Self-reporting versus parental reporting of acute respiratory symptoms of children and their relation to pulmonary function and air pollution

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Background Studies of acute effects of outdoor air pollution on acute respiratory symptoms in children generally rely on reports by parents. Little is known about the validity of parental reporting of symptoms of their children. We therefore compared symptoms reported by the parents with self-reported symptoms and measured pulmonary function of 741 7–11-year-old Dutch children. We also analysed the association of symptoms reported by the child or parent and outdoor air pollution.

Methods The parents of the children completed a daily diary of symptoms of their children for about 3 months. The children reported presence of acute respiratory symptoms in the preceding week before a pulmonary function test was conducted (6–10 test days).

Results Children reported between 80% and 220% more acute respiratory symptoms than their parents for them in the same period. The agreement between symptom reports by the parent and the child was low to moderate (Kappa between 0.22 for eye irritation and 0.43 for fever). Presence of cough reported by child or parent was associated with similar small decrements in forced vital capacity (FVC), forced expiratory volume in one second (FEV1.0) and especially peak expiratory flow (PEF) and maximal mid-expiratory flow (FEF25–75). The largest pulmonary function decrements were found when symptoms were reported by both parent and child. Symptoms reported by either child or parent were not associated with air pollution.

Conclusions Symptom reports of the children were more prevalent but did not agree well with parental reports. The similar association with pulmonary function suggested that self-reported symptoms were neither superior nor inferior to symptoms reported by the parents.

Keywords Respiratory symptoms, agreement, children, air pollution, pulmonary function

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The effects of ambient air pollution on acute respiratory symptoms of children are generally studied using parental reports in a daily diary. Several studies using this approach have found significant increases of acute respiratory symptoms associated with increases of daily outdoor air pollution.1–4 Other studies did not find consistent associations between air pollution and acute respiratory symptoms.5–7 In some studies that reported no consistent associations between air pollution and respiratory symptoms,6,7 small negative effects on pulmonary function were found.7,8 The inconsistency between studies and between effect parameters within our studies may be explained by a variety of reasons including power of the study, uncontrolled confounders and exposure differences. A low reliability of parental reports of acute respiratory symptoms of their children may play a role as well. Self-reported symptoms might be more reliable and more strongly related to air pollution. However, little information is available on this issue. A study in Mexico City of children 7–9 years old found a significant association between ambient ozone (O3) concentrations and self-reported cough and phlegm.9 However, the authors expressed concern about the reliability of the symptom reports by the

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children. In two summer studies in the US significant associations between self-reported symptoms of fourth and fifth grade children and aerosol acidity were reported. In a series of epidemiological studies in the Netherlands we reported effects of air pollution on pulmonary function and acute respiratory symptoms of 7–11-year-old children reported in a daily diary filled out by the parents. In these studies information about acute respiratory symptoms was also collected by interviewing the child before pulmonary function tests. This allows a comparison between parental and self-reported symptoms. The purpose of this paper is to investigate the agreement between symptoms reported by the child and his/her parents. Second, symptom reporting of both child and parent are compared with repeated pulmonary function measurements. Third, the association between symptoms reported by child and parent and air pollution is evaluated.

## Methods

### Population and data

Data from epidemiological studies conducted in the winters of 1987–1990 and the summer of 1989 were used. Population selection, exposure assessment, pulmonary function measurement methods and the respiratory symptom diary have been previously described. Briefly, general population samples of children 7–11 years old living in non-urban towns in the Netherlands were selected through the schools. In this analysis, only schools with daily PM10 measurements were included. This includes two schools in Deurne measured in the winter of 1987/88, three different schools in Deurne in the winter of 1988/89, four different schools in Deurne in the summer of 1989 and two schools in Venlo in the winter of 1989/90.

Pulmonary function of each child was tested at school on 6–10 days selected in advance. The interval between successive pulmonary function measurements was between one and 3 weeks for the different schools. The parents of the child completed a daily diary, in which presence of acute respiratory symptoms was recorded. The diary was completed for the full study period of the child (about 3 months).

