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The Environment in Pediatric Practice: A Study of New York Pediatricians' Attitudes, Beliefs, and Practices towards Children's Environmental Health

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ABSTRACT *Chronic diseases of environmental origin are a significant and increasing public health problem among the children of New York State, yet few resources exist to address this growing burden. To assess New York State pediatricians self-perceived competency in dealing with common environmental exposures and diseases of environmental origin in children, we assessed their attitudes and beliefs about the role of the environment in children's health. A four-page survey was sent to 1,500 randomly selected members of the New York State American Academy of Pediatrics in February 2004. We obtained a 20.3% response rate after one follow-up mailing; respondents and nonrespondents did not differ in years of licensure or county of residence. Respondents agreed that the role of environment in children's health is significant (mean 4.44 ± 0.72 on 1–5 Likert scale). They voiced high self-efficacy in dealing with lead exposure (mean 4.16–4.24 ± 0.90–1.05), but their confidence in their skills for addressing pesticides, mercury and mold was much lower (means 2.51–3.21 ± 0.90–1.23; $p < 0.001$). About 93.8% would send patients to a clinic "where pediatricians*

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could refer patients for clinical evaluation and treatment of their environmental health concerns." These findings indicate that New York pediatricians agree that children are suffering preventable illnesses of environmental origin but feel ill-equipped to educate families about common exposures. Significant demand exists for specialized centers of excellence that can evaluate environmental health concerns, and for educational opportunities.

KEYWORDS *AAP, Asthma, Environmental pediatrics, HPV chemicals, New York State, Pediatrician attitudes, PEHSU*

INTRODUCTION

Patterns of illness among children in New York and other states have changed substantially in the past 100 years.[1] The major illnesses confronting children today are a group of chronic conditions, including a number of psychosocial and behavioral conditions termed the "new pediatric morbidity."[2] Many of these diseases may be exacerbated or caused by environmental factors. These include asthma,[3] childhood cancers,[4–6] lead poisoning[7] and neurodevelopmental disorders.[8] Using federal and New York State data sources, the environmentally attributable cost of lead poisoning, asthma, pediatric cancer and neurobehavioral disorders in New York State's children in 2000 has been estimated to be $4.65 billion (range $4.13–$5.50 billion, 2000 dollars).[9]

Infants and children are qualitatively different from mature humans in many aspects of their behavior and biology and thus are more vulnerable to many toxic chemicals in the environment. Lead,[10–13] mercury,[14–18] pesticides,[19] tobacco smoke,[20] alcohol,[21] dioxins[22] and polychlorinated biphenyls[23] are among the chemicals that have been found to be especially hazardous for children. The U.S. Centers for Disease Control's *Third National Report on Human Exposure to Environmental Chemicals* has determined that children bear significantly heavier body burdens of many environmental chemicals than adults . For example, children in the study had a two-fold higher mean serum level of cotinine, the principal metabolite of second-hand cigarette smoke, and significantly higher levels of lead compared to adults.[24]

Despite decades of increased public, regulatory and scientific awareness and effort, relatively little is known about the chemical environment and its impact on New York's children. Today there exist more than 80,000 synthetic chemicals, nearly all of them invented since World War II. Children are especially at risk of exposure to the 2,800 of these chemicals that are produced in quantities of more than one million tons per year. These high-production-volume (HPV) chemicals are widely distributed in the environment—in air, food, water, and consumer products,[25] yet only 43% of HPV chemicals have been tested for their health effects in humans, and fewer than 20% have been tested for their toxicity to human development.[26] The U.S. Environmental Protection Agency has designated eighty-six hazardous waste sites in New York State for cleanup as part of its Superfund program,[27] and the Toxic Release Inventory provides some data on the geographic location of toxic releases into the air, water and land.[28] New York is one of only three states nationwide with pesticide registries[29] and also monitors outdoor air pollutants at a number of sites that are widely distributed across the State.[30] Incomplete knowledge about the chemical exposures and their impact on children further confounds efforts at prevention and effective intervention.

