

Serum Pesticide Concentrations in Farming Cooperatives in Honduras

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There are concerns in developing countries that extensive use of pesticides is causing increased morbidity and mortality, and that proscribed organochloride pesticides are still in use. In southern Honduras, measurements of organochloride pesticides in adipose tissue from 10 unselected surgical specimens in 1980 (Bueso, unpublished) reflected body burdens similar to those found from excessive exposures as in Triana, Alabama, in the 1970's (Kreiss et al 1981). We carried out a pilot study in Honduras which consisted of measuring serum pesticide concentrations in a population exposed to heavy agricultural spraying and one not exposed to this type spraying to determine the extent of exposure to these compounds and the feasibility of obtaining a test and comparison group for a health effects study.

MATERIALS AND METHODS

The exposed group was selected from three farming cooperatives near Choluteca, in southern Honduras, in which there is extensive (16-30 times per year) aerial spraying of pesticides. Information from a brief questionnaire provided an exposure index based on (1) task related to pesticide spraying, (2) years at that task, (3) approximate distance of residence from spraying, and (4) years at that residence, which was used to rank volunteers (Table 1). The product of scores obtained was used to select the top scoring 75% of sixty volunteers. Numbers were assigned and fifteen participants randomly selected for the study. Among the 15 participants, the median score was 286, with a range of 72 to 720. Numbers were then assigned to the remaining volunteers and five more randomly selected for a

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Table 1. Pesticide Exposure Index

<u>Task</u>	<u>Score</u>	<u>Distance of Residence from</u>		<u>Years at Residence</u>	
		<u>Spraying</u>	<u>Score</u>	<u>Residence</u>	<u>Score</u>
Flagmen	4	<200 meters	3	10-15	3
Pest-counter	3	200-500 meters	2	5-10	2
Mixer	2	>500 meters	1	<5	1
Tower-man	1				
<u>Years at Task</u>					
Exposure index=					
(task score X years at task) X (length of residence score X distance score)					

total of 20. Among the 5 participants, the median score was 36, with a range of 0.25 to 63. The comparison group was selected from a town near Choluteca where there is only one local application of pesticides per season. Twenty men out of 40 volunteers were age-matched to within two years of the test group.

Blood pressure, weight, and height were measured on 20 men from the test area and 19 men from the comparison area. One of the volunteers from the comparison group dropped out prior to blood drawing. Serum samples were analyzed for the following compounds: hexachlorobenzene, polychlorinated biphenyls (PCBs as Aroclor 1260¹), gamma-, beta-hexachlorocyclohexane (B-HCCH), oxychlordane, heptachlor epoxide (HE), transnonachlor (TN), dieldrin, endrin, methoxychlor (p,p'-), DDT and related compounds (DDT, DDE), and Mirex. The specimens were analyzed by gas liquid chromatography with electron capture detection. The identification of methoxychlor was confirmed by mass spectral analysis.

Body mass index (BMI) was calculated as weight (kg)/height (cm)². DDT and DDE measurements were log transformed to obtain normally distributed data.

For comparison of pesticide concentrations, a one-tailed T-test for equality of means of the two groups was used and a Type I error of 10% (alpha=0.1) accepted. With 20 men in each group, this would give 89% power to detect a large effect, that is 0.8 times the standard deviation of the pesticide concentration within each group (Cohen 1977). For comparison

¹ Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

of blood pressure, weight, and height, a two-tailed T-test was used. A Wilcoxon Rank Sum Test was used to compare medians between groups for HE and B-HCCH because of the frequency of values below detection limits which, when taken as half of the recorded value (Rappe et al 1988; Gleit 1985; McBean and Rovers 1984) resulted in nonnormally distributed data.

RESULTS AND DISCUSSION

The populations from the farming cooperative and the comparison town were similar in racial mix (Mestizo), apparent socioeconomic status, diet, and physical activity, and dissimilar in the use of agricultural pesticides. The comparison population lived at a higher altitude (about 600 meters) than the test population (sea level). Diastolic blood pressure, weight, height, and age were not significantly different in the two groups, but systolic blood pressure was significantly lower in the test group (Table 2). Most published data indicate that blood pressure, in people of the same age, is lower in those living at high altitude than those at sea level (Baker 1969; Marticorena 1969; Frisancho 1975). In the present study, the comparison group, which lived at a higher altitude, had higher systolic blood pressure. We did not, therefore, believe that differences in blood pressure were explained by altitude. We have found no reports in the literature of a negative correlation between systolic blood pressure and serum DDT concentrations.

