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Exposure Factors to Organophosphate and Carbamates Pesticides in the Putumayo Department, 2006

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1. Introduction

One of the main problems faced by the world in the XXI century is the environment degradation. The rapid scientific and technological advances have generated immense developments for the humankind but, also, they have altered in a global way, the ecological balance of the planet.

Among the environmental agents harmful to the health, the chemical products occupy the most important place as a public health problem in the developing countries, due to the inadequate way they are manufactured and the substances used for the same, and also to the way the chemical residues are discarded (Corey, 1988).

The effects of the pesticides in the human and environment contamination is caused by the large quantity and assortment of substances that are applied to the agriculture and to the handling done of the pesticides during the application, transportation, storage and elimination of its residues (Idrovo, 1999).

Among the more than 70,000 chemical substances currently on the market, the synthetic pesticides have been occupying an important place since 1940, and have been converted into the principal strategy for the pest control (OPS, 2004; Henao, 1991).

The agricultural development model in Colombia sustains itself principally in the use of agrochemicals, which most of the times are used without the necessary technical investigation, without knowing the multiplicity of the regional features such as the climate variety, the species diversity and the cultures heterogeneity (Idrovo, 1999).

The World Health Organization (OMS, in Spanish) points out that during the first half of the decade of the eighties, about 1,000,000 cases of not deliberate poisoning with pesticides occurred, of which 70 % were originated within the working activity; it is believed that during the same period, close to 2,000,000 poisonings with suicidal purposes happened, and 7, 3 % of all the poisonings were lethal cases (OMS, 1992). The International Labour Organization (OIT)

for its part believes that the pesticides can be connected with 14, 0 % of the occupational injuries in the agricultural sector and of 10, 0 % of all the deaths (Córdoba, 2000). In the whole world, 148 epidemic break outs were registered between 1951 and 1990 because of the pesticides, causing 24,731 poisonings and 1065 deaths (Levine R.S, Doull J., 1992). In the developing countries, the pesticides cause up to one million poisoning cases and up to 20,000 deaths, annually (Durán J.J., Collí J., 2000).

According to the International Organization of Consumers Union, an agricultural worker dies every 4 hours in developing countries due to poisoning by pesticides, which is equivalent to more than 10,000 deaths per year, and another 375,000 poison themselves with these products (United Nations Food and Agricultural Organization, 1986).

The Overseeing System in Public Health (*SIVIGILA*, 2005) informed that during year 2005 in which the study was carried out, the Department of Putumayo was in the country, the region with major poisonings incidence due to pesticides (see chart., 1), 8,777 cases were reported for 2006, 13,179 cases for 2007, 18,105 cases for 2008, and 19,723 cases of poisoning appeared already for pesticides during 2009 (*SIVIGILA*, 2009).