A national network of 12 Pediatric Environmental Health Specialty Units (PEHSUs) was established in 1998 by the U.S. Agency for Toxic Substances and Disease Registry to diagnose and treat children with diseases of toxic environmental origin, to reduce environmental health threats to children, to improve practitioner access to expertise in environmental medicine, and to strengthen health prevention capacity.[31] The PEHSU that serves New York, New Jersey, Puerto Rico and the Virgin Islands (Federal Region II) is located at the Mount Sinai School of Medicine in Manhattan. Table 1 presents the rapid increase in demand for services over the period from 1998–2004, and the geographic distribution of calls received. The PEHSU is already working at near 100% capacity, and data from the PEHSU indicate that the vast majority of referrals to the Region II center derive from the surrounding areas in southern New York and northern New Jersey, both located within one-to-two hours driving distance from the referral center.[32]

Other resources across New York State include seven regional Lead Resource Centers in Albany, Valhalla, Buffalo, Mineola, the Bronx, Syracuse, and Rochester;[33] a free comprehensive teratogen that offers telephone service and staffs clinical sites in Binghamton, Utica, and the North Country;[34] nine Occupational Health Centers of Excellence;[35] the Perinatal Environmental and Drug Exposure Consultation Service at the University of Rochester Medical Center;[36] and six regional Poison Control Centers located in Buffalo, Rochester, Syracuse, Sleepy Hollow, Mineola and New York City.[37]

Though the public is concerned about environmental threats to children's health[38] and patients frequently ask physicians about environmental exposures,[39] physicians have little training in environmental health. A study of Georgia pediatricians in 2000 found that 53.5% of pediatricians reported seeing patients seriously affected by environmental exposures but only one in five had received specific training in environmental pediatrics.[40] In a survey conducted in 2002 of tri-state

TABLE 1. Patient volume (1999–2004) and geographical distribution (first quarter 2003–first quarter 2004), Mount Sinai Pediatric Environmental Health Specialty Unit

Year	Calls handled	Patients seen	Outreach and education activities
1999	76	18	~10
2000	96	29	~15
2001	240	25	~30
2002	349	55	~55
2003	358	50	~90
2004 (estimated)	450	55	~120

Geographic subdivision	Calls received
Manhattan	78
Westchester County	53
Kings County, Brooklyn	51
New Jersey	24
Long Island	15
Bronx County	13
Queens County	10
Upstate New York	9
Rockland County	7
Outside New York and New Jersey	5

(NY, NJ, CT) pediatricians, Yue-Yung et al.[41] reported that even in practices where practitioners acknowledged being very affected by the events of the World Trade Center and that their practices responded to numerous questions on the environmental impact of September 11, most reported insufficient training and lack of preparedness in environmental issues. We surveyed New York State pediatricians to determine their level of self-efficacy for many common environmental exposures and diseases of environmental origin and to assess their opinion about the need for additional clinical resources for children's environmental health.

MATERIALS AND METHODS

Sample Development and Data Collection

We obtained a membership roster for District II (New York State) of the American Academy of Pediatrics (AAP). The District is divided into three Chapters. Chapter 1 serves upstate New York; Chapter 2 is comprised of Brooklyn, Queens, Nassau and Suffolk counties; and Chapter 3 is comprised of the counties of the Bronx, Manhattan, Staten Island, Dutchess, Orange, Putnam, Rockland, and Westchester. As of January 27, 2004, the membership in each of the Chapters was 1,030, 1,738, and 1,586, respectively.[42] In February 2004, a mail survey accompanied by a cover letter was sent to 500 randomly selected members in each NY Chapter. A stamped, addressed return envelope was included and, a second copy of the survey was sent to those pediatricians who had not returned surveys within 6 weeks.

