Predecisional Draft for Public Comment

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DIAGNOSTIC EVALUATION OF CHILDREN WITH RESPIRATORY SYMPTOMS AND POTENTIAL EXPOSURE TO DIISOCYANATES FROM THE TRINITY AMERICAN CORPORATION

Please Provide Comments by July 14, 2000 to:

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ABSTRACT

Previous environmental and biomedical testing in the Glenola community of North Carolina was consistent with human exposure to diisocyanates, a group of potent pulmonary sensitizers. These substances were released from the nearby Trinity American facility during foam production. Airborne releases from the plant increased when the patented "quick cure" method was introduced in 1993.

The main goal of this investigation was to identify children with asthma who lived near the plant during the time period the quick cure method was used. We interviewed parents or guardians of 231 local children by telephone and confirmed exposure potential for 204 children; 118 of these 204 children had respiratory symptoms and were offered a clinical evaluation. A diagnosis of asthma was made for 28 of 55 children from the study area who completed a clinical evaluation; asthma was considered possible for another 10 children. Recommendations for medical care were made as appropriate.

A secondary goal was to characterize the current burden of pediatric asthma in the community. Participation in the telephone screening was excellent, but a limited number of eligible children completed a clinical evaluation. As planned, statistical inferences are avoided and grouped analyses are presented as descriptive and exploratory. Even so, the information collected is most consistent with a high prevalence of asthma among the community's children. Two children had antibodies to diisocyanates, providing evidence for airborne exposure away from the site.

DIAGNOSTIC EVALUATION OF CHILDREN WITH RESPIRATORY SYMPTOMS AND POTENTIAL EXPOSURE TO DIISOCYANATES FROM THE TRINITY AMERICAN CORPORATION

INTRODUCTION

Background Information

The Trinity American Corporation (Trinity American) produced foam and fiber in Glenola, North Carolina from 1981 until September 1997. The company's process for making polyurethane foam was changed to the "quick cure" process in 1993. This process produced foam by reacting a polyoxypropylenetriol resin with water and an excess of toluene diisocyanate (TDI), a well-recognized cause of occupational asthma *(1)*. TDI that remained after the polymerization process was then exhausted directly into the air; at times, methylene chloride was used as a blowing agent to produce a higher grade of foam. Introduction of the quick cure process led to increasing concern among local residents about odors and the possibility of health effects *(2)*.

Recent Events

In 1995, a number of adult Glenola residents complained to the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) that increased emissions from the Trinity American facility was adversely affecting their health. The state of North Carolina supported a case series of standardized clinical evaluations for symptomatic residents between June 1997 and March 1998 by the Duke University Occupational and Environmental Medicine (DOEM) program. Six of 38 adults tested (18.2%) had antibodies to one or more diisocyanates, but one of them may have been exposed at work. The authors concluded in the 1998 report that the results were "...highly suggestive of environmental exposure from the plant." Many residents had symptoms consistent with reactive airway disease and 61.1% (22 of 36) reacted during methacholine challenge testing. The authors concluded that "...a plausible link exists between exposure..... and symptoms experienced by community residents *(3)*."

In the fall of 1996, Glenola residents asked ATSDR to determine whether emissions from Trinity American could adversely affect their health. Environmental monitoring provided evidence that diisocyanates were periodically present in the air. When ATSDR established a "call-in line" in 1997, these residents made more than 200 phone calls to report site emissions or neurological and respiratory symptoms. ATSDR and EPA personnel present during a visible release

confirmed the odor and also experienced some of these symptoms *(4)*.

In order to further assess exposure in this community, ATSDR and the Randolph County Health Department conducted a biological exposure investigation in the fall of 1997. Local residents (n=113) provided blood samples to be tested for Immunoglobulin E (IgE) and Immunoglobulin G (IgG) antibodies to diisocyanates. Ten participants had specific antibodies to one or more diisocyanates, though one of them may have been exposed at work *(5, 6)*.

The ATSDR Health Consultation *(4)* found evidence of a completed exposure pathway and the ATSDR Public Health Advisory *(2)* recommended additional medical testing to assess exposure and associated health effects. Community members offered little support for additional medical testing among adults, but acknowledged concern about children. Anecdotally, one of the original petitioners moved away from the area because a preschool child developed respiratory problems.

GOALS AND OBJECTIVES

Our primary goal was to identify and make treatment recommendations for children with asthma who were exposed to airborne emissions from the Trinity American site. The objectives supporting this goal were:

(1) screen potentially exposed children for respiratory symptoms by interviewing parents or guardians by telephone;

(2) refer symptomatic children for diagnostic evaluation (including pulmonary function testing and total serum IgE levels) by an asthma specialist; and,

(3) test symptomatic children for antibodies to diisocyanates.

A secondary goal was to characterize the current burden of pediatric asthma in this community.

STUDY METHODS

Study Design

This study evaluated respiratory health among children residing near the Trinity American

facility in Glenola, North Carolina. A cross-sectional telephone screening survey identified children with respiratory symptoms commonly associated with asthma. These symptomatic children were offered a clinical evaluation by a physician specializing in the diagnosis and treatment of pediatric asthma. Clinical participants were also asked to provide a blood sample to be tested for antibodies to diisocyanates, a biomarker of exposure.

Telephone screening was conducted from December 30, 1998, through January 30, 1999. Diagnostic evaluations were offered on weekends during March 1999 and on April 10, 1999.

Eligibility Criteria

The study area included residences one mile or less from Trinity American's point source for airborne emissions. The study time period was from January 1993 through September 1997. Children were eligible for the study if they met the following criteria:

(1) the child's name appeared on the list of Randolph County School System students who registered for the 1998-1999 school year;

(2) the child's current residence was confirmed to be in the study area; and,

(3) residential information collected during the screening survey confirmed that the child resided in the study area for at least two months during the study time period.

In addition, the Randolph County Health Department distributed ATSDR information sheets to households in the study area. Parents and guardians were offered a toll-free phone number to use for identifying additional school age children. Children who met the residency requirements (above) were added to the list provided by the school board.

Screening Outcomes

If the parent or guardian reported one or more respiratory symptoms associated with asthma, the child was considered symptomatic and offered a medical evaluation. In summary form, the category "symptomatic" required: (a) night cough, wheezing, or shortness of breath during the past 12 months; (b) ever wheezing; or, (c) an asthma diagnosis from a doctor after reaching 5

years of age. All participants were age 5 or more; younger children may wheeze without bronchospasm and may not be able to cooperate during spirometry.

Study Instruments

Screening Interview Form *(Appendix A)*
This screening questionnaire was administered by telephone. Each address during the study time period was recorded on the interview form and plotted using the Geographic Information System (GIS). If the eligibility criteria were met, the child was considered a study participant. Based on their closest residence to the point source, study participants were identified by relative distances in miles as the near distance group ($\leq$ 0.50); the middle distance group (0.50 < distance $\leq$ 0.75); or, the far distance group (0.75 < distance $\leq$ 1.0). The descriptive terms (near, far, and middle) only have meaning with relation to each other. All children living within one mile of the release point were considered at risk for exposure.

The questions used to categorize each child as symptomatic or asymptomatic are found in Appendix A (Questions B1 through B7). These respiratory questions identified key indicators (symptoms or history) associated with the presence of asthma. The wording was modeled after questionnaires from:

(1) the "International Study of Asthma and Allergies in Childhood (ISAAC)" *(7)*;

(2) the "National Health and Nutrition Examination Survey (NHANES)" *(8)*;

(3) the "Guidelines for the Diagnosis and Management of Asthma" *(9)*.

In-Person Interview Form *(Appendix B)*
When symptomatic children came for a clinical evaluation, the first activity after informed consent was the in-person interview. This form was completed by the interviewer and reviewed by the examining physician.

Physician's Checklist *(Appendix C)*
Physicians checked off significant findings related to medical history, respiratory symptoms, and the physical examination. This information was used later to dictate the medical record and letters to parents or guardians.

Diagnosis Form *(Appendix D)*

The Diagnosis Form was developed to encourage consistent recording and to provide discrete outcome categories amenable to electronic storage and descriptive analyses.

