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Asthma Morbidity Among Children Evaluated by Asthma Case Detection

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Abstract

OBJECTIVE—Population-based asthma detection is a potential strategy to reduce asthma morbidity in children; however, the burden of respiratory symptoms and health care use among children identified by case detection is not well known.

METHODS—Data come from a school-based asthma case detection validation study of 3539 children. Respiratory symptoms, emergency department (ED) visits, and hospitalizations were assessed by questionnaire for children whose case detection result and physician study diagnosis agreed.

RESULTS—Physician evaluation of 530 case detection results yielded 420 cases of agreement (168 children with previously diagnosed asthma, 39 with undiagnosed asthma, and 213 without asthma). Children with previously diagnosed asthma were more likely to be male ($P < .0001$). No differences in severity were observed in children with previously and undiagnosed asthma ($P = .31$). Children with undiagnosed asthma reported less frequent daytime and nighttime symptoms than children with previously diagnosed asthma but more than those without asthma ($P < .0001$). The proportion of children with at least 1 respiratory-related ED visit in the past year was 32%, 3%, and 3% for those with previously diagnosed, undiagnosed, and no asthma, respectively ($P < .0001$). The proportion with at least 1 respiratory-related hospitalization was 8%, 0%, and 0%, respectively ($P < .0001$). There were no differences in nonrespiratory ED visits ($P = .93$).

CONCLUSIONS—Despite similar physician-rated severity, children with undiagnosed asthma reported significantly less frequent respiratory symptoms and health care use than children with previously diagnosed asthma. These findings suggest that the potential health gains from case detection may be smaller than expected.

Keywords

asthma; mass screening; child; hospitalization; signs and symptoms (respiratory); emergency department

WHAT'S KNOWN ON THIS SUBJECT

Undiagnosed asthma is a significant problem in low income, urban populations. Populationbased case detection can identify children with undiagnosed asthma. However, the benefits from doing so are unclear.

WHAT THIS STUDY ADDS

This is the first report comparing respiratory symptoms, ED visits, and hospitalizations among children identified by case detection as having undiagnosed, previously diagnosed and no asthma and for whom the case detection result was confirmed by a physician.

Asthma is a common chronic condition of childhood that is associated with frequent symptoms, excess health care use, and significant costs.^{1,2} Asthma is diagnosed when respiratory symptoms such as cough, wheezing, and chest tightness prompt additional evaluation. The 2007 Guidelines for the Diagnosis and Management of Asthma recommend that physicians use a detailed history and physical examination augmented by spirometry to confirm the diagnosis.³ However, relying on physician diagnosis alone may not identify all children who could benefit from treatment, because many children's asthma goes undiagnosed.⁴⁻¹⁴ Population-based case detection, often referred to as screening, may increase disease recognition improve treatment, and reduce symptoms and health care use. Case detection methods that use questionnaires alone or use questionnaires in combination with assessment of lung function have been successfully conducted in various settings.⁴⁻¹⁴

Publications by Boss et al¹⁵ and Gerald et al¹⁶ questioned whether population-based asthma case detection would actually improve in asthma outcomes. One reason is that early intervention has not been shown to clearly improve long-term outcomes.¹⁷ It is also unclear whether communities with the highest asthma prevalence have the resources to confirm the case detection results and provide long-term follow-up for children with newly diagnosed asthma.¹⁶ Lastly, the actual burden of asthma symptoms and health care use in children with undiagnosed asthma is unknown.

Previous studies suggest that children with undiagnosed asthma have fewer symptoms than children with previously diagnosed asthma but more than children without asthma. Joseph et al¹⁸ found that urban elementary school children with undiagnosed asthma reported similar frequency of daytime and nighttime symptoms as children with previously diagnosed asthma; however, they reported fewer emergency department (ED) visits. The authors concluded that children with undiagnosed asthma have symptoms of similar frequency but of lesser severity than children with previously diagnosed asthma. van Gent et al¹⁹ found that elementary school children with undiagnosed asthma in the Netherlands reported symptoms, quality of life, and school absences intermediate between children with previously diagnosed asthma and children without asthma; however, children with undiagnosed asthma had lung function that was worse than either group.

These studies used case detection to identify children with undiagnosed asthma; however, the case detection result was not confirmed by using the gold standard, physician diagnosis. We address this limitation by reporting respiratory symptoms, ED visits, and hospitalizations in a

group of elementary school children who participated in an asthma case detection program where the case detection result was confirmed by blinded physician evaluation.

METHODS

The methods for the original validation study have been previously described.⁷ Briefly, the validation study evaluated a multistage school-based asthma case detection program in a population of primarily black, low-income, urban elementary students. A parental questionnaire augmented by spirometry and exercise testing was used (Fig 1). The study was approved and monitored by the institutional review board of the University of Alabama at Birmingham. All parents signed informed consent, and children provided assent.

