# Positioning through Play Clothes

## Wearable GPS Devices Track Exposures

Capturing children's exposure to pesticides is a complex and difficult task. It's especially difficult in an area where crops are sprayed, because the spray causes a one-time spike in pesticide concentrations at discrete locations. Yet getting a good estimate of exposure requires a detailed knowledge of the time children spend in pesticide-affected areas. Given the inexact methods of monitoring both time and location together, this knowledge has been hard to obtain. Now, however, wearable Global Positioning System (GPS) sensors developed by University of Washington researchers may provide a practical research tool for time–location analysis [*EHP* 111:115–122].

**High-tech tots.** Experimental clothing uses Global Positioning System technology to record children's locations while playing, enabling comparison with data on pesticide spray drift to better estimate exposures.

In the past, attempts at linking exposure duration and pollutant concentrations in well-defined areas relied on interviews or diaries, which may be subject to memory bias or reporting errors. GPS technology, in which a receiver determines its own location by comparing different satellite signals, has been used in many military and civilian applications to locate position to an accuracy of a few meters. It has not, however, been used previously in a time–location study of children's exposure to pollutants, although earlier research has shown that data gathered by a GPS unit can be effectively mapped to help assess human exposure to chemicals.

As the first part of a project to look at the role of pesticide spray drift in rural exposures, the researchers developed and tested some novel children's clothing. The clothing incorporates a GPS tracking device, allowing the researchers to map the child's location data with a geographic information system. The researchers sewed several pieces of the clothing in a variety of sizes and two styles: bib overalls and vests. Each GPS device, designed specifically for this study, contains a battery pack, central electronics unit, and antenna, and can record its position as often as every 5 seconds. In both outfits the battery and electronics unit are concealed in closed pockets on the front, and the antenna is laid horizontally along the shoulder for maximum reception.

The 11 participants in the study, who wore the clothing for 7 to 11 hours, were children of faculty and staff at the university. Elgethun says the key to the success of this feasibility study was ensuring that the 2- to 8-year-old children were receptive to the project by meeting with them early on and enlisting their parents' help. Children over age 4 preferred the vest, while the younger ones preferred the overalls. None of the children complained about the weight or restrictiveness of the clothes (although two 2-year-olds didn't care for the color or style of the overalls).

In testing the capabilities of the wired outfits, the researchers learned that the GPS signals were clearly recordable with a few exceptions. There was no reception when the child went inside a concrete/steel-frame building or walked near power substation transformers. Reception was reduced when the child went inside a wood-frame building or stood in front of an operating microwave oven. Typically the location could be resolved and mapped at 2–3 meters outdoors and 4–5 meters indoors, allowing the child to be located in individual rooms, on specific parts of a playground, or on one side or the other of a fence.

Based on this test, the researchers have been studying the time–location activities of children in rural areas, where pesticides are used routinely in crop production and may be dispersed over wide areas (publication of those results is upcoming). By combining their novel clothing with data about the time and place of pesticide applications and concurrent environmental monitoring, the researchers hope to characterize the children's activities and thus better understand the multiple pathways by which they may be exposed to pesticides. **–W. Conard Holton**

# Bacterial Bad Guys

## Ranking the Threat of Six Common Microbes

Studies have shown that occupants of moldy buildings can suffer from adverse health effects ranging from eye irritation to severe respiratory problems to (rarely) death. Only a fraction of the microorganisms found in living spaces have been characterized to any extent, but now a research team from Finland's National Public Health Institute reports that among the bacteria and fungi occurring in buildings, bacteria may pose the greater health risk to occupants [*EHP* 111:85–92]. The team's work provides the first hierarchical assessment of some of the dangers posed by selected noninfectious indoor microorganisms, especially those associated with water damage.

To rank the hazards of indoor microorganisms, the team selected three species each of bacteria and fungi that are typically (but not exclusively) found in water-damaged buildings, or that grow especially well in such buildings. The gram-positive bacteria *Streptomyces californicus* and *Bacillus cereus* are known inhabitants of water-damaged buildings, and the gram-negative bacterium *Pseudomonas fluorescens* is found in many indoor and outdoor environments. The fungus *Penicillium spinulosum* is regularly found in both normal and water-damaged indoor environments, whereas the fungi *Stachybotrys chartarum* and *Aspergillus versicolor* tend to accompany only heavy indoor water damage. Of the strains of bacteria and fungi studied, four were isolated in buildings with moisture problems, but two that the team found to be the most potent—*P. fluorescens* and *B. cereus*—were isolated in residences without proven water damage.

The team assessed the health impacts of these organisms, grown on an ordinary laboratory medium, by exposing them *in vitro* to mouse and human cells. The team evaluated the effects of the organisms by measuring the cells' production of interleukin 1β, interleukin 6, tumor necrosis factor-α, and nitric oxide (all of which are involved in inflammation response) and by measuring cell viability. The team tested a range of concentrations of the organisms as well as a range of exposure times of up to 48 hours.

