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Important Exposure Factors for Children

An Analysis of Laboratory and Observational Field Data Characterizing Cumulative Exposure to Pesticides

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Important Exposure Factors for Children

An Analysis of Laboratory and Observational Field Data Characterizing Cumulative Exposure to Pesticides

By

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Notice

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Abstract

In an effort to facilitate more realistic risk assessments that take into account unique childhood vulnerabilities to environmental toxicants, the U.S. EPA's National Exposure Research Laboratory (NERL) developed a framework for systematically identifying and addressing the most important sources, routes, and pathways of children's exposure to pesticides. Four priority research areas were identified as representing critical data gaps in our understanding of environmental risks to children. Several targeted studies were conducted under NERL's children's exposure research program to specifically address these priority research needs. This document is a comprehensive summary report of data collected in these studies to address the priority research needs and is intended for an audience of exposure scientists, exposure modelers, and risk assessors. The parameters measured and the measurement methods are described. Data on representative organophosphate and pyrethroid pesticides are compared across studies and across compounds with the primary purpose of identifying or evaluating important factors influencing exposures along each relevant pathway. Summary statistics, comparative analyses, and spatial and temporal patterns are presented to address previously identified data gaps. Results are compared across studies in order to identify trends that might provide a better understanding of the factors affecting children's exposures. While highlights of the results of individual studies are presented, the focus is on presenting insights gleaned from the analysis of the aggregated data from several studies. By examining relationships among application patterns, exposures, and biomarkers for multiple compounds from different classes of pesticides, this report strives to help produce more reliable approaches for assessing cumulative exposure.

Executive Summary

In an effort to facilitate more realistic risk assessments that take into account unique childhood vulnerabilities to environmental toxicants, the National Exposure Research Laboratory (NERL) in the U.S. Environmental Protection Agency's (U.S. EPA) Office of Research and Development (ORD) developed a framework for systematically identifying and addressing the most important sources, routes, and pathways of children's exposure to pesticides (Cohen Hubal *et al.,* 2000a, 2000b). Using this framework, a screening-level assessment was performed to identify the exposure pathways with the greatest potential exposures. The uncertainty associated with assessing exposure along each pathway was then evaluated through an exhaustive review of available data. Four priority research areas were identified as representing critical data gaps in our understanding of environmental risks to children. The absence of sufficient real-world data in all four of these areas produces an excessive reliance on default assumptions when assessing exposure. These *priority research areas* are: 1) pesticide use patterns; 2) spatial and temporal distributions of residues in residential dwellings; 3) dermal absorption and indirect (non-dietary) ingestion; and 4) dietary ingestion.

Several targeted studies were conducted or financially supported by NERL under the children's exposure research program to specifically address these priority research needs. These studies included:

- Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants ("CTEPP")
- First National Environmental Health Survey of Child Care Centers ("CCC")
- Biological and Environmental Monitoring for Organophosphate and Pyrethroid Pesticide Exposures in Children Living in Jacksonville, Florida ("JAX")
- Center for the Health Assessment of Mothers and Children of Salinas Quantitative Exposure Assessment Study ("CHAMACOS")
- Children's Pesticide Post-Application Exposure Study ("CPPAES")
- Distribution of Chlorpyrifos Following a Crack and Crevice Type Application in the US EPA Indoor Air Quality Test Research House ("Test House")
- Pilot Study Examining Translocation Pathways Following a Granular Application of Diazinon to Residential Lawns ("PET")
- Dietary Intake of Young Children ("DIYC")
- Characterizing Pesticide Residue Transfer Efficiencies ("Transfer")
- Food Transfer Studies ("Food")
- Feasibility of Macroactivity Approach to Assess Dermal Exposure ("Daycare")

Two studies performed prior to the identification of priority research areas also provided useful data. These were:

- National Human Exposure Assessment Survey in Arizona (NHEXAS-AZ)
- Minnesota Children's Pesticide Exposure Study ("MNCPES")

All studies involving children were observational research studies, as defined in 40 CFR Part 26.402. All study protocols and procedures to obtain the assent of the children and informed consent of their parents or guardians were reviewed and approved by an independent institutional review board (IRB) and complied with all applicable requirements of the Common Rule regarding additional protections for children. Further, all protocols regarding recruitment and treatment of participants were reviewed by the EPA Human Subjects Research Review Official (HSRRO) to assure compliance with the Federal Policy for the Protection of Human Subjects.