On the Diagnosis Form, the examining physicians assigned one of the following outcomes to participants:

Outcome 1 -- asthma is present (supported by history and abnormal PFTs);

Outcome 2 -- asthma is present (supported by the history without abnormal PFTs);

Outcome 3 -- asthma is possible (cannot diagnose or exclude asthma); or,

Outcome 4 -- asthma is not present (the diagnosis was excluded).

Pulmonary Function Tests (PFTs)

The NIH consensus guidelines *(9)* base the diagnosis of asthma on a determination that (a) episodic symptoms of airflow obstruction are present; (b) airflow obstruction is at least partially reversible; and, (c) that alternative diagnoses are excluded. Spirometry in children typically includes the forced expiratory volume in 1 second (FEV1), the forced vital capacity (FVC), and their calculated ratio (FEV1/FVC). The FEV1 and FEV1/FVC are lower when the airway is obstructed. Generally speaking, airflow obstruction is established if the FEV1 is less than 80% of predicted or if the FEV1/FVC ratio is less than 65% (or below the lower limit of normal). Reversibility is typically established if the FEV1 increases by 12% (or more) after a short-acting beta2-agonist such as albuterol is administered. These guidelines for interpreting PFTs were specified in the study protocol.

It is more difficult to obtain consistent spirometry results in younger children. Because priority was given to the clinical standard of care, the clinicians actually interpreted the results as they do in their routine clinical practice (see Discussion). This included consideration of the FEF_{25-75}, a parameter shown to be clinically relevant in pediatric asthma *(10)*. In our analyses, "abnormal PFTs" refer to PFTs the clinicians interpreted as "abnormal."

Biomarkers

After obtaining informed consent, a blood specimen was collected and sent to the University of Cincinnati Diagnostic Allergy Laboratory. This specimen was tested for immunoglobulin G (IgG) and immunoglobulin E (IgE) antibodies to toluene diisocyanate (TDI), diphenyl-methane

diisocyanate (MDI), and hexamethylene diisocyanate (HDI). A blood specimen was also sent to a local laboratory for total serum IgE antibodies.

Field Procedures and Quality Assurance

Interviewing and Scheduling

The National Opinion Research Center (NORC) was contracted to administer the screening interviews by telephone, schedule eligible children for diagnostic evaluations, obtain informed consent from children and parents, administer the in-person interview, and escort participants through various components of the diagnostic evaluation . NORC developed procedure manuals for telephone interviewers and field personnel. After training, NORC interviewers demonstrated their competence in mock interviews before working with study participants.

Medical Personnel

Two physicians certified by the American Board of Pediatrics and the American Board of Allergy and Immunology were recruited from the same university-based specialty practice. The two spirometry technicians selected were experienced with children and met the current American Thoracic Society criteria *(11)*. Phlebotomy technicians with pediatric experience were recruited from a local hospital.

Pulmonary Function Testing

Objective measurements can provide better evidence for airway obstruction and reversibility than either symptoms or physical examination. Spirometry was chosen (rather than peak flow measurements), because more reliable comparison values were available from prediction equations. The spirometry equipment met ATS standards and the technicians were required to follow established procedures regarding technique, calibration methods, and preventive maintenance.

Data Management and Descriptive Analyses

The information from the telephone survey (symptoms and residential history), the in-person interview (symptoms and additional respiratory information), and the clinical evaluations (medical history and examination) were initially recorded on paper forms. EpiInfo Version 6.04b was used to create a customized data entry program with error checking. After the data was entered, the file was translated to a SAS database and combined with other electronic data (PFTs and blood tests) submitted by the clinical contractor. The final database was rechecked by selected comparisons with paper copies.

All analyses were performed using the SAS System for Windows ver. 6.12. The study parameters were examined for consistency using standard SAS procedures. The prevalences of various respiratory symptoms reported during the screening interview were examined after grouping children by distance from the point source of airborne emissions. Respiratory symptoms and diagnostic outcomes for children in the clinical phase were examined in a similar manner.

RESULTS

Figure 1 tracks study participants through the selection, screening, and clinical phases [Figure 1]. The reader may wish to refer to Figure 1 periodically throughout the "Results" section.

Screening

Selection and Participation in the Screening Interview

GIS plots confirmed that 225 of the 259 children identified by the Board of Education resided in the study area and belonged on the original list (Figure 1). During the telephone interviews, 24 siblings were identified and added to the study. Interviews were completed for 231 (92.8%) of the 249 children potentially eligible for the study.

In addition to the children added from study area households, a number of parents or guardians requested screening for themselves or for children who did not fully meet the study's eligibility criteria. Because a plausible basis for exposure existed, three parents and nine additional children were evaluated by questionnaire and (if symptomatic) offered a diagnostic evaluation; they did not become study participants and were not included in grouped analyses.

Demographics and Other Characteristics

We did not inquire about race during the screening interview, but virtually all residents of the study area were white. In Table 1, children from the original list and the siblings added to the list were combined (n=231). After plotting the addresses reported for the period 1993-1997, 88.3% of these children met the study eligibility criteria (Figure 1) and formed the study group (N=204).

Respiratory Symptoms Reported in the Screening Interview

Study participants were assigned to the near (n = 77), middle (n = 54), or far distance groups (n = 73) based on distance from Trinity American's point source of airborne emissions. Compared to the other distance groups, children in the near group had a slightly higher

prevalence of night cough during the prior 12 months (42.9%), wheezing during the past 12 months (31.2%), ever wheezing (31.2%), and ever having a diagnosis of asthma (19.5%) (Table 2). However, the differences between groups were small and there was no obvious dose response. The prevalence of sudden severe or recurrent episodes of shortness of breath and of asthma diagnoses after reaching 5 years of age was not increased in the near group.

If one or more key indicators was reported during the screening interview, the child was considered symptomatic. The overall prevalence of being symptomatic was 57.8 % (118 of 204 children). The prevalence of symptoms was not higher in the near group than in the far group.

Diagnostic Evaluations

Selection and Participation

The 118 symptomatic children were offered a diagnostic evaluation. This evaluation consisted of an in-person interview, a medical history and examination focused on the respiratory system, and pulmonary function testing. Fifty-five (46.6 %) of the symptomatic children completed the evaluation (Figure 1).

Demographics and Smoking Prevalence

The 55 children who completed the diagnostic evaluation included 36 boys and 19 girls. The prevalence of regular smoking in their homes during the study period was 58.8%. According to the Behavioral Risk Factor Surveillance System (BRFSS) data, 26.1% of children in North Carolina were exposed to environmental tobacco smoke in their homes during 1996 *(12)*.

Respiratory Symptoms Reported in the In-Person Interview

Symptoms reported during the in-person interview are shown in Table 3. Compared to other distance groups, children in the middle group had a higher prevalence of wheezing during the past 12 months (76%), ever wheezing (84.6%), and asthma diagnoses after reaching 5 years of age (30.8%). The prevalence of passive smoke in the home was also higher in the middle group (60.2 %).

Biomarkers

Forty-four of the 55 participants provided a blood specimen; one child had IgG antibodies to TDI and to HDI. This child lived approximately 2/3 mile from the site. A second child (tested by special request) also had IgG antibodies to TDI; while not qualifying for the study, this child did spend time at a residence near the site during the study time period.

There were 8 children whose total IgE levels were interpreted as "probably atopic allergy" by the reporting laboratory. While total IgE levels for children with asthma are frequently increased, the relationship between total IgE and TDI-induced asthma is unknown. The test provided a moderately useful piece of information for clinicians to consider, but total IgE levels are not necessary to diagnose or exclude asthma.

Pulmonary Function Tests (PFTs)

The age a child can successfully complete pulmonary function testing depends on the individual child. One 5-year-old participant was unable to successfully complete the tests.

Table 4 shows spirometry results for 17 children with pulmonary function tests interpreted as abnormal by the physicians. For these subjects, administering the bronchodilator led to an average increase of 8.8% in FEV1 (range 3.1% to 15.9%) and an average increase of 31.9% in FEF_{25-75} (range 11.3% to 70.6%). Only 1 of the 17 children with asthma and abnormal PFTs had used a modern aerosol known to reduce airway inflammation during the past 12 months.

