Nutrition and Healthy Aging

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Tufts University
Boston, Massachusetts USA
Disclosures

- DSM Nutritionals
- Mead Johnson
OUTLINE

• Statistics on aging population
• Physiological changes with aging
• Change in nutrient needs in aging
• Special considerations for bioactives
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2011: first generation of baby boomers turn 65

CURRENT POPULATION REPORTS, Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050, U.S. Census Bureau.
Changes with Aging
Factors Affecting Inadequate Micronutrient Status in Older Adults

Reduced Absorption

Altered Nutrient Metabolism

Poor Nutrition

Low Income

Social Factors

Nutrition Knowledge

Drug-induced Deficiencies

Dementia

Depression

Chronic Disease

Lower Nutrient Intake

Reduced Calorie Intake

Nutritional Risk
Changes with Aging
Stomach

- **Atrophic gastritis**: loss of gastric secretions (low acid and pepsin)
- **Peptic ulcer**: can lead to overuse of antacids
- **NSAIDs**: most commonly prescribed medication for >65yrs; can result in mucosal injury, GI bleeding
Prevalence of Atrophic Gastritis Increases with Age

Boston Nutritional Status Survey

Absorption of Crystalline and Protein Bound B12 in Normal and Mild Atrophic Gastritis

Baik and Russell Ann Rev Nutr 1999
Changes with Aging
Immune Function

- Changes in immune system with aging
  - Decline in mass of immune tissue
  - Decline in immune function, particularly T-cell function
  - Increased susceptibility to infection, certain cancers

- Nutrient regulators of immune function
  - vitamin E
  - Selenium
  - vitamin A
  - vitamin D
  - zinc
  - iron
  - fatty acids
Effect of Vitamin E on Immune Function

Meydani, et al. JAMA 1997
Normal Bone

Osteoporotic Bone
Nutritional Factors in Osteoporosis

- **Nutrient intake**
  - Inadequate Ca, Vit D, protein, (folate, vit B12, vit K?)
  - Excessive alcohol, Na, caffeine, (vit A?)

- **Impaired absorption**
  - ↓ absorption of calcium carbonate in atrophic gastritis
  - ↓ calcium absorption due to intestinal resistance to 1,25D

- **Decreased biosynthesis of vitamin D**
  - ↓ sun exposure
  - ↓ capacity of skin to synthesize vit D from 7-DHC precursor

- **Altered vitamin D metabolism**
  - Impaired conversion of 25D→1,25D in chronic kidney disease
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Changes with Aging
Skeletal System

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Considerations with Aging
Changes in Body Composition

- **Sarcopenia**: decrease in lean body mass with aging, often with concomitant increase in fat mass (total body weight may not change)

- **Obesity**: excessive body weight that predisposes an individual to a variety of comorbidities
Diseases Associated with Obesity

- CVD
- Stroke
- Hypertension
- Metabolic syndrome
- Dyslipidemia
- Cancer
Percent of population that is obese and overweight (BMI equal to or greater than 25.0)

Data source: The National Health and Nutrition Examination Survey
Changes in Nutrient Needs with Aging
Changes with Aging
Energy

- Requirements for energy decrease with age because of reductions in metabolic rate
  - Loss of lean body mass
  - Decreased energy expenditure for physical activity
- As energy needs decrease, it becomes more difficult to meet nutrient requirements
  - Need for a nutrient-dense diet
  - Micronutrient supplementation (calcium, vit D, B12)
Changes with Aging
Energy

- Requirements for energy decrease with age because of reductions in metabolic rate
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  - Need for an nutrient-dense diet
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Changes with Aging
Carbohydrate

- NO change with aging, but decreased calorie needs will mean decreased total consumption of CHOs to maintain weight

- Indigestible dietary fiber is useful for addressing some GI disorders (20-30 g/day recommended)
  - constipation, diverticulitis, diabetes, hyperlipidemia
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Changes with Aging
Protein

