

4th INTERNATIONAL CONFERENCE ON CHILDREN'S HEALTH AND THE ENVIRONMENT

Reducing environmental risks for our children

MALNUTRITION, PESTICIDES EXPOSURE AND NEUROBEHAVIORAL DEFICITS IN ECUADORIAN SCHOOL CHILDREN

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- MALNUTRITION HAS BEEN CONSIDERED A MAIN CAUSE OF NEUROBEHAVIORAL DEFICITS IN DEVELOPING COUNTRIES
- SOMETIMES ALSO EDUCATIONAL SYSTEM WERE FOUND AS RESPONSABLE OF OBSTACLES OF CHILDREN TO LEARN
- ALWAYS SOCIO-ECONOMICAL FACTORS HAVE AN IMPORTANT INFLUENCE IN MANY DISEASES IN LATIN AMERICAN COUNTRIES

- NOW A DAYS ENVIRONMENTAL FACTORS ARE MORE AND MORE INCLUDED AS CO-DETERMINANTS OF DISEASES IN ADULTS AND CHILDREN
- RESEARCH IS ALSO CHANGING: IT SEEMS IT IS GOING FROM CONGENITAL MALFORMATIONS TO PRENATAL EXPOSURES AND DEVELOPMENTAL DISORDERS

- FLORICULTURE IS AN IMPORTANT AGROINDUSTRY IN ECUADOR. MORE THAN 50.000 PERSONS ARE DIRECTLY EMPLOYED IN FLOWER PLANTATIONS

- 60% OF WORK FORCE ARE WOMEN
- DIFFERENT WORKPLACES ARE INCLUDED IN FLOWER PRODUCTION

The Ecuadorian Floriculture

Greenhouses



Greenhouses



Cultivation



Cultivation



Applicators



Applicator



The application



Cultivation worker while application



Application of pesticides



Transport from cultivation area to post-harvest



Post-harvest area entrance



Post-harvest entrance



Post-Harvest entrance



Inside Post-harvest area



Post-harvest area









Storage







Maintenance



- WORKING CONDITIONS ARE NOT GOOD: A HEAVY EXPOSURE TO PESTICIDES IS VERY COMMON
- MOST OF THE PESTICIDES USED ARE ORGANOPHOSPHATES, CARBAMATES AND PIRETROIDES
- PREGNANT WOMEN WORK WITHOUT PROTECTION FROM THE BEGINNING AND ARE AT WORK A FEW DAYS BEFORE DELIVERY
- THERE IS A LOW DOSE-LONG TERM EXPOSURE TO PESTICIDES IN PARTICULAR IN GREENHOUSES, POST-HARVEST AND NURSERY

- IN TABACUNDO, ECUADOR, ALL THE CHILDREN (79) ATTENDING THE TWO LOWEST GRADES OF A PUBLIC SCHOOL WERE INVITED FOR CLINICAL EXAMINATIONS
- SOME TESTS LIKE REACTION TIME, SANTA ANA DEXTERITY TEST, STANFORD BINET COPYING, WECHSLER INTELLIGENCE SCALE FOR CHILDREN-REVISED DIGIT SPANS FORWARD WERE APPLIED
- RECENT PESTICIDE EXPOSURE WAS ASSESSED BY ERYTHROCYTE ACETYLCHOLINE ESTERASE ACTIVITY AND URINARY EXCRETION OF ORGANOPHOSPHATE METABOLITES
- MOTHERS WERE INTERVIEWED ASKING ABOUT PESTICIDE EXPOSURE DURING PREGNANCY

RESULTS

- 7 CHILDREN WERE EXCLUDED OF THE DATA ANALYSIS DUE TO OTHER DISEASES OR AGE > 9 YEARS
- MATERNAL OCCUPATIONAL HISTORY REVEALED 37 CHILDREN HAVE BEEN EXPOSED TO PESTICIDES DURING DEVELOPMENT
- PRENATAL PESTICIDE EXPOSURE WAS ASSOCIATED WITH A HIGHER SYSTOLIC BLOOD PRESSURE THAN IN CONTROLS

- 14 EXPOSED CHILDREN AND 9 CONTROLS SHOWED ≥ 1 NEUROLOGICAL ABNORMALITIES
- OF 5 NEUROBEHAVIORAL TESTS, THE STANFORD-BINET COPYING TEST SHOWED A LOWER DRAWING SCORE FOR COPYING DESIGNS IN EXPOSED CHILDREN THAN IN CONTROLS