In the case detection procedure, parents were first asked, “Has a doctor ever said your child has asthma?” and “Has your child ever taken asthma medicine (pills, inhaler, or puffers)? If yes, has this been in the past 12 months?” If parents responded yes to all 3 questions the child was considered to have previously diagnosed asthma and did not proceed further with case detection. If parents reported no asthma medication use in the past year, regardless of their other responses, the child was not considered to have previously diagnosed asthma; instead, these children continued with case detection because they might benefit if they were experiencing symptoms and had evidence of impaired lung function.

Case detection continued with 3 symptom-based questions: (1) “Has your child ever had a wheezing or whistling sound in the chest?” (2) “Has your child ever had breathing problems (coughing, wheezing, whistling in the chest, shortness of breath, chest tightness) when he/she first woke up in the morning?” (3) “Has your child ever had breathing problems (coughing, wheezing, whistling in the chest, shortness of breath, chest tightness) that woke him/her up at night?” If parents responded yes to any question, the child underwent basic spirometry at school followed by submaximal exercise testing if spirometry was normal. Children who had a forced expiratory volume in 1 second-forced vital capacity ratio (FEV1/FVC) <80% of predicted or who had a ≥15% decline in forced expiratory volume in 1 second or a ≥25% decline in forced expiratory flow (FEF) over 25% to 75% of forced expiratory volume from baseline during a 5-minute submaximal exercise test were classified as having probable asthma. If a parent reported no symptoms or if a child had normal spirometry and exercise testing, the child was classified as not having asthma.

Parents of children who completed case detection were approached to have their child’s case detection result confirmed by blinded physician evaluation at no cost. Parents of all children with previously diagnosed or undiagnosed asthma were approached. A random sample ($n = 260$) of parents of children without asthma were approached (Fig 2).

At the physician visit, caregivers were asked about daytime and nighttime cough, wheezing, and shortness of breath in the past 30 days. They were also asked about the number of ED visits and hospitalizations for respiratory and nonrespiratory illnesses in the past year. Physical examinations and spirometry were performed for all children. A diagnosis of asthma was based on a study physician’s (pediatric pulmonologist or allergist) composite evaluation of the child’s health history, physical examination, and spirometry in accordance with the 1997 Guidelines for the Diagnosis and Management of Asthma.²⁰

The analytic sample ($N = 420$) was composed of children whose physician study diagnosis and case detection result agreed. This sample was chosen to reflect instances when the case detection result was most likely to represent the diagnostic outcome in the community. Comparisons were made between children with previously diagnosed, undiagnosed, and no asthma and the outcomes of interest by using the χ^2 test for categorical variables and analysis of variance for continuous variables.

RESULTS

Questionnaires were distributed to parents of 3539 children, and ultimately 3280 (93%) children completed case detection (Fig 2). Of the 415 children who completed case detection and were classified as having previously diagnosed asthma, 178 (43%) were evaluated by a study physician. Of the 84 children who completed case detection and were classified as having probable asthma, 46 (55%) were evaluated by a study physician. A 10% random sample ($n = 260$) of the 2781 children who completed the case detection procedure and were classified as having no asthma were evaluated by a study physician. The analytic sample was composed of 420 (79%) children whose case detection result and physician diagnosis agreed. In this group, 39 had undiagnosed asthma, 168 had previously diagnosed asthma, and 213 had no asthma. There were no differences in age, gender, or race between children who completed case detection and the subset who were evaluated by a study physician.

Children with previously diagnosed asthma were more likely to be male ($P < .0001$); otherwise, the groups were comparable with respect to age, race, and environmental tobacco smoke exposure (Table 1). The distribution of asthma severity as evaluated by a study physician did not differ between children with undiagnosed and previously diagnosed asthma ($P = .31$; Table 2).

Among the 39 children with undiagnosed asthma, 16 (41%) reported no previous asthma diagnosis or medication use. This group most clearly represented children with undiagnosed asthma. Among the remaining 23 children, 12 (31%) reported no previous diagnosis but did report a remote history of medication use. These children had been previously treated but either did not receive a formal diagnosis or could not remember one. Eleven (28%) reported a previous diagnosis but no medication use in the past year. These children may not have received prescriptions, may not have been adherent, or may have been thought to have “outgrown” their asthma.

