Pediatr Allergy Immunol 2004: 15: 166–171
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PEDIATRIC ALLERGY AND IMMUNOLOGY

Predictors of health care utilization of children with asthma in the community

Maziak W, von Mutius E, Keil U, Hirsch T, Leupold W, Rzehak P, Behrens T, Weiland SK. Predictors of health care utilization of children with asthma in the community.
Pediatr Allergy Immunol 2004: 15: 166–171. © 2004 Blackwell Munksgaard

The aim of this study was to assess the pattern of use of health care services among children with asthma symptoms within the community, and assess groups at increased risk of emergency department (ED) visits or hospital admissions (HA). Using International Study of Asthma and Allergies in Childhood phase II protocol, information about asthma management and utilization of health care services was collected by parental questionnaire in a community-based random sample of 5–7- and 9–11-year-old children (n = 11,094) in Dresden and Munich. Only 11.2% of children with current wheeze did not utilize any health care facility or consultation for their asthma symptoms in the 12 months prior to survey, while 86.2%, 12.3%, and 3.6% had at least one asthma related physician's consultation, ED visits, or HA, respectively. Predictors of ED visits and HA among current wheezers were: younger age, male gender, speech-limiting wheeze, level of exposure to environmental tobacco smoke. In addition, children of low socioeconomic status were more likely to have ED visits because of their asthma. Childhood asthma is a major public health problem in Germany leading to substantial morbidity and utilization of health care services. Exposure to tobacco smoke comes out as the major modifiable risk factor related to asthma morbidity in children.

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Key words: asthma; children; cross-sectional; health care; emergency department; hospitalization

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Accepted 1 June 2003

More than a decade has elapsed since the introduction of the first international guidelines for the management of childhood asthma (1). Still, in reality asthma management is far from being standardized in most of the countries that adopted and used those or similar guidelines (2), and we are far from having achieved the desired standards in asthma control (3). Inadequate asthma management leads to needless sufferings of patients and huge economic burden to the health care system. In Germany, children with severe asthma cost the health care system 4811 DM (2460 EURO) per asthmatic child annually, mostly because of hospital expenses (4). Studies in the US have shown that emergency department (ED) visits and hospital admissions (HA) account for almost three quarters of the direct costs of asthma (5).

From the clinical point of view asthma-related ED visits and HA represent an unfavorable outcome that should be avoided by proper asthma management. The search into this issue requires adequate evaluation of current treatment practices and guidelines and physician–patients ability to comply with them (6, 7). From a public health stand point, patterns of asthma-related health care utilization and characterization of children at increased risks of ED visits and HA are important to determine the overall burden of the disease within the society, its strain on the health care system, and consequently to inform the design of effective interventions. Recently, Kennedy et al. identified several factors associated with ED visits of asthmatic children in the US including, allergen exposure, impoverishment, lack of medical insurance, insufficient self-management skills, and African–American background (8).

Within the framework of phase II of the International Study of Asthma and Allergies in Childhood (ISAAC) in Germany (9, 10), detailed information about the use of health care

facilities, severity of symptoms, and asthma management was collected. In this study, this information will be used to analyze patterns of asthma-related utilization of various health care services and identify groups at increased risk of emergency and HA. Understandably, health care utilization, particularly ED visits and HA, depend on treatment practices of physicians and their patients alike (11–14), and those merit attention. The cross-sectional design of this study however makes it difficult to assess the temporal sequence of events, and thus limits the ability to clearly assess the role of treatment practices on the burden of asthma on patients and on the health care system.

Methods

Study population

The study methods have been described in detail elsewhere (9,10). Briefly, cross-sectional surveys were conducted between 1995 and 1996 in two German cities (Dresden and Munich). Community-based random samples of fourth graders (n = 3017 in Dresden and n = 2612 in Munich) and of school beginners (n = 3300 in Dresden and n = 2165 in Munich) were surveyed using the parental questionnaire according to ISAAC phase II protocol. The questionnaires were completed for 83.0% and 87.6% of the older children, and 85.7% and 78.6% of the younger ones, in Dresden and Munich, respectively. As most (over 95%) of school beginners were between 5 and 7 years, and most of fourth graders were between 9 and 11 years at the time of survey, we will refer to these groups as the 5–7- and 9–11-year-olds, respectively. Characteristics of the study population are given in Table 1.