- STUNTING WAS ASSOCIATED WITH A LOWER SCORE ON THIS TEST ONLY AND BOTH RISK FACTORS REMAINED STATISTICALLY SIGNIFICANT IN A MULTIPLE REGRESSION ANALYSIS WITH ADJUSTMENT FOR DEMOGRAPHIC AND SOCIAL CONFOUNDERS
- INCREASED EXCRETION OF DIMETHYL AND DIETHYL METABOLITES OF ORGANOPHOSPHATES WAS ASSOCIATED WITH INCREASED REACTION TIME AND NO OTHER OUTCOMES

TABLE 1 Demographic and Past Medical History Parameters for 35 Ecuadorian Primary School Children Without (Controls) and 37 Children With (Exposed) Prenatal Pesticide Exposure

Parameter	Controls	Exposed	<i>P</i>
Gender, boy/girl, <i>n</i>	15/20	19/18	.47
School grade, 2nd/3rd, <i>n</i>	19/16	20/17	.98
Housing, traditional/contemporary, <i>n</i>	14/21	15/22	.96
Running water at home, yes/no, <i>n</i>	25/10	36/1	.002
Sewage drainage at home, yes/no, <i>n</i>	15/20	16/21	.97
No. of meals per day, 2/3, <i>n</i>	8/27	8/29	.90
Protein-rich diet, yes/no, <i>n</i>	18/17	21/16	.65
Chronic disease, yes/no, <i>n</i>	4/31	3/34	.64
History of trauma or accident, yes/no, <i>n</i>	12/23	10/26	.55
History of meningitis, yes/no, <i>n</i>	1/34	2/35	.59
No. of siblings, mean (SD)	3.4 (3.7)	2.5 (2.1)	.21
Delivery, clinic/at home, <i>n</i>	21/14	24/13	.67
Maternal smoking during pregnancy, yes/no, <i>n</i>	1/34	2/35	.59
Maternal alcohol drinking during pregnancy, yes/no, <i>n</i>	2/33	4/33	.43
Maternal age, mean (SD), <i>y</i>	31.5 (7.2)	30.7 (5.6)	.58
Maternal race, Amerindian/Mestizo-Hispanic, <i>n</i>	29/6	30/7	.97
Maternal education, primary school only/above, <i>n</i>	30/3	27/9	.23

TABLE 2 Pesticide Exposure (nmol/kg per day) Calculated From Metabolite Concentrations in Urine for 35 Ecuadorian Primary School Children Without (Controls) and 37 Children With (Exposed) Prenatal Pesticide Exposure

Analyte	Controls			Exposed			<i>p</i> ^a
	No. Detectable	Median	Maximum	No. Detectable	Median	Maximum	
Dimethyldithiophosphate	12	—	0.85	8	—	1.08	.21
Dimethylthiophosphate	7	—	4.12	5	—	4.77	.47
Dimethylphosphate	31	0.409	2.39	30	0.200	6.78	.06
Diethyldithiophosphate	0	—	—	0	—	—	1.00
Diethylthiophosphate	19	0.095	0.45	23	0.078	6.77	.48
Diethylphosphate	30	0.297	2.19	29	0.193	7.85	.05
All dimethyl metabolites	31	0.417	6.53	30	0.207	6.94	.07
All diethyl metabolites	31	0.426	2.49	33	0.273	14.62	.04

The level of detection was 0.3 $\mu\text{g/L}$ for dimethylphosphate and dimethylthiophosphate and 0.1 $\mu\text{g/L}$ for all other alkylphosphate metabolites measured. If detectable concentrations were present in less than half of the samples, no median is indicated.

^a Mann-Whitney test.

TABLE 3 Anthropometric and Other Clinical Results for 35 Ecuadorian Primary School Children Without (Controls) and 37 Children With (Exposed) Prenatal Pesticide Exposure

Parameter	Controls (N = 35)		Exposed (N = 37)		P
	Mean \pm SD	Range	Mean \pm SD	Range	
Age, y	7.14 \pm 0.85	5.71 to 8.63	7.09 \pm 0.67	5.81 to 8.82	.78
Weight, kg	20.4 \pm 2.9	15.1 to 29.0	20.1 \pm 2.1	16.5 to 26.0	.56
Height, cm	113.2 \pm 7.3	103.5 to 131.5	111.6 \pm 5.1	100.5 to 123.0	.27
Height for age, z	-1.59 \pm 0.99	-3.26 to 0.36	-1.84 \pm 0.83	-3.65 to 0.35	.26
Weight for age, z	-0.84 \pm 0.78	-2.26 to 0.63	-0.92 \pm 0.64	-2.06 to 0.52	.64
Weight for height, z	0.34 \pm 0.71	-1.02 to 1.55	0.50 \pm 0.72	-1.07 to 1.04	.34
BMI, kg/m ²	15.9 \pm 1.1	13.7 to 17.6	16.1 \pm 1.1	13.9 to 18.6	.38
Head circumference, cm	50.7 \pm 1.3	48 to 53	50.8 \pm 1.4	47.5 to 53.5	.70
Hematocrit, %	42.3 \pm 3.2	32 to 48	41.2 \pm 2.2	37 to 46	.11
Acetylcholinesterase, U/g of hemoglobin	26.7 \pm 3.0	20.1 to 32.7	27.0 \pm 2.4	23.2 to 33.2	.59

