Environmental pesticide exposure in Honduras following hurricane Mitch

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Objective To investigate whether environmental contamination occurred in the wake of hurricane Mitch (30–31 October 1998), we conducted a population-based cross-sectional household survey in the *barrio* of Istoca, Department of Choluteca, Honduras. The goals were to evaluate chemical contamination of potable water and the extent of human exposure to chemicals as a result of extensive flooding.

Methods The survey consisted of an environmental exposure assessment, which included assaying water and soil samples for contaminants, and taking blood and urine samples from 45 adolescents aged 15–18 years. We also made a subjective questionnaire assessment of 155 households.

Findings There was significant contamination of the soil in Istoca, but no water contamination in the aftermath of hurricane Mitch. The soil levels of chlopyrifos and parathion were 30- and 1000-times higher, respectively, than the Environmental Data Quality Level. However, the most striking finding was the detection of elevated levels of chlorinated and organophosphate pesticides in adolescents. Toxicological analyses of serum specimens showed that 51% of the samples had elevated levels of 1,1-dichloro-2,2-bis-(*p*-chlorophenyl) ethylene (*p,p*-DDE) (range, 1.16–96.9 ng/ml) (US reference mean = 3.5 ng/ml) in adults). Dieldrin levels >0.2 ng/ml were also present in 23% of the serum specimens (serum levels of this analyte in US adolescents are <0.2 ng/ml). Of 43 urine samples analysed for organophosphate metabolites, 18.6% contained diethyl phosphate (DEP) at levels which were greater that the reference mean of 6.45 μg/g creatinine. We also detected elevated levels of *p*-nitrophenol (*p*-NP) and of 3,5,6-trichloro-2-pyridinol (3,5,6-TCPY) in 91% and 42% of the samples, respectively.

Conclusions The elevated levels of chlorinated pesticides were surprising, since although these substances were banned in Honduras 15 years ago it appears that they are still being used in the country. Moreover, elevated levels of organophosphates were detected in the study adolescents even three weeks after the hurricane. Since these chemicals are usually cleared from the body quickly, our data suggest that the adolescents face an ongoing threat from pesticide exposure.

Keywords: Insecticides; Drinking water/chemistry; Water pollutants, Chemical; Natural disasters; Environmental monitoring; Households; Cross-sectional studies; Honduras (*source: MeSH*).

Mots clés: Insecticides; Eau potable/composition chimique; Polluants chimiques eau; Cataclysme; Surveillance environnement; Ménages; Etude section efficace; Honduras (*source: INSERM*).

Palabras clave: Insecticidas; Agua potable/química; Contaminantes químicos del agua; Desastres naturales; Monitoreo del ambiente; Hogares; Estudios transversales; Honduras (*fuente: BIREME*).

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Voir page 293 le résumé en français. En la página 294 figura un resumen en español.

Introduction

On 24 October 1998, the Atlantic tropical storm Mitch was upgraded to a hurricane that quickly developed into one of the strongest and most damaging ever to hit Central America. As hurricane Mitch traveled inland over Honduras on 30 October 1998, it produced torrential rains that caused catastrophic floods and mud slides throughout the country. Rivers flooded Tegucigalpa, the capital, and swept onwards toward the south. The Honduran National Emergency Commission reported that 6546 people were killed and 1.1 million people were displaced by the hurricane and the associated flooding. Overall, 1.5 million people were affected.

The flooding increased the potential for environmental contamination by toxic chemicals, since inundated toxic waste sites can release harmful chemicals stored at ground level (*1*). When industrial

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and agricultural areas are submerged under flood water, unusually high levels of agricultural chemicals and pesticides can be flushed into residential areas and rivers, exacerbating the environmental contamination (*2*). Consequently, in the aftermath of hurricane Mitch, a major concern for the Ministry of Health was that people would be exposed to hazardous chemicals, particularly organophosphates — compounds that had replaced chlorinated pesticides, which were used widely in Honduras to control agricultural and nuisance pests until they were banned in 1984. Residues of organophosphate pesticides can be found widely in food, in drinking-water, in occupational settings and in public places (*3, 4*).

