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Socio-demographic Characteristics and Safety Practices in Pesticide Applicators in Zangiabad Area, Iran

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Abstract: Iran is the largest producer of pistachios in the world and farmers apply chemicals in pistachio orchards to pest control. A high risk of occupational human exposure to pesticides may occur in applicators if they do not practice adequate protective measures. The present study was designed to determine socio-demographic characteristics, knowledge of safety practices and use of protective measures for applicators to avoid pesticide contamination. Structured face-to-face interviews were conducted and a questionnaire was administered to obtain information on characteristics such as environmental exposure, personal characteristics, lifestyle factors and agricultural work practices. There was a significant difference in educational level between cases and controls ($\alpha < 0.05$) and cases had a generally lower educational level than controls. Among the pesticides that were used for pistachio pest control, amitraz was dominant. The most common form of packaging used to pesticides, especially amitraz, in the study area was COEX, Aluminum, and PET. In order to dispose of empty containers, most of the farmers sell empty containers for recycling, but it is not clear who buys them and how they are recycled. Health effects of pesticides underscore the importance of alternative methods for pest management to reduce pesticide exposure.

Key words: Health effects, Safety Practices, Amitraz, Iran

INTRODUCTION

The Islamic Republic of Iran is the largest producer of pistachios in the world, accounting for about two-thirds of the global planted areas and slightly more than one-half of the world's production in the recent years (Boshrabadi *et al.*, 2007). About 13 different pests and diseases have been found to attack pistachios. Farmers currently apply a range of 20 chemicals in pistachio orchards, including endosulfan, zolone (phosalone) and amitraz. Farmers usually spray pistachios six times per season and 1,800 tonnes of pesticides are used on this crop annually (Heidari, 2003). Although, most human exposure to pesticides can probably be linked to dietary, inhalation or dermal contamination, other factors, such as age (Wolff *et al.*, 2005; Zumbado *et al.*, 2005), gender (Zumbado *et al.*, 2005; Dirtu *et al.*, 2006), educational status (van-der-Hoek and Konradsen, 2005), life style (Glynn *et al.*, 2003), and type of habitat (Zumbado *et al.*, 2005) have been reported to be good predictors of pesticide levels in human populations. The use of protective measures has an important role in preventing pesticide exposure (Yucra *et al.*, 2006); therefore, a high risk of occupational human exposure to pesticides may occur in applicators if they do not practice adequate protective measures.

Demographic data such as age, sex, life style, and educational level of pesticide applicators were gathered in some studies (Glynn *et al.*, 2003; Carreno *et al.*, 2007). Knowledge about safety practices in handling pesticides, characteristics of pesticide application and the use of protective measures to avoid pesticide contamination were determined in other studies (Dirtu *et al.*, 2006; Yucra *et al.*, 2006). There are certain measures which should always be undertaken by pesticide operators to help protect themselves against contamination during the handling and application of pesticides (FAO, 1990). Educational level was shown to have a protective effect against poisoning occurrences during the stage with high exposure to chemicals (Faria *et al.*, 2009). Continuous education and training programs for agricultural workers will promote awareness and minimize the hazards of occupational pesticide exposure. Therefore, every opportunity should be taken to educate farmers on the basic relationship between pesticide toxicity, exposure and hazards (FAO, 1990). The

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first principle is to always read and follow the recommendations given on the label of the pesticide container. Nevertheless, the safety instructions on the containers are often written in unfamiliar languages; many farmers are illiterate, and the instructions themselves are difficult to follow (Eddleston *et al.*, 2002).

Chances of personal contamination can greatly be reduced if direct exposure to the skin, nose, mouth or eyes is avoided or minimized while working with pesticides. The most appropriate application technique should be used in pest control. Occupational illness is common since it is impractical and expensive to use safety equipment and the applicators may have difficulties in hot and humid conditions because of discomfort caused by wearing protective apparel with low heat dissipation (Eddleston *et al.*, 2002). Pesticides should be stored out of the home in an appropriate place such as barn. Unless empty pesticide containers are managed correctly, they are hazardous to both human and the environment. Containers abandoned in the environment can lead to pesticide pollution in soil and groundwater (FAO/WHO, 2008). Applicators and their family members have the highest risks of pesticide exposure as they can easily come in contact with the pesticides such as when mixing the chemicals or when applying them to the crops and when the pesticide residues are carried home (Sam *et al.*, 2008).

