Nutrition in Health and Disease course

15 hours, 1 credit.

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Foundations of a Healthy Diet

Introduction

For many years, the definition of a "healthy diet" was primarily about preventing nutrient deficiencies. In recent decades, however, this definition has significantly expanded. Today, a healthy diet is understood to be one that not only meets our basic nutritional needs but also optimizes long-term health and helps prevent chronic diseases like heart disease, diabetes, and cancer.

I. Core Foundations of a Healthy Diet

A healthy diet is built on two fundamental pillars: the balance of energy, and the individualization of dietary advice.

A. Quantity versus Quality

A complete definition of a healthy diet must address the critical balance between the energy (calories) we consume and the energy we expend.

Weight Management: Maintaining a healthy weight is a cornerstone of good health. The studies emphasize a key point: even the healthiest combination of foods, if consumed in slight excess (by only a few percent) over an extended period, will lead to overweight. This highlights that both the quantity (how much we eat) and the quality (what we eat) of our diet are essential.

B. Individualization of Guidance

Dietary guidance must be tailored to the individual because our bodies process and utilize nutrients differently. What is optimal for one person may be less effective or even problematic for another. This variation is due to a complex interplay of the following factors:

1. Genetic Variation

- Our DNA contains blueprints for producing enzymes, transporters, and receptors involved in metabolizing nutrients. Small differences in these genes (called polymorphisms) can significantly alter how we respond to specific components of our diet.
- Examples:

- **Lactose Intolerance:** A well-known example is the genetic variation that leads to reduced production of the lactase enzyme in adulthood, making it difficult to digest the sugar (lactose) in milk.
- **Caffeine Metabolism:** Some people possess a genetic variant that causes them to metabolize caffeine slowly, leading to a higher risk of heart attack with high coffee consumption, while fast metabolizers are not affected.
- **Salt Sensitivity:** Genetic differences can determine how strongly an individual's blood pressure responds to dietary sodium intake.

2. Age

- Nutritional requirements evolve throughout the human lifespan as the body's growth, maintenance, and metabolic demands change.
- Examples:
  - **Infants & Children:** Have high needs for protein, calcium, and calories per kilogram of body weight to support rapid growth and bone development.
  - **Adolescents:** Require increased iron (especially menstruating females) and calcium for continued development.
  - **Adults:** Focus shifts to maintaining muscle mass, bone density, and preventing chronic disease. Caloric needs often decrease due to a slower metabolism and reduced activity.
  - **Older Adults:** Need more protein to combat sarcopenia (age-related muscle loss), more calcium and Vitamin D to maintain bone health, and often require more fiber and fluid to support digestive health.

3. Body Size and Composition

- A person's total energy (calorie) requirement is directly influenced by their body's size and the proportion of muscle to fat.
- Examples:
  - **Basal Metabolic Rate (BMR):** A larger person, and specifically one with more lean muscle mass, has a higher BMR. Muscle tissue is metabolically more active than fat tissue, meaning it burns more calories at rest. Therefore, two people of the same weight but different body compositions will have different caloric needs.
  - **Dosage Considerations:** Nutrient requirements for vitamins and minerals are often given as a daily value, but optimal intake can be influenced by body size. For instance, fluid needs are closely tied to body weight.

4. Physical Activity Level

- Physical activity is a major variable in the energy balance equation. It significantly increases the body's demand for both calories and specific nutrients involved in energy production and muscle repair.
- Examples:

- **Energy:** An endurance athlete may require twice the daily calories of a sedentary individual of the same age and size.
- **Macronutrients:** Active individuals need more carbohydrates to fuel muscles and replenish glycogen stores, and more protein to repair and build muscle tissue.
- **Micronutrients:** Sweat losses increase the need for electrolytes like sodium and potassium, and the heightened metabolic activity can increase demands for B-vitamins.

5. Physiological States (e.g., Pregnancy)

- Certain life stages create unique nutritional demands to support the growth and health of both the individual and another life.
- Examples:
  - **Pregnancy & Lactation:** Requirements for nearly all nutrients increase. Key examples include folic acid (to prevent neural tube defects), iron (to support increased blood volume and fetal growth), calcium (for fetal bone development), and calories (to fuel the mother's and baby's metabolism).
  - **Illness or Recovery:** The body's need for protein, calories, and specific nutrients like zinc and Vitamin C can skyrocket during periods of infection, trauma, or post-surgery to support immune function and tissue repair.

