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Children's Pesticide Exposure in the Seattle Metropolitan Area

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Pesticide exposure among young children has received national attention since passage of the Food Quality Protection Act by Congress in 1996. Our group at the University of Washington (UW) has conducted several studies of children's exposures in agricultural communities. Recently, the U.S. Environmental Protection Agency provided us with funding to monitor children in the Seattle metropolitan area. We felt it was important to understand how children are exposed to pesticides in urban and suburban environments and to see if these exposures differed substantially from exposures in agricultural communities.

We determined children's exposure levels through analysis of urine samples for dialkylphosphate metabolites (the common breakdown products of the organophosphorus, a.k.a. OP, pesticides) and through interviews with parents about pesticide use in and around the home.

Populations Studied

Two communities located in the Seattle metropolitan area were selected for subject recruitment. Community 1 is south of the city of Seattle in King County. This area is densely populated and "urban" in nature. The residents in this area are predominantly

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lower to middle income and many reside in multi-family dwellings. Community 2 is a suburb north of Seattle in south Snohomish and north King counties. The area is inhabited predominantly by middle to upper-middle income families residing in single-family dwellings.

Children in the study were between two and five years of age. Participants included fifty-eight children from fifty families recruited from Community 1, and fifty-two children from forty-six families recruited from Community 2. The final study group consisted of fifty children from Community 1 and forty-six children from Community 2.

Biological Monitoring

Two urine samples were collected from each child. The first (spring) sample was collected in May-June of 1998, and the second (fall) sample in September-November of 1998. Urine samples were analyzed for the six common OP pesticide metabolites. OP pesticides that contain methyl groups (e.g., azinphos-methyl, phosmet, methyl parathion, malathion) can produce three dimethyl alkylphosphate metabolites, while OP pesticides that have ethyl structures (e.g., chlorpyrifos, diazinon) can produce three diethyl alkylphosphate metabolites. Collectively, these metabolites are known as dialkylphosphates, or DAPs.

Interview

Parents were interviewed at the time of the spring sample pick-up. Questions regarding residential environment included home ownership status, length of time at current residence, and housekeeping practices. Residential pesticide use information was gathered by establishing whether the household had any pets, a lawn, or a vegetable or flower garden. Families were asked if a family member or a professional had used pesticides on pets, lawn, garden, or interior of the home within the previous six months. We also asked which specific pesticide products were used and asked to see them if available. When possible we recorded the product name, EPA registration number, application date, and application location. Finally, questions were asked regarding the child’s activities and behaviors, such as the child’s frequency of hand washing, placement of hands in the mouth, and thumb sucking. A brief follow-up questionnaire was administered with the fall sample collection, focusing on insecticide use since the previous sample collection.

Key Findings

Eighty-six percent of the study children (83) had at least one measurable metabolite in the spring sampling, and 92% (88) had at least one measurable metabolite in the fall sampling. Only one of the ninety-six children had no measurable metabolites in either sample. OP pesticide concentrations were similar across seasons (spring and fall) for each community, so the two samples from each child were averaged to represent the metabolite concentrations during the study period (May to November 1998). Table 1 provides descriptive statistics of DAP concentrations in urine collected from the ninety-six study children. No significant differences were found for the median concentrations of either dimethyl or diethyl OP pesticide metabolite concentrations across communities (Mann-Whitney U test, $p > .05$). However, dimethyl concentrations were higher than diethyl DAP concentrations in both communities. Pooling data from the two communities, the median concentrations of dimethyl and diethyl DAPs were 0.11 and 0.04 µmol/L, respectively. No differences were seen based on gender or age.

The reported residential pesticide use and the corresponding median metabolite concentrations in children are listed in Table 2. Forty-nine families (predominately in Community 2) reported having a garden, and twenty-seven of them had applied pesticides in the garden in the past six months. Only one family reported use of pesticides in the week preceding sample collection. Children living in a household with a garden had significantly higher diethyl concentrations than those without a garden (Mann-Whitney U test, $p = .04$). Children had significantly higher concentrations (both dimethyl and diethyl) when living in households where garden pesticide use was reported (Mann-Whitney U test, $p = .05$ and $p = .02$ for dimethyl and diethyl metabolites, respectively). Significantly higher dimethyl concentrations were found in children who had pets in the household, but no association was found for either dimethyl or diethyl metabolite concentrations and the use of pesticides on family pets. Twenty-three families reported having their homes treated for fleas, cockroaches or other insects, and forty-five families reported using pesticides on their lawns, but children's metabolite concentrations were not significantly different from those whose parents reported no pesticide use. Figures 1 and 2 show the box plots of dimethyl and diethyl concentrations in children's urine, grouped by different residential use of pesticides. Analysis of data gathered through parental interviews regarding child behavior and family hygienic practices did not reveal any significant associations between these practices and metabolite concentrations.

