Characteristics of Inner-City Children With Asthma: The National Cooperative Inner-City Asthma Study

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Summary. Asthma morbidity has increased dramatically in the past decade, especially among poor and minority children in the inner cities. The National Cooperative Inner-City Asthma Study (NCICAS) is a multicenter study designed to determine factors that contribute to asthma morbidity in children in the inner cities. A total of 1,528 children with asthma, ages 4 to 9 years old, were enrolled in a broad-based epidemiologic investigation of factors which were thought to be related to asthma morbidity. Baseline assessment included morbidity, allergy evaluation, adherence and access to care, home visits, and pulmonary function. Interval assessments were conducted at 3, 6, and 9 months after the baseline evaluations.

Over the one-year period, 83% of the children had no hospitalizations and 3.6% had two or more. The children averaged 3 to 3.5 days of wheeze for each of the four two-week recall periods. The pattern of skin test sensitivity differed from other populations in that positive reactions to cockroach were higher (35%) and positive reactions to house dust mite were lower (31%). Caretakers reported smoking in 39% of households of children with asthma, and cotinine/creatinine ratios exceeded 30 ng/mg in 48% of the sample. High exposure (>40 ppb) to nitrogen dioxide was found in 24% of homes. Although the majority of children had insurance coverage, 53% of study participants found it difficult to get follow-up asthma care. The data demonstrate that symptoms are frequent but do not result in hospitalization in the majority of children. These data indicate a number of areas which are potential contributors to the asthma morbidity in this population, such as environmental factors, lack of access to care, and adherence to treatment. Interventions to reduce asthma morbidity are more likely to be successful if they address the many different asthma risks found in the inner cities. Pediatr. Pulmonol. 1997;24:253–262.

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INTRODUCTION

The morbidity and mortality associated with asthma have increased in recent years. During the decade from 1982 to 1991, mortality due to asthma has increased 42% among 5–34-year-olds.1 Weitzman et al., found a 39% increase in the prevalence of active asthma among children under 18 years of age.2 This increase is even more dramatic among the very young, under age 5.3 Poor and minority urban areas contribute disproportionately to this increasing asthma morbidity and mortality.4–6 The majority of these studies of increased asthma morbidity have focused on hospitalization or emergency department (ED) visits taken from large national utilization databases.3,4,7–9 A number of other studies have measured symptom incidence in samples of asthmatics, usually at a single point in time.10 Those studies have focused on factors which may be related to this increased morbidity and have typically focused on the relationship of one, or possibly two factors and their impact on hospitalizations and ED use. The first phase of the National Cooperative Inner-City Asthma Study (NCICAS) was specifically designed to capture extensive utilization and symptom data on a large sample of inner-city children, with repeated measures of utilizations and symptoms over an extended period of time. This report provides a detailed description of utilization and asthma symptoms over a one-year period, the environmental milieu, and access to care in a geographically diverse inner-city population of children with mild to severe asthma. The psychosocial characteristics of this cohort are published elsewhere.11 Subsequent analyses will allow us to relate specific factors to morbidity among inner-city asthmatics and provide the basis for an intervention.

METHODS

In the NCICAS project, 1,528 children with asthma, ages 4 through 9, and their caretakers were given an extensive baseline assessment including demographic characteristics, health history, medicine use, access to care, adherence to treatment, environmental factors, psychological assessments, as well as symptoms and health care utilization. The full design and methodology of NCICAS is detailed in accompanying articles published in this journal issue.11,12 Children were recruited from EDs and clinics in inner-city areas based on physician-diagnosed asthma and presence of asthma symptoms for more than 3 days in the previous 12 months, or cough, wheezing, or shortness of breath that lasted more than 6 weeks in the previous 12 months. This recruitment procedure yielded a sample in which 9.5% of the children had not been diagnosed with asthma but were recruited based on asthma symptoms.

Skin-prick allergy tests, pulmonary function, and urine collection for cotinine were done. Home visits were conducted to gather dust samples for roach, dust mite, and cat allergens in a large subsample of the families. During this home visit, the environment was assessed and the collection of nitrogen dioxide (NO₂) specimens was initiated. Following this baseline assessment, telephone assessments of symptoms and utilization were conducted at 3-, 6-, and 9-month intervals. Recall over the prior 3 months for utilization (hospitalizations, ED visits, and unscheduled physician visits) was assessed at baseline and at each 3-month follow-up telephone call, providing a full year of utilization information for the sample. At each of these four measurement periods, a 2-week recall of symptoms was obtained (loss of sleep, slow-down of play, and wheeze).

