Morbidity and mortality resulting from asthma has increased in the United States and across the world in the past few decades (1). For example, hospitalization among persons ages 0–24 years has increased by 27% between 1980 and 1993 (from 16.8 to 21.4 per 10,000 persons), with the highest increases in hospitalization associated with the youngest ages (2,3). Respiratory symptoms resembling asthma tend to be present early in life (4) but asthma is not usually diagnosed until a later age (5). Pediatric asthma is difficult to diagnose because of the heterogeneity of the clinical presentation in early life, the variability of symptom patterns, differences in individual clinical courses, and the similarity of physiologic events with other conditions (6).

Because asthma is not diagnosed early in life, diagnosis of risk for asthma is important. For example, the use of inhaled anti-inflammatory agents is an important asthma therapy, but prescribing it to wheezing children younger than age 3 years is controversial because many of them would not develop asthma. It is therefore important to identify factors that would help to detect children at high risk for asthma (7). Early childhood wheezing is one important respiratory condition indicative of asthma but it has multiple etiologies and is not always related to persistent wheezing and asthma (5,8,9). However, studies show that early-childhood wheezing, especially with atopy and sensitization to environmental allergens, is a good predictor of persistent wheezing and the diagnosis of asthma in school age (10). Martinez suggested that children with recurrent wheezing and atopic dermatitis or parental history of asthma have a significantly increased risk for asthma (11). This is supported also by an ISAAC Finnish study that found that among wheezy children younger than age 3 a history of food allergy, itchy rash, family history of asthma, and exposure to tobacco smoke at home were independent predictors of symptom persistence (7). Similarly, Castro-Rodriguez and colleagues found that 76% of children who were classified as high risk for asthma before age 3 in fact had asthma during the school-age years. The authors concluded that “subsequent development of asthma can be predicted with reasonable accuracy using simple, clinically based parameters” (12).
Our study is set in an urban minority community expected to be a high-risk area for pediatric asthma because of high rates of poverty and environmental exposures to allergens and pollution (13,14). We report preliminary findings on prevalence of respiratory symptoms suggestive of asthma and their treatment in the first year of life.

METHODS

We report preliminary data from an ongoing prospective cohort study of African-American and Dominican women and their newborns conducted by the Columbia Center for Children’s Environmental Health (the Center) in New York City neighborhoods at high risk for asthma, including upper Manhattan and the South Bronx. The Center study was initiated in 1997 to evaluate the effects of prenatal and postnatal exposures to environmental toxins, including allergens and air pollution, on the development of asthma. This article reports on 92 infants who were older than age 12 months and had complete information on four quarterly interviews.

Women were enrolled into the study during pregnancy through a variety of sources in the target neighborhoods including prenatal clinics, Women Infants and Children (WIC) offices, and flyers and referrals. The study was restricted to women ages 18–35 who self-identified themselves as African-American or Dominican and had resided in northern Manhattan (Central Harlem or Washington Heights) or the South Bronx for at least 1 year before pregnancy. Women were excluded if they smoked cigarettes or used other tobacco products during pregnancy, used illicit drugs, had diabetes, hypertension, or known HIV or had had their first prenatal visit after the twentieth week of pregnancy. During the first year after delivery, mothers (or, rarely, another caretaker) were interviewed every 3 months by telephone (3 and 9 months) or in person (6 and 12 months) when they are asked about the baby’s health and development.

The sample included 92 infants whose caretakers completed all four interviews during the first year of life. 51% of the infants were African-American and 49% of Dominican origin, 49% were male, and their mean weight at birth was 3.4 kg (SD = 0.5). Mothers’ mean age at first interview was 25 (SD = 5), 60% of them were born in the United States, 74% completed high school or less, and 63% were never married. The median household per capita income was $5000, 88% of mothers were Medicaid recipients, and 41% were on public assistance.

Measures

Respiratory Symptoms

Respiratory symptoms were measured by asking the respondent (usually the mother) whether in the 3 months before the interview the baby has had any of these symptoms: cough, difficulty breathing, wheezing, croupy cough, ear infection, sore throat. For each symptom the caretaker reported, she was asked whether the baby was taken for a scheduled doctor visit, an emergency room visit, and whether the baby was hospitalized.