The goals of this study were to evaluate the chemical contamination of potable water and the extent of human exposure to chemicals as a result of the flooding associated with hurricane Mitch.

Methods

To identify potable water sources and assess potential health effects from hurricane Mitch, we conducted both an environmental exposure assessment, including the collection and analysis of environmental and biological samples, and a population-based cross-sectional household survey in the *barrio* of Istoca, Department of Choluteca. We selected this community of 440 households and approximately 3100 residents because it was located in an area that was hard hit by the hurricane and the subsequent flooding, and because it was known that 300–400 barrels of pesticides and chemicals had been released into the community, including toluene and endosulfan. The study sample consisted of households in Istoca with adolescents aged 15–18 years who had been resident in the *barrio* since August 1998.

Cross-sectional survey

The questionnaire assessed household demographics; occupational exposure to pesticides; the quality of drinking-water; the handling, treatment and storage of drinking-water; whether an individual had a history of smoking; and self-reported health effects after the hurricane and at the time of the interview. Assuming that 15% of the water sources were chemically contaminated, and taking a confidence interval of 95% and a power of 80%, we calculated that a significant sample size corresponded to 133 households. To account for non-responses (e.g. people refusing to participate or not being home), the desired sample size was increased by 25% to 166 households. After losses due to attrition, we conducted interviews with one adult in 155 households. A total of 96% of 155 households surveyed had at least one member aged 15–18 years who had lived in Istoca since August 1998. In these households, a parent or guardian of the adolescent was interviewed.

Environmental sampling

The environmental assessment directly sampled 12 water sources that were reported to have been contaminated during the flood. These sites included:

1. A cistern from Pinguino, a private water purification company.
2. Bags of water purchased directly from Pinguino.
3. A tap at Trefica, a local manufacturer of metal products.
4. The wells of the Bella Vista and 20 de Mayo communities in Istoca.
5. The cistern of Servicio Autonomo Nacional de Alcantarillados y Acueductos (SANAA), the Honduras water authority. This had been closed down after the flood because of suspected contamination.
6. Five private residential wells used as drinking-water sources and suspected to be contaminated.
7. The Rio Choluteca at a site used by *barrio* residents for bathing and laundry.

Of the 45 study households that provided biological samples, 16 supplied samples of their drinking-water at the time of the interview. Ten homes reported obtaining drinking-water from Pinguino, three from Trefica, one from a truck cistern, one from a private residential well, and one from a household reporting the use of processed water from the Rio Choluteca. Samples were analysed for organophosphate pesticides using US Environmental Protection Agency (EPA) SW-846 method 8141 (*5*); organochlorine pesticides were assayed using EPA SW-846 method 8081A (*6*). The Ministry of Health Forensic Medicine Laboratory also collected twelve one-litre water samples in Istoca during the week beginning 16 November 1998. The samples were divided into two equal subsamples and the CDC team brought one of each subsample to the USA for analysis.

Soil samples were collected from six sites that were suspected of being contaminated, that were heavily residential, or that were used for recreational activities. After removing the covering vegetation at each site, soil samples were collected from the top 7.5 cm of soil. Samples were analysed for organophosphate and organochlorine pesticides.

Biological sampling

Adolescents aged 15–18 years were chosen for the study because of the low probability that they had been exposed to pesticides at work, prior to the hurricane. Blood and urine samples were obtained from one adolescent in each study household; in households with more than one adolescent who met the age criterion, one was randomly selected to provide the samples. Samples were obtained from the first 45 households surveyed, where the parent or guardian consented to the participation of the adolescent. Because of an error, however, only 43 samples were analysed. Ideally three 10-ml samples plus one 4-ml sample of blood should have been collected from each subject, but this was not always possible because of subject reluctance to provide these quantities.

All 43 urine samples were analysed for organophosphates and all 43 blood samples for chlorinated pesticides. Concentrations of organophosphate analytes were expressed as μg/g creatinine, rather than as units of cholinesterase, because a single determination of cholinesterase is not sufficient for interpreting toxicity without baseline measurements, and the method used may be insensitive (*7*).

