Dietary habits and hearing

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Abstract

Objective: Study groups from three age cohorts of 70–75 year-olds were investigated to search for possible correlations between dietary habits and auditory function. Design: A cross-sectional, epidemiological study. Study sample: A total number of 524 people (275 women, 249 men) were recruited from three age cohorts. The study sample was representative of the general population. All participants answered a diet history and were tested with pure-tone audiometry. Eleven categories of food consumption were related to pure-tone averages of low-mid frequency hearing, and high frequency hearing. Results: Two consistent correlations between diet and hearing were observed. One was a correlation between good hearing and a high consumption of fish in the male group. The other was a correlation between poor high frequency hearing and a high consumption of food rich in low molecular carbohydrates in both genders; a larger effect size was seen in females. Conclusions: The study indicates that diet is important for aural health in aging. According to this study fish is beneficial to hearing, whereas consumption of “junk food”, rich in low molecular carbohydrates, is detrimental. Other correlations, e.g. between high consumption of antioxidants, were not demonstrated here, but cannot be excluded.

Key Words: Aging; demographics/epidemiology; hearing conservation; medical audiology

In recent years, increasing interest has been focused on the influence of diet on hearing capacity. In most of these studies, the effects of different micronutrients in the food have been investigated. The influence of different micronutrients, like vitamins A, C, E, B2 (riboflavin), B9 (folic acid), B12, and magnesium, on hearing capacity has been studied in humans as well as in research animals. Animal studies have shown that antioxidants have a protective effect on hearing. Seidman (2000) studied different nutritional strategies on rats. A 30%-caloric restricted group showed the best hearing, the lowest quantity of mtDNA deletions (associated with aging and presbyacusis), and the least amount of outer hair cell (OHC) loss. The antioxidant-treated rats showed improved auditory sensitivity and a trend toward fewer mtDNA deletions. The placebo rats had the poorest hearing, the most mtDNA deletions, and the greatest degree of OHC loss. The study favors the concept that nutritional and pharmacological strategies can be of importance to reduce presbyacusis. LePrell et al (2011) studied a nutrient-enhanced diet, including beta-carotene, vitamins E and C, and magnesium, on CBA/J mice. The diet gave protection against hearing loss, but hair cell survival was not enhanced. Noise-induced loss of type II fibrocytes in the lateral wall was significantly reduced. However, in another study no favorable influence from diet was observed. Sha et al (2012) studied CBA/J mice placed either on a diet supplemented with multiple antioxidants or a control diet. Auditory thresholds increased with age but there were no significant differences between the two groups. Hair cell loss and degeneration of spiral ganglion cells were the same in both groups. The results did not support the benefit of antioxidant intervention in age-related hearing loss for normally maintained animals.

There are also some human studies on the effect of diet and micronutrients on hearing capacity. In two studies from the Blue Mountain Hearing Study (Spankovich et al, 2011; Gopinath et al, 2011) positive effects of micronutrients on hearing were reported. These micronutrients included vitamins with antioxidant properties: Vitamins A including beta-carotene, C, and E. In addition, riboflavin, magnesium, and lycopene also showed positive effects. However, longitudinal data did not demonstrate any association between dietary antioxidant intake and hearing loss in older adults, most probably because of insufficient study power. Shargorodsky et al (2010) reported that higher intake of vitamin C, E, beta carotene, or B12 did not reduce the risk of hearing loss in adult males, measured as self-reported, professionally-diagnosed hearing loss. However, elderly men may benefit from higher folate intake to reduce the risk of hearing loss.
Materials and Methods

Study groups

The total number of subjects in this study was 524 (women: 275; men: 249). Three age cohorts were included. (1) Cohort 1, consisting of randomly selected participants who were born in 1901-02, examined at age 70. The cohort consisted of 30% of all 70-year-olds living in Gothenburg at that time. The response rate was 86%. A random subgroup of 38% of the participants was tested with audiometry. A dietary questionnaire (Diet history, DH) was completed by 37%. The total number of participants with information about both hearing and diet was 182 (94 women, 88 men, 18% of the cohort). (2) Cohort 5, born in 1922, tested at age 70. Seventeen percent of all 70-year-old persons in the city were randomly selected and invited, and the response rate was 66%. Audiometry was performed on 55% of the participants, and the DH was completed by 38%. Information about both hearing and diet was available for 80 persons, 43 women and 37 men (16%). (3) Cohort 6, born in 1930, tested at age 70 (DH), and at age 75 (audiometry). At age 75, 41% were invited, and the response rate was 61%. Of the participants, 74% were tested with audiometry. The DH was answered at age 70. In all, 262 participants (138 women and 124 men) took part in both investigations.