Survey Instrument Development

We developed a four-page, 25-item survey modeled on a previous survey by Kilpatrick et al.[40] The questionnaire was divided into three sections. The first section ascertained attitudes, beliefs, and self-efficacy on children's environmental health with an emphasis on environmental history-taking. The second section asked pediatricians to identify preferred sources of information and sources or methods they would find most helpful in learning more about children's environmental health. The final section queried respondents for demographic and practice information. Pilot testing of the questionnaire was performed (n = 2) and modifications made to improve clarity and convenience. The survey was endorsed by AAP District II. The Institutional Review Board of the Mount Sinai School of Medicine reviewed and approved this study. Waiver of signed consent was granted.

In Section 1, pediatricians were asked to rate their agreement with a series of belief statements on a Likert scale of 1–5, from "strongly disagree" to "strongly agree." These questions asked pediatricians about their perceived need for environmental history-taking and their role in helping parents protect their children from hazardous environmental exposures. Pediatricians were also asked whether history-taking helped identify exposures causing specific symptoms, and whether it would take up too much time. A Likert 1–5 scale was also used to rate respondent beliefs in the importance of environmental health impacts in children's health and of assessing environmental exposures through history-taking in pediatric practice. Pediatricians were also asked to assess their ability to control environmental health hazards and to rate whether the magnitude of children's environment-related illness is increasing. We also asked pediatricians to state how frequently they took a routine environmental history as part of the well-child visit. Respondents were asked to note whether they had encountered inquiries about certain categories of environmental

exposures (e.g., lead, pesticides, mold, etc.) in the past year, whether these inquiries are made during patient visits, and the circumstances in which they are asked (i.e., routinely; based on suspicion of a possible environmental exposure; based on a parent's concern about a possible environmental exposure). We also asked participants to respond to a series of three self-efficacy statements (history-taking skills, discussing exposures with parents, and finding resources to evaluate exposures) for four environmental exposures (lead, mold, pesticides and mercury), also using a five-point Likert scale.

In Section 2, respondents were asked whether they knew about the Region II PEHSU or made referrals there and how many hypothetical referrals they would make to a clinic where patients could be referred for clinical evaluation and treatment of their environmental health concerns. Pediatricians were also asked whether they had a copy of either the AAP's *Handbook of Pediatric Environmental Health*, published in 1999, or the newer *Pediatric Environmental Health*, published by the Academy in 2003 within 3 months before the first mailing of surveys. They were also asked to check off current preferred sources of information and which new sources or methods would be most helpful in learning more about children's environmental health.

Our analyses included two demographic variables (age, collapsed into five categories—< 35; 35 to 44; 45 to 54; 55 to 64; and >65 years of age—and gender) and eight practitioner characteristics. Location was based on three variables: the AAP chapter to which the practitioner belonged; county of practitioner address; and State region of practitioner address (as defined by the New York State Department of Economic Development).[43] Date of licensure was obtained from New York State Department of Education records, which are publicly accessible on the Internet.[44] The variable for primary setting of practice included private practice without HMO, public/community clinic, teaching, private practice with HMO, and research. The variable for practice type included primary care, specialty and urgent care/emergency. The percent of patients on public assistance in respondent practices was categorized into four categories (0–24%; 25–49%; 50–74%; >75%). Years in practice were recoded into the following categories: 5 years or less, 6 to 10 years, 11 to 20 years, 21 to 30 years, and >30 years.

Statistical Analysis

Statistical analyses were conducted using SPSS 13.0 (SPSS, Inc, Chicago, IL). Routine data entry and cleaning procedures checked for outliers and data entry errors. We randomly sampled and checked 10% of the questionnaires for accuracy. Chi-squared tests were used for analysis of categorical variables. For each of the three sets of self-efficacy questions on history-taking skills, discussing exposures with parents, and finding resources to evaluate exposures, Wilcoxon rank-sum tests were used to compare self-efficacy amongst the respondents for lead with self-efficacy for mercury, mold and pesticides.

