Pesticides Use and Potential for Intoxication in the Eastern Province of Saudi Arabia: A Cross-sectional Study

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A cross-sectional epidemiologic study involving 89 organophosphate pesticide (OPP) handlers was undertaken in the eastern province of the Kingdom of Saudi Arabia with the objective of assessing the working conditions and determining the prevalence of intoxication as measured by the inhibition of the enzyme acetylcholinesterase (ChE), and liver enzymes. The study was also supplemented by a survey of all pesticide importers in the region inquiring about the types of pesticides imported. Local shops and supermarkets were visited and the insecticides available for domestic use were identified.

Of the liver enzymes SGOT was the most frequently deranged. In all, 28% of the subjects had some degree of suppression of ChE activity though a significant reduction of 75% or more was noted in only four subjects. Based on the WHO classification some of the imported pesticides were classified as extremely hazardous (Class 1A), others could not be traced in that classification and the extent of their toxicity remained unknown to the investigators. Pre-employment and periodic medical examinations are recommended in addition to the formulation of health education programmes for all concerned.

Expansion in agriculture and the need to control pests and disease vectors entail the continuous use of pesticides. In some Third World countries pesticides can be imported by the private sector with only limited control. Such a practice may endanger the lives of people and animals, and may have a deleterious effect on the environment. Some of these pesticides are highly toxic and may cause poisoning after laundering of contaminated coveralls.¹

The World Health Organization, quoted by Wasilewski,² estimates that nearly half a million cases of pesticide poisoning occur each year with at least 9000 deaths, 99% of them in the Third World countries, while others gave double these figures.³ In Trinidad and Tobago 293 cases of
definite pesticide poisoning were reported during 1977 and 1978, while in Sri Lanka five of every 1000 agricultural workers are admitted yearly because of pesticide poisoning.

In the Kingdom of Saudi Arabia, the Directorate of Agriculture and Water (DAW) in the eastern province during the year 1982, recorded 42 types of pesticides used, the majority of which were of the organophosphate group.

The present study was an attempt to assess the standard of safety of the working conditions, and the prevalence of symptoms and signs of organophosphate pesticides (OPP) intoxication among individuals handling these chemicals in agricultural and other settings. In addition, the types of pesticides available for domestic use were also investigated.

It is hoped that the findings of this study will be utilized in the formulation of an appropriate preventive care programme in this area of environmental toxicology.

Materials and Methods

During the year 1985, 78 male organophosphate pesticide (OPP) handlers in Al-Khobar, Dammam and Qatif municipalities and 11 from the DAW in Dammam and Qatif, eastern province, participated in the study. All 89 subjects were examined only when handling OPP the nature of which was verified from the label on the container. Information on length of service, method of spraying, previous occupational exposure to pesticides, knowledge of hazards of the pesticides, and history of liver or heart diseases was obtained by use of a questionnaire which was administered during an interview by one interviewer. A random sample of three groups of sprayers was chosen and the process of application of the pesticides was observed.

All 10 pesticide importers in the region were surveyed using a separate questionnaire with the objective of obtaining a list of imported pesticides and those most frequently used. Other questions were related to years in

business, source of information about toxicity, how farmers obtain the chemicals and whether they consider farmers to be aware of the health hazards.

The three largest local shops and supermarkets in Al-Khobar were also included to identify the ingredients of insecticides available for domestic use.

Serum bilirubin, total protein, albumin, alkaline phosphatase, SGOT, and SGPT were determined at King Fahd Hospital of the University (KFHU) Al-Khobar, using a commercially available kit (Duponct Aca, USA). The normal values using this kit were 0.1–1.5 mg/dl, 6.0–8.0 g/dl, 3.5–4.8 g/dl, 5–14 IU/dl, 7–14 IU/l and 5–35 IU/l respectively.