Results

Cross-sectional survey

A total of 155 households (1041 people) participated in the survey. The average household consisted of 7 people (range, 3–13). Of the adult respondents, 58% were males, 69% had completed primary education, 8% were smokers, and 47% worked. The age of the 45 adolescents who provided biological samples ranged from 15–18 years (median, 17 years). A total of 75% were female, 60% had finished primary education, 9% were smokers and 49% worked.

Prior to the flood, most area households obtained water from home taps connected to a well operated by SANAA, but the well was closed after the flooding because it was suspected that it had become contaminated with pesticides. Not surprisingly, therefore, survey participants reported a major change in their use of water sources after hurricane Mitch. Before the hurricane, 65 participants (41.9%) reported drawing water from a tap in the house, 57 (36.8%) from a tap in the yard, while 14 (9%) used private wells. After the hurricane, only 9 households (5.8%) drew water from a tap in a house, 7 (4.5%) from a tap in the yard, while 49 (31.6%) reported using private wells. However, 129 households (83%) reported having no complaints about the taste or odour of the water, probably because the households chlorinated their water before drinking it or using it for cooking. A total of 146 households (94%) reported that they stored their water: 71% in plastic containers and 24% in any available containers. Regardless of the containers used, 148 households (98.7%) reported cleaning the storage containers with soap and water and 130 households (89%) cleaned the containers daily (because of non-responses to some of the questions, the percentages do not sum to 100%). There were no statistically significant differences in the use, treatment and handling of water between households with (n = 45) and without (n = 110) adolescents (Table 1). Similarly, no significant associations between symptoms and water quality were observed for surveyed households with and without adolescents (see Biological monitoring, below).

Environmental monitoring

A total of 29 water samples were analysed for one or more contaminants. One sample, taken from a private home, contained 0.22 μg/l diazinon, which is less than the US Environmental Protection Agency's 1- and 10-day health advisory levels (maximum concentrations recommended for drinking-water) of 20 μg/l (*8*). No other organophosphate pesticides nor organochlorine pesticides were detected in the water samples. Similarly, no organochlorine pesticides were detected in the samples analysed by the Ministry of Health's Forensic Medicine Laboratory.

In contrast, each of the six soil samples taken in Istoca contained detectable concentrations of at least one pesticide (Table 2). One sample, taken adjacent to a community well, contained 460 μg parathion per kg soil, 1000-times greater than the Environmental Data Quality Level (EDQL) of 0.292 μg/kg soil. Additionally, the concentration of disulfoton in a soil sample taken from the backyard of a home was 750 μg/kg, 35-times the EDQL for disulfoton of 20 μg/kg soil. Although no environmental standards exist for chlorothalonil and terbufos, the concentrations of these compounds in soil samples taken near community wells may be considered high enough to pose an immediate health concern (*9*). The concentrations of other pesticides in the soil samples were either lower than the reference concentrations for these chemicals, or were not considered to be acutely toxic (*10*).

Biological monitoring

Toxicological analysis of the 43 serum specimens for 17 chlorinated compounds, including 1,1,1-tricholoro-2,2-bis-(*p*-chlorophenyl)ethane (DDT), revealed unusually high concentrations of the DDT metabolite 1,1-dichloro-2,2-bis-(*p*-chlorophenyl)-ethylene (*p,p*-DDE) and dieldrin. In 41 (95%) of the samples analysed, *p,p*-DDE was detected at levels in the range 1.16–96.9 ng/ml, and 51% of the adolescents had *p,p*-DDE levels >3.5 ng/ml, the reference mean for adults in the USA. For comparison, *p,p*-DDE is not usually detected in 99% of young people in this age group in the USA. Toxicological analysis of the serum specimens also found that 23% of the study subjects had dieldrin levels >0.2 ng/ml (serum levels of this analyte in US adolescents are <0.2 ng/ml).

