

Occupational acute pesticide poisoning: a cross-sectional study of Turkish vegetable and fruit farmers based on self-reported symptoms and job characteristics

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PAROLE CHIAVE: Intossicazione acuta da pesticidi; coltivatori; prevalenza; fattori di rischio

ABSTRACT

Background: Occupational pesticide poisoning is an important public health concern worldwide, especially in developing countries. **Objectives:** This study was aimed at determining the prevalence and risk factors of acute pesticide poisoning (APP) among the vegetable and fruit farmers in Karacabey District in northwest Turkey. **Methods:** The study group consisted of 565 farmers. The dependent variable of the study is APP defined according to the World Health Organization's APP case definition matrix. The study's independent variables are the farmers' sociodemographic characteristics and the preventive measures they use when they are applying pesticides. The chi-square and logistic regression analysis analyzed the relationship between the dependent and independent variables. **Results:** A total of 64 (11.3%) farmers reported APP and 75% of them presented to a health institution due to symptoms. The factors associated with increased risk of APP were: illiteracy (odds ratio (OR)=2.5), 14 years and less farming experience (OR=3.3), not reading the pesticide labels (OR=6.4), and contact with liquid pesticides (OR=2.3). **Conclusions:** The study shows that approximately one out of ten farmers experience APP. Training programs should be planned and monitored to improve farmers' awareness of the dangers of pesticides, and they should be encouraged to adopt and implement protective measures.

RIASSUNTO

«**Intossicazione occupazionale acuta da pesticidi: studio trasversale di coltivatori di frutta e verdura turchi basato su sintomi autoriferiti e caratteristiche occupazionali**». **Introduzione:** L'intossicazione occupazionale da pesticidi è un importante problema sanitario a livello mondiale, specialmente nei paesi in via di sviluppo. **Obiettivi:** Determinare la prevalenza e i fattori di rischio dell'intossicazione acuta da pesticidi (AAP) tra i coltivatori di frutta e verdura nel distretto di Karacabey nella Turchia nord occidentale. **Metodi:** Il campione studiato era composto da 565 coltivatori. La variabile dipendente dello studio è l'AAP così come classificato dalla definizione di caso dell'Organizzazione Mondiale della Sanità. Le variabili indipendenti sono costituite dalle caratteristiche sociodemografiche dei soggetti dello studio e dalle misure di prevenzione da loro adottate nell'utilizzo dei pesticidi. La relazione tra variabile dipendente ed indipendenti è stata analizzata attraverso test del Chi quadro e analisi della regressione logistica. **Risultati:** Sessantaquattro coltivatori (11.3%) hanno riferito AAP e il 75% di loro si è presentato a un'istituzione sanitaria a causa dei sintomi. I fattori associati con un rischio accresciuto di AAP sono risultati: analfabetismo

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(odds ratio (OR)=2.5), 14 anni o meno di esperienza lavorativa in agricoltura (OR=3.3), mancata lettura delle etichette dei pesticidi (OR=6.4), e contatto con pesticidi liquidi (OR=2.3). **Conclusioni:** Lo studio mostra che circa un coltivatore su dieci è a rischio di AAP. Programmi di addestramento dovrebbero essere messi in atto e monitorati per migliorare la consapevolezza dei pericoli insiti nell'uso dei pesticidi da parte dei coltivatori, che dovrebbero essere incoraggiati ad adottare misure di protezione individuale.

INTRODUCTION

Pesticides are substances or mixtures of substances that have been used for many years to destroy, control or remove pests such as insects, rodents, fungi and weeds (4). Pesticides, by their nature, are potentially toxic to humans and many organisms other than their target audience; therefore, they must be used safely, and their waste should be disposed of appropriately. However, occupational acute pesticide poisoning (APP) emerges as a serious public health problem due to unsafe pesticide application (27). Agricultural workers are at risk of being exposed to pesticide poisoning during transport, dilution, mixing and application of pesticides (28). Typically, around 10% of total pesticide exposures in agricultural occupations occur through the respiratory tract, the rest through dermal absorption or digestion (26). It is estimated that approximately 1-5 million cases of pesticide poisoning occur per year among agricultural workers, mostly in developing countries (1). Developing countries consume 20-30% of the total global pesticide consumption (19). Still, agricultural workers in these countries are particularly susceptible to the health effects of pesticide exposure because of factors such as insufficient regulations, lack of surveillance systems, lack of training, poor work conditions, poorly maintained or nonexistent personal protective equipment and unsafe storage and application (15). Self-inflicted poisonings are also a serious public health problem in many parts of the world, with ingestion of pesticides being one of the most common methods of suicide deaths and suicide attempts (18, 28).

