Nutrition Assessment Module 8

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References: Lee RD, Nieman DC. Nutritional assessment. 6th ed. New York, NY: McGraw-Hill; 2013.

Lecture Notes: Computerized Dietary Analysis and Energy Estimation

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Computerized Dietary Analysis and Advanced Body Composition

Computerized Dietary Analysis: Manual calculation of nutrients is slow and prone to human error. Computer software allows nutritionists to quickly crunch numbers for thousands of foods.

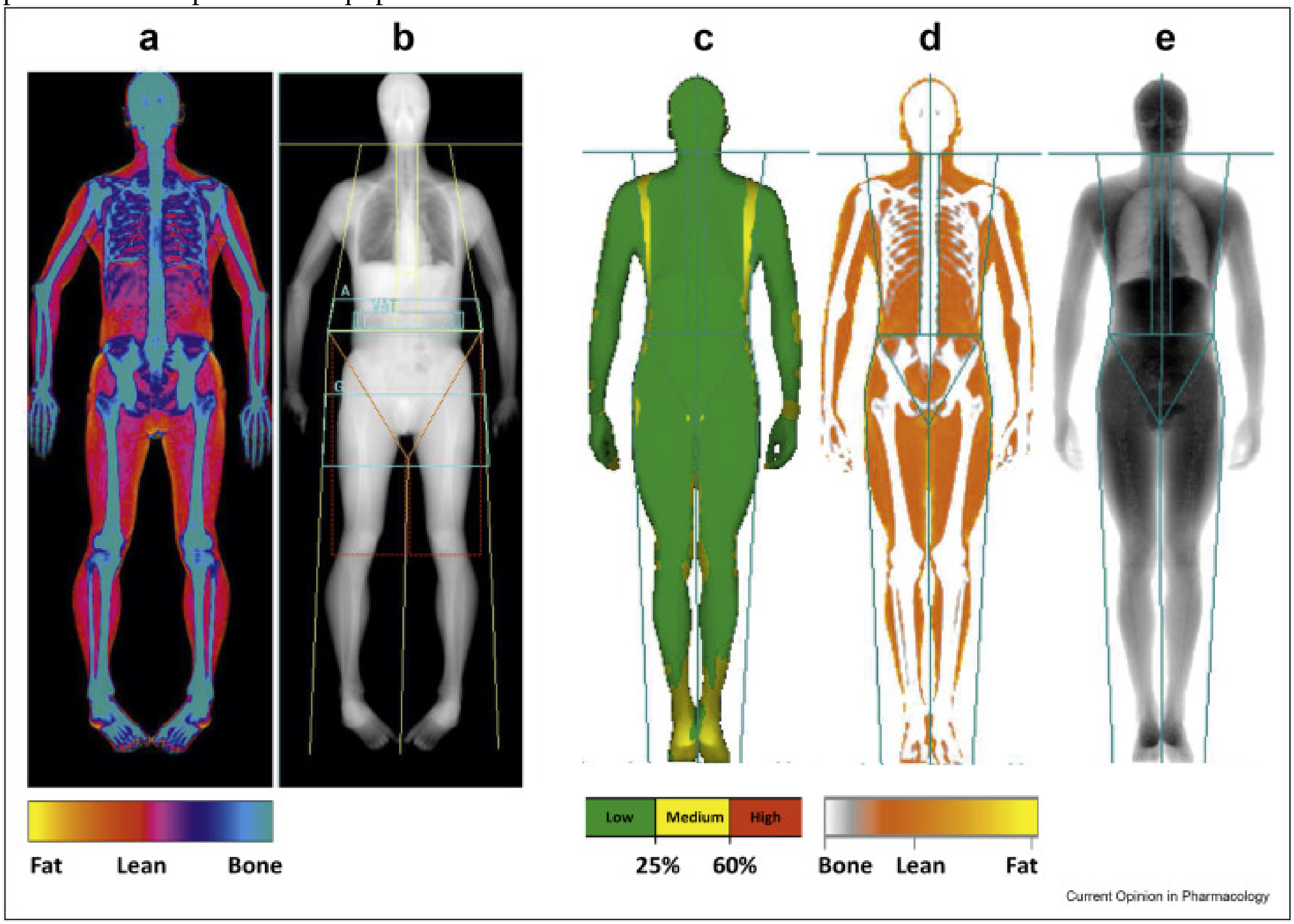
- **Key Components of a System:**
    1. **Nutrient Database:** The "heart" of the system. Most use the **USDA Standard Reference (SR)** and the **Food and Nutrient Database for Dietary Studies (FNDDS)**.
    2. **Program Operation:** How you search for foods, enter portion sizes, and edit lists.
    3. **System Output:** The reports provided, such as graphs, spreadsheets, or a "Nutrition Facts" label.
- Examples: NutritionCalc Plus (for students), SuperTracker (USDA online tool), and Food Processor SQL (professional).