We classified the 23 children who reported either a previous diagnosis or previous treatment (but not in the past 12 months) as having undiagnosed asthma because they were untreated and had respiratory symptoms and impaired lung function. Our decision is consistent with the observation that children who are prescribed asthma medications often do not have a physician diagnosis and have been previously shown to experience more morbidity and health care use than do children who receive a diagnosis and are treated.^{21,22}

Children with previously diagnosed asthma were more likely to report daytime and nighttime cough, wheeze, and shortness of breath than children with undiagnosed asthma or no asthma ($P < .0001$; Figs 3 and 4). Among children with undiagnosed asthma, there were no differences in daytime or nighttime symptoms between those who never reported a previous asthma diagnosis or medication use ($n = 16$) and those who did but had not taken medication in the past year ($n = 23$).

Among children with previously diagnosed asthma, 32% ($n = 54$) reported at least 1 respiratory-related ED visit in the past 12 months as compared with 3% ($n = 1$) of children with undiagnosed asthma and 3% ($n = 6$) of children without asthma ($P < .0001$; Fig 5). Furthermore, 8% ($n = 13$) of children with previously diagnosed asthma reported at least 1 respiratory-related hospitalization in the past 12 months as compared with 0% ($n = 0$) of children with undiagnosed asthma and 0% ($n = 0$) of children without asthma ($P < .0001$). There were no differences in nonrespiratory ED visits between children with previously diagnosed, undiagnosed, and no asthma ($P = .93$). Children with undiagnosed asthma were not more likely to be hospitalized for nonrespiratory illness (5%) than children without asthma (1%; $P = .17$). Nonrespiratory hospitalization data were not available for children with previously diagnosed asthma.

DISCUSSION

Children with undiagnosed asthma identified by population-based case detection reported less frequent respiratory symptoms than children with previously diagnosed asthma but more frequent symptoms than children without asthma. Despite more frequent symptoms, children who were identified by case detection had identical levels of respiratory-related ED visits and hospitalizations as those without asthma. These findings suggest that asthma case detection might lead to symptom improvement, but it is unlikely to reduce population-level health care use because the children whom it identifies rarely experience respiratory-related ED visits or hospitalizations. These findings are also interesting because children with previously diagnosed and undiagnosed asthma had similar distributions of physician-rated severity. To our knowledge, this is the first report of asthma outcomes of children whose case detection result has been confirmed by physician diagnosis.

Our findings are consistent with those of Joseph et al,¹⁸ who found that children with undiagnosed asthma reported fewer all-cause ED visits, fewer missed school days, and fewer days with restricted activity than children with previously diagnosed asthma despite similar number of days and nights with asthma symptoms. Respiratory symptoms without associated ED visits and hospitalizations may contribute to underdiagnosis because these symptoms may be difficult to distinguish from a nontrivial rate of respiratory symptoms, particularly cough, in children without asthma. Even so, it is interesting that 60% of children with undiagnosed asthma in our study reported a previous asthma diagnosis or asthma medication use (just not in the past year). This suggests that misdiagnosis may not account for a majority of children who have undiagnosed asthma as identified by populationbased asthma detection.

We chose medication use in the past year as the primary determinant of previously diagnosed asthma to maximize the benefit of case detection. With this definition, children who might have otherwise been lost to follow-up, have been nonadherent, or have been considered to have “grown out” of their asthma were reevaluated for current symptoms and lung function. Our results demonstrate that this decision was reasonable, because more than one half of those identified had a remote history of asthma but were not taking medications despite symptoms and abnormal lung function. Without population-based case detection, these children would likely remain untreated.

Although children who were identified by case detection had almost no asthma-related health care use, they did experience more frequent symptoms than did children without asthma. If these children were identified, then treatment might reduce their symptoms; however, previous reports suggested that symptom improvement may not lead to measurable improvements in function. A 2007 study by van Gent et al¹⁹ found no differences in physical activity between children with undiagnosed, diagnosed, and no asthma; however, asthma-specific quality of life was lower in children with undiagnosed and diagnosed asthma as compared with healthy control subjects.²³ Backer et al²⁴ reported that children with diagnosed asthma had lower quality-of-life scores than did children with undiagnosed asthma, but comparison with healthy control subjects was not made. A school-based educational intervention by using Open Airways in children with undiagnosed asthma did not show significant reduction in symptom days or nights.¹⁸ These findings suggest that children with undiagnosed asthma are experiencing symptoms but that these symptoms may be difficult to reduce and reductions may yield improvements that are difficult to measure.

One explanation that may account for our observed differences in symptoms and health care use among children with previously diagnosed and undiagnosed asthma is poor perception of symptoms in children with undiagnosed asthma. Dyspnea perception in patients with asthma is highly variable and may not correlate with presence of airflow obstruction.^{25,26} It is also

possible that social or behavioral factors within the family unit may limit the recognition of symptoms and their impact, resulting in a differential response. Children with undiagnosed asthma could also lack insurance or access to care. Although this study did not collect information on health insurance status, our work in this population suggests that most of these children participate in Medicaid or the state child health insurance program (AllKids). In addition, the ED cannot turn away children without health insurance, and it is a major portal for admissions. For these reasons, we believe that the lack of health insurance is unlikely to explain the difference in health care use.