Occupational poisoning due to pesticides is common in developing countries because farmers are often not well trained, and some are illiterate and consider using safety equipment as impractical and expensive (Sam *et al.*, 2008). The lack of rigorous legislation and regulations in controlling the use of pesticides has also led to their widespread availability and unrestricted use, leading to serious acute health problems, as well as local and global environmental contamination (Ecobichon, 2001). Furthermore, pesticide poisoning causes more deaths than infectious diseases in the developing world. Moreover, the use of pesticides is poorly regulated and often dangerous, whereas their easy availability has also made them a popular method of self-harm (Eddleston *et al.*, 2002). The present study was conducted to determine socio-demographic characteristics and safety practices of amitraz applicators in the Zangiabad area in Iran.

Methodology:

Study Area:

Zangiabad is located in a semi-arid region 20 km north of Kerman city, capital of Kerman province. Pistachio is the most important crop grown in Kerman province, which is the largest producer of pistachio in Iran, accounting for 74.2 percent of pistachio output on average between 1995 and 2003 (Boshrabadi *et al.*, 2007). The use of pesticides in this region is unavoidable, because pistachios are the solitary source of population income.

Study Population:

The requirements to participate in the study were to have worked with pesticides and lived in Zangiabad for at least two years prior to the study. The applicators participating in the study were identified and recruited by the Health Care Centre in the Zangiabad area. From the universe of applicators in Zangiabad, 102 of them agreed to participate in the study.

Data Collection:

A questionnaire based on the questionnaires which were used in the previous studies by Yucra *et al*. (2006), Faria *et al*. (2009) and Carreno *et al*. (2007), with a slight modification after the review by the Unit of Environmental Health of Universiti Putra Malaysia (UPM), Malaysia, was administered. Prior to the application of the questionnaire to the participants, a preliminary study was conducted with 5 pesticide applicators to learn if they understood the questions, following which the questionnaire was modified accordingly. Each individual selected as a case or a control was interviewed initially to obtain their basic information such as name and address, whereas an explanation of the study was given and their permission sought to be a participant in the study. If they agreed to participate in the study, they were then interviewed, using the questionnaire. The main interviews were conducted when the applicators were finished with their work and were back in their homes.

Structured face-to-face interviews were conducted by trained interviewers to gather data on socio-demographic characteristics, knowledge and practice of safety guidelines for pesticide use, and lifestyle factors. The questionnaire was administered to each volunteer to obtain information on characteristics such as environmental exposure, personal characteristics, and agricultural work practice. Socio-demographic characteristics and agricultural practices of the amitraz applicator cases were compared with a control group.
A population of residents of Zangiabad, all male with the same age range (the study was restricted to people of 18-60 years of age) were interviewed and served as controls. The study population was thus defined as all pesticide applicators of 18 years of age and older living in the study area.

The questionnaire included questions related to: socio-demographic information, for example, age, weight, education, and marital status; the names of pesticides used; and protective equipment used during application of pesticides. Applicators were asked to define how frequently they used amitraz. Data related to the kind of pesticides used, kinds of protective measures used during application, and management of pesticides and clothes after pesticide application were also recorded. Environmental exposure to pesticides was measured according to the duration of exposure (in days, months and years of exposure), and the use of personal protection equipment. An attempt was made to identify the pesticides that the families kept in their houses at the time of the home visit. Information was also collected on whether any family member of the subject had participated in an agricultural training program on the safe use of pesticides or integrated pest management (IPM). The questionnaire results were transferred into a spreadsheet, and, where appropriate, processed and categorized into a small number of discrete bands.

Data Analysis:

Statistical analyses were performed using SPSS (Statistic Package for the Social Sciences) version 17.0 software. P-values < 0.05 (two-tailed) were considered statistically significant. Descriptive data were presented as arithmetic means and standard deviations (mean ± SD), as well as frequencies. Differences between cases and controls for socio-demographic characteristics were tested using the t-test and chi-squared statistics.