The studies took place in EPA research laboratories, in the EPA Indoor Air Quality Research Test House, in private residences, and in child care centers. The studies have been grouped as a) large observational field studies (NHEXAS-AZ, MNCPES, CTEPP, and CCC), b) small pilot-scale observational studies (JAX, CPPAES, DIYC, CHAMACOS, and Daycare), and c) laboratory studies (Test House, Transfer, and Food). The large observational field studies had either a regional (NHEXAS-AZ, MNCPES, CTEPP) or national (CCC) focus. A broad suite of chemical contaminants, including organophosphate and pyrethroid pesticides and their metabolites, were typically measured in multiple environmental media and in urine. Some of the small pilot-scale studies included measurements of multiple chemicals in multiple media in locations either with year-round residential pesticide use (JAX) or in close proximity to agricultural fields (CHAMACOS). Other pilot-scale studies focused on a single compound (CPPAES, DIYC, PET, Daycare). The laboratory studies (Transfer, Food, Test House) evaluated factors affecting transfer from surfaces or investigated post-application spatial and temporal variability. One of the primary objectives for all of these studies was to determine and quantify the key factors that influence exposure along the pathways relevant to the four priority research areas.

This document is a comprehensive summary report of data collected under the NERL children's exposure research program and is intended for an audience of exposure scientists, exposure modelers, and risk assessors. The parameters measured and the measurement methods are described. Data on representative organophosphate and pyrethroid pesticides are compared across studies and across compounds with the primary purpose of identifying or evaluating important factors influencing exposures along each relevant pathway. Summary statistics, comparative analyses, and spatial and temporal patterns are presented to address previously identified data gaps. Results are compared across studies in order to identify trends that might provide a better understanding of the factors affecting children's exposures. While highlights of the results of individual studies are presented, the focus is on presenting insights gleaned from the analysis of the aggregated data from several studies. By examining relationships among application patterns, exposures, and biomarkers for multiple compounds from different classes of pesticides, this report strives to help produce more reliable approaches for assessing cumulative exposure.

With limited data available to EPA researchers on the types, locations, and frequency of pesticide usage in residential and other non-occupational environments, pesticide use patterns were identified as a <u>priority research area</u>. Accordingly, pesticide use information was collected by inventory and questionnaire in each of the field studies. Questionnaire items and inventory forms differed, geographic regions represented were limited, and the total number of study participants was relatively small. Furthermore, during the period of four years covered (1997 to 2001), pesticide manufacturers were increasingly replacing organophosphates with pyrethroids in their formulations, and restrictions on residential applications of the most commonly used organophosphates were approaching. Nevertheless, important usage information was produced by the studies. Pyrethrins and their synthetic analogs (pyrethroids), specifically permethrin, cypermethrin, and allethrin, are clearly the most frequently used insecticides for indoor applications in homes and child care centers based on inventories and records. Organophosphates appear to persist in indoor environments, as chlorpyrifos and diazinon were more frequently detected in screening wipes (at frequencies comparable to permethrin) than in inventories. Among the carbamates, only propoxur and carbaryl were inventoried or reportedly used.

"Crack-and-crevice" type applications were used more often than either broadcast or total release aerosol ("fogger") applications. Applications were more likely to be performed by the resident than by a professional service in JAX, and also as reported in NHANES. In JAX, the modes of application included hand pump sprayer (37%), aerosol can (24%), fogger (3%), and baits (3%), but the pertinence of these results to other locations is unknown. Apart from these results, information on application type and method was not collected.

Pesticide products were found in at least 86% of JAX and MNCPES screening households, with a mean of three products per household. There is evidence in support of a pattern of higher application frequencies in warmer climates, with the percentage of participants reporting use in a given time period highest in Florida, lower in North Carolina and Ohio, and lowest in Minnesota. The percentage in Jacksonville, FL is substantially higher, and the percentage in Minnesota is substantially lower, than the national average reported in NHANES. In childcare centers, monthly interior pesticide applications were performed in about a third of the CCC facilities nationwide and were anecdotally found to be standard practice among daycares contacted in North Carolina.

