Pilot Study of The Potential for Human Exposures to Pet-borne Diazinon Residues Following Lawn Applications in North Carolina

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Abstract

This study examined the potential for indoor/outdoor pet dogs to transport and translocate diazinon residues into homes and onto occupants following residential lawn applications. One primary objective was to investigate the potential exposures of children and their pet dogs to diazinon after a lawn application at their homes. Six families and their pet dogs were recruited into the study within a 50-mile radius of the Research Triangle Park area of North Carolina. Monitoring was conducted at pre-, 1, 2, 4, and 8 days post-application of a commercial formulation of diazinon by the homeowner. Environmental samples that were collected consisted of indoor air, soil, dust, and transferable residues from lawns and floors. First morning void urine samples were collected from both a child (< 14 years) and their parent. Samples taken from the dogs included fur clippings, paw wipes, and transferable residues using cotton gloves. Transferable residues were collected from dogs by a technician, stroking the dog five times (head-to-rump) each sampling day and by each child playing with their pet for 15-minutes on Day 2 post-application. All samples were analyzed for diazinon, except for urine, by GC/MS. Urine samples were analyzed for 2-isopropyl-6-methyl-pyrimidin-4-ol (IMPy), the specific metabolite for diazinon, by HPLC/MS-MS. We report here the levels of diazinon measured in fur clipping, paw wipe, and transferable residue samples and urinary IMPy concentrations for children and adults.

Introduction

Diazinon is an organophosphorus insecticide that was commonly used to control for insect pests on residential lawns and gardens. About 4 million lbs of diazinon were applied annually at residences in the United States until December 2004. The U.S. Environmental Protection Agency (USEPA) restricted the use of this insecticide for almost all residential and other similar settings (e.g., schools, parks) where children could be potentially exposed (USEPA, 2006).

A few studies have reported the intrusion of diazinon inside homes after outdoor applications on lawns or perimeters of residences (Lewis et al., 2001; Morgan et al., 2001). These studies have suggested that the applied diazinon was likely being tracked in by occupants or migrating by air into homes after outdoor applications. In addition, pet dogs may be an important factor for the intrusion of pesticides such as diazinon into homes after lawn applications (Morgan et al., 2001; Nishioka et al., 2001). Pesticide residues tracked in by pet dogs may be deposited onto surfaces and volatilize or resuspended into air, potentially exposing occupants. In addition, pets may transfer pesticides to humans through direct intimate contact such as petting, playing, kissing, licking and resting on laps (Boone et al, 2001; Morgan et al., 2001). Residues sorbed to pet hair and skin may readily transfer to human hands or clothing during such contacts as well.

Humans can be potentially exposed to this semi-volatile insecticide through the inhalation, ingestion, and dermal routes of exposure. Once diazinon is absorbed, it is rapidly metabolized into several metabolites including diethylphosphate (DEP), diethylthiophosphate (DETP), and 2-isopropyl-6-methyl-4-pyrimidiol in the body (IMPy; Garfitt et al., 2002; CDC, 2005). IMPy is commonly used as the specific urinary biomarker of exposure to diazinon.

In this observational study, the objectives were to investigate the potential exposures of occupants and their pet dogs to diazinon after a lawn application at their homes and determine if intimate contacts between occupants and their pet dogs resulted in measurable exposures.

Study Design

Participants
- Six families with a child (<14 yrs.) and pet dog (>1 yr)
- Homeowner planning to apply a granular formulation of diazinon to the lawn

Study Site
- Piedmont area of North Carolina
- Single family residences

Duration
- Study conducted from April to August 2001
- Field sampling occurred over a 9-day period at each home

The study protocol 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.

Sampling Protocol

Table 1 shows the types of samples that were collected at pre-application and 1, 2, 4, and 8 days post-application of diazinon to residential lawns. Results for the personal samples collected in this study (purple text) are presented in this poster.

Table 1. Samples collected at each home during the study.

Medium	Pre	1	2	4	8
Air (Living Room)	X	X	X	X	X
Air (Child's Bedroom)	X	X	X	X	X
PUF Roller (Turf)	X	X	X	X	X
PUF Roller (Indoors)	X	X	X	X	X
Soil	X	X	X	X	X
Entryway (Doormat)			X	X	X
Track-in (HVS3)	X		X	X	X
Urine Void (Adult)[a]	X	X	X	X	X
Urine Void (Child)[a]	X	X	X	X	X
Fur Clippings (Dog)	X	X	X	X	X
Paw Wipes (Dog)	X	X	X	X	X
Cotton Gloves (Child)			X		
Cotton Glove (Technician)	X	X	X	X	X

[a]First morning void

Participant Information

The children's ages ranged from 5 to 13 years. Four of the children were female and two were male. Table 2 has shown the physical characteristics of the pet dogs in this study.

Table 2. Physical characteristics of the dogs.