Results:

Socio-demographic Characteristics:

The number of investigated participants in this study comprised 204 men, including 102 pesticide applicators, and 102 residents living in the study area. Table 1 shows the socio-demographic characteristics of the cases and controls. The mean age of participants was 30.9 ± 11.5 years (mean ± SD), ranging from 18 to 60 years. 51% of pesticide applicators had ages between 18–29 years. Nonetheless, there was no significant difference between the age of the applicators and the residents ($p < 0.05$). The mean weight of participants was 67.3 ± 8.6 kg (mean ± SD), while the mean weight of pesticide applicators was 66.14 ± 8.3 kg. From 204 men, 64.2% were married, and 35.8% others were single. There was no significant difference in the marital status between the applicators and residents ($p < 0.05$). The most abundance of educational status was the primary/elementary level. This value was 62.8 % and 55.9% for the applicators and the residents, respectively. Meanwhile, there was a significant difference in the educational level between cases and controls ($p < 0.05$). In particular, the cases had a generally lower educational level than the controls; with around 18.6% of the applicators had completed their high school education, and only 5.9% of them had a university education. According to the interviews, the prevalence of regular smoking (at least one cigarette/day) was 24.5% and 25.5% for applicators and residents, respectively. However, none of them consumed alcoholic drinks.

Type of Pesticide Used:

In the pistachio orchards, pesticide applicators were asked about the name of the pesticide that they handled. In 87 of the cases, the pesticide containers were available for inspection and in a few cases where the containers were not available; the applicators provided the researcher with the name of the pesticides used. Table 2 presents the main pesticides used for controlling pests in pistachio orchards in the Zangiabad zone as a centre for pistachio cultivation. It was found that the insecticide/acaricide amitraz was the most frequently used pesticide to pistachio pests control in the study area (90.1%), and this was followed by spirodiclofen (3%), acetamiprid (2%), and thiamethoxam (2%). Amitraz is considered by the World Health Organization (WHO) as a class III pesticide, i.e. slightly toxic (Al-Thani *et al.*, 2003). In Iran, amitraz is available under the proprietary name Mitac, with 20% emulsifable concentrate. Although amitraz, the prominent pesticide, is from the formamidin group, other groups of pesticides which consist of organochlorine, organophosphate, neonicotinoid and insect growth regulators (IGR) were also used for controlling pistachio pests in the study area. A wide range of toxicity and LD_{50} was observed in pesticides used, for instance endosulfan, an organochlorine pesticide, classified as class I-highly toxic with oral LD_{50} 160 mg/kg (EXTOXNET, 1996), while thiamethoxam is a neonicotinoid pesticide considered as class III-slightly toxic with LD_{50} 5000 mg/kg (Anikwe *et al.*, 2009).

Amitraz Exposure:

Exposure data of pesticide applicators is summarized in Table 3. Fourty three and two percent of subjects worked as pesticide applicators for 2-5 years. They usually apply pesticides around 4 hours per day, on 20 days per month (maximum 24 days), and for 4 to 6 months per year. Eighty seven and two percent of the applicators stated that they usually took a shower after a working day. Moreover, 76 (74.5 %) applicators kept their work clothing at home and then used them again, whereas 26 applicators (27.5 %) wore work clothing at home and washed them after getting home.

There were no significant differences between the cases and the controls in agricultural practices for the rest of the year. In relation to protective measures used during pesticide application, none of the applicators in the Zangiabad zone used the protective measures which are normally required and adequate safety devices. In other words, nobody used gloves, masks, plastic cover, boots, apron, and waterproof garment.

The farmers bought pesticides from several sources, but the majority (91.2 %) purchased them from agricultural stores. It was found that pesticide products were stored in 74.5 % of the households investigated. There was not a significant difference for storing the pesticides between the cases and controls. Amitraz was found in 97% of the houses of cases and 93% of the houses of controls (Table 4). The most common form of packaging used for pesticides, especially amitraz, in the study area was COEX (71.5 %), aluminium (17.6 %), and PET (10.7 %). In order to dispose of empty containers, most of the farmers (55.9%) sell empty containers for recycling, but it is not clear who bought them or how they were recycled. Thirty seven and two percent disposed of them in the environment and 6.9% dropped them into municipal solid waste. Ten applicators (97%) reported that they had some kind of knowledge for pesticide handling. It should be noted that very few persons had been trained on the safe use of pesticides or IPM.

