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STUDY

Pesticide Patch Test Series for the Assessment of Allergic Contact Dermatitis among Banana Plantation Workers in Panama

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Background: **Irritant contact dermatitis and allergic contact dermatitis (ACD) are frequent among agricultural workers and require targeted interventions. Patch testing is necessary for differential diagnosis, but patch testing with pesticides is uncommon.**

Objective: **This study explores the frequency of ACD and sensitization to pesticides among highly exposed banana plantation workers.**

Methods: **Frequently and recently used pesticides on banana plantations in Divala, Panama, were documented. A pesticide patch test tray specific for this population was prepared. A structured interview was administered to 366 participants, followed by a complete skin examination. The pesticide patch test series, as well as a standard patch test series, was applied to 37 workers with dermatoses likely to be pesticide related and to 23 control workers without dermatoses.**

Results: **The pesticide patch tests identified 15 cases (41%) of ACD (20 positive reactions) among the 37 workers diagnosed with pesticide dermatosis. Three controls had allergic reactions to pesticides (4 positive reactions). The pesticides were carbaryl (5 cases), benomyl (4 cases), ethoprophos (3), chlorothalonil (2), imazalil (2), glyphosate (2), thiabendazole (2), chlorpyrifos (1), oxyfluorfen (1), propiconazole (1), and tridemorph (1). Ethoprophos and tridemorph had not been previously identified as sensitizers. Thus, the prevalence of ACD was 0.03 (15 of 366). On the basis of observed prevalences of positive patch-test reactions among the subgroups with and without dermatoses, we estimated that ≥ 16% of the entire population may be sensitized to pesticides.**

Conclusion: **Sensitization to pesticides among banana plantation workers is a frequent occupational health problem. Pesticide patch test trays should be used in assessing skin diseases in highly exposed workers.**

PESTICIDES ARE AN EXTREMELY HETEROGENEOUS GROUP of chemical compounds. There may be over 50,000 commercial formulations with some 600 active ingredients in common use.[1] Skin is the major route of exposure, particularly in developing countries.[2,3] Pesticides are increasingly identified as a cause of occupational skin diseases.[2] In California, for example, 150 pesticide-related skin problems were reported during 1999, representing 20% of all diseases caused by pesticides in that state.[4] In Panama, an incidence rate of 11 cases per 1,000 banana plantation workers has been reported for contact dermatitis,[5] and in 1997, pesticide-related skin disease reported to the national occupational health services made up 50% of the 661 cases.[6] In Costa Rica, a time series of pesticide-related illness showed a clear increase in topical injuries, particularly among women working in agriculture.[7]

Contact dermatitis is by far the most frequent skin disorder associated with pesticides. Some pesticides that are frequently identified as skin pathogens are propargite, benomyl, sulfur, captan, carbamates, chlorothalonil, and pyrethroids.[2,6,8,9] It has been estimated that allergic contact dermatitis (ACD) may account for 25 to 30% of the contact dermatitis cases in general, the rest being irritant contact dermatitis (ICD).[10] Different pesticides have different irritant and sensitizing properties. For example, paraquat is known as a potent skin irritant,[11] and benomyl is a frequent cause of ACD.[12] Chlorothalonil causes ICD, ACD, photoallergy and photoirritation, dyschromic skin changes (hyper- and hypopigmentation), urticaria, and anaphylactic reaction with risk of death.[2,5,6,12–14]

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In the 1980s, pesticide-related ACD became an issue, and several studies examined allergic reactions in agricultural populations and other occupationally exposed and unexposed populations on patch tests with different trays of pesticide skin patches.[15] A number of studies showed that ACD was more frequent among pesticide-exposed populations than previously thought.[5,13,15] To reach a correct diagnosis leading to proper preventive action, it was recommended that agricultural workers with contact dermatitis be patch-tested with pesticides.[15,16] Today, however, there are only a few published reports on pesticide patch test series[17–20]; these series include relatively few pesticides, mostly those used in the United States and Europe. Thus, patch testing for pesticides remains generally uncommon. One reason for the absence of commercial pesticide patch test trays is the large number of pesticides in use, along with important variations by geographic regions and crops and rapid changes with time. Patch tests for a number of pesticides have been prepared for experimental or clinical research; countries that have done so include Panama, where some experience has been built up in developing patch tests for a number of pesticides, including chlorothalonil, imazalil, thiabendazole, propiconazole, and dalaphon.[2,5,13]

This study explores the frequency of pesticide ACD and sensitization among workers highly exposed to pesticides, by means of a pesticide patch test tray specific for this population.