There were no statistically significant differences in the total number of products found or reportedly used in MNCPES based on either population density (urban vs. non-urban households) or other socio-demographic factors including race, ethnicity, home type, income, and level of education. Similarly, analysis of CTEPP data found no association between application frequency and either population density or income class.

A second primary research area is spatial and temporal distributions of pesticides in residential dwellings. Spatial and temporal heterogeneity may affect exposure estimates along all exposure routes. Absorption via the inhalation route relies on the measured airborne concentration. Absorption via the dermal and indirect ingestion routes relies on the measured surface loading. Even estimates of dietary ingestion for children may depend on surface concentrations due to pesticide transfer during food preparation and handling. Examination of distribution patterns of airborne and surface residues has yielded important insights.

The organophosphate insecticides chlorpyrifos and diazinon were most frequently detected in both indoor air and outdoor air in these field studies, but the detection frequencies in outdoor air were lower and more variable across studies. Chlorpyrifos was frequently detected even after its indoor residential use was restricted, perhaps due to emissions from indoor sinks (*e.g.*, carpets) and from continued use of existing home inventories. Indoor air concentrations were typically an order of magnitude higher than outdoor air concentrations, with notable exceptions of outdoor diazinon and permethrin levels which were nearly as high as indoor levels in JAX, and outdoor diazinon levels that exceeded indoor levels in the agricultural community monitored in CHAMACOS. The low pesticide concentrations routinely measured outdoors (notwithstanding the exceptions noted) together with the relatively short time spent outdoors suggests that inhalation of outdoor air is not typically an important contributor to aggregate pesticide exposure. The similarity across large observational field studies in the variability of the observed indoor air chlorpyrifos concentrations, despite sample collection periods ranging from 1 to 7 days, suggests that air concentrations are reasonably consistent from day-to-day in the absence of a recent application.

The median indoor air concentrations of the organophosphates are higher than that of the pyrethroids. While these studies were conducted at a time when organophosphates arguably dominated the marketplace, a comparison of the mean levels of various organochlorine, organophosphate, and pyrethroid pesticides measured in CTEPP finds that the concentrations measured in the absence of recent applications appear to be strongly influenced by vapor pressure, with the more volatile pesticides, such as chlorpyrifos, found at the highest levels. Consequently, the importance of inhalation as a route of exposure for pesticides is likely to decrease as less volatile pesticides, such as the pyrethroids, are introduced into the market.

Differences in sampling methods, year of the study, and time of year when samples were collected make it difficult to distinguish any regional differences in pesticide concentrations. In general, median indoor air concentrations were somewhat higher in southern states (NHEXAS-AZ and CTEPP-NC) than in northern states (MNCPES and CTEPP-OH). However, the distributions exhibit considerable overlap across geographical locations. When daycare measurements are included, a geographical difference is less obvious, perhaps due to regular, calendar-based pesticide treatments at many daycare facilities.

Irrespective of region, differences in indoor air levels between homes and daycares were not found to be statistically significant. Similar mean indoor air levels observed in homes and daycares demonstrate the potential for continued exposure as a child spends time in other indoor locations. Additional concentration measurements in other locations would be useful to examine exposure potential from different settings such as schools, restaurants, and other public and private locations where pesticides are also applied.

Differences in indoor air concentrations associated with population density and income level were observed in the field studies. Differences between urban and rural air concentrations were observed in both MNCPES and CTEPP. In fact, urban chlorpyrifos levels were about 25% higher than rural levels across studies. A reasonable explanation may be that urban areas require more intensive use of pesticide products to control a range of pests over a wider seasonal span. Concentrations of chlorpyrifos and diazinon were higher in low-income homes than in medium/high income homes in CTEPP, but the difference was statistically significant only for diazinon, and only in NC.

Within-home spatial and temporal patterns were investigated following a crack and crevice application of chlorpyrifos in the kitchen of the Test House. The pesticide was detected even in the farthest bedroom from the application, with a concentration gradient observed from the kitchen to the den (proximal area) to the master bedroom (distal area). Temporally, airborne concentrations peaked on day 1, then decreased by approximately 80%, but were still measurable, at 21 days after application. In contrast, airborne diazinon concentrations among homes in the DIYC study were most pronounced 4-5 days after application. Between-home spatial variability following a pesticide application was investigated in the CPPAES study. Indoor air chlorpyrifos concentrations spanned more than an order of magnitude among the homes one day after application.

