Consumption of omega-3 fatty acids and fish and risk of age-related hearing loss

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Instructor: VS 劉殿楨
Introduction

- Presbycusis
  - Age-related hearing loss (HL)
  - 2nd common handicapping
  - Medical and socioeconomic costs
  - Aging population

- Risk factors & prevention!
Possible risk factors

- Genetic
- Noise
- Certain diseases

- Hair cells
- Cochlear blood flow
  - Single vascularization
Previous studies

Hearing loss ↔ moderate ↔ Cardiovascular disease events

Unsaturated fats
(especially long-chain omega-3 polyunsaturated fatty acids, n-3 PUFAs)

?
Our goal

Fish contain n-3 PUFAs
- (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA))

To study the relationship between
“n-3 PUFAs”, “Fish”, and “Presbycusis”
- Cross-sectional and longitudinal associations
Subjects and Methods (1)

- Study population
  - Blue Mountains Eye Study (BMES) cohort
    - BMES-2, BMES-3
  - Extension study

- Excluding
  - HL from birth
  - Otosclerosis and/or conductive HL
  - Incomplete audiologic data
  → Leaving 2442/2956 participants
Subjects and Methods (2)

- Dietary data
  - 145-item food-frequency questionnaire (FFQ), 9-category frequency scale
    - Frequency of consuming fish and oily fish (salmon, tuna, sardines), and method of preparation
  - Australian Food Composition Tables
Subjects and Methods (3)

- Audiologic examination
  - Pure-tone audiometry (PTA)

- Hearing impairment:
  - 500, 1000, 2000, and 4000 Hz ($\text{PTA}_{0.5–4 \, \text{kHz}}$)
  - >25 decibels (dB) HL in the better of the 2 ears

- Progression of hearing impairment:
  - $\text{PTA}_{0.5–4 \, \text{kHz}}$ at follow-up that was >5 dB HL higher than at baseline
Results (1)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No hearing loss (n = 1660; 68.0%)</th>
<th>Any hearing loss (n = 782; 32.0%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men [n (%)]</td>
<td>656 (39.5)</td>
<td>397 (50.8)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age (y)</td>
<td>63.5 ± 7.8</td>
<td>72.7 ± 8.3</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>No tertiary qualifications [n (%)]</td>
<td>483 (31.0)</td>
<td>312 (42.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Exposure to workplace noise [n (%)]</td>
<td>565 (34.2)</td>
<td>331 (42.4)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoker [n (%)]</td>
<td>163 (9.8)</td>
<td>63 (8.1)</td>
<td>0.17</td>
</tr>
<tr>
<td>Family history of hearing loss [n (%)]</td>
<td>722 (43.5)</td>
<td>356 (45.5)</td>
<td>0.35</td>
</tr>
<tr>
<td>History of stroke [n (%)]</td>
<td>46 (2.8)</td>
<td>52 (6.7)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>History of type 2 diabetes [n (%)]</td>
<td>131 (7.9)</td>
<td>98 (12.5)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Fish servings/wk [n (%)]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>531 (32.0)</td>
<td>254 (32.5)</td>
<td></td>
</tr>
<tr>
<td>≥1 to &lt;2</td>
<td>554 (33.4)</td>
<td>270 (34.5)</td>
<td>0.71</td>
</tr>
<tr>
<td>≥2</td>
<td>575 (34.6)</td>
<td>258 (33.0)</td>
<td></td>
</tr>
<tr>
<td>Total n−3 PUFAs</td>
<td>1.21 ± 0.49</td>
<td>1.17 ± 0.46</td>
<td>0.08</td>
</tr>
<tr>
<td>Long-chain n−3 PUFAs</td>
<td>0.27 ± 0.30</td>
<td>0.25 ± 0.30</td>
<td>0.39</td>
</tr>
</tbody>
</table>

BMHS, Blue Mountains Hearing Study; PUFAs, polyunsaturated fatty acids.

1 Mean ± SD (all such values).

- 2442/2956 participants
- Baseline HL prevalence associated with male, aged, no tertiary qualifications, exposure to workplace noise, history of stroke or T2DM
Results (2)

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Associations between baseline dietary intake of polyunsaturated fatty acids (PUFAs) and consumption of fish and the prevalence of hearing loss (HL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any level of HL (≥25 dB HL) (n = 782; 32.0%)</td>
</tr>
<tr>
<td></td>
<td>Values</td>
</tr>
<tr>
<td>Energy-adjusted fatty acid intake</td>
<td></td>
</tr>
<tr>
<td>Total n-3 PUFAs</td>
<td>1.20 (0.05–4.85)$^4$</td>
</tr>
<tr>
<td>Long-chain n-3 PUFAs</td>
<td>0.26 (0.00–4.18)</td>
</tr>
<tr>
<td>Fish servings/wk</td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>254/785$^5$</td>
</tr>
<tr>
<td>≥1 to &lt;2</td>
<td>270/824</td>
</tr>
<tr>
<td>≥2</td>
<td>258/833</td>
</tr>
<tr>
<td>$^1$ dB, decibels. For total n-3 PUFAs. 1 SD = 0.78, and for long-chain n-3 PUFAs, 1 SD = 0.30.</td>
<td></td>
</tr>
<tr>
<td>$^2$ Logistic regression analysis adjusted for age, sex, education, exposure to noise at work, family history of HL, smoking, previous history of diagnosed stroke, and diabetes.</td>
<td></td>
</tr>
<tr>
<td>$^3$ Mean; range in parentheses (all such values).</td>
<td></td>
</tr>
<tr>
<td>$^4$ Odds ratio per 1 SD; 95% CI in parentheses (all such values).</td>
<td></td>
</tr>
<tr>
<td>$^5$ No. of cases/no. at risk (all such values).</td>
<td></td>
</tr>
</tbody>
</table>