Diagnostic Outcomes

The asthma specialists chose one of four diagnostic outcomes for each child *(Appendix D)*. Because participation in the diagnostic evaluations was low, the outcomes were combined in Table 3 and Table 5. In Table 3, clinical asthma included Outcome 1 (asthma with abnormal PFTs) and Outcome 2 (asthma without abnormal PFTs). The prevalence of clinical asthma was similar across the three distance groups (53.9%, 53.9%, 43.8%).

In Table 5, Outcomes 1, 2, and 3 were combined as asthma (present or possible) and compared to Outcome 4 (not asthma) by distance group. Viewing outcomes this way, the prevalence of asthma (present or possible) was higher in the middle group (84.6%) than in the other two distance groups.

DISCUSSION

Study Strengths

Participation in the screening phase was high, with only one parent (of two children) refusing to participate. The parents of sixteen children could not be located, so the screening interview was completed for 231 (92.8%) of 249 eligible children.

The likelihood of residential exposure to airborne diisocyanates was supported by previous environmental and biomedical investigations, but study area children had not been systematically tested for biomarkers of exposure or evaluated for disease. The health effect most often associated with TDI is asthma, a chronic disease with well-defined symptoms *(1)*. The airway obstruction in asthma is variable, but when present it is easy to document physiologic changes in the child's airways with spirometry.

The physicians selected for the clinical evaluations are recognized specialists in the diagnosis and treatment of children with asthma. This enhanced their credibility and provided a level of consultation that was not readily available in this community.

Study Limitations

Participation in the clinical phase was low. While 118 children were considered symptomatic, only 55 (46.6%) participated in the diagnostic evaluations. This was surprising after the high level of participation (92.8%) in the screening interviews. The low level of participation in diagnostic evaluations may have resulted from a progressive decline in community concern after Trinity American closed in September 1997. In addition, participants had to drive up to 30 minutes to reach the clinic at the Randolph County Health Department. The facility was ideal, but travel time and distance were undoubtably factors for some parents, even with a small expense reimbursement and an offer to provide transportation for families who expressed the need.

Additional information about other risk factors for asthma would have been useful. The screening interview was designed to screen for symptoms and collect residential history without burdening participants; we did not ask about other risk factors for asthma, including smoking patterns in the home. We did collect detailed information on environmental tobacco smoke during the in-person interview, but participation was low.

The study protocol specified criteria from national consensus guidelines *(9)* that are more useful when a child is followed over time or evaluated during an acute respiratory illness. These criteria did not make a very useful case definition for our participants, who were identified by screening interviews and evaluated in a one-time clinical encounter. This was predictable, given that airway obstruction and reversibility vary over time and methacholine challenge testing was not employed. For children with clearly abnormal PFTs (well-documented obstruction and

reversibility) on the day tested, the diagnosis of asthma is straightforward; for children without abnormal PFTs on the
day tested, categories that reflect some uncertainty are necessary (e.g., possible asthma) to avoid constraining the examining physicians to arbitrary choices *(13)*. The specialists ultimately used their clinical judgement, giving additional weight to respiratory symptoms and accepting evidence for obstruction and reversibility not specified in the protocol (e.g., changes in FEF_{25-75}). This was appropriate and consistent with their usual clinical practice and the priority given to individuals; however, the judgements that went into selecting and grouping the diagnoses are likely contributors to the nondifferential misclassification of outcomes. While the validity of individual diagnoses are difficult to evaluate objectively, we can partially assess the performance of the various outcome categories on a group level (see " PFTs and Diagnostic Outcomes" below).

Interpretation of Results

The distance between the site's emission point and the child's residence served as a surrogate estimate of relative exposure. With the point source as the center, the study area was divided by concentric circles at 0.5 , 0.75 , and 1.0 miles to define the near, middle, and far distance groups. It was assumed that the likelihood and intensity of exposure to TDI decreased as this distance increased, but this is not a certainty.

Biomarkers

Antibodies to diisocyanates are uncommon in the general population *(14, 15*). Most people do not make these antibodies even when exposed, but a few positive results are usually found when a group of exposed people are tested. One large study of exposed workers identified IgE antibodies to diisocyanates in less than 10% of 1780 adults tested *(16)*. Among subsets of these workers who were also tested for IgG antibodies, IgG antibodies to diisocyanates were somewhat more common than IgE antibodies. Generally speaking, when an exposed group is tested one expects to find at least a few with IgE and (or) IgG antibodies to one or more diisocyanates.

Total serum IgE antibodies are sometimes increased in atopic (allergy prone) children, who are at increased risk for asthma. This test is not a very sensitive biomarker for asthma and is not necessary to make a diagnosis.

Previous biomarker studies in this community *(3, 5)* identified adult residents with antibodies to diisocyanates; while the immunologic response of children has not been studied, community children were tested with the expectation that a few were likely to have antibodies to one or more

diisocyanates. Indeed, two children did have these antibodies, providing additional evidence of exposure in the community. These two children appear to have been exposed at two separate residences just beyond 2/3 mile from the emission point; that is, they were in the middle distance area (between the 0.50 mile circle and the 0.75 mile circle).

Children with diisocyanate antibodies have not been previously reported in the peer reviewed literature. When considered along with the results of previous biomarker studies at this site *(3, 5, 6),* there is considerable evidence for human exposure to diisocyanates released during foam production at Trinity American.

Respiratory Symptoms

For the 204 participants who completed screening interviews, 118 (57.8%) children were considered symptomatic and eligible for a clinical evaluation. Compared to children from the other two distance groups, children in the near group area had a slightly higher prevalence of night cough during the prior 12 months, wheezing during the past 12 months, ever wheezing, and ever having a diagnosis of asthma. The difference in prevalences among children from the three distance groups was small and there was no obvious dose response present.

For the 55 participants who completed in-person interviews, certain key indicators were more common among children from the middle area (Table 3). These indicators were wheezing during the past 12 months (76%), ever wheezing (84.6%), and asthma diagnoses after reaching 5 years of age (30.8%) . With such high prevalences of wheezing, one might expect that the prevalence of asthma would also be higher among children from the middle area. In fact, Table 3 shows that the prevalence of clinical asthma (Outcomes 1 and 2) was similar among children from the three areas. In Table 5, Outcomes 1, 2, and 3 were combined as asthma (present or possible) and compared to Outcome 4 (not asthma). The prevalence of asthma (present or possible) was highest among children from the middle area (84.6%), who also had the highest prevalences of wheezing.

PFTs and Diagnostic Outcomes

On any given day, a child with asthma may have better spirometry results than predicted and a child without asthma may have worse results than predicted. However, a group of children with asthma would be expected to have a higher prevalence of test results less than predicted than a group without asthma. For this study, the prevalence of test results less than predicted would be expected to progress from highest for Outcome 1 (asthma with abnormal PFTs) to lowest for Outcome 4 (not asthma).

Indeed, PFT results in two extreme outcome groups are quite distinct (Table 6). The prevalence

of test results less than predicted for Outcome 1 vs. Outcome 4 was 88.2% vs. 41.2% for FEV1; 94.1% vs. 23.5% for FEV1/FVC; and, 100% vs. 23.5 % for FEF_{25-75}. The distinction between Outcome 2 (asthma without abnormal PFTs) and Outcome 3 (possible asthma) is harder to define.

Both groups have respiratory symptoms and normal (or at least not "abnormal") test results. The prevalences of test results less than predicted with Outcome 2 are similar to the prevalences with Outcome 3 (Table 6). To the extent the prevalences differ, the direction of the difference is opposite to that expected; that is, the prevalence of test results less than predicted with Outcome 2 is less than with Outcome 3. At least on this characteristic (prevalence of test results less than predicted), the distinction between Outcomes 2 and 3 does not appear to be meaningful.

