Introduction

The lack of a standardized definition of asthma is an ongoing challenge for asthma epidemiology. Unlike Europe, Asia, and Australia, where asthma epidemiology is largely informed by the International Study of Asthma and Allergies in Childhood (ISAAC) and the European Community Respiratory Health Survey (ECRHS), investigation of asthma prevalence and asthma-related morbidity in the United States has been predicated upon national surveys in which the key indicator for asthma is report of physician diagnosis. [1–3] Report of diagnosis, rather than determination of prevalence by report/presentation of symptoms, poses two distinct challenges for epidemiologic research. Differences in diagnosed asthma may partially reflect differences in access to health services and diagnostic practice rather than differences in asthma prevalence. [4] Although studies in the US based on symptom data have confirmed that limited access to healthcare is tied to undiagnosed asthma in low-SES communities, [5,6] little is known about the contribution of variations in asthma diagnosis to prevalence estimates. As a result, systematic differences in the perception of asthma symptoms and their clinical interpretation and labeling may play an important role in the apparent patterns of disease prevalence. [7] Artefactual changes in asthma prevalence may arise from changes over time in the perception and interpretation of symptoms, [8,9] and differences in the proportion of the population with symptoms labeled as asthma. [10–12] Early population-based research suggested that asthma epidemiology is dependent on the diagnostic habits of physicians in the locale, as well as a measure of the prevalence of a specific syndrome. [13] Given acknowledged limitations in the label of asthma [14,15] and accumulating evidence that physicians may vary in their classification of disease, [16] assumption of a uniform interpretation and application of the diagnostic label of asthma in these asthma questionnaires may lead to bias in interpretation of these data. In order to adequately interpret data collected from these national surveillance efforts, a valid methodology for reliably determining how physicians perceive and label asthma and asthma symptoms across geographic and clinical settings is required.

The objective of this pilot study was to examine variability in the nomenclature and labeling of asthma and its primary symptoms among a sample of pediatricians using the standardized audiovisual presentations of asthma of the International Study of Asthma and Allergies in Childhood (ISAAC) video questionnaire. This methodology allowed us to collect information about the perception and labeling of asthma by physicians in a manner that
minimized bias introduced by the effect of language, culture, and interview technique, as well as patient mix and clinical setting.

Methods

ISAAC Audiovisual Questionnaire

The ISAAC video questionnaire (AVQ 3.0, © Otago University) was developed in the 1990s by the Wellington Asthma Research Group to be a standardized methodology for determining the prevalence of asthma symptoms in children. [17–19]. To date, it has been used among hundreds of thousands of children in more than 40 countries to estimate the prevalence of asthma symptoms [20].

In the international version of the video, young adults from a variety of ethnic backgrounds can be seen and heard manifesting different symptoms of asthma during a set of five short (25 second) sequences. The sequences display a Caucasian female seated with moderate wheezing at rest; two Maori males, one who wheezes after exercise, and one who does not; an East Asian male waking at night with wheezing; a Caucasian female waking at night with coughing; and a South Asian female with a severe attack of asthma with wheezing and dyspnea. Further information about the development, validation and utilization of the video questionnaire has been published elsewhere [17–19].

Study Population and Setting

In 2008, we recruited practicing pediatricians from the electronic mailing list of the Wisconsin chapter of the American Academy of Pediatrics (WI-AAP) to participate in the survey. Participants viewed the video scenes online and completed the survey electronically.

Survey Instruments, Responses and Coding

The anonymous survey instrument (see Appendix S1) included questions on demographics (age, sex, race), training and education (board certification, major practice area), and practice characteristics (location, setting, average number of patients per day, insurance and Medicaid status of patients). No personally identifying information was collected by the survey.

Potential participants were instructed that that they would be taking a survey to evaluate their perceptions of respiratory symptoms. The terms ‘asthma’ and ‘ISAAC’ were never referenced in the recruitment materials or in the survey. Practitioners were not informed in advance that the video was an instrument used in asthma epidemiology, nor that the purpose of the study involved asthma in any way.

Participants were asked to describe all of the signs and symptoms they observed in each video scene and to suggest for each scene likely diagnoses or causes of the presentation. No further guidance or restrictions were placed on the number or nature of their responses to the questions. Single term responses, such as wheeze, were permitted. We included and retained all answers, and collapsed or aggregated only misspelled or derivations of single terms, such as wheeze and wheezing.

Statistical Methods

For each video scene, we calculated p-values and odds ratios using Cochran-Mantel-Haensel tests to determine the association between the description of symptom(s) and suggestion of the label of asthma. To assess the relationship between demographic, training, and practice variables, and suggestion of the label of asthma for each of scenes, participants who provided diagnostic labels for all five scenes were categorized into those who suggested the label asthma for all five scenes and those who did not. We conducted a bivariate analysis with all demographic, training and practice variables collected from the survey, and included variables significant at the p<0.15 level in a multivariate logistic regression model. All statistical analyses were conducted with SAS Version 9.2 (SAS, Cary, NC, USA).