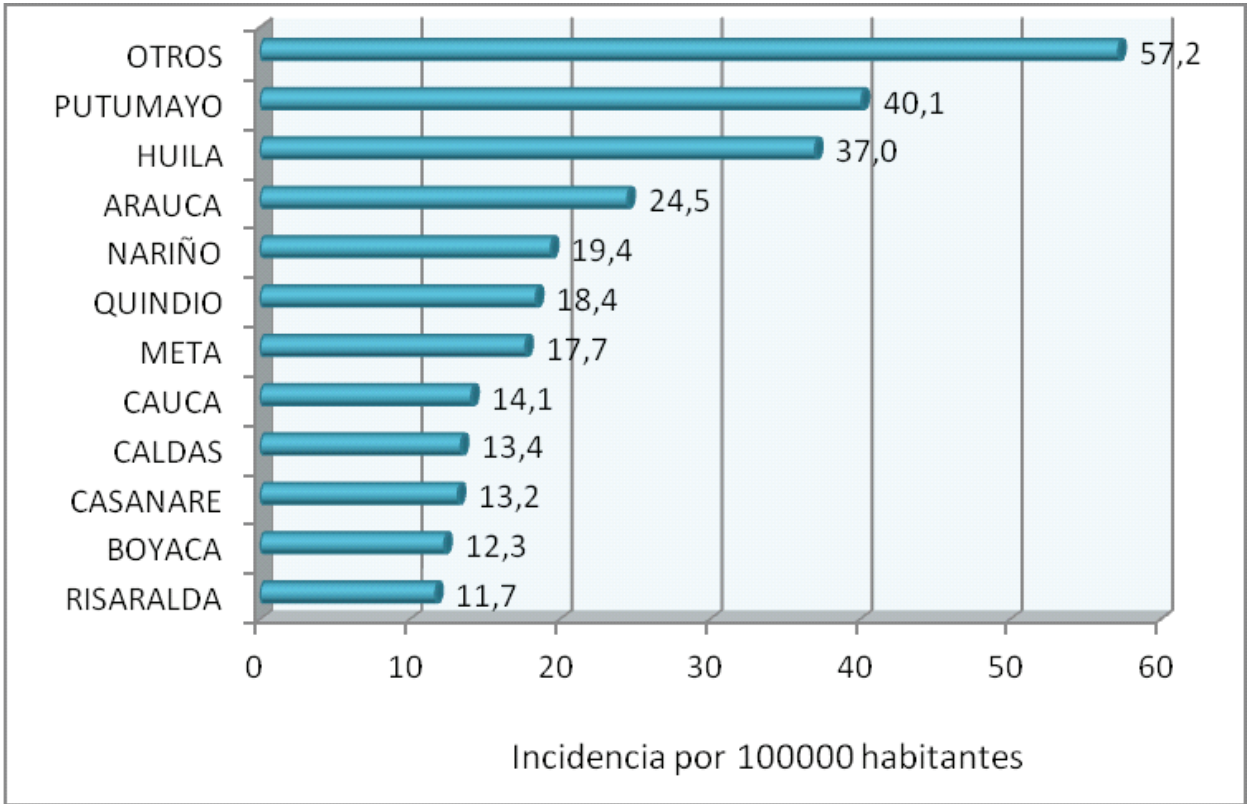


Fig. 1. Incidence by departments, the occurrence of poisonings caused by pesticides, *SIVIGILA*, Colombia, 2005.

The Health Administrative Department of Putumayo showed 248 poisonings due to chemical substances for the year 2005, of which the pesticides were the principal cause in 145 of those (58,4 %); it was reported a major frequency in the municipalities of Puerto Asís (26,9 %), Mocoa (19,3 %), Valle del Guamuez (15,2 %), San Miguel (9,0 %) and Orito (8,3 %). Out of the 145 persons poisoned with pesticides, women presented major number of poisonings (56,5 %) than men (43,4 %); the most affected age group was that from 11 to 20 years (44,1 %), followed by the group from 21 to 30 years (26,9 %) (Revelo D. 2005).

There is a number of types of poisoning, which according to the time passed between the contact with the toxicant and the appearance of the symptoms, the intensity and duration of the symptoms and the quantity of the toxicant, three are classified as follows: acute: for the appearance of a sudden clinical manifestation within 24 hours of exposure to an agent, of short exposure to high doses (cyanide, organophosphate insecticides); chronic: for repeated exposure to very low doses of an agent during long periods of time and with late effects, (organophosphate pesticides, organochlorine pesticides, lead, mercury, white phosphorus) and acute in chronic: acute exposure on a base of chronic exposure to the same agent (Varona M., et al., 2003).

Most of the poisonings reported in our country occur due to organophosphate and carbamates pesticides, which are extensively used as agricultural supplies, domestic pesticides and for the control of epidemic illnesses vectors (Idrovo, 1999; Varona M., et al, 1998). The assessment of the acetylcholinesterase enzyme activity has been used as effect biomarker for these groups of pesticides (Henao, 1990), for which several methodologies have been developed. Among them are those which use colour indicators, such as that of Limperos and Ranta, or the Ellman method, as well as electrometric methodologies, such as that of Michel (Michel, 1949; Limperos G. and Ranta K., 1953).

The colorimetric method of Limperos and Ranta allows the pursuit of large population groups for being a screening technique of low cost and simple to perform. The electrometric method of Michel is based on a quantitative assessment, measuring the fall of the pH as the acetylcholine substratum is hydrolyzed forming acetic acid (Michel, 1949).