Diet history

A diet history (DH) was used, capturing food intake over the past three months in a detailed dietetic interview (Steen et al, 1977; Eiben et al, 2004). The DH has been validated and it was found to give energy intake values comparable to those energy expenditure values predicted by the heart rate method and activity diary. However, it underestimated usual energy intake by 12% compared with the energy expenditure measured by the doubly-labelled water method in 12 subjects, and some obesity-related underreporting was observed (Rothenberg et al, 1996, 1997, 1998). The purpose was to compare dietary practices among different birth cohorts. The same DH method has been used in all three cohorts. Methodological details on examinations have been published (Rothenberg et al, 1996, 1997, 1998).

Food intake in grams per day, measured as the mean of the DH, was studied both as a continuous variable, as well as divided into quartiles, from highest (Q4) to lowest intake (Q1). Consumption of food was grouped into 11 categories: (1) Fruits; (2) Vegetables; (3) Legumes, nuts and seeds; (4) Cereals; (5) Potatoes; (6) Fish; (7) Red meat; (8) White meat; (9) Eggs; (10) Dairy products; (11) Low molecular carbohydrates, consisting of four items (juice and soft drinks; cakes and biscuits; refined sugar; honey, and sweets). This compilation (#11) was considered to represent unhealthy eating habits, or ‘junk food’.

Calculations of the content of single micronutrients in the diet, like vitamins and fatty acids, were not performed in this study.

Pure-tone audiometry

Pure-tone thresholds were tested with pure-tone audiometry, using Kamplex DA2, Madsen OB 70 (Cohort 1 and 5) or Interacoustics AD27 (Cohort 6) audiometers and TDH-39 head phones. The tests were performed in a quiet office room. The ambient background noise levels were measured in the test room at one occasion. The background noise was at most 23 dB at 0.25 kHz, and it did not exceed 20 dB in the frequency range 1–8 kHz. In cohorts 1 and 5, testing was performed by trained clinical audiologists, with masking of the contralateral ear when appropriate. In cohort 6, testing was performed by nurses with special training in audiometry, but no masking was performed. Detailed descriptions have been published previously (Jonsson et al, 1998; Rosenhall et al, 2013). Pure-tone thresholds from 0.5 through 8 kHz were measured.

Pure-tone averages in dB HL were calculated across 0.5, 1, and 2 kHz (LFA-low frequency average) and across 4 and 8 kHz (HFA - high frequency average). The right and left ears were analysed separately. The better ear (according to the pure-tone average of all initially measured frequencies) was also included.

Statistics

Multiple linear regression was used to study if there were correlations between intake of food as the explanatory variable, and hearing thresholds as the dependent variable. Cohorts and gender were included as covariate variables (predictors). A test of correlation coefficients was also performed. A negative correlation coefficient, i.e. a low value for audiometry, and a high value for food intake in g/day, indicated better hearing with higher intake. A positive correlation coefficient, on the other hand, indicated poorer hearing with a higher food intake.

Results

Intake of fish

In the male group there was a correlation between high intake of fish (Q4) and better hearing (low threshold values), see Table 1 and Figure 1. The difference in hearing was significant for both ears in the low and mid frequencies (0.5–2 kHz) and in

Table 1. Male group. Analysis of correlation coefficients between hearing expressed as two pure-tone averages, 0.5, 1, and 2 kHz, and 4 and 8 kHz, and high intake of fish. High intake of fish correlated with better hearing. Significance levels are given.

<table>
<thead>
<tr>
<th></th>
<th>PTA 0.5–2 kHz</th>
<th>PTA 4 and 8 kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right ear</td>
<td>p = 0.0193</td>
<td>ns</td>
</tr>
<tr>
<td>Left ear</td>
<td>p = 0.0151</td>
<td>p = 0.0219</td>
</tr>
<tr>
<td>Better ear</td>
<td>p = 0.0080</td>
<td>p = 0.0513 (trend)</td>
</tr>
</tbody>
</table>

ns: not significant.
the high frequencies (4 and 8 kHz) for the left ear. The poorest hearing thresholds were observed in the quartile with the lowest intake of fish (Q1) (Figure 1).

The correlation was significant in Cohort 6, a trend was observed in Cohort 5, but no correlation was seen in Cohort 1. There were no correlations between intake of fish and hearing in the female group.

Low molecular carbohydrate intake
The total consumption (g/day) of four types of foods rich in low molecular carbohydrates was compared with audiometry results. High intake of these foods correlated significantly with poor high frequency hearing (4 and 8 kHz), in the female group, right ear (Table 2). When both genders were compiled, the correlation between high intake and poor high frequency hearing became highly significant for both ears.

Other dietary factors
Regarding the other nine food group categories, no consistent correlations with hearing were observed. A number of sporadic, erratic correlations, were observed, but these correlations were discarded.