Significance of the Findings

These findings indicate that nearly all children sampled in the Seattle metropolitan area had measurable OP pesticide metabolites in their urine. The most striking finding was the association between reported residential pesticide use and elevated OP pesticide metabolite concentrations in children. Children whose families reported pesticide use in their gardens had significantly higher concentrations than those who had gardens but reported no use of pesticides. Ten of twenty-seven families who reported using pesticides in their gardens used either chlorpyrifos or diazinon, both diethyl OP pesticides. Increased DAP levels were associated with OP pesticide use in the garden even where the families had not applied pesticides for months.

This biological monitoring survey documents exposures to OP pesticides among children living in urban/suburban communities. The use of urinary metabolites as biomarkers provides an estimate of exposure by all routes (dermal, respiratory, and oral) and assesses actual, rather than potential absorption. Common urinary metabolites are produced by the body following exposure to OP pesticides, so it is not possible to attribute exposure to specific OP pesticides without detailed knowledge of sources and exposure pathways. A number of OP pesticides are registered and used in the United States, and most produce these metabolites. For the findings reported here, it is likely that children's exposure to OP pesticides was the result of both ingestion of food containing pesticide residues and contact with pesticide residues in the residential environment.

Data obtained from the parental interview and follow-up questionnaire were helpful in identifying factors that may influence a child’s pesticide levels. We asked parents about home pesticide use within the previous six months. In many cases, the parent did not know the name of the product used. Often the parent being interviewed was not the parent who had applied the pesticides. If the product was still on hand, we asked to see the product and then recorded important information about the product, such as the active ingredients and the EPA registration number. In some, but not all, of the few cases where professional lawn applicator services were used, we were able to obtain information on products applied.

Socioeconomic indicators, such as annual household income and housing type, were not useful predictors of children's exposure to pesticides in this population. One child’s parents in Community 2 reported buying exclusively organic produce and did not use any pesticides at home. This child was the only subject whose urine samples showed no measurable concentrations of any of the DAP metabolites in the spring and fall samples.

Symptoms related to OP pesticide exposure in this study were not specifically examined, but none were reported by either parents or children. It is unlikely that the exposures observed in this population would have resulted in acute intoxications. There is a lack of scientific knowledge regarding the long-term health effects of low-level exposure to OP pesticides in children. This study lends support to a public health recommendation that, where possible, OP pesticide use should be avoided in areas where children are likely to play. If a residential pesticide application is necessary, it is important to follow the label instructions. Special caution should be taken to avoid contamination of surfaces that are likely to be contacted by children and other occupants. Looking ahead, we hope to sample this population again to determine whether changes are occurring in pesticide exposure among young children.

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Table 1. Methyl and ethyl OP pesticide metabolite concentrations (µmol/L) [a] in urine samples collected from children living in two communities in the Seattle metropolitan area.

	Community 1		**Community 2**		**All Children** [b]	
	Methyl [c]	Ethyl [d]	Methyl [c]	Ethyl [d]	Methyl [c]	Ethyl [d]
Mean	0.17	0.04	0.20	0.05	0.19	0.05
N	50	50	46	46	96	96
10th Percentile	0.04	0.03	0.05	0.03	0.04	0.03
25th Percentile	0.05	0.03	0.07	0.03	0.06	0.03
50th Percentile	0.10	0.03	0.11	0.04	0.11*	0.04*
75th Percentile	0.25	0.04	0.25	0.05	0.25	0.05
90th Percentile	0.45	0.06	0.48	0.10	0.45	0.07

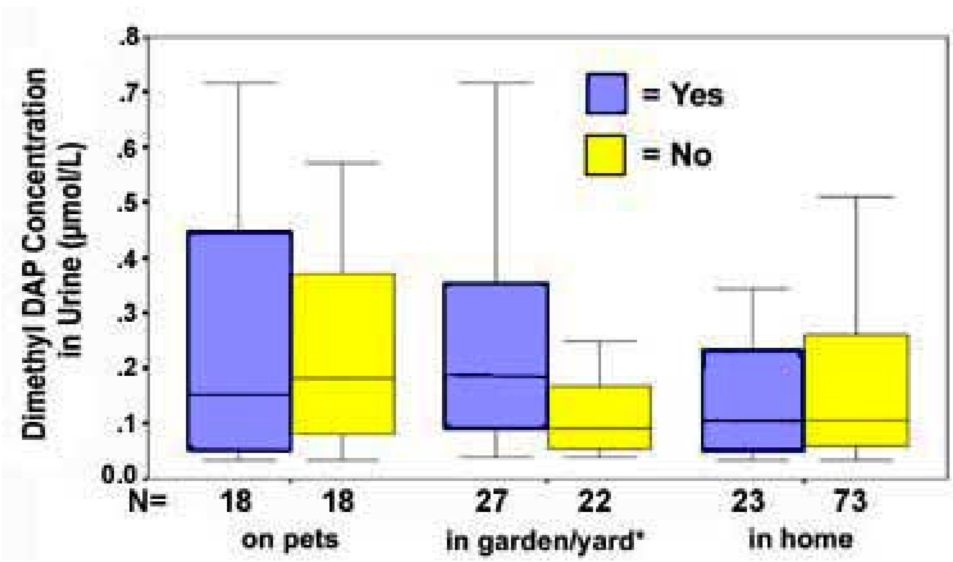
[a] Concentrations were the average of spring and fall data.
[b] Children included Community 1 and 2.
[c] Methyl is sum of DMP, DMTP, and DMDTP concentrations.
[d] Ethyl is sum of DEP and DETP concentrations.
* p<.001 (statistical test).