Of the 43 urine samples analysed for organophosphate metabolites, 33 contained detectable levels of diethyl phosphate (DEP). DEP was detected in 8 (18.6%) of the samples above the reference mean of 6.45 μg/g creatinine (*11*) (Fig. 1). This reference mean was reported in a study of the general population of Italy, which assessed exposure both from environmental and dietary sources, rather than dietary sources only (*11*). The levels of *p*-nitrophenol (*p*-NP) were also elevated in 91% of the samples. Concentrations of *p*-NP in urine, after correction for creatinine, reached as high as 2100 μg/g in one sample (range 2.2–2100 μg/g). Based on the reference range for the adult US population, 84% of the samples had *p*-NP concentrations above the reference median of <1 μg/g, and 56% of the samples had concentrations > 3.8 μg/g, the upper 95% limit (Fig. 2) (*7*).

Overall, the levels of 3,5,6-trichloro-2-pyridinol (3,5,6-TCPY) in the 43 serum samples lay in the range 1–104 μg/g. In 42% of the samples, the concentration of 3,5,6-TCPY was higher than the reference median concentration for US adults of 2.2 μg/g, and 28% of the samples had levels above the 95th percentile level of 8.2 μg/g (Fig. 3) (*7*). If the reference mean of 2.8 μg/g reported in a study of the general population of Italy (*12*) is used, we detected elevated levels of 3,5,6-TCPY levels in 39.5% of the samples analysed.

The most common self-reported symptoms among the 45 adolescents were headache (44.4%), tiredness/weakness (42.2%), skin rash (40%), abdominal pain (33.3%), fever (27.7%), decreased appetite (24.4%), chills (22.2%) and nausea (22.2%). These symptoms were reported more frequently among the study adolescents than among adults from surveyed households (Table 3).

Discussion

Our investigation showed that hurricane Mitch and the associated flooding produced little contamination of the water supplies. Of the water samples taken from homes, private wells, public community wells, emergency water supplies provided by local companies, and from the Rio Choluteca, only one sample had any detectable contaminants above expected levels. And even in that sample, taken from a water reservoir in a home, the organophosphate pesticide, diazinon, was present at a level 100-times lower than the US EPA 1- and 10-day health advisory levels of 20 μg/l (*8*). This suggested that chemicals from agricultural land and chemical manufacturing and storage facilities, which were released into the water during the hurricane and subsequent flooding, were diluted or washed away with the flood water. Although short-term exposure to high concentrations of diazinon may lead to acute toxic effects on the nervous system, there is no evidence that long-term exposure to low levels of diazinon, such as those detected in this study, causes any harmful health effects in people (*13*).

In contrast to the water samples, where contaminants were detected in only one sample, all of the soil samples contained detectable levels of pesticides. Three of the soil samples contained levels of organophosphate pesticides that may be high enough to be a health concern. These samples were collected adjacent to two community wells, Bella Vista and 20 de Mayo, and in the backyard of a home; they contained parathion, terbufos, and disulfoton, respectively. The level of chlorthalonil, an organochlorine pesticide, detected in a soil sample taken from the well in 20 de Mayo may be cause for concern, but no soil reference concentration exists for this compound. Other pesticides, chlorpyrifos, α- and ß-endosulfan, and heptachlor epoxide were also present in soil samples, but not at concentrations considered to present an acute risk to human health.

The limited contamination of the water sources suggested that water ingestion is not an important exposure pathway for the pesticides studied. How-

Table 1. **Frequency of water issues among households in Istoca, Honduras, 1998**

Water issue	Households without adolescents (*n* = 110)[a]	Households with adolescents (*n* = 45)
No. of respondents using a private well prior to hurricane Mitch	11 (10)[b]	3 (6.7)
No. of respondents using a private well after hurricane Mitch	31 (28.2)	18 (40)
No. of respondents reporting no water problems after hurricane Mitch	99 (90)	30 (66)
No. of respondents reporting water problems after hurricane Mitch	11 (10)	15 (33)
No. of respondents using water treatment of any kind	67 (61)	20 (44.4)
No. of respondents using chlorination to treat water	54 (50)	21 (47)
No. of respondents who stored water	104 (94.5)	42 (93)
No. of respondents who used plastic containers to store water	68 (66.7)	34 (81)
No. of respondents who used any available container to store water	29 (28.4)	5 (11.9)
No. of respondents who cleaned containers before use	106 (100)	42 (95.5)

[a] Maximum value. The actual number of respondents varied for different questions.