The comparison in Table 5 (asthma, present or possible vs. not asthma) leads to results more consistent with the high prevalence of wheezing in the middle distance group. It is also worth noting that the two children with diisocyanate specific antibodies appear to have been exposed at approximately 2/3 mile from the site (middle distance), providing evidence of significant exposure in the near and middle distance areas. Passive exposure to tobacco smoke was common among participants who completed the in-person interview, both for children with asthma and children without asthma (Table 6).

The 55 symptomatic children who participated in diagnostic evaluations cannot be assumed to be representative of the community (or even of symptomatic children), given the uncertainty associated with a small population, a low participation rate, and diagnostic outcomes based on one clinical interaction. Still, for exploratory purposes, we can estimate the prevalence of asthma given certain explicit assumptions. That is, we know there were 118 symptomatic participants in the screening phase of the study (N=204). We also know that asthma was present (diagnosed) for 28 children and considered possible for 10 children among the 55 symptomatic participants who completed a clinical evaluation. Consider the following three scenarios:

Scenario 1: Assume that the prevalence of asthma for symptomatic children not evaluated was the same as that of symptomatic children who were evaluated. Overall, asthma would be present or possible for 82 of 204 participants (40 %). This figure may estimate an upper boundary for asthma prevalence.

Scenario 2: Assume that the prevalence of asthma for symptomatic children not evaluated was ½ that for symptomatic children who were evaluated. Overall, asthma would be present or possible for 60 of 204 participants (29 %). This figure

may be the best estimate of asthma prevalence.

Scenario 3(a) Assume that the prevalence of asthma for symptomatic children not evaluated was zero (all children with asthma were evaluated and diagnosed). Overall, asthma would be present or possible for 38 of 204 participants (19 %). This figure may estimate a lower boundary for asthma prevalence.

Scenario 3(b) Or, assume Scenario 3 (a) is true and that none of the children categorized "asthma is possible" actually have asthma. Asthma would still be present (diagnosed) for 28 of 204 participants (14%).

While the true prevalence of asthma among community children is unknown, it is higher than the prevalence reported for children (under age 18) in the 1996 National Health Interview Survey (6.2 %) *(17)* and higher than the prevalences found in other studies more similar to the one reported here (<10 %) *(13)*. Indeed, the prevalence in this rural community may be more like the prevalence seen in high risk inner city environments, where asthma prevalence (diagnosed and undiagnosed) often exceeds 25%.

CONCLUSIONS

1. The estimated prevalence of asthma among school-aged children living near the Trinity American facility is higher than expected. Even with conservative assumptions, the prevalence of asthma is unlikely to be less than 15 to 20 %.

2. The prevalence of respiratory symptoms reported during telephone screening was high among school-aged children living near the facility. The significance of these screening results was confirmed by two asthma specialists, who categorized asthma as present or possible for a majority of the symptomatic children they evaluated.

3. A number of children in this community were exposed to airborne diisocyanates released from the Trinity American site. Two children who spent time in the study area had antibodies to one or more diisocyanates; one child qualified as a study participant and the other was tested by special request.

4. This study does not prove that the high prevalence of adverse respiratory outcomes is related to past emissions from the Trinity American plant, but the results are consistent with such a

hypothesis.

RECOMMENDATIONS

1. Community health education is needed to enable parents to:

   (a) identify common symptoms that suggest asthma;

   (b) seek professional evaluation when appropriate; and,

   (c) take steps to improve every child's environment (e.g., not smoking in the car or home).

2. Continuing medical education is needed to enable physicians to:

   (a) discuss the evidence for exposure and adverse health effects with patients; and,

   (b) diagnose, treat, follow, and refer asthma patients in accordance with consensus guidelines.

3. It is very likely that some individuals were sensitized to diisocyanates; therefore, diisocyanates should not be released into this community's air for the foreseeable future.

4. The off-site emissions from other foam producing plants should be monitored. If exposure potential is documented, consideration should be given to testing residents of adjacent communities for biomarkers of exposure and adverse health effects. The conventional wisdom that diisocyanates are solely an occupational hazard is no longer plausible.

ACKNOWLEDGMENTS

ATSDR Collaborators

The ATSDR Principal Investigator (PI) was Dan Middleton, with support from Mary White, Chief of the Health Investigations Branch, Division of Health Studies. Roberta Hilsdon provided assistance during initial planning and data collection. Ravishankar Rao plotted current addresses and Bill Henriques plotted residential histories using GIS. Carolyn Harris and Judy Smith provided financial oversight and monitored the contractors' performance and progress.

The original ATSDR Trinity Team provided the environmental groundwork for this health study. Theresa Kilgus was team leader, with support from John Abraham, Chief of the Exposure Investigation and Consultation Branch, Division of Health Assessment and Consultation. Lynn Wilder (and others) collected many environmental samples and Greg Zarus developed exposure models. Dahna Batts-Osborne developed a protocol and Ken Orloff performed the ATSDR biomarker study. Susan Metcalf served as in-house pediatric consultant. Steven Kinsler helped to explain diisocyanate toxicology. Cate McKinney, Maria Teran-Maciver, and Dan Holcombe facilitated community involvement.

Other Collaborators

Randolph County Health Department

MiMi Cooper provided advice and counsel to ATSDR throughout the work at this site. As Health Director in Randolph County, Ms. Cooper participated in numerous public meetings and graciously made the department's clinic available for diagnostic evaluations over several weekends.

Duke University Medical Center

Physicians Larry Williams and Laurie Anne Myers of Duke University traveled many miles to provide clinical services, as did spirometry technicians Virginia Labelle and Debra Sedlak.

National Opinion Research Corporation (NORC)

Screening and in-person interviews were contracted to NORC. A number people there made important contributions, including Missy Koppleman, Ann Cederlund, Bronwyn Nichols, Toby Singer, Heather Ferguson, Tina Dennis, and the NORC telephone interviewers. Cheryl Gilbert, Barbara Watt, and Ken Miller provided their assistance at the clinical evaluation site.

Midwest Research Institute (MRI)

The essential clinical evaluations and laboratory testing were contracted through MRI. Sarah Hatch planned laboratory services and enlisted specialty physicians, spirometry technicians, and

phlebotomists. Lee Patterson was at the clinic early and late to make it all work.

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TABLES

Table 1.—Demographic and Study Characteristics by Selection Group[1]

Characteristics	Selection Group		
	Original List (n = 207)	**Added** (n = 24)	**Combined**[2] (n = 231)
	%	**%**	**%**
Exposure Potential[3]			
Yes	89.9	75.0	88.3
No	6.3	16.7	7.4
Unknown	3.9	8.3	4.3
Sex			
Male	55.1	50.0	54.5
Female	44.9	50.0	45.5
Average Age			
Male	11.5 years	9.9 years	11.3
Female	11.6 years	9.7 years	11.4
Screening Status			
Symptomatic	53.6	66.7	55.0
Asymptomatic	46.4	33.3	45.0

1 Participants are grouped by the way they entered the study; that is,
(a) children identified on the original list from the school board; and,
(b) children residing in a study household and "Added" by parents/guardians.

2 "Combined" -- children from the original list and siblings in study households identified by parents or guardians and added to the study.

3 Exposure potential was categorized as:
(a) "Yes" (204 children) or "No" (17 children) based on GIS confirmation that the child resided (or not) within 1 mile of the emission source during the study time period; or,
(b) "Unknown" (10 children), if address information could not be plotted using GIS.

Table 2.—Symptoms reported in the screening interview by distance category

Symptom [1] Reported	Distance Categories [2] for Study Participants [3] (n=204)			
	0.50 Mile (n = 77) **n (%)**	**0.75 Mile** (n = 54) **n (%)**	**1.00 Mile** (n = 73) **n (%)**	**Total** (n =204) **n (%)**
Night Cough	33 (42.9)	21 (38.9)	26 (35.6)	80 (39.2)
Wheezing	24 (31.2)	12 (22.2)	19 (26.0)	55 (27.0)
Short of Breath	14 (18.2)	12 (22.2)	13 (17.8)	39 (19.1)
Ever Wheezed	36 (46.8)	21 (38.9)	29 (39.7)	86 (42.2)
Asthma Dx (ever)	15 (19.5)	6 (11.1)	10 (13.7)	31 (15.2)
Asthma Dx (≥5) [4]	6 (7.8)	2 (3.7)	8 (11.0)	16 (7.8)
Symptomatic [5]	46(59.7)	28 (51.8)	44 (60.3)	118 (57.8)

[1] The interviewer coded responses: (a) yes (b) no (c) don't know or (d) refused. Comments that clarified responses were recorded. See Appendix 1 for interview questions.

