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Health Complaints Related to Pesticide Stored at a Public Health Clinic

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Employees at a health center in Georgia were concerned that symptoms experienced by some employees were related to pesticide exposure at the center. Malathion and DDT, used for mosquito control from 1969 to 1981, had been stored and handled at the center's first floor. We surveyed 117 (91%) of 129 employees to determine whether reported symptoms were associated with pesticide exposure. We performed environmental sampling for pesticides. We analyzed serum samples for 17 chlorinated pesticides, and urine samples for malathion. We found that 37% of the participants had reported a diagnosis of sinusitis and 24% of bronchitis since working at the health center. Frequently reported symptoms were eye irritation (44%) and headache (68%). DDT and malathion were found at levels of 2.4 and 11%, respectively, in bulk samples from the loading dock of the building. Multivariate analysis of responses to the questionnaire showed that the perception of odors, inadequate air flow, and length of employment were significantly associated with the employees' health complaints. Pesticide concentrations in employees' serum and urine samples were not associated with any health complaint. The health complaints reported by the employees at the health center were precipitated by both environmental and psychological factors. The epidemiology and laboratory components of this study highlight the importance of obtaining biological measurements in episodes of perceived environmental exposure.

Key Words: **pesticides; biomarkers; environmental sampling; exposure; psychogenic.**

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BACKGROUND

The Health Center, a three-story, 55,000 square foot facility, was constructed in 1963–1964. The building serves as a County community health clinic. The majority of the space is used for clinical services. The Environmental Section of the County Health Department was housed on the first floor of the central portion of the Health Center from 1969 to 1982. The rear of the central building has a loading dock which, until the early 1980s, was used as a mixing area for pesticides such as malathion and DDT, that were used for mosquito control programs. Malathion, DDT, and other chemicals were kept in a first-floor storage room within the facility adjacent to the loading dock. There are anecdotal reports of spills occurring while personnel were mixing pesticides for spraying. On one occasion during 1982–1983, cleanup of a spill necessitated oversight by the State Environmental Protection Division and NIOSH. In 1984, after the Environmental Section was moved out of the building, the first floor was used for clinical services.

On August 8, 1995, the State Health Department, Division of Public Health, requested assistance from the Centers for Disease Control and Prevention (CDC) in conducting an investigation of possible exposure to pesticides among employees at the Health Center. The request was prompted by workers' concerns regarding health problems, which they related to possible exposure to pesticides in the building.

In response to this request, investigators from the National Center for Environmental Health (NCEH) conducted a site visit. During our site visit the storage room in the first floor had a very distinct odor and also had numerous stains on the floor that

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may have been caused by chemical spills. In addition, intermittent complaints about building-related symptoms had been noted since 1992 and these complaints had recently increased. The purpose of our study was to determine if the employees' health complaints were related to pesticide exposure at the health clinic.

METHODS

Environmental Sampling

While the building was occupied, we conducted environmental monitoring for standard indoor-air environmental quality parameters, carbon dioxide (CO_2), and volatile organic compounds (VOCs) at the health center. Measurements were obtained at various intervals (11:30 AM and 2:30 PM) and locations throughout the building (main hallways, clinic area, laboratories, second floor, and X-ray developer room). We collected two surface grab bulk samples of expansion joint material from the loading dock. In addition, we collected eight bulk samples of various materials inside the building. The items sampled were carpeting, foam from the wall, a wall partition, fiberglass insulation, ceiling tile, polyfiber, a filter from the air conditioning unit, and residue from a vacuum cleaner bag. In addition, investigators collected nine surface wipe samples to assess residual pesticide contamination. Surface wipe samples were collected by wiping areas of 100 cm^2 with 3×3 inch preextracted cotton gauze moistened with 91% isopropyl alcohol. NIOSH investigators also collected four indoor air samples in the building using OSHA versatile sampler sorbent tubes (OVS-2) and analyzed them for organophosphates. In addition, they collected five indoor-air samples using the carbotrap 300 multibed thermal desorption tubes and these were analyzed by GC/MS for volatile organic compounds (VOCs) in an attempt to identify the chemicals responsible for the odors. We also collected and analyzed four indoor-air samples for organophosphates.

