Nutrition and respiratory health in children in six Central and Eastern European countries

T Antova, S Pattenden, B Nikiforov, G S Leonardi, B Boeva, T Fletcher, P Rudnai, H Slachtova, C Tabak, R Zlotkowska, D Houthuijs, B Brunekreef, J Holikova

**Background:** The results of studies on the effect of nutrition on respiratory diseases are inconsistent. The role of nutrition in children’s respiratory health was therefore analysed within the cross sectional Central European Study on Air Pollution and Respiratory Health (CESAR).

**Method:** A total of 20 271 children aged 7–11 were surveyed in six European countries. Respiratory health and food intake were assessed using questionnaires. Associations between four symptoms and nutritional factors were evaluated using logistic regression, controlling for area plus other potential confounders.

**Results:** All symptoms showed initial associations with nutritional factors. Low consumption of fish and of summer and winter fruit were the most consistent predictors. In a fully adjusted model low fish intake remained a significant independent predictor of persistent cough (OR=1.18; 95% CI 1.04 to 1.34), wheeze ever (OR=1.14; 95% CI 1.03 to 1.25) and current wheeze (OR=1.21; 95% CI 1.06 to 1.39) and a weaker predictor of winter cough (OR=1.10; 95% CI 0.99 to 1.23). Low summer fruit intake was a predictor of winter cough (OR=1.40; 95% CI 1.10 to 1.79) and persistent cough (OR=1.35; 95% CI 1.01 to 1.82). Low winter fruit intake was associated with winter cough (OR=1.28; 95% CI 1.09 to 1.51). Associations between symptoms and vegetable intake were inconsistent. Low summer fruit intake was a stronger predictor of winter cough (OR=1.28; 95% CI 1.09 to 1.51) but, overall, winter intake had inverse associations with both coughs. Associations between winter vegetable intake and wheeze varied considerably between countries.

**Conclusion:** A number of associations were found between respiratory symptoms and low intake of fish, fruit and vegetables in children. Low fish intake was the most consistent predictor of poor respiratory health. Fruit and vegetable intake showed stronger associations with cough than with wheeze.

A n increase in the prevalence of respiratory diseases during the last decades has pointed scientific research towards identification of risk factors contributing to this negative trend in public health. The wide variations in the prevalence of respiratory diseases and asthma in different countries are probably due to environmental and not genetic factors. It has been suggested that diets poor in antioxidants and minerals or with an unbalanced intake of essential fatty acids are among these potential risk factors for asthma and respiratory illness.1, 2

The possible protective effects of fish intake on health may be due mainly to fish oil containing omega-3 polyunsaturated fatty acids (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) which shunt the eicosanoid production away from the arachidonic acid pathway. Fish oil may therefore alleviate certain inflammatory respiratory diseases,3, 4 preserve normal airway resistance,5 and modulate allergic sensitisation.6 Fruit and vegetables are rich sources of a variety of nutrients including vitamins, trace minerals, dietary fibre and biologically active compounds which have antioxidant, antibacterial, and antiviral effects and assist in detoxification of enzymes and stimulation of the immune system.6

However, epidemiological evidence linking these foods to respiratory disease has not been consistent. A few studies have observed the beneficial effect of fruit7–9 and vegetables10 in relation to children’s respiratory health, reporting a reduction in respiratory symptoms and respiratory infections and an improvement in pulmonary function. Several publications have supported these findings in adults,11, 12 but others13–15 have shown no clear associations. A potential protective role of fish in reducing the risk of asthma in childhood was reported in Australia.16 A crude association found between fish intake and asthma among Saudi Arabian children did not prove robust to controlling for other risk factors, and an increased risk of asthma with fish consumption has been reported in Japanese children.17 18

In this paper we present data relating diet to respiratory symptoms among children participating in the Central European Study on Air pollution and Respiratory health (CESAR). Although the main focus of the CESAR study was on the relation between air pollution and children’s respiratory health, some information was also gathered on diet. The resulting data set from over 20 000 children allowed us to examine the role played by nutritional factors, testing the hypotheses that low intake of fresh fruit, vegetables, and fish increases the risk of respiratory disorders.