Serum pesticide concentrations for individuals are given for those pesticides that were at or above detection limits in at least one person (Table 3). Mean DDE and DDT levels were higher in the exposed group, but differences were not statistically significant (Table 4). Furthermore, concentrations of DDT, B-HCCH, HE, and TN were in the range found in the general population of the United States (Murphy and Harvey 1985), concentrations not reported to be associated with adverse health effects, or as in the case of DDT, concentrations reported not to be associated with adverse health effects (LeMotte 1969; Warnick and Carter 1972). Median DDE concentrations were slightly higher than those seen in the United States. Conversion of DDT to the much less toxic DDE is a minor pathway for DDT metabolism, most DDT being excreted in urine as DDA. DDE represents preformed dietary DDE, rather than endogenously produced DDE (Baselt 1982), and is not necessarily evidence of past exposure to DDT.

The test group had significantly higher concentrations of serum HE. HE levels were low, however, with a median value of 0.21 ug/L, the highest being 0.558 ug/L. For comparison, in the United States in the National Health and Nutrition Examination Survey (NHANES) 2.5% of the population showed levels of HE above the detection limit of 1 ug/L (Murphy and Harvey 1985).

Table 2. Physical Characteristics of the Study Groups

	Exposed (n=20)	Comparison (n=19)
Age (years)	43.3±12	41.5±9
Weight (pounds)	145±34	130±13
Height (inches)	65±3	66±2
Systolic blood pressure (mm Hg)	110±14	121±13*
Diastolic blood pressure (mm Hg)	71±10	74±11

*Difference significant at the 0.05 level.

A peak with a retention time of methoxychlor was present in the serum of one the comparison group and was confirmed as methoxychlor by mass spectral analysis. Concentrations of other pesticides in this participant's serum did not reflect excessive exposure.

Studies in western, industrialized societies have shown a positive correlation between DDE and DDT concentrations and age (Kreiss et al 1981; Davies et al 1974). We failed to demonstrate this relationship in the population from this nonindustrialized area. We did find statistically significant correlations between DDT and BMI, DDT and weight, DDE and BMI, and DDE and weight (Table 5). These differences in findings may be related to the fact that in western populations weight increases with age until about the seventh decade. Weight gain is due to increased adiposity, and adipose tissue is the storage depot for persistent organochlorides. Therefore, the previously reported association with age may have been confounded by weight. The absence of a positive correlation between weight and age has been reported in other populations from nonindustrial areas such as the Qash'qai nomads in Iran (Page et al 1981) and in certain groups in the Solomon Islands (Friedlander and Rhoads 1982). Failure to detect PCBs in this population is also indicative of the nonindustrial character of the environment from which the population was drawn.

The findings reported here suggest that the body burdens of organochlorides are similar to those found in the United States which are not found to be associated with adverse health effects. They also provide evidence that the population is not currently being exposed to appreciable amounts of organochloride pesticides. Organochlorides were legally discontinued in 1980, and these specimens were taken 8 years later. Participants tended to be lean which may mean that storage of pesticides was less than what would be seen in a population with more adipose tissue. Elimination through urine (of the metabolite DDA) may have therefore been more complete. We could not, however, rule out excessive exposure to, or adverse health effects from, organophosphate or carbamate pesticides, which have

Table 3 Concentrations (mg/L) of Chlorinated Pesticides in Serum

Specimen # Test Group	p,p'-DDE	B-HCH	HE	TN	p,p'-DDT	p,p'-DDT	DDT	Methoxychlor
0001	32.2	<0.28*	0.515	0.298	<0.24	2.81	<0.24	<0.24
0002	116.4	1.37	0.362	0.304	<0.24	9.01	<0.24	<0.24
0003	40.11	0.973	0.434	0.325	<0.24	4.57	<0.24	<0.24
0004	69.58	0.903	0.338	0.269	<0.24	3.35	<0.24	<0.24
0020	15.10	0.59	0.531	<0.25	<0.24	1.06	<0.24	<0.24
0021	71.85	0.41	0.337	<0.25	<0.24	3.39	<0.24	<0.24
0022	80.28	0.45	0.372	<0.25	<0.24	2.63	<0.24	<0.24
0023	30.95	<0.28	0.349	0.283	<0.24	1.40	<0.24	<0.24
0024	37.24	<0.28	0.200	<0.25	<0.24	2.25	<0.24	<0.24
0025	25.55	0.37	<0.19	<0.25	<0.24	1.52	<0.24	<0.24
0026	18.35	<0.28	0.303	<0.25	<0.24	2.17	<0.24	<0.24
0027	8.09	<0.28	0.262	<0.25	<0.24	1.62	<0.24	<0.24
0028	26.76	<0.28	0.279	<0.25	<0.24	2.16	<0.24	<0.24
0029	25.08	<0.28	0.414	<0.25	<0.24	0.863	<0.24	<0.24
0030	25.03	<0.28	0.423	<0.25	<0.24	0.828	<0.24	<0.24
0031	31.94	<0.28	0.351	<0.25	<0.24	1.49	<0.24	<0.24
0032	33.71	0.40	0.325	0.264	<0.24	1.31	<0.24	<0.24
0033	20.61	0.362	0.210	<0.25	<0.24	1.39	<0.24	<0.24
0034	76.04	0.301	0.558	0.392	<0.24	6.98	<0.24	<0.24
0035	60.29	0.807	0.424	0.380	<0.24	2.84	<0.24	<0.24