The activity of the enzyme cholinesterase (ChE) in whole blood was determined before (a pre-exposure base line) and approximately 10 min after spraying using a tintometric method (Tintometer field kit). The reproducibility of results obtained using this kit, which was recommended to the investigators by the WHO is well documented. Blood samples (0.01 ml) were obtained by finger prick after careful and thorough cleaning of the hands. The normal range of the ChE activity using this method is between 87.5 and 100%.

The subjects were used as their own controls for determining ChE activity since a blood sample was taken twice; before and after exposure; no facilities were available to the investigators to assess the purity of the pesticides in use.

The methods of spraying and types of pesticides used are mentioned in the Results section.

Results

The mean age (±SD) of the municipality handlers was 27.3 (±6.0) years, while the DAW handlers had a mean age of 39.8 (±11.5) years. The length of service for all subjects ranged from 1 month to 20 years.

Pesticides belonging to the organophosphate, organochlorine, carbamates, and pyrethroids classes were in use, but only handlers of the first group were studied. The OPPs in use at the time of the study were PC-30\textsuperscript{b} (chlorpyrifos methyl), Gardona\textsuperscript{b} (tetrachlorvinphos), Superox\textsuperscript{b} (dimethyl-methylcarboxy amide-methylophos- phorothiolhionate), Alphacon 10 WP\textsuperscript{b} (iodofenphos), and Baytex\textsuperscript{b} (fenithion).

The DAW sprayers dilute the pesticides in the open air in the field, and the task was not assigned to any particular individual. Field spraying was carried out on a daily basis (except Fridays) during the mornings only; the spraying time varied between 1 1/2 and 3 hours, using the high pressure method delivering a fine aerosol of OPP. No knapsack or fogging devices were used.

One municipality worker was assigned to mix the pesticide inside a small side room. Only the Al-Khobar mixing room had exhaust and ventilation fans. Spraying was done on a weekly rotational basis using one of three different pesticides at a time during the week. One of these was a residual (persistent) OPP which was applied by high pressure spraying inside and around trash containers. The frequency of spraying was twice per day, throughout the week, during the cool hours, and lasted between 2 and 3 hours but no spraying was carried out on windy or rainy days.

Training in spraying techniques had been received by 43 (48.0%) handlers. Protective clothing in the form of masks (not of the right type) boots, gloves, and cotton
coverall suits were provided to 38 (42.7%) of the 89 subjects while 21 (23.6%) had some of these and the remaining 30 (33.7%) had none. Qateef sprayers were provided with gloves and aprons only 2 days after the start of this survey.

Liver function tests
Of the 89 operatives, 22 (24.7%) had one or more liver function parameters outside the normal range (Fig. 1), while nine (10.1%) had two abnormal values. SGOT was the most frequently affected (in 18 persons (20.2%)). However, only one had a value more than twice the upper limit of normal and was clinically jaundiced (bilirubin 2.2 mg/dl) while the rest of the percentage increases ranged from as low as 7.0% to 66.0%. Such increases were of little clinical significance.

Seven subjects (7.9%) had SGOT and SGPT simultaneously elevated. Both enzymes showed some relationship with the years of service. The derangement was more frequent for those whose service extended between 9 and 17 years (p<0.1 for SGOT and <0.05 for SGPT) but no such effect was noticed for the other operatives.

Figure 1. Distribution of liver function parameters in 22 pesticide handlers with one or more abnormal values.
Table 1
Symptoms and length of service of four pesticide handlers in the eastern province with a significantly low ChE activity