Materials and Methods

Subjects

Banana cultivation was selected for the study because the banana is one of the crops that are subjected to the highest pesticide use in Central America[2] and because of a high incidence of pesticide-related skin disorders among banana plantation workers.[5,6,13,21,22] Considering the wide geographic variation in pesticide use, we selected banana farms in a confined region to ensure that the test tray would evaluate the sensitization of workers to all or most of the pesticides to which they were potentially exposed. The study was carried out in the county of Divala, in the northwest plain of Panama.

Four of thirteen banana plantations in the district were randomly selected for the study. A total of 517 workers were employed at the target plantations at the start of the study, 366 (71%) of whom participated in the study, the participation rate ranging from 62 to 76% between the plantations. The most common reason for nonparticipation was the absence of workers during data collection for this study owing to sick leaves or recent layoffs; 14 (4%) of the workers refused to participate. Most of the participants were men (because these plantations employed very few women) and were between the ages of 25 and 50 years. About 4.2% of the workers were illiterate, and 25% had had an incomplete elementary school education (Table 1). We explained the study verbally in understandable wording to all workers before we asked them to sign a consent form. We gave all workers, including those who could not read or write, a copy of the consent form for further consultation. All workers with skin disease received medical attention and treatment when indicated. The study was approved by the Scientific and Ethical Committee of the Hospital Rafael Hernández in David, Panama.

Tasks and Exposures on the Plantations

An inventory was made of the most frequently and recently used pesticides on the banana plantations in Divala by reviewing national publications.[22] Table 2 contains a list

Table 1. Characteristics of Study Participants by Plantation

	Plantation				
	A	*B*	*C*	*D*	*All*
Number of Employees	137	159	129	92	517
Number of Participants	100	120	80	66	366
Participation rate (%)	73.0	75.5	62.0	71.7	70.8
Male gender (%)	98.0	96.7	100.0	100.0	98.4
Education					
No schooling (%)	5.0	4.2	5.0	3.0	4.2
Incomplete primary education (%)	19.0	22.5	23.6	36.4	25.4
Primary school (%)	56.0	55.8	57.5	47.0	54.6
High school (%)	13.0	10.0	12.5	10.6	11.5
Higher education (%)	6.0	5.0	1.3	3.0	4.1
Unknown (%)	1.0	2.5	—	—	1.1
Age in years					
18–25 (%)	9.0	5.0	5.0	12.1	7.7
26–50 (%)	66.0	75.8	85.0	77.3	75.4
> 50 (%)	25.0	19.2	10.0	10.6	16.9
Type of work					
Field (%)	55.0	46.7	46.3	51.5	49.7
Packing (%)	7.0	8.3	21.3	7.6	10.7
Both field and packing (%)	32.0	36.7	30.0	37.9	34.2
Administration/security (%)	5.0	5.8	2.5	1.5	4.0
Unknown (%)	1.0	2.5	—	1.5	1.4

Table 2. Pesticides Most Frequently Used in 1999 on Banana Plantations in Divala, Panama

Pesticide	*Use*	*Application Technique*	*Frequency of Application*	*EPA Category for Acute Dermal Toxicity**
Chlorothalonil	Fungicide	Field, aerial	Every 1–2 weeks (sprayed fungicide cocktail, often in combination with mineral oil)	IV
Benomyl	Fungicide	Field, aerial		IV
Maneb	Fungicide	Field, aerial		IV
Propiconazole	Fungicide	Field, aerial		—
Tridemorph	Fungicide	Field, aerial		III
Imazalil	Fungicide (post harvest)	Packing plant (inside open-ended box on conveyer belt or by injection into water basins)	At each packing occasion (2–5 times per week)	II
Thiabendazole	Fungicide (post harvest)	Packing plant (inside open-ended box on conveyer belt or by injection into water basins)	At each packing occasion (2–5 times per week)	IV
Chlorpyrifos	Insecticide	Field (impregnated bag, covering of fruit bunch)	Each bunch, continuous	IV
Carbaryl	Nematocide	Field (application of granules to soil; portable granular applicator)	2–3 times per year (one of various nematocides)	II
Ethoprophos	Nematocide	Field (application of granules to soil; portable granular applicator)		I
Paraquat	Herbicide	Field (terrestrial, backpack)	Every 6–12 weeks, depending on the herbicide	IV
Diquat	Herbicide	Field (terrestrial, backpack)		IV
Glyphosate	Herbicide	Field (terrestrial, backpack)		IV
Oxyfluorfen	Herbicide	Field (terrestrial, backpack)		IV