Table 1. Characteristics of the study population (n = 11,094)

	Dresden n (%)†	Munich n (%)‡
Age group (year)		
5–7	3300 (52.2)	2165 (45.3)
9–11	3017 (47.8)*	2612 (54.7)
Gender		
Boys	3289 (52.1)	2390 (50.0)
Girls	3026 (47.9)*	2386 (50.0)
Socioeconomic status		
Low	3263 (54.0)	2183 (47.2)
High	2782 (46.0)*	2440 (52.8)
Current wheeze		
Yes	456 (7.4)*	412 (8.8)
No	5702 (92.6)	4281 (91.2)
Asthma diagnosis ever		
Yes	419 (6.8)*	474 (10.1)
No	5720 (93.2)	4200 (89.9)
Current asthma		
Yes	221 (3.5)*	233 (4.9)
No	6065 (96.5)	4533 (95.1)
Number of asthma attacks/past 12 months		
0	5792 (93.8)	4338 (92.3)
1–3	293 (4.7)*	253 (5.4)
4	87 (1.4)*	108 (2.3)
Speech limiting wheeze/past 12 months		
Yes	102 (1.7)*	111 (2.4)
No	6078 (98.3)	4593 (97.6)

*$p \leq 0.05$ using the chi-square test comparing study regions.
†n = 6317.
‡n = 4777.

Measures and definitions

The parental questionnaire included ISAAC phase II core questions on the occurrence and severity of wheezing episodes during the 12 months prior to the survey. Current wheeze was defined as a positive response to the question: has your child had wheezing or whistling in the chest in the last 12 months? If, in addition, parents reported physician diagnosis of asthma, children were said to have current asthma (6). Severity of asthma was assessed using the ISAAC core questions on the number of wheezing attacks and the occurrence of speech-limiting wheeze in the 12 months prior to the survey. Current wheezers were further classified into three groups of severity; those with none, one to three, or four and more episodes in the past 12 months. Parental asthma was assessed by asking the parents if they were ever diagnosed with asthma. The socioeconomic status (SES) was considered high if at least one of the parents had an educational degree that requires at least 12 years of formal schooling.

In addition, the questionnaire included questions about the utilization of health services for wheezing or asthma in the past 12 months, including asthma-related physicians' consultations (further related questions inquire about the number of consultations that were routine asthma control visits or unplanned attack-related visits), ED visits, and HA. All health care utilization related variables were categorized into non vs. any for the purpose of the analysis.

Children's exposure to environmental tobacco smoke (ETS) was assessed by asking about the presence of smokers within the household of the surveyed, and if a positive answer was given, parents were asked about the total number of cigarettes smoked in the house daily by all smokers. In the analysis, level of children's exposure to ETS was categorized according to the total number of cigarettes smoked at home into 0–9 cig/day, and 10 cig/day.

The analysis was restricted to children of German nationality (n = 11,094), as the proportion of non-German children differed substantially between Dresden (1%) and Munich (22%). However, the rate of ED visits and HA did not differ significantly between German (12.3% and 3.6%, respectively) and non-German (9.9% and 4.2%, respectively) current wheezers ($p > 0.05$ for both figures).

Statistical analysis

The chi-square test was used for the comparison of dichotomous variables, with $p < 0.05$ considered statistically significant. Logistic regression analysis was performed to assess correlates of ED visits and HA. All relevant factors (considered in the univariate analysis) were entered in the models and were allowed to be backwardly selected depending on the value of the likelihood ratio statistic. A third model was built to assess correlates of repeated ED visits/HA. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated. All analyses were conducted using SAS 8.2 (SAS Institute Inc., Cary, NC, USA).

Results

Characteristics of the study's population in relation to asthma symptoms and diagnosis are listed in Table 1. Only 11.2% (97 of 868) of current wheezers and 5.9% (27 of 454) of current asthmatics did not utilize any health care facility or consultation for their asthma symptoms in the 12 months prior to survey. On the contrary, 86.2% of current wheezers had at least one asthma related physician's consultation and among those 36.5% (228 of 624) reported routine asthma control visits, and 86.7% (541 of 624) attack-related visits. As for ED visits or HA, 12.3% and 3.6% of current wheezers had at least one ED visit/hospitalization, respectively. The prevalence of ED visits and HA among wheezers with asthma diagnosis (current asthmatics) is 13.8% (61 of 441) and 4.3% (19 of 441), respectively.

In Table 2 various forms of utilization of health care services among children with asthma symptoms are stratified according to sociodemographic and severity characteristics. It shows that ED visits were in the univariate analyses associated with younger age, severe symptoms (four wheezing episodes), the presence of speech-limiting wheeze, and parental asthma ($p < 0.05$ for all). HA, however, were only associated with SES ($p < 0.05$) and speech-limiting wheeze in the univariate analysis ($p < 0.001$).