Before each pulmonary function test, the children were asked by the lung function technician whether they had experienced acute respiratory symptoms in the preceding week. The exact questions were: ‘Did you cough a lot this week?’, ‘Did you have a runny or blocked nose this week?’, ‘Did you have a hoarse voice this week?’, ‘Did you have throat pain this week?’, ‘Did you have fever this week?’, ‘Were you bothered by itchy or red eyes this week?’. All questions had to be answered with ‘yes’ or ‘no’, as in the diary. Questions referred to the previous week because literature suggested that respiratory infections were associated with prolonged decrements of pulmonary function. The technicians were instructed to ask for the child’s assessment of his/her symptoms. No diagnosis by the technician was allowed.

Ambient concentrations of particles <10 μm (PM10), sulphur dioxide (SO2), nitrogen dioxide (NO2), black smoke and O3 measured at fixed sites on a daily basis were used as the exposure variables. Before the first pulmonary function test (which coincided with the start of diary completion), the parents filled out a standardized questionnaire with questions about the presence of chronic respiratory symptoms in the child (ever and in the past 12 months), personal characteristics and home environment. In this analysis only the questions about chronic respiratory symptoms in the past 12 months have been used.

The first test has been excluded in all calculations because no diary information was available for the week preceding the test. In addition, learning effects of performing spirometry in these children have been documented.

### Data analysis

The agreement between acute respiratory symptom reports by the child and the parent was investigated using cross-tabulations. Daily symptom data from the diary completed by the parent were recoded to weekly data coinciding with the weeks for which the children reported symptoms. In addition to comparing the frequency of symptom reporting by children and parents, Cohen’s Kappa was calculated as a chance corrected measure of agreement. As a guideline, Kappa values <0.40 can be considered as showing poor agreement, 0.40–0.75 fair to good agreement and >0.75 excellent agreement.

The association between acute respiratory symptom reports by child or parent and pulmonary function was studied using multiple linear regression. The natural logarithm of Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1,0), Peak Expiratory Flow (PEF) and Maximal Mid-expiratory flow (FEF25–75) were used as dependent variables. All analyses have been adjusted for the natural logarithms of height, weight and age at the first visit, gender and an interaction between gender and logarithm of height as independent variables. To describe the change of lung function due to lung growth, a linear day of study variable was included. A linear time trend has been shown to be reasonable for this population when the first visit has been excluded. Symptom reports (yes/no) by the child or the parent were first entered in separate models. Next, three indicator variables were entered describing observations for which: both child and parent reported a symptom, only the child and only the parent reported a symptom. Observations for which both child and parent reported no symptom were the reference group. Multiple observations per child were included (both for analyses of separate reports and for combined reports), thus the use of ordinary least squares regression was not appropriate. Repeated measurements were modelled using generalized estimating equations, assuming an exchangeable working correlation structure. This assumes equal correlation between observations from the same child on different days. This was considered plausible because measurements were 1–3 weeks apart. In addition, preliminary calculations using an unstructured correlation structure supported this choice. Robust variance estimates were calculated which are valid even when this working assumption is incorrect. An alternative modelling approach using mixed effects models with the SAS procedure MIXED gave similar parameter and standard error estimates.

The association of acute respiratory symptom reports by child/parent and air pollutants was studied using multiple logistic regression, adjusting for age, gender and chronic respiratory symptoms of the child. The weekly mean of daily average PM10, black smoke, SO2 and NO2 and daily maximum O3 concentration were entered separately as independent variables. Weekly mean concentrations were only calculated when >5 days with valid measurements were available. All models
included season and ambient temperature as potential time-varying confounders. A detailed description of season using indicator variables for groups of two consecutive months did not show differences within seasons. Thus, a more crude indicator variable comparing the cold months (November–April) to the warm months (May–October) was used. Different temperature variables were constructed from the daily minimum temperatures. In logistic regression models adjusting for season, the weekly average of daily minimum temperature was more significantly related to symptom reports than the lowest temperature during the week or the average of the previous three days. Lowess smoothing,18,19 a non-parametric smoothing technique, suggested a significant non-linear relationship between weekly average temperature and symptom prevalence. There was little association from +13 to about +8°C and a significant linear increase from +8 to −4°C. For the final calculations, two new variables were defined, allowing separate linear slopes below and >8°C. This method has been used in daily mortality time series analyses to describe non-linear associations with temperature.20,21 Repeated measurements were modelled using the generalized estimating equations (GEE), assuming an exchangeable working correlation structure.