Adapted from Lara MA.[22]
EPA = Environmental Protection Agency.
*I: corrosive; II: severe irritation at 72 hours; III: moderate irritation at 72 hours; IV: slight irritation.

of these pesticides, together with several exposure determinants on the banana plantations included in this study, and acute dermal toxicity according to the Environmental Protection Agency.

Two working areas were clearly defined at the plantations: the field and the packing plant. The field workers ensure optimal growing conditions for the fruit, harvest the fruit, and transport it to the packing plant. The workers at the packing plant are responsible for cutting the bunches into "hands" ("manos" in Spanish), selecting the fruit that is suitable for export, washing the "hands," and packing them into boxes. Table 3 outlines the main tasks at the banana farm and possible pesticide exposure. Eighty-five percent of the workers were field workers exclusively or field workers who also did packing, 11% did packing only, and 4% did neither packing nor field work (see Table 1).

Interviews and Medical Examination

At the work sites, the participants were first administered a structured interview covering demographic and job information, dermal pesticide exposure, and protective measures. A complete skin examination followed, carried out by the main author (H.P.). To confirm clinical diagnoses, we used a Wood's lamp, potassium hydroxide skin scrapings, fungus culture, Gram's staining, and (in a few selected cases in which the patient clearly benefited) biopsies. Finally, we used the pesticide patch test series developed for this study (Table 4), as well as a standard patch test series.

Patch Testing

All workers suspected with pesticide contact dermatitis (37 cases) and a control group of 23 office employees with no such finding during skin examination were tested with the standard patch test series (SPTS) and the pesticide patch test series. Four controls had occasional exposure to pesticides during supervisory duties in the banana fields and in storage locations. To test with the SPTS, TRUE Test (Mekos Laboratories A/S, Hillerod, Denmark) was applied to unaffected skin on the worker's upper middle

Table 3. Job Tasks on Banana Plantations and Main Possible Pesticide Exposures*

Job	*Description of Job Task*	*Pesticide Exposure*
Field work		
Ditch digger	Clearing canals of debris	Direct contact possible with fungicides from aerial spraying; runoff of any terrestrially applied pesticides
Dedaughterer	Removing any unwanted "daughter" plants	Direct skin contact with residues on banana leaves and from aerial fungicide spraying; work in fields with application of nematocides and herbicides
Supporter	Applying twine to support banana plant and leaves	As for dedaughterers
Leaf remover	Removing unwanted or diseased leaves from the plant	As for dedaughterers
Bagger	Placing insecticide-impregnated plastic bags over the fruit	Direct contact with chlorpyrifos-impregnated bag; also as for dedaughterers
Defoliator	Cutting or folding leaves and identifying the "daughter" plants that will be left to replace the mother plants	As for dedaughterers; also during some application of nematocides around new plants
Cutter	Cutting down and carrying the bananas to the cable system for transportation of the banana bunches	As for dedaughterers
Carrier	Pulling banana bunches ("banana train") along the cable to the packing plant	During pesticide applications
Driver	Driving tractor; controlling the cables	As for dedaughterers. Minimal exposure, except for aerial spraying.
Backpack sprayer	Spraying herbicides	Direct contact with herbicides during preparation, application, and cleaning; direct and indirect contact from aerial spraying. High exposure risk.
Nematocide applicator	Applying nematocides	Direct and indirect contact with nematocides, work in fields with application of herbicides; aerial spraying. High exposure risk.
Flagger	Signaling liner for aerial spraying	Aerially sprayed fungicides
Supervisor	Supervising mixing, transport, and application of pesticides	Indirect contact
Packing plant work		
Bag remover	Removing chlorpyrifos-impregnated bags	Direct skin contact with chlorpyrifos on bags and with possible residues from aerial spraying
Fruit receiver	Reviewing fruit for quality	Direct skin contact with bananas containing possible residues from aerial spraying. Minimal exposure.
Flower remover	Removing flowers from plants	Direct skin contact with bananas containing possible residues from aerial spraying. Minimal exposure.
Dehander	Cutting of the banana "hands" and placing them in water basins with pesticide mixture	Direct skin contact with bananas containing possible residues from aerial spraying, contact with water containing pesticide residues
Loader	Loading rejected bananas on trucks to be hauled away	Minimal or no exposure
Remover	Removing bananas from water basins and placing them on trays	As for dehanders
Weigher	Weighing bananas and pushing them into a chamber where they are sprayed	Direct skin contact possible with postharvest fungicides or through aerosols