RDA for men/women >18 yrs
– 0.80 g/kg BW/day

NO change for older adults, but some argue that older adults may need up to 1.0-1.25 g/kg BW/day
– Free-living elders in Boston consume 1.05 g/kg/day on average (Munro, 1987)
– 25% of this population consume < 0.8 g/kg/day (Harz, 1992)
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Changes with Aging

Fat

NO change with aging

Minimum of 10% total energy from fat
Maximum $\leq 30\%$ total energy from fat
  - 8-10% calories from saturated fat
  - 10% calories from polyunsaturated fats
  - rest as monounsaturated fats
  - Dietary cholesterol $\leq 300$ mg/day
Changes with Aging

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NO change with aging

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Maximum ≤ 30% total energy from fat
  – 8-10% calories from saturated fat
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  – Dietary cholesterol ≤ 300 mg/day
Changes with Aging
Fluids and Electrolytes

- Thirst sensitivity decreases with age
- Decreased ability of kidneys to concentrate urine and conserve water
- Voluntary decrease in fluid intake (incontinence)
- Total body water decreases with age with the decrease in lean body mass
Changes with Aging
Fluids and Electrolytes

• Inadequate fluid intake can lead to:
  – Physiological effects
  – Inappropriate dosage of medications (toxicity)
  – Greater sensitivity to extreme environmental temperatures
## Changes with Aging
### Fat Soluble Vitamins

<table>
<thead>
<tr>
<th>Age</th>
<th>Vit A</th>
<th>Vit D*</th>
<th>Vit E</th>
<th>Vit K*</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-50</td>
<td>700/900 µg RAE</td>
<td>5 µg</td>
<td>15 mg</td>
<td>90/120 µg</td>
</tr>
<tr>
<td>51-70</td>
<td>700/900 µg RAE</td>
<td>10 µg</td>
<td>15 mg</td>
<td>90/120 µg</td>
</tr>
<tr>
<td>70+</td>
<td>700/900 µg RAE</td>
<td>15 µg</td>
<td>15 mg</td>
<td>90/120 µg</td>
</tr>
</tbody>
</table>

* DRI Across Age Groups

* AI Women/Men
# Changes with Aging

## Water Soluble Vitamins

<table>
<thead>
<tr>
<th>Age</th>
<th>Vit C</th>
<th>Vit B6</th>
<th>Vit B12#</th>
<th>Folate</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-50</td>
<td>75/90 mg</td>
<td>1.3 mg</td>
<td>2.4 μg</td>
<td>400 μg</td>
</tr>
<tr>
<td>51-70</td>
<td>75/90 mg</td>
<td>1.5/1.7 mg</td>
<td>2.4 μg</td>
<td>400 μg</td>
</tr>
<tr>
<td>70+</td>
<td>75/90 mg</td>
<td>1.5/1.7 mg</td>
<td>2.4 μg</td>
<td>400 μg</td>
</tr>
</tbody>
</table>

# DRI Across Age Groups

Because 10-30% of older people may malabsorb food-bound B12, adults over 50 should consume fortified foods or B12 supplements.
### Changes with Aging

#### Minerals

<table>
<thead>
<tr>
<th>Age</th>
<th>Ca</th>
<th>Cr*</th>
<th>Fe</th>
<th>Na</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-50</td>
<td>1000 mg</td>
<td>25/35 µg</td>
<td>18/8 mg</td>
<td>1.5 g</td>
<td>2.3 g</td>
</tr>
<tr>
<td>51-70</td>
<td>1200 mg</td>
<td>20/30 µg</td>
<td>8 mg</td>
<td>1.3 g</td>
<td>2.0 g</td>
</tr>
<tr>
<td>70+</td>
<td>1200 mg</td>
<td>20/30 µg</td>
<td>8 mg</td>
<td>1.2 g</td>
<td>1.8 g</td>
</tr>
</tbody>
</table>