Diagnosis of Asthma and Eczema

Asthma diagnosis was measured by asking respondents whether in the 3 months before the interview “your doctor said that your child has asthma” or “might have asthma or asthma symptoms.” The diagnosis of eczema was measured by asking whether the doctor said that the child had eczema. If yes, the respondent was asked about related treatment and hospitalizations.

Asthma Risk Index

Following Castro-Rodriguez and colleagues, we classified infants as high risk for developing asthma if they had recurrent wheezing along with eczema or parental history of asthma (12). Recurrent wheezing was defined as reports of wheezing in two or more quarters.

Diagnosis of Medical Condition

The medical conditions were measured by asking respondents whether in the 3 months before the interview “a doctor or a nurse” has told them that the child had any of the following problems: pneumonia, bronchiolitis, bronchitis, croup, sinus trouble, pulmonary tuberculosis, other infections, or other illnesses.

Parental History of Asthma

At the 3 months’ interview, respondents were asked if the biological mother and father have “ever been diagnosed with asthma.”
Data Analysis

We present prevalence and 95% confidence intervals of breathing symptoms, atopy, and health care utilization for a cohort of infants. Statistical analysis was done using SPSS version 10 for Windows, except relative risk and 95% confidence intervals that were calculated using Epi Info version 6.

RESULTS

Prevalence of Symptoms

Figure 1 shows 3-months’ prevalence for respiratory and ear, nose, and throat symptoms during the first year at 3, 6, 9, and 12 months. The figure shows high prevalence of cough throughout the first year, affecting more than half of the cohort. It also shows that, unlike croupy cough and ear infections, which rise in incidence in the second quarter, reports of cough, difficulty breathing, and wheezing begin in the first quarter, affecting 12%–22% of infants throughout the year.

Figure 2 shows the cumulative incidence of wheezing (reported in one quarter only) and of recurrent wheezing episodes (reported in two or more quarters). By the end of the first year, wheezing was reported for 36 (39%, 95% confidence interval [CI] = 29%, 49%) of the infants in the cohort. A total of 19 (21%, CI = 13%, 29%) of the infants experienced wheezing in one of the quarters only, and 17 (18%, CI = 10%, 26%) in two or more quarters. Figure 2 also shows that during the same period, the infants experienced a similar increase in several symptoms suggestive of allergies. By the end of the first year, 20 (22%, CI = 14%, 30%) infants were diagnosed with eczema by a physician.

Respondents reported parental history of asthma for 21 (23%, CI = 14%, 32%) of the infants. Using our definition of asthma risk index—recurrent wheezing along with eczema or parental history of asthma—eight (9%, CI = 3%, 15%) of the infants were classified as high risk for developing asthma by the end of the first year of life. We also estimated the prevalence of an expanded definition of high risk by including infants who had been diagnosed with asthma by a doctor (see the following section) but who were not captured by asthma risk index. Using this expanded definition, the number of infants with asthma or suspected asthma increased to 18 (20%, CI = 12%, 28%).

Five of the ten infants thus added have been treated with asthma medication, suggesting that their symptoms may have abated. Table 1 shows prevalence estimates for risk for asthma by this definition and for recurrent wheezing alone. There were no significant differences in prevalence of risk for asthma by gender, ethnicity, maternal education level, or income.
but risk for asthma was highly related to having had a lower respiratory illness (pneumonia, bronchiolitis, bronchitis, or croup).

### Asthma Diagnosis and Treatment

By age 12 months, 15 (16%, CI 9%, 23%) of the infants in the cohort had been diagnosed by a doctor with asthma or probable asthma. There was only moderate agreement between doctor diagnosis of asthma and report of two or more wheezing episodes (Kappa = 0.32, p = .002) or our classification of risk for asthma, with the more stringent definition improving only slightly on recurrent wheezing alone (Kappa = 0.36, p < .001).

Of the 15 infants diagnosed with asthma, 9 (60%) have taken medicine for asthma and 3 (20%) have been hospitalized overnight for asthma. Overall, during the first year of life, wheezing required significant care: 30 (33%) of the infants in the cohort visited a doctor’s office, 20 (22%) were seen in an emergency department, and 18 (20%) were hospitalized overnight for asthma.