In developed countries, the annual APP incidence rate in full-time agricultural workers is 18.2 per 100,000 (23). Data about APP occurrence in developing countries is limited, and the actual size of the problem is unknown since the available data

largely depends on hospital-based research. Since severe cases often present to the hospital, the results from these studies do not reflect the real prevalence of APPs in agricultural workers. Moreover, many mild or moderate cases escape diagnosis (3). Results from community-based studies also show significant variations. In a study, it was stated that the frequency of non-intentional occupational APP cases varies between 10 and 50% in developing countries (1). In rural farming villages in Tanzania, 93% of farmers experienced pesticide poisoning 1-7 times in their lifetime, and three out of four farmers suffered from poisoning two or more times (20). In India, 83.6% of cotton growers showed APP symptoms. Of them, 39.6% had mild symptoms, 38% had moderate symptoms, and 6% had severe symptoms (16). APP prevalence was 16% in Jamaica (19), 23% in South Korea (12), 60% in Iran (2), and 82% in Kuwait (9). The wide variation of the results obtained in the studies largely depends on the methodological differences among studies and the lack of standard case definition for APP. The World Health Organization (WHO) has developed a practical case identification matrix that standardizes the definition of APP cases and can be used in rural clinics and primary care settings to improve the estimates of APP cases (23).

According to the data of 2018, 7.7% of Turkey's population lives in villages and the agricultural sector constitutes the primary source of recruitment, especially for this population (5). As of September 2019, there were approximately 5.5 million people employed in the agricultural sector, and they constituted 19% of the total employed population (25). The agricultural sector is an important employment area, and the use of pesticides is increasing in Turkey (average pesticide use per cultivated area was 1.08 kg/ha in 1990, and 2.31 kg/ha in 2017) (7). Yet, there is almost no field study to determine the

pesticide exposure and risk factors in agricultural workers (22). The present study aimed at filling the gap in this field and aimed at a) establishing the prevalence of APP based on the WHO case classification matrix, and b) investigating the sociodemographic and behavioural factors affecting the risk of APP among the male farmers engaged in the cultivation of fruits and vegetables in Karacabey district of Bursa, a province in northwestern Turkey.

METHODS

The cross-sectional study was carried out in Karacabey district of Bursa in 2019. The target population of the study was 9,750 male farmers registered in Karacabey Agriculture District Directorate. The sample size was calculated as 565, assuming a 50% prevalence of APP (unknown prevalence). With these numbers, the 95% confidence interval would be 46 to 54% (i.e. 4% margin of error) which we consider sufficiently precise (Epi Info StatCalc program was used). The study group was determined by 1/17 systematic sampling from the list of registered farmers. Considering the possibility of refusals and/or losses in the study, an additional 10% ($n=56$) of sample size was determined as a substitute.

The participating farmers were interviewed using the face-to-face interview technique. During the interviews, they were administered a 67-item questionnaire. First of all, the farmers were asked if they were actively working on pesticide spraying. Only the farmers who have been actively engaged in spraying were included in the study. Since 27 of the farmers refused to participate in the study, the targeted sample size was reached with the farmers determined as substitutes. The questionnaire was pilot tested with ten farmers who were not included in the study sample.

The dependent variable of the study was acute pesticide poisoning. Based on the WHO standard case definition, an APP case is defined as two or more symptoms that occur within 48 hours of spraying in the past year (23). The symptoms can affect the respiratory system, the nervous system, the gastrointestinal system, the urinary system, the cardiovascular system, and involve dermal, ocular and general symptoms. The independent variables

of the study were age, location, marital status, education level, monthly income, smoking, having chronic diseases, farming experience and the personal protective measures taken by the farmers. Descriptive data obtained from the study were summarized as percentage distribution. The chi-square and logistic regression analysis analyzed the relationship between the dependent and independent variables. The dependent variable was coded two categories as "0" for the ones that report or do not report a symptom and "1" for possible APP cases. The variables with a p-value of <0.05 in the chi-square analysis were included in the logistic regression analysis. Data were analyzed using the SPSS. Ethical approval was obtained from Balıkesir University to conduct the study (Date: 04.04.2018, No: 2018/73). Verbal consent indicating that they volunteered to participate in the study was obtained from the farmers.

RESULTS

In the study, 565 farmers actively working in the application of pesticides were reached. The farmers' mean age was 47.7 ± 9.9 years, and 72.2% of them were in the age group 40-59 years. Only 9.9% of the farmers lived in the district centre. Nine per cent had no formal education, and four out of five were married. More than half of farmers (53.8%) were active smokers, and 22.5% had a chronic disease. Sixty-five point eight per cent had been farming for 15 years and over (Table 1). The products grown by the farmers included: tomatoes (68.5%), peppers (51.3), potatoes (34.3), onions (28.5), melons (26.4), watermelons (7.6%), eggplants (2.8%) and cucumbers (1.1%).

Table 2 presents some preventive measures taken by the participating farmers during the pesticide application process. Seventy-five point two per cent read the label instructions on the pesticide packaging, 84.2% wore gloves during the preparation, and 77.7% wore gloves while spraying. Sixty-five point eight per cent wore coveralls while spraying, 57.3% wore protective glasses, and 56.1% wore masks. 41.4% declared a possible contact with liquid pesticides while preparing or spraying them (Table 2).