* AI

Women/Men

DRI Across Age Groups
# Percent of Americans ≥ 70 y with Vitamin Intake <75% RDA

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>35.4</td>
<td>33.7</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>52.6</td>
<td>56.5</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>24.5</td>
<td>25.9</td>
</tr>
<tr>
<td>Vitamin B1</td>
<td>10.0</td>
<td>14.9</td>
</tr>
<tr>
<td>Vitamin B2</td>
<td>8.7</td>
<td>15.9</td>
</tr>
<tr>
<td>Niacin</td>
<td>9.1</td>
<td>14.8</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>34.4</td>
<td>37.0</td>
</tr>
<tr>
<td>Folate</td>
<td>18.0</td>
<td>23.5</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>6.3</td>
<td>20.1</td>
</tr>
</tbody>
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Inadequate dietary intakes to meet micronutrient requirements are common

Impaired absorption of:

- *Folate* (in atrophic gastritis b/c pH dependence)
- *Vitamin B6* (even with supplementation, up to 40% of older adults remain B6 deficient)
- *Vitamin B12* (in atrophic gastritis b/c protein-bound vit B12 cannot be released without stomach acid)
- *Vitamin K* (in liver damage, atrophic gastritis, or with use of anticoagulants)
- *Vitamin D* (↓ photoconversion of 7-DHC)
- *Calcium* (↓ vitamin D and inactivity)
Summary
Nutrition and Aging

- Inadequate dietary intakes to meet micronutrient requirements are common
- Impaired absorption of:
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Considerations with Aging Polypharmacy

- Older adults use >25% of all prescriptions
- Average 4.5 prescriptions per older adult
- Drug-nutrient interactions
Drug-Induced Nutritional Deficiencies

• **Warfarin:** ↓ reductase/carboxylation of vitamin K

• **Hydrochlorothiazide, Sulindac:** ↓ dihydrofolate reductase

• **Cimetidine:** ↑ gastric pH and ↓ bioavailability of vitamin B6, folic acid, iron, zinc

• **Cimetidine, Isoniazid, Prednisone:** ↓ hepatic and renal hydroxylation of vitamin D

• **Amitriptyline, Chlorpromazine:** ↓ cofactor FAD and vitamin B12
Nutrient-Induced Changes in Drug Action

- **Folic acid** ↓ phenytoin bioavailability
- **Niacin** ↑ risk of myopathy with statins
- **Vitamin A** competes with receptors for isotretinoin
- **Vitamin C** acidifies urine and ↓ efficacy of gentamicin
- **Vitamin B6** ↓ response to levodopa
Re-evaluation of the DRIs for 70+ yrs?
Special Considerations for Bioactives and the Elderly?
Inflammation and oxidation are believed to be involved in age-related macular degeneration and cognitive decline.
Bioactives of Interest

- DHA = anti-inflammatory
- Lutein = anti-oxidant
Lutein is one of over 600 known naturally occurring plant pigments, known as carotenoids.

Rich dietary sources of lutein include green leafy vegetables such as spinach and kale.

Lutein selectively accumulates in human retina and brain.

Lutein status is related to decreased AMD risk and cognition.
DHA

- **DHA** is present in abundance in certain fish (such as tuna and bluefish) and marine animal oils.

- **DHA** is a predominant PUFA in the retina and brain.

- Low **DHA** status is associated with decreased risk of AMD and cognitive function.
Cognitive findings of an exploratory trial of docosahexaenoic acid and lutein supplementation in older women

Elizabeth J. Johnson¹, Karen McDonald¹, Susan M. Caldarella², Hae-yun Chung³, Aron M. Troen¹, D. Max Snodderly⁴

**Study design:** randomized, double-blinded, placebo-controlled, intervention trial

**Subjects:** Healthy women (60-80 years)

**Intervention (4 months):**
- Placebo (n = 10)
- Lutein, 12 mg/d (n = 11)
- DHA, 800 mg/d (n = 14)
- Lutein + DHA (n = 14)

*Johnson , et al. J Nutr Neuroscience 2008*
Executive Function
Verbal Fluency (more = better)

*significantly increased from baseline

Learning
Shopping List, change in the number of trials to learn list
(less = better)