[2] Distance between the point source of emissions and residence(s) during the exposure period, grouped by concentric circular segments with 1/4 mile radial increments.

[3] A child became a study participant after a parent or guardian completed the screening interview and researchers confirmed that the residential information collected met the study's eligibility criteria.

[4] Participants were classified as symptomatic (or not) based on the screening interview.

Table 3.—Symptoms reported in-person and diagnoses by distance groups.

Outcomes	Distance Groups [3] of Participants who Completed the Asthma Evaluation (N = 55) n (%)			
Symptoms Reported In-Person [1] **and Clinical Diagnoses** [2]	**0.50 Mile** [4] (n = 26) n (%)	**0.75 Mile** (n = 13) n (%)	**1.00 Mile** (n =1 6) n (%)	**Total** (n = 55) n (%)
Night Cough	13 (50.0)	8 (61.5)	12 (75.0)	33 (60.0)
Wheezing	14 (53.9)	10 (76.9)	10 (62.5)	34 (61.8)
Short of breath	14 (53.9)	6 (46.2)	8 (50.0)	28 (50.9)
Ever Wheezed	20 (76.9)	11 (84.6)	13 (81.3)	44 (80.0)
Asthma Dx (ever)	9 (34.6)	5 (38.5)	4 (25.0)	18 (32.7)
Asthma Dx (≥ age 5)	2 (7.7)	4 (30.8)	1 (6.25)	7 (12.7)
Passive Smoke (93-97) [4]	15 (57.7)	9 (69.2)	8 (50.0)	32 (58.8)
Clinical Asthma [2]	14 (53.9)	7 (53.9)	7 (43.8)	28 (50.9)
Possible Asthma	3 (11.5)	4 (30.8)	3 (18.8)	10 (18.2)
Not Asthma	9 (34.6)	2 (15.4)	6 (37.5)	17 (30.9)

[1] Symptoms from the "In-Person" interview given at the beginning of the clinical evaluation.

[2] The diagnostic categories in this table include:
(a) "Clinical Asthma" (with or w/o abnormal PFTs) -- Outcomes 1 and 2 combined;
(b) "Possible Asthma" (further evaluation needed) -- Outcome 3; and,
(c) "Not asthma" – Outcome 4.

[3] Distance (D) between the point source of emissions and residence(s) during the study time period, grouped by concentric circular segments ($D \leq 0.5$, $0.5 < D \leq 0.75$, $0.75 < D \leq 1.0$ miles).

[4] The parent or guardian indicated that someone smoked regularly inside the home during the study time period (1993 - 1997).

Table 4.—Improvement in "abnormal" pulmonary function test results after albuterol.

Child	FEV1 Pre- and Post- Medication with Albuterol and % Improved			FEF_{25-75} Pre- and Post- Medication with Albuterol and % Improved		
	Pre-Med (liters)	Post-Med (liters)	Improved [1] (%)	Pre-Med (liters/sec)	Post-Med (liters/sec)	Improved [2] (%)
1	2.80	2.99	6.8	3.02	3.63	20.2
2	2.13	2.43	14.1	1.65	2.31	40.0
3	2.82	3.08	9.2	2.88	3.37	17.0
4	1.54	1.64	6.5	1.49	2.06	38.3
5	1.52	1.57	3.3	1.28	1.54	20.3
6	2.23	2.47	10.8	2	3.24	62.0
7	1.45	1.62	11.7	1.24	1.38	11.3
8	1.99	2.19	10.1	1.95	2.48	27.2
9	1.69	1.90	12.4	1.57	2.18	38.9
10	1.96	2.02	3.1	1.66	2.17	30.7
11	2.38	2.50	5.0	2.34	3.13	33.8
12	3.14	3.36	7.0	3.52	4.10	16.5
13	2.29	2.41	5.2	2.46	2.79	13.4
14	1.15	1.22	6.1	1.12	1.53	36.6
15	3.60	4.08	13.3	3.72	4.65	25.0
16	2.76	3.03	9.8	2.38	3.34	40.3
17	1.07	1.24	15.9	1.02	1.74	70.6

[1] For the 17 subjects whose PFTs were interpreted as "abnormal" by the asthma specialist, the average increase in FEV1 after administering the bronchodilator was 8.8% (range 3.1% to 15.9%).

[2] For the 17 subjects whose PFTs were interpreted as "abnormal" by the asthma specialist, the average increase in FEF_{25-75} after administering the bronchodilator was 31.9% (range 11.3% to 70.6%).

Table 5.—Respiratory outcomes by distance groups.

Respiratory Outcomes	Distance Groups [1] of Participants who Completed the Asthma Evaluation (n = 55) n (%)			
	0.50 Mile (n = 26) n (%)	**0.75 Mile** (n = 13) n (%)	**1.00 Mile** (n =1 6) n (%)	**Total** (n = 55) n (%
Asthma, Present or Possible [2]	17 (65.4)	11 (84.6)	10 (62.5)	38 (69.1)
Not Asthma [3]	9 (34.6)	2 (15.4)	6 (37.5)	17 (30.9)
FEV1 < predicted [4]	14 (53.8)	11 (84.6)	11 (68.8)	36 (65.5)
FEV1/FVC < predicted [4]	17 (65.4)	11 (84.6)	9 (56.3)	37 (67.3)
FEF_{25-75} < predicted [4]	16 (61.5)	11 (84.6)	9 (56.3)	36 (65.5)

[1] Distance (D) between the point source of emissions and residence(s) during the exposure period, grouped by concentric circular segments ($D \leq 0.5$, $0.5 < D \leq 0.75$, $0.75 < D \leq 1.0$ miles).

[2] "Asthma, Present or Possible " - Outcomes 1, 2, and 3 combined;
includes children that the clinical specialist diagnosed as:
(a) "asthma with abnormal PFTs;" (b) "asthma w/o abnormal PFTs;"or, (c) "possible asthma."

[3] "Not Asthma" – Outcome 4; the clinical specialist was able to exclude the possibility of asthma.

[4] The number and per cent of children with a test result below the predicted value.

Table 6.— Comparison of pulmonary function test results to predicted values by diagnosis.

Summary PFT Results	Diagnostic Outcomes for Study Participants who Completed the Asthma Evaluation[1] (n=55)			
	Outcome 1	Outcome 2	Outcome 3	Outcome 4
	Asthma[2] with Abnormal PFTs (n = 17) **n (%)**	Asthma w/o Abnormal PFTs (n = 11) **n (%)**	Possible Asthma (n = 10) **n (%)**	Not Asthma (n = 17) **n (%)**
FEV1 < predicted	15 (88.2)	7 (63.6)	7 (70.0)	7 (41.2)
FEV1/FVC<predicted	16 (94.1)	8 (72.7)	9 (90.0)	4 (23.5)
FEF_{25-75} < predicted	17 (100.0)	7 (63.6)	8 (80.0)	4 (23.5)
Passive Smoke (93-97)	12 (70.6)	5 (45.5)	3 (30.0)	12 (70.6)

[1] A completed evaluation included (at least) the screening interview, the in-person interview, medical history and physical, and pulmonary function testing.