**Results**

**Study population**

The study included 1043 children. However, 46 non-white children were excluded from the analyses because of potential racial differences in pulmonary function. In addition, 251 children were excluded because of early drop out of the diary study and five children did not perform any valid pulmonary function test. Thus, 741 children had at least one valid lung function test and available diary information (Table 1). Children with and without complete diary information were similar in age, gender and frequency of chronic respiratory symptom reporting. In addition, the lung function decrements associated with presence of cough reported by the child were similar for the children with and without diary information. The average number of valid pulmonary function tests per child, excluding the first test day, was 7.8 (range 1–9).

**Comparison of symptom reports by child and parent**

Children reported between 1.8 and 3.2 times more acute symptoms than their parents reported for them in the same period (Table 2). In addition to a large number of observations for which the parent denied symptoms reported by the child, there were also a considerable number of observations for which the child did not report symptoms reported by the parent. Kappa values indicated poor to moderate agreement. The highest Kappa value (0.43) was found for fever.

Stratified analyses showed similar results for boys and girls and for children below and above the median age. Kappa values for the younger children were somewhat lower than for the older children for throat pain (0.18 versus 0.35) but higher for fever (0.52 versus 0.27). Kappa values tended to be slightly higher in the summer season. For children with chronic respiratory symptoms (particularly chronic cough) the difference between frequency of reporting acute symptoms (particularly cough and runny nose) was smaller (Table 3). Agreement was slightly higher than for the children without chronic respiratory symptoms but still low.

**Association of acute respiratory symptoms and pulmonary function**

Presence of cough in the preceding week was associated with small but significant decrements in PEF, FEF_{25–75} and to a lesser degree FEV_{1.0} and FVC (Table 4). Presence of cough reported by the child or the parent was associated with similar decrements.

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| Table 1 Characteristics of children included in the analysis of self-reported acute respiratory symptoms: age at initial visit, distribution of individual mean pulmonary function (without first test) and presence of chronic respiratory symptoms in the past 12 months |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Age (years)     | Mean (SD)       | Minimum–Maximum | No. of children |
| 9.4 (1.2)       | 7.0–12.4        | 741             |
| FVC (l)         | 2.16 (0.40)     | 1.30–4.11       | 741             |
| FEV_{1.0} (l/s) | 1.90 (0.34)     | 1.14–3.68       | 741             |
| PEF (l/s)       | 4.51 (0.90)     | 1.81–9.01       | 741             |
| FEF_{25–75} (l/s)| 2.18 (0.55)    | 0.92–4.37       | 741             |
| No. (%)         |                 |                 |                 |
| Girls           | 365 (49.3)      | 741             |
| Wheeze          | 88 (11.9)       | 737             |
| Attacks of wheeze and shortness of breath | 59 (8.0) | 734 |
| Chronic cough   | 57 (7.8)        | 731             |
| Any chronic respiratory symptom^a | 131 (17.9) | 730 |

^a Presence of one or more of the symptoms chronic cough, wheeze, shortness of breath, attacks of shortness of breath with wheeze or doctor diagnosed asthma in the previous year.

| Table 2 Comparison of weekly acute respiratory symptom prevalence (%) of 7–11-year-old children, reported by the child or parent |
|---------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Symptom            | Child no Parent no^a | Child no Parent yes | Child yes Parent no | Child yes Parent yes | Child yes Parent yes | Child yes Parent yes | Parent yes | Kappa | N^c |
| Cough              | 69.2             | 5.0             | 17.6           | 8.2             | 25.8           | 13.3           | 0.30          | 5578            |
| Runny nose         | 59.9             | 5.6             | 20.7           | 13.9           | 34.5           | 19.4           | 0.35          | 5580            |
| Throat pain        | 85.9             | 1.4             | 10.1           | 2.6             | 12.7           | 4.0             | 0.27          | 5563            |
| Fever              | 97.2             | 0.3             | 1.7            | 0.8             | 2.5            | 1.1             | 0.43          | 5559            |
| Eye irritation     | 95.7             | 0.9             | 2.8            | 0.6             | 3.4            | 1.5             | 0.22          | 5558            |

^a Percentage of all observations for which the child reported ‘no’ and the parent also reported ‘no’.