The National Health Institute, through the representation of the PanAmerican Health Organization (*OPS*) in Colombia, implemented the methodology *SARAR*, which is an educational strategy that uses visual materials as posters, cards with illustrations, messages suitable and easy to understand to the persons of the rural environment, who can put them into practice to reduce the use of pesticides, the effects on the health, and the avoidance of environmental contamination. With this training, the population acquires the aptitude to recognize situations of risk associated with the handling of pesticides, to identify inconveniences that demonstrate deterioration in the health, to take part in improvement programs of the environmental and work conditions in the localities where they live, to define goals in short and medium term to protect the individual and family health, and to initialize a reflection process on the importance and the profit of the biological control of the handling of pets (*OPS*, 2003; Nutrition Institute of Central America and Panama, 1999).

Likewise, it is clear that the use of pesticides is a direct consequence of the need of improving the harvests and of avoiding the losses caused by the pests. With the use of the pesticides, the food production has increased in 50 %, but unfortunately has generated new risks, which are evident in new pathologies, resultant from the exposure to these toxicants (Garcia, J.E., 1998).

This study was carried out bearing in mind the high use of pesticides in the Department of Putumayo, because in this Department do not exist information sources that allow evaluating the scope of the problem caused by use of pesticides; in order to assess the exposure to organophosphate and carbamates pesticides in the agricultural population, by means of the assessment of the levels of acetylcholinesterase in the blood of the occupationally exposed workers; using Michel's method. There also the use and handling of the pesticides was described with the objective of realizing interventions in the community to minimize the risks associated with the use of these substances.

2. Methodology

A cross sectional study was carried out in a sample of 204 workers occupationally exposed to pesticides, belonging to the municipalities of Puerto Asís, Orito, Valle del Guamuez and San Miguel in the Department of Putumayo, during the years 2005-2006.

The size of the sample was calculated with a power of 80 %, a significance level of 99 %, a predominance expected of 50 % and a percentage loss of 20 %, and a size sample of 198 individuals was obtained, distributed proportionally in every municipality, bearing in mind its agricultural population. Six additional workers were included, who requested to take part and complied with the study criteria of inclusion.

The workers were informed about the targets and the benefits of the investigation and, once they voluntarily accepted their participation, signed a written assent.

The criteria of inclusion of the population under study was determined by the workers who were using organophosphate or carbamates pesticides in their habitual job and they were selected with the help of the Administrative Department of Health of Putumayo. Workers not exposed to these pesticides, as well as pregnant women or who were taking contraceptive oral, workers with history of hepatic illness or diabetes, and all those who did not accept to take part, there were excluded.

A survey was done to them, with which information of demographic type, occupational background, toxicological and clinical precedents, was obtained. A blood sample was gathered for the assessment of the activity of the acetylcholinesterase enzyme within the three days following the exposure to the pesticides; bearing in mind the toxic kinetics of these groups of pesticides (Henao S. & Corey G., 1991; a Obiols J., 2006; b Obiols J., 2006). A pilot study was carried out in 10 % of the whole force of workers of the sample, in order to conduct the adjustments to the occupational survey. These persons were not part of the population under study.

For the assessment of the acetylcholinesterase enzyme activity of every worker, 10 ml of blood were obtained through venous puncture, in tubes with sodium heparin as anticoagulant. The samples were placed in refrigeration since the moment of the collection until they came to the Environmental and occupational health group, of the National Health Institute, where the analyses were carried out. Once the samples were in the laboratory, they were codified again in order to minimize the analyst's bias.

Later, they were fractioned to be processed and to perform the respective assessment of the activity of the acetylcholinesterase enzyme, using the Michel's method.

For this method it was necessary to carry out a separation of the sample by centrifugation and to work with the plasma and the erythrocytes. The original procedure was validated by the Environmental and occupational health group; the time of the test reaction was modified, which originally was of 60 minutes to 40 minutes for erythrocytes and 45 minutes for plasma (Morato R, Lancheros A, Murcia A. Study of some factors that affect the acetylcholinesterase assessment in erythrocytes and plasma, using the electrometric method of Michel; data without publishing).

