Vector Control Workers and Psychological Distress

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Abstract

Background Due to the low cost of organophosphate pesticides (OP), its prevalent use has become a public health problem in Ecuador with an increase in cases of organophosphate poisoning in Guayaquil.

Objective The aim of this research is to demonstrate that chronic exposure to OP leads to symptoms of headaches, fasciculation, and psychiatric distress such as anxiety and depression.

Methods Through inclusion criteria, workers from vector control of one district of Guayaquil was obtained. The Brief Symptoms Inventory (BSI-18) questionnaire was applied for neuropsychiatric assessment through its Global Severity Index (GSI).

Results The BSI-18 presented a Cronbach's $\alpha = 0.833$, with a 24.94 ± 15.361 mean for the GSI, which indicates the evident psychiatric distress on subjects averaged 41.29 years of average of 6.29 years of working period, and daily exposure of 5.6 hours to pesticides. Besides, none of the personnel use all protection equipment in their activity.

Conclusion The neuropsychiatric effects of chronic organophosphate exposure were identified in workers during vector control, especially in those do not use protection.

Background

Organophosphorus pesticides (OP) are a group of phosphorus-derived organic substances frequently used in developing and underdeveloped countries to prevent and control vector-borne diseases (1). The incidence of labor origin diseases related to OP is 1.17 per 100,000 workers (2) and can cause up to 200,000 deaths per year (3). A study of neurotoxic effects associated with the use of OP, an incidence of clinical manifestations of the intermediate syndrome, is shown in between 7.7% and 84% of cases of OP poisoning (4).

The incorrect handling of the chemical has become a challenge for public and agricultural health programs because of the danger it poses from its high acute and/or chronic toxicity (5). This arises as a result of the inhibition of the enzyme acetylcholinesterase (Ach) that leads to the accumulation of acetylcholine and subsequent activation of cholinergic, muscarinic and nicotinic receptors (6).

Therefore, the central and peripheral nervous system will be persistently affected by cholinergic effects at acute exposure to low doses, which include symptoms such as nausea, headache, tachycardia, paresthesia and fasciculations (7) (8). Several articles showed that chronic exposure to OP can induce DNA damage, decreased Ach activity and hepato-nephrotoxicity, considering that this exposure causes changes in the levels of: glucose, cholesterol, triglyceride, creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) and Ach (9) (10) (11) (12).

Multiple epidemiological studies have identified associations between occupational exposure to OP and neurodegenerative, psychiatric and motor and sensory deficits (13) (14) (15). Prolonged exposure to low

doses has been associated with anxiety crisis and depression (16).

Accordingly, in a study conducted among fruit producers in Brazil, an association was found between chronic exposure to OP and the increased prevalence of minor psychiatric and behavioral disorders (17). Then, a study of banana workers in Costa Rica concluded that there are symptoms of psychological distress and suicidal thoughts from exposure to organophosphates (18). Therefore it is hypothesized that vector control workers experience distress, presenting depressive and manic conditions because of exposure to organophosphates due to their action in the adrenergic system (19) (20). Lastly, an epidemiological report of pesticide poisoning in Ecuador, banana farmers at coastal region are highly affected by symptomatic poisoning outcomes, along with workers in the Andes and Amazon region (21).

In 1993, Leonard R. Derogatis began developing a questionnaire to assess psychological distress, which was condensed into a more concise version in 2001: the BSI – 18 (Brief Symptom Inventory) questionnaire (22) (23) (24). This 18-question survey uses the Likert scale (from 0 to 4) to evaluate three factors: somatization (items 1,4,7,10,13,16); depression (items 2,5,8,11, 14,17); and anxiety (items 3,6,9,12,15,18).

The Global Severity Index (GSI) is obtained from the sum of all the items in the questionnaire, ranging from 0 to 72. A GSI score of 13 or higher identifies positive cases of psychological distress (25). Mason (26) deemed the BSI – 18 a useful tool to assess these disorders with validity and precision (27).

The aim of this study is to identify the levels of psychological distress in personnel exposed to organophosphates (Temephos) in vector control workers according to the role they play and other characteristics in the fumigation process.