[b] Figures in parentheses are percentages.

Table 2. **Pesticides in soil samples taken in Istoca, Choluteca, Honduras, November 1998**

Sample site	Pesticides detected	(concentration)
1. Near well house in 20 de Mayo (field)	α– and β– Endosulfan	(0.1 mg/kg)
2. Near well house in 20 de Mayo (under truck)	Chlorothalonil Chlorpyrifos α– and β– Endosulfan Terbufos	(0.97 mg/kg) (0.014 mg/kg) (0.01 mg/kg) (0.5 mg/kg)
3. Next to well in Bella Vista	α– and β– Endosulfan Parathion M	(0.015 mg/kg) (0.46 mg/kg)
4. Bank of Rio Choluteca near Istoca	Heptachlor epoxide	(0.01 mg/kg)
5. In backyard of a residence under a barrel	Chlorpyrifos Disulfoton	(0.01 mg/kg) (0.75 mg/kg)
6. Park in Choluteca next to Rio Choluteca	Chlorpyrifos	(0.01 mg/kg)

Fig. 1. **Distribution of diethyl phosphate (DEP) levels in urine samples from 43 adolescents, Honduras, 1998**

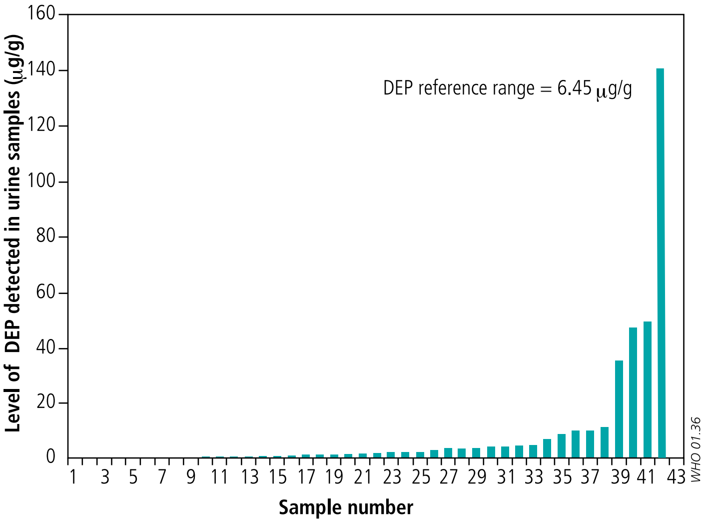


Fig. 2. **Distribution of *p*-nitrophenol (PNP) levels in urine samples from 43 adolescents, Honduras, 1998**

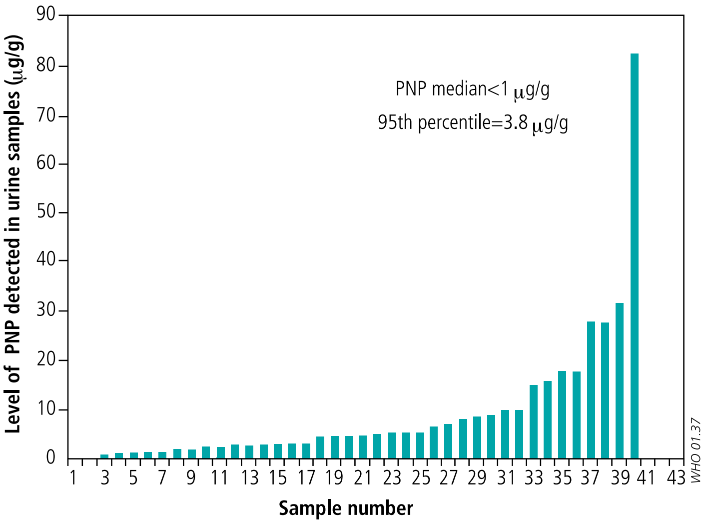
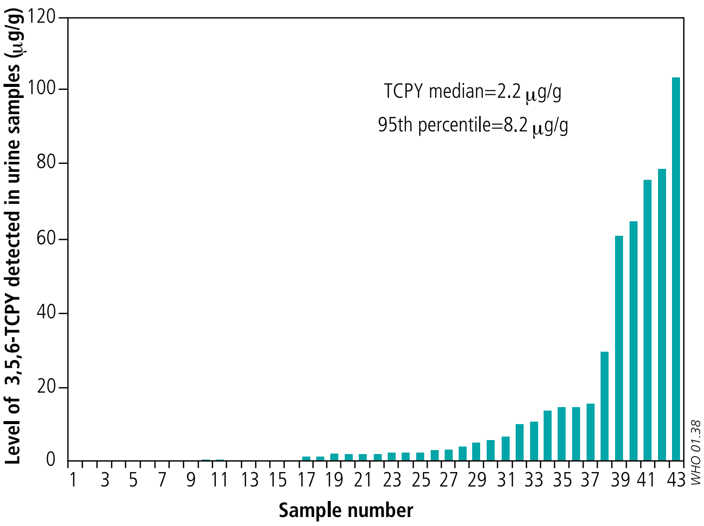