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>ChE activity (%) before spraying</th>
<th>ChE activity (%) after spraying</th>
<th>Length of service (months)</th>
<th>Designated job</th>
<th>Liver function test</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>100</td>
<td>75</td>
<td>5</td>
<td>Sprayer</td>
<td>Elevated SGOT</td>
<td>Headache, dizziness</td>
</tr>
<tr>
<td>2.</td>
<td>100</td>
<td>75</td>
<td>18</td>
<td>Mixer for 3 months</td>
<td>Normal</td>
<td>Nausea, weakness of eye sight, muscle cramps, headache, easy fatigueability, heaviness in the head, loss of appetite, skin irritation, dizziness</td>
</tr>
<tr>
<td>3.</td>
<td>62.5</td>
<td>62.5</td>
<td>11</td>
<td>Mixer</td>
<td>Normal</td>
<td>Muscle cramps, headache, trembling of hands/legs, heaviness in the head, skin irritation</td>
</tr>
<tr>
<td>4.</td>
<td>75</td>
<td>75</td>
<td>11</td>
<td>Sprayer</td>
<td>Normal</td>
<td></td>
</tr>
</tbody>
</table>

*Pesticides involved were chlorpyrifos methyl, tetrachlorvinphos, iodofenphos and fenthion.

Table 2
Imported pesticides available in eastern province grouped by degree of toxicity according to the WHO classification

<table>
<thead>
<tr>
<th>Toxicity class</th>
<th>Pesticide</th>
<th>Chemical group</th>
<th>Oral LD₅₀ rats (mg/kg bodyweight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA (extremely hazardous)</td>
<td>Chlorfenvinphos (Supona®)</td>
<td>OPP</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>DDVP (Nogos®, Nuvan®)</td>
<td>OPP</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Methidathion (Supracide®)</td>
<td>OPP</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Dimethoate (Roger®)</td>
<td>OPP</td>
<td>50</td>
</tr>
<tr>
<td>II (moderately hazardous)</td>
<td>DDT (Neocidol 60 EC®)</td>
<td>Organochlorine</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Chlorpyrifos (Dursban®)</td>
<td>OPP</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Primiphosmethyl (Actellic 60®)</td>
<td>OPP</td>
<td>2018</td>
</tr>
<tr>
<td></td>
<td>Dicofol (Klthane®)</td>
<td>Organochlorine</td>
<td>690</td>
</tr>
<tr>
<td></td>
<td>Malathion (Malathion®)</td>
<td>OPP</td>
<td>2100</td>
</tr>
<tr>
<td></td>
<td>Bromophos (Nexion®)</td>
<td>OPP</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Trichlorfon (Dipterex®)</td>
<td>OPP</td>
<td>560</td>
</tr>
<tr>
<td>Could not be traced in the list</td>
<td>Amitrex 75®, 88, and 80</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peristhinit® 10%</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restine 155®</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Super 5/5 EC®</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Super 8/64®</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Super 158® and 500 E</td>
<td>Pyrethroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Samid SP® and 80 WP</td>
<td>Carbamate</td>
<td></td>
</tr>
</tbody>
</table>

Acetylcholinesterase (ChE) activity
Of all handlers, 25 (28.0%) had 12.5% inhibition of ChE activity, but this was considered within the normal range, while in two others the activity dropped to 75.0% and a further two had significantly low levels at the start of the working day and did not revert to normal by the end of the shift (Table 1). Paradoxically, two additional subjects had significantly preshift low levels of ChE activity which reverted to normal after spraying. The possibility of a measurement or recording error in the latter two cases could not be excluded.

Pesticide importers
The experience in business of the importers ranged from 3 to 36 years. The toxicity of the imported pesticides (Table 2) varied from slightly hazardous (Class III) to extremely hazardous (Class 1A) according to the WHO classification.

The pesticides in common use were Actellic® and Dursban® (both OPP), and pyrethroids. The majority of these imported chemicals belong to the OPP group. A license from the Ministry of Agriculture and Water was
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mandatory before a specific pesticide could be imported. Although Neocidol® is banned in this country, one firm admitted to its importation.

The present study revealed that no health education pamphlets on pesticides were ever distributed to the farmers and the importers claimed that they had never received any from the manufacturers. The survey of the local shops and supermarkets revealed that all of them sold pesticides. The components of the marketed pesticide formulations intended for domestic use were usually stated but sometimes without the composition. DDVP (an OPP), which is highly toxic (Class 1B), was among the ingredients of more than one brand of pesticide aerosol.

