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Project Summary

Field Methods Evaluation for Estimating Polycyclic Aromatic Hydrocarbon Exposure: Children in Low-Income Families that Include Smokers

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The objective of this study is to evaluate field methods for measuring the exposure to polycyclic aromatic hydrocarbon (PAH) of children in low-income families who live in homes occupied by smokers. Under this Work Assignment, measurements of total exposure to PAH were planned for four households. The study households were selected based on the following criteria: low income, a child of preschool age who is toilet trained and who spends most of his/her time at home, and at least one adult smoker. Two households were located in downtown Durham, NC, near heavy traffic, and two were located in rural areas at Zebulon and Holly Springs, NC, away from heavy traffic. The field sampling was conducted during August 1995. Prior to the field study, study protocols, questionnaires, informed consent forms, and a Quality Systems and Implementation Plan (QSIP) were prepared. These documents were submitted to the Human Subjects Committees of Battelle, Survey Research Associates/Battelle, and U.S. Environmental Protection Agency (EPA) for approvals.

Multimedia samples collected were indoor and outdoor air, house and entryway dust, pathway soil, food, and urine. These samples were prepared for PAH and hydroxy-PAH analyses by the methods described in the QSIP. Indoor levels of B2 PAH (probable human carcinogens) ranged from 3.2 to 53 ng/m³. Outdoor B2 PAH levels ranged from 0.60 to 3.4 ng/m³. In general, the outdoor PAH levels were lower than the indoor PAH levels. The total house dust loadings ranged from 2.98 to 691 g/m². Extremely high dust loading (691 g/m²) was observed in one household. The fine dust fraction (<150μm) of these households represents 36.7% to 93.8% of the corresponding total dust loadings. Levels of B2 PAH ranged from 0.83 to 3.8 ppm in house dust, from 0.19 to 1.5 ppm in entryway dust, and from 0.029 to 1.8 ppm in pathway soil. The sum of B2 PAH concentrations found in 24-hr composite food samples were from 0.24 to 0.50 ppb for adults and from 0.16 to 0.91 ppb for children. Urinary PAH metabolites, i.e., hydroxy-PAH, ranged from <0.017 to 0.94 μg/L for adults and from <0.017 to 0.26 μg/L for children.

This Project Summary was developed by EPA's National Exposure Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Many PAHs present in air, dust, soil, and food are known carcinogens or mutagens, and adverse health effects have been linked to exposure to PAH. Children can be exposed to PAH by inhaling contaminated air, by ingesting tainted food, or by nondietary ingestion or dermal absorption from contaminated dust or soil. The exposure resulting from ingestion of dust or soil is believed to be more important for

young children because of their typical play activities.

Higher ambient PAH concentrations have been observed in air in inner city areas in comparison to rural areas, because higher mobile source emissions and local stationary source emissions exist in the inner city. For the same reasons, higher PAH concentrations have been found in the soil from inner city areas in comparison with remote rural areas, and in inner city road dust in areas with heavy traffic. Two significant indoor PAH contamination sources are environmental tobacco smoke and unvented heating appliances such as kerosene or gas space heaters.

Children from inner city and rural areas may experience different PAH exposures because of the differences in the nature and level of PAH contamination in these areas. Socioeconomic status and other factors, such as location (inner city versus rural areas), are usually adjusted for or are not considered in field studies to assess human exposure to environmental pollutants. These adjustments or omissions result in a lack of data on the relationship between these factors, and the potential for exposure of this disadvantaged group is usually ignored.

Under EPA Cooperative Agreement CR822073, a three-year study is being conducted to develop and evaluate field methods to estimate children's exposure to PAH. The preliminary results from the first phase of the cooperative study suggest that the dietary pathway is a significant route of exposure for children. That study includes children from nine low-income homes located in urban and rural areas in Durham, Zebulon, and Holly Springs, NC, and which are inhabited by nonsmokers.

It is desirable to evaluate the PAH total exposure field methodology for children in smokers' homes. Homes occupied by young children and smokers and having low household incomes were already identified under the Cooperative Agreement. In the present work assignment, the aim was to evaluate the methods, to obtain range-finding estimates of the PAH exposure of such children, and to estimate the relative importance of the inhalation, dermal, and dietary pathways for this exposure. This study was conducted with survey instruments that were previously developed under the Cooperative Agreement.