6. Metabolic Health (e.g., Insulin Resistance)

- Underlying metabolic conditions fundamentally alter how the body processes macronutrients, particularly carbohydrates and fats.
- Examples:
  - **Insulin Resistance & Type 2 Diabetes:** For an individual with insulin resistance, the body has difficulty using carbohydrates for energy, leading to high blood sugar. Therefore, a diet that carefully manages the type, amount, and timing of carbohydrate intake (focusing on high-fiber, low-glycemic options) is crucial. This is less critical for someone with normal insulin sensitivity.
  - **Polycystic Ovary Syndrome (PCOS):** Often linked with insulin resistance, requiring similar dietary modifications.
  - **Liver or Kidney Disease:** These conditions require strict management of protein, sodium, and other electrolytes, which is unnecessary for a healthy individual.

II. Dietary Fat and Chronic Disease

The relationship between dietary fat and health is complex. It is no longer just about "low-fat"; the type of fat we consume is critically important.

A. Dietary Fat and Cardiovascular Disease (CHD)

1. Saturated Fat vs. Carbohydrate:

Early recommendations focused on reducing total fat intake to lower CHD risk. Cholesterol Effects: It is well-established that saturated fats and dietary cholesterol increase serum LDL ("bad") cholesterol.

The Substitution Problem: Replacing saturated fat with carbohydrate does lower total and LDL cholesterol, but it also lowers HDL ("good") cholesterol. Since the ratio of Total Cholesterol: HDL is a strong predictor of CHD risk, this substitution may not provide the best benefit.

2. Total Fat vs. Quality of Fat:

Total Fat Intake: At a population level, total fat intake itself shows little consistent association with CHD rates. For example, the classic Seven Countries Study found the lowest CHD rate in Crete, despite a high fat intake, due to high consumption of olive oil (a source of healthy monounsaturated fat).

Saturated Fat Intake: In contrast, saturated fat intake has been consistently and positively related to CHD risk.

3. Polyunsaturated Fat (PUFA) Benefits:

Cholesterol Lowering: Polyunsaturated fats decrease serum LDL cholesterol.

CHD Risk Reduction: PUFA, mainly linoleic acid (an Omega-6 fatty acid), has been inversely associated with CHD risk. Replacing saturated fat with PUFA has been shown to reduce the incidence of CHD.

Key Insight: The benefits are greatest when unsaturated fats (like PUFA) replace saturated fats. The benefits are minimal if carbohydrates replace saturated fat.

4. PUFA Concerns:

- **Cancer Risk:** Some animal studies have shown that very high intakes of omega-6 PUFA (e.g., from corn oil) can promote tumor growth.
- **Inflammation and Thrombosis:** Based on animal studies, a very high ratio of omega-6 to omega-3 fatty acids might promote inflammation and blood clots. This highlights the importance of balance, not just high intake.

B. Trans-Fatty Acids (TFAs)

Source: TFAs are artificially created by the partial hydrogenation of liquid vegetable oils. They were once common in margarine, vegetable shortening, and many processed foods and could account for up to 40% of these products. (Note: Many countries have now banned or severely restricted their use).

Adverse Effects: TFAs have a uniquely harmful effect on blood lipids: they increase LDL ("bad" cholesterol) and decrease HDL ("good" cholesterol).

Disease Association: TFA intake has been strongly associated with an increased risk of CHD and has also been positively associated with the risk of Type 2 Diabetes Mellitus (T2DM).

C. Dietary Fat, Type 2 Diabetes (T2DM), and Cancer

1. Type 2 Diabetes (T2DM):

Total Fat: The overall percentage of calories from fat does not appear to be directly related to the risk of developing T2DM.

PUFA Benefit: Polyunsaturated fat is inversely associated with T2DM risk, consistent with its positive effect on improving insulin sensitivity.

Red Meat Risk: Consumption of red meat, particularly processed red meat (like bacon and sausages), has been consistently associated with a greater risk of T2DM.

2. Cancer:

Breast Cancer: Earlier hypotheses suggested low-fat diets could reduce breast cancer risk. However, data from many large prospective studies have found no significantly elevated risk of breast cancer among women with the highest total fat intake.

Colorectal Cancer: Associations have been observed between red and processed meat consumption and an increased risk of colorectal cancer. Importantly, this risk may be due to components other than fat, such as:

- Heat-induced carcinogens formed during cooking (e.g., grilling).
- The high content of readily available iron (heme iron).
- Preservatives used in processed meats (like nitrates and nitrites).

Key Takeaway: A healthy diet is not about a single "good" or "bad" nutrient. It is about the overall pattern of eating—emphasizing healthy fats, lean proteins, whole grains, and plenty of fruits and vegetables—while managing total energy intake to maintain a healthy weight.

End of module 3