TABLE 4 Neurobehavioral Outcome Results (Mean \pm SD) in 72 Ecuadorian Primary School Children in Relation to Pesticide Exposure

Outcome	Prenatal Exposure		<i>P</i>	Current Exposure		<i>P</i>
	No (<i>N</i> = 35)	Yes (<i>N</i> = 37)		No (<i>N</i> = 51)	Yes (<i>N</i> = 21)	
Blood pressure						
Systolic	99.4 \pm 7.8	104.0 \pm 8.4	.02	102.2 \pm 9.1	100.6 \pm 6.3	.46
Diastolic	65.9 \pm 9.4	68.5 \pm 6.9	.19	67.8 \pm 8.3	65.7 \pm 8.0	.32
Sway area, cm ²						
Open eyes	385 \pm 214	361 \pm 200	.63	362 \pm 170	401 \pm 282	.49
Closed eyes	588 \pm 282	570 \pm 355	.82	559 \pm 289	624 \pm 388	.44
Santa Ana, total No. correct	30.3 \pm 6.0	30.2 \pm 6.3	.95	30.9 \pm 6.5	28.6 \pm 4.6	.15
Mean reaction time, ms	459 \pm 134	437 \pm 89	.43	426 \pm 85	500 \pm 153	.011
Digit Span forward	2.9 \pm 1.3	3.1 \pm 1.2	.58	3.1 \pm 1.3	2.9 \pm 1.1	.54
Stanford-Binet copying						
Designs 13–20	3.1 \pm 1.6	2.3 \pm 1.2	.02	2.8 \pm 1.6	3.0 \pm 1.7	.76
All designs	3.3 \pm 1.8	2.5 \pm 1.3	.03	2.7 \pm 1.5	2.8 \pm 1.4	.76

TABLE 5 Averages and SD of Blood Pressures and Stanford-Binet Copying Scores for 72 Ecuadorian Primary School Children in Regard to Prenatal Pesticide Exposure and Stunting (Height-for-Age z Score of Less Than -2)

Outcome	Unexposed		Exposed		<i>P</i>
	<i>N</i>	Mean ± SD	<i>N</i>	Mean ± SD	
Systolic blood pressure, mm Hg					
Not stunted	19	100.4 ± 6.9	22	103.3 ± 9.2	.26
Stunted	16	98.3 ± 8.9	15	105.0 ± 7.1	.03
<i>p</i>		.43		.55	
Diastolic blood pressure, mm Hg					
Not stunted	19	67.7 ± 8.9	22	68.7 ± 7.4	.68
Stunted	16	63.8 ± 9.7	15	68.1 ± 6.3	.16
<i>p</i>		.23		.79	
Stanford-Binet copying score (13–20)					
Not stunted	19	3.68 ± 1.73	22	2.45 ± 1.14	.01
Stunted	16	2.38 ± 1.15	15	2.07 ± 1.16	.46
<i>p</i>		.02		.32	
Stanford-Binet copying, total score					
Not stunted	19	4.00 ± 1.97	22	2.68 ± 1.32	.02
Stunted	16	2.44 ± 1.26	15	2.13 ± 1.19	.50
<i>p</i>		.01		.21	

TABLE 6 Multiple Linear-Regression Results for Independent Predictors of Blood Pressure and Stanford-Binet Copying Scores for 72 Ecuadorian Primary School Children

Outcome and Predictors	β	SE	<i>P</i>
Systolic blood pressure, mm Hg			
Prenatal pesticide exposure	4.57	1.89	.018
Stunted	-2.81	2.41	.25
Weight, kg	-0.83	0.58	.16
Male gender	2.41	1.95	.22
Age, y	3.79	1.63	.024
Stanford-Binet copying score (13-20)			
Prenatal pesticide exposure	-1.01	0.37	.009
Stunted	-0.74	0.35	.038
Male gender	-0.13	0.35	.70
Age, y	0.27	0.23	.24
Mother primary school only	-0.01	0.24	.97
Risk factors in past medical history	-0.24	0.38	.53
Two meals per day only	-0.13	0.41	.76
No drinking water at home	-0.59	0.50	.25