Logistic regression analysis shows that factors associated with ED visits and HA were similar, including age, gender, speech-limiting wheeze,

Table 2. Differences in health care utilization among current wheezers (n = 868) according to sociodemographic and disease characteristics

	Physician's consultations [n/N (%)]	Emergency department visits [n/N (%)]	Hospital admissions [n/N (%)]
Age group (year)			
5–7	296/339 (87.3)	58/345 (16.8)	16/351 (4.6)
9–11	328/385 (85.2)	33/392 (8.4)*	11/389 (2.8)
Gender			
Boys	395/452 (87.4)	63/462 (13.6)	21/462 (4.5)
Girls	227/270 (84.1)	28/273 (10.3)	5/276 (1.8)
Socioeconomic status			
Low	295/332 (88.9)	50/337 (14.8)	17/337 (5.0)
High	314/376 (83.5)*	39/384 (10.2)	9/387 (2.3)*
Study area			
Dresden	332/375 (88.5)	53/380 (13.9)	16/384 (4.2)
Munich	292/349 (83.7)	38/357 (10.6)	11/356 (3.1)
Asthma diagnosis ever			
Yes	410/437 (93.8)	61/441 (13.8)	19/441 (4.3)
No	212/285 (74.4)*	30/294 (10.2)	8/297 (2.7)
Number of asthma attacks/past 12 months			
0	57/76 (75.0)*	7/83 (8.4)	2/85 (2.4)
1–3	386/453 (85.2)*	53/460 (11.5)	16/459 (3.5)
4	167/178 (93.8)*	31/177 (17.5)*	9/179 (5.0)
Speech-limiting wheeze/ past 12 months			
Yes	172/185 (93.0)	43/189 (22.8)	15/189 (7.9)
No	444/530 (83.8)*	47/539 (8.7)*	12/542 (2.2)*
Parental asthma			
Yes	135/154 (87.7)	25/155 (16.1)	8/156 (5.1)
No	427/491 (87.0)	52/501 (10.4)*	15/505 (3.0)
Total†	624/724 (86.2)	91/737 (12.3)	27/740 (3.6)

*$p \leq 0.05$ using the chi-square test.
†The denominators in the total do not add to 868 because of different missings for each variable.

Table 3. Factors associated with emergency department visits and hospitalizations among current wheezers

	Emergency department visits (n = 665)		Hospital admissions (n = 667)	
	OR*	95% CI	OR*	95% CI
Age (5–7-year vs. 9–11-year-old)	3.00	1.81–4.97	2.27	0.98–5.30
Sex (male vs. female)	1.58	0.94–2.65	2.91	1.05–8.08
Speech-limiting wheeze (yes vs. no)	3.67	2.24–6.02	4.60	1.98–10.69
Environmental tobacco smoke (≥10 cig/day vs. <10 cig/day)	1.90	0.96–3.74	2.75	1.01–7.53
Socioeconomic status (low vs. high)	1.60	0.98–2.62	–	–

*Odds ratio (OR) are adjusted for all variables listed in Table. The final models resulted from backward selection using starting models with the following variables: age, city of residence, sex, socioeconomic status, the presence of asthma diagnosis, severity (number of wheezing attacks), severity (presence of speech-limiting wheeze), level of exposure to environmental tobacco smoke within household.
CI, confidence interval.

and the level of exposure to ETS (Table 3). ED visits in addition, were associated with low SES (Table 3).

Sixteen children among current wheezers in the sample reported repeated ED visits/HA in the past 12 months (14 had repeated ED visits and two repeated HAs). Correlates of repeated ED visits/HA in the multivariate analysis were: four and more asthma attacks vs. <4 (OR = 7.57, 95% CI = 2.34–24.49), male gender (OR = 5.53, 95% CI = 1.20–25.41), and the presence of speech-limiting wheeze (OR = 4.78, 95% CI = 1.58–14.52). However, this analysis is based on only 16 events and should be interpreted with caution.

Discussion

This population-based study shows a considerable asthma-related utilization of health services in Germany, whereby only about a tenth of children with current wheeze did not use direct medical help or consultation related to their asthma symptoms in the 12 months prior to survey. More serious outcomes such as ED visits or HA were reported less frequently accounting for 12.3% and 3.6% of health care utilization among current wheezers, respectively. Younger asthmatics, male asthmatics, and asthmatics reporting at least one severe episode of wheezing were at particular risk of requiring hospital care for their asthma symptoms. Exposure to tobacco smoke comes out as an important modifiable factor leading to increased morbidity and health care utilization of asthmatic children in the population.