To estimate the annual volume of potential referrals to a regionalized system of children's environmental health clinics, we used the lowest number in the range of referrals each respondent suggested (e.g., two for the response two to five). We summed the number of referrals suggested by respondents, and to extrapolate the number of hypothetical referrals from respondents to the number of possible, we multiplied the number of referrals by the AAP membership at the time of the survey (1,030 + 1,738 + 1,586 = 4,354) and divided that by the number of surveys we mailed (1,500; 4,354/1,500 = 2.91). This assumes that nonrespondents would make

no referrals, and therefore represents a lower bound on the range of possible referrals. As a higher bound, we multiplied the number of hypothetical referrals from respondents by the ratio of the AAP membership and the number of respondents (4,354/301 = 14.47). This assumes that nonrespondents would refer with the same frequency as respondents.

Nonresponse Analysis

Using cross-tabulations, we compared the differences in survey response by county, AAP region, date of licensure, and region of the State. All 11 regions of the State were represented amongst respondents. Surveys were sent to pediatricians from 53 of the counties in the State and received from 35 counties; a survey was received from every county to which more than seven surveys were mailed. Respondents did not significantly differ by date of licensure ($p = 0.889$). Respondents frequency of response also did not statistically differ by county, AAP region, date of licensure, and by region of the State.

RESULTS

Of the 1,500 questionnaires mailed, 301 were completed, and 15 were returned as undeliverable. The overall response rate was therefore 301 of a possible 1,485 respondents, or 20.3%. After excluding 24 questionnaires from respondents who reported that they were not currently in pediatric practice, the final sample analyzed consisted of 277 practicing pediatricians.

The mean age (± SD) was 44.3 ± 12.7 years, and the mean number of years in practice was 13.7 ± 12.0 (Table 2). The respondents were about equally divided

TABLE 2. Description of respondents and their practices

Characteristic	No.	Percent
Age (mean ± SD)	44.3 ± 12.7	
Years in practice (mean ± SD)	13.7 ± 12.0	
Sex		
Male	118	43.1
Female	156	56.9
Practice type		
Primary care	207	77.5
Specialty	51	19.1
Urgent care/emergency	9	3.3
Practice setting		
Private without HMO	114	41.5
Public/community clinic	129	46.9
Teaching	20	7.2
Other	3	0.1
Private with HMO	7	2.5
Research	2	0.1
Patients on medicaid or public assistance		
0–24%	109	40.7
25–49%	40	14.9
50–74%	38	14.2
75–100%	81	30.2

between men and women and were also equally divided between public, community clinics and private, primary care practices. Specialties were also represented, including neonatology, adolescent medicine, pediatric cardiology, gastroenterology, and allergy. About one-half of the respondents reported that ≥50% of their patients were enrolled in Medicaid or public-funded assistance.

Only one in five respondents reported having had any training in environmental history-taking (20.2%). Almost all of the respondents (93.5%) reported a past experience with a patient who had been affected by an environmental exposure, such as a case of lead poisoning. Less than one half of respondents (46.9%) had a copy of the AAP's *Handbook of Pediatric Environmental Health*.

Table 3 presents data on attitudes, beliefs, and self-efficacy regarding environmental history-taking. Pediatricians agreed relatively strongly that environmental history-taking would help parents protect their children from hazardous environmental exposures and would help identify exposures related to health concerns (mean ± SD = 4.07 ± 0.75). There was overwhelming disagreement with the

TABLE 3. Pediatricians' self-reported attitudes, beliefs, and self-efficacy regarding environmental health