The analysis of the results was done using as normality ranges those reported by Henao S. et al. (chart 1) and those found by the Environmental and occupational health group, which values are 0,91-1,64 Δ pH/hour for erythrocytes and 0,71-1,17 Δ pH/hour for plasma.

A simple analysis was carried out of all the variables to assess the descriptive statistics such as the measurement of central tendency and dispersion. Furthermore, the variables were crisscrossed to judge associations statistically noteworthy; for such effect the program Epi-

Info 6.04 and Epidat 3.0 was used. The comparisons between those presenting values of acetylcholinesterase below the established used ranges in each of the methods were carried out in tables of 2x2.

ASSESSMENTS	SEX	RANGE(Δ pH/hour)	AVERAGE(Δ pH/hour)
Erythrocytes	Men	0.58 - 0.95	0.766
	Women	0.56 - 0.94	0.750
Plasma	Men	0.52 - 1.39	0.953
	Women	0.38 - 1.25	0.817

Chart 1. Normal values of acetylcholinesterase (Henao S., et al, 1990)

An analysis of variance ANOVA was carried out between the variable assessment of acetyl cholinesterase and the features of the individuals under the study. Using an simple random sampling, among the totality of individuals, 51 workers were chosen who were trained using the SARAR methodology of community education in the use and handling of pesticides and, later the acquired knowledge was evaluated. This study was approved by the Technical Investigation Committee and the Ethics Committee of the National Health Institute.

3. Results

204 workers occupationally exposed to insecticides from the municipalities of Puerto Asís, Orito, Valle del Guamuez and San Miguel, were selected to conform the sample of the study, and an equal number of surveys and biological samples were gathered. Out of the total participant workers, 94, 1 % (192) belonged to the rural area and the remainder to the urban area. In terms of sex, 86,8 % (177) were men and 13,2 % (27) women, and their ages were ranging between the 13 and 74 years, with an mean of 34 years for the two sexes. The age of the men was between the 16 and 73 years (mean = 33, 9 years, median = 34 years and DE = 11, 7) and that of the women, between the 13 and 74 years (mean = 34, 8 years, median = 34 years and DE=14, 2). As per statistics there were not significant differences between the ages regarding to sex. As for the enrolment to the General System of Social Security in Health (SGSSS), 54,9 % (112) of the individuals of the sample belonged to the contributory regime, 32,8 % (57) were linked and 12,3 % (25) were of the subsidized regime. On the topic of the schooling level, 92, 6 % (188) of the individuals did not finish the secondary school and 3, 9 % (8) are illiterate. At the moment of carrying out the interview, 86,3 % (175) reported themselves as agriculturists. As for the exposure to pesticides, 53, 0 % (96) of the individuals informed that it was by means of respiratory route and 47, 0 % (109) for direct contact; none reported as exposure route the oral one. The time of exposure to the pesticides ranged between three months and 30 years, with an average of exposure of nine years, for men (mean =9,6 years, median=10 years and DE=10 years) and in women, between four months and 20 years (mean =5,9 years, median=5 years and DE=10). A difference statistically significant was found in the exposure time to insecticides between men and women (ANOVA t=2, 76 p=0,006). 45,6 % (93) of the workers reported to fumigate as minimum of two times a week, 27,5 % (56) fumigates every 15 days and 22,5 % (46) between one and three months. 80, 1 % works full time (8 hours a day) in fumigation and, in general, they work with pesticides an average

of 7, 3 hours per day. The workers recount that the work performed during the no fumigation period is that of preparing the ground (52, 2 %), harvesting (10 %), domestic works (9 %), scraping (5 %) and different activities (5 %), among others. It is surprising that 91, 2 % (186) of the workers informed that they have not received training on the safe handling of pesticides.

In terms of pesticides use, 100 % of the workers who entered into the study reported the use of organophosphate and carbamates pesticides. 41, 5 % (116) affirmed to have used bi-pyridyl (quaternary ammonium); 19, 6 % (52), phosphonoaminoacid; 29, 1 % (77), 2, 4-D-dichlorophenoxyacetic acid, and 9, 8 % (26) organochlorine pesticides.

