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Individual-level Interventions to Reduce Exposure to Pesticides and Other Household Contaminants

Symposium Abstract

Intervention studies provide a unique opportunity to evaluate the effectiveness of exposure reduction strategies, to infer a potential cause-effect relationship between sources and exposure levels, and to understand the relative impact of different sources on total exposure. Individual-level intervention studies, specifically, are those studies focused on changes in individual-level behavior and exposure patterns. Individual-level interventions are particularly useful for studying exposures to pesticides and other semi-volatile organic compounds (SVOCs) due to the wide variety of sources of these compounds, particularly within the indoor environment, and relationship between personal choices, uses, and behaviors and sources. For example, products with fragrances may contain phthalates, many of which are considered endocrine disruptors; therefore, by reducing the use of fragranced products or substituting them with products without or with lower concentrations of phthalates, exposure to these compounds can be reduced at an individual level. The potential success of an intervention study was observed in a study in which elementary school-age children's diets were switched from a conventional diet to an organic food diet over a 5 day period. Using a longitudinal approach, the investigators observed a decrease in the urinary concentrations of several organophosphorus pesticides shortly after the switch to an organic diet and then an increase in concentrations once the children returned to the conventional diet. Intervention studies, however, may not always lead to reductions in exposure or may potentially result in unintended changes in exposure due to substitution. Providing alternatives and understanding the potential impact of alternatives on exposure is necessary in an effective intervention study aimed at reducing overall exposures and potential adverse health effects. This symposium on individual-level interventions related to pesticide and other SVOCs will: 1) explore issues related to the development of effective intervention studies; 2) evaluate the efficacy of intervention studies to reduce exposures; 3) discuss potential unintended consequences of interventions due to substitutions; 4) share results from longer-term follow-up after; and 5) highlight issues related to sharing results with study participants.

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Development of an Evidence-based Intervention Study to Reduce Exposures to Contaminants in Consumer Products

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In response to public demand for information to guide consumer product choices to reduce exposures to chemicals of concern, Silent Spring Institute has launched a new project to develop evidence-based recommendations for exposure reduction. Informed by our previous research characterizing varied classes of endocrine disrupting compounds (EDCs) in indoor air and house dust, we have now tested 186 products for over 65 chemicals, including phthalates, fragrances, antimicrobials, parabens, and perfluorinated compounds. Both alternative and conventional products were included in the analysis. Products were categorized either as "conventional" or "alternative" depending on advertising terminology, including "greener", "organic" or "safer"; and ingredients lists, such as being free of phthalates, parabens, and fragrances. For each product type, Silent Spring Institute submitted three to five

conventional products, which were combined into a composite sample by the analytical laboratory based on approximate market share, and one alternative product, if it was available. Antimicrobials triclosan and triclocarban were detected in conventional bar soaps, hand soaps and toothpastes. DEHP (bis(2-ethylhexyl)phthalate) was found in a vinyl shower curtain (almost 28% by weight), conventional deodorants, lip products, and nail products. Parabens, which are often used as preservatives, were found at substantially higher levels in conventional body lotions, face lotions, hand soaps, lip products, some cosmetics and hair products than in alternative products. Using these data, we have developed a protocol for household exposure reduction to be tested in an intervention study involving 20 participants who will be asked to use alternative cleaning products for 2-3 months and alternative personal care products for the final 2 weeks of the study. Samples of air, dust and urine will be collected prior, during and after product switch and used to quantify the relationship between product use and exposure.

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The Attribution of Urban and Suburban Children's Exposures to Common Pesticides Present in the Environment

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Despite the widespread use of common pesticides such as organophosphorus (OP) and synthetic pyrethroid (SP) insecticides that led to common exposure in the population, few studies have been conducted to quantitatively assess human, particularly children's, long term exposures to those pesticides. The Children Pesticide Exposure Study (CPES) was designed to establish the longitudinal daily pesticide exposure profiles in a cohort of children living in two urban and suburban communities, one in Seattle WA (CPESWA) and the other in Atlanta GA (CPESGA), using urinary metabolites as exposure biomarkers. Twenty-three children ages 3-11 who only consumed conventional diets were enrolled in the CPESWA in which two daily urine samples, daily dietary consumption and residential pesticides use information were collected from each participant for multiple consecutive days (7 to 15 days) in each of the four seasons. Children switched to organic diets for 5 consecutive days in the summer and fall sampling seasons, and their daily urine samples were analyzed for selected metabolites of OP and SP. We observed a measurable effect of reducing malathion and chlorpyrifos exposure by substituting children's conventional diets with organic food items. We also observed a seasonal effect on the OP urinary metabolite concentrations in children, which is correspondent to the consumption of fresh produce throughout the year. However, when we took into account season, age, sex, diet, and self-reported use of pesticides in a linear mixed effects model, results suggested that the combination of the use of pyrethroids in the household, dietary intake, and seasonal differences play a significant role in predicting children's exposure to synthetic pyrethroids. The findings from CPESWA support the conclusion made by the NRC's 1993 report that dietary intake of OP pesticides represents the major source of exposure in infants and young children. We also found that while CPESWA children continuously exposed to pyrethroids through their diets all year long, the exposure pattern for pyrethroids was periodically modified by episodes of relatively high exposures resulting from residential uses. The results from the CPES provide opportunities to implement effective intervention measure to further reduce pesticide exposure among children.