*significantly increased from baseline

*significantly increased from baseline

Johnson, et al, J Nutr Neuroscience, 200
Short-Term Memory
Memory in Reality Apartment test (more = better)

*significantly increased from baseline

Johnson , et al, J Nutr Neuroscience, 200
Georgia Centenarian Study

Brain carotenoids
- 48 decedents
- Agreed donate their brain after death
- Age >98 y

Serum carotenoids
- 305 adults
- Age >70 y
- Community-dwelling and institutionalized
- Georgia

http://www.geron.uga.edu/research/centenarianstudy.php
Brain concentrations of lutein, zeaxanthin, β-carotene and α-tocopherol by pre-mortem GDS score in individuals with normal cognitive function and MCI

<table>
<thead>
<tr>
<th>Global Deterioration Scale (GDS)</th>
<th>1* (n=5)</th>
<th>2** (n=6)</th>
<th>3*** (n=10)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutein, pmol/g</td>
<td>175 ± 24</td>
<td>114 ± 20</td>
<td>65 ± 16</td>
<td>0.016</td>
</tr>
<tr>
<td>Zeaxanthin, pmol/g</td>
<td>49 ± 9</td>
<td>37 ± 8</td>
<td>26 ± 6</td>
<td>0.217</td>
</tr>
<tr>
<td>β-carotene, pmol/g</td>
<td>80 ± 14</td>
<td>45 ± 11</td>
<td>41 ± 9</td>
<td>0.109</td>
</tr>
<tr>
<td>α-tocopherol, nmol/g</td>
<td>62.8 ± 6.4</td>
<td>65.6 ± 5.2</td>
<td>61.4 ± 4.3</td>
<td>0.843</td>
</tr>
</tbody>
</table>

Values are estimated marginal means ± standard error

*GDS=1, normal cognitive function **GDS=2, subjective mild memory loss and ***GDS=3: mild cognitive impairment

Johnson EJ et al. Abstract FASEB J 2011;25:975.21
Correlations - brain lutein, zeaxanthin, β-carotene and α-tocopherol concentrations and pre-mortem cognitive function measures.

<table>
<thead>
<tr>
<th></th>
<th>MMSE</th>
<th>BDS</th>
<th>Verbal Fluency</th>
<th>Word List Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lutein</strong></td>
<td>0.638</td>
<td>0.704</td>
<td>0.577</td>
<td>0.542</td>
</tr>
<tr>
<td></td>
<td>(p=0.035)</td>
<td>(p=0.016)</td>
<td>(p=0.063)</td>
<td>(p=0.085)</td>
</tr>
<tr>
<td><strong>Zeaxanthin</strong></td>
<td>0.437</td>
<td>0.149</td>
<td>0.495</td>
<td>0.127</td>
</tr>
<tr>
<td></td>
<td>(p=0.143)</td>
<td>(p=0.663)</td>
<td>(p=0.121)</td>
<td>(p=0.710)</td>
</tr>
<tr>
<td><strong>β-carotene</strong></td>
<td>0.380</td>
<td>0.178</td>
<td>0.489</td>
<td>0.200</td>
</tr>
<tr>
<td></td>
<td>(p=0.249)</td>
<td>(p=0.600)</td>
<td>(p=0.127)</td>
<td>(p=0.556)</td>
</tr>
<tr>
<td><strong>α-tocopherol</strong></td>
<td>0.195</td>
<td>0.030</td>
<td>0.183</td>
<td>0.171</td>
</tr>
<tr>
<td></td>
<td>(p=0.566)</td>
<td>(p=0.930)</td>
<td>(p=0.590)</td>
<td>(p=0.615)</td>
</tr>
</tbody>
</table>

Values are age, sex, education, diabetes and hypertension adjusted partial correlation coefficients ‘r’

Johnson EJ et al. 2013
Cross-sectional relationship between fatty acids in the brain and pre-mortem measures of cognition in decedents with normal cognitive function, mild memory loss, or MCI (n).