The insecticide *tamarón* (organophosphate) was the most used by the workers, with 86, 0 % (177), followed by *furadán* (carbamate), with 56, 4 % (115).

In terms of the toxicological category, 75, 2 % stated to use pesticides category I (extremely toxic); 13, 0 %, category II (highly toxic), and only 11, 8 % uses pesticides category IV (lightly toxic). None of them reported the use of pesticides of toxicological category III. In Colombia the well-known toxicological categories are: category I: extremely toxic, category II: highly toxic, category III: moderately toxic, and category IV: lightly toxic (Department of Health, 1991; ARP Colpatria, 2000).

According to the gathered information, 163 (79, 9 %) of those polled recounted that they use some element of personal protection when they are applying the pesticides (chart 2).

About the elements of personal protection brought by the workers, only a relation was statistically significant between the use of boots of high cane and the minor probability of presenting poisonings (OR=0,11, IC 0,01-0,89, p=0,014).

Upon having evaluated the hygiene measures, it was possible to demonstrate that 96, 1 % (196) of the workers recount that they change clothes at the end of the working day, 82, 4 % (168) change every day, 12, 7 % (26) do it twice a week and 99 % (202) take a shower on having finished the working day. 44, 1 % (90) affirms washing the clothes in the house and 20, 6 % (42) do it in the river. Likewise, 46, 1 % (94) of the polled persons wash the clothes mixed with that of the family.

As for the eating habits, smoking and consuming liquor, it was found that a high percentage of the workers, 85,3 % (174), ingest some food in the farming area and, of these, only 57,1 % (100) informs that always bathes the hands before consuming food. In terms of the habit of smoking, 67 (32, 8 %) workers recount to do it and 19 (28, 4 %) does it in the farming area. They smoke between 1 and 20 cigarettes, with an mean of 6, 4 cigarettes per day. Also, 127 (62, 3 %) individuals consume liquor, of which, 66 (52, 0 %) says to do it occasionally.

ELEMENTS OF PERSONAL PROTECTION	USAGE FREQUENCY	% USAGE
Street clothes	201	98,5 %
Boots high cane	169	82,8 %
Boots low cane	14	6,9 %
Gloves	6	3,0 %
Disposable mouth cover	5	2,5 %
Respirator	5	2,5 %
Uniform	3	1,5 %
Goggles	2	1,0 %
Bib	1	0,5 %

Chart 2. Elements of personal protection of the polled agricultural workers, Colombia, 2005.

54, 4 % (111) of the workers mention storing the pesticides in an exclusive area, 27, 9 % (57) in a site out of the house and 17, 6 % (36) inside the house. 55,4 % (113) of the workers leave in the farming field the already used packing of the pesticides, 24 % (49) burns them, 18,6 % (38) buries them, 1,5 % (3) leaves them close to the creek and 0,5 % (1) deposits them in the cistern. Among the symptoms reported by the workers, the most frequent were: cephalic, 51, 3 % (39); dizziness, 43, 4 % (33); ocular burning, 40, 8 % (31); weakness, 30, 3 % (23), and abdominal pain, 28, 9 % (22). The clinical symptoms organized by systems are shown in chart 3, where it is possible to notice that the largest percentage (45, 2 %) appears in the neurological system.

Grouping by system	Nº	%
Neurological system	161	45,2
Digestive	64	18,0
Organs of the senses	58	16,3
Haematopoietic	36	10,1
Skin	19	5,3
Respiratory	18	5,1
TOTAL	356	100,0

Chart 3. Grouping by systems of the clinical symptoms offered by the workers exposed to pesticides in the Department of Putumayo.

46, 6 % (95) of the workers showed to have poisoned themselves with pesticides; of these, 71 % (66) preferred to take home-made medicines and only 17, 2 % (16) consulted a doctor. 76, 1 % (70) poisoned themselves with the insecticide *furadán*.