Advanced Body Composition Models: Body weight alone does not distinguish between fat and muscle.

- The Two-Compartment Model: Divides the body into Fat Mass and Fat-Free Mass (muscle, bone, water).
- **Advanced Techniques:**
    - **Densitometry (Underwater Weighing):** Based on Archimedes’ principle, measuring how much water the body displaces.
    - **Air Displacement Plethysmography:** Uses a chamber (like the Bod Pod) to measure body volume via air displacement.
    - **Dual-Energy X-Ray Absorptiometry (DXA):** Measures bone mineral density and soft tissue composition using low-dose X-rays.

Dual-Energy X-Ray Absorptiometry (DXA) is a widely used, evidence-based method for assessing body composition and bone mineral density (BMD). It uses two low-dose X-ray beams with different energy levels to differentiate between bone tissue, lean body mass, and fat mass. DXA is considered the gold standard for diagnosing osteoporosis and evaluating fracture risk. In clinical nutrition and research, it is also commonly used to assess regional and total body fat distribution, muscle mass, and sarcopenia.

- DXA provides highly accurate and reproducible measurements with minimal radiation exposure. It is particularly useful in older adults, postmenopausal women, athletes, and patients with chronic diseases such as obesity, cancer, and renal disease. Studies have shown that DXA has high precision for measuring body composition compared with anthropometric methods. However, limitations include high cost, limited portability, and the need for trained personnel and specialized equipment.



- Overall, DXA is an important tool in clinical assessment because it provides reliable information about bone health and body composition, helping guide nutritional and medical interventions.

    - **Bioelectrical Impedance Analysis (BIA):** Measures the body's resistance to a small electrical current to estimate total body water and fat.
- Bioelectrical Impedance Analysis (BIA) is a noninvasive and relatively inexpensive method used to estimate body composition. It works by passing a small electrical current through the body and measuring the resistance (impedance) to the current. Because water and lean tissue conduct electricity better than fat tissue, BIA can estimate total body water, fat-free mass, and body fat percentage.
- BIA is widely used in clinical nutrition, sports medicine, and community health because it is quick, portable, and easy to perform. Evidence suggests that BIA provides reasonably accurate estimates of body composition in healthy individuals when standardized procedures are followed. It is particularly useful for monitoring nutritional status, obesity, hydration, and muscle mass changes over time.
- However, BIA accuracy can be affected by hydration status, recent food intake, exercise, fever, and certain medical conditions such as edema or dehydration. Therefore, measurements should be performed under standardized conditions for better reliability. Although less accurate than DXA, BIA remains a practical and accessible tool for routine nutritional assessment in both clinical and outpatient settings.

Introduction to Energy and Protein Requirements

Adequate energy and protein intake are essential for:

- Maintaining body functions
- Preserving muscle mass
- Supporting growth and healing
- Preventing malnutrition
- Improving recovery in hospitalized patients

In clinical nutrition, estimating nutritional requirements is important for:

- Nutrition assessment
- Medical nutrition therapy
- Enteral and parenteral nutrition planning
- Monitoring critically ill patients

Components of Total Energy Expenditure (TEE)

Definition: Total Energy Expenditure (TEE) refers to the total amount of energy the body uses over 24 hours.