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When comparing equivalent numbers of each organism, the team found the three bacteria to be the more potent inflammation stimulators, and ranked them in the order *P. fluorescens*, then *S. californicus*, then *B. cereus*. The fungi followed the bacteria in potency, in the order *Sta. chartarum*, then *A. versicolor*, then *Pe. spinulosum*. The team found the results regarding cell viability to be less definitive, but ranked the organisms to reflect more pronounced effects from some fungi and reduced effects from some bacteria: *P. fluorescens* (most potent), *Sta. chartarum*, *S. californicus*, *A. versicolor*, *B. cereus*, and finally *Pe. spinulosum* (least potent).

Although the team's findings provide some of the first guidance on the degree to which the microorganisms of the indoor environment can affect human health, much research remains to be done, acknowledges first author Kati Huttunen. For instance, additional studies should evaluate lower organism concentrations and longer exposure times that more closely approximate those found in indoor environments. Other research should assess the importance of surface and building materials as growth media on the toxin production of fungi and bacteria, and investigate synergistic or antagonistic effects that could occur with other organisms or substances in the indoor environment. Finally, further study should focus on other microorganisms, as well as other strains of these six organisms, and explore health criteria other than inflammation and cell viability, both *in vitro* and *in vivo*. **–Bob Weinhold**

# Prevalent Risk to Pregnant Women

## Studying Household Pesticide Exposures

Traditionally, risk assessment of pesticide exposure has focused on agricultural and occupational use of pesticides. However, there is growing evidence that pesticide concentrations may be even higher in urban areas—especially within homes—than in rural areas. In this month's issue, a team of researchers led by Gertrud Berkowitz at the Mount Sinai School of Medicine report that pregnant women in New York City face considerable pesticide exposure [***EHP* 111:79–84**]. The findings are part of Mount Sinai's prospective Children's Environmental Health Study, which is examining the effects of indoor pesticide exposure on fetal growth and development among these women's babies.

Among the pesticides studied were chlorpyrifos and pentachlorophenol. Chlorpyrifos residues persist up to two weeks after application, exposing people to levels far above those recommended by the U.S. Environmental Protection Agency (EPA)—potential exposure to young infants can reach levels 60–120 times greater than the EPA-recommended reference levels. Although an agreement between the EPA and pesticide manufacturers ended the sale of virtually all household-use products containing chlorpyrifos by late 2001, at the time the study was being set up (1998), chlorpyrifos was the most frequently used pesticide in Manhattan and Brooklyn, and the chemical may still be stored in some homes. Pentachlorophenol is used as a fungicide and herbicide, and was widely used as a wood preservative until the 1970s.

Other studies have quantitated urban use of household pesticides and measured pesticide exposure in adults and children. This is the first, however, to look at urinary pesticide metabolites in pregnant women as a marker of their exposure to these chemicals.

For this part of the study, the cohort included 386 pregnant Hispanic, black, white, and mixed-race women who went on to give birth at Mount Sinai Hospital between May 1998 and July 2001. The researchers collected a urine specimen from each woman during her third trimester and quantified the levels of urinary pesticide metabolites. Each woman also filled out a questionnaire that assessed her exposure to pesticides in her home and in common areas of her apartment building.

When considering reported pesticide use by someone living within the home, exposure was higher among black and Hispanic women, younger women, and single and cohabiting (versus married) women. However, when considering any reported pesticide use, including that by an exterminator or building employee (such as a superintendant), the sociodemographic differences disappeared. Only 46.4% of the women reported that they or a family member had applied pesticides during the woman's pregnancy. However, when pesticides applied by exterminators and building employees were also considered, a total of 72.3% of this pregnant cohort were exposed, a number close to the 80% previously reported for a different pregnant New York cohort.

However, the researchers found that pesticide metabolite levels were higher in this population than in some previously described populations. For example, the median metabolite concentration of 11.3 µg/g for chlorpyrifos was similar to that found in another recent study of children but higher than the median found in the National Health and Nutrition Examination Survey (NHANES) III. Similarly, the median metabolite concentration of 7.3 µg/g for pentachlorophenol was over six times that found in NHANES III but similar to levels among children in a recently reported German study.

To explain the discrepancies between questionnaire and metabolite data, the researchers point out that questionnaires tend to yield only limited information on the specific type and amount of exposure, and are also subject to over- and underreporting. On the other hand, metabolite data reflect not only home-use pesticide exposures but also exposures through food, the workplace, and other sources. While understandable, these limitations point up the difficulty of accurately estimating pesticide exposure and should be considered, the authors say, when interpreting the results of this and similar studies. **–Victoria McGovern**

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**Not what you were expecting?** New research shows that indoor pesticide residues, which can persist weeks after use, leave pregnant women particularly at risk, especially in urban areas.