We also observed that children with previously diagnosed asthma were more likely to be male than those with undiagnosed asthma. Others have noted that gender may be an independent risk factor for underdiagnosis and undertreatment of asthma.²⁷ It is unclear to what extent gender differences in symptoms or diagnostic bias might account for our findings.

As mentioned previously, an unexpected finding was that physician-rated asthma severity did not differ among those with undiagnosed and previously diagnosed asthma. Clark et al⁵ reported that, on average, children whose asthma was diagnosed by case detection had lesser severity than children with a previous diagnosis. Furthermore, one would expect that children with previously diagnosed and undiagnosed asthma of similar severity would have at least equal symptom burden and health care use, particularly given that children with undiagnosed asthma are untreated. One possible explanation for this finding was our use of the 1997 Guidelines for the Diagnosis and Management of Asthma.³ These guidelines recommended that severity be based on the highest level in any 1 criterion without regard to future exacerbation risk. Our results could reflect the difficulty of assigning asthma severity long after the initial diagnosis. Children with previously diagnosed asthma reported taking medication within the past 12 months, and it seems reasonable to conclude that they would have better health than if they were not treated. Our findings support the difference between asthma severity and asthma control now emphasized in the 2007 guidelines.³ Asthma control is now considered a more important indicator of future exacerbation risk than severity. In this study, we observed that children with mild persistent asthma reported more respiratory-related ED visits and an equal number of respiratory-related hospitalizations than children with moderate/severe asthma. This provides additional evidence that asthma control, not severity, is the most reliable indicator of exacerbation risk.

This study has several limitations. The first is a relatively small number of children with newly diagnosed asthma; however, the overall study was adequately powered to detect a statistically significant difference in symptoms and health care use between the groups. In addition to being statistically significant, the observed differences seem to be clinically significant. Our findings may have limited generalizability given that the study population was composed of minority children from a large low-income, urban school system; however, this population stands to benefit most from case detection, because they have a disproportionate burden of asthma prevalence and limited access to adequate health care.^{5,16} Response bias in children who presented for physician confirmation could have influenced our results; however, we did not observe differences by race, gender, or age among those who completed case detection and those who were evaluated by a study physician. If response bias were present, then it is likely that children with the most severe respiratory symptoms in all 3 groups (previous, probable, and no asthma) were most likely to attend the physician visit.

The absence of quality-of-life measurements limits our ability to draw conclusions about how much impact symptoms have in children with undiagnosed asthma. Long-term follow-up of these children and their quality-of-life and health outcomes after identification would be helpful.

CONCLUSIONS

Children who were identified by asthma case detection experienced more frequent respiratory symptoms than children without asthma, but these symptoms did not lead to excess health care use. In the absence of population-based case detection, these children may have never come to the attention of the health care system. The current use of physician diagnosis seems to capture the majority of children who have asthma and are experiencing significant morbidity. Population-based case detection may be the only way to identify the child with difficult-to-diagnose asthma; however, the health gains from doing so are likely to be minimal.

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ABBREVIATION

ED, emergency department.

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FIGURE 1.

Case detection method. FEV₁ indicates forced expiratory volume in 1 second; FVC, forced vital capacity; FEF_{25%-75%}, forced expiratory flow over 25% to 75% of forced expiratory volume.

FIGURE 2.
Case detection outcomes.

FIGURE 3.

Percentage of parents who reported daytime cough, wheeze, and shortness of breath more than twice in the past 30 days.

FIGURE 4.

Percentage of parents who reported cough, wheeze, and shortness of breath while the child was asleep more than twice in the past 30 days.

FIGURE 5. Percentage of parents who reported ≥ 1 respiratory-related ED visit and hospitalization in the past 12 months.

TABLE 1

Demographic Characteristics (N = 420)

Characteristic	Undiagnosed Asthma (n = 39)	Previously Diagnosed Asthma (n = 168)	No Asthma (n = 261)	P
Gender, % male	41	64	43	<.0001
Race, % black	87	89	89	.9400
Age, mean, y	8.9	8.8	8.7	.5300
ETS exposure, %				.3900
Home	39	36	Not collected	
Outside home	24	20	Not collected	
None	37	44	Not collected	

ETS indicates environmental tobacco smoke.

TABLE 2Asthma Severity by Diagnosis Status ($N = 207$)

Asthma Severity	Undiagnosed Asthma ($n = 39$), n (%)	Previously Diagnosed Asthma ($n = 168$), n (%)
Intermittent	14 (36)	61 (36)
Mild	10 (26)	61 (36)
Moderate/severe	15 (38)	46 (27)

 $P = .31$.