Table 1: Socio-demographic Characteristics of the Applicators and Residents in Zangiabad, Iran, 2008

Characteristics	Applicators		Residents	
	No	%	No	%
Age group (years)				
18 to 29	52	51.0	47	46.1
30 to 39	28	27.4	30	29.4
40 to 49	12	11.8	14	13.7
50 to 59	10	9.8	11	10.8
Weight (kg)				
40 to 59	26	25.5	26	25.5
60 to 79	67	65.7	68	66.7
80 to 99	9	8.8	8	7.8
Marital status				
Married	67	65.7	64	62.7
Single	35	34.3	38	37.3
Educational level				
Illiterate	13	12.7	3	2.9
Primary/ elementary	64	62.8	57	55.9
Secondary	19	18.6	31	30.4
University	6	5.9	11	10.8
Life-style factors				
Tobacco consumption	25	24.5	26	25.5
Alcoholic consumption	0.00	0.00	0.00	0.00

Table 2: Types of Pesticides Used on Pistachio Trees in the Zangiabad, Iran, 2008

Common name	Trade name	Pesticide group	No	%	Toxicity (WHO Class)	Oral LD50(mg/kg; rat)
Amitraz	Mitac	Formamidin	92	90	III	531 (M); 515 (F)
Spirodiclofen	Envidor	IGR	3	3	III	2000
Acetamiprid	Mospilan	Neonicotinoid	2	2	III1	297 (M); 944 (F)
Thiamethoxam	Actara	Neonicotinoid	2	2	III	5000
Imidacloprid	Confidor	Neonicotinoid	1	1	III	5000
Endosulfan	Endosulfan	Organochlorine	1	1	I	18 to 160
Ethion	Ethion	Organophosphate	1	1	II	208

Table 3: Exposure Data in Amitraz Applicators of Zangiabad Area, Iran

Characteristics	No	%
Exposure to pesticides (years)		
2 to 5	44	43.2
6 to 9	21	20.6
10 to 20	23	22.5
> 20	14	13.7
Exposure to pesticides (days/month)		
≤ 8	6	5.9
9 to 12	23	22.6
13 to 16	34	33.3
> 16	39	38.2

Table 3: Continue.

Takes shower after a working day		
Yes	89	87.2
No	13	12.8
Work clothing		
Keep at home and use again	76	74.5
wear at home and wash after using	26	27.5
Occupation for the rest of the year		
Agriculture	93	91.2
Bricklayer's	6	5.9
Student	3	2.9
Personal protection equipment usage		
Yes	0	0
No	102	100
Reason for not using all protective measures		
Uncomfortable use	63	61.8
Lack of economic resources	23	22.5
Ignorance	16	15.7

Table 4: Data for Amitraz Application in the Zangiabad Area, Iran

Characteristics	No	%
Where pesticides were bought		
Agricultural stores	93	91.2
Cooperatives	9	8.8
The place of pesticide containers store		
inside hous	76	74.5
outside house	20	19.6
Used pesticide as soon as they were bought	6	5.9
Disposal of empty containers		
Sold for recycling	57	55.9
Disposed of into the environment	38	37.2
Drop to the municipal solid wastes	7	6.9
Technical advice for pesticide use		
Never received	3	2.9
Directly from the salesman	33	32.4
Technicians from the ministry of agriculture	5	4.9
Neighbors and other friends	61	59.8

Discussion:

Pesticide exposure depends on dosage, concentration in the environment, the time period during which the person is exposed and the use of personal protective equipment (Nilsson, 1996). In the Zangiabad area, with 5280_{ha} of pistachio orchard area, about 39600 liters of amitraz (EC, 20%) was consumed to pistachio pest control in 2008. Since, pistachios are one of the most important agricultural products in Iran; the use of amitraz is therefore intensive throughout Iran. With regard to the high usage of amitraz in Iran, especially in the study area, the contact of the community with this pesticide could be recognized as a major environmental health problem.