Dog	Age (yr)	Gender	Weight (lbs)	Breed	Hair Type
Dog 1	3	Male	40	Bulldog/Boxer mix	Short
Dog 2	5	Female	40	Basset Hound/Saint Bernard/ Golden Retriever mix	Medium
Dog 3	2	Male	12	Lhasa Apso	Medium
Dog 4	7	Male	10	Pomeranian	Long
Dog 5	9	Female	75	Black Labrador	Short
Dog 6	3	Male	75	Alaskan Malamute	Long

Results

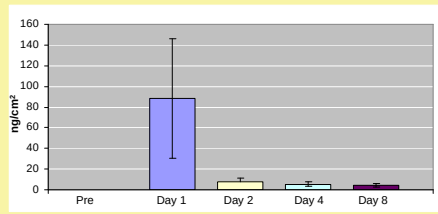
Paw wipes (Figure 1a). The mean loadings of diazinon on the dogs' paws were over 900 times greater on day 1 post-application (88.1±100.1 ng/cm^2) compared to pre-application (<0.09 ng/cm^2), and these residues remained elevated above background levels up to day 8 post-application.

Fur clippings (Figure 1b). The levels of diazinon on the fur clippings were on average at least 14 times higher on each sampling day post-application than at pre-application of diazinon (0.8±0.4 ng/cm^2) to the lawns.

Cotton glove (Technician; Figure 1c). The mean loadings of diazinon were highest on the technician's glove samples on day 1 post-application (10.4±23.9 ng/cm^2), but declined substantially by day 2 post-application (1.3±1.4 ng/cm^2).

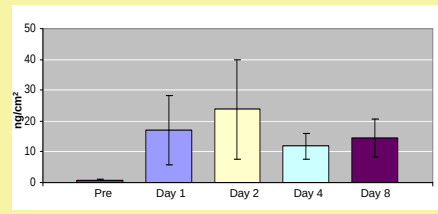
Cotton gloves (Child; Figure 1d). The loadings of diazinon on the children's cotton glove samples ranged from <0.01 ng/cm^2 to 53.7 ng/cm^2 on day 2 post-application.

Urine (Figure 2). IMPy concentrations for the participants' ranged from <0.3 to 5.5 ng/mL before application and <0.3 ng/mL to 12.5 ng/mL after application of diazinon. The maximum IMPy concentrations occurred for one child (6.2 ng/mL) and one adult (12.5 ng/mL) from different households on Day 1 post-application of diazinon to turf. The mean urinary IMPy concentrations for children or adults were not statistically different ($p<0.05$) at pre-application compared to post-application of diazinon to turf at these homes.



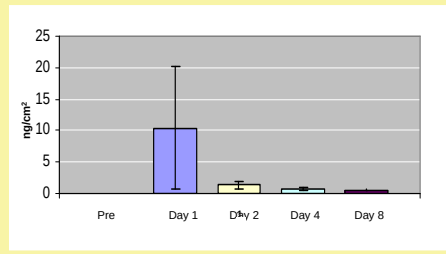
[a]Standard error bars
[b]Samples from three dogs were lost due to laboratory error

Figure 1a. Mean loadings of diazinon on the paws of the dogs at each sampling interval.



[a]Standard error bars

Figure 1b. Mean loadings of diazinon on the fur of dogs at each sampling interval.



[a]Standard error bars

Figure 1c. Mean loadings of diazinon on the cotton glove worn by the technician at each sampling interval.

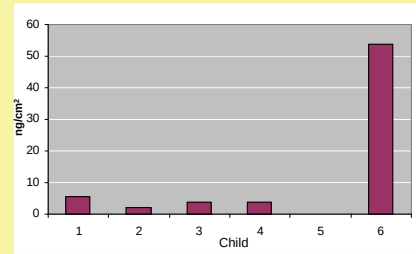
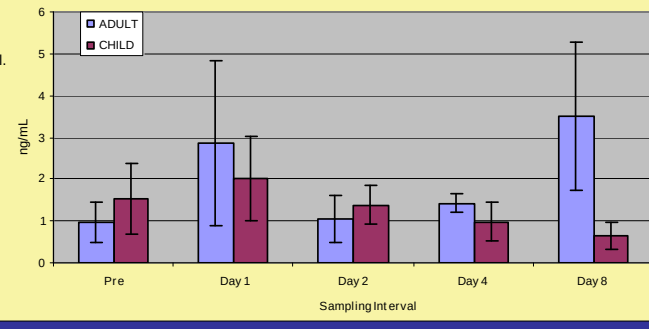


Figure 1d. Mean loadings of diazinon on the cotton gloves worn by each child on day 2 post-application.

Figure 2. Urinary IMPy concentrations for children and adults at each sampling interval.



Discussion

- These participants were likely exposed to low levels of diazinon through several sources (i.e., air, dust, floors, and lawns) and routes (i.e., inhalation, dermal, and ingestion) after application to turf at their homes.
- The pet dogs were exposed to substantial amounts of diazinon residues on their paws and fur after application of diazinon to the lawns.
- The pet dog appears to be a good vehicle (pathway) for tracking in and translocating diazinon residues inside the homes.
- The participants were probably exposed to low levels of diazinon residues through intimate contacts (i.e., petting) with their pet dogs.
- Based on the urinary biomarker of exposure (IMPy), these participants appeared to have similar exposures to diazinon before and after application of diazinon to their lawns.
- The participants' exposures to diazinon may have been underestimated based solely on first morning void urine samples. After our study was conducted, Garfitt et al., 2002 reported that the urinary elimination half-lives for DEP and DETP through oral and dermal exposure were about ~2 and 12 hrs, respectively, in humans.

References

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