Main Components of TEE

1. Resting Energy Expenditure (REE)
2. Thermic Effect of Food (TEF)
3. Physical Activity Energy Expenditure

1. Resting Energy Expenditure (REE)

Definition: Energy required to maintain vital body functions while at rest.

Functions Supported by REE

- Heartbeat
- Respiration
- Blood circulation
- Kidney function
- Brain activity
- Maintenance of body temperature

Contribution to Total Energy: Accounts for approximately 65–75% of TEE.

Factors Affecting REE

Increase REE

- Fever
- Infection
- Burns
- Trauma
- Hyperthyroidism
- Pregnancy

Decrease REE

- Starvation
- Aging
- Hypothyroidism
- Loss of lean body mass

Clinical Importance

Hospitalized patients may develop:

- Hypermetabolism
- Increased catabolism
- Muscle wasting

Therefore, accurate estimation of REE is essential in:

- ICU patients
- Burn patients
- Surgical patients
- Cancer patients

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2. Thermic Effect of Food (TEF)

Definition: The Thermic Effect of Food (TEF) refers to the energy required for the digestion, absorption, metabolism, and storage of nutrients. It usually accounts for approximately 5–10% of Total Energy Expenditure (TEE).

Energy used for:

- Digestion
- Absorption
- Metabolism
- Storage of nutrients

Macronutrient Effects

- Protein has the highest thermic effect.
- Fat has the lowest thermic effect.

3. Physical Activity Energy Expenditure

Definition: Energy expended during:

- Exercise
- Daily activities
- Occupational work

Most Variable Component Depends on:

- Activity level
- Age
- Occupation
- Functional status

Clinical Relevance: Hospitalized patients often have:

- Reduced mobility
- Bed rest
- Lower physical activity expenditure

However, critically ill patients may still have high total needs because of metabolic stress.

Estimating Energy Requirements

Importance in Clinical Nutrition. Accurate energy estimation helps:

- Prevent underfeeding
- Prevent overfeeding
- Improve wound healing
- Reduce complications
- Preserve lean body mass

Methods of Estimating Energy Needs

A. Indirect Calorimetry

Definition: Measures oxygen consumption and carbon dioxide production to determine actual energy expenditure. It is the most accurate method and useful in critically ill patients

Indications: ICU patients, ventilator-dependent patients, severe burns, and obesity

Limitations: Expensive and requires specialized equipment

Clinical Recommendation: The Academy of Nutrition and Dietetics recommends indirect calorimetry when available.

B. Predictive Equations: Used when indirect calorimetry is unavailable.

1. Harris–Benedict Equation

Variables used in this equation are weight, height, age, and sex. Clinical Use: Historically popular but may overestimate needs in some patients.

2. Mifflin–St Jeor Equation

More accurate in overweight and obese individuals. Recommended For obesity and outpatient nutrition counseling.

Table 5.6 Equations for Determining Resting Energy Expenditure for Adults*

Name	Equation
Mifflin-St Jeor Equations	Men: REE = [10 × weight (kilograms)] + [6.25 × height (centimeters)] – (5 × age) + 5
	Women: REE = [10 × weight (kilograms)] + [6.25 × height (centimeters)] − (5 × age) − 161
Harris Benedict Equation	Men: REE = [66.5 + 13.8 × weight (kilograms)] + [5.0 × height (centimeters)] − 6.8 × age
	Women: REE = [655.1 + 9.6 × weight (kilograms)] + [1.9 × height (centimeters)] − 4.7 × age
To convert inches to centimeters, multiply inches times 2.54. To convert pounds to kilograms, divide pounds by 2.2.	