In terms of assessment of the acetylcholinesterase enzyme activity conducted to 204 workers, the ranges of S. Henao et al. (Henao S., 1990) and those of the Environmental and occupational health group using Michel's method, are shown in chart 4, indicating the frequency found according to sex and the number of persons who presented values below the lower limit, which means enzyme inhibition. Bearing in mind the ranges reported by S. Henao et al., 17,6 % (36) of the individuals of the study presented enzyme inhibition, while, for the ranges obtained by the Environmental and occupational health group, 26,5 % (54) showed abnormal values.

Crosses were made between the levels of acetylcholinesterase and the variables included in the survey. A difference statistically significant was found only between the levels of acetylcholinesterase performed by means of Michel's techniques in red blood cells, of the workers who expressed to have presented poisoning with pesticides and those who did not show it (ANOVA $t=2$, $p < 0,05$), although the mean levels are within the range of normal values. For the plasmatic acetylcholinesterase, no significant differences were found with any variable.

Through this project, 51 agricultural workers of the department of Putumayo were trained and, later the knowledge acquired was evaluated by means of the methodology of community education SARAR for the use and suitable handling of pesticides. Out of 17 asked questions, almost half (8) were correctly answered by more than 80% of the interrogated persons.

N Assessment	Sex		Range Δ pH/h Henao S, <i>et al.</i>	Range Δ pH/h INS **	Frequency Henao S, <i>et al.</i>		Frequency INS **	
					Number	%	Number	%
Erythrocytes	177	Men	0,804-0,992	0,91-1,64	30	16,9	47	26,6
	27	Women	0,822-0,99		2	7,4	2	7,4
Plasma	177	Men	0,799-1,107	0,71-1,14	4	2,3	3	2,3
	27	Women	0,756-0,994		0	0,0	2	7,4

** National Health Institute. Morato R, Lancheros A, Murcia A. Study of some factors affecting the acetylcholinesterase assessment in erythrocytes and plasma, using the electrometrical method of Michel.

Chart 4. Comparison of the acetylcholinesterase enzyme activity with the measurement ranges of Henao S., et al. (Henao S., 1990), and of the Environmental and occupational health group, by genre, using Michel's method.

4. Discussion

Although the incidence of poisonings is not accurately known in the worldwide environment, it is anticipated that every year one million persons dies as a consequence of diverse poisonings.

The World Health Organization informs that the incidence of poisonings caused by pesticides has doubled in the last 10 years in the world; nevertheless, there is not known the entire number of cases that take place annually and the seriousness of the notified cases. That's why it becomes necessary that the countries establish programs and research projects, which allow the identification of the risk factors in order to which preventive measurements be established and, at the same time, be working in the diagnosis of the poisonings and the processing of the subjects poisoned (OMS, 1998). This work allows understanding the real dimension of the pesticides problem in the department of Putumayo and using an educational intervention on the community, fundamental pillar in the prevention of risks and in the use and suitable handling of these chemical substances.

Having seen the results, it was observed that, of the whole input of workers who participated in the study, the labour force is mostly of the masculine sex, with a very wide age range, it ranged between the 16 and 73 years; it was found that very young people, as well as of the third age, are farmers exposed to a large variety of pesticides.

Almost a third part of the workers reported not to be affiliated to the General System of Social Security in Health and they do not have the resources to affiliate to the occupational hazards system. The previous matter can be due to the fact that the majority works informally and does not have an employment contract. Neither there exist a Plan of basic attention that values the occupational component of the informal sector and that allows the workers to be trained in the handling of the pesticides.

In terms of the exposure to pesticides, the principal input routes were the respiratory and the dermal, as it is expected for this group of substances. It is important to highlight that the average exposure time to pesticides was nine years for the men and 5,9 for the women, which is considered to be a chronic exposure that can unleash long-term effects. Also, 45,6% of the workers report to fumigate as a minimum of two times a week and in average 7,3 hours a day, which increases the exposure to the pesticides used.