Home visits were conducted on 663 (43.4%) of study subjects between November and July. Using a checklist, information was recorded both from direct inspection (such as general repair, carpeting, mattress covers, evidence of infestation, and of smoking in the home) or from questions to the family (such as laundry arrangements, pets, or infestations).

Skin Tests

Skin testing was performed by the prick puncture method on the volar surface of the forearm using a MultiTester® device.13 Allergen extracts (D. pteronyssinus, D. farinae, cat pelt, dog pelt, rat pelt, mouse pelt, German and American cockroach mixture, Alternaria tenuis, Penicillium, mixed grasses, orchard grass, white oak, maple, and giant and short ragweed) were obtained in glycerosaline (Greer Laboratories, Lenoir, NC). All extracts were 1:20 weight/volume except mites, which were 10,000 Allergy Units (AU) per ml. Resulting wheals were outlined in ink 15 minutes after puncture and the outline transferred to tape. A test was considered valid if the negative control wheal was at least 1 mm smaller than the positive histamine wheal. A test for any given antigen was considered positive if its value exceeded the negative wheal by at least 2 mm.

Smoking

Urine samples were collected from children at the time of the baseline interview, then transferred to capped plas-
tic tubes, frozen, and shipped in dry ice to a central laboratory at Henry Ford Hospital. Samples were analyzed for cotinine content with an ELISA method using a polyclonal antibody (Cotitraq®; Serex, Englewood, NJ). Urinary creatinine was assayed by the clinical chemistry laboratory at Henry Ford Hospital and results were reported as continine/creatinine ratio (ng/mg).

Nitrogen Dioxide

Questions potentially relevant to NO₂ exposure were asked during the baseline interview and confirmed during the home visit. At the time of the home visit a Palmes tube was taped to a wall in the child’s sleeping area. The family was instructed to seal and mail them back to the asthma study center after 7 days. The tube was shipped to a central laboratory for analysis. The samplers have a sensitivity of 600 ppb-hr, so that over 7 days a concentration above 3.6 ppb could be detected and samples differing by this same amount could be distinguished.

Peak Flow

Participants and their caretakers were instructed on the use of a portable Mini-Wright peak flow meter during the baseline visit and re-instructed by telephone quarterly prior to interval assessments. Subjects were instructed to use the peak flow meter twice daily prior to use of an inhaled bronchodilator (in the morning and evening) for a 2-week period, recording the largest of three maximal expiratory maneuvers on a peak flow/symptom diary that was returned in person or by mail. They also were asked to record information regarding concurrent symptoms and illnesses on this diary. Participants were told that the purpose of peak flow monitoring was to help doctors better understand how to treat asthma. They were not given specific instructions on interpreting peak flow values; rather, they were instructed to follow their physician’s usual guidelines for managing their asthma.

For each 2-week period, the mean absolute peak flow and the mean percentage of predicted, peak flow, adjusted for height, gender, race, and age, were calculated for all records containing at least 14 (out of a total maximum of 28) entries. Summary measures (over all four assessments) were calculated for those with valid records (i.e., ≥14 entries) for at least two surveys (n = 1,007).

Pulmonary Function

Spirometry (pre-and post-bronchodilator) was assessed at the baseline visit in children age ≥6 years using a 12 L dry-sealed spirometer (Pulmo-Screen II/E/VRS; S&M Instrument, Doylestown, PA). Subjects were not asked to refrain from medication use prior to testing. Prior to use of an inhaled bronchodilator, at least five and no more than eight attempts were made to obtain at least three acceptable forced expiratory maneuvers. In subjects who had not used an inhaled bronchodilator within 2 hours of testing, acute bronchodilation was achieved with inhalation of a nebulized 0.083% albuterol solution. Ten minutes following this, spirometry was repeated, with no more than five attempts to obtain three acceptable forced expiratory maneuvers. All maneuvers were done in the standing position, with the nose pinched closed manually.

All studies were reviewed by a single observer for acceptability and quality of the FEV₁ (flow) and FVC (volume). FEV₁ was considered “acceptable” when the back-extrapolated volume was <5% of the FVC and the first 1 sec of the maneuver was free from artifact or coughing, and “optimal” when the flow-volume curve showed a sharp, rapid rise to peak expiratory flow (<80 msec from start of test). The FVC was considered acceptable when expiratory time was >3 secs and a plateau (no visible change in volume) was demonstrated during the last 1 sec of exhalation. The FVC was considered optimal when a plateau was demonstrated and the maneuver exceeded 4 sec. All data were adjusted for body temperature and barometric pressure (BTPS). Predicted values, specific for race, gender, and height, were calculated based on the equations by Dockery et al., using the maximal acceptable values.