^b Percentage of all observations for which child reported ‘yes’.

^c Total number of observations (multiple observations per child).
in pulmonary function. The largest pulmonary function decrements were observed when symptoms were reported by both parent and child.

Decrement of pulmonary function associated with runny nose and throat pain were similar for reports by child or parent, as well. The strongest decrements were again found when symptoms were reported by both. The pulmonary function decrements associated with presence of runny nose and throat pain were smaller than for cough and reports of runny nose without presence of cough were not associated with decrements of pulmonary function. Reports of throat pain without cough was only associated with a small decrement in PEF. No association was found for reports of eye irritation.

Fever reported by the child was less strongly associated with pulmonary function than fever reported by the parents. Fever reported by the child was associated with decrements (95% CI in parentheses) of FVC, FEV\textsubscript{1.0}, PEF and FEF\textsubscript{25-75} of \(-0.6\%\) (\(-1.5, 0.2\)), \(-0.7\%\) (\(-1.7, 0.3\)), \(-2.5\%\) (\(-0.7, -4.3\)) and \(-1.5\%\) (\(-3.6, 0.7\)). Fever reported by the parents was associated with decrements of \(-2.9\%\) (\(-5.0, 0.8\)), \(-3.4\%\) (\(-5.4, -1.3\)), \(-6.0\%\) (\(-8.5, -3.4\)) and \(-2.7\%\) (\(-8.2, 3.2\)) for FVC, FEV\textsubscript{1.0}, PEF and FEF\textsubscript{25-75} respectively.

Presence of cough reported by the child was associated with similar decrements in pulmonary function in boys and girls and children below and above the median age. Decrement of pulmonary function were found in children with and without chronic respiratory symptoms. Children with chronic cough tended to have larger decrements in pulmonary function associated with acute cough: \(-2.0\%\) (\(-3.8, -0.1\)), \(-2.3\%\) (\(-4.0, -0.5\)), \(-5.2\%\) (\(-8.2, -2.2\)) and \(-4.4\%\) (\(-6.9, -1.8\)) for FVC, FEV\textsubscript{1.0}, PEF and FEF\textsubscript{25-75} respectively.

Discussion

The frequency of acute respiratory symptoms of children aged 7–11 years reported by the children was between 80% and 220% higher than symptoms by the parents. The agreement between symptom reports by the parent and the child was low to moderate. Presence of cough reported by child or parent was associated with similar small decrements of FVC, FEV\textsubscript{1.0} and

### Table 4

Comparison of weekly acute cough prevalence (%) of 7–11-year-old children, reported by the child or parent in children with or without chronic respiratory symptoms in the previous year

| Chronic respiratory symptom, no cough | Child 28.9 | Parent 18.8 | Kappa 0.28 | N 526 |
| No chronic respiratory symptoms | 25.0 | 11.6 | 0.29 | 4352 |

\( ^a \) Absence of the symptoms: chronic cough, wheeze, shortness of breath. Attacks of shortness of breath with wheeze and doctor diagnosed asthma in the previous year.

\( ^b \) Total number of observations (multiple observations per child).

### Table 6

Comparison of weekly acute cough prevalence (%) of 7–11-year-old children, reported by the child or parent in children with or without chronic respiratory symptoms in the previous year

<table>
<thead>
<tr>
<th>Model</th>
<th>Report by</th>
<th>FVC</th>
<th>FEV\textsubscript{1.0}</th>
<th>PEF</th>
<th>FEF\textsubscript{25-75}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Child</td>
<td>(-0.4) ((-0.7, -0.0))</td>
<td>(-1.0) ((-1.4, -0.6))</td>
<td>(-3.3) ((-4.1, -2.5))</td>
<td>(-2.9) ((-3.8, -2.0))</td>
</tr>
<tr>
<td>2</td>
<td>Parent</td>
<td>(-0.3) ((-0.7, 0.2))</td>
<td>(-1.0) ((-1.5, -0.5))</td>
<td>(-4.5) ((-5.5, -3.6))</td>
<td>(-3.3) ((-4.4, -2.2))</td>
</tr>
<tr>
<td>3</td>
<td>Child yes, parent yes</td>
<td>(-0.7) ((-1.3, -0.0))</td>
<td>(-1.8) ((-2.6, -1.1))</td>
<td>(-6.3) ((-7.5, -5.1))</td>
<td>(-5.4) ((-6.8, -3.8))</td>
</tr>
<tr>
<td></td>
<td>Child yes, parent no</td>
<td>(-0.1) ((-0.5, 0.2))</td>
<td>(-0.6) ((-1.0, -0.1))</td>
<td>(-2.1) ((-3.0, -1.3))</td>
<td>(-1.8) ((-2.8, -0.8))</td>
</tr>
<tr>
<td></td>
<td>Child no, parent yes</td>
<td>0.4 (0.2, 1.0)</td>
<td>0.1 (0.6, 0.7)</td>
<td>(-2.8) ((-4.2, -1.4))</td>
<td>(-0.8) ((-2.6, 0.9))</td>
</tr>
</tbody>
</table>