Table 2. Intake of low molecular carbohydrates related to hearing, shown for female and male groups, separately and combined. Analysis of correlation coefficients between high-frequency hearing (pure-tone average of 4 and 8 kHz), and diet. High intake of low molecular carbohydrates correlated with poor high-frequency hearing. Significance levels are given.

<table>
<thead>
<tr>
<th></th>
<th>PTA 4–8 kHz,</th>
<th>PTA 4–8 kHz,</th>
<th>PTA 4–8 kHz,</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td>W+M</td>
</tr>
<tr>
<td>Right ear</td>
<td>p = 0.0472</td>
<td>p = 0.0509 (trend)</td>
<td>p = 0.0002</td>
</tr>
<tr>
<td>Left ear</td>
<td>ns</td>
<td>ns</td>
<td>p = 0.0033</td>
</tr>
<tr>
<td>Better ear</td>
<td>p = 0.0348</td>
<td>ns</td>
<td>p = 0.0003</td>
</tr>
</tbody>
</table>

ns: not significant

Discussion
In the present study, a correlation between good hearing and a high consumption of fish was observed in the male group. This finding supports the finding of Gopinath et al (2010), who reported an inverse association between higher intakes of long-chain n-3 dietary polyunsaturated fatty acids and regular weekly consumption of fish and hearing loss, in the Blue Mountain Hearing Study. In our study the effect was observed only in the male group, in both ears, and predominantly in the low- and mid-frequency range. A continuous change of dB values should be discerned in all four quartiles of food intake. The correlation was observed in two of the three cohorts. Reduction of noise-induced hearing loss (NIHL) could possibly be suspected because of the appearance only in the male group, but seems to be less probable since there was no significant positive effect at 8 kHz. Another possibility is that the effect is related to protection against cardiovascular disease which can affect the low- and mid-frequencies (Gates et al, 1993; Rosenhall & Sundh, 2006). Evidence has suggested an important role of n-3 polyunsaturated fatty acids in the prevention and treatment of cardiovascular disease (Hu, 2001).

In the female group in this study, no association of hearing with high consumption of fish was observed. The reason for this is not known. There is a gender factor regarding hearing in old age, with a general observation that women have better hearing than men (Jönsson & Rosenhall, 1998).

There is a tradition of eating fish in Gothenburg, a city that faces the North Sea, and which is an important landing port for fishing boats. The observation that a high consumption of fish might protect hearing, at least in men, is interesting. However, some caution should be expressed since the study group is relatively small, and further studies should be performed. Adjustments for possible confounding factors can perhaps be performed in an extended study group.

An intriguing finding in this study is an adverse effect of ‘junk food’ on hearing. A correlation between high intake of low-molecular carbohydrates and high frequency hearing loss is suggested. This supports the concept that the quality of the food is of importance for the hearing expressed by Spankovich & LePrell (2013) in the NHANES study. They reported a significant negative relationship between dietary quality and thresholds at higher frequencies, where higher dietary quality was associated with lower hearing thresholds. Their findings support an association between healthier eating and better high frequency thresholds. Our finding that low quality food might influence high frequency hearing negatively is intriguing, but needs further support since our sample size was relatively small. An indication of the paucity of the sample is that the analyses of women and men separately hardly resulted in any significant correlations, while the compilation of both genders did. Moreover, selection of food varies by education and occupational status in both sexes although socio-economic disparities in diet quality have been observed in men only (Cabrera et al, 2007).

The hypothesis that a diet rich in antioxidants (Spankovich et al, 2011; Gopinath et al, 2011), or other micronutrients like folic acid (Sharorgodsky et al, 2010), is beneficial for hearing was not confirmed in this study. No correlation between consumption of fruits and vegetables, with a high content of antioxidants, and hearing was observed. However, our study does not exclude the existence of such a relationship. A critical factor is probably the relatively small sample of the study population. Further, the range of intake in the different quartiles may be too narrow. A conclusion is that this
study does not permit reliable conclusions about single micronutrients. It is known that the general intake of fruits and vegetables has increased over the last 30–40 years, as well as recently in the elderly (Eiben et al, 2004). The participants possibly had a lower consumption earlier in life than when reporting at age 70.

Summary and Conclusions

The evaluation of the influence of diet on hearing is complex, with a multitude of confounding factors. Absence of a statistical correlation does not exclude an association, and vice versa. The present study supports the observation by Gopinath et al (2010) that consumption of fish could be beneficial to preserve hearing. There is also an indication that high intake of junk food, rich in low molecular carbohydrates, is associated with high-frequency hearing loss. The study indicates that a healthy diet might be beneficial for hearing, but does not give support that supplementation of single micronutrients in the diet may be recommended as otoprotective.

Declaration of interest: The authors report no conflicts of interest.

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References