Questionnaire

We conducted a cross-sectional study using a standardized questionnaire that was designed to assess physical characteristics of the work environment, pesticide exposure, and sick building syndrome and interviewed 117 (91%) of 129 health center employees to determine the relationship of reported symptoms to possible pesticide exposure or other factors. We asked for demographic data, medical history, dates and severity of symptoms, and information about environmental exposures, equipment used at work, the working environment, and stress factors associated with the employees' job or life in general. All medical and other data were self-reported. We asked the participants about the occurrence and severity of their illnesses and symptoms during four time periods:

The base time period: time of hire to July 1991, when a new building near the health center building opened. Some employees moved to the new building and others did not.

Time period 1: July 1991–May 11, 1995. This period includes the hypochlorite spill incident on May 2, 1995, and the employee evacuation on May 11.

Time period 2: May 12, 1995–July 17, 1995. During this period, the employees were working in another building near the health center.

Time period 3: July 18, 1995–July 31, 1995. During this period, employees returned to the health center and resumed their activities.

Biological Sampling

Our study also included biological sampling. We collected serum and urine samples from the first 99 of the 129 employees who volunteered for sample collection. Of the 117 employees who answered the questionnaire, 85 (72%) provided serum samples and 90 (76%) provided urine samples. We analyzed serum samples for 17 chlorinated compounds, including DDT and its metabolites, and we analyzed urine samples for malathion urinary metabolites (Table 1).

Data Analysis

The questionnaire assessed 151 predictors that we grouped into four categories: environmental (such as work or live on a farm, smoking status, air circulation, unpleasant odors, temperature changes, type of carpeting, cleanliness of the working area, new paint, new furniture), demographic (age, race, gender, marital status, number of children, educational level), phychological (such as knowing someone with similar complaints, working hard, harmony within working group, work satisfaction, promotion at work), and miscellaneous (such as equipment used, inadequate lighting, computer glare). We selected reported symptoms and illnesses for further statistical analysis if they had increased in severity or first manifested themselves while the employee was working at the health center. Statistical analysis was performed using SAS.

TABLE 1
Organochlorine and Malathion Metabolites Which Were Analyzed in Blood and Urine Samples

Chlorinated compounds	Malathion metabolites
Aldrin	Malathion diacid
DDD,*p-p*	Malathion monoacid
DDE,*p-p*	Malathion
	3-dimethylalkylphosphate
DDE,*o-p*	
DDT,*p-p*	
DDT,*o,p*	
Dieldrin	
Endrin	
Heptachlor	
Heptachlor epoxide	
Hexachlorobenzene	
Hexachlorocyclohexane, beta	
Hexachlorocyclohexane, alpha	
Hexachlorocyclohexane, delta	
Hexachlorocyclohexane, gamma	
Mirex	
Nonachlor, *trans*-oxychlordane	
PCBs	

Statistical significance was set at 0.05 with two-tailed tests of significance. All odds ratios are reported with a 95% confidence interval.

RESULTS

The indoor-air temperature (72–77°F) and relative humidity (RH) (49–57%) throughout the facility were within acceptable comfort ranges specified by ASHRAE, [1] (ASHRAE recommends that the temperature range from 68 to 74°F in winter and from 73 to 79°F in summer and that RH be maintained between 30 and 60%). Carbon dioxide measurements (575–850 ppm) were also within ASHRAE guidelines [2] and indicated that sufficient outside air was provided to occupied areas. When indoor carbon dioxide concentration exceeds 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected [2]. VOC monitoring conducted inside the building did not detect any unusual compounds, and there were no measurable differences between the indoor and the outdoor VOC concentrations. The integrated VOC monitoring did not identify the compounds responsible for the odor.

Analyses of outside bulk samples from the maintenance dock showed high concentrations of malathion (110,000 μg/g, 11%) and total DDT (24,000 μg/sample, 2.4%). Analyses of the inside bulk samples detected low concentrations of various organochlorine pesticides, the highest being 5 ppm of 4-4′-DDT detected in the first floor carpet. Trace quantities of organochlorine pesticides were detected in surface wipe samples obtained from areas inside the health center (Table 2).

Toxicologic analyses of 99 serum specimens for 17 chlorinated compounds, including DDT, and of 99 urine specimens for malathion revealed that concentrations of all chemicals were well below the median reference range of 12.6 ppb and also below the upper 95% limit for the reference range for the U.S. population (52.9 ppb) [3]. *p-p′*-DDE was detected in 86% of the samples analyzed at levels that ranged from 0.11 to 13.0 ppb (reference range median is 12.9 ppb), 12% of the samples analyzed were below the analytical detection limit, and only two serum samples contained *p-p′*-DDE at levels above the reference range median of 12.6 ppb. The levels detected in these samples were 21.6 and 36.8 ppb. However, both of these participants had the potential for substantial exposure to DDT outside the health center. Both were recent immigrants from an area in Asia where DTT use was still occurring. Two urine samples were positive for traces of malathion breakdown products.