Attitude statements	
Conducting an environmental health history on all my patients would:	Mean ± SD
Help parents prevent exposures to environmental threats (n = 276)	3.99 ± 0.72
Identify the exposures related to health concerns (n = 276)	4.07 ± 0.75
Take up too much time (n = 277)	2.49 ± 1.01
Not be necessary (n = 276)	1.57 ± 0.73
Belief statements	Mean ± SD
The role of environmental health impacts on children is of little importance (1) → of great importance (5) (n = 277)	4.44 ± 0.72
Assessing environmental exposures through history-taking in pediatric practice is of little importance (1) → of great importance (5) (n = 277)	4.09 ± 0.98
The magnitude of children's environmental related-illnesses is decreasing (1) → increasing (5) (n = 275)	3.76 ± 1.04
The amount of control pediatricians have over environmental health hazards is minimal (1) → maximal (5) (n = 277)	2.89 ± 0.84
Self efficacy statements (n = 277)	Mean ± SD
How confident are you in taking a patient history on:	
Lead exposure	4.18 ± 0.91
Pesticide exposure	2.83 ± 1.14*
Mercury exposure	2.51 ± 1.13*
Mold exposure	3.15 ± 1.16*
How confident are you in discussing with parents or guardians the impact of:	
Lead exposure on health	4.24 ± 0.90
Pesticide exposure on health	2.87 ± 1.17*
Mercury exposure on health	2.74 ± 1.18*
Mold exposure on health	3.21 ± 1.17*
How confident are you in finding resources to evaluate:	
Lead exposure	4.16 ± 1.05
Pesticide exposure	2.68 ± 1.21*
Mercury exposure	2.64 ± 1.23*
Mold exposure	2.94 ± 1.23*

*$p < 0.001$ compared with lead.
Scale: Strongly disagree (1); strongly agree (5).

statement, "Conducting an environmental history on all my patients would not be necessary" (mean ± SD = 1.57 ± 0.73).

Respondents generally indicated that they attach considerable importance to environmental exposures. The "role of environmental health impacts on children" yielded a mean score of 4.44, and "assessing environmental exposures through history-taking in pediatric practice" yielded a mean score of 4.09. Pediatricians showed a tendency to believe that the magnitude of children's environment-related illness is increasing (mean 3.76). However, the responses suggested little belief that pediatricians have control over environmental health hazards, with the mean score (2.89) falling below the midpoint of the continuum.

Respondents voiced high levels of self-efficacy for history-taking, discussing lead exposures with parents, and finding diagnosis and treatment resources related to lead exposures, with all three items having mean values greater than four. For pesticide, mercury and mold exposures, the mean responses were much lower (all $p < 0.001$ compared with equivalent questions for lead).

Figure 1 shows data on the pediatricians' self-reported interview practices. Of the 277 respondents, 139 (50.2%) routinely took a history as part of the well-child visit that included asking about cigarette smoking around the child, parental occupation and housing (Table 4). A high percentage of respondents reported routinely asking about cigarette smoking around the child (93%), pets in the home (78%), lead (83%), sun exposure (80%), parental/teen occupation (73%), and home injury prevention (72%). Routine inquiry usually elicited the highest frequency of asking about environmental exposure, although for molds, parental inquiry had triggered more questions than had routine history-taking or physician inquiry. Fewer than 10% of respondents reported asking about pesticides, mercury, polychlorinated biphenyls, asbestos, radiation exposure, nitrates, radon, arsenic, volatile organic compounds, formaldehyde, and phthalates in response to any of the three triggers.