It was defined that is very remarkable the percentage of use of category I pesticides (extremely toxic) and category II (highly toxic), according to the classification given by the Health Department of Colombia (Department of Health, 1991), The evidence continuously accumulates data on alterations of the health due to the pesticides (Cordoba D, 2000). This makes necessary that the workers learn on the effects that can unleash the exposure to the pesticides, it is necessary also to sensitize them in order that they do a rational use of these products and that they reduce in a significant way the use of toxicological pesticides category I and II.

More than the third part of the interrogated persons recalls to have presented a poisoning with the insecticide *furadán*, which is classified among the carbamates, in toxicological category I (Agricultural Colombian Institute, 2002). In case of poisoning, only one small percentage (17,2 %) consults the doctor; they prefer to take home-made medicines, which makes difficult the correct diagnosis and processing of the poisoned patient, as well as the notification of the case to SIVIGILA, thus increasing the sub-registering of cases of poisoning by pesticides.

All the surveyed persons used the organophosphate or carbamates pesticides; the herbicide *paraquat* was the second most used pesticides by the workers, which is classified by the Health Department of Colombia under toxicological category I (Agricultural Colombian Institute, 2002). It was also found, that 9, 8 % of the workers uses organochlorine insecticides, which are currently prohibited in our country. These substances are a permanent risk for the population working in agriculture, as well as for the environment; therefore it is necessary to press hard over the potential adverse effects on the health that these pesticides can produce.

Among the matters of hygiene and industrial safety, most of the questioned persons reported as personal protection equipment only the street clothes and the high cane boots, and very few use ocular, respiratory, and upper members' protection. It is indispensable that the worker be trained in order that he wears light working clothes covering most of the cutaneous surface when mixing or applying pesticides, as well as when cleaning the equipment and emptying receptacles or disposing the remains of the used pesticides. Also, they must wear gloves, boots and masks adapted to the manoeuvring of the pesticides.

46,1 % of the surveyed persons washes the working clothes mixed with the rest of the clothes, which implies that not only the workers but his families are exposed, since they can transport pesticides particles in their clothes.

Another risk factor is the food consumption, being that a high percentage (85, 3 %) does it in the farming field, and a lower percentage smokes in the site; 17, 6 % of the workers stores the pesticides inside the house, which can cause a potential increase of the exposure to pesticides. Likewise, the workers leave the empty packing in the farming field, others leave them close to the creek or bury them, generating contamination in the environment.

Among the clinical symptoms, the predominant complain of the workers was about the neurological system, which coincide with the symptoms of poisoning proper of organophosphate and carbamates pesticides (Toro G. et al, 2002). The organophosphate is still the most used insecticide in the world, particularly in developing countries (Idrovo A.J., 1999). These insecticides and the carbamates are esters of the phosphoric and carbamic acid, they share as common pharmacological feature the inhibition of enzymes with esterase activity, more specifically, the inhibition of the acetylcholinesterase enzyme. They are easily hydrolyzed and have scarce permanence power in the environment (Henao S., 1991).

The measurement of the acetylcholinesterase levels in blood keeps on being a biomarker extensively used to measure the exposure to these substances. Nevertheless, the interpretations of the results are very variable. There exist genetic, physiological causes and associate pathologies, which can lessen the levels of this enzyme.

Also, there is an important change within the same individual. For such a reason, the medical surveillance of the workers exposed continuously to these two groups of insecticides, must include, in addition to the medical examination, the assessment of the acetylcholinesterase enzyme before to the exposure (basal) and every three months during the time that the exposure lasts (Henao S., 1991).

In this study, the acetylcholinesterase levels in blood were determined using Michel's technique, which is thought of being the master standard of reference (Henao S., 1991). The reference ranges used to account the results in this work are those reported by Henao S., et al. and they were compared with the ones set up by the Environmental and occupational health group. The distribution of inhibition frequencies for the different normality ranges is similar in both cases.

Nevertheless, the data brought by Henao S., et al. (Henao S., 1990) for pseudocholinesterase protect more the worker, likewise with the data brought by the National Institute of Health, but for the real acetylcholinesterase (Henao S., 1991), being this a very subtle difference.