continued

Table 3. *Continued*

Job	*Description of Job Task*	*Pesticide Exposure*
Sticker placer	Pulling trays out of the chamber and placing a sticker on each banana bunch	Direct skin contact possible with postharvest fungicides or through aerosols
Packers	Arranging plastic bags inside cardboard boxes, placing the "hands" into the box, and topping the box	Some exposure to residues on bananas
Supervisor	Supervising mixing and application of fungicides	Exposure to imazalil, thiabendazole, aluminum hydroxide, chlorine

*Personal inspection by author (H.P.).

back and secured with hypoallergenic 3M Transpore Surgical Tape (3M Health Care, St. Paul, MN). Allergens were left covered for 48 hours. Readings were performed at 48 hours (20 minutes after removal of tape) and at 96 hours.

The pesticide patch test tray was prepared at the Laboratory for Pesticide Residue Analysis of the Central American Institute for Studies on Toxic Substances at the Universidad Nacional in Heredia, Costa Rica, according to standard international chemical guidelines (see Table 4). Most of the pesticide standards used (with a purity of > 94%) were obtained from Dr. E.-M. Ehrenstorfer-Schäfers of Augsburg, Germany, or from Riedel de Haen of Seelze, Germany. Vehicles used were white petrolatum (Laboratorios Zepol, Curridabat, Costa Rica), isooctane (Omnisolve, EM Science, Gibbstown, NJ), water (Milli-Q water purification system, Millipore Corporation, Bedford, MA), or a 1:1 mixture of water and acetone (Omnisolve, EM Science). For pesticides with test concentrations published in the literature, we used those concentrations and vehicles. For the remaining compounds (ethoprophos and tridemorph), we used concentrations of 0.1% weight per weight (w/w) instead of the usually recommended 1.0% w/w because of toxicity considerations.[23]

Table 4. Pesticide Patch-Test Battery for Testing Banana Plantation Workers in Panama

Pesticide	*Chemical Group*	*Use*	*Target Concentration (%)*	*Concentration in Vehicle (% w/w)**	*Vehicle*
Chlorothalonil	Benzocloronitrile or dicarbonitrile	F	0.001	0.0017	Iso
Benomyl	Benzimidazole	F	1.00	0.96	P
Maneb	Dithiocarbamate	F	1.00	0.78	P
Propiconazole	Triazole	F	0.50	0.44 (3.07 mg/mL)	Iso
Tridemorph	Morpholine	F	0.02	0.02	P
Imazalil	Imidazol	F	1.00	0.94	P
Thiabendazole	Benzimidazole	F	0.10	0.10	P
Chlorpyrifos	Organophosphate	I	1.00	0.99	P
Carbaryl	Carbamate	I/N	1.00	0.99	P
Ethoprophos	Organophosphate	I	0.01	0.02	P
Paraquat	Bipyridyl	H	0.10	0.16	P
Diquat	Bipyridyl	H	0.10	0.11	P
Glyphosate	Phosphonic acid	H	1.00	0.60 (6.1 mg/mL)	W
Oxyfluorfen	Nitrophenyl ether	H	0.01	0.02 (0.14 mg/mL)	Iso
Zineb†	Dithiocarbamate	F	1.00	1.00	P
Lindane†	Organochlorine	I	1.00	1.00	P

F = fungicide; H = herbicide; I = insecticide; Iso = isooctane; N = nematocide; P = petrolatum; W = water; w/w = weight per weight.
*In case of liquid vehicle, concentration is also given in milligrams per milliliter, within parentheses.
†From the pesticide tray of the Spanish Group of Research in Contact Dermatitis (manufactured by J. Marti Tor, Barcelona, Spain).