Fig. 3. **Distribution of 3,5,6-trichloro-2-pyridinol (3,5,6-TCPY) levels in urine samples from 43 adolescents, Honduras, 1998**



ever, since the focus of the sampling was on water supplies, two other pathways, dust and food, were not studied and these may represent significant exposure pathways. Exposure to dust through inhalation and ingestion, and ingestion of food with pesticide residues, were likely to be two major routes of exposure and may not be related to hurricane Mitch. Dust from mud drying in the fields was a major problem after the flooding. During the course of this investigation, we observed periods of minimal visibility and many Istoca residents used dust masks.

The most striking finding of the study was that adolescents residing in Istoca are at risk from exposure to high levels of pesticides. Elevated levels of chlorinated pesticides were found in adolescents, even though their use was banned in Honduras in 1984; and the adolescents still showed high urine levels of organophosphate metabolites 3 weeks after the hurricane struck. The two main chlorinated pesticides detected at elevated levels in adolescents were *p,p*-DDE and dieldrin. For *p,p*-DDE, levels of 2–4 ng/ml are usually found in US adults, with a reference mean of 3.5 ng/ml; dieldrin is not usually detected in US adolescents of similar age to the Honduran adolescents. Detection of elevated levels of chlorinated pesticides in Honduran adolescents implies that these chemicals, despite being banned substances, are still being used illegally in the area. Both DDT and DDE are endocrine disruptors and block the action of natural hormones at estrogen receptor sites. Possible side-effects of environmental estrogens (e.g. DDT) and antiandrogens (e.g. DDE) include abnormal sexual development and increased risk for cancers, such as those of the breast and prostate (*14*).

In general, organophosphate pesticides have a short half-life and their metabolites are mostly excreted in the urine within 24 hours (*11*). It was surprising therefore to find elevated levels of *p*-NP, an analyte of the parent compounds parathion and methyl parathion; and of 3,5,6-TCPY, an analyte of chlopyrifos, in adolescent urine samples as long as 3 weeks after the hurricane struck. In addition, parathion was detected at a level of 0.46 mg/kg in one soil sample, and chlopyrifos at levels up to 0.014 mg/kg in three soil samples. The detection of high levels of organophosphate metabolites in adolescent urine samples almost one month after hurricane Mitch suggested that the Istoca adolescents continued to be exposed to organophosphate pesticides.

Acute toxicity related to organophosphate pesticides is usually of rapid onset (*15*). Symptoms associated with organophosphate poisoning include diarrhoea, urination, salivation, headache, fatigue, nausea, vomiting, cramps, lachrymation, vertigo and loss of reflexes (*16, 17*). Children may be more susceptible to environmental exposure of these compounds than adults and their developing system may be uniquely vulnerable to their effects (*14*). Prolonged (chronic) exposure to organophosphates may result in impaired memory and concentration, disorientation, severe depression, confusion, speech difficulties, delayed reaction times and insomnia (*16*). Even though the adolescents in the study were exposed to organophosphate levels higher than normal, an association between exposure and self-reported symptoms could not be established, because the reported symptoms were nonspecific and were not clinically confirmed.

