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Pesticides in Lebanon: a knowledge, attitude, and practice study
Pascale R. Salameh, a, * Isabelle Baldi, b Patrick Brochard, b and Bernadette Abi Saleh a

a Faculty of Pharmacy, Lebanese University, Beirut, Lebanon
b ISPED, Bordeaux 2 University, Bordeaux, France

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Abstract

Pesticides, despite their known toxicity, are widely used in developing countries. Evaluating the pattern of their use would be interesting to assess the appropriateness of adequate intervention. Using a standardized questionnaire, a knowledge, attitude, and practice study was performed in two Lebanese regions, in which a group of agricultural workers was compared to workers of the general population and a third group of pesticide distributors. Agricultural workers were exposed to pesticides during cropping, mixing, loading, and application (100%). They had low pesticide knowledge scales compared to pesticide distributors and to the general population workers \((P < 10^{-7})\). The preventive measures they took were low, and the lower their knowledge was, the lower were the preventive measures applied \((P < 10^{-3})\). Pesticide safety education is necessary in order to induce protective behavior among agricultural workers. The general population may also benefit from increasing their awareness regarding pesticides.

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1. Introduction

Pesticides are widely used throughout the world, especially in agriculture for crop protection. According to the WHO, developing countries use about 20% of the pesticides in the world, and this use is increasing \((\text{WHO and UNEP, 1990})\). This intrinsically dangerous technology is being promoted in a setting without technical and human resources to control it properly \((\text{Wesseling et al., 1997})\).

Epidemiological studies regarding pesticides are considered important in order to decrease pesticide risk and to help public health policies \((\text{WHO, 1991})\). Studies on knowledge, attitudes, and practices (KAP) indicate that unsafe use of pesticides is common in developing countries, with a further need for research focusing on simple methods for surveillance, in order to develop and evaluate rapid local interventions \((\text{Wesseling et al., 1997})\). The workers’ knowledge of hazards, which must be factual and correct, is important for the prevention of acute poisoning; erroneous beliefs can seriously impair workers’ capacity to protect themselves against risks \((\text{Koh and Jeyaratnam, 1996})\).

In Lebanon, pesticide organization started in 1982, when the government issued a decree regarding the creation of a scientific committee for these products; this committee was to define and study pesticide use in Lebanon and to set conditions for authorization for their importation, sale, preparation, labeling, and use \((\text{Lebanese Government, 1982})\). Despite the existence of a list promoted in 1992 by the Ministry of Agriculture on officially forbidden pesticides, government control and law enforcement are still weak. Even banned products are available by illegal means and used by the untrained public, in addition to the misuse of several agents, regardless of any health and ecological toxicity risks \((\text{Trabulsi, 1991}; \text{Abou Fakhr et al., 1995})\).

The objective of our study was to assess the knowledge of pesticide applicators and distributors in comparison with that of the general population of workers in Lebanon, as well as protection measures taken by applicators.

Abbreviations: EPA, Environmental Protection Agency; \(r_s\), Spearman correlation coefficient; WHO, World Health Organization
*Corresponding author. Jdeidet El Meten, Chalet Suisse St., Ramza Azzam Bldg, 5th floor, Beirut, Lebanon. Fax: +961-9-934164.
E-mail address: pascalesalameh@yahoo.com (P.R. Salameh).
2. Materials and methods

We conducted a cross-sectional KAP study among agricultural workers, the general worker population, and a group of pesticide distributors.

Data were collected in 1997, in two Lebanese regions: Mount Lebanon (counties of Meten, Kesrouan, and Jbeil) and Bekaa (counties of Zahlé, Baalbeck, and Western Bekaa). These two regions are characterized by an important agricultural activity.

Mount Lebanon is a mountainous region delimited by seashore; cultures are in greenhouses on the littoral (vegetable cultures such as tomatoes and cucumbers) and in the open air in the mountains (fruits such as apples and pears). The Bekaa plain culture is mainly done in the open air (vineyards and vegetable plantations).