In accordance with the procedures outlined by Abrahams and colleagues,[23] we applied ethoprophos and tridemorph to 10 consenting subjects from an urban dermatologic clinic who were not exposed to pesticides. We evaluated the responses at 96 hours. None of these patients developed a positive patch-test reaction at 96 hours. The pesticide patch test series was applied to the workers at the same time as the SPTS was applied, with Finn Chambers (Epitest Ltd Oy, Tuusula, Finland) and 3M Micropore tape. Readings were made as were made for the SPTS. The results of the SPTS and the pesticide patch test series were interpreted according to International Contact Dermatitis Research Group (ICDRG) criteria (weak nonvesicular reaction [erythema, infiltration, papules]; strong edematous or vesicular reaction; extreme spreading, bullous, and ulcerative reaction; doubtful reaction [macular erythema only]; irritant reaction; and negative reaction).[24]

Determination of ICD versus ACD

Participants with a positive history of pesticide exposure and dermatoses with pain, burning, stinging, and discomfort exceeding pruritus early in the clinical course or with predominating fissuring or chemical burns were diagnosed as having ICD. ICD was confirmed by either an irritant patch-test result (the tested skin appearing glazed or scalded or having a bullous, annular, or pustular pattern) or a negative patch-test result. The diagnosis of ACD was

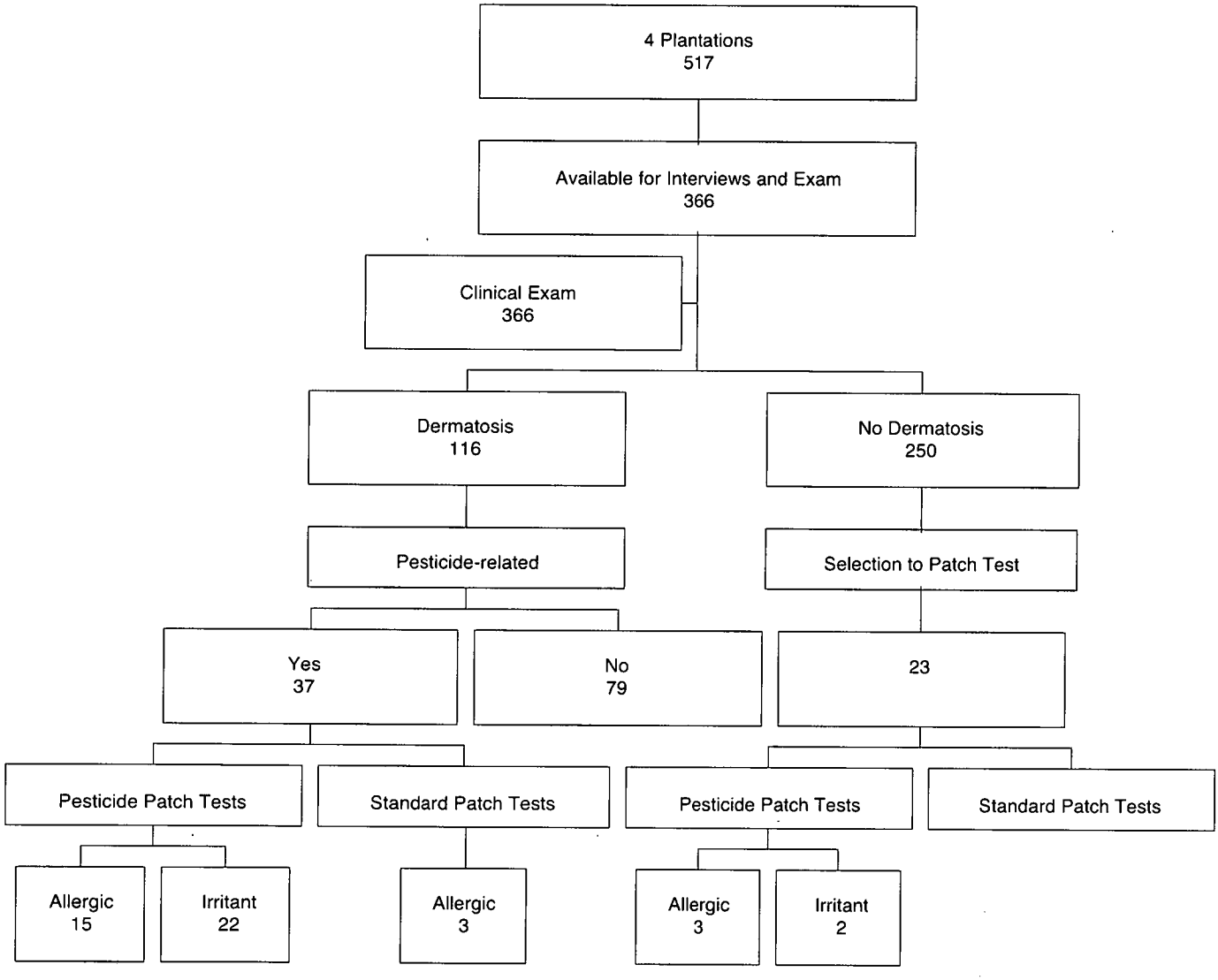

Figure 1. Schematic illustration of the study design and results.