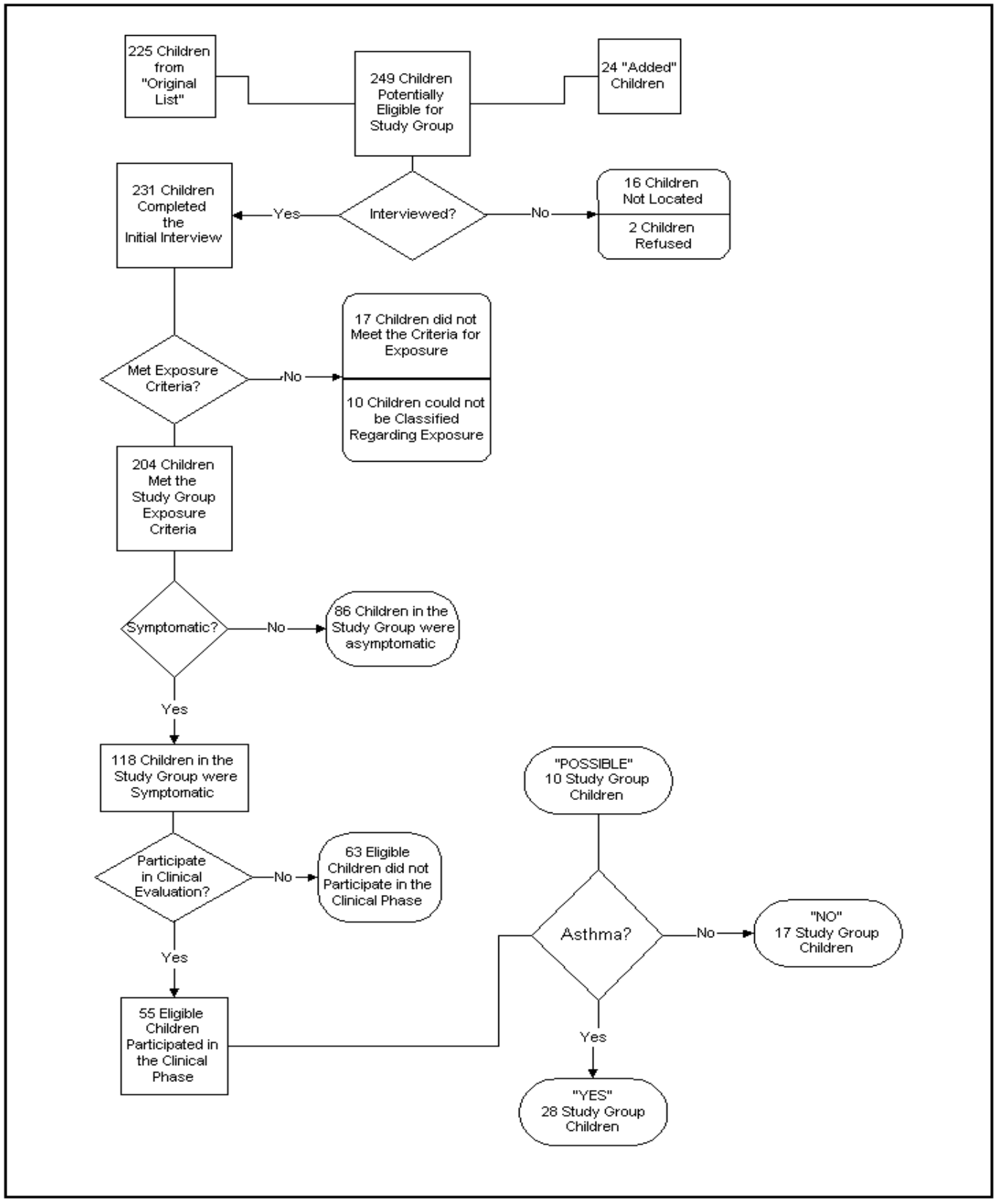
[2] "Abnormal PFTs" in this table refers to the physician's interpretation.

[3] Asthma cannot be either diagnosed or ruled out without additional evaluation.

FIGURES

Figure 1: Flowchart

FIGURE 1: FLOWCHART



APPENDICES

Appendix A. Screening Interview Form

Appendix B. In-Person Interview Form

Appendix C. Physician's Checklist

Appendix D. Diagnosis Form

Appendix A

Screening Interview Form

Appendix A: Screening Interview Form

TELEPHONE QUESTIONS FOR RESIDENTS

CHILD

HHID: <HHID> Interviewer Name: ____________________
CHID: <CHID> Time of Interview: ____________________
Child Name: <CHFN_U> <CHMN_U> <CHLN_U> Date of Interview: _____ / ______ / _____
Address: <ADDR_U> <APT_U> <CITY_U>, <STATE_U> <ZIP_U>
Phone Number(s): <MOMAR1_U> <MOMPH1_U> , <DADAR1_U><DADPH1_U>

- -

A1. ***INTERVIEWER INSTRUCTION:***
IF THIS IS CHILD # 1, CONTINUE TO A2. OTHERWISE GO TO A6.

INTRODUCTION
A2. May I speak with the parent or guardian of <CHFN_U> <CHLN_U>? (CIRCLE ONE)

1. Yes.................. GO TO A3

2. Not Available.. SET A CALLBACK DATE/TIME, RECORD IN ROC
____

3. Refused........... IF R IS UNWILLING TO PARTICIPATE AFTER YOU HAVE ADDRESSED R'S QUESTIONS/ CONCERNS, STATE REASON WHY R IS UNWILLING HERE:

____

____

A3. ***Hello, my name is (INTERVIEWER NAME). I am calling on behalf of the Agency for Toxic Substances and Disease Registry (ATSDR).*** During 1997, ATSDR studied the air near the Trinity American site in Randolph County, North Carolina. At times, a chemical called TDI and other diisocyanates were present in the air. These chemicals were a threat to the health of people living nearby. Foam is no longer made at the Trinity site, but we are concerned about children who could have been exposed to these chemicals in the past.

We are conducting research to investigate the health of children who live within a mile of the Trinity site. Since you live within one mile of the site, your child might have been exposed to TDI. I would like for you to take a moment to answer a few questions about each of your school-age children. The questions will be about breathing symptoms and conditions. Your participation is voluntary and you can choose not to answer any question. This information you give us will be treated as confidential and protected to the full extent of the law. Reports written about this investigation will not identify specific individuals. The benefit to your child is that a breathing problem might be found early. Early treatment is important for some breathing problems.

This will take about 5 minutes for each school age child. Some parents or guardians who we speak with by phone may be contacted again in the near future. Please stop me at any time if you have questions.

May I begin?

1. ***Yes ..... GO TO A4***
2. ***No ..... SET A CALLBACK TIME IF POSSIBLE. IF R IS UNWILLING TO PARTICIPATE AFTER YOU HAVE ADDRESSED R'S QUESTIONS/ CONCERNS, STATE REASON WHY R IS UNWILLING HERE:***

_____

_____

A4. What relation are you to <CHFN_U>? (CIRCLE ONE)

1. PARENT
2. GUARDIAN
3. OTHER..... (SPECIFY) _____

A5. What is your full name? _____ _____ _____
First Middle Last

A6. Now I would like to confirm some information about <CHFN_U> .

Is this child's full name <CHFN_U> <CHMN_U> <CHLN_U>?

1. Yes..... GO TO A7
2. No ..... CORRECT BELOW:

Child's full name is: _____ _____ _____
First Middle Last

A7. What is <CHFN_U>'s date of birth?..... _____ / _____ / _____
MM DD YYYY

A8. What is <CHFN_U>'s current age?..... _____ years

A9. Is <CHFN_U> a boy or girl?..... CIRCLE ONE: 1. Boy
2. Girl

A10. INTERVIEWER INSTRUCTION:

IF THIS IS CHILD # 1 IN THE HOUSEHOLD, GO TO A11.
IF THIS IS CHILD # 2, # 3, OR # 4, CONTINUE TO A10A.

A10a. Is all of the address information that you gave me for <CHFN_U1> the same for this child?

1. ***Yes ..... GO TO B1***
2. ***No ..... CONTINUE TO A11***

A11. Is the current address for <CHFN_U>: <ADDR_U>, <APT_U>, <CITY_U>, <STATE_U> <ZIP_U>?

IMPORTANT: VERIFY EVERY PART OF THIS ADDRESS. IF ANYTHING NEEDS TO BE ADDED OR CHANGED, SUCH AS ADDING AN APT OR LOT NUMBER, OR CHANGING A CITY, CORRECT IT BELOW BY WRITING THE FULL ACCURATE ADDRESS.