Methods

Study design and participants

A cross-sectional observational study was conducted. The participants come from the Vector Control program of one District Health of Guayaquil. A prescreening was done to all workers and it was found that 92 subjects qualify to participate in the study. From these, 47 subjects accepted to participate and signed the Informed Consent Form. The study and informed consent was approved by the Universidad Espíritu Santo (UEES) occupational safety and health master's program research commission. Based on national regulation, Ethics Committee submission is not needed(28). The inclusion criteria considered were: Be over 18 years of age, have more than 2 years in the activity and be either a fumigator or larvicide applicator. All were exposed to the organophosphorus compound known as Temephos and none had been diagnosed with any neuropsychiatric disease. There were no exclusion criteria considered for this study.

Materials

After the informed consent form was signed, the indications and questionnaires BSI-18 and AUDIT (Abuse and Use Disorders Identification Test) were delivered. At the end of the workday, participants filled out both questionnaires in their own booths.

The AUDIT questionnaire is used to identify whether there are pathological or mental disorders associated with alcoholism (29). It consists of ten questions, each with scores from 1 to 4. The result is categorized as low risk (0–7), medium risk (8–15), high risk (16–19), and probable dependence (20–40).

Data Analysis

For statistical analysis, SPSS V.24.0 was employed: Descriptive statistics were performed, and Cronbach's alpha was calculated to measure the reliability of the instruments. Additionally, normality tests were implemented, and the nonparametric tests was applied for differences according to Mann-Whitney U ranks and Spearman's Rank for correlation Test, in conjunction with the BSI-18 questionnaire scores.

Results

The description of the demographic, labor and exposure variables of the group studied are in Table 1.

Table 1
Participant's features

Variable	Frequency	Percentage
Gender		
Male	26	61.9
Female	16	38.1
Civil Status		
Married	18	42.9
Civil Union	10	23.8
Single	9	21.4
Divorced	3	7.1
Widow/er	2	4.8
Education		
Primary	4	9.5
Secondary	27	64.3
Technical	11	26.2
Work Contact		
LOSEP	29	31
Working Code	13	69
Role		
Larvicide applicators	27	64.3
Fumigator	14	33.3
Use of Protection		
Gloves	29	69
Mask	23	54
Glasses	0	0
Uniform	14	33.3

The mean age of the subjects studied averaged 41.29 (SD 11.6) years of age with an average working period of 6.29 (SD 4.6) years. Additionally, it was assessed that the average time to which participants

are exposed per day is 5.6 (SD 0.5) hours.

The BSI – 18 Questionnaire resulted in a **Cronbach's $\alpha = 0.833$** for all the items, which indicates good internal consistency since the closer to the maximum value, 1, the greater the reliability of the scale. The values obtained for each item, subscale and GSI are described in Table 2.

	Mean	Standard Deviation	95.0% IL	95.0% SL
Global Severity Index (GSI)	24.94	15.62	20.35	29.52
Somatization	10.06	6.02	8.30	11.83
Depression	6.40	5.22	4.87	7.94
Anxiety	9.74	5.48	8.13	11.35
AUDIT Score	3.06	3.74	1.97	4.16

Table 2

Mean and standard deviation to all poll's items (n=47).

None of the workers use protective goggles, and only the larvicide applicators tend to use gloves. Eight of the larvicide applicators (72.7%) wear masks, and 21 fumigators (58.3%) also do.

In the results obtained, psychiatric distress is evident in the study population with a mean of 24.94 ± 15.361 .

The Fumigators have a 34.09 (SD 9.29) average GSI, in contrast to the 22.14 (SD 16.17) of the Larvicide applicators, being significant at a p-value of 0.035, using the U of Mann-Whitney test with a 31.59 average range in contrast to a 21.68 average range.

The AUDIT test obtained a score of $n = 2.2$ (SD ± 3.4); these variables were not considered because they do not reflect alcohol addiction. This result resembles the study of psychological distress in Thai migrant workers in Israel (30), where no relationship was found between psychological distress and alcohol consumption.

Discussion

Lamentably, only 51% of the identified subjects accepted to participate in the study. This low rate of acceptance is due to the 49% of the workers that were in conflict of signing the Informed Consent Form (ICF), even though the ICF process was explained in detail. The main reason for this was that they were afraid of losing their job by having their responses exposed to Mass-Medias. This is compatible with the findings done by Gebremariam, which showed that patient's participation was more likely when the Consent Process is done verbally rather than written (31).

