Assessing Exposure Factors of Asthmatic Children

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BACKGROUND

Introduction

Since 1980, there has been a 75% increase in the prevalence of asthma in children in the U.S. The Tampa Asthmatic Children's Study (TACS) was one of a number of pilot studies conducted to evaluate methods for assessing asthmatic children's (< 6 yrs.) exposures to air pollutants.

PURPOSE

To develop and evaluate the accuracy of survey and direct measure instruments to be used for the estimate of exposure, dose, and risk. The evaluations used known facts, data, assumptions, inferences, and professional observations of exposure scenarios.

MATERIALS AND METHODS

Nine asthmatic children who did not attend preschool or daycare programs were recruited for personal, residential indoor and outdoor, and central site monitoring. The concentrations of combustion related products, PM and air toxics were monitored over a 4 day period, including weekdays and weekends. Residence, participant and follow-up survey information were collected, and the children's daily activities (including their locations) were recorded every 15 minutes by the parents in a time activity diary (TAD). The children wore an accelerometer on one ankle to obtain an objective and direct measure of exertion (e.g. sedentary, light, moderate, and vigorous). Data from the diaries were also used to estimate the activity exertion levels and energy expenditures of the child. The ventilation rates and potential dose were calculated using the following equations:

Eq. 1. Ventilation Rate (V_E) = EE x H x VQ

EE=energy expenditure,
H= average O2 uptake,
VQ= ventilation equivalent for O2

Eq. 2. Potential Dose (PD) =V_E (m3/day) x PE (ug/m3)

V_E = Ventilation Rate
PE = potential exposure

Table.1. Potential Dose

Participant	Ventilation Rate (V_E =m^3/day)	Potential Exopsure (ug/m^3)	Potential Dose (ug/day)
1	8.2	11.4	93.5
3	3.6	10.5	37.8
4	3.2	16.5	52.8
5	4.4	10.3	45.3
6	6.7	18.4	123.3
7	3.7	16.3	60.3
8	1.9	9.3	17.7
9	4.8	7.6	36.5

RESULTS

The concentrations of the monitored pollutants were within the acceptable limits for the National Ambient Air Quality Standards (Table.2). Variations in PM and peak concentrations measured with continuous nephelometers were consistent with activity and exertion information collected from the TADs, residence surveys, participant surveys and follow-up questionnaires. Digital accelerometer exertion data and time activity diary information were highly correlated (r=0.9). On average, the children participated in sedentary activities 45% of the time and spent 81% of their time indoors at home. Their estimated ventilation rates averaged 39% less than the predicted rates for children without asthma for the same age, gender and body mass class, as determined using the Child Specific Exposure Factors Handbook (Table. 1, figs.1 & 2).

Table 2. Pollutant Concentrations

Pollutants	Mean (ppb)	Min (ppb)	Max (ppb)
Personal Ozone	9.6	3.1	28.2
Indoor Ozone	7.4	2.7	28.2
Outdoor Ozone	22.4	8.5	35.8
Ambient Ozone	32.5	11.5	70.5
Personal NO_2	30.0	9.7	174.6
Indoor NO_2	24.1	9.9	134.1
Outdoor NO_2	38.3	8.0	163.9
Ambient NO_2	38.3	18.3	170.7
Personal SO_2	2.5	0.5	14.5
Indoor SO_2	3.5	0.5	16.8
Outdoor SO_2	2.2	0.9	5.8
Ambient SO_2	2.6	1.4	7.2

Table 3. Exposure Factors

Exposure factors	Results
Age of Dwelling	Avg = 27 yrs
Air Conditioning	100% (Central 78%)
Heat source Electric	100%
Cooking fuel Electric	100%
Smokers in home	0%
Mildew	0%
Dust	56% med to heavy
Carpet in child's room	55%
Pets	33%
Air exchange	Avg = 0.3/hr

CONCLUSIONS

The information collected from the surveys and questionnaires were useful for identifying sources and activities that may impact asthmatic children's exposures to air pollutants. The lower estimated ventilation rates likely resulted in lower potential intake doses for the asthmatic children, as compared with non-asthmatic children (fig.2). However, lifestyle factors such as sedentary activities, housing factors, and the amount of time spent indoors may have a greater influence on the disease state. The observations support the need to collect data on activities and lifestyle factors in large-scale asthma studies to model asthmatic children's exposures and intake dose rates.

fig.1. Ventilation Rates (participant's vs non-asthmatics)

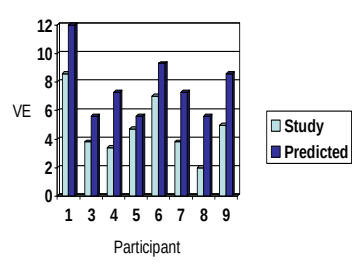
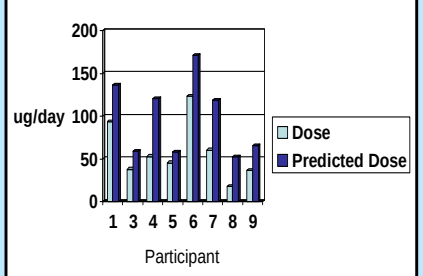


fig.2. Potential Dose vs. Predicted Dose



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