\( ^a \) In all models we adjusted for gender, linear time trend, natural logarithms of age, height and weight and an interaction between gender and logarithm of height.

\( ^b \) Percentage difference between presence and absence of cough (95% confidence interval in parentheses), calculated as \((e^B - 1)*100\).
parental symptom reports might partly be due to differences in PM10, black smoke, O3, SO2 and NO2 in the week preceding exactly the same diary used in the present study. The results of obtaining data from child and parent. It is probably difficult mode of reporting. The parents were completing a daily diary, the mothers of 65% of the children reported a general health of air pollution. In a study of 2561 0–14-year-old Dutch children for young children to complete a daily diary for a period of 7–11-year-old children deviations of weekly average air pollution concentrations for cough of from East Boston, a questionnaire administered to the parents by telephone (once every 2 weeks) elicited 10% more reports of runny nose, 28% more sore throat, 15% more cough than a daily diary filled out by the same parents.23 The diary used was exactly the same diary used in the present study. The results from these two studies suggest that a diary results in a lower prevalence in reported symptoms. The differences in our study between reports by child and parent were much larger (80–220%). This suggests that these differences were not only due to the fact that parents filled out a diary and children answered direct questions.

Few respiratory epidemiology studies in children have addressed the agreement between child and parental symptom reporting. Osman and Silverman24 reported that in more recent quality of life questionnaires in asthma, information from children is obtained as well. Parental reports may become less accurate when children become more independent. In addition, parental reports may reflect more the impact of the child illness on the proxy than on the child itself.24 There is a large literature on agreement between parental and children reports in psychiatry, for example.25,26 In general, these studies find low agreement between reports of child and parent.25,26 In a study of 307 6–16-year-old children Herjancic and Reich25 observed good agreement (Kappa >0.50) between mother and child reports of objective, easily observable and severe symptoms. Poor agreement (Kappa <0.30) was found for symptoms requiring interpretation and those concerning relationships at home.25 Children reported more subjective symptoms (both psychological and somatic) whereas parents reported more milder and common behavioural problems.25 Poor agreement between psychological problems reported by child or parent (Kappa’s between 0.19 and 0.26) was also found in a group of 83 chronically ill children.27 Children had diabetes, cystic fibrosis, inflammatory bowel disease or cancer but were not psychiatric patients.27 A study in 78 6–19-year-old children with diabetes evaluated agreement between parental and child's reports of adherence to diabetes management measures such as injection regularity and eating frequency using a 24-h recall interview on nine occasions in 3 months.28 A high correlation was found between all (quantitative) measures of adherence reported by either child or parent, which was similar for all four age groups.28 Good agreement (average Kappa of 0.60) was also found for questions on physical function, psychosocial function and general health in a study of 40 children (mean age 14 years) with juvenile arthritis.29 For painful red eyes, shortness of breath, cough and fever Kappas of 0.44, 0.54, 0.74 and 0.80 were found respectively,29 considerably higher than for the corresponding symptoms in our study. Doherty et al30 reported an intraclass correlation coefficient of 0.86 for disability scores comparing child and mothers’ reports in 20 8–14-year-old patients with juvenile arthritis.30 In contrast, a non-significant intraclass correlation of −0.19 was found for the highly subjective symptom pain.30 In a case-control study of childhood melanoma, agreement between responses of children (written questionnaire) and parents (oral interview) measured as weighted Kappas ranged from 0.88 for eye colour to 0.11 for peeling sunburn. No consistent difference in agreement was found between males and females and between three age categories (10–12, 13–17, 17–24 year),31 as in the present study.