sustained by a positive history of exposure followed by dermatitis several days to several weeks later, with vesicles predominating in acute ACD and with a drier, more fissured, and more lichenified form in chronic allergic dermatitis. These findings were confirmed by a positive patch-test result.

Based on the prevalences of positive patch-test responses among the workers with pesticide-related dermatoses and among the controls, a minimum overall prevalence of pesticide sensitization was estimated for the target population of banana plantation workers.

Results

Clinical Examination

The skin examination identified 116 (32%) cases of dermatosis among the 366 examined subjects. They had 127 different types of skin lesions. In 37 (32%) of the subjects, the dermatoses were considered to be related to exposure to pesticide (Fig 1). All were contact dermatitis. The most prevalent dermatoses unrelated to pesticides were shoulder panniculitis (30 cases), dermatophytosis (18 cases [7 tinea corporis and 11 tinea pedis]), and scabies (11 cases). Shoulder panniculitis seems to be an important occupational problem and is probably related to iterative traumatic skin lesions on the worker's shoulder caused by carrying banana bunches and hand ladders, plus certain activities such as harvesting and leaf removing and bagging (see Table 3).

Patch-Test Reactions according to ICDRG Criteria

Among the 37 subjects with pesticide-related dermatosis diagnosed by skin examination, 15 (41%) were identified by patch testing as having ACD caused by dermal exposure to various nematocides, insecticides, fungicides, and herbicides (20 positive reactions). Thus, the prevalence of ACD was 4% (15 of 366). In addition, 3 of the 23 subjects for whom there were no findings on skin examination had allergic reactions to pesticides (4 positive reactions) (Table 5). The insecticide and nematocide carbaryl triggered most of the allergic skin reactions (5 cases) and was followed by the fungicide benomyl (4 cases) and the nematocide ethoprophos (3 cases). With the SPTS, a positive result was found for chromium in one worker and for para-phenylenediamine and mercaptobenzothiazole in another worker.

Positive test results were had by 5 field workers (including two security guards who were present in the field), 9 packing plant workers (including an office worker with supervising responsibilities), 1 worker who worked in both the field and the packing plant, and 3 administrative employees. A relatively high number of these individuals were supervisors (four with dermatosis and one without dermatosis), who represent a minority at banana plantations. The pesticides for which the workers tested positive were not always the ones associated with the given tasks. Workers at the packing plant and office workers had mostly positive reactions to field pesticides, but field workers did not have positive reactions to the two tested fungicides used in the packing plant. Among the packing plant fungicides, imazalil triggered positive reactions in two packing plant workers, and thiabendazole caused positive reactions in one supervisor and one office employee.

Table 5. Pesticides as Skin Sensitizers in 24 Workers on Banana Plantations in Panama (n = 60)*

Pesticide	*Number of Workers Sensitized*	*%*
Carbaryl (I)	5†	20.8
Benomyl (F)	4‡	16.6
Ethoprophos (I)	3	12.5
Imazalil (F)	2	8.3
Chlorothalonil (F)	2	8.3
Thiabendazole (F)	2†	8.3
Glyphosate (H)	2	8.3
Chlorpyrifos (I)	1	4.2
Propiconazole (F)	1	4.2
Oxyfluorfen (N)	1	4.2
Tridemorph (F)	1	4.2
Total	24	100.0

F = fungicide; H = herbicide; I = insecticide; N = nematocide.
*37 with dermatosis and 23 without dermatosis.
†One allergic reaction in workers without dermatosis.
‡Two allergic reactions in workers without dermatosis.