- Dietary total n-3 PUFAs
- Prevalence of HL
# Results (3)

## TABLE 3

<table>
<thead>
<tr>
<th>Energy-adjusted fatty acid intake</th>
<th>Values</th>
<th>Age- and sex-adjusted</th>
<th>Multivariate-adjusted $^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total n-3 PUFAs</td>
<td>1.12 (0.08–4.02)$^3$</td>
<td>0.86 (0.71, 1.04)$^4$</td>
<td>0.86 (0.71, 1.04)</td>
</tr>
<tr>
<td>Long-chain n-3 PUFAs</td>
<td>0.27 (0.00–3.09)</td>
<td>0.77 (0.61, 0.99)</td>
<td>0.76 (0.60, 0.97)</td>
</tr>
<tr>
<td>$\alpha$-Linolenic acid</td>
<td>0.89 (0.00–2.81)</td>
<td>0.96 (0.80, 1.16)</td>
<td>0.99 (0.82, 1.19)</td>
</tr>
<tr>
<td>Total n-6 PUFAs</td>
<td>9.16 (0.02–30.07)</td>
<td>0.94 (0.77, 1.14)</td>
<td>0.93 (0.76, 1.14)</td>
</tr>
</tbody>
</table>

$^1$ dB, decibels. For total n-3 PUFAs, 1 SD = 0.50; for long-chain n-3 PUFAs, 1 SD = 0.30; for $\alpha$-linolenic acid, 1 SD = 0.41; and for total n-6 PUFAs, 1 SD = 3.68.

$^2$ Logistic regression analysis adjusted for age, sex, exposure to noise at work, and family history of HL.

$^3$ Mean; range in parentheses (all such values).

$^4$ Odds ratio per 1 SD; 95% CI in parentheses (all such values).

- Higher dietary intake of long-chain n-3 PUFAs
- Risk of developing incident HL ↓
- Linear relation
Results (4)

<table>
<thead>
<tr>
<th>Fish servings/wk</th>
<th>Incident HL (≥25 dB HL) (n = 141; 17.7%)</th>
<th>Progression of HL (≥5 dB HL) (n = 182; 47.2%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cases/no. at risk</td>
<td>Age- and sex-adjusted</td>
</tr>
<tr>
<td>&lt;1</td>
<td>46/261</td>
<td>1.0 (reference)&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>≥1 to &lt;2</td>
<td>61/264</td>
<td>1.17 (0.75, 1.83)</td>
</tr>
<tr>
<td>≥2</td>
<td>34/239</td>
<td>0.57 (0.35, 0.95)</td>
</tr>
<tr>
<td>P for trend</td>
<td>0.03</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<sup>1</sup> dB, decibels.
<sup>2</sup> Logistic regression analysis adjusted for age, sex, exposure to noise at work, and family history of HL.
<sup>3</sup> Odds ratio; 95% CI in parentheses (all such values).

- Regular consumption of fish
- 5-year incidence and progression of HL
- Fish-oil supplements: no less likely to develop HL
Discussion (1)

Dietary total n-3 PUFAs \( \Rightarrow \) Prevalence of HL

Dietary long-chain n-3 PUFAs \( \Rightarrow \) Incidence of HL
Discussion (2)

- Regular consumption ($\geq 1$, <2 servings/wk) of fish
  - Slow the progression of an existing HL
  - “Threshold effect” at 1–2 servings of fish/wk?
Discussion (3)

- Dietary supplementation with fish oil n-3 fatty acids for 1 year
  - Cardiovascular deaths, sudden cardiac death, global mortality, and nonfatal cardiovascular events ↓

- But not in this study
  - Few participants took fish-oil supplements at baseline
  - Exact dosage?
Discussion (4)

- Encouraging changes in the nutritional status of older adults
  - Similar to that for CV diseases
  - Low in saturated fatty acids and high in long-chain n-3 PUFAs from fish and fish oils
Discussion (5)

Key strengths of this study:

- Relatively high participation
- Standardized audiometric testing
- Participants were unaware of the study question
- Dietary data were collected before detection of the 5-y incidence of HL
Discussion (6)

- Limitations of this study:
  - A longitudinal study with only 2 repeated observations – learning effect?
  - FFQ – measurement error/bias
  - Other underlying healthy lifestyle risk factors
Conclusion

- Increasing the consumption of fish and intake of n-3 PUFAs in the diet could be beneficial to preserve cochlear function and reduce the HL associated with increasing age.

- Still need:
  - High-quality randomized controlled trials of long duration
  - Future large prospective studies
Reference