 0.9 kcal/kg/hr
0.9 x body wt x 24 hr

For man ---------- 1 kcal/kg/hr
1 x body wt x 24 hr

Basal metabolism varies from one individual to the next. It is also not constant throughout life, the values during sleep are about (10%) less.

Factors Influencing BMR:-

The four main factors influencing BMR are:-

1. lean body mass.
2. growth
3. fever and disease.
4. cold climate

1. Lean body mass

Is the major factor influencing BMR because of its greater level of metabolic activity than that of less active tissues, such as fat and bones. Body area and sex affect the basal metabolism, most persons undergo a low reduction in their basal metabolic rate throughout life. The decrease in the rate with ageing is explained largely by decreases in the lean body mass. As energy needs decline with age by (1-3%) per decade. Women have a lower rate than men because of their smaller body size, and it has also been shown to vary with menstrual cycle. It increases (7.7) in the postovulatory period and drops in the early stages of pregnancy and lactation.

2. Growth

Growth during childhood and pregnancy as well as milk production during lactation, requires anabolic work due to the influence of growth hormone.

3. Fever and Disease

Fever increases heat production approximately (13%) of the basal metabolic rate for each (1C°) rise in body temperature. In addition, diseases involving increased cell activity, such as cancer, certain anemias, cardiac failure, hypertension and respiratory problems such as emphysema usually increase BMR, also hyperthyroidism , the rate may be increased (50-75%) above normal standards. Conversely the abnormal states of starvation and malnutrition lower BMR, because the lean body mass is diminished.

4.Cold Climate

BMR rises in response to lower temperatures as a compensatory mechanism to maintain body temperature.

2. Thermic Effect of Food

The thermic effect of food (TEF) refers to increase in energy expenditure above the basal metabolic rate that occurs a few hours after the ingestion of a meal. It is also known as specific dynamic action and is a consequence of the extra energy released in relation to the digestion, absorption and metabolism of the food. In the case of protein, the TEF amounts to be about (30%), for carbohydrate is (6%) and for fat is (4%) of the energy value of the food ingested. The ingestion of (25g) of protein that has(100) Cal, lead to (30) Cal of extra heat, therefore only (70) Cal of potentially useful energy can be derived from (25) gram of protein. To estimate the calories needed, the TEF is considered to be (6%) of BMR.

TEF= 6% of BMR

3. Physical Activity Needs

Exercise involved in work and recreation or in physical training and competition accounts for wide individual variations in energy requirements. The energy used by physical activity can be approximated as percentage of person BMR and varies with the degree of physical activity.

Average activity level	Energy cost % of BMR
Sedentary	20%
Light	30%
Moderate	40%
Heavy	50%

In summary, then the basic components of energy requirements or can called it the total energy out put is:

Total energy requirements = (BMR- 10% for sleep) +TEF + physical activity

A man who weight (75) kg and is working as a manger of an office (light) activity. Calculate his total energy requirements and his daily requirements of protein, CHO and fat.

BMR = 1 Cal x wt x 24 hr
BMR = 1 x 75 x 24 hr = 1800
BMR = 10% for sleep = 1800-180 = 1620 Cal
TEF = 6% of BMR = 1800 x 6/100 = 108 Cal
Physical activity = 30/100 x 1800 = 450 Cal
Total energy requirements = (BMR-10%) + TEF + physical activity
= 1620 + 108 + 450 = 2268 Cal

CHO 1gram = 4 Cal

50-60% of total calories from CHO

= 2268/2 = 1134 Cal

= 1134/4 = 283.5 gram CHO daily

Protein: 15-29% of total Calories

15% of total Calories = 340.2 ≈ 340 Cal

1 gram = 4 Cal

85 gram protein

Fat: 25-30% of total calories

25% of total calories = 567Cal

1 gram = 9 Cal

63 gram of fat daily

How do you estimate energy requirements in over weight patients.
It is more difficult to predict energy requirements in obese patients because of their great variability in body composition. Several approaches have been suggested. One commonly used technique is to use an `adjusted weight` which is the ideal weight plus 25% of the difference between the observed weight and the ideal weight. This approach based on the theory that fat tissue consumes about a quarter of the number of calories as normal tissue.

Adjusted weight = ideal weight + 0.25 x (observed weight – ideal weight)

Example:

A man his weight is 115kg, who should weight 80kg, how many Kcal he need per day? With moderate physical activity.

Adjusted weight = 80 + 0.25 (115 – 80)

= 88.75 ≈ 88kg

BMR = 1 x wt x24 = 1x 88 x 24 = 2112 Cal

Sleep = 10% of BMR = 10/100 x 2112 = 211.2 Cal

TEF = 6% of BMR = 6/100 x 2112 = 126.72 Cal

Physical activity = 40% of BMR = 40/100 x 2112 = 844.8 Cal

TER = (2112 – 211.2) + 126.72 + 844.8 = 2872.3 Cal

Energy needs for special groups of the population

Pregnancy:

The calories must be sufficient to:-

supply the increased energy and nutrient demands by the increased metabolic work load, including some maternal fat storage and fetal fat storage to ensure an optimal newborn size for survival.

spare protein for tissue building.

An additional amount of energy, 300 Cal during the second and third trimesters of rapid growth making a total of about 2200 to 2500 Cal which about 10-15% increase above the mothers general pregnant need.

Lactation:

Energy requirement varies with the amount of milk produced. An average daily milk production for lactating woman is (850) ml providing about 600 Cal daily, so the requirement for lactation is about 1000 Cal per day. Increased stores of maternal fat during pregnancy provide about (1/3) of the energy cost of lactation during first 3 or 4 months, thus the RDA standard is an extra (500) Cal.


Thank you
very much