RESULTS

Demographics of the NCICAS population

A total of 1,528 caretaker and child pairs completed the baseline interview. The 3-, 6-, and 9-month assessments were completed by 91%, 92%, and 95% of the participants. Demographic information is shown in Table 1. The average age of the children was 6.2 years and 62% of the children were boys. At the time of the baseline interview, 79.9% were in school, ranging from preschool to grade 4. According to the caretaker’s report, 73% of the children were African American, 20% Latino, and 7% were white/other. The vast majority (96%) of the caretakers were women. Approximately 23% reported that they were currently married, 53.8% were single, and the remainder were divorced, separated, or widowed. Sixty-six percent of the caretakers and/or mothers and 70.1% of the biological fathers had at least a high school education.

Table 2 shows the household income. Sixty-one percent reported a household income below $15,000, which is the federal poverty level for a family of four. Slightly more than half (52.5%) of the children lived in a home where at least one adult had a regular paying job. Among the recruited children, 24.7% were reported as being in a neonatal intensive care unit; 10.3% were on a
respirator at birth, while 17.9% had low birth weight (<5.5 lbs.) More than half (57.4%) had a family history of asthma.

Utilization and Asthma Symptoms

Table 3 shows health system utilization, asthma symptoms and impact of asthma on the caretaker. Utilization (hospitalization and unscheduled visits to the ED, clinic, or physician’s office) was based on a 3-month recall. All symptom measures (wheeze, loss of sleep, reduced play activities, etc.) were based on a 2-week recall with the exception of “percent school days missed,” which was based on the last 3 months. All of these measures, including utilization measures, were collected at baseline and at each 3-month interval assessment. For these children, they averaged approximately 3 to 3½ days of wheeze for each of the four 2-week recalls. The caretaker indicated that the children had approximately 2 days per week of reduced play activity due to their asthma, and just less than 2 days per week of sleep disruption due to asthma. Since children had varying numbers of days of school during the prior 3 months, the results presented here are based on the percent of available school days missed due to asthma. Given that a 3-month period would permit approximately 65 days of school, these children are missing approximately 4 days (6%) to 6½ days (10%) due to asthma.

Table 4 presents the distribution of unscheduled visits due to asthma in a year and the number of hospitalizations due to asthma in a year, respectively. In this population, 34.3% had no unscheduled visits and 82.9% had no hospitalizations.

Access to Care

Data on the usual place of follow-up asthma care and insurance status are noted in Table 5. For 84.8%, the children received follow-up asthma care from the same place where they received primary care, but for only 39.5% was this the same place that they also received care for acute symptoms. A hospital-based pediatric clinic was the most common site for follow-up care (38.4%), followed closely by a health center (36.1%). However, only 67.4% saw the same provider for asthma follow-up and primary care.

Medications

As part of the baseline interview, caretakers reported the asthma medications prescribed for their child during the previous 3 months. In Table 6 the results are displayed separately for subjects recruited in the ED during an acute attack, for those recruited during a non-acute visit, and for the population as a whole. Overall, 17% of the children were not using any asthma medications. Nearly twice as many ED recruits were prescribed two or more medications compared to non-acute recruits (82% vs. 48%); this ratio was reversed for one medication. Among children taking asthma medi-
cations, 54% of acute ED recruits and 72% of non-acute subjects were taking oral beta-agonists. Overall, 28% of children taking medications were receiving inhaled steroids or cromolyn. Beta-agonists were the only medication used by 42% of children taking any asthma medication. Of the 952 children attending school, 29% stated that the school did not allow the administration of medications. Nineteen percent of caretakers reported that they were giving some medications less often than prescribed.

**Home Visits**

Only 17% of the families lived in detached houses. Most families lived in apartments (57%), duplexes (10%), or row houses (14%). Forty-four percent of the homes were estimated to be more than 50 years old and were frequently in poor repair with leaky roofs (12%), broken windows (13%), broken plaster (28%), and peeling paint (32%). Wall-to-wall carpet was common (41% of TV/living rooms, 32% of bedrooms), but only 38% had a functioning vacuum cleaner. Signs of roach infestation were seen in 66% and of mice in 29%.