1. Yes ..... GO TO A12
2. No, current address is: _____ _____
   Street Apt / Lot # (CIRCLE ONE)

   _____ _____ _____
   City State Zip

A12. In what month and year did <CHFN_U> move to the current address? _____ / _____
MM YYYY

A13. Did <CHFN_U> live at any addresses in Randolph County other than the current address between 1993 and 1997?

1. ***Yes ..... GO TO A13A***
2. ***No ..... GO TO B1***

A13A. ADDRESS 1: _____ _____ _____ _____ _____
Street Apt / Lot City State Zip

DATE OF OCCUPANCY AT ADDRESS 1: _____ / _____ ***TO*** _____ / _____
MM YYYY MM YYYY

CONFIRM: This was in Randolph County? ***1. Yes***
2. No
8. Don't Know

A13B. ADDRESS 2: _____ _____ _____ _____ _____
Street *Apt / Lot* *City* *State* *Zip*

DATE OF OCCUPANCY AT ADDRESS 2: _____ / _____ ***TO*** _____ / _____
MM *YYYY* *MM* *YYYY*

CONFIRM: This was in Randolph County? ***1. Yes***
2. No
8. Don't Know

A13C. ADDRESS 3: _____ _____ _____ _____ _____
Street *Apt / Lot* *City* *State* *Zip*

DATE OF OCCUPANCY AT ADDRESS 3: _____ / _____ ***TO*** _____ / _____
MM *YYYY* *MM* *YYYY*

CONFIRM: This was in Randolph County? ***1. Yes***
2. No
8. Don't Know

A13D. ADDRESS 4: _____ _____ _____ _____ _____
Street *Apt / Lot* *City* *State* *Zip*

DATE OF OCCUPANCY AT ADDRESS 4: _____ / _____ ***TO*** _____ / _____
MM *YYYY* *MM* *YYYY*

CONFIRM: This was in Randolph County? ***1. Yes***
2. No
8. Don't Know

"KEY" QUESTIONS: CIRCLE ONE ANSWER NUMBER FOR EACH QUESTION. ENTER ANY COMMENTS IN THE BLANK LINES BELOW THE QUESTIONS.

B1. **In the last 12 months**, has this child had a dry cough at night, apart from a cough associated with a cold or chest infection?.....
_____
_____

1. YES
2. NO
8. DON'T KNOW
9. REFUSED

B2. Has your child had wheezing or whistling in the chest **in the last 12 months**?.....
_____
_____

1. YES
2. NO
8. DON'T KNOW
9. REFUSED

B3. **In the last 12 months**, has your child had a sudden severe episode or recurrent episodes of shortness of breath? .....

1. YES
2. NO
8. DON'T KNOW
9. REFUSED

B4. **Compared to 12 months ago**, which of the following best describes your child's breathing?.....

1. worse
2. the same
3. improved
8. DON'T KNOW
9. REFUSED

B5. Has your child **ever** had wheezing or whistling in the chest at any time in the past? .....

1. YES
2. NO
8. DON'T KNOW
9. REFUSED

B6. Did a doctor **ever** tell you that this child had asthma? .....

1. YES..GO TO B7
2. NO..GO TO C1
8. DON'T KNOW..GO TO C1
9. REFUSED..GO TO C1

B7. At what age was this child first diagnosed with asthma?..... _____years

88. DON'T KNOW
99. REFUSED

CONTACT INFORMATION

C1. INTERVIEWER INSTRUCTION:

IF THIS IS <u>NOT</u> THE LAST CHILD OF THE HOUSEHOLD, GO TO THE <u>NEXT</u> <u>QUESTIONNAIRE</u> OF THIS HOUSEHOLD.

IF THIS <u>IS</u> THE LAST CHILD OF THE HOUSEHOLD, CONTINUE TO C2.

C2. If we need to contact you again and have difficulty reaching you, do you have another phone number we could try?

1. Yes ..... GO TO C2A

2. No ..... GO TO C3

C2A. ALTERNATE PHONE NUMBER: <u>( ) -</u>

C3. Is there another person, such as the child's other parent or a relative, we could contact if we have difficulty reaching you?

1. ***Yes ..... GO TO C3A***
2. ***No ..... GO TO C4***

C3A. What is his or her name? _____ _____ _____
First *Middle* *Last*

Phone number? (____) _____ - _____

Relationship to the child? (CIRCLE ONE)

1. ***PARENT***
2. ***RELATIVE***
3. ***NEIGHBOR***
4. ***OTHER ..... SPECIFY:*** _____

C4. Thank you for taking the time to answer these questions. This information will be reviewed by Dr. Middleton, a doctor at ATSDR. If it could benefit your child, ATSDR will offer a doctor's exam and testing at a convenient time and place at no cost to you. You will receive a letter from Dr. Middleton within one month. If you would like, I can give you his phone number for future reference. The number is 1-888-427ATSDR or 1-404-639-5142. END CALL.

COMMENTS:

_____
_____
_____
_____
_____
_____

Appendix B

In-Person Interview

APPENDIX B: In-Person Interview

Trinity Face to Face Questionnaire

HHID: <HHID>
CHID: <CHID>
Child Name: <CHFN_U> <CHMN_U> <CHLN_U>
Current Address: <ADDR_U> <APT_U>, <CITY_U>, <STATE_U> <ZIP_U>
Phone Number(s):
Child's Date of Birth: <CHDOB_U>

Interviewer Name: _____
Time of Interview: _____
Date of Interview: _____ / _____ / _____

- -

FA1. ASK THE ADULT PRESENT: What relation are you to <CHFN_U>? (CIRCLE ONE)

1. MOTHER
2. FATHER
3. GUARDIAN
4. OTHER..... (SPECIFY RELATION) _____

➜ IF NOT A PARENT OR GUARDIAN, IMMEDIATELY CONSULT THE SITE COORDINATOR FOR FURTHER INSTRUCTIONS.

FA2. What is your full name? _____ _____ _____
First Middle Last

FA3. Is the current address for <CHFN_U>: <ADDR_U> <APT_U>, <CITY_U>, <STATE_U> <ZIP_U>?

1. Yes
2. No, current address is: _____ _____
   Street Apt / Lot # (CIRCLE ONE)

   _____ _____ _____
   City State Zip

FA4. Is the current phone number for <CHFN_U>: <MOMAR1_U>-<MOMPH1_U>?

1. Yes
2. No, current phone number is: _____ - _____
   Area Code Phone Number

CIRCLE ONE ANSWER NUMBER FOR EACH QUESTION. ENTER ANY COMMENTS IN THE BLANK LINES BELOW THE QUESTIONS.

COUGH

FB1. **In the last 12 months,** has this child had a dry cough at night, apart from a cough associated with a cold or chest infection?.....
_____
_____

1. YES
2. NO..**GO TO FB4**
8. DON'T KNOW..**GO TO FB4**
9. REFUSED..**GO TO FB4**

FB2. **Over the last 12 months,** has this child's dry cough at night.....
_____
_____

1. Increased
2. Stayed the same
3. Decreased
8. DON'T KNOW
9. REFUSED

FB3. **In the last 12 months,** how often, on average has this child had a dry cough at night?.....
_____
_____

1. Less than 1 night per week
2. 1 or more nights per week
8. DON'T KNOW
9. REFUSED

WHEEZING

FB4. Has this child had wheezing or whistling in the chest **in the last 12 months?**..... 1. YES
2. NO..**GO TO FB7**
8. DON'T KNOW..**GO TO FB7**
9. REFUSED..**GO TO FB7**

FB5. **In the last 12 months,** how often, on average has your child's sleep been disturbed due to wheezing?.....1. Never
2. Less than 1 night per week
3. 1 or more nights per week
8. DON'T KNOW
9. REFUSED