Table 2. Residential use of pesticides and the corresponding median dialkylphosphate concentrations (µmol/L) [a] in children living in the Seattle metropolitan area[b]

Question	Dimethyl DAP concentration (µmol/L)			Diethyl DAP concentration (µmol/L)		
	Positive response (N) [c]	Negative response (N) [c]	***p*-value** [d]	Positive response	Negative response	***p*-value** [d]
Do you have a flower/vegetable garden?	0.14 (49)	0.08 (46)	0.11	0.04	0.03	0.04
Do you apply any pesticides to your garden?	0.19 (27)	0.09 (22)	0.05	0.04	0.03	0.02
Do you apply any pesticides to your lawn?	0.14 (45)	0.09 (48)	0.13	0.04	0.04	0.68
Does this household have any cats or dogs?	0.16 (40)	0.09 (56)	0.04	0.04	0.04	0.40
Are any of the following used on your cats and/or dogs? (flea powder, flea collar, or shampoo) [e]	0.15 (18)	0.18 (18)	0.80	0.04	0.03	0.14
Since January 1998, has this home been treated for flies, fleas, cockroaches, or other insects (this includes products like Raid, fly strips, etc)?	0.11 (23)	0.11 (73)	0.35	0.03	0.04	0.27

[a] Concentrations were the average of spring and fall data.
[b] Seattle metropolitan area included Community 1 and 2.
[c] Numbers of families who responded.
[d] Whitney U-Wilcoxon Rank Sum W Test.
[e] Four families who owned a dog or cat did not answer this question.

Figure 1. Residential use of pesticides and the distribution of dimethyl dialkylphosphate concentrations (µmol/L) in children living in the Seattle metropolitan area (*significantly higher dimethyl DAP concentrations were found in children whose parents reported use of pesticides in their gardens/yards, based on statistical test, p=.05).



ED. NOTE: Figures 1 and 2 are shown in a box plot format. Box plots show the entire distribution of data that were collected. The data in a box plot represent percentiles for the data distribution. In Figures 1 and 2, the data for pesticide metabolites in urine range from the 10th percentile (the bottom of the crossed line or "t") to the 90th percentile of residues (the top of the crossed line). The ends of the box represent, respectively, the 25th and 75th percentile. The horizontal line in the box represents the 50th percentile. Fifty percent of all residues are greater than the value given for the 50th percentile (and 50% are less). Similarly, the 75th percentile value is greater than 75% of all other metabolite residue values.

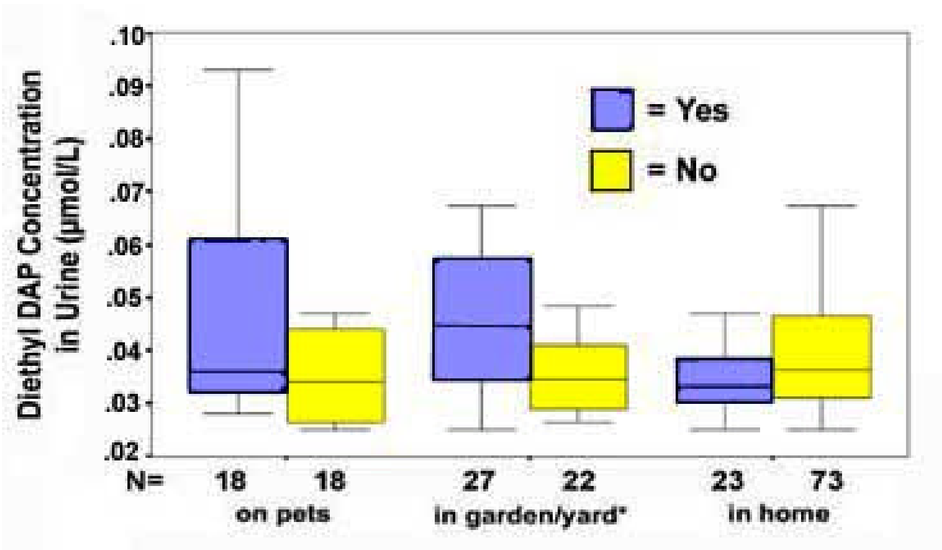


Figure 2. Residential use of pesticides and the distribution of diethyl dialkylphosphate concentrations (µmol/L) in children living in the Seattle metropolitan area (*Significantly higher diethyl DAP concentrations were found in children whose parents reported use of pesticides in their gardens/yards, based on statistical test, p=.02).

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