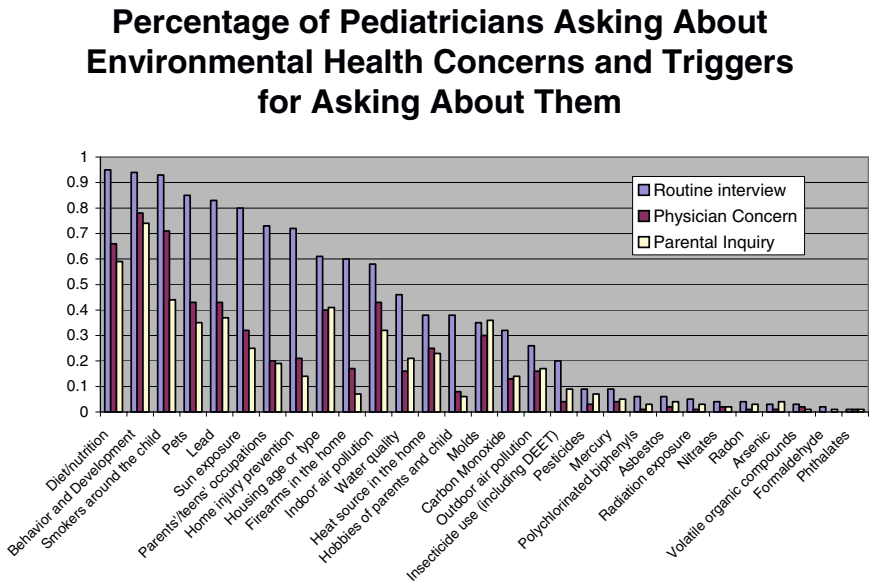

FIGURE 1. Percentage of pediatricians reporting asking about individual exposures routinely, and the frequency of physician and parental concerns.

TABLE 4. Frequencies of pediatrician activities, attitudes, beliefs, and self-efficacy regarding environmental health

Clinical activities	Number of respondents who report these activities (percent)
Routinely discuss housing, parental occupation, and environmental tobacco smoke as part of well-child care (n = 277)	139 (50.2)
Routinely take an environmental history as part of well-child visit >60% of time (n = 277)	73 (27.2)
Seen any patients affected by an environmental exposure in the past year (n = 262)	252 (93.5)
No patients	17 (6.5)
One patient	10 (3.8)
2–5 patients	58 (22.1)
6–9 patients	38 (14.5)
10–19 patients	43 (16.4)
Twenty or more patients	96 (36.6)
Know about the PEHSU (n = 277)	26 (9.4)
Referred patients to the PEHSU in the past year (n = 268)	8 (3.0)
No patients	260 (97.0)
One patient	2 (0.7)
2–5 patients	4 (1.4)
6–9 patients	0 (0.0)
10–19 patients	2 (0.7)
Twenty or more patients	0 (0.0)
Would refer patients to referral clinic for evaluation and treatment (n = 257)	241 (93.8)
No patients	16 (6.2)
One patient/year	13 (5.1)
2–5 patients/year	91 (35.4)
6–9 patients/year	52 (20.2)
10–19 patients/year	47 (18.3)
Twenty or more patients/year	38 (14.8)
Have received environmental history training (n = 277)	56 (20.2)
Provide patient educational materials in environmental health (n = 277)	126 (45.5)
Interested in learning more about environmental health (n = 277)	244 (88.1)

The most common source of information on environmental exposures pediatricians identified was the AAP (89.9%). Other important sources included professional literature (71.8%), government agencies (57.8%), health departments (57.8%), lectures/grand rounds (49.5%), and government websites (47.3%). About 88.1% of respondents affirmed that they would like to learn more about children's environmental health. When asked about sources they would find most helpful in obtaining further information, the responses were similar: guidelines from the AAP (72.6%), patient education materials (52.0%), specialist presentations (46.9%), continuing medical education classes (38.3%), newsletters (34.7%) and journals (31.8%).

Relatively few pediatricians (9.4%) knew about the PEHSU (Table 4) or made referrals to the PEHSU (3.0%). All of the referrals reported came from respondents

from New York City, Hudson Valley and Long Island (data not shown). Despite the relatively low referral rate to the PEHSU, demand for clinical referral resources was extremely high. 93.8% of respondents would refer patients to a clinic "where pediatricians could refer patients for clinical evaluation and treatment of their environmental health concerns."