Significant progress has also been made in understanding spatial and temporal distributions of organophosphate residues on surfaces. In a published analysis of the MNCPES surface wipe data, Lioy and colleagues (2000) reported substantial variability in surface chlorpyrifos levels among different rooms. Substantial variability among and within rooms is also evident in the Daycare data. Furthermore, data from the Test House also show that surface loadings cannot be assumed to be homogenous even within a room. These observations suggest that multiple locations should be sampled to more accurately represent surface loadings. Exposure modelers using probabilistic methods have already begun to account for differences in surface loadings based on proximity to application sites in order to reduce possible exposure misclassification in their exposure estimates.

A number of observations suggest that there is substantial translocation of pesticides from application surfaces to adjacent surfaces, but levels remain higher at the application location. In CPPAES, the post-application chlorpyrifos loadings were higher than the pre-application values even on surfaces that did not receive a direct application. In DIYC, the transferable residues on the counters were nearly as high as those on the floors immediately after application. In JAX, the application area surface residue loadings were generally higher than the play area surface residue concentrations. In the CCC, the floor residue loadings were generally higher than the desk top loadings. High loadings of diazinon in indoor house dust following the lawn treatment in the PET study suggest that transfer into the house may also occur.

Examination of chlorpyrifos and diazinon loadings following applications indicates that *total available residue* loadings decay at a slower rate than airborne concentrations. Total available residue loadings (obtained by methods intended to measure the total amount of contaminant on a surface) also appear to decline at a slower rate than *transferable residue* loadings (intended to represent the amount that is transferred as a result of contact with the contaminated surface). In fact, using a total available residue method, chlorpyrifos was measured in 62% of the MNCPES samples, even in the absence of a recent pesticide application.

On a regional level, Jacksonville, Florida, an area known for year-round pest control issues and identified as having high pesticide usage during the NOPES study (Whitmore *et al.,* 1994), had much higher surface concentrations than any of the other studies without recent applications. Within a given region, however, there appears to be little relationship between questionnaire information and measured surface values. Previously published results from the MNCPES indicate that the residential pesticide use questions and overall screening approach used in the MNCPES were ineffective for identifying households with higher levels of individual target pesticides (Sexton *et al.,* 2003). Results from the CPPAES study suggest that cleaning activities and ventilation influence surface concentrations; it appears that the surface chlorpyrifos loadings were lower in those homes in which the occupants reported additional cleaning activities and/or high ventilation rates.

While significant progress has been made in understanding spatial distributions of organophosphate and pyrethroid pesticides in the absence of a recent application and in understanding spatial and temporal distributions of organophosphate pesticides following an application, no data have been produced on the spatial and temporal distributions of pyrethroids following applications. The movement of residentially applied insecticides follows a complex and poorly understood process of transformation and phase distribution and is influenced by several factors. Differences in physicochemical characteristics make it difficult to generalize the spatial and temporal distributions of organophosphate pesticides to pyrethroid pesticides, but with information on chemical properties and on human activities, distribution patterns can be modeled.

The third <u>primary research area</u> was identified as dermal absorption and indirect ingestion. Intake via these exposure routes is often estimated using measurements of pesticide concentrations in dust and soil and pesticide loadings on surfaces. Intake estimates also rely on numerous default exposure factor assumptions. Pesticides in dust generally had high detection frequencies, consistent with dust being considered a repository of contaminants. Detection frequencies for soil samples, on the other hand, were generally low (with the exception of measurements made immediately following lawn applications).

Compounds found at relatively higher concentrations in dust tend to be found at relatively lower concentrations in air. The less volatile pyrethroid pesticides tend to partition to the dust and may degrade more slowly allowing accumulation over time from repeated applications. This underscores the importance of dust as a primary residential exposure medium for the less volatile pesticides. In addition, the exposure factors that are important for other nonvolatile contaminants such as lead may also be important for the less volatile pesticides.