Despite the delivery of personal protective equipment considering the results, the participants do not make full use of it because of discomfort and failures, and as a result all subjects were exposed to OP.

The BSI-18 Questionnaire is a reliable and valid tool that emerges from SCL-90 (32). This questionnaire was validated in oncological populations (25), in which a GSI ≥ 57 was established for severe neuropsychiatric condition. Nonetheless, the studies by Ávila et al. (33) and Andreu (23) in Hispanic populations with cancer, established that a GSI ≥ 14 is positive for identifying patients with psychiatric distress (Cronbach's $\alpha = 0.888$ and 0.89).

A Universidad Peruana Cayetano Heredia study that identifies neurotoxic symptoms due to exposure to organophosphates in agricultural workers determined its reliability by assessing the internal consistency of the "Questionnaire of subjective neurotoxic symptoms of Almirall, based on the questionnaire of H. Hänninen and K. Lindstrom"; that study obtained a Cronbach's alpha of 0.93 which indicates a high internal consistency similar to those of the current study (34).

Unfortunately, a limitation of the study was not being able to find populations with the same characteristics in which the same evaluation tool was used. The Costa Rican study also uses the BSI, but not the AUDIT, concluding that with a population of 130, 78 were poisoned (18). Although Khan's study (35) surveys a similar population, another type of questionnaire was used (Q16).

However, OP exposure was evidenced by the suppression of AchP levels as they correlate to the questionnaire scores- both final and subclass scores. This correlation was similar to the results reported by Khan (35) ($p = 0.007$), Marrero (36) ($p < 0.05$) and Salvi (14) ($p < 0.05$). Simultaneously, Marrero and Salvi conducted research studies in South American populations (Venezuela and Brazil); although these demonstrated a correlation between symptoms and cholinesterase levels, specific questionnaires for depression and anxiety were not used; however, there were follow-up studies and somatization evaluations.

The type of OP participants handled corresponds to their position: larvicide applicators use Temephos, while fumigators use Malathion / Deltametrina. Though these positions work on two stages of the same process, one position tends to dermal exposure(37) and the other to inhalation (38), but both groups are affected. This reinforces the theory of Damalas(39) which maintains the aforementioned routes as the main avenues of intoxication.

Notwithstanding that none of the collaborators had baseline cholinesterase tests and all denied smoking, it is vital to know if the participants are active or passive smokers since nicotine increases the release of the adrenocorticotrophic hormone (40) (41). For future studies, these initial exams should be requested to avoid biases and increase the sensitivity of the study.

Worek (42) suggests measuring the levels of this enzyme before exposing workers to OP because the titers can vary from one individual to another by intrinsic-extrinsic or genetic factors (43).

Conclusions

The present research establishes the presence of neuropsychiatric effects, such as depression and anxiety, as well as symptoms, such as headaches and fasciculation, with chronic occupational exposure to organophosphorus agents in Vector Control Program workers. Fumigators present a higher levels of psychological distress than larvicide applicators.

The results show that, even when provided with protective equipment, workers are unaware of the importance of its use or the potential dangers of handling the chemical. Therefore, the use of protective equipment was not applied by the workers as should.

Furthermore, the strength of the current research is that it was carried out within the Malaria control staff, who supposedly must carry out the entire safety protocol.

Finally, future studies should evaluate populations that go through the same process with different chemical or organic agents that have basal levels of plasma cholinesterase (erythrocyte fraction).

Abbreviations

The Brief Symptoms Inventory (BSI-18)

Global Severity Index (GSI).

Organophosphorus pesticides (OP)

Acetylcholinesterase (Ach)

Aminotransferase (AST)

Alanine aminotransferase (ALT)

Alkaline phosphatase (ALP)

AUDIT (Abuse and Use Disorders Identification Test)

Universidad de Especialidades Espíritu Santo (UEES)

Declarations

Ethics approval and consent to participate: Written informed consent was obtained from each study participant. The study and informed consent was approved by the UEES occupational safety and health master's program research commission. Protocol's submission to Ethics Committee is not necessary, based on national regulations.

Consent for publication: Not applicable.

Availability of data and material: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interest.

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Authors' contributions: PC and EA were responsible for data collection. GA and JG elaborated the paper and the data analysis. All authors reviewed the literature and contributed to the edition of the document.

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Figures

Figure 1
Mean of the Global Severity Index in larvicide applicators and fumigators.

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