DISCUSSION

New York pediatricians who participated in our survey demonstrated a high level of interest in children's environmental health, a high level of belief that environmental exposures impact their patients' health, and a high level of interest in learning more about the field. Except for lead exposure, pediatricians reported very little prior training in taking environmental histories and low self-efficacy in discussing environmental exposures with parents and locating diagnosis and treatment resources related to environmental exposures.

Our response rate of 20.3% is low, which is likely to have introduced significant selection bias. However, this rate is not atypical for a physician mail survey,[45] and by all available measures—county, years of licensure in New York, region of the State and AAP region—the respondents and nonrespondents were roughly similar. Limitations of this study include that our results may overstate (or understate) the levels of concern about environmental health problems amongst children and of interest in learning about environmental health among pediatricians. Similarly, because our results are based on self-report, the social desirability of the "right" answer may overstate the level of interest.

Further work is needed to explain why the federally sponsored Pediatric Environmental Health Specialty Unit for Region II (New York, New Jersey, Puerto Rico and the Virgin Islands) was the least used resource for pediatricians. Given that the PEHSU handles most consultations over the phone, better dissemination of the information regarding the presence of the regional center and/or more centers within the tri-state area might facilitate improved access. Funding for extensive outreach is not provided by ATSDR, but the Association of Occupational and Environmental Centers has recently begun such a campaign.[46] However, a telephone resource may not be helpful to a pediatrician who evaluates a child with a suspected disease of environmental origin or an environmental exposure. Pediatricians may prefer a nearby clinical site where a complete, in-person evaluation can be performed, just as they might prefer to refer patients to a nearby pediatric cardiologist or endocrinologist rather than a faraway, highly specialized institution.

One alternative approach to dealing with present and future problems in children's environmental health is the establishment of a statewide, regionalized children's environmental health system. The statewide system would consist initially of four to six children's environmental health clinical centers, linked through an office responsible for coordinating common activities, closely coordinated with the New York State Departments of Health and Environmental Conservation and well integrated into the medical services delivery system of the state.

Indeed, our survey suggests strong pediatrician interest in a clinic system as an efficient and effective solution. The 277 practicing respondents would make at least 1,737 referrals to such a clinical resource. If all 4,354 members of the New York State AAP would make referrals with equal frequency, then this suggests that pediatricians would make 25,134 referrals annually to a regional clinic system for children's environmental health concerns. If the 1,500 pediatricians surveyed would

make a total of 2,477 referrals, and the other members of the New York State AAP would make referrals with equal frequency, then 5,054 referrals would be made annually.

Public interest in New York for a regional system of children's environmental clinics is also high. In the spring of 2004, we assembled a series of community meetings in Syracuse, Rochester, Albany, Westchester County, Ulster County, Port Washington and Buffalo.* The sixty-one participants overwhelmingly stated the need for local clinical resources to educate providers, families and communities and perform environmental and clinical assessments when environmental health concerns arise. While only seven (11%) had heard about the PEHSU, only 16 (32%) of those who completed the questionnaire were willing to travel more than 2 h to have their child seen in a children's environmental health clinic.

Recognition, treatment and prevention of environmentally related illness in children requires collaboration among child health professionals, physicians specialized in occupational and environmental medicine, toxicologists, nurses, social workers, industrial hygienists, safety specialists, researchers, attorneys, government agencies and nongovernment organizations. Ultimately, the control of environmental disease relies on the recognition and diagnosis of environmentally related disease and the development and implementation of statewide surveillance, prevention and control programs. The survey data that we have collected further underline a number of gaps in the protection of New York's children from environmental hazards. Our hope is that this analysis prompts further specific discussion and development of solutions to a rising epidemic amongst the State's children.

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*Consent was implied by completion of the form and/or verbal contribution. Attendance at each focus group was strictly voluntary and participation was at the discretion of the attendee. The Institutional Review Board of the Mount Sinai School of Medicine exempted the community meetings from review.

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