<table>
<thead>
<tr>
<th></th>
<th>MMSE (23)</th>
<th>SIB (23)</th>
<th>COWAT (23)</th>
<th>BDS (23)</th>
<th>Verbal Fluency (21)</th>
<th>Boston naming (19)</th>
<th>WLMT (16)</th>
<th>CP (20)</th>
<th>WL recognition (18)</th>
<th>CP recall (19)</th>
<th>FOME recall (23)</th>
<th>FOME retention (23)</th>
<th>DAFS (23)</th>
<th>CERAD total (16)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SFA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>0.12</td>
<td>-0.15</td>
<td>0.28*</td>
<td>0.20</td>
<td>0.14</td>
<td>0.41</td>
<td>0.32</td>
<td>0.56**</td>
<td>0.34</td>
<td>0.42*</td>
<td>0.12</td>
<td>0.23</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>MUFA</strong></td>
<td>-0.25</td>
<td>-0.006</td>
<td>-0.40*</td>
<td>-0.45**</td>
<td>-0.30</td>
<td>-0.40</td>
<td>-0.30</td>
<td>-0.56**</td>
<td>-0.33</td>
<td>-0.40</td>
<td>-0.13</td>
<td>-0.20</td>
<td>-0.25</td>
<td>-0.36</td>
</tr>
<tr>
<td><strong>PUFA n-6</strong></td>
<td>0.15</td>
<td>-0.47**</td>
<td>0.12</td>
<td>-0.04</td>
<td>0.24</td>
<td>0.08</td>
<td>0.08</td>
<td>0.19</td>
<td>-0.11</td>
<td>0.13</td>
<td>-0.01</td>
<td>-0.27</td>
<td>-0.14</td>
<td>-0.17</td>
</tr>
<tr>
<td><strong>PUFA n-3</strong></td>
<td>0.35</td>
<td>0.51**</td>
<td>0.43*</td>
<td>0.69***</td>
<td>0.42*</td>
<td>0.42*</td>
<td>0.28</td>
<td>0.40</td>
<td>0.41</td>
<td>0.37</td>
<td>0.27</td>
<td>0.29</td>
<td>0.38*</td>
<td>0.58***</td>
</tr>
<tr>
<td><strong>trans</strong></td>
<td>-0.06</td>
<td>-0.41*</td>
<td>-0.34</td>
<td>-0.22</td>
<td>-0.19</td>
<td>0.10</td>
<td>0.48*</td>
<td>0.02</td>
<td>0.11</td>
<td>-0.21</td>
<td>-0.28</td>
<td>-0.04</td>
<td>0.14</td>
<td>-0.29</td>
</tr>
<tr>
<td><strong>DHA</strong></td>
<td>0.41*</td>
<td>0.41*</td>
<td>0.50**</td>
<td>0.71***</td>
<td>0.47**</td>
<td>0.53**</td>
<td>0.36</td>
<td>0.50**</td>
<td>0.45*</td>
<td>0.45*</td>
<td>0.30</td>
<td>0.28</td>
<td>0.38*</td>
<td>0.57***</td>
</tr>
</tbody>
</table>

Values are partial correlation coefficients adjusted for age, sex, education, diabetes, and hypertension 
*P<0.1, **P<0.05, ***P<0.01

SFA: saturated fatty acid, MUFA: monounsaturated fatty acids, n6PUFA: n6 polyunsaturated fatty acid, n3PUFA: n3 polyunsaturated fatty acid, Trans: trans fatty acid, DHA: docosahexaenoic acid.

MMSE: mini-mental state examination; SIB: Severe Impairment Battery; COWAT: controlled oral word association test; BDS: Behavioral Dyscontrol Scale; WLMT: Word List Memory Test; CP: Constructional Praxis; FOME: Fuld Object Memory Evaluation; WAIS: WAIS-III similarities; DAFS: Direct Assessment of Functional Status; CERAD: Consortium to Establish a Registry for Alzheimer’s Disease.
Interaction * between brain concentrations of lutein & DHA with cognitive function. Adjusted for age, sex, education, hypertension, and diabetes.