APP prevalence was 11.3% in the study. More

Table 1 - Descriptive characteristics of the farmers, Karacabey district of Bursa, Turkey

Variables	n	%
Age group		
20-39	96	17.0
40-59	408	72.2
60 and above	61	10.8
Location		
District centre	56	9.9
Village	509	90.1
Education level		
Illiterate	51	9.0
Primary school	206	36.5
Secondary school	201	35.6
High school and above	107	18.9
Marital status		
Married	412	72.9
Single	153	27.1
Monthly income*		
349 USD and below	117	20.7
Above 349 USD	448	79.3
Smoking		
Yes	304	53.8
No	261	46.2
Having chronic disease **		
Yes	127	22.5
No	438	77.5
Farming experience (years)		
1-14	193	34.2
15 and over	372	65.8
Total	565	100.0

According to the 20 June 2019 exchange rate * Reported chronic diseases are COPD (n=32), hypertension (n=68), diabetes (n=36), asthma (n=27), cancer (n=6). 7.3% (n=41) of farmers reported more than one chronic disease.

than half of APP cases (59.4%) presented to the hospital emergency room due to their symptoms and 15.6% of them presented to their family physicians. Of the farmers who presented to the health institution, 11 (17.2%) were hospitalized, and 53 (82.8%)

Table 2 - Farmer behavior to fulfil preventive measures during the pesticide application process (n= 565)

Variables	Yes		No	
	n	%*	n	%*
Do you read the label on the pesticide packaging?	425	75.2	140	24.8
Do you wear gloves when preparing pesticides?	476	84.2	89	15.8
Do you wear gloves when spraying?	439	77.7	126	22.3
Do you wear coveralls when spraying?	372	65.8	193	34.2
Do you wear boots when spraying?	423	74.9	142	25.1
Do you wear safety glasses when spraying?	324	57.3	241	42.7
Do you wear a mask when spraying?	317	56.1	248	43.9
Do you wear hats when spraying?	430	76.1	135	23.9
Do you have contact with liquid medicines while preparing pesticides or spraying?	234	41.4	331	58.6
Do you consume food during spraying?	231	40.9	334	59.1
Do you smoke while spraying?	223	39.5	342	60.5
Do you wash your hands after spraying?	497	88.0	68	12.0
Do you take a shower after spraying?	475	84.1	90	15.9

*Row percentage

underwent outpatient treatment. The most frequent APP symptoms suffered by the farmers were respiratory symptoms (32.2%), gastrointestinal symptoms (31.6%), neurological signs (19.5%) and ocular symptoms (8.0%). Specifically, the most commonly reported symptoms were cough (14.9%), dyspnea (12.6%), abdominal cramping (11.5%), headache (20.9%) and vomiting (10.3%) (Table 3). According to their statements, 61.9% had mild symptoms, 36.0% had moderate symptoms, and 2.0% had severe symptoms (data not shown).

Table 4 shows the results of the univariate and multivariate analysis between dependent and

Table 3 - Prevalence of acute pesticide poisoning (APP), health institution referral of APP and symptom distribution

	n	%
Acute pesticide poisoning		
Yes*	64	11.3
No	501	88.7
Total	565	100.0
Health institution referral due to symptoms		
Emergency	38	59.4
Family doctor	10	15.6
Not applying	16	25.0
Total	64	100.0
Symptoms		
Cough	26	14.9
Dyspnoea	22	12.6
Abdominal cramping	20	11.5
Headache	19	10.9
Vomiting	18	10.3
Chest pain	9	5.2
Diarrhoea	7	4.0
Dizziness	7	4.0
Airway irritation	6	3.4
Confusion	5	2.9
Lacrimation	4	2.3
Skin lesions/irritation	4	2.3
Nausea	4	2.3
Ocular irritation	3	1.7
Visual changes	3	1.7
Other**	17	9.8
Total	174	100.0

* Farmers who report two or more symptoms within 48 hours after the last year spraying

**Loss of appetite (n=2), bloody stools (n=2), sneezing (n=2), oral irritation (=2), blurred vision (n=1), drowsiness (n=1), profuse sweating (n=1), oedema / swelling (n=1), conjunctivitis (n=1), corneal abrasion (n=1), ocular burn (n=1), ocular pain (n=1), fever of short duration (n=1).

independent variables. The multivariate analysis revealed that illiteracy increased the APP risk 2.5 times (P=0.031). Farming duration below 15 years increased the risk 3.3 times (P=0.000), not reading

the label on the pesticide package increased the risk 6.4 times (P=0.000) and direct contact with liquids during the preparation of pesticides or spraying increased the risk 2.3 times (P=0.011) (Table 4).

DISCUSSION

To the best of our knowledge, this is the first study conducted to determine the APP prevalence using the WHO case classification matrix in Turkey. The study provides useful information on APP prevalence and risk factors in Karacabey district in Bursa, a province in the northwestern part of Turkey. In the present study, the APP prevalence was 11.3%. Of the participating farmers, 64 reported two or more APP symptoms within 48 hours of pesticide application in the past year. The majority of the APP symptoms reported (98.0%) were mild or moderate. The most commonly reported symptoms were respiratory (32.2%) and gastrointestinal (31.6%) system symptoms. Three out of four farmers with APP symptoms (75%) showed up to a health facility due to their symptoms. It is difficult to compare the studies conducted on the APP prevalence due to their methodological differences. In a study conducted in China based on the WHO case classification matrix, