1. Nutrition and Aging

Nutrition and Aging

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2. Nutrition and Aging

Nutrition and Aging

- Malnutrition in the Elderly
- The Effects of Aging on 3 of the Main Determinants of Nutritional Status
  1. Nutrient Intake
  2. Nutrient Absorption (vit B12, calcium)
  3. Nutrient Metabolism (vit D, protein, energy)
- Obesity
- Case Study: Osteoporosis

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3. Nutrition and Aging: Slide 3

4. Increased Risk

Elderly individuals are at increased risk of both malnutrition and obesity

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5. Prevalence of Malnutrition in Elderly Populations

Prevalence of Malnutrition in Elderly Populations

Community-dwelling:
3 to 11%
Nursing home residents:
17 to 65%
Hospital inpatients:
15 to 40%

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6. Malnutrition associations

Malnutrition is associated with:

Increased risk of
- Functional disability
- Nosocomial infections
- Perioperative complications
- Morbidity and mortality
And
- Longer hospital length of stay
- Increased health-care expenditures

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7. Determinants of Nutritional Status

Determinants of Nutritional Status

- Intake of nutrients
- Absorption of nutrients
- Nutrient losses
- Nutrient metabolism

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8. Determinants of Nutritional Status

Determinants of Nutritional Status:
3 out of 4 are profoundly affected by aging

- Intake of nutrients
- Absorption of nutrients
- Nutrient losses
- Nutrient metabolism

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9. Nutrient Intake in the Elderly

Nutrient Intake in the Elderly

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10. Factors which Affect Nutrient Intake in the Elderly

Factors which Affect Nutrient Intake in the Elderly

- Limited mobility
- Financial hardship
- Visual impairment
- Social isolation
- Mood disorders
- Medications with anorectic effects
- Alcohol, tobacco and drug use
- Adherence to special diets
- Dysgeusia
- Poor oral or dental health
- Dysphagia

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11. Tooth Loss, Nutrition and Aging

Tooth Loss, Nutrition and Aging

- 13 to 42% of individuals over age 65 have lost all their natural teeth (BRFSS, 2002)
- Individuals with inadequate dentition have lower micronutrient intakes
- Extensive tooth loss is associated with an increased risk of malnutrition

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12. Micronutrient Intake and Dental Status

Micronutrient Intake and Dental Status

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13. Absorption of Nutrients

Absorption of Nutrients: Gastrointestinal Function in the Elderly

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14. Gastrointestinal Changes in Aging

Gastrointestinal Changes in Aging

- Higher prevalence of atrophic gastritis
- Higher prevalence of esophageal dysmotility
- Increased prevalence of lactose intolerance
- Delayed gastric emptying time
  - Total intestinal transit time is unchanged
- Pancreatic exocrine function is preserved under normal dietary conditions

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15. Atrophic Gastritis

16. Atrophic Gastritis

Type A: pernicious anemia
- autoimmune disorder (antibodies to parietal cells or intrinsic factor)

Type B
- chronic inflammatory disorder
- associated with *Helicobacter pylori* infection
- results in decreased secretion of hydrochloric acid, pepsin and intrinsic factor
17. Stomach acid releases B12

Stomach acid releases B12 bound to proteins in food. Intrinsic factor forms a complex with B12 – the complex binds to IF receptors in the ileum, and B12 is absorbed.

(Image removed due to copyright restrictions.)

18. Consequences of Atrophic Gastritis: Vitamin B12

Consequences of Atrophic Gastritis: Vit B_{12}

- Decreased secretion of hydrochloric acid and pepsin
- Decreased release of protein-bound B12 in food
- Increased density of bacterial populations in the small intestine
- Decreased availability (and absorption) of vitamin B12

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19. Nutritional Consequences of Atrophic Gastritis

- Decreased availability and absorption of food-bound **vitamin B12** (not crystalline B12)
- Decreased absorption of **calcium carbonate**, if it is taken without food (Recker, 1985)
- Decreased absorption of **non-heme iron** (Skikne, Lynch et al. 1981)


20. Nutrition and Aging: Slide 20

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Data from Krasinski et al. J Am Geriatr Soc. 1986;34:800-6
21. Nutrition and Aging: Slide 21


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22. B12 Insufficiency

B12 insufficiency results in elevated serum homocysteine and methylmalonic acid

- The two vitamin B12-dependent enzymes; L-methylmalonyl-CoA mutase (left) and methionine synthase (right).


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23. Abnormal Serum Homocysteine, Methylmalonic Acid and Folate... 

Abnormal Serum Homocysteine, Methylmalonic Acid and Folate by Serum B₁₂ level

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24. Response of Serum MMA to Parenteral B12 Administration

Response of Serum MMA to Parenteral B12 Administration


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25. Consequences of Vitamin B12 Deficiency

Consequences of Vitamin $B_{12}$ Deficiency

- Ineffective DNA synthesis $\rightarrow$ Megaloblastic anemia
- Inadequate myelin synthesis $\rightarrow$ Neurologic damage
- Hyperhomocysteinemia $\rightarrow$ Cardiovascular disease

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26. The Effects of Aging on Nutrient Metabolism

The Effects of Aging on Nutrient Metabolism

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27. Changes in Nutrient Metabolism and Requirements

**Aging and Disease are Associated with Many Changes in Nutrient Metabolism & Requirements:**

- Altered vitamin D metabolism in aging and chronic kidney disease (resulting in increased calcium needs)
- Protein requirements may increase with aging
- Decreased clearance of potassium, phosphorus, and magnesium in chronic kidney disease
- Body composition changes → decreased energy expenditure in aging
- Increased energy expenditure in Parkinson’s disease, cancer, infection, congestive heart failure and chronic pulmonary disease
- Vitamin A metabolism may decrease with aging

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28. Vitamin D Metabolism

**Vitamin D Metabolism**

\[
\begin{align*}
7\text{-dehydrocholesterol} & \downarrow \\
\text{Cholecalciferol (vitamin D₃)} & \downarrow \\
25\text{-hydroxycholecalciferol} & \downarrow \\
1,25\text{-dihydroxycholecalciferol} & \downarrow
\end{align*}
\]

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29. Biosynthesis of Vitamin D

Biosynthesis of Vitamin D

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30. Serum 25-hydroxyvitamin D levels decline with age

Serum 25-hydroxyvitamin D levels decline with age

Data from NHANES III, 1988-94

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31. Nutrition and Aging: Slide 31

![Prevalence of Vitamin D Deficiency in the Elderly](image)

Data from Gloth et al. JAMA. 1995; 274:1683-6.
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32. Consequences of Vitamin D Deficiency

- **Secondary hyperparathyroidism**
- **Bone disease:**
  - osteomalacia (adults) or rickets (children) due to insufficient mineralization of osteoid
  - Increased bone turnover
  - Increased fracture risk
- **Decreased absorption of calcium.** In cases of severe deficiency, may cause hypocalcemia

Muscle weakness and pain?

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33. Nutrition and Aging: Slide 33

Intestinal calcium absorption

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34. Impaired Vitamin D Metabolism

Due to Impaired Vitamin D Metabolism, Calcium Absorption is Decreased in Aging

- Decreased biosynthesis of vitamin D
- Relative intestinal resistance to 1,25-dihydroxyvitamin D (Pattanaungkul, Riggs et al. 2000)
- Impaired conversion of 25-OH to 1,25-(OH)₂ vitamin D in chronic kidney disease

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35. **Protein Metabolism**

**Protein Metabolism May Also Change in Aging**

- Current RDA for protein is 0.8 g/kg/day, which may be inadequate in the elderly.
- Protein requirements in elderly appear to be **increased**, although the etiology is not clear (increased catabolism v. decreased synthesis).
- Most Americans eat much more than the RDA for protein, but **older individuals are more likely to consume less than the RDA**.
  - 25% of healthy free-living elderly in the Boston area consume less than the RDA for protein. (Hartz, 1992)

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36. **Nutrient Metabolism in the Elderly**

**Nutrient Metabolism in the Elderly:**

the Effect of Body Composition Changes
37. Sarcopenia

**Sarcopenia**

- Sarcopenia
  - From the Greek, meaning “poverty of flesh”
  - Defined as the decrease in lean body mass seen with aging
- Often associated with a concomitant increase in fat mass
- Total body weight may not change

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38. Change in appendicular muscle mass

**Change in appendicular muscle mass as a function of age**

(Image removed due to copyright restrictions.)


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39. Prevalence of Sarcopenia

Prevalence of Sarcopenia

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From Baumgartner et al., Am J Epidem 1998; 147:755-63

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40. Sarcopenia is a Multifactorial Disorder

Sarcopenia is a Multifactorial Disorder

- Decreased levels of **sex hormones** (testosterone and DHEA)
- Decreased levels of **growth hormone and insulin-like growth factor 1 (IGF-1)**
- Increased **cytokine** production
- **Neuromuscular changes**
- **Physical inactivity**
- **Malnutrition**, especially protein deficiency
- **Smoking**

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Consequences of Sarcopenia

- Decreased resting energy expenditure
- Decreased insulin sensitivity
- Diminished muscle strength
- Increased risk of physical disability
- Increased risk of falls
- Increased risk of mortality

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Exercise And Nutritional Supplementation (360 kcal) For Physical Frailty In Very Elderly People

(Fiatarone, NEJM, 1994)

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43. Obesity in the Elderly

44. Body Mass Index

**Body Mass Index**

\[ BMI = \frac{\text{Weight (kg)}}{\text{Height}^2 (m)} \]

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5 - 24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0 - 29.9</td>
</tr>
<tr>
<td>Obesity, class I</td>
<td>30.0 - 34.9</td>
</tr>
<tr>
<td>Obesity, class II</td>
<td>35.0 - 39.9</td>
</tr>
<tr>
<td>Obesity, class III</td>
<td>&gt; 40</td>
</tr>
</tbody>
</table>

Chart source: NIH

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Prevalence of Obesity Increases with Age


(c) 2005, Lisa Neff, M.D.

Diseases Associated with Obesity

- Cardiovascular disease
- Stroke
- Hypertension
- Diabetes
- Metabolic Syndrome
- Dislipidemia
- Cancer
  - Breast cancer (in postmenopausal women)
  - Endometrial cancer
  - Colorectal cancer
  - Esophageal cancer
  - Gastric cancer
  - Renal cell carcinoma
  - Liver cancer
  - Pancreatic cancer
  - Multiple myeloma
  - Non-Hodgkin's Lymphoma
- GERD
- Cholelithiasis
- Non-alcoholic steatohepatitis
- Sleep apnea
- Obesity Hypoventilation Syndrome
- Asthma
- Pseudotumor cerebri
- Osteoarthritis
- Gout
- Infertility
- Polycystic Ovary Syndrome
- Urinary Incontinence

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Panel A: data from the Nurses’ Health Study.


Panel B: data from the Health Professionals Follow-up Study.

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Case Study:

Osteoporosis

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49. Nutritional Factors in the Development of Osteoporosis

**Nutritional Factors in the Development of Osteoporosis**

- **Inadequate nutrient intake**
  - Decreased intake of calcium, vitamin D (and protein?)

- **Impaired absorption of nutrients**
  - Decreased absorption of calcium carbonate due to atrophic gastritis
  - Decreased calcium absorption due to intestinal resistance to 1,25-dihydroxyvitamin D

- **Decreased biosynthesis of vitamin D**
  - Decreased sun exposure
  - Decreased capacity of skin to synthesize vitamin D

- **Altered vitamin D metabolism**
  - Impaired conversion of 25-OH to 1,25-(OH)₂ vitamin D in chronic kidney disease

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50. Metabolic and Lifestyle Factors in the Development of Osteoporosis

**Metabolic and Lifestyle Factors in the Development of Osteoporosis**

- **Low body weight** and loss of muscle mass (sarcopenia)
- **Hormone deficiencies**
- **Sedentary lifestyle**
- **Smoking**

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Mrs. M. is a 75-year-old widow who lives alone. She has a history of hypertension and hyperlipidemia, for which she takes several medications. She follows a low-cholesterol diet prescribed by her doctor years ago. She smoked for many years but quit about 20 years ago. Her husband died 1 year ago, and since that time she has lost ten pounds. She says “it’s too much trouble to cook for one person,” and she often skips meals.

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53. Mrs. M.

Mrs. M.

When she eats, her usual diet is as follows:

- Breakfast: toast with jam and margarine, tea with honey
- Lunch: vegetable soup, crackers, water with lemon
- Dinner: turkey sandwich with lettuce, sliced tomato
- Snack: fruit cocktail or crackers

(c) 2005, Lisa Neff, M.D.

54. Mrs. M.

Mrs. M.

When she eats, her usual diet is as follows:

- Breakfast: toast with jam and margarine, tea with honey
- Lunch: vegetable soup, crackers, water with lemon
- Dinner: turkey sandwich with lettuce, sliced tomato
- Snack: fruit cocktail or crackers

Diet is low in calcium, vitamin D, and protein

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Mrs. M.

Mrs. M. reports that she is not as spry as she once was. She is sedentary and spends most of her time indoors.

Last week Mrs. M. slipped on a loose rug in her apartment and fell on her left side. She was admitted to the hospital with a hip fracture and was found to have osteoporosis. BMI at admission was 17.

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Mrs. M.

Mrs. M. reports that she is not as spry as she once was. She is sedentary and spends most of her time indoors.

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57. Effect of Calcium and Vitamin D Supplementation

Effect of Calcium and Vitamin D Supplementation on Bone Density in Men and Women 65 Years of Age or Older

- 3 year double-blind, randomized, placebo-controlled study
- n=389 healthy, community-dwelling men and women age 65 and older
- Ca + D had a positive impact on change in bone mineral density
- Fracture incidence: 5.9% in treatment group versus 12.9% in placebo group
  (RR 0.6, 95%CI 0.2-0.9, p=.02)

Data from Dawson-Hughes et al. NEJM 1997;337:670-6.

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58. Calcium and Vitamin D Supplements

Calcium and Vitamin D Supplements Reduce Tooth Loss in the Elderly

- 3 year double-blind, randomized, placebo-controlled trial
- n=145
- Treatment group received 500 mg calcium citrate and 700 IU cholecalciferol daily
- 13% of treatment group and 27% of placebo group lost one or more teeth
  (OR 0.4, 95%CI 0.2-0.9, p<.05)


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Summary

Nutrient intake can be affected.

Biosynthesis of vitamin D declines.

Absorption of vitamin B12 and calcium decreases.

Changes in nutrient metabolism occur in aging (e.g. energy expenditure declines and protein requirements may increase).
61. **Nutritional Needs Change with Aging**

**Increased requirements:**
- calcium
- vitamin D
- vitamin B12
- (vitamin B6)
- (protein)

**Decreased requirements:**
- calories
- (vitamin A)

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62. **Quote**

*We cannot live the afternoon of life according to the program of life's morning: For what was great in the morning will be little at evening, and what in the morning was true will at evening have become a lie.*

- *Carl Jung*

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