In general, concentrations of a chemical or pesticide ⩽ 95th percentile concentration of the reference range are considered normal; concentrations >95th percentile are considered to be elevated and therefore indicate exposure (*18*). In Istoca, 56% of adolescents tested had *p*-NP levels > 95th percentile concentration of the reference range, and 28% of adolescents tested had 3,5,6-TCPY levels >95th percentile concentration. Clearly, residents of Istoca have higher than normal exposures to these pesticides, perhaps through multiple exposure pathways, which could include ingestion of food and water, inhalation of dust and air, and dermal contact with soil.

To our knowledge, no reference ranges have been published for the exposure of adolescents to organophosphates or chlorinated pesticides in non-occupational residential settings in Latin America. We therefore used reference ranges for adults with similar exposures in North America and Europe. Even so, the information derived from this investigation cannot be considered a baseline for Honduras, because it was collected from an area heavily affected by hurricane Mitch, and no pre-hurricane comparison data were available. Nevertheless, the findings suggest that the residents of Istoca were exposed to significant levels of chlorinated pesticides prior to the hurricane, and continue to be exposed to organophosphate pesticides, and this represents a potential public health hazard to the community. This investigation also expanded the present knowledge base for exposure to organophosphates and chlorinated pesticides in Central America, particularly among adolescents. ■

Table 3. **Frequency of symptoms reported by households and study adolescents, Istoca, Honduras, 1998**

Symptoms	Surveyed households (*n* = 110)[a]	Surveyed adolescents (*n* = 45)
Abdominal pain	6 (12.8)[b]	15 (33.3)
Chills	4 (8.9)	10 (22.2)
Decreased appetite	7 (15.6)	11 (24.4)
Fever	3 (15.6)	12 (26.7)
Headache	13 (28.9)	20 (44.4)
Skin rash	10 (22.2)	18 (40.0)
Eye irritation	7 (15.6)	12 (26.7)
Nausea	3 (6.7)	10 (22.2)
Tiredness	4 (8.9)	19 (42.2)
Flu-like symptoms	11 (24.4)	22 (48.99)

[a] Maximum value. The actual number of respondents varied for different questions.

[b] Figures in parentheses are percentages.

Acknowledgements

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Conflict of interests: none declared.

Résumé

Exposition environnementale aux pesticides au Honduras après le passage de l'ouragan Mitch

Objectif Pour rechercher la présence d'une contamination de l'environnement après le passage de l'ouragan Mitch (30-31 octobre 1998), nous avons réalisé en population une enquête transversale sur les ménages dans le *barrio* d'Istoca (département de Choluteca) au Honduras. Le but de cette étude était d'évaluer la contamination chimique de l'eau de boisson et l'importance de l'exposition humaine à des produits chimiques à la suite d'inondations de grande étendue.

Méthodes L'enquête consistait en une évaluation de l'exposition environnementale, avec recherche de contaminants dans des échantillons d'eau et de sol et analyse d'échantillons de sang et d'urine prélevés chez 45 adolescents âgés de 15 à 18 ans. Nous avons également procédé à une évaluation subjective au moyen d'un questionnaire sur 155 ménages.