Measurements of total exposure to PAH were made for four households. The study households were selected on the basis of the following criteria: low income, a child of preschool age who is toilet trained and who spends most of his/her time at home, and at least one adult smoker. Two households selected for this study were located in downtown Durham, NC. They are within one mile of several major highways and streets, including Interstate Highway 85, U.S. Business 85, and Durham Freeway (Highway 147). The other two households were located in rural areas, one household about 25 mi northeast of Raleigh and one household about 20 mi southeast of Raleigh. The field sampling activities of this study were performed in conjunction with the Cooperative Agreement study. A total of 13 households (4 from this study and 9 from the Cooperative Agreement study) was sampled in August 1995. Multimedia samples were collected to determine PAH and hydroxy-PAH.

Results and Conclusions

In the research conducted under CR822073, we demonstrated an effective approach for conducting a screening survey for selection of households from low-income families. This approach included posting study flyers at county Special Supplement Food Program for Women, Infants and Children offices, food stamp offices, social services department, and health department, and asking eligible and interested participants to call in. We also asked interested participants to refer their friends or relatives to us. All four study households and four backup households were recruited similarly.

In general the study consent forms, pre-monitoring questionnaires, post-monitoring questionnaires, and Participant Information Booklets, which were developed under CR822073 and used here, were easy for adult subjects to understand. Adult subjects had no difficulties recording child activity diaries, adult/child food diaries, and collecting adult/child food samples. However, we found that child urine collection was difficult for three of the four adult subjects. During the post-monitoring interview, these adult subjects reported that it was difficult to collect child urine samples through the urine collectors (bonnets) because their children were not used to the urine collectors. In one household, the adult subject was unable to collect two out of four child urine grab samples. Participants' feedback about the study was documented during the post-monitoring interview. They responded that overall study activities did not burden or bother them. Three out of four participants expressed their willingness to participate again in a similar, future study even if the incentive payment were reduced from $75 to $50.

The smoking habits of three adult subjects during the field monitoring period were in agreement with their typical smoking behaviors recorded during the screening survey. The daily number of cigarettes smoked, as estimated by these three subjects in the screening survey, were similar to the number of cigarettes smoked during the field monitoring period. For the remaining adult subject, the number of cigarettes smoked during sampling was nearly four times lower than that estimated in the screening survey. It is possible that subjects changed their behavior due to the field monitoring activities, even though we asked them not to change their normal routines.

We demonstrated that the 2-day-3-house sampling protocol developed under the Cooperative Agreement could be successfully applied to both field studies. The field activities were successfully completed on time and within budget. These household screening and field sampling protocols could be modified easily for a large-scale exposure field study.

For the four study homes, the PAH concentrations in indoor air were higher than those in the corresponding outdoor air. Higher outdoor PAH concentrations were observed in the inner city as compared to rural areas. The concentrations of target PAH ranged from 0.08 to 3,600 ng/m^3 in indoor air and from 0.03 to 1,700 ng/m^3 in outdoor air. The house dust loadings in the inner city households were higher than those in the rural area households. The B2 PAH (probable human carcinogens) accounted for roughly half of all target PAH in all but one house dust, entryway soil, and pathway soil sample. The concentrations of target PAH in house dust, entryway dust, and soil ranged from 0.001 to 1.4 ppm. The concentrations of most target PAH found in 24-hr food composite samples were usually less than 1 ppb. The hydroxy-PAH concentrations ranged from <0.017 µg/mL to 0.94 µg/mL in the urine samples.

In general, total PAH exposure to both adults and children through the inhalation pathway was greater than through the dietary and nondietary ingestion pathways. However, the dietary and nondietary ingestion pathways were more important than the inhalation pathway for exposure of adults and children to nonvolatile PAH including B2 PAH.

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The complete report, entitled "Field Methods Evaluation for Estimating Polycyclic Aromatic Hydrocarbon Exposure: Children in Low-Income Families that Include Smokers," (Order No. PB97-144869; Cost: $31.00, subject to change) will be available only from
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