**METHODS**

A cross sectional multicentre study was performed in 1996 in a total of 25 areas in six Central and Eastern European countries (Bulgaria, Czech Republic, Hungary, Poland, Romania and Slovakia). Within each country, towns were selected to create a contrast in exposure to particulate air pollution. Other selection criteria were: an homogenous exposure of the subjects within each town, a sufficient number of primary school children (>1500), relatively low migration rate, and comparable socioeconomic profile (towns of about 100 000 citizens with comparable lifestyle characteristics, organised and accessible health services, and accessible education). A detailed selection procedure of the study areas has been described by Houthuijs et al.19

In each area about 1000 primary school children aged 7–11 were invited to participate in the study. The children were...
Definition of outcome respiratory variables

Four outcome variables for children’s health—two for cough, two for wheeze symptoms—were defined as follows:

Winter cough: “yes” to question “Does this child usually cough during the day or at night in autumn-winter season?”

Persistent cough: “yes” to question “Did this child cough on most days for at least 3 months consecutively in the last autumn-winter season?”

Wheeze ever: “yes” to one or both of the following questions “Has this child ever had wheezing or whistling in the chest at any time in the past” and “Has this child ever had attacks of shortness of breath with wheezing?”

Current wheeze: “yes” to question “Has the child’s chest sounded wheezy or whistling in the last 12 months?”

Definition of nutritional risk factors

Based on previous studies which showed that food frequency measures are accurate and useful in screening dietary surveillance, we redesigned the part of the food frequency questionnaire used in the British survey of adults dietary surveillance, we redesigned the part of the food frequency questionnaire used in the British survey of adults...

Table 1

<table>
<thead>
<tr>
<th>Food intake</th>
<th>Prevalence (%) of studied respiratory symptoms (total for all six countries)</th>
<th>Frequency (%) of fish, fruit and vegetable intake</th>
<th>Risk factors variables (categories)</th>
<th>Model 1</th>
<th>Model 3</th>
<th>OR* 95% CI</th>
<th>p value</th>
<th>OR† 95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter cough</td>
<td></td>
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<td></td>
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<tr>
<td>≥1/month</td>
<td>n=19726</td>
<td>n=19790</td>
<td>1.24</td>
<td>1.10</td>
<td>0.99 to 1.23</td>
<td>0.07</td>
<td>n=19725</td>
<td>n=16853</td>
<td>1.24</td>
</tr>
<tr>
<td>&lt;1/month</td>
<td>n=19789</td>
<td>1.36</td>
<td>1.20</td>
<td>1.10</td>
<td>0.99 to 1.23</td>
<td>0.07</td>
<td>n=19789</td>
<td>n=16895</td>
<td>1.31</td>
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<tr>
<td>Persistent cough</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>≥1/month</td>
<td>n=19218</td>
<td>n=19216</td>
<td>1.28</td>
<td>1.18</td>
<td>1.04 to 1.34</td>
<td>0.01</td>
<td>n=19217</td>
<td>n=16471</td>
<td>1.30</td>
</tr>
<tr>
<td>&lt;1/month</td>
<td>n=19460</td>
<td>1.19</td>
<td>1.09</td>
<td>1.14</td>
<td>1.03 to 1.25</td>
<td>0.01</td>
<td>n=19462</td>
<td>n=16648</td>
<td>1.19</td>
</tr>
<tr>
<td>Wheeze ever</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>≥1/month</td>
<td>n=19463</td>
<td>n=3673</td>
<td>1.24</td>
<td>1.21</td>
<td>1.06 to 1.39</td>
<td>0.01</td>
<td>n=19462</td>
<td>n=16648</td>
<td>1.24</td>
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<tr>
<td>&lt;1/month</td>
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</table>

*pOR adjusted for area, age, and sex.
†OR adjusted for all tested nutritional factors included simultaneously in the model and for area, age, sex, pets, indoor moisture, use of gas oven for heating, additional unvented gas heating, passive smoking, mother’s education, father’s occupation, parent’s allergy, respondent and overcrowding.
p=p for trend.
Table 3

<table>
<thead>
<tr>
<th>Fruit intake in summer</th>
<th>Fruit intake in winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk factor variables (categories)</td>
<td>Outcome variables of respiratory health</td>
</tr>
<tr>
<td>n=19717</td>
<td>OR* 95% CI p value</td>
</tr>
<tr>
<td>n=19784</td>
<td>OR† 95% CI p value</td>
</tr>
</tbody>
</table>

- **Winter cough**
  - >4/week: 1 (ref)
  - 2–4/week: 1.25 (1.15 to 1.37) 1.06 (0.95 to 1.20)
  - <2/week: 1.54 (1.24 to 1.91)

- **Current wheeze**
  - >4/week: 1 (ref)
  - 2–4/week: 1.04 (0.93 to 1.17)
  - <2/week: 1.20 (1.01 to 1.42)

*OR adjusted for area, age and sex. †OR adjusted for all tested nutritional factors included simultaneously in the model and for area, age, sex, pets, indoor moisture, use of gas oven for heating, additional unvented gas heating, number of smokers in household (0, 1, 2 or 2+), mother's education (higher, secondary, apprenticed, primary), father's occupation (professional, clerical, skilled manual, semi/unskilled, undefined), parent's allergy (0, 1, 2 parents with allergy), respondent (person that filled out the questionnaire), and overcrowding (>1 person per room). The third contained, in addition, all nutritional risk factors simultaneously in order to identify their independent associations with the outcomes.