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A Case Study Examining the Effects of Integrated Pest Management on Pesticide Residues and Residents' Pest Control Practices

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Pesticide exposures may be elevated among residents of low-income multi-unit dwellings due to severe pest infestation and resulting misapplication of pesticides. Structural Integrated Pest Management (IPM) is focused on modifying pest habitats while relying on little or no pesticides. Studies which have evaluated IPM effectiveness have not routinely examined its impact on pesticide reductions indoors. In this study, we looked at the effect of the interventions on both resident pest control practices as well as pesticide residues by comparing both pre- and post-intervention measurements of the representative pesticide residues (chlorpyrifos, diazinon, permethrin, cypermethrin and cyfluthrin) in kitchen floor wipes. The IPM interventions included resident education, professional house cleaning and the application of low impact pesticides (e.g., gels and roach baits) by a professional pesticide applicator. It was conducted in 42 households in Boston Public Housing developments. There was a reduction in families reporting cockroach infestation (52% to 21%), as well as those reporting the use of chemical pesticides including sprays (38% to 0%) and smoke bombs (27% to 0%). Good housekeeping practices also improved (19% to 38%). With the exception of diazinon (pvalue=0.04 for reduction), mean concentration changes for the other prevalent pesticides were not significantly different from zero at the 0.05 level. Certain household attributes, however, were found to be associated with concentration change. For example, IPM training was associated with both a decrease in cyfluthrin concentrations and an increase in permethrin concentration, which may be suggestive of a pesticide substitution. In general, homes with poor housekeeping were found to have higher baseline pesticide concentrations than homes with good housekeeping and achieved greater reductions in pesticide residues, suggesting that dust reservoirs may be important sources of exposure. Public health implications: Need effective interventions to prevent residents' potential exposures to pesticides in the home. Substitutes may also be harmful.

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Residential Pesticide Use Patterns Among an Inner-City Cohort in New York City and the Impact of an Intervention to Reduce Pesticide Use and Exposure

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We report results of a pilot intervention designed to test the efficacy of integrated pest management (IMP) at reducing pest infestation and residential pesticide exposure during pregnancy among women in NYC as well as cross-sectional and longitudinal data collected on pesticide use patterns in the CCCEH Mother's

and Newborn's study. For the intervention pilot, baseline samples including a pest sighting and pesticide use questionnaire, 2-week indoor air sample and pest infestation assessment were collected from cases and controls upon enrollment. In cases, the intervention began after baseline and consisted of three main components: extensive cleaning, low-toxicity pesticide application and behavioral/health education plan. Indoor air monitoring and pest infestation assessments were repeated for cases and controls 6-8 weeks following baseline. Maternal and cord blood samples were collected upon delivery. For the CCCEH study, a questionnaire including items on reported pest sightings and pesticide use during pregnancy was administered at enrollment. Participants are also asked about pesticide use annually until the child reaches age 36 months and biannually until the child reaches age 9 years. In the intervention pilot, there was a 59% decrease in total cockroach infestation among intervention households following the intervention ($p = 0.016$). Non-intervention households showed no significant cockroach reduction. Air levels of piperonyl butoxide were significantly reduced following the intervention ($p = 0.016$). Levels of cis- and trans-permethrin decreased marginally in post-intervention compared to pre-intervention air samples in the majority of homes, and increased slightly in non-intervention homes. Levels of three pesticides in plasma were significantly lower among intervention cases (1-isopropoxyphenol, $p = 0.04$, cis-permethrin, $p = 0.03$, and trans-permethrin, $p = 0.003$). In the CCCEH cohort, cross-sectional analysis suggests overall pesticide use in the cohort remains consistent over time (88% of subjects report use during pregnancy), and high toxicity pesticide use has increased (from 47% in 2000 to 74% in 2006). Results indicate that IPM can be successful at reducing pest infestations and residential pesticide exposure; however, they are an ongoing problem in this cohort.

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Reporting Individual-level Exposure Measurements to Participants in Intervention Studies for Emerging Contaminants

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Individual-level intervention studies pose particular challenges for researchers to report results to study participants. In the past, researchers typically reported individual results only when a finding was judged clinically significant: when there was an established safety criterion and health recommendation for findings above the criterion. Increasingly, community research contexts draw on "right to know" principles that call for more complete reporting of individual results. Planning report-back in these studies requires new informed consent protocols and communications that address scientific uncertainty about relationships between exposure and health and about options for exposure reduction. We report on our methods and experience reporting individual results for 89 endocrine disruptors in air, dust, and urine; interviews with 30 of our participants who received their own results; and 25 interviews with other researchers who have conducted individual exposure report-back. Well-designed individual report-back methods in intervention studies can be an important motivator for study participation and exposure reduction behavior and improve science literacy more generally.