Prevalence of Pesticide Sensitization

The prevalence of pesticide sensitization in the study population of banana plantation workers ($N = 366$) can be estimated by dividing the population into the following three subgroups (see Fig 1):

1. Subjects with pesticide-related dermatosis who were tested ($N_1 = 37$; number of sensitized cases [A_1] = 15; prevalence [P_1] = 0.41 [15 of 37])
2. Subjects with no dermatosis who were tested ($N_2 = 23$; $A_2 = 3$; $P_2 = 0.13$ [3 of 23])
3. Untested subjects: 227 free of any dermatoses and 79 who had dermatosis unrelated to pesticides ($N_3 = 306$; A_3 and P_3, unknown). A lower limit of A_3 may be

taken as $P_2 \times N_3 = 0.13 \times 306 \approx 40$, and a lower limit of the prevalence in the entire population is therefore $(15 + 3 + 40) \div 366 \approx 0.16$ (16%).

Discussion

This study developed a pesticide patch test tray to test a specific worker population in Panama that was highly exposed to pesticides and found a positive response in 41% of workers diagnosed with a pesticide-associated contact dermatitis and in 13% of control workers without dermatoses. Although the prevalence of ACD was 3%, at least 16% of the entire worker population was estimated to have been sensitized to pesticides.

Although pesticide patch tests have been developed in previous studies,[11,16–18,23] this has seldom been done in a developing country and never to test a group of workers exposed to multiple pesticides.

Thirteen of the 16 tested pesticides are known to have sensitizing properties, according to the US Environmental Protection Agency and published literature. Sensitizing properties have been reported for carbaryl (a carbamate insecticide and nematocide), chlorothalonil, benomyl (a benzimidazole fungicide), imazalil (a conazole fungicide), glyphosate (a phosphonic acid herbicide), thiabendazole, and propiconazole.[2,5,13,25] In agreement with previous studies,[5,12,13] fungicides as a group were found to be the most common cause of pesticide-related ACD in this population, but the insecticide carbaryl was the most commonly identified sensitizer. In a previous report on contact dermatitis in banana plantation workers,[5] carbaryl did not appear as a cause of ACD, probably because carbaryl was used less or not at all on the banana plantations covered in that study.

To our knowledge, no previous studies have identified ethoprophos or tridemorph as human sensitizers. Tridemorph,[5] a morpholine fungicide, is a recognized skin irritant with an ID_{50} of 0.05%, ID_{50} being the concentration (in percent) of a chemical that causes an irritant test reaction after one application in 50% of the persons or animals tested. Our case tested positive (with the characteristics of an allergic reaction) at a dose of 0.02%. However, considering that this dose is close to the irritant dose, more clinical studies are needed to confirm the allergic nature of this contact dermatitis.

A prevalence of 16% of sensitized workers appears high when compared with findings reported for other agricultural populations, which range from 5 to 10%.[18,25] However, banana plantation workers are exposed to a large number of pesticides during working hours and often also at home as they generally live in the middle of the plantations. The fact that packing plant workers mostly had positive test reactions to pesticides used in the field may be explained by indirect exposure by way of the ambient air in the open packing plant or in the houses nearby.[26,27] The selection of a control group among asymptomatic workers was restricted to office workers, only some of whom had occasional contact with pesticides in supervising tasks. The probability of sensitization in this group is probably lower than that in field and packing plant workers, who have much higher and more frequent exposures. Therefore, the estimated prevalence among the nontested workers represents a minimum; the true prevalence is likely to be higher. Retrospectively, it would have been better to have randomly selected a control group from all workers without dermatoses to represent the total study population for the estimation of the true prevalence of sensitization.

One limitation of the study is that the correct concentration for patch testing is uncertain with many pesticides because they have not been widely used. This is particularly the case for ethoprophos and tridemorph because no previous reports exist and because 10 volunteers with negative patch-test reactions make up a rather small group for confirming that an appropriate concentration has been used. At least 20 to 50 control subjects would have been required for statistical and scientific validity.[28,29] However, we feel confident that the reactions observed are well interpreted.

Conclusion

Pesticide patch test trays can be developed in Central America and should be used as an instrument in the assessment of health problems in worker groups that are highly exposed to pesticides. The application of this diagnostic tool showed high prevalences of dermatoses among banana plantation workers exposed to pesticides with known sensitizing properties but also to several pesticides not previously known to be human sensitizers. The study confirms that when applied to these agricultural workers, standard patch test series are not sufficient to prove an allergic skin reaction because banana plantation workers are not frequently exposed to these allergens. It is therefore necessary to test agricultural workers with specific pesticide patch test series.

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