In order to guide the process of the poisoned patient and to establish the inability or redeployment of the worker, it is suggested to bear in mind the value of the real acetylcholinesterase activity, since this activity delays more the regeneration after its inhibition (Henao S., 1991). That's why the management of the poisoned persons is done according to the grade of inhibition of the enzymatic activity. On this matter, the plasmatic acetylcholinesterase has speedier recovery than the erythrocytic; therefore, the exposure withdrawal of the worker will be kept as long as the acetylcholinesterase erythrocytic return to basal levels or come to levels next to these (Idrovo A.J., 1999).

So, the activity ranges found by Michel's method in the Environmental and occupational health group is comparable with those found by Henao et al. (Henao S., 1990) and it is a precise, exact, sensitive and solid alternative to determine the enzymatic activity, being this constituted in a tool for the follow-up and surveillance of the labor exposure to organophosphate and carbamates pesticides in Colombia (b Obiols J., 2006).

Other bibliographical reports on normality ranges of the acetylcholinesterase activity are those of Rider et al. (Rider J.A. et al, 1957), who carried out an evaluation in 800 healthy patients, establishing their ranges, which for the case of our data are very low values, and of M. Siquiera et al. (Siquiera M.E., 1978), who reported normality ranges for plasmatic and erythrocytic acetylcholinesterase with higher values; none of the previous ones matches the conditions of Colombia. Finally, it is important that in the future a follow up of this group of workers be done, in order to identify if chronic effects exist caused by the use of these pesticides.

There becomes necessary a joint effort of the health organizations, educational entities, health secretariats and organizations of environmental protection, in order to develop surveillance programs for the workers of the informal sector and for their families. The The Health Administrative Department of Putumayo must reinforce the implementation of the surveillance protocol in public health set up by the Department of the Social Protection and the National Institute of Health related to poisonings by pesticides.

Likewise, it is necessary to keep on developing training programs for the workers and their families, by means of the use of the SARAR methodology, and in this way to comply with Decree 1843 of 1991 about the sanitary dispositions on the use and handling of pesticides (Department of Health, 1991).

The need of training is sustained also in the high exposure to pesticides in chronic way and in the low coverage grade by the SGSSS, found in the study; this deserves that the education in the use and handling of pesticides keeps being encouraged. The educational component is very important to prevent the labour exposure risks to pesticides, and in this population its implementation is essential, since 91, 2 % of the polled workers stated not to have received training on the safe pesticides handling. The SARAR methodology is a tool simple and easy to be implemented, which seeks to promote durable changes in the practices to reach effectiveness in the suitable pesticides handling and which allows the workers, in turn, to serve as information multipliers and to learn good agricultural practices.

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6. Conflict of interests

The authors declare that no conflict of interests exists in this publication. It is reproduced under authorization from the Biomedical Publishing Committee, which was published in "Varona M, Henao GL, Lancheros A, Murcia A, Díaz S, Morato Ro, et al. Exposure factors to organophosphate pesticides and carbamates in the Department of Putumayo. *Biomédica* 2007; 27:400-9".

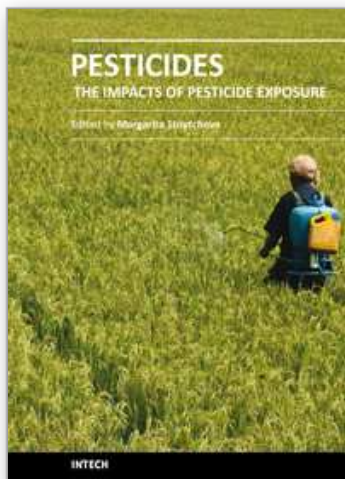
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Pesticides - The Impacts of Pesticides Exposure

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Pesticides are supposed to complete their intended function without “any unreasonable risk to man or the environment”. Pesticides approval and registration are performed “taking into account the economic, social and environmental costs and benefits of the use of any pesticide”. The present book documents the various adverse impacts of pesticides usage: pollution, dietary intake and health effects such as birth defects, neurological disorders, cancer and hormone disruption. Risk assessment methods and the involvement of molecular modeling to the knowledge of pesticides are highlighted, too. The volume summarizes the expertise of leading specialists from all over the world.

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