* < = detection limit; half of this value used for mean calculation.

Specimen #	Comparison Group	P,p'-DDE	B-HCHH	HE	TN	o,p'-DDT	P,p'-DDT	Methoxychlor
0005		11.14	<0.39	<0.27	<0.30	<0.32	1.70	5.16
0006		46.71	<0.39	<0.27	<0.30	<0.32	2.45	<0.24
0007		17.97	<0.39	<0.27	<0.30	<0.32	2.24	<0.24
0008		31.29	<0.39	<0.27	<0.30	<0.32	1.74	<0.24
0009		58.37	<0.39	<0.27	<0.30	<0.32	2.30	<0.24
0010		37.45	<0.39	<0.27	0.955	<0.32	1.30	<0.24
0011		18.13	<0.39	<0.27	0.586	<0.32	0.865	<0.24
0012		25.61	<0.52	<0.37	<0.489	<0.42	0.868	<0.24
0013		36.61	<0.39	<0.27	<0.30	<0.32	1.85	<0.24
0014		13.82	<0.76	<0.55	0.838	<0.63	1.16	<0.24
0016		40.10	<0.39	<0.27	0.504	<0.32	1.69	<0.24
0017		22.71	<0.52	<0.37	<0.489	<0.42	1.23	<0.24
0018		17.55	<0.39	<0.27	1.61	0.328	0.636	<0.24
0019		63.85	<0.39	<0.27	<0.37	<0.32	1.92	<0.24
0036		9.62	<0.39	<0.27	<0.37	<0.32	1.12	<2.03
0037		55.17	<0.39	<0.27	<0.37	<0.32	2.13	<2.03
0038		68.36	<0.39	<0.27	<0.37	<0.32	4.44	<2.03
0039		7.21	<0.39	<0.27	<0.37	<0.32	0.799	<2.03
0040		6.00	<0.78	<0.55	<0.73	<0.63	1.71	<4.07

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Table 4. Serum Pesticide Concentrations in the Study Groups

Analyte	Exposed		Comparison		Wilcox p	T Test p
	Mean	Median	Mean	Median		
DDE	42.5	32.0	30.9	25.6	0.156	0.15
DDT	2.69	2.17	1.69	1.70	0.100	0.06
B-HCCH*	0.44	0.37	0.22	0.19	0.675	_____
HE*	0.34	0.34	0.15	0.13	0.0001	_____

*In cases where the value for BBHC and HE were designated "<"; half of this value was used for mean calculation

Table 5. Correlations of LogDDE and LogDDT with Weight and BMI

LogDDE with age	r = 0.244	p = 0.1336	n=30
LogDDT with age	r = 0.234	p = 0.1510	n=39
LogDDE with Weight	r = 0.609	p = 0.0043	n=39
LogDDT with Weight	r = 0.783	p = 0.0001	n=39
LogDDE with BMI	r = 0.621	p = 0.0034	n=39
LogDDT with BMI	r = 0.830	p = 0.0001	n=39

replaced organochlorides in the test area. However, most of the population has remained in the same area and at the same tasks for most of their working careers. Organophosphate and carbamate exposure in these individuals may therefore be similar to organochloride exposure, i.e. not excessive. Monitoring serum and red blood cell cholinesterase activity, and perhaps vitamin A, before, during, and after the spraying season would help answer questions about organophosphate and carbamate exposure.

Acknowledgment: The authors thank Patricia C. McClure of the Toxicology Branch, of EHLS, CEHIC, CDC for her technical assistance.

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Received August 6, 1988; accepted September 15, 1988.