Although amitraz is less toxic, it would require legislation to ban the most toxic pesticides and establish agricultural policies that promote less use of pesticides by farmers. A recent idea is a 'Minimum Pesticides List' aimed to supply information so that local public health and agricultural government officials can select the minimal number of relatively safe and effective pesticides for roles within an IPM system (Eddleston *et al.*, 2002). The high consumption of Amitraz and its availability in farmers' homes sometimes have resulted to their misuses, like suicide (Eizadi-Mood *et al.*, 2007). However, individuals with mild or moderate poisoning do not always seek health services or are not diagnosed as cases of poisoning (Faria *et al.*, 2009). Heidari (2003) described the high incidence of blood cancer among farmers and their families in Damghan, a pistachio-growing center in Iran, fueling concerns that pesticide exposure may play a role. It was rather surprisingly to find that all of the applicators did not use any kind of protection while applying pesticides. According to the information gathered during the interviews, the main reason for not using protective clothing during pesticide application was that it was uncomfortable to use. In a study in Peru, 24 % of the pesticide applicators stated the same reason for not using all protective measures (Yucra *et al.*, 2006). The second reason for non-use was economic. The same finding was found by Yassin *et al*. (2002) among the agricultural farm workers in the Gaza Strip, Palestine. An important way of decreasing exposure is to find comfortable and less expensive protective garments. Preferably, a properly designed garment made of suitable protective material would be worn over the areas of the body likely to be exposed. The choice of appropriate material such as cotton will enable workers to work comfortably and efficiently, which also helps to assure safe working practices (FAO, 1990). The use of masks was shown to be associated with fewer occurrences of pesticide-related symptoms (Faria *et al.*, 2009). This is because wearing masks such as oral–nasal mask can prevent pesticide drifts from entering through the mouth or nose into the human body (Yassin *et al.*, 2002). Not using protective measures in the study area was probably related to socio-demographic factors, such as education level. In other studies conducted on agricultural workers, education level showed a protective effect against pesticide poisoning (Sam *et al.*, 2008; Faria *et al.*, 2009). Around 97 % of the Zangiabad population had gone beyond the primary school level, thus contrasting with the rate of 100 % found in other studies (Berkowitz *et al.*, 2003; Carreno *et al.*, 2007). Another problem is the storage of pesticides after they are acquired by applicators. Regarding recycling of pesticide containers, the glass, steel and aluminum could be made into new products after having been melted at high temperature. The process of melting and re-refining of these materials is sufficient to destroy any remaining pesticide residues. The situation with plastics is different. The melting temperatures of plastic materials are relatively low and may be insufficient to destroy or remove the pesticide contaminants. In this case, it is necessary to ensure that the recycled plastic is manufactured into products with minimum potential for human contact and are not likely to be recycled again, for example as electrical conduits. Recycling is important as containers abandoned in the environment can lead to pesticide pollution in soil and groundwater (FAO/WHO, 2008). It is the duty of all users of pesticides to act responsibly when acquiring, storing and applying pesticides (FAO/WHO, 2008).

Therefore, it is crucial that people get information about the risks of the use of pesticides in an inadequate way (Yucra *et al.*, 2006). Education programs can be run by farmer cooperatives, farmer field schools, NGOs, extension services, agricultural colleges and schools. They can raise awareness towards the correct use of pesticides and the disposal of empty containers (FAO/WHO, 2008). The findings of the present study showed that pesticide applicators received information about the danger of pesticides from the neighbours and other friends, but not given any training in relation to handling amitraz. Neighbors and friends are not adequately qualified persons for training farm workers about proper handling of pesticides, as has been seen previously. However, the applicators are not fully aware of the relative toxicity of the pesticides they are using. In order to minimize amitraz poisoning, public education should be given on primary prevention of poisoning.

Moreover, a guideline could be provided by agriculture or the health ministry. Sustainable agriculture relies increasingly on alternatives to conventional chemical insecticides for pest management which are environmentally friendly and reduce the amount of human contact with pesticides (Lacey and Shapiro-Ilan, 2003). These alternative methods for controlling pistachio pests include biological control methods, (Lacey and Shapiro-Ilan, 2003), insect growth regulators (Lababidi, 2002), and the kaolin particle film technology (Saour, 2005) which are ideal candidates for incorporation into integrated pest management strategies in pistachio orchards in order to reduce pesticide exposure. Farmers rely on chemical control because they are unaware of the population balance between pests and natural enemies in their agro-ecosystems (Heidari, 2003).

Conclusion:

The findings of the present study emphasize the need for creating awareness among those who are working with pesticides about the potential hazard of pesticide exposure and the importance of using appropriate clothing and equipment for protection as well as a continuous training in the use of pesticides by the pesticide applicators, and farmers from this area. The pesticide applicators in the study area do not use suitable garment for their protection against pesticides. More importantly, future agricultural practice must aim to reduce pesticide use to the minimum. Since such action may take several years to be realized, pesticides causing the most human ill health and environmental contamination should be restricted in the meantime. It is suggested that all persons who wish to apply restricted-use pesticides in this area must obtain a pesticide applicators' license through the Department of Agriculture. Another suggestion is to have a WHO and FAO endorsed Minimum Pesticides List. Such a list would lead to an easily adopted strategy to assess all pesticides on the basis of indications, human and environmental toxicity and cost. To decrease the health risks of pesticide applicators among workers it is necessary to study the relationship between the concentrations occurring in the environment and the exposure to humans. In this way, the health risk can be estimated and adequate safety measures can be established. At the present there are no concentration limits or hygienic values for chemical substances applied in pistachio cultivation in Iran.

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