Impact of vitamins & nutrients on neurological function

Effect of over supplementation of vitamins and nutrients

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Lecture Outline

• Topics from last class
  • Supplement
  • The optic nerve and how nutrition affects it
  • Neurogenesis: Hippocampus and Olfactory Bulb
  • How to know if you are deficient in vitamins
  • Neurotransmission in more detail

• Interactions of vitamins and pharmaceutical drugs

• Over Supplementation
  • B-vitamins
  • Vitamin E
  • Vitamin D
  • Choline

• Future Learning Resources
  • Nutrition
  • Neuroscience
Muscle Loss

More information:
https://ensure.com/muscle-loss-recovery
Optic Nerve
Optic Nerve
Nutrition for the eye: what foods are best for eye health?

**Dark green leafy vegetables**: kale, spinach, fresh parsley, collard greens, mustard greens.

**Yellow/orange vegetables**: carrots, corn, pumpkin.

**Other vegetables**: broccoli, green peas, brussels sprouts.

**Yellow/orange fruits** as well as most berries, especially gojiberrys, bilberries and blueberries.

More information: http://www.visionsofjoy.org/nutrition.htm
Nerve Conditions

- **Optic neuritis** causes inflammation in your optic nerve
  - autoimmune condition such as multiple sclerosis

- **Glaucoma** is one of the most common conditions that may damage your optic nerve
  - World Health Organization reports that glaucoma is one of the leading causes of blindness worldwide
Glaucoma

Development of Glaucoma

Healthy Eye

Flow of aqueous humour through the drainage canal.

Vitreous body

Glaucoma

1. Drainage canal blocked; build up of fluid.

2. Increased pressure damages blood vessels and optic nerve.
Nutrition and the Eye

• Nutrients beneficial for the eye include:
  • Vitamin C
  • Vitamin E
  • Vitamin A
  • Copper
  • Zinc
  • Selenium

• Omega-3 (anti-inflammatory)
Neurogenesis

- Neurogenesis (birth of new neurons) continues throughout life
- Areas in the brain: hippocampus and olfactory bulb
- Rate of neurogenesis declines with age because of neural stem cells
Neurogenesis: Olfactory Bulb

- As we age neural stem cells are not:
  - Responsiveness to stimulating environmental cues
  - Decrease or disappearance in environmental cues
  - Increase in inhibitory factors
Neurogenesis: Olfactory Bulb
Neurogenesis: Olfactory Bulb

Short Video Clip:
https://www.dnalc.org/content/2073/liedo_pierre_m_03.ogg
How to know if you are deficient in vitamins?

• Different symptoms for each vitamin, nutrient or mineral
• Body stores vitamins, nutrients and minerals
• Body is good at compensating

• Symptoms
• Blood tests

• Useful websites:
  http://www.marieclaire.com/health-fitness/a15599/vitamin-nutrient-deficiency/
Neurotransmission

Neurotransmission
Neurotransmission

Interactions of vitamins and pharmaceutical drugs

https://www.youtube.com/watch?v=qovaZNiOsfM
Hypervitaminosis

• refers to a condition of abnormally high storage levels of vitamins, which can lead to toxic symptoms
VIDEO: 10 surprising dangers of vitamins and supplements

Supplements of Vitamins and Nutrients

• Individual differences (e.g. diseases)
• Environment (e.g. North America)

• Not tightly regulated
B-vitamin over supplementation
Fortification in Canada

Since 1998 the Government of Canada has required that folic acid be added to all white flour and enriched pasta and cornmeal products sold in Canada.

Health Canada, 2008
Fortification

Table 1. Levels of folic acid fortification in countries with mandatory fortification programs.

<table>
<thead>
<tr>
<th>Country</th>
<th>Fortification level</th>
<th>Date of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States [25]</td>
<td>140 μg/100 g</td>
<td>1998</td>
</tr>
<tr>
<td>Canada [33]</td>
<td>150 μg/100 g</td>
<td>1998</td>
</tr>
<tr>
<td>Costa Rica [34]</td>
<td>180 μg/100 g</td>
<td>1998</td>
</tr>
<tr>
<td>Chile [35]</td>
<td>220 μg/100 g</td>
<td>2000</td>
</tr>
<tr>
<td>South Africa [36]</td>
<td>150 μg/100 g</td>
<td>2003</td>
</tr>
</tbody>
</table>

Crider et al., 2011
Grain Fortification Legislation

84 countries require fortification of wheat flour, maize flour, and/or rice

August 2015. Source: Food Fortification Initiative.
To request data, e-mail info@ffinetwork.org
Fortification in Canada Results

A 7-province study showed a reduction of 46% in the overall rate of NTDs, including live births, stillbirths and cases detected prenatally in pregnancies that were subsequently terminated.