The results suggest that to achieve satisfactory asthma control in pediatric patients to enable them to lead a life as close to normal as possible is difficult. The majority of children with asthma symptoms in our survey needed unplanned visits to one or more health care facilities in the past 12 months, and 12.9% (96 of 742) of them had to seek hospital care because of their symptoms. In comparison, the Asthma in America Survey reported higher rates of ED visits (23%) and HA (9%) among current asthmatics (3). Using similar case definition as in the Asthma in America survey, our figures regarding ED visits and HA (i.e., among current asthmatics) become 13.8% and 4.3%, respectively. Such differences may be explained with the higher proportion of severe asthma in American children (15), and differences in social and health delivery systems between the two countries. Apparently, a substantial proportion of asthmatic children in the US, especially among the underprivileged, received their asthma care directly from emergency health care facilities (16).

As identifying children at increased risk of ED visits and HA is of major importance to devise ways to reduce these stressful events, we tried to explore potential correlates of ED visits and HA among current wheezers. As expected, there was a marked overlap between predictors of ED visits and HA (Table 3). Studies from other countries have identified young age, low SES, race, and under-treatment with anti-inflammatory drugs as factors associated with increased risks of ED visits/HA (17–21). The following criteria in our population were predictors of an increased risk of ED visits and HA because of asthma: young age, male gender, presence of severe symptoms, and high exposure to ETS. These trends could be related to the nature of childhood asthma and to differences in parents' help-seeking behavior. The influence of parental factors however, seem minimal in our population as parents of asthmatics did not show preferential pattern of physician consultation according to age or sex of their children, and their own asthma history. On the contrary, the difference in ED visits according to SES found in our study cannot be explained by differential access to primary health care facilities as some studies from the US suggest (22–24), as the rate of physician visits were even higher among asthmatics having low compared with high SES, indicating that children with asthma in Germany have an overall good access to primary health care services.

Our study shows that male asthmatics are more likely to have ED visits or hospitalizations because of asthma than female asthmatics. We have seen previously that male asthmatics are more likely to be diagnosed with asthma than female asthmatics using the same data set (6). However, the male predominance of ED visits and hospitalization because of asthma is likely to have a true gender-related component, as it continues to come out after adjustment for asthma diagnosis in the multivariate analysis. This indicates that gender can be a factor related to ED visits and hospitalization in childhood asthma, a finding that was reported in other populations as well (25, 26).

We showed in our data that children with reported severe episodes of wheezing (such as speech-limiting wheeze) were more likely to visit the ED or be admitted to the hospital. ED visits were the highest in this group [22.8% (43 of 189)] in the univariate analysis, and children with speech-limiting wheeze were about four times as likely to have ED visits and HA compared with other current wheezers in the multivariate ana-

lysis. Noticeably, we have shown previously that only less than a third of children with speech-limiting wheeze in our population reported receiving regular anti-inflammatory drugs in the past 12 months (6), despite the fact that over 40% of children with speech-limiting wheeze in our study reported four or more asthma attacks in the previous year. Our results indicate therefore, that regardless of frequency of symptoms, reporting of a severe asthma episode should by itself raise awareness of care providers that thorough evaluation and close management, and above all probably good provider–patient communication, are warranted (27, 28).

The association between level of exposure to ETS and ED visits and HA of asthmatic children merit special attention. Parental smoking has been linked to an increased likelihood of children developing asthma and increased asthma morbidity in children (29–32). In addition, ETS exposure was found to be associated with wheezing-related ED visits in a sample of the US and Canadian children (33). However, evidence from population-based studies about the association between exposure to ETS and ED visits and HA for children with asthma have not been straightforward. For example, Evans et al. found that ETS exposure was positively associated with ED visits but not with HA (34).

Studying more than 10,000 children in Germany, we could demonstrate that asthmatic children exposed to high levels (10 cig/day) of ETS were about three times more likely to be hospitalized, and two times more likely to be admitted to the ED because of asthma after adjusting for possible confounders, than current wheezers with low or no ETS exposure. Therefore, in light of the costs for hospital care for asthma (35), of ETS exposure being a modifiable factor (36), and of current worrisome trends in smoking in children and adolescents in Germany (37, 38), the role of ETS exposure in asthma morbidity among children should receive due attention in Germany.

Conclusions

The current study shows that childhood asthma is causing a substantial strain on health care services in Germany, where more than half of children with asthma symptoms made unplanned visits to health care facilities in the 12 months prior to the study. Obviously, there is room for improvement of this situation by paying particular attention to children at increased risk and addressing modifiable negative factors. Younger children, male children, children with severe asthma symptoms are at increased risk of requiring hospital care in our population, and thus should be closely evaluated and monitored. In particular, in light of the salience of the negative effect of ETS exposure on asthma morbidity among children in our population, our results should form an anchor to educate the public about the hazards of exposure to ETS for children with asthma, and to strengthen the general anti-tobacco atmosphere in Germany.

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