How Nutrition Changes the Aging Brain

INTRODUCTION TO NUTRITION, THE BRAIN-GUT AXIS, AND THE IMPACT OF AGING ON NUTRITION

Nafisa Jadavji, PhD
nafisa.jadavji@carleton.ca
Outline for Lecture

• Questions from previous lecture

• Introduction to Nutrition

• Brain Gut Axis

• Impact of Aging Nutrition
**Dopamine and Schizophrenia**

- Dopamine is an inhibitory neurotransmitter in schizophrenia
  - Dopamine dysregulation in the brain

- Dopamine hypothesis transmission
  - Hyperactive (High activity): mesolimbic areas
Dopamine and Schizophrenia

• Dopamine hypothesis transmission
  • Hypoactive (low activity): prefrontal cortex
Serotonin and Schizophrenia

- Reduced evidence of serotonin involved in schizophrenia
- Drugs that target serotonin not effective in schizophrenia
Resveratrol

- A type of phenol
- Reactive toward oxidation
- Act like antioxidants

Supplements:
- Lack of research to understand side effects
- Might interact with aspirin, blood thinners
Useful textbook for further reading
Introduction to Nutrition: Why do we eat?

• Adults eat 2000 pounds of food/year
• We eat because we are hungry
• Our bodies need energy and nutrients to live and function
Introduction to Nutrition: Water

• Body is 60% $\text{H}_2\text{O}$ (for example: 42L in 154lbs person)

• Water is excreted in urine ridding the body of end products of metabolism

• Need to increase intake $\text{H}_2\text{O}$ to balance losses

• Dehydration can occurs in days, but one can survive for several days without food
Introduction to Nutrition: Energy

• Need energy to perform physical work

• Work has to be done to lift a load against the force of gravity, must be a source of energy to perform work
Introduction to Nutrition: Energy

- Basal energy requirement for organs

*Figure 1.2* Percentage of resting energy expenditure by different organs of the body.
Introduction to Nutrition: Metabolic fuels

- Carbohydrates, fats, proteins and alcohol
- Make CO$_2$ and H$_2$O
- Energy yielded from starting products is same as end products
Introduction to Nutrition: Carbohydrates

• There is no requirement of carbohydrates
• Carbohydrates can be derived from proteins
• Minimum of 100g of carbs/day to maintain blood glucose concentration for brain and red blood cell metabolism
Introduction to Nutrition: Fats

• There is no requirement of fats

• But they are nutritionally important

• Diets 35-40% of energy from fat is associated with increased risk of heart disease and cancer

• Too little fat in diet, hard to meet energy requirements
Introduction to Nutrition: Fats

- Vitamin absorption (vitamins A, D, E, and K) are stored in fat

- 2 essential fatty acid come from fat, cannot be produced from body

- Fats add flavor and lubricate food
Fat in the brain

• 20% of the fat in the brain is composed of omega 3 and 6 essential fatty acids
• These fats must be provided by the diet

• Cell membranes: choline, uridine, DHA

• Neurotransmitter synthesis
  • E.g. choline makes acetylcholine
Introduction to Nutrition: Proteins

• Requirement in diet

• As child grows, changes in protein; adults require more proteins

• There is a continual loss of protein
  • Hair loss
  • Shedding of skin cells
  • Molecules being secreted into the gut
  • Tissue proteins (continually being broken down and replaced)
Introduction to Nutrition: Proteins

- Adult with inadequate intake will be unable to replace loss of protein
  - Begin to loose tissue protein
Introduction to Nutrition: Micronutrients

• Requirement in body for variety of minerals and salts

• Metals and ions are required by body must be provided to body

• Vitamins, variety of function, can’t be synthesized by body
Vitamins

Can be categorized as:

1) FAT SOLUBLE
2) WATER SOLUBLE

Solubility
Fat Soluble

- Vitamins A, D, E and K

- Soluble in fats
- Stores in body tissues
- They are absorbed by fat globules and moved into circulation (intestine)

- BOTTOM LINE: vitamin stays in your body
Fat Soluble

• Too much vitamins in body can develop hypervitaminosis (too much vitamins)