Résultats Nous avons observé une contamination importante des sols à Istoca, mais pas de contamination de l'eau après le passage de l'ouragan Mitch. Les teneurs des sols en chlorpyrifos et en parathion étaient respectivement 30 et 1000 fois supérieures aux valeurs retenues pour la qualité de l'environnement (EDQL). L'observation la plus frappante était cependant la détection de taux élevés de pesticides chlorés et organophosphorés chez les adolescents. Les analyses toxicologiques effectuées sur les échantillons de sérum ont montré que 51 % d'entre eux contenaient des quantités élevées de 1,1-dichloro-2,2-bis-(*p*-chlorophényl)-éthylène (*p,p*-DDE) (intervalle : 1,16-96,9 ng/ml) (valeur moyenne de référence pour les Etats-Unis d'Amérique : 3,5 ng/ml chez l'adulte). Des taux de dieldrine supérieurs à 0,2 ng/ml étaient également présents dans 23 % des échantillons de sérum (aux Etats-Unis, les taux sériques de dieldrine chez les adolescents sont inférieurs à 0,2 ng/ml). Sur 43 échantillons d'urine dans lesquels on a recherché des métabolites de pesticides organophosphorés, 18,6 % contenaient du phosphate de diéthyle (DEP) en quantité supérieure à la valeur moyenne de référence (6,45 µg/g de créatinine). Nous avons également détecté des taux élevés de *p*-nitrophénol (*p*-NP) dans 91 % des échantillons et de 3,5,6-trichloro-2-pyridinol (3,5,6-TCPY) dans 42 % des échantillons.

Conclusion Les taux élevés de pesticides chlorés mis en évidence étaient surprenants ; en effet, bien que ces substances soient interdites au Honduras depuis 15 ans, il apparaît qu'elles sont encore utilisées dans le pays. De plus, des taux élevés d'organophosphorés étaient détectés chez les adolescents participant à l'étude, même trois semaines après le passage de l'ouragan. Comme ces composés sont en général rapidement éliminés de l'organisme, nos résultats semblent indiquer que les adolescents restent sous la menace d'une exposition aux pesticides.

Resumen

Exposición ambiental a plaguicidas en Honduras tras el huracán Mitch

Objetivo A fin de investigar si hubo contaminación ambiental tras el huracán Mitch (30–31 de octubre de 1998), realizamos una encuesta domiciliaria transversal basada en la población en el barrio de Istoca del Departamento de Choluteca, Honduras. Se trataba de evaluar la contaminación química del agua potable y la exposición humana a productos químicos que hubieran podido provocar las extensas inundaciones.

Métodos Como parte de la evaluación de la exposición ambiental, se analizaron muestras de agua y suelo en busca de contaminantes y se obtuvieron muestras de sangre y orina de 45 adolescentes de 15 a 18 años. Realizamos asimismo una evaluación de 155 hogares mediante un cuestionario subjetivo.

Resultados Después del huracán Mitch se detectó en Istoca una contaminación importante del suelo, pero no así del agua. Las concentraciones de clopirifos y paratión en el suelo eran 30 y 1000 veces superiores, respectivamente, a las establecidas en los Niveles de Calidad de los Datos Ambientales. Sin embargo, lo más sorprendente fue la detección de niveles elevados de plaguicidas clorados y organofosforados entre los adolescentes. El análisis toxicológico de las muestras de suero mostró en un 51% de los casos niveles elevados de 1,1-dicloro-2,2-bis-(*p*-clorofenil)-etileno (*p,p*-DDE) (intervalo: 1,16-96,9 ng/ml) (media de referencia de EE.UU. = 3,5 ng/ml en adultos). Se detectaron asimismo niveles de dieldrina > 0,2 ng/ml en el 23% de las muestras séricas (las concentraciones séricas de este analito entre los adolescentes de Estados Unidos son inferiores a 0,2 ng/ml). De 43 muestras de orina analizadas para detectar metabolitos organofosforados, el 18,6% contenían concentraciones de dietilfosfato (DEP) superiores a la media de referencia de 6,45 µg/g de creatinina. También detectamos niveles elevados de *p*-nitrofenol (*p*-NP) y de 3,5,6-tricloro-2-piridinol (3,5,6-TCPY) en el 91% y el 42% de las muestras, respectivamente.

Conclusiones El sorpresivo hallazgo de niveles elevados de plaguicidas clorados lleva a pensar que, aunque esas sustancias fueron prohibidas en Honduras hace 15 años, aún se siguen usando en el país. Además, se detectaron altas concentraciones de organofosforados en los adolescentes del estudio, incluso tres semanas después del huracán. Puesto que esos productos químicos suelen desaparecer rápidamente del organismo, nuestros datos llevan a pensar que la exposición a plaguicidas constituye una amenaza persistente para los adolescentes.

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