The low to moderate agreement found in this study is consistent with the relatively mild nature of most symptoms. Parents may therefore not have noticed or reported these symptoms. There was a tendency for the agreement of more severe symptoms (cough, fever) to be better than for symptoms such as eye irritation and throat pain. Probably, the generally healthy nature

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### Table 5 Distribution of weekly average ambient air pollution concentrations (μg/m³) and temperature (°C)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Mean (SD)</th>
<th>Minimum–Maximum</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM10</td>
<td>48 (16)</td>
<td>21–92</td>
<td>82</td>
</tr>
<tr>
<td>Black smoke</td>
<td>13 (8)</td>
<td>3–45</td>
<td>82</td>
</tr>
<tr>
<td>SO2</td>
<td>12 (5)</td>
<td>4–32</td>
<td>85</td>
</tr>
<tr>
<td>NO2</td>
<td>33 (10)</td>
<td>15–63</td>
<td>85</td>
</tr>
<tr>
<td>O3</td>
<td>76 (44)</td>
<td>14–172</td>
<td>81</td>
</tr>
<tr>
<td>Temperature</td>
<td>6 (4)</td>
<td>4–13</td>
<td>85</td>
</tr>
</tbody>
</table>

a Weekly average of daily minimum temperature, 1-hour maximum ozone and 24-hour average concentration of other pollutants.

b Number of distinct study days for which a weekly average exposure was calculated.

### Table 6 Adjusted odds ratio a for an increase of two standard deviations of weekly average air pollution concentrations for cough of 7–11-year-old children (95% confidence interval in parentheses)

<table>
<thead>
<tr>
<th>Reported by child</th>
<th>Reported by parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM10</td>
<td>0.93 (0.80, 1.07)</td>
</tr>
<tr>
<td>Black smoke</td>
<td>0.92 (0.79, 1.07)</td>
</tr>
<tr>
<td>SO2</td>
<td>0.88 (0.76, 1.01)</td>
</tr>
<tr>
<td>NO2</td>
<td>1.01 (0.88, 1.16)</td>
</tr>
<tr>
<td>O3</td>
<td>1.09 (0.84, 1.40)</td>
</tr>
</tbody>
</table>

a In all analyses we adjusted for age, gender and presence of chronic respiratory symptoms of the child, season and ambient temperature.

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especially PEF and FEF25–75. Symptoms reported by either child or parent were not associated with the average concentration of PM10, black smoke, O3, SO2 and NO2 in the week preceding the symptom report.

**Agreement between parental and children’s symptom reports**

The low to moderate agreement between children’s and parental symptom reports might partly be due to differences in mode of reporting. The parents were completing a daily diary, while the children were asked questions during a pulmonary function test at school. These methods represent natural ways of obtaining data from child and parent. It is probably difficult for young children to complete a daily diary for a period of about 3 months, a typical period in panel studies of acute effects of air pollution. In a study of 2561 0–14-year-old Dutch children the mothers of 65% of the children reported a general health problem (such as colds, ear problems, diarrhoea) for their child in the past 14 days in a health interview.22 In a daily diary for 54% of these same children a symptom was recorded in a 14-day period. The difference was especially present in mothers with low education.22 In a study of 422 children 5–11 years old from East Boston, a questionnaire administered to the parents by telephone (once every 2 weeks) elicited 10% more reports of runny nose, 28% more sore throat, 15% more cough than a daily diary filled out by the same parents.23 The diary used was exactly the same diary used in the present study. The results
of the sample played a role as well. For children with chronic respiratory symptoms a much lower difference between the child’s and parental reporting of symptoms was found. It is likely that parents pay more attention to a child with chronic health problems.

Alternatively, children may not have understood the questions that were asked. However, the difference between child and parent reports was essentially the same for the younger and older children. In addition, symptom reports by the child only were associated with similar decrements in pulmonary function as parental reports.

Association between symptom reports and pulmonary function

Symptom reports by the child only or the parent only were associated with similar small decrements of especially PEF and FEF_{25-75}. This suggests that both child and parent fail to report symptoms that have an impact on the respiratory system beyond the upper airways. It also documents that children were able to answer questions about their health in a meaningful way. The largest decrements of pulmonary function were found when symptoms were reported by both parent and child, probably suggesting that more serious symptoms were reported by both child and parent.