Pyrethroids generally have low vapor pressures and Henry's Law constants, thus they are poorly volatilized and exist almost entirely in the particulate phase at room temperature. Furthermore, high octanol/water (K_{ow}) and water/organic carbon (K_{oc}) partition coefficients cause pyrethroids to partition into lipids and into organic matter. With these characteristics, pyrethroids can be expected to bind readily to the particulate matter that comprises house dust. Particles resuspended by human activity then act as the primary vector for pyrethroid transport and for human exposure. Particle-bound movement and transfer of pyrethroids imply a decreased importance of the inhalation route and an increased importance of routes that involve dermal transfer, such as indirect ingestion and dermal absorption. Exposure of young children, for whom indirect ingestion of residues from object- and hand-to-mouth activities is particularly important, may be most strongly affected. In fact, algorithm-based estimates of distributions of intake of chlorpyrifos and permethrin from the four contributing routes among the CTEPP-OH children indicated that the contribution from the indirect route is much more important for permethrin than for chlorpyrifos.

Comparisons of pesticide surface loadings (ng/cm^2) showed higher levels in the CTEPP daycare centers than in the homes. This appears to be the result of higher amounts of dust in the daycare centers, as there is not as large of a difference in the pesticide concentrations (ng/g) in the dust. Studies with lead have suggested that loading may have a greater impact than concentration on actual intake, thus higher amounts of dust may be important even if the concentration within the dust is similar.

Data from our studies show that the collection methods utilized may have sizeable effects on estimates of dermal exposure and indirect ingestion. Total residue methods, which use both solvent and mechanical action to remove residues that may have penetrated into the surface, produce the highest values, followed by dust methods, and then by transferable residue methods. These methods are intended to measures different types of transfer, and efficiencies for various methods have been previously published. Use of total residue methods allows the assessor to use appropriate transfer factors to represent a transfer efficiency applicable to a given scenario. Questions remain, however, on exactly how much of what is measured by total residue methods is truly available for transfer and how much would otherwise be trapped in the pores and/or body material of the surfaces if not for the mechanical and solvent action of the methods.

Even the amount of solvent used with wipe samples affects the results. The low pesticide surface loadings obtained with 2 mL isopropyl alcohol wipes in both the NC and OH CTEPP studies (loadings similar to those obtained with the polyurethane foam [PUF] roller) suggest that the amount of IPA applied to the wipe may affect the amount of pesticide residue recovered. Surface type has also been shown to affect the collection efficiency of wipes. Recently published NERL data (Rohrer *et al.,* 2003) found that with respect to pesticide transfer, wiping from hard surfaces greatly exceeded carpet, and wiping from tile generally exceeded hardwood. Clearly, some standardization of surface sampling methods is needed.

Although successfully used in laboratory studies, the Modified C18 Surface Press Sampler was rarely able to measure pesticide residues in field studies. The original press sampler was designed to measure transfer of dust-bound pesticides to the skin from a single hand press onto a carpeted surface. The uses for the modified C18 surface press sampler have expanded to include hard surfaces and longer contact times, effectively using the press sampler in a manner for which it was not intended. Our data suggest that the sensitivity of the modified C18 surface press sampler may be too low to measure residential pesticide residues (which may transfer by both equilibrium mass transfer and mechanical transfer).

Laboratory studies using fluorescent tracers (as surrogates for pesticide residues) indicated that *tracer type*, *surface type*, *contact motion*, and *skin condition* were all significant factors. Transfer was greater with laminate (over carpet), smudge (over press), and sticky skin (over moist or dry). *Contact duration* and *pressure* (force) were not found to be important factors. The effect of surface type appeared to diminish with repeated contact, while the effect of skin condition (moist vs. dry) appeared to increase with repeated contact. Additional studies are still needed to gain a better understanding of the key factors that influence the dermal transfer and indirect ingestion of pesticides.

The frequencies of hand- and object-to-mouth contacts were quantified for preschool children in the CTEPP and CPPEAS studies using the Virtual Timing Device (VTD) software (Zartarian *et al.*. 1997). The CPPAES results support the use of the commonly assumed median count of 9.5 hand-to-mouth contacts per hour; however CTEPP data suggest a much higher value for younger children. The CTEPP methodology also accounts for combination hand- and object-to-mouth contacts during both eating and non-eating events.

The fourth <u>primary research area</u> was identified as dietary ingestion. Diet can be an important pathway of exposure. Foods may contain residues of pesticides and other environmental chemicals because of intentional applications or may become contaminated during processing, distribution, storage, and consumption. For certain chemicals, diet is potentially the *predominant* pathway of exposure. Children's dietary exposure to pesticides is not limited to the residues in or on foods when they are brought into the home. Children's unique handling of foods prior to consumption requires special attention, but it is rarely considered in study designs.