FB6. **In the last 12 months,** has wheezing ever been severe enough to limit your child's speech to only one or two words at a time between breaths?..... 1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB7. **In the last 12 months,** has your child's chest sounded wheezy during or after exercise?..... 1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB8. Has this child **ever** had wheezing or whistling in the chest at any time in the past?..... 1. YES
2. NO..**GO TO FB11**
8. DON'T KNOW..**GO TO FB11**
9. REFUSED..**GO TO FB11**

FB9. At what age did this child **first** wheeze?..... _____years
88. DON'T KNOW
99. REFUSED

FB9a. What was the calendar year?..... _____
8888. DON'T KNOW
9999. REFUSED

FB10. At what age did this child **last** wheeze?..... _____years
88. DON'T KNOW
99. REFUSED

FB10a. What was the calendar year?..... _____
8888. DON'T KNOW
9999. REFUSED

SHORTNESS OF BREATH

FB11. **In the last 12 months,** has this child had episodes of shortness of breath? ..... 1. YES
2. NO..**GO TO FB13**
8. DON'T KNOW..**GO TO FB13**
9. REFUSED..**GO TO FB13**

FB12. **In the last 12 months,** how often, on average has this child had shortness of breath?.....
1. Less than once per week
2. More than once per week
8. DON'T KNOW
9. REFUSED

OVERALL BREATHING

FB13. **Compared to 12 months ago**, which of the following best describes your child's overall breathing now?.....
1. Worse
2. The same
3. Improved
8. DON'T KNOW
9. REFUSED

INTERFERENCE WITH USUAL ACTIVITIES

FB14. **In the last 12 months,** how often did you limit this child's activities that he/she wanted to do (excluding school attendance) due to wheezing, dry cough, and/or breathing difficulties?.....
1. Never
2. Less than 1 time per week
3. 1 or more times a week
4. Almost daily
8. DON'T KNOW
9. REFUSED

FB15. **In the last 12 months,** how often did this child miss school due to wheezing, dry cough, and/or breathing difficulties?.....
1. Never
2. Less than 1 day per month
3. 1-3 days per month
4. About 1 day per week
5. More than 1 day per week
8. DON'T KNOW
9. REFUSED

FB16. **In the last 12 months,** how many times did this child go to an emergency room due to wheezing, dry cough, and/or breathing difficulties?..... _____ times
888. DON'T KNOW
999. REFUSED

FB17. **In the last 12 months,** how many times did this child go to the doctor's office due to wheezing, dry cough, and/or breathing difficulties?..... _____ times
888. DON'T KNOW
999. REFUSED

FB18. Has this child **ever** been hospitalized overnight for breathing difficulties?.....
1. YES
2. NO..**GO TO FB21**
8. DON'T KNOW..**GO TO FB21**
9. REFUSED..**GO TO FB21**

FB19. How old was this child **the first time** she/he was hospitalized for breathing difficulties?..... _____years
88. DON'T KNOW
99. REFUSED

FB19a. What was the calendar year?..... _____
8888. DON'T KNOW
9999. REFUSED

FB20. How old was this child **the last time** she/he was hospitalized for breathing difficulties?..... _____years
88. DON'T KNOW
99. REFUSED

FB20a. What was the calendar year?..... _____
8888. DON'T KNOW
9999. REFUSED

MEDICATIONS

FB21. Has this child **ever** taken medication for asthma or another breathing difficulty?.....1. YES
2. NO.. **GO TO FB23**
8. DON'T KNOW..**GO TO FB23**
9. REFUSED..**GO TO FB23**

FB22. **In the last 12 months**, has this child taken medications for asthma or any other breathing difficulty?.....1. YES
2. NO.. **GO TO FB23**
8. DON'T KNOW.. **GO TO FB23**
9. REFUSED.. **GO TO FB23**

FB22a. List these medications: (WRITE 88 FOR "DON'T KNOW" OR 99 FOR "REFUSED" RESPONSES)

Medication #1: _____
Medication #2: _____
Medication #3: _____
Medication #4: _____
Medication #5: _____
Medication #6: _____
Medication #7: _____
Medication #8: _____
Medication #9: _____
Medication #10: _____

DIAGNOSES

FB23. Has this child **ever** had asthma?..... 1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB24. Did a doctor **ever** tell you that this child had asthma?..... 1. YES
2. NO..**GO TO FB26**
8. DON'T KNOW..**GO TO FB26**
9. REFUSED..**GO TO FB26**

FB25. At what age was this child first diagnosed with asthma?..... _____years
88. DON'T KNOW

99. REFUSED

FB25a. What was the calendar year?..... _____
8888. DON'T KNOW
9999. REFUSED

CIGARETTE SMOKE

FB26. Has this child **ever** smoked cigarettes regularly -- that is, smoked daily for at least a month?.....1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB27. Did anyone regularly smoke cigarettes inside your home during any part of 1998?.....1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB28. Did anyone regularly smoke cigarettes inside your home during any time between 1993 and 1997 (inclusive)?..... 1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FB29. Did anyone regularly smoke cigarettes in your home prior to 1993?.....1. YES
2. NO
8. DON'T KNOW
9. REFUSED

FC1. Thank you very much for answering these questions.

COMMENTS:

Appendix C

Physician's Checklist

Appendix C: Physician's Checklist

Evaluation Checklist and Summary
*(To be completed by **physician** during the evaluation)*

Child's Name: _____ SSN:_____-___-_____ ID Number_____

Directions: mark each line with an "X" in the appropriate blank.

YES	NO	Don't Know	History of ...
_____	_____	_____	.....recurrent cough
_____	_____	_____	.....cough worse at night
_____	_____	_____	.....recurrent wheeze
_____	_____	_____	.....recurrent difficulty breathing
_____	_____	_____	.....recurrent chest tightness
_____	_____	_____	.....previous diagnosis of asthma
_____	_____	_____	.....symptoms at night (awakening patient)
_____	_____	_____	.....bronchopulmonary dysplasia
_____	_____	_____	.....pneumonia
_____	_____	_____	.....smoking in household or day care (past)
_____	_____	_____	.....smoking in household or day care (present)
_____	_____	_____	.....patient smoking (past, more than once)
_____	_____	_____	.....patient smoking (current)
_____	_____	_____	.....family members with atopic disease
_____	_____	_____	.....onset or worsening of respiratory symptoms after January 1993
_____	_____	_____	.....improvement in respiratory symptoms since September 1997

YES	NO	Don't Know	Symptoms occur or worsen with exposure to...
_____	_____	_____	.....exercise
_____	_____	_____	.....viral infection
_____	_____	_____	.....animals with fur or feathers
_____	_____	_____	.....house-dust mites (via mattresses, pillows, upholstery, carpets)
_____	_____	_____	.....mold
_____	_____	_____	.....airborne irritants (smoke, odors, chemicals, dust, vapors)
_____	_____	_____	.....pollen
_____	_____	_____	.....cold air
_____	_____	_____	.....strong emotions (laughing or crying hard)

YES	NO	Don't Know	Physical examination revealed...
_____	_____	_____	.....expiratory wheezing with normal breathing
_____	_____	_____	.....hyperexpansion of the thorax
_____	_____	_____	.....increased nasal secretion, mucosal swelling, or nasal polyps
_____	_____	_____	.....allergic skin condition (e.g., atopic dermatitis/eczema)

***Note: Adapted from NIH Pub.No. 97-4051;*"*Guidelines for the Diagnosis and Management of Asthma.*"**

Appendix D

Diagnosis Form

Appendix D: Diagnosis Form

PHYSICIAN'S OUTCOME SHEET

DIAGNOSIS	CIRCLE ONE				
This patient's **diagnosis** is best described as:	1	2	3	4	5

CHOICES

1. **ASTHMA IS PRESENT.**
   The diagnosis is supported by the history **AND** pulmonary function tests.

2. **ASTHMA IS PRESENT.**
   The diagnosis is supported by the history **WITHOUT** abnormal pulmonary function tests.

3. **ASTHMA IS POSSIBLE.**
   The diagnosis cannot be made or excluded without further observation.

4. **ASTHMA IS NOT PRESENT.**
   The diagnosis is excluded by the history and the pulmonary function tests.

5. **OTHER**

   Diagnosis:_____

   Supported by:_____

_____

_____

_____