• Can become deficient in vitamins if:
  • Fat intake is too low
  • Fat absorptions is compromised by certain drugs (e.g. cystic fibrosis deficiency of enzyme (breaks things down) in pancreas which disrupts absorption of fate from intestine
Water Soluble

Vitamins B and C

- Require continuous supply to your body
- Steady daily intake required
- Take too much, then your body removes it (e.g. pee it out)
Review Video

Link to video: https://www.youtube.com/watch?v=fR3NxCR9z2U&t=261s
The brain is involved in nutrition!
Brain-Gut Axis

Influence on:
- motility
- secretion
- nutrient delivery
- microbial balance

Influence on:
- neurotransmitters
- stress/anxiety
- mood
- behaviour

Gut-Brain Axis

Brain

Gut

Microbiota
Brain-Gut Axis

• Bidirectional communication between central and enteric nervous system

• Links cognitive centers of the brain with peripheral intestinal functions

• Enteric nervous system:
  • Mesh-like system of neurons
  • Govern gastrointestinal system
  • 2nd brain
Brain-Gut Axis

• Microbiota: resides in gut flora

• Microbiota: largest number of bacteria and greatest number of species compared to other areas of the body

• Relationship between bacteria and humans is non-harmful coexistence

• Microorganisms benefit from energy released from body
Brain-Gut Axis

- Bacteria make vitamins B, K and metabolize things we can’t, like bile acids
- The composition of the bacteria in the gut changes over time
- Diet and health changes bacteria
Brain-Gut Axis

• Gut flora produce a range of neuroactive molecules:
  • Acetylcholine
  • GABA
  • Serotonin

• All regulate movement and sensation in gut

• Gut flora release molecules that can transmit information about state of the intestine to brain (via vagus nerve)
Interaction between brain and gut
Questions?
BREAK
Brain-Gut Axis Research

Probiotics

2016 small clinical trial showed potential benefits of available strains of probiotics on CNS disorders

*Bifidabacterium*
*Lactibacillus genera*
Brain-Gut Axis Research

Anxiety and Mood Disorders

• People with anxiety and mood disorders have gastrointestinal problems

• Contradictory results: people with major depressive disorders and healthy people gut flora comparison

• 2004 study, germ free mice have exaggerated HPA axis in response to stress, add *Bifidobacterium* to gut reverse effect
Brain-Gut Axis Research

Anxiety and Mood Disorders

• 2016 bacteria in gut produce neurotransmitters

Noradrenalin: *Escherichia Bacillus, Saccharomyces*

Serotonin: *Candida; Streptocaccus; Escherichia*
Brain-Gut Axis Research

Parkinson’s disease (PD)

GI dysfunction has a high prevalence in preclinical PD

PD patients have altered gut changes in bacteria

Bacteria produce short chain fatty acids, permeate the blood-brain barrier
Brain-Gut Axis Research

Parkinson’s disease (PD)

Bacteria produce short chain fatty acids, permeate the blood brain barrier

Generate inflammation in brain and alpha-synuclein levels
Impact of Aging on Nutrition

• Aging impacts nutrition
Impact of Aging on Nutrition

- Body composition
  - Decline in lean body mass
  - Increase in fat mass
Impact of Aging on Nutrition

• Bone Density
  • Peak density achieved around early adulthood
  • Plateaus between 3rd and 4th decades of life
  • Then declines
Impact of Aging on Nutrition

Endocrine function
- considerable changes
- due to alteration in hormone secretion, receptor number and alterations in sensitivity
- decrease in pancreatic beta cell function, decrease in insulin secretion
- increase risk in type of diabetes
- decrease in testosterone in men
- decrease in oestrogen and progesterone in women
Impact of Aging on Nutrition

**Gastrointestinal tract**
- taste and olfactory perception decline with age
- sensory desire to eat decline with age
- malabsorption of certain nutrients
- 20-50% of older adults believed to suffer from an inflammation of stomach lining
- impaired secretion of stomach acids
- intrinsic factor require for vitamin B12, impaired IF = vitamin B12 deficiencies
Impact of Aging on Nutrition