### Table 1

Cumulative prevalence of asthma risk and asthma diagnosis among 12-month-old infants by gender, mother’s ethnicity and education, and history of lower respiratory disease (n = 92).

<table>
<thead>
<tr>
<th></th>
<th>Asthma risk or doctor-diagnosed asthma</th>
<th>Recurrent wheezing only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevalence (%) RR (95% CI)</td>
<td>Prevalence (%) RR (95% CI)</td>
</tr>
<tr>
<td>Infant’s gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>17 1.31 (0.6, 3.0)</td>
<td>13 1.9 (0.8, 4.7)</td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Mother’s ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>15 1.64 (0.7, 3.9)</td>
<td>13 1.9 (0.8, 4.7)</td>
</tr>
<tr>
<td>Dominican</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Mother’s education</td>
<td></td>
<td></td>
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<tr>
<td>High school or more</td>
<td>21 1.44 (0.5, 4.0)</td>
<td>18 1.0 (0.4, 2.7)</td>
</tr>
<tr>
<td>Below high school</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Lower respiratory disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(pneumonia, bronchiolitis, bronchitis or croup)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>7 7.8 (3.1, 19.5)</td>
<td>12 3.4 (1.5, 7.7)</td>
</tr>
<tr>
<td>Yes</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>
department, and 6 (6%) were hospitalized overnight for a wheezing episode at least once (see other conditions in Fig. 3).

DISCUSSION

We adopted Castro-Rodriguez and colleagues’ method to assess high risk for asthma among 1-year-old infants by using a measure of recurrent wheezing, atopy, parental history of asthma, and reported doctor diagnosis of asthma (12). Based on this index, 20% of the infants were classified as high risk for persistent asthma. This is much higher than the 3%–5% prevalence reported for the US population for children ages 0–5 (14,15), and 6.5%–7% reported by two Western European studies for children 4 and 1 year-old, respectively (16,17). On the other hand, our findings are consistent with the upper end of prevalences reported by other studies of high-risk infants, including a study of infants at risk because of parental history of asthma or allergy (18). This supports the proposition that the urban community we are studying is at high risk for asthma and respiratory diseases. Unlike some studies, we did not find the expected gender difference in asthma at this age (12,17), but this is consistent with some studies of individuals in areas of high asthma prevalence (18,19).

Interestingly, despite their young age and the difficulty of diagnosing asthma at this age, 16% of the infants have been diagnosed with asthma or probable asthma, and two-thirds of them have been treated with asthma medication. Consistent with other studies, we found that asthma and early wheezing are an important cause of emergency department visits, as reported by 22% of the sample. Doctor’s diagnosis of asthma correlated only moderately with Castro-Rodriguez and colleagues’ clinical index, suggesting that doctors use additional criteria to support their diagnosis, but our findings can also be related to measurement error related to respondents’ report of doctor diagnosis and recall of symptoms by the respondents. We also found a strong association between risk for asthma, wheezing, and other lower respiratory illnesses (pneumonia, bronchiolitis, bronchitis, or croup). It is possible that exposure to allergens increases the risk of bronchial inflammation through allergenic and nonallergenic mechanisms (18).

Our study is limited in that it relies on self-report of symptoms and doctor diagnoses and therefore is subject to bias and measurement error. For example, because many of the mothers are single, they may have underreported paternal history of asthma. This may lead to underreporting of some infants at risk of asthma and reduce precision in our estimates. Also, because we study a cohort selected for its high-risk residents, it has little variability in important potential predictors, limiting our ability to assess the impact of income or other SES measures. However, evidence from other studies demonstrates the important impact of poverty on asthma (14). Finally, because our study criteria excludes women with high-risk pregnancies, we are limited in testing the impact of risk factors such as low birthweight and prematurity (18).

Our cohort study aims to improve understanding of respiratory symptoms as early predictor of asthma. As evidence increasingly suggests that asthma begins early in life, further studies are needed to explore...
the early natural history of the disease. Studies need to also improve our understanding of early therapeutic interventions and targeted preventive strategies (20).

ACKNOWLEDGMENTS

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