Discussion

Pesticide handlers are at risk of poisoning if there is no adherence to precautionary measures. The degree of intoxication to man depends on many factors such as the type and toxicity of the pesticide used, the availability and use of protective clothing, and the duration of exposure.

A very significant finding in the present study was the lack of specific protective clothing which is essential for the safety of the exposed employee.10-12

Liver damage is usually a late sequel of chronic exposure to pesticides.13 It is worth noting that none of the subjects studied had muscle or heart disease or were involved in intense physical work apart from holding a hose while spraying. An increase in the serum levels of SGOT in hepatocellular damage is not necessarily accompanied by a simultaneous rise in the level of SGPT.14 Our findings are consistent with this view. It is rather difficult to attribute the impairment in liver function tests solely to exposure to OPP especially since the levels were not very high and there was no pre-employment medical examination data to form a basis for comparison. Furthermore, alcohol intake, although prohibited in this country, cannot be ruled out. The relationship of SGOT and SGPT elevation with the years of service may be due to the fact that the actual spraying was carried out by those with a service range of 9–17 years; supporting them were the junior workers (with less than 9 years of service), while the senior subjects (more than 17 years of service) only played a supervisory role.

Few of our subjects had significant postexposure reduction of ChE activity. Other investigators have, however, demonstrated a reduction in the activity of this enzyme in a large number of pesticide handlers.15,16 In those studies, the exposure time was up to 10 hours per day compared to only 3 hours in our study which may partly explain this low incidence of inhibition. Furthermore, a change in the activity of this enzyme may not always be a true indicator of the degree of toxicity of the OPP.17 Consequently, some of our subjects may actually have been poisoned but this was not reflected by an inhibition of the ChE activity.

Two handlers (one mixer and the other a sprayer) had low levels of ChE activity which were equal at both pre and postshift. It is conceivable that chronic exposure and possible high dosing may have kept the postshift activity at the preshift level. A technical error is most unlikely since these subjects were among a group who were examined the same day by the same technologist using the same reagents.

Our results show that farmers purchasing pesticides directly from private importers are at a special risk of poisoning especially since some of the imported pesticides are extremely toxic (Class 1A).9 These farmers may or may not be literate or may not even be aware of the health hazards of these chemicals. Furthermore, information about pesticides when provided on the containers may not be bold enough. At the present time there is very little health education to farmers. Coupled with illiteracy and the importation of extremely toxic chemicals, this group of the population is placed at a special risk.

Some deaths among the public in Saudi Arabia attributed to pesticides have been reported.15 Approximately 1000 deaths were reported to have occurred annually in one developing country.19 On the basis of the statistics from that report it was estimated that nearly 2.9 million cases of pesticides intoxication occur annually in the Third World with a death toll of about 220 000. The investigators in the present study believe that more cases of intoxication happen among the public and agricultural workers in the Kingdom but probably either pass unrecognized or the patients do not report to hospitals especially if farm workers are unaware of their social insurance rights.20 Some such incidents may happen on farms or in areas too distant from medical care facilities.

In conclusion, the present study has highlighted the possibility of pesticide poisoning and serious shortcomings in handling techniques and protective procedures in the area under study.

Based on these results it is recommended that health education should be available to all concerned, in addition to preemployment and periodic medical check-ups of the directly exposed employees, provision of the right type of protective clothing to the handlers, and appropriate measures to protect the public.

Acknowledgement

The authors are grateful to King Abdulaziz City for Science and Technology, Saudi Arabia, for funding this work which is part of Research grant No. AR4-026 to study drug and poison problems in the eastern province of this country. We are also grateful to the Directorate
of Agriculture and Water, the municipalities in Dammam, Al-Khobar and Qateef in the eastern province for allowing us to examine their employees.

References