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3. Estimated Energy Requirement (EER)

Developed by National Academy of Sciences Based on: Doubly labeled water studies and used mainly for: Healthy populations

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3.4 Steps for Determining Total Energy Expenditure

Step 1: Determine Resting Energy Expenditure (REE)

- Indirect calorimetry
- Predictive equations

Step 2: Determine Physical Activity Factor (PA)

Table 5.7 Physical Activity (PA) Level Factors

Activity Level	PA	Typical Daily Living Activities
Sedentary	1.2	Only physical activities typical of daily living
Low active	1.375	30–60 minutes of moderate activity
Active	1.55	≥60 minutes of moderate activity
Very active	1.725	≥60 minutes of moderate activity plus 60 minute vigorous or 120 minutes of moderate activity
Extremely active	1.9	Daily vigorous activity

Note: Moderate activity is equivalent to walking at 3 to 4½ mph.

Example of Estimating Total Energy Expenditure (TEE)

Patient Information

- Male patient
- Age: 35 years
- Weight: 70 kg
- Height: 175 cm
- Physical activity: Light activity

Step 1: Estimate Resting Energy Expenditure (REE)

Using the Harris–Benedict Equation for men:

REE=66+(13.7×weight)+(5×height)−(6.8×age)

Substitute the values:

REE=66+(13.7×70)+(5×175)−(6.8×35)

Step 2: Select Physical Activity (PA) Factor

For light activity:

PA=1.3PA = 1.3PA=1.3

Step 3: Calculate Total Energy Expenditure (TEE)

$TEE = REE \times PA$

$TEE = 1662 \times 1.3$. $TEE \approx 2160$ kcal/day

Clinical Note: Hospitalized patients are usually: Sedentary, Bedbound, Physically inactive

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3.5 Stress and Clinical Adjustments

Stress Response in Illness

Severe illness increases:

- Metabolic rate
- Protein breakdown
- Energy requirements

Conditions Associated with Increased Energy Needs

Condition	Effect
Fever	Increased metabolic rate
Surgery	Increased healing demands
Trauma	Increased catabolism
Burns	Markedly increased energy needs
Sepsis	Hypermetabolism

Consequences of Inadequate Nutrition in Hospitalized Patients

- Delayed wound healing
- Muscle loss
- Increased infection risk
- Longer hospital stay
- Increased mortality

Note: If the patient is hospitalized with infection, trauma, or burns, an additional stress factor may be added, which increases total energy requirements.

3.6 Protein Requirements

Functions of Protein

- Tissue repair
- Enzyme production
- Hormone synthesis
- Immune function
- Preservation of muscle mass

Protein Requirements in Healthy Adults

Recommended Intake

0.8 g/kg/day

Example: 70 kg adult: $70 \times 0.8 = 56$ g/day

Protein Requirements in Clinical Conditions

Mild Stress

Examples

- Minor infection
- Mild surgery

Requirement: 0.8–1.2 g/kg/day

Moderate Stress

Examples

- Pneumonia
- Major surgery

Requirement: 1.2–1.5 g/kg/day

Severe Stress

Examples

- Severe burns
- Trauma

- Sepsis
- ICU patients

Requirement: 1.6–2.2 g/kg/day

Protein Needs in Special Populations

1. Older Adults: Higher intake may help prevent sarcopenia.
2. Burn Patients: Extremely high protein needs due to tissue loss.
3. Renal Disease: Protein intake may need adjustment depending on:

    - Dialysis status
    - Kidney function

3.7 Nitrogen Balance

Definition: Nitrogen balance evaluates protein status by comparing:

- Nitrogen intake with
- Nitrogen losses

Types of Nitrogen Balance

1. **Positive Nitrogen Balance**

Intake > Loss

Seen In

- Growth
- Pregnancy
- Recovery from illness
- Muscle building

2. **Neutral Nitrogen Balance**

Intake = Loss

Indicates stable body protein stores

3. **Negative Nitrogen Balance**

Loss > Intake

Causes

- Starvation
- Severe infection
- Trauma
- Burns
- Cancer cachexia

Clinical Consequences

- Muscle wasting
- Poor wound healing
- Weak immunity

Clinical Application of Energy and Protein Assessment

Nutrition Care in Hospitals Includes:

1. Nutrition screening
2. Nutrition assessment
3. Estimating requirements
4. Monitoring intake
5. Adjusting nutrition support

…*End of Module 8*