The results from the second model were very similar to those from the fully adjusted third model, and for simplicity we report only the latter. This was true for all the nutritional factors.

The likelihood ratio test was used to test for interactions between country and nutritional factors. Where these interactions were significant the results are given separately for each country, obtained by including interaction terms in the final model.

RESULTS

A total of 33,051 children were invited to participate in the study. The parents of 23,731 (71.8%) gave consent for their participation; 21,743 questionnaires were returned, a response rate of 65.8%. A database was created from 20,271 (61.3%) children aged 7–11 years. Children who changed address in 1995 (the year before the study, n=1194) or who did not fulfil the age criteria (n=194) were not included in the database. Eighty-four questionnaires were not entered for various reasons, in most cases because data from all items were not available.

Fish

The “high consumption” group contained the most children, both overall and for each country (Table 1). Low fish consumption was consistently associated with respiratory health (Table 2). After adjusting for age, sex and area, the estimated ORs for low versus high fish intake were 1.30 for both persistent cough and winter cough, 1.24 for current wheeze, and 1.19 for wheeze ever. In the third model which contained all nutritional factors simultaneously as well as additional potential confounders, independent associations were retained with persistent cough (OR=1.18; 95% CI 1.04 to 1.34), wheeze ever (OR=1.14; 95% CI 1.03 to 1.25) and current wheeze (OR=1.21; 95% CI 1.06 to 1.39), and a weaker association with winter cough (OR=1.10; 95% CI 0.99 to 1.23).
Table 4

<table>
<thead>
<tr>
<th>Vegetable intake in summer</th>
<th>Vegetable intake in winter</th>
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<tbody>
<tr>
<td>Vegetable intake</td>
<td>Vegetable intake</td>
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<tr>
<td>Risk factor categories</td>
<td>Risk factor categories</td>
</tr>
<tr>
<td>Outcome variables of respiratory health</td>
<td>Outcome variables of respiratory health</td>
</tr>
<tr>
<td>Winter cough &gt;4/week</td>
<td>Persistent cough &gt;4/week</td>
</tr>
<tr>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>2–4/week</td>
<td>2–4/week</td>
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<tr>
<td>1.15 (1.06 to 1.24)</td>
<td>1.07 (0.97 to 1.18)</td>
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<tr>
<td>&lt;2/week</td>
<td>&lt;2/week</td>
</tr>
<tr>
<td>1.49 (1.30 to 1.72)</td>
<td>1.23 (1.04 to 1.47)</td>
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<tr>
<td>2–4/week</td>
<td>2–4/week</td>
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<tr>
<td>1.02 (0.93 to 1.11)</td>
<td>1.08 (0.93 to 1.24)</td>
</tr>
<tr>
<td>&lt;2/week</td>
<td>&lt;2/week</td>
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<tr>
<td>1.17 (1.05 to 1.31)</td>
<td>1.08 (0.93 to 1.24)</td>
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<tr>
<td>Persistent cough &gt;4/week</td>
<td>Persistent cough &gt;4/week</td>
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<tr>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>2–4/week</td>
<td>2–4/week</td>
</tr>
<tr>
<td>1.00 (0.91 to 1.10)</td>
<td>1.00 (0.91 to 1.10)</td>
</tr>
<tr>
<td>&lt;2/week</td>
<td>&lt;2/week</td>
</tr>
<tr>
<td>0.88 (0.77 to 1.00)</td>
<td>0.88 (0.77 to 1.00)</td>
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<tr>
<td>Current wheeze &gt;4/week</td>
<td>Current wheeze &gt;4/week</td>
</tr>
<tr>
<td>1 (ref)</td>
<td>1 (ref)</td>
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<tr>
<td>2–4/week</td>
<td>2–4/week</td>
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<tr>
<td>1.00 (0.90 to 1.11)</td>
<td>1.00 (0.90 to 1.11)</td>
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<tr>
<td>&lt;2/week</td>
<td>&lt;2/week</td>
</tr>
<tr>
<td>1.00 (0.90 to 1.11)</td>
<td>1.00 (0.90 to 1.11)</td>
</tr>
</tbody>
</table>

*OR adjusted for area, age and sex. †OR adjusted for all tested nutritional factors included simultaneously in the model and for area, age, sex, pets, indoor moisture, use of gas oven for heating, additional unvented gas heating, passive smoking, mother's education, father's occupation, parent's allergy, respondent and overcrowding. p=p for trend.