Based on route-specific intake estimates, dietary ingestion represented the dominant route of exposure for chlorpyrifos, diazinon, and permethrin in the CTEPP study. Unfortunately, the route that represented the dominant route of exposure was also the route with the lowest detection frequencies (approximately 2/3 of the values for permethrin in CTEPP were nondetects), which increases the uncertainty in the estimates. Substituting a fraction of the detection limit for values below the limit of detection may have a disproportionate impact on assessing the importance of the dietary route.

The most common measure of dietary exposure was by composited duplicate diet analyses. However, great care must be taken to ensure that the duplicate diet accurately reflects what is actually consumed instead of what is served because significant quantities of food may remain uneaten by children. Duplicate diets fail to capture those pesticide residues transferred to foods as a result of the child's handling of food prior to and during consumption. In DIYC, estimates of dietary intake that included excess contamination due to handling were as much as double the estimates of intake based on duplicate diet alone. These results suggest that dietary estimates based on duplicate diet may not be as reliable for young children as they are for adults.

Progress has been made in many areas and we are beginning to understand the environment that children live in, their activities, and the resulting exposures. However, research is still needed to adequately characterize the magnitude, routes and pathways of exposure. We still need to understand the key factors that influence the dermal transfer and indirect ingestion of pesticides. We need to be able to more accurately assess dietary exposure. In order to evaluate exposure models, we must be able to quantify the relationships between and among environmental concentrations of pesticides in various media, children's activities, and the results of biomarkers of exposures as measured in urine and/or blood. Exposure models outputs that include the timing and route of exposure need to be linked to PBPK models in order to develop accurate assessment of target tissue dose. Research, especially model development, needs to extend beyond single chemical aggregate exposures and dose to include exposures and risks that accumulate across chemicals and over time.

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Acknowledgments

We would like to acknowledge the many researchers and support staff who contributed to this report by their design and implementation of the included studies. The contributors are too numerous to acknowledge individually, but the organizations that collaborated on this research are listed in the report and Appendix B. This report would not be possible without all of the hard work that was put into the individual studies. A number of other researchers in the Human Exposure and Atmospheric Sciences Division, including Dr. Jianping (Jim) Xue, Mr. Thomas McCurdy, Dr. Rogelio Tornero-Velez, and Mr. M. Scott Clifton, made valuable contributions to this report by their analyses of data, reviews, and comments.

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Abbreviations and Acronyms

%Det	Percent of samples above detection limit
2,4-D	2,4-Dichlorophenoxyacetic acid
3-PBA	3-Phenoxybenzoic acid
ACH	Air exchanges per hour
AER	Air exchange rate
AEV	Application effective volume
ANOVA	Analysis of variance
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AZ	National Human Exposure Assessment Survey in Arizona
C18 Press	C18 surface press sampler
CCC	First National Environmental Health Survey of Child Care Centers Study
CDC	Centers for Disease Control
CDIM	Children's Dietary Intake Model
CHA	Center for the Health Assessment of Mothers and Children of Salinas Quantitative Exposure Assessment Study
CHAMACOS	Center for the Health Assessment of Mothers and Children of Salinas Quantitative Exposure Assessment Study
cis-P	*cis*-Permethrin
c-Perm	*cis*-Permethrin
c-Permethrin	*cis*-Permethrin
CPPAES Pre	CPPAES Study, pre-application days only
CPPAES	Children's Pesticide Post-Application Exposure Study
CRE	Creatinine
CTEPP	Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants Study
CTEPP-NC	CTEPP Study, North Carolina homes and daycares
CTEPP-NC d	CTEPP Study, North Carolina daycares only
CTEPP-NC DAYCARE	CTEPP Study, North Carolina daycares only
CTEPP-NC h	CTEPP Study, North Carolina homes only
CTEPP-NC HOME	CTEPP Study, North Carolina homes only
CTEPP-OH	CTEPP Study, Ohio homes and daycares
CTEPP-OH d	CTEPP Study, Ohio daycares only
CTEPP-OH DAYCARE	CTEPP Study, Ohio daycares only
CTEPP-OH h	CTEPP Study, Ohio homes only
CTEPP-OH HOME	CTEPP Study, Ohio homes only
DAP	Dialkylphosphate