**Immune Function**
- dysregulation in both innate and adaptive immune function
- resulting in increased risk and severity of infection
Impact of Aging on Nutrition

**Energy requirements**

- Energy average requirement (EAR) is the average requirement to maintain a healthy body.
- EAR is calculated from metabolic rate and physical activity level.
- EAR is lower in elderly adults than young adults.
- Increase in EAR because of comorbidities and infections.
Impact of Aging on Nutrition

Protein requirements
- Complex
- Too much protein bad and too little, not OK
# Assessment of nutritional status in elderly

<table>
<thead>
<tr>
<th>Dietary intake</th>
<th>Food dairies; frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anthropometric measurements</strong></td>
<td>Height, weight, BMI, skill fold thickness</td>
</tr>
</tbody>
</table>
| **Body Composition**        | Dual energy X-ray absorptiometry (DEXA): determine muscle mass  
Bioelectrical impedance (BIA): assess dehydration of body |
| **Biochemical indicators**  | Plasma vitamin B12; serum ferritin (iron) |
| **Nutrition screening tools** | Assessment tools |
Malnutrition in elderly

• Increase in prevalence in older adults
• Common in elderly that are hospitalized and institutionalized

• Malnutrition associated with prolonged hospital stay, impaired wound healing and increase in mortality
Malnutrition in elderly

• Dementia or stroke patients
  • Dysphagia → difficulty eating or swallowing
  • Increase risk in malnutrition
Malnutrition in elderly

• **Consequences**
  • Loss of muscle mass and strength
    • Reduced mobility
    • Affects respiratory (increase lung infection) and cardiac muscle function (heart failure)
  • Reduced immune function, increase risk of infection
  • Poor wound healing
  • Loss of mucosal integrity leading to malabsorption
  • Increase risk of pressure sores
  • Psychological impact, causing apathy and depression, exacerbates situation
Malnutrition in elderly

- Study of 1203 free living and special housed residents
- 60-90 year olds in Sweden
- Risk of malnutrition independent predictor of mortality
Malnutrition in older adults

https://www.youtube.com/watch?v=iPNZKyxqN1U
Nutritional Support

1. Oral nutrition support (ONS): food, supplements, sip foods
2. Enteral Feeding: delivery of nutrients to gut
3. Parenteral nutrition: intravenous nutrition

ONS reduced costs at hospital because reduced complications reduced mortality and hospital stay

ONS offered to free living and community dwelling older adults reduced infections, improved quality of life, fewer falls and reduced hospital admissions
Best vitamins for older adults

Kirkland Signature Mature Multi 50+
• The multivitamin contains a large dose of Vitamin D, which helps prevent osteoporosis.
• It also features vitamin B12, a compound that seniors lose the ability to absorb efficiently.
• Kirkland's vitamins are inexpensive and provide a balanced source of important vitamins and minerals tailored to older adults' physical needs.
Best vitamins for older adults

One A Day
• One A Day offers separate multivitamins for senior men and women.

Centrum Silver
• Centrum Silver is a multivitamin with age-adjusted doses of nutrients for people aged 50 years and older
• it contains vitamins A, B6, B12, C, D, E and K in addition to folic acid, calcium, zinc and other minerals
• Centrum Silver is fortified with antioxidants that may fight cellular effects of aging
• Centrum Silver multivitamins are available in regular tablets as well as chewable pills
Best vitamins for older adults

Generic Brands

• most department and health food stores carry generic brands of vitamins designed for older adults
• check the label to determine if a generic brand will be an acceptable substitute
• look for high levels of vitamins A, C, D, E and K. B vitamins, including niacin, thiamine, folic acid, riboflavin, B6 and B12 are also important
Conclusions

- Healthy older people more likely than young adults to achieve recommended in take of vitamins and minerals
- Absorption and metabolism of some nutrients may be impaired in older people
- Aging associated with changes in body composition and deterioration
- Fall in energy requirement and associated energy intake
Health Aging with Nutrition

https://www.youtube.com/watch?v=KD-FmeueFUo
Questions?
Next class...How Nutrition Impacts Mild Cognitive Impairment & Alzheimer’s disease