Of the 129 employees, 117 (91%) participated in the interview. Employees ranged in age from 21 to 68 years, with a median of 43 years; 94% were female. Race distribution was 59% black, 38% white, and 3% other.

TABLE 2
Surface Sample Results

Sample discription	Compounds detected	μg/cm^2
Former pesticide storage room	Lindane	5.67
	Chlordane	0.123
	DDT	0.099
	DDE	0.098
	Diazinon	0.087
	DDD	0.036
	Dieldrin	0.050
	Heptachlor	0.0088
	Endrin	0.0042
Vinyl chair seat	Endrin	0.0067
Computer monitor	Non detect	NA
Desk chair	Non detect	NA
Top of file cabinet	Non detect	NA
Blank	DDT	0.0019
Wall, under light switch	DDD	0.016
	Chlorpyrifos	0.12
	Baythroid	0.034
Wall (chase corner), first floor bathroom	Diazinon	0.087
	Baythroid	0.017
Blank	Non detect	NA

TABLE 3

Psychological Predictors Associated with the Reported Symptoms and Illnesses, Study of Health Center, Georgia, 1995

Reported symptoms or illnesses	Predictors	OR	95% CI
Sinusitis	Knowing someone with similar symptoms	9.1	2.7–30.9
	Work hard very often	9.8	2.3–40.9
Bronchitis	None	None	None
Eye irritation	Knowing someone with similar symptoms	9.2	2.5–34.7
Headache	Knowing someone with similar symptoms	6.4	2.4–17.1
	Work hard very often	4.1	1.5–11.3

The symptoms and illnesses that employees reported increasing in severity every time they worked at the health center were sinusitis (37%), bronchitis (24%), eye irritation (44%), and headache (68%).

Lack of a college degree was the only demographic predictor significantly associated with reported symptoms and illnesses. The most significant environmental predictor from the logistic regression model was the employees' perception of unpleasant odors while they were in the building and was associated with more frequent reporting of sinusitis, eye irritation, and headache (odds ratio (OR) = 5.8, 95% confidence interval (CI) = 1.9–17.4, OR = 19.0, 95% CI = 2.9–124.4, and OR = 5.5, 95% CI = 1.8–16.2). Seventy percent of the employees reported noticing a particular odor in the work area that they characterized as "chemical." Employee perception of improper airflow was also statistically significant. Perception of too little air flow was associated with more frequent reporting of sinusitis (OR = 3.9, 95% CI = 1.2–13.2), perception of too much air and too dry air was associated with bronchitis (OR = 10.3, 95% CI = 2.7–39.3, OR = 4.4, 95% CI = 1.4–14.1, respectively), and perception of too dry air was associated with more frequent reporting of eye irritation (OR = 5.4, 95% CI = 1.4–20.4). Significant results of the logistic regression model for psychological predictors are listed in Table 3.

Working at the health center for 3 or more years and having had a recent promotion were the main miscellaneous predictors significantly associated with sinusitis (OR = 3.7, 95% CI = 1.5–8.7), bronchitis (OR = 4.3, 95% CI = 1.7–11.0), and headache (OR = 2.6, 95% CI = 1.1–6.0). Length of employment was found to be associated with having had a recent promotion and had similar odds ratios.

DISCUSSION

This study highlights the importance of incorporating biological measurements in the evaluation of episodes of perceived environmental exposure. We believe that by combining biological and environmental sampling with traditional epidemiologic techniques we were able to more fully assess the relationship of employees' symptoms to various factors in this outbreak investigation.

We found that four reported illnesses or symptoms (sinusitis, bronchitis, eye irritation, and headache) increased in severity or first manifested themselves while the affected employee was working at the health center. The common environmental factors statistically associated with these reported symptoms and illnesses are factors related to the physical characteristics of the environment. A role for these factors in the employees' illness has biological plausibility since headache, sinus congestion, and eye irritation could be attributed to poor indoor air quality [4]. Inspection of the building showed that a number of offices have the air exhaust vent in close proximity to the air intake vent, a situation that could contribute to poor indoor-air quality (Fig. 1).