Daycare / DAYCARE	Feasibility of Macroactivity Approach to Assess Dermal Exposure Study
Dep Coup	Deposition coupon
DC	Deposition coupon
DCHD	Duval County Health Department
DEET	N,N-diethyl-meta-toluamide
DIYC	Dietary Intake of Young Children Study
EOSHI	Environmental and Occupational Health Sciences Institute Study
Food	Food Transfer Studies
FQPA	Food Quality Protection Act
GC/ECD	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectroscopy
GLM	Generalized linear model
GM	Geometric mean
GSD	Standard deviation of the geometric mean
HUD	US Department of Housing and Urban Development
HVS3	High Volume Small Surface Sampler
ICC	Intraclass Correlation Coefficient
IMP / IMPy	2-Isopropyl-6-methyl-4-pyrimidinol
IPA	Isopropyl alcohol
IPA Wipe	Isopropyl alcohol wipe
JAX	Biological and Environmental Monitoring for Organophosphate and Pyrethroid Pesticide Exposures in Children Living in Jacksonville, Florida Study
JAX-AG	JAX Study, Aggregate Exposure Assessment phase
JAX-AGG	JAX Study, Aggregate Exposure Assessment phase
JAXAGGREGATE	JAX Study, Aggregate Exposure Assessment phase
JAX-SC	JAX Study, Screening phase
JAX-SCR	JAX Study, Screening phase
JAXSCREENING	JAX Study, Screening phase
LOD	Limit of detection
LWW	Lioy-Weisel-Wainman wipe sampler
Max	Maximum
MCPA	(4-chloro-2-methylphenoxy)acetic acid
MDA	Malathion dicarboxylic acid
MDL	Minimum detection limit
MGK 264	N-octyl bicycloheptene dicarboximide
Min	Minimum
MNCPES / MN	Minnesota Children's Pesticide Exposure Study
MPA	2-methyl-3-phenylbenzoic acid
N	Sample size
NC Daycare	CTEPP Study, North Carolina daycares only
NC DC	CTEPP Study, North Carolina daycares only
NC HM	CTEPP Study, North Carolina homes only
NC Home	CTEPP Study, North Carolina homes only

NC	North Carolina
NERL	National Exposure Research Laboratory
NHANES	National Health and Nutrition Examination Survey Study
NHEXAS-AZ	National Human Exposure Assessment Survey in Arizona
NOPES	Non-Occupational Pesticide Exposure Study
NRMRL	National Risk Management Research Laboratory
OCHP	Office of Children's Health Protection
OH Daycare	CTEPP Study, Ohio daycares only
OH DC	CTEPP Study, Ohio daycares only
OH HM	CTEPP Study, Ohio homes only
OH Home	CTEPP Study, Ohio homes only
OH	CTEPP Study, Ohio
OP	Organophosphate
OPP	Office of Pesticide Programs
OPPT	Office of Pollution Prevention and Toxics
ORD	Office of Research and Development
P25	25^{th} percentile
P50	Median / 50^{th} percentile
P75	75^{th} percentile
P95	95^{th} percentile
PBPK	Physiologically-Based Pharmacokinetic Model
PET	A Pilot Study Examining Translocation Pathways Following a Granular Application of Diazinon to Residential Lawns Study
PUF	Polyurethane foam
PYR	Pyrethroid
REJV	Residential Exposure Joint Venture
RTI	Research Triangle Institute
SD	Standard deviation of the arithmetic mean
SHEDS	Stochastic Human Exposure and Dose Simulation Model
STAR	Science to Achieve Results
TCPY / TCP / TCPy	3,5,6-Trichloro-2-pyridinol
TE	Transfer Efficiency
TEST / TESTHOUSE / Test House	The Distribution of Chlorpyrifos Following a Crack and Crevice Type Application in the US EPA Indoor Air Quality (IAQ) Research House Study
TESTHOUSE Pre	Test House Study, pre-application day only
t-Permethrin	*trans*-Permethrin
t-Perm	*trans*-Permethrin
trans-P	*trans*-Permethrin
Transfer	Characterizing Pesticide Residue Transfer Efficiencies
US CPSC	US Consumer Product Safety Commission
US EPA	U.S. Environmental Protection Agency
VTD	Virtual Timing Device