Health Canada, 2008
Questions?
Break!
Over supplementation of folic acid

• mandatory fortification has lead to increase in folate levels in general population
• longer term effects of high folate levels not known
• Approximately 5 studies in pregnant Canadian women reporting increased levels of folic acid and metabolized folic acid
• Effects of maternal folic acid supplementation on offspring health unknown
Over supplementation of folic acid

• Maternal folate supplementation in rats, results in small fetuses and poor protein utilization in late gestation (Achon et al., 1999)
High Dietary Folate Supplementation Affects Gestational Development and Dietary Protein Utilization in Rats, Achon et al., 1999

### TABLE 2

**Gestation outcome in Wistar rat dams fed folic acid-supplemented or control diets**

<table>
<thead>
<tr>
<th>Dams</th>
<th>Live Fetuses/ Litter</th>
<th>Fetal Body Weight</th>
<th>Fetal Vertex-coccyx Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td></td>
<td>g</td>
</tr>
<tr>
<td>Supplemented</td>
<td>11</td>
<td>11.4 ± 1.16</td>
<td>3.15 ± 0.10**</td>
</tr>
<tr>
<td>Control</td>
<td>9</td>
<td>11.6 ± 0.74</td>
<td>3.49 ± 0.22</td>
</tr>
</tbody>
</table>

1 Values are means ± SEM. **Significantly different from control group, *P* < 0.001.
Maternal Over supplementation of Folic Acid

Folic Acid:

2 mg/kg
CD Mthfr +/-

40 mg/kg
FASD Mthfr +/-

10.5 embryos

Pickell et al., 2010
B-vitamin supplementation in the elderly
Neurodegeneration Progression

**Mild Cognitive Impairment**
- **Duration:** 7 years
- **Disease begins in Medial Temporal Lobe**
- **Symptoms:** Short-term memory loss

**Mild Alzheimer’s**
- **Duration:** 2 years
- **Disease spreads to Lateral Temporal & Parietal Lobes**
- **Symptoms include:**
  - Reading problems
  - Poor object recognition
  - Poor direction sense

**Moderate Alzheimer’s**
- **Duration:** 2 years
- **Disease spreads to Frontal Lobe**
- **Symptoms include:**
  - Poor judgment
  - Impulsivity
  - Short attention

**Severe Alzheimer’s**
- **Duration:** 3 years
- **Disease spreads to Occipital Lobe**
- **Symptoms include:**
  - Visual problems
Folate supplementation in Elderly

Study Background
- 2004-06
- Patients with Mild Cognitive Impairment (MCI) & controls
- Treatment, 2 years; Folic Acid and Vitamin B12

Smith et al., 2010
Folate supplementation in Elderly
Folate supplementation in Elderly

Placebo

Treated
Effect of B-vitamin supplementation on grey matter volume in patients with Mild Cognitive Impairment

**Objective**: investigate whether Alzheimer's disease related gray matter atrophy can be reduced via B-vitamin supplementation

- Patients: Mild Cognitive Impairment
- 2 Years of B-vitamin supplementation
- MRI
Results

B-vitamin supplementation for 2 years reduces brain shrinkages by 7-fold
Results

Treated individuals with the highest levels of homocysteine benefited most from B-vitamin supplementation.
Too much folate

- Exacerbate neurological consequence of vitamin B12 deficiency
- Safe upper limit of 1.0mg/day
Folate and Cancer

• Plays 2 roles in cancer: protecting against cancer initiation and facilitating progression
• > (greater than) 0.004mg/day, 20% increase in breast cancer
• High blood folate concentrations, increase risk of prostate cancer in males 59 and older

Mullin, 2011
Choline over supplementation

• Side effects
• dizziness
• lightheadedness
• high doses of choline can lower your blood pressure.
• excessive sweating and salivation, fishy body odor caused by byproducts of choline metabolism in your body
• Long-term effects unknown
Vitamin E over supplementation

- **too much vitamin E** can increase risk of bleeding
- long-term, this may increase risk of bleeding in the brain and stroke
- Can be particularly harmful to people on blood thinners and other medications.
Vitamin D

- Fat soluble, stays in blood for long time
- Too much vitamin D in your body, level will produce a chemical call 25(OH)D
- High levels of vitamin D (25(OH)D in blood may cause high levels of calcium to develop in blood (hypercalcemia)
Vitamin over supplementation video

https://www.sharecare.com/video/health-topics-a-z/vitamins/how-can-i-make-my-skin-glow
Future learning: Nutrition

- The Institute of Holistic Nutrition: Ottawa campus
  - [http://www.instituteofholisticnutrition.com](http://www.instituteofholisticnutrition.com)

**Text Books Available on Amazon:**

**Whole: Rethinking the Science of Nutrition**
by T. Colin Campbell, Howard Jacobson

**The China Study: The Most Comprehensive Study of Nutrition Ever Conducted and the Startling Implications for Diet, Weight Loss and Long-term Health**
by T. Colin Campbell

**Introduction to Human Nutrition 2nd Edition**
by Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster
Future Learning: Neuroscience

YouTube Channel: Neuro Transmissions
https://www.youtube.com/user/neurotransmissions

Alzheimer's disease blog (for non-scientists)
https://alzscience.wordpress.com/

List of Neuroscience Blogs:
http://www.prymd.com/blog/the-best-brain-blogs-neuroscience-for-the-non-scientific/
More questions?

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Please fill out course evaluations!