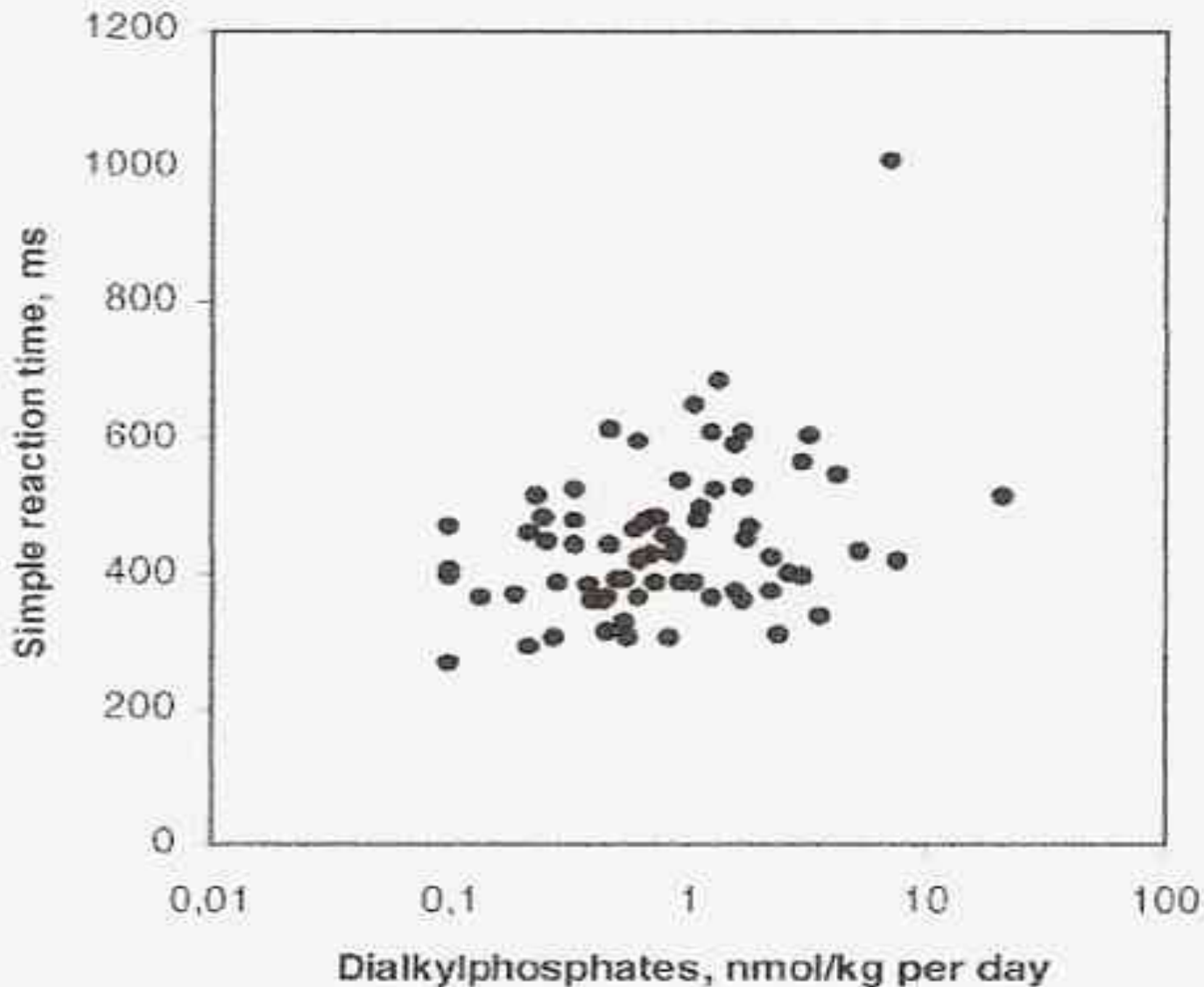


FIGURE 1

Average simple reaction time for right and left hands in relation to composite urinary excretion of dimethylphosphate and diethylphosphate metabolites in 72 Ecuadorian school children ($r = 0.36$; $P = .002$).

- CONCLUSIONS
- PRENATAL PESTICIDE EXPOSURE MAY CAUSE LASTING NEUROTOXIC DAMAGE AND ADD TO THE ADVERSE EFFECTS OF MALNUTRITION IN DEVELOPING COUNTRIES
- THE EFFECTS DIFFER FROM THOSE DUE TO ACUTE PESTICIDE EXPOSURE
- INDEPENDENT PREDICTORS SHOULD BE CONSIDERED TO LOOK FOR ENVIRONMENTAL AND SOCIAL FACTORS OF HEALTH DISORDERS IN DEVELOPING COUNTRIES