A sample of agricultural pesticide applicators was taken from the two regions, and workers of sectors other than agriculture constituted the comparison group issuing from the general population. Other sectors included construction field workers (54%) and commercial workers (shop owners and workers) (46%). Both groups were selected by the method of quota sampling according to region, sex, and age distribution.

In addition, a third group of pesticide distributors was compiled from a list obtained from the Lebanese Ministry of Agriculture, by random sampling using a random number generator. This group has potential contact with pesticides, since they manipulate pesticides in closed containers.

A standardized questionnaire was applied, in order to obtain data on subjects’ exposure to pesticides and knowledge and prevention measures regarding them. Subjects gave their oral informed consent to participate in the study, after hearing the explanation of the study’s objective. A trained interviewer asked the questions in the local language for a mean of 30 min. Agricultural workers were able to answer all the questions, except the one regarding the names of used pesticides; it was subsequently eliminated from analysis.

Exposure was defined as “certain” for subjects with direct occupational contact with pesticides (preparation, application, and crop harvesting). Distributors were classified as subjects with “possible” exposure, while the general population individuals were classified as subjects with “no exposure.” Cumulative exposure duration for subjects with certain exposure was calculated by multiplying the number of hours of exposure per day, the number of working days per year, and the number of years of occupation. Direct (preparation and application) and indirect (field reentry and crop harvesting) exposures were taken into consideration.

For pesticide education and prevention measures assessment, global quantitative scales were created: correct answers according to the WHO guidelines (Henry and Wiseman, 1998) were rated 1 and false answers were rated 0. Pesticide knowledge was totally rated over 19, with an acceptable threshold of 10 (mean obtained by distributors, taken as a reference). Prevention was rated over 16, with an acceptable threshold of 11 (number of measures normally taken even in the absence of financial means). Global individual education was evaluated by the number of years at school.

Data entry and statistical analysis were done on the Epiinfo Software, release 6, distributed by the Centers for Disease Control, Atlanta, Georgia, USA. Two-tailed statistical tests were used, with an admitted error of 5%: χ² test for dichotomous or multinomial qualitative variables, Kruskal-Wallis test for quantitative variables with nonhomogeneous variances or nonnormal distribution, and ANOVA for quantitative variables of normal distribution and homogeneous variances. A Spearman rank correlation was applied for association between ordinal variables.

A bivariate analysis was performed using the Mantel Haenszel method for adjustment over potential confounding between the general population group and agricultural workers: baseline characteristics known to affect a subject’s education or that present differences with a P value <0.2 were used as adjustment variables for bivariate analysis.

3. Results

3.1. Social and demographic characteristics

Social and demographic characteristics of comparison groups are presented in Table 1. The study involved 206 individuals: 89 agricultural workers, 88 general population workers, and 29 pesticide distributors. There were more Lebanese workers in the distributors group than in the two other groups. Socioeconomic variables, including monthly income, number of subjects per family, and global education level, differed significantly: pesticide distributors had a higher monthly income and global education level and a lower number of individuals per family than other workers (Table 1). However, subjects were comparable in terms of age and sex distribution (P >0.05).

3.2. Exposure description

Pesticide exposure description was reported: most individuals used liquid (n = 87; 97.8%) or powder (n = 69; 77.5%) pesticides. Fumigation was reported less often (n = 13; 14.6%). Application was performed manually or by truck, and subjects mainly prepared, mixed, loaded, and applied pesticides by themselves (n = 76; 85%). All of them declared having an indirect contact with pesticides through field reentry and
agricultural product harvesting \((n = 89; 100\%)\). Subjects were aware of dermal and respiratory exposure \((n = 84; 94.4\%)\), but not of ingestion \((n = 15; 16.9\%)\) during occupational use.