Ethical/Human Subjects Review

This research was reviewed and approved by the Executive Committee of the Wisconsin Chapter of the American Academy of Pediatrics, the Health Sciences Institutional Review Board at the University of Wisconsin – Madison, and the Institutional Review Board at the Medical College of Wisconsin. A small donation was made to the Wisconsin Academy of Pediatrics Foundation for each participant who completed the survey and video questionnaire.

Results

Study Population

The survey was electronically mailed to 962 WI-AAP registered clinicians. A total of 116 (12%) clinicians completed the survey. Three participants reported familiarity with the video and were excluded from the primary analysis. Participants averaged 43 years of age (range: 26–72) and reported a mean of 13.3 years in practice (range: 0–40). Table 1 summarizes the main demographic and clinical characteristics of the study sample. More than half of the respondents were female (56%), and general pediatricians (79%); a total of 18 sub-specialties were reported. A majority of respondents practiced in urban settings (54%) in a hospital or clinic (56%). Clinicians from 20 (28%) counties in Wisconsin participated in the survey with clusters of responses from the major population centers of the state. Data on select attributes of the study population were available through the WI-AAP database. Mean age of WI-AAP members was also 43 years (range: 20–03). Overall, 95% of WI-AAP members listed their practice in the state. Total membership represented 46 counties, with the majority of physicians located in the population centers [Milwaukee County (28%) and Dane County (19%).] There was no significant difference between proportion of total members and survey respondents from Milwaukee County (p = 0.10) but a significantly higher proportion of respondents from Dane County were included in the study sample compared to the study population (p = 0.03). There were no significant differences in gender (55% female v. 56% female, p = 0.92) or percent board certified (74% v. 79%, p = 0.56) between the study population and study sample, respectively. The study population had a significantly lower percentage of current pediatric residents compared to the study sample (3% v. 19%, p<0.001.).

Symptom Description

Practitioners reported a wide range of symptoms in each of the five video sequences. A total of 143 different symptoms were suggested by practitioners who completed the survey. The mean (±SD) number of distinct symptom labels suggested by the entire group of practitioners for the five scenes was 29 (±5.0), with a range of 25–57. Individually, practitioners reported an average of 3 (±2.8) symptoms per scene. Wheeze was the most frequent symptom reported for four of the five scenes [range: 56% (Scene 5) - 91% (Scene 2)] and the most common symptom identified overall. Cough was noted by the second largest number of practitioners, largely because it was the principal characteristic in Scene 4 [identified cough: 100%], and commonly identified even when it represented an incidental part of the presentation, as in Scene 1 (identified cough: 61%).
The number of participants who suggested the principal characteristic(s) of the scene ranged from 5.5% for Scene 5 (featuring dyspnea and wheeze, both required) to 100% for Scene 4 (nocturnal cough). The majority of survey respondents (64.5%) reported the principal characteristic for three of the five scenes; 3.5% of respondents described the principal characteristic for all five scenes.

Disease Interpretation and Labeling

Overall, 70 diagnostic labels were used to describe the likely causes of the five presentations. The number of labels offered by practitioners ranged from 11 (for Scene 2, exercise-induced wheeze) to 26 (for Scene 3, nocturnal wheeze). The most common interpretations for the five scenes are presented in Table 2. Asthma was the most frequently suggested diagnostic label for all 5 scenes, which ranged from 70% for Scene 3 (nocturnal wheeze) to 93% for Scene 2 (exercise-induced wheeze). Nearly half of all respondents (47.8%) suggested the label of asthma for all five scenes. Only two individuals did not suggest the term asthma for any of the five scenes. There were no suggestions of asthma subdiagnoses (e.g. allergic asthma), with the exception of Scene 2, in which exercise-induced asthma, allergy-induced asthma and

Table 1. Demographic and clinical practice characteristics of survey respondents (n = 113).

| Characteristic               | N  | %   |
|-----------------------------|----|-----|
| **Sociodemographic**        |    |     |
| Age, in years (mean)        | 43 | 56.2|
| Female                      | 63 | 56.2|
| Race                        |    |     |
| White                       | 98 | 86.7|
| Black                       | 0  | 0   |
| Latino                      | 2  | 1.8 |
| Asian                       | 7  | 6.2 |
| Refused                     | 4  | 3.5 |
| **Clinical practice**       |    |     |
| Location                    |    |     |
| Rural Practice              | 11 | 9.7 |
| Suburban                    | 40 | 35.4|
| Urban                       | 61 | 54.0|
| Board Certified             | 89 | 78.8|
| General Pediatrics          | 79 | 69.9|
| Pediatrics Resident         | 22 | 19.5|
| Type of Practice            |    |     |
| Group                       | 53 | 46.9|
| Hospital/Clinic             | 63 | 55.6|
| Medical School              | 28 | 24.8|
| **Pct Medicaid**            |    |     |
| 0–30%                       | 62 | 54.9|
| >30%                        | 50 | 44.3|
| **Pct Uninsured**           |    |     |
| 0–10%                       | 82 | 72.6|
| >10%                        | 28 | 24.7|

*Practice categories are not mutually exclusive; respondents able to choose more than one.