DISCUSSION

This is the first attempt to analyse the role of potential nutritional risk factors in the respiratory health of children from Central and Eastern European countries. The most important finding is a clear independent association between fish intake and children's respiratory illness, particularly symptoms of wheeze and persistent cough. Hodge et al. found that fish intake had a protective effect against childhood asthma in Australia, but otherwise there has been little consistent evidence of these associations.

Our high fish consumption category (>1 portion per month) is not particularly high, but the categories were formed in this way to avoid groups with very small numbers. To check that our finding was not an artefact of grouping we performed a sensitivity analysis using a three level fish intake category: >2 portions/week (baseline group), 1–4 times/
Nutrition and respiratory health in children of Central and Eastern Europe

month, and never or <1/month. Significance was greatly reduced as expected, but similar patterns of association were seen with ORs for the lowest versus highest group of 1.23 (95% CI 1.10 to 1.51, p trend=0.013) for persistent cough, 1.08 (95% CI 0.92 to 1.27, p trend=0.058) for wheeze ever, 1.13 (95% CI 0.90 to 1.42, p trend=0.049) for current wheeze, and 1.05 (95% CI 0.90 to 1.24, p trend=0.3) for winter cough (results not shown).

In accordance with some previous studies, our results broadly support the hypothesis of beneficial effects of fruit consumption on respiratory health, although on cough rather than wheeze symptoms. Without wishing to place too much emphasis on the least consistent results, we consider why (a) fruit has stronger associations than vegetable consumption and (b) winter consumption has weaker associations—sometimes in the opposite direction—than summer consumption.

It may be that the protective effects of high fruit intake on respiratory health are genuinely much stronger than for vegetable intake. A clear beneficial association between vegetable consumption and chronic bronchitis and bronchial asthma in adults has been reported only by La Vecchia et al and a weaker beneficial trend was reported by Butland et al. A recent report has linked tomato intake with a reduction in respiratory infections in Sudanese children.

The associations of higher symptom prevalence with greater winter vegetable consumption may also reflect true relationships, although we doubt this. They may be chance findings or a result of uncontrolled confounding, but we have used a wide range of individual potential confounders in our model. Another possible explanation may be that of reverse causality, given that consumption of winter vegetables was very low. In winter, when symptoms of bronchitis are most likely to be present, if fresh vegetables are given preferentially to (or given that consumption of winter vegetables was very low. In

...In summary, the results of our study support the hypothesis of a link between diet and respiratory health. However, estimates of effect are moderate with positive ORs ranging from about 1.10 to 1.40. The proportion of subjects with current wheeze attributable to eating fish less than once a month, for example, is 3.7% (95% CI 1.0 to 6.3), but these figures refer to common childhood symptoms with a prevalence of about 10% for current wheeze and over 20% for winter coughs. Respiratory illnesses may impact on children’s schooling, affect their future health, and increase the burden both on families and on health services. Asthma in particular has been increasing in prevalence, with hypothesised links to traffic pollution and to lifestyle (which may include diet). In such a context, appropriate nutrition may have an important role to play in maintaining health and reducing the prevalence of these symptoms and their resulting burden.

ACKNOWLEDGEMENTS

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REFERENCES

LUNG ALERT

Pulmonary artery catheters are not routinely indicated during and after surgery


Recent observational studies suggest that the use of pulmonary artery catheters to guide treatment is associated with increased mortality. Outcomes have been confounded by the severity of the underlying illness. This multicentre, randomised, controlled clinical trial involving blinded assessment of outcomes compared treatment guided by a pulmonary artery catheter with standard treatment (not guided by a pulmonary artery catheter) in 1946 at risk elderly patients (American Society of Anaesthesiologists class III and IV risk) undergoing surgery followed by a stay in the intensive care unit (ICU). Patients were aged >60 years and were scheduled for urgent or elective major abdominal, thoracic, vascular, or hip fracture surgery. There was no difference between the two groups in rate of in-hospital mortality, length of hospital stay (median 10.0 days for both), or survival at 6 or 12 months. However, there was a higher rate of acute pulmonary embolism in the catheter group (8 v 0, p=0.004).

The study showed that, in this group of patients, medical management directed by pulmonary artery catheters had no advantage over standard treatment. Whether the results of this study extend to patients other than those at high risk is not at present known.

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