### 3.3. Pesticide knowledge

Despite the fact that 69.9\% of people considered pesticides as toxic products, most of them reported lacking adequate information (Table 2). Almost half of them did not know any pesticide name, and more than 2/3 could not name any dangerous pesticide. Less than 10\% had previously heard about the forbidden pesticides list distributed by the Ministry of Agriculture. The majority ignored protective measures or knew little about them, and more than 50\% cited useless protective measures (protection of the face by a tissue or a paper face mask). This was especially true for the nonexposed worker group, from which responses were inadequate for most of the asked questions, followed by the agricultural group and then by the possible exposure group \((P < 0.01)\).

Most individuals (85\%) expressed the need for pesticide safety education by specialists. Information regarding pesticides was most often received through oral communication for the general population workers (52.3\%; \(P < 10^{-2}\)) or experience (44.9\% for agricultural workers and 55.2\% for pesticide distributors; \(P < 10^{-3}\)) (Table 3). Lower proportions declared receiving information from a specialist, or through reading by pesticide recipients.

As for agriculture workers, the mean \((M)\) obtained on a knowledge scale for pesticide education was 7.4 of 19, with a standard deviation (SD) of 4.0. More than 75%
of them were graded below 10. Individuals with possible exposure (distributors) have higher education regarding pesticides ($M = 11.5$; $SD = 2.5$), in comparison with agricultural workers that are certainly exposed and the general population ($M = 5$; $SD = 3.1$) ($P < 10^{-7}$). The obtained result remained statistically significant after adjustment for monthly income ($P < 10^{-4}$), family size ($P < 10^{-4}$), global educational level ($P < 10^{-4}$), nationality ($P < 10^{-6}$), and sex ($P < 10^{-8}$).

### 3.4. Prevention measures

In Table 4, we describe prevention measures taken by individuals having direct contact with pesticides. A great proportion stored pesticides away from food, did not eat during application, applied pesticides with the wind direction, and took a shower at the end of their work shift (>90%). A lower proportion did not smoke during application (80%), cleaned clothes and underwear separately from other clothes (63.5%), had clothing facilities on the work site (50.6%), and wore hats (61.2%) and special shoes (47.1%). Those who used special gloves, clothing, and face and eye masks and manipulated pesticides with special tools were rare (<25%). Putting described preventive measures on a scale gave a mean of 7.45 of 16 and a standard deviation of 2.7.

Containers’ fate after use was also described. The proportion of good practice represented only 41.2% of subjects’ habits (digging special holes, incineration). The majority of subjects would discard pesticide container wastes into the environment (soil or water) (40%) or with other trash (27%). It was notable that 2.4% of subjects used containers for storing water or food.

Agricultural workers with higher prevention rating tended to have lower cumulative exposure duration ($P < 10^{-2}$). Having a lower general educational level and getting pesticide information through oral communication were associated with lower prevention measures ($P < 10^{-5}$ and $P < 10^{-2}$, respectively). Moreover, agricultural workers with more pesticide education tended to have higher prevention levels on the respective scales ($P < 10^{-3}$; $r_s = 0.29$, and 95% CI $0.08 < r_s < 0.47$).

### 4. Discussion

From this study, we noted a high proportion of subjects who reported not having adequate information regarding pesticides in Lebanon. When taking into account differences in socioeconomic levels, global education, and nationality, pesticide distributors had better knowledge regarding pesticides than agricultural workers. In addition, both the former and the latter had better knowledge regarding pesticides than the general population.

Agricultural workers who had long experience with pesticide application took fewer prevention measures. Among subjects with low pesticide knowledge, information was received only by oral communication and poor protective measures were observed. Adequate information sources and quality seem, however, to induce risk perception and taking of prevention measures, despite the low global education level of involved subjects.