**Skin Tests**

A total of 1,286 children had complete skin test results with valid positive and negative control test results. Of this number, 989 (77%) had at least one positive skin test, and 606 (47%) had three or more positive skin tests. The frequency of positive responses to various allergen extracts is shown in Figure 1.

**Smoking**

At the baseline assessment, 887 families (59%) included at least one smoker and 588 caretakers (39%)
reported that they smoked. Someone was smoking in the home during 10% of the home visits. Of 1,446 urine samples, 48% collected from the asthmatic children at the time of the baseline interviews had a cotinine/creatinine ratio (CCR) above 30 ng/mg, which is consistent with significant tobacco smoke exposure within the last 24 hours.

Nitrogen Dioxide

At the home visit, 89% of homes used a gas stove and 16% used the stove or a space heater to supplement home heating. Only 13% of kitchens had an outside vent fan and 24% of kitchens either had no outside window or a window that was painted shut. Study personnel placed Palmes tubes and 525 were returned. Nitrogen dioxide concentrations were as high as 480 ppb and 24% of the children were exposed in their sleeping area to mean levels higher than 40 ppb during the 1-week collection period.

Peak Flow

A total of 3,616 peak flow diaries were received, but 166 were excluded because they contained fewer than 14 out of the required 28 readings. The remaining diaries represented 59%, 61%, 60%, and 59% of the patients who were contacted at baseline, 3, 6, and 9 months.

Table 7 provides the absolute peak flows and the height, gender, and race-adjusted percentage of predicted peak flows for each 2-week monitoring period. Although the mean values were within the normal range (84–89% of predicted), there was a wide coefficient of variation of 25–26%.

Pulmonary Function

Of the 900 participants age 6–9 years, 827 (92%) had spirometry performed. Of these, 683 subjects (83%) had at least one acceptable FEV₁ and 476 (56%) had at least one acceptable FVC value obtained during a pre-bronchodilator maneuver. Bronchodilator inhalation was performed on 691 subjects, and resulted in at least one acceptable FEV₁ in 582 subjects (84%) and at least one acceptable FVC in 451 subjects (65%).

Mean (± SD) percent predicted FEV₁ and FVC were 96.6% ± 16.9% (range 31.2 to 142.4%) and 99.5% ± 15.3 (range 32.1 to 137.5), respectively, and the FEV₁/FVC was 0.83 ± 0.09. Only 9.7% of subjects with acceptable FEV₁ values had FEV₁ levels <75% of the predicted value, adjusted for height, gender, and race. Following a bronchodilator, FEV₁ increased by a mean of 10.2% ± 13% (p < 0.0001) and FVC increased by 4.7% ± 9.4% (p < 0.001). Of the 528 subjects with acceptable FEV₁ measurements before and after bronchodilator administration, 182 (34.5%) had a ≥12% increase in post-bronchodilator FEV₁.

DISCUSSION

This report describes the baseline characteristics and the environment of the subjects participating in the inner-city study of children with asthma and recruited by the NCICAS project. Because of the variable nature of asthma, a full year’s morbidity experience provided a better characterization of the individual child with asthma than previous short-term studies. This study is unique in that asthma symptoms and health care utilization data were collected in a prospective manner by the use of four contacts—the baseline interview and three telephone contacts at 3, 6, and 9 months post-baseline.
The objective of this prospective method of data collection was to maximize the accuracy of the data collected by minimizing the period of recall.

The primary focus of the NCICAS recruitment was to sample children with asthma living in the inner-city. However, NCICAS was not designed to be a population-based study of inner-city childhood asthma. The recruitment process was based in medical facilities and not in community facilities and it emphasized the recruitment of moderate to severe asthmatics. As a consequence, the morbidity experience of the NCICAS population as reflected by asthma hospitalizations was higher than that typically reported in the literature. The direct impact of recruiting children during acute attacks at the ED can be seen by their higher baseline morbidity, shown in Table 2. Using the 1988 Child Health Supplement from the National Health Interview Survey, Halfon, et al. found 10.6% of poor children with asthma were hospitalized in the last year, as compared to 17.1% in the NCICAS sample. Lozano et al. found an average of 0.085 hospitalizations per person-years in asthmatic children ages 3 to 17 years receiving Medicaid in Washington State, as compared to 0.28 hospitalizations in the NCICAS population. In contrast, a number of population characteristics were as expected in an inner-city population. The NCICAS sample largely consisted of minorities living at or below the poverty level. The prevalence of low birth weight in our population was twice the national average,
but was similar to levels reported previously for pre-
dominantly poor African Americans and US-born His-
apanics.19,20