Table 2. The most common diagnostic labels suggested for each of the five audiovisual scenes.

| Scene 1 | n | Scene 2 | n | Scene 3 | n | Scene 4 | n | Scene 5 | n |
|---------|---|---------|---|---------|---|---------|---|---------|---|
| Asthma  | 102 | Exercise-induced asthma | 88 | Asthma | 76 | Asthma | 81 | Asthma | 82 |
| Bronchospasm | 5 | Exercise-induced bronchospasm | 6 | Bronchospasm | 5 | Bronchospasm | 5 | Bronchospasm | 5 |
| Airway obstruction | 21 | Upper airway obstruction | 12 | Upper airway obstruction | 12 | Upper airway obstruction | 11 | Upper airway obstruction | 11 |
| Reactive airway disease (RAD) | 8 | Reactive airway disease (RAD) | 5 | Reactive airway disease (RAD) | 5 | Reactive airway disease (RAD) | 5 | Reactive airway disease (RAD) | 5 |
| Upper respiratory infection | 3 | Upper respiratory infection | 5 | Upper respiratory infection | 5 | Upper respiratory infection | 5 | Upper respiratory infection | 5 |
| Reactive airway disease (RAD) | 2 | Reactive airway disease (RAD) | 1 | Reactive airway disease (RAD) | 1 | Reactive airway disease (RAD) | 1 | Reactive airway disease (RAD) | 1 |
| Asthma or exercise-induced asthma | 17 | Asthma or exercise-induced asthma | 17 | Asthma or exercise-induced asthma | 17 | Asthma or exercise-induced asthma | 17 | Asthma or exercise-induced asthma | 17 |
| Croup | 21 | Croup | 21 | Croup | 21 | Croup | 21 | Croup | 21 |
| Other | 5 | Other | 5 | Other | 5 | Other | 5 | Other | 5 |

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exercise-induced bronchospasm where both suggested, and classified as positive asthma responses.

Pediatricians suggested more than twice the number of diagnostic labels for scenes featuring nocturnal symptoms (n = 42) and for the scene featuring a severe exacerbation (n = 29) compared to the scene depicting exercise-induced wheeze (n = 11). Overall, there was a strong negative correlation between the number of labels of suggested for a scene and the proportion of practitioners who suggested asthma as a diagnostic label, though this trend was not significant (p = −0.75, p = 0.14).

Symptoms and label association

Table 3 summarizes the association between identification of the featured symptom(s) and use of the diagnostic label of asthma. We observed the strongest association (symptom identified and label of asthma suggested) for scenes with exercise and wheeze with exercise (87% and 80%, respectively); this was significantly higher than the association for scenes with nighttime wheeze and nighttime cough (64% and 75%, respectively; difference from Scene 2 to Scene 4: p < 0.0001.) The largest category for Scene 5 (dyspnea and wheeze) was suggestion of the label of asthma without report of the symptoms (71%). The odds ratio for use of the asthma label given symptom identification was positive and significant for Scene 1 (OR: 11.6, 95% CI: 3.6, 36.9), Scene 2, (OR: 22.9, 95% CI: 3.0, 195.5), and Scene 3 (OR: 3.1, 95% CI: 1.9, 5.0). For Scene 4, all participants identified the symptom of cough, but only 75% suggested the label of asthma. With regard to Scene 5, there was a positive but non-significant association between symptom identification (both wheeze and dyspnea) and asthma label (OR: 1.6, 95% CI: 0.2, 10.1). Overall, the odds that practitioners who described the symptoms featured in the scenes would suggest the label of asthma as a possible cause of the presentations were 80% greater than the odds of those who did not report the primary symptoms of the scene (OR: 1.8, 95% CI: 1.1–3.0.).

Factors associated with use of the asthma label

A total of 109 (96%) respondents provided a diagnostic label(s) for all five scenes, and were included in the multivariable analysis. Overall, 54 respondents (49%) suggested the label of asthma for all five video scenes. All demographic, training and practice characteristics that were associated with suggestion of the label of asthma for each scene; of those clinicians who fully completed the survey, over half suggested a diagnostic label of asthma for all five scenes. Some of this variation resulted from differences in the representation of physician diagnosis, understanding of the diagnostic patterns of physicians for respiratory disease is a critical and overlooked aspect of asthma epidemiology.