In most developing countries, a number of important obstacles to agrochemical safety can be identified: there is insufficient legislation for pesticide use and registration in addition to a lack of technical regulatory
research facilities to monitor pesticide residues and effects (Kimani and Mwanthi, 1995). Illiteracy, poverty, and lower sanitation and medical care standards result in higher health risks during occupational, accidental, and long-term exposure to pesticides and their residues (Kimani and Mwanthi, 1995). Employers, for their part, do not see fit to invest time and money in preemployment screening, periodic health examinations, or hygiene surveys (Ecobichon, 2000). This is expected to apply to Lebanon. Moreover, many companies try to hide the true name of the prepared product, put unclear labels, encourage agricultural workers to use more concentrated products, and make any pesticide readily available to the final user without prescription (Trabulsi, 1991).

Information, instruction, and training of pesticide-exposed workers should be promoted, since these activities are fundamental aspects of health protection. In fact, the workplace is a common context within which health promotion, disease, and injury prevention programs are conducted. Occupational safety and health interventions may involve engineering, administrative, and individual behavior change strategies (Henney and Goldenhar, 1996). Basic objectives of education are to ensure that workers understand the health hazards of relevant pesticides, become familiar with and adopt proper work practices, use protective equipment properly, practice personal hygiene measures, recognize early symptoms of overexposure or poisoning, and obtain first aid at the earliest time possible. The WHO has recommended the use of pesticides only by trained people (WHO, 1991). For most of the pesticides, using protective measures results in more than one order of magnitude decrease in exposure. Similar reductions are seen for harvesters using gloves compared to those not using gloves (Woodruff et al., 1994). This could contribute to decreasing pesticide health effects.

Results similar to ours have already been reported in other developing countries. In the Gaza Strip, an assessment of KAP was done on 189 farm workers: they reported high levels of knowledge of pesticides, but the use of protective measures was poor (Yassin et al., 2002). Practices regarding pesticides in 128 West Bank farmers were evaluated, and results similar to ours were reported: reentry onto fields prior to 3 days (98%), low protective measure use (8–51%), with the main source of information being agricultural extension workers (38%) (Richter et al., 1997). In Kenya, knowledge about pesticides and awareness regarding their safety in handling and storage was limited in a rural agricultural community (Kimani and Mwanthi, 1995). An action-oriented approach to farm workers’ education has been undertaken in Nicaragua and Puerto Rico: teaching farm workers about the hazards and safe use of pesticides, as well as empowering them to take preventive and protective actions, gave a positive outcome (Weinger and Lyons, 1992). This would lead, as expected, to a decrease in poisoning prevalence parallel to exposure reduction. Among Chinese applicators from one village, a safety educational program decreased the prevalence of pesticide poisoning from 1.05% to 0.25% (i.e., from 105 to 25 per 10,000 inhabitants per year); moreover, a 68.2% reduction in poisonings was observed in 10 other villages (Chen et al., 1998). Among Korean farmers, safety education for application was inversely associated with pesticide poisoning (Shin et al., 1998). In a review of an intervention’s efficiency in reducing pesticide overexposure and poisonings, Keifer found that changes in preparation and application procedures, personal protective equipment, and biological monitoring were effective in reducing exposure (Keifer, 2000).

Furthermore, promoting an integrated pest management program is necessary. A joint Israeli–Palestinian and Jordanian program was established to decrease pesticide use, promote integrated pest management, and restrict ecosystem damage while maintaining or increasing cotton yield; preliminary results indicated that it was possible (Richter and Safi, 1997; Richter et al., 1997).

The general Lebanese population would also benefit from pesticide education. This population is generally kept at risk, because longer periods elapse before a highly toxic pesticide is banned or restricted, compared with developed countries (El Sebae, 1993). Educating people would help them to take part in or to give advice to the regulatory process of governmental toxic control. Empowering the public with information helps with compliance with existing or new laws; informed people can even identify and solve local environmental problems without relying solely on government intervention and resources (EPA, 1997).

In conclusion, Lebanese general population workers, and agricultural workers in particular, seem to be unaware of real pesticide risks and lack safety education. In addition, these workers do not take enough protection measures, which may predispose them to higher intoxication risks than the general population. Occupational prevention for pesticide safety is necessary. Governmental intervention is also needed to ensure proper legislation regarding public health risks and hazards.

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