It is evident that, in this population, symptoms were
frequent, adding up to more than 2 months per year. The
symptoms were severe enough to have an impact on
school attendance, sleep, and caretaker activities. Despite
the frequency of symptoms, hospitalization was an infre-
cuent event. Only 3.7% of the population had two or
more hospitalizations and 83% had none. Two percent of
the population had six or more unscheduled visits and
one-third had none. A small proportion of patients re-
quired hospitalization or made multiple ED visits; other
studies have shown that these events account for 43% of
the costs of asthma.21

The presence or absence of a regular source of primary
or preventive care is considered particularly important
for individuals with ongoing health conditions such as
asthma and has traditionally been used to measure access
to care. It was surprising, given the morbidity in our
population and the importance of access to good quality
health care for preventing morbidity, that nearly all re-
pondents reported having a usual place for follow-up
care. However, over half of the respondents reported that
it was difficult to get care for an asthma attack as well as
for follow-up visits. This is particularly intriguing since,
in our sample, over 92% of children were covered by
insurance. Nearly three-quarters were covered by Med-
icaid, which has been shown to improve access to care
for children. Our data support the findings of St. Peter et
al. and Halfon and Newacheck17,22 that poor children
with Medicaid are very likely to report a usual source of
routine care, but are likely to receive that care in a neigh-
borhood health center or hospital-based clinic rather than
a physician’s office and are unlikely to have continuity
between usual sources of routine (follow-up) and acute
care.

If the variable “having a usual place for follow-up
asthma care” adequately measured access, we would not
have found that more than 50% of respondents reported
that it was hard to get follow-up care, particularly since
nearly all children in our sample were covered by insur-
ance. We will have to investigate specific barriers to care
as well as different ways to measure access to care.
Moreover, variations or limitations in access do not tell
us much about the quality of care delivered. It may be
that attributes of the care and the relative lack of contin-
uity of care for these children may contribute more to
the relationship between health care delivery and mor-
bidity among children with asthma than more traditional
measures of access.

These data suggest that inner-city children with asth-
ma are more likely to receive two or more medications
during the previous 3 months if they have had an asthma
attack. While there is a possibility that some of the chil-
dren recruited during a non-acute visit had an acute ex-
acerbation during the three months prior to the baseline
interview, these children were nearly twice as likely to
report being prescribed a single medicine and half as
likely to be prescribed two or more medicines.

Among the non-acute recruits, the reported prescrip-
tion of inhaled anti-inflammatory medications was 24%,
compared to 22% for US pediatricians in 1993.23 The
population in this study had an overall level of morbidity
and medications prescribed that indicate a symptomatic
population. If there were adherence to current treatment
guidelines, we would have expected greater use of anti-
inflammatory medications for the degree of symptoms
reported. Use of beta-agonists as the only medication
was more widespread than inhaled anti-inflammatory medi-
cations. Although this suggests sub-optimal therapy, fur-
ther investigation is needed to assess whether the pattern
of medication use is due to poor access to quality medical
care or poor adherence to a preventive medical regimen.

Although the frequency of positive skin tests seen in
this population (77% with one or more positive skin
tests) is similar to that seen in other studies of asthmatic
children, the pattern of positive skin tests seen among
inner-city children in this study differs from previous
reports. In studies of unselected or middle-class asth-
matic children, 50–60% had positive skin tests to house
dust mite, 30% or more had positive skin tests to cat or
dog, and positive skin tests to cockroach was uncom-
mon.24,25 Previous reports regarding Alternaria sensitiv-
ity in children have indicated that 4 to 13% had a positive
skin test, which is substantially lower than in this popu-
lation.26,27 The pattern of observed skin test sensitivity
clearly reflects the unique allergenic environment to
which inner-city children are exposed and may be an
important consideration in designing environmental in-
terventions in this population.

This study demonstrates that exposure to environmen-
tal tobacco smoke (ETS) is common among inner-city
children with asthma. The percent of homes with at least
one smoker, the percent of asthmatics who smoke, and
the percent of children with a CCR greater than 30 ng/mg
is similar to a previous study of inner-city asthmatics.28
The question arises as to whether these percentages are
overestimates because of the deliberate recruitment of a
substantial proportion of acute asthmatics from the ED.
This is unlikely because Ehrlich et al. did not demon-
strate differences in exposure between those with acute
and non-acute asthma.28 Since ETS is a risk factor for
asthma and associated with increased bronchial reactiv-
ity, the data suggest that reduction of this risk factor
should be an important goal for an intervention program.