Despite these problems, there have been few systematic attempts to understand the extent to which practicing pediatricians vary in their interpretation and labeling of the disease and its primary symptoms. Since asthma surveillance relies frequently on self- or parental-report of physician diagnosis, understanding the diagnostic patterns of physicians for respiratory disease is a critical and overlooked aspect of asthma epidemiology.

This analysis demonstrates that a sample of practicing pediatricians varied in the labels suggested to describe the likely causes of standardized presentations of asthma. Overall, there is a high proportion of clinicians suggested a diagnostic label of asthma for each scene; of those clinicians who fully completed the survey, over half suggested a diagnostic label of asthma for all five scenes. Some of this variation resulted from differences in the identification of the primary characteristic of asthma featured in the scenes.

Our results also suggest that some pediatricians may be less aware of the relationship between nocturnal symptoms and

### Table 3. Observed association between identification of primary symptom(s) and suggestion of label of asthma, by scene.

| Scene No. | Scene Description       | n   | Primary Symptom identified/asthma suggested (%) | Primary Symptom identified/asthma not suggested (%) | Primary Symptom not identified/asthma suggested (%) | Primary Symptom not identified/asthma not suggested (%) |
|-----------|-------------------------|-----|-----------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| 1         | Wheeze at rest          | 113 | 86.7                                          | 3.5                                              | 53                                               | 4.2                                              |
| 2         | Wheeze with exercise    | 110 | 86.4                                          | 1.8                                              | 6.4                                              | 5.5                                              |
| 3         | Nocturnal wheeze        | 109 | 64.2                                          | 18.4                                             | 5.5                                              | 11.9                                             |
| 4         | Nocturnal cough         | 109 | 75.2                                          | 24.8                                             | 0.0                                              | 0.0                                              |
| 5         | Dyspnea and wheeze      | 109 | 4.6                                           | 97.4                                             | 70.6                                             | 23.0                                             |

N reflects number of respondents to each question.

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### Table 4. Demographic, patient, and practice characteristics of participants suggesting label of asthma for all 5 vignettes (n = 54).

|                                     | Crude OR | 95% CI | Adjusted OR | 95% CI |
|-------------------------------------|----------|--------|-------------|--------|
| General Pediatrics practice         | 0.50     | (0.22, 1.16) | 0.86       | (0.33, 2.24) |
| Practice in a medical school        | 2.43     | (0.98, 6.05) | 2.15       | (0.78, 5.93) |
| Practice in Urban Center            | 0.50     | (0.22, 1.11) | 0.23       | (0.11, 0.78) |
| Age*                                | 0.96     | (0.93, 1.00) | 0.95       | (0.91, 0.99) |

Variables were included in the analysis if chisq test p < 0.15 in bivariate analysis.

*Age included in the model as a continuous variable; all other variables entered into model as binary.

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We found no other significant relationships among other measured demographic characteristics (sex, race/ethnicity), training (specialization or board certification), or patient mix.

### Discussion

Although asthma is the most common chronic disease that pediatricians diagnose and treat, it remains a complex clinical challenge. The disease is characterized by a variety of common phenotypes and an evolving clinical nomenclature; consistently high rates of underdiagnosis have been reported worldwide. Despite these problems, there have been few systematic attempts to understand the extent to which practicing pediatricians vary in their interpretation and labeling of the disease and its primary symptoms. Since asthma surveillance relies frequently on self- or parental-report of physician diagnosis, understanding the diagnostic patterns of physicians for respiratory disease is a critical and overlooked aspect of asthma epidemiology.

This analysis demonstrates that a sample of practicing pediatricians varied in the labels suggested to describe the likely causes of standardized presentations of asthma. Overall, there is a high proportion of clinicians suggested a diagnostic label of asthma for each scene; of those clinicians who fully completed the survey, over half suggested a diagnostic label of asthma for all five scenes. Some of this variation resulted from differences in the identification of the primary characteristic of asthma featured in the scenes.

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Labeling of Asthma

Practicing pediatricians vary in the terms used to label standardized symptoms of asthma. This variability suggests that existing methods of ascertaining the prevalence of asthma by inquiring about a diagnostic history of asthma may underestimate the true prevalence of the disease. In addition, the results suggest that congruence between diagnostic labels and epidemiological case definitions of asthma can no longer be assumed. Further efforts to standardize and align these two important components will result in improved research, interventions and evaluations.
Supporting Information

Appendix S1.
(DOCX)

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Author Contributions

Conceived and designed the experiments: DVS. Performed the experiments: DVS SM. Analyzed the data: SM MJM. Contributed reagents/materials/analysis tools: JC TEC. Wrote the paper: DVS SM MJM JC TEG.