<table>
<thead>
<tr>
<th>Cognitive test</th>
<th>Frontal Cortex</th>
<th>Temporal Cortex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled word association test**</td>
<td>-0.0003</td>
<td>-0.0005</td>
</tr>
<tr>
<td>Verbal fluency</td>
<td>-0.0043</td>
<td>-0.0008&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Boston naming test</td>
<td>-0.0043</td>
<td>-0.0078</td>
</tr>
<tr>
<td>Wais III similarities**</td>
<td>-0.0003</td>
<td>-0.0001</td>
</tr>
<tr>
<td>Consortium to establish registry for Alzheimer’s dx (CERAD)</td>
<td>-0.064&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.125&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Behavioral dyscontrol scale</td>
<td>-0.23</td>
<td>-0.0003</td>
</tr>
<tr>
<td>Word list memory</td>
<td>0.0007</td>
<td>-0.0029</td>
</tr>
<tr>
<td>Word list recognition</td>
<td>-0.0019&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.0014&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Work list recall</td>
<td>-0.0027&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.0056&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Interaction term is log lutein*DHA3; **log transformed
<sup>a</sup>p <0.05; <sup>b</sup>p <0.01
Lutein and DHA status is related to better cognitive function in the elderly.

The association of lutein or DHA with cognition is dependent on the other.

However, their combined effect is less than expected if the two nutrients were added together.
Lutein and DHA status is related to better cognitive function in the elderly.

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Conclusion

Lutein and DHA status is related to better cognitive function in the elderly.

The association of lutein or DHA with cognition is dependent on the other.

However, their combined effect is less than expected if the two nutrients were added together.
## Dietary Recommendations for Omega-3 Fatty Acids

<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
<th>recommendation (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>UK Scientific Advisory Committee on Nutrition</td>
<td>450</td>
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<tr>
<td>2004</td>
<td>Intl Society for Study of Fatty Acids &amp; Lipids</td>
<td>≥500</td>
</tr>
<tr>
<td>2003</td>
<td>WHO FAO</td>
<td>400-1000</td>
</tr>
<tr>
<td>2004</td>
<td>European Society of Cardiology</td>
<td>1000*</td>
</tr>
<tr>
<td>2002</td>
<td>American Heart Association</td>
<td>450 or 1000*</td>
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<tr>
<td>2001</td>
<td>Health Council of the Netherlands</td>
<td>200</td>
</tr>
<tr>
<td>2000</td>
<td>Eurodiet</td>
<td>200</td>
</tr>
</tbody>
</table>

* for secondary prevention of coronary heart disease
While no recommended daily allowance currently exists for lutein, positive effects on eye disease prevention have been seen at dietary intake levels of ~6 mg/day.

Problem

- In U.S. intakes of **omega-3 fatty acids** and **lutein** is below what is recommended for **MOST** individuals.
Omega-3-DHA
average intake <100 mg/d for those >50 yrs

Lutein
average intake is <2 mg for those >50 yrs

Dietary Reference Intakes, Food & Nutrition board, Institute of Medicine
Should we consider guidelines/recommendations for lutein and DHA for the elderly?
TUFTS

Food Guide Pyramid for Older Adults

- **Calcium, Vitamin D, Vitamin B-12 Supplements**
  Not all people need these supplements, check with your healthcare provider

- **Low- and Nonfat Dairy Products**
  3 or more servings

- **Dry Beans and Nuts, Fish, Poultry, Lean Meat, Eggs**
  2 or more servings

- **Bright-Colored Vegetables**
  3 or more servings

- **Deep-Colored Fruit**
  2 or more servings

- **Whole, Enriched and Fortified Grains and Cereals**
  6 or more servings

- **Water/Liquids**
  8 or more servings

  - High-fiber choices

Choose whole grains and fortified foods such as brown rice, 100% whole-wheat bread, and bran cereals

Choose water, fruit or vegetable juice, low- and nonfat milk, or soup

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