On average, peak flows were within normal limits but
varied greatly among participants. There was limited ad-
herence to this aspect of the protocol, i.e., less than two-
thirds of participants returned peak flow diaries. This lack of adherence is likely related to the demands made by twice-daily monitoring and the limited clinical feedback provided to participants regarding the personal use of peak flow data. In pilot studies, we demonstrated that actual adherence to peak flow monitoring in a similar research setting was limited by large amounts of missing or fabricated data that increased markedly after two weeks of monitoring. These data emphasize that research protocols that make daily demands on participants may have limited success unless clear personal benefit from participation can be demonstrated directly to participants.

Although results from spirometry and peak flow monitoring showed a good level of agreement between absolute FEV\textsubscript{1} and mean peak flow (r = 0.65, P < 0.0001), on average, the percent of predicted peak flows were lower than percent predicted FEV\textsubscript{1}. It is likely that spirometry and peak flow monitoring provide somewhat different types of information on airway physiology. Other possibilities include different reference populations used for calculating percent predictive values and differences in effort between supervised and unsupervised maneuvers.

Because of the young age and potential morbidity in this study population, the criteria for acceptability of pulmonary function curves were modified from those recommended by the ATS to allow analysis of FEV\textsubscript{1} or FVC data, even if maneuvers were not available that met both start and end of test criteria. Data were also analyzed even if they were based on only one acceptable value (205 FEV\textsubscript{1} values and 89 FVC values measured pre-bronchodilator); however, mean FEV\textsubscript{1} and FVC from children with only one acceptable value did not differ significantly from data of subjects with two or more acceptable maneuvers. Interestingly, mean levels of FEV\textsubscript{1} and FVC were close to 100% of the predicted values, and only 9.7% of subjects had values <75% of predicted. This suggests that in our high-risk population, those children who could adequately perform the forced expiratory maneuvers, had “baseline” levels of spirometry that were largely within the normal range. For those recruited during an acute attack, baseline studies were performed at least 3 weeks following the episode and, thus, participants may have been under better asthma control than at other times. The exclusion of children unable to perform the spirometric maneuvers because of poor lung function may result in an underestimation of the mean FEV\textsubscript{1} values. This possibility is less likely to be a major factor because younger age was related to the inability to perform the maneuvers. These data nevertheless suggest that even among a “high risk” inner-city population, as represented in NCICAS, many children have normal lung function measured at a single point in time, apart from during an acute episode.

A significant bronchodilator response is often considered a sine qua non for asthma diagnosis. Only one-third of our population of children demonstrated a 12% or greater increase in FEV\textsubscript{1}. The relatively high levels of lung function may indicate that most participants were tested during times of relatively minimal bronchospasm. These data emphasize the potential limitations of using a bronchodilator response as a diagnostic tool, and the influences of medication use, intrinsic variability in responses, and baseline lung function must be considered.

**SUMMARY**

The data presented in this report address baseline characteristics of a broad-based population of children with asthma. A large number of possible risk factors for asthma morbidity were clearly present in this population. Further analysis is required to assess the interactions of asthma morbidity with the environment, psychosocial factors, access to care, and adherence. In addition, the relationship with ethnicity and severity of asthma needs further analysis.

Data regarding morbidity of inner-city children with asthma have mainly addressed hospitalization and ED visits. This study provides comprehensive data regarding symptoms and limitation of daily activities, in addition to utilization of hospital services in geographically diverse inner-city populations with asthma.

In the past, the cost-effectiveness of asthma interventions have been evaluated by their ability to reduce the “direct” expenditures for asthma such as hospitalizations and ED visits. These interventions are aimed at the high users of such services—a relatively small proportion of asthmatics. A much larger portion of the asthmatic population can be targeted by interventions aimed at reducing asthma symptoms to lessen the burden of asthma on the daily life of the family. Potentially greater cost savings are possible for this type of intervention as the “indirect” costs of asthma associated with time lost from work by the parents, disruption of family life, and the child’s school activities are almost twice as high as the “direct” cost for children under 18 years of age.

**REFERENCES**

6. Targonski PV, Persky VW, Orris P, Addington W. Trends in...