The observation that acute respiratory symptoms were associated with larger decrements for PEF and FEF_{25-75} than for FVC and FEV_{1.0} is consistent with the few other studies in children. \[3^{2-34}\] In a longitudinal study of 2.5–11-year-old children, upper respiratory illnesses on the test day were associated with decrements of 2.9, 1.4, 5.6 and 4.3% for FVC, FEV_{1.0}, PEF and FEF_{25-75} respectively (calculated for the 27 children >7 years). \[3^{2}\] A cross-sectional study of 10–16-year-old children found a lower pulmonary function in 65 children with mild acute respiratory infection compared to 440 children without acute respiratory infection, after adjusting for anthropometry and chronic respiratory symptoms. \[3^{3-35}\] Combining data from boys and girls, decrements of 2.1, 2.8, 4.6 and 5.4% for FVC, FEV_{1.0}, PEF and FEF_{25-75} respectively were calculated. A longitudinal study in two schools in Ohio found that acute respiratory symptoms reported by children in a diary completed at school and checked by two technicians was associated with decreased pulmonary function. \[3^{4}\] Combining data from the two schools, decrements of 4.8, 6.3 and 7.1% for FVC, FEV_{1.0} and FEF_{25-75} respectively were calculated. Several studies in adults also found small, significant decrements in pulmonary function associated with acute respiratory symptoms \[3^{5,36}\] or increased serum respiratory virus antibodies. \[3^{7}\] Some older, small studies in adults did not find significant changes in spirometric pulmonary function. \[3^{8}\] Collectively, the results of these studies suggest that even upper respiratory infections impact lower, peripheral airways. \[12\] Suggested mechanisms for the observed pulmonary function changes following respiratory virus infections, a major cause of upper respiratory symptoms, include airway inflammation and bronchial epithelial damage leading to increased bronchial muscle reactivity. \[12\]

Several studies have indicated that presence of chronic respiratory symptoms (including chronic cough) or past acute respiratory illness is associated with larger decrements in FEF_{25-75} than FVC and FEV_{1.0}. \[3^{9,40}\] In the Dutch study \[3^{9}\] PEF decrements were also larger than for FVC and FEV_{1.0} (not reported in Gold’s study). Since it is plausible that children with chronic respiratory symptoms also experience more acute respiratory symptoms, the results of our analyses might be confounded by this factor. However, a stratified analysis showed decrements associated with acute cough in children without and with chronic respiratory symptoms. In the latter children the decrements were larger and involving changes of FVC and FEV_{1.0} as well.

Association between symptoms and air pollution

The lack of association between concentrations of any of the measured air pollutants and symptoms reported by child or parent, is consistent with results reported earlier for these children using time series analyses of the diary reports. \[6,7\] In a review of recent epidemiological studies, a mean increase of 1.2% in cough prevalence for an increase of PM10 concentration of 10 μg/m^3 was found. \[3^{11}\] Several factors limit the interpretation of our data. First, symptom data reported by the child were only available on a weekly basis, thus it was not possible to investigate effects of current air pollution exposures. Secondly, no information on lower respiratory symptoms was available. In a review of recent epidemiological studies, the combined effect estimate for lower respiratory symptoms was substantially larger than for upper respiratory symptoms and cough. \[3^{11}\] Third, the number of observations per child was considerably smaller than for typical panel studies. Thus, the power may have been more limited. The presented 95% CI suggested that the available number of observations was high enough to allow reasonably precise estimates of odds ratios.

In conclusion, 7–11-year-old children reported considerably more symptoms than their parents for them, but the agreement with parental reports was low. Symptom reports by the children had a similar association with pulmonary function as symptoms reported by the parents, suggesting that self-reported symptoms were neither superior nor inferior to symptoms reported by the parents. Especially in populations in which it is difficult to obtain reliable information from a daily diary completed by parents, it may be worthwhile to use symptoms reported by children. Information on current, lower respiratory symptoms should be collected in future studies as well. More work is necessary in respiratory epidemiology to determine whether parental reports can be used to obtain reliable information about symptoms of their children.

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