Employees reported that they frequently kept exterior doors open at their work area in an attempt to increase the amount of fresh air in the building. On May 12, 1995, an assessment of the heating, ventilation, and air conditioning system had shown that the building was maintained at a slightly negative pressure relative to the pressure outdoors because of an imbalance between the outdoor supply air and the air exhaust system. This imbalance may

FIG. 1. An air exhaust vent in close proximity to the air intake vent in one of several offices at the public health clinic.

have allowed for untempered and unfiltered outdoor air to enter the building. The Environmental Protection Agency (EPA) recommends designing and operating buildings at a slightly positive or neutral pressure to reduce the effects of unwanted infiltration of unconditioned air [4].

Several factors may have contributed to the odors in the building. Floor drain traps that should ordinarily contain water were dry, resulting in sewer gas odors. The rear storage room, which at one time contained pesticides, had a very distinct odor and numerous strains on the floor. While we did not test to determine the nature of these stains we believe that they may have been caused by previous chemical spills. Although low levels of organochlorine pesticides were detected in the bulk and dust wipe samples collected inside the building, the importance of this finding is not known, since criteria for evaluating surfaces contaminated with chlorinated pesticides have not been established. Higher levels of pesticides were found in the bulk samples collected from the loading dock. Nevertheless, our analyses of biological samples indicated that employees' exposure to oganochlorine pesticides was minimal. Only two urine specimens had traces of malathion breakdown products. However, because some urine samples were obtained as long as 3 days after the employees left the building and because malathion breakdown products are usually excreted within approximately 24 h after exposure, this does not prove absence of past malathion exposure and this exposure cannot be fully excluded. We also found that having been promoted while employed at the center was associated with health complaints. Since length of employment is correlated with having been promoted, this could be an indication of extended environmental exposure. Thus, we believe that an environmental origin for the health complaints cannot be excluded because of the reported odors, improper air flow, and traces of pesticides in bulk and surface wipe samples.

In circumstances such as those at the health center, the effect of psychogenic illness also cannot be excluded as a contributing factor to some of the employees' reported symptoms. The presence of a stressful situation has been temporally related to psychogenic illness and has been postulated to be necessary for the development of a "contagion" [5]. Symptoms occurring during psychogenic illness are subjective and nonspecific in nature, frequently consisting of headache, nausea, and weakness [6]. Usually the stressor precedes or initiates the psychogenic illness [7–10]. The employees in the center have certainly experienced stressful situations: They were evacuated twice, and 15 employees required medical treatment for exposure to chlorine fumes.

We questioned the employees extensively about stressors caused by labor-management relations. Employees died report that they often worked very hard, and they perceived the management as uncaring. During the individual interviews, employees reported that their work site was somewhat dirty, and that they have been complaining about the dirtiness of the building for several years without response from management. The perceived lack of response from the management could have been another source of stress.

In a work place setting such as this, the sudden and dramatic illness of an initiator, frequently accompanied by allusions to hazardous agents in the work environment, informs others who have previously "suffered in silence" that their feelings are shared by at least one other person [6]. This "initiator hypothesis" may be applicable in the present investigation because affected employees disproportionately heard about or knew other workers who had similar symptoms. The employees frequently identified the other person as a co-worker at work.

We found that not having a college degree was associated with the illnesses or symptoms workers reported. This association does not imply a causal relationship but could have psychologic implications. In general, females without higher education are likely to find employment stressful, boring, and low paying [11]. On the basis of our data, we believe that both environmental and psychological factors contributed to the employees' reported illnesses and symptoms.

CONCLUSIONS

The illnesses and symptoms reported in this study may have been precipitated by both environmental and psychological factors which combined to increase the employees' level of concern and contributed to recurrences of symptoms when the employees were moved back to the building. Although an association of the health complaints with pesticide exposure cannot be completely excluded, biological monitoring gave no evidence of substantial exposures to malathion, DDT, or 16 other chlorinated compounds. The epidemiologic and laboratory components of this study highlight the importance of incorporating biological measurements of exposure in epidemiologic investigations of

environmental hazards. Without biological samples, we would have had to estimate employees' possible exposure on the basis of analyses of the environmental samples, which did detect pesticides. However, by measuring pesticide levels in people and finding little evidence of pesticide exposure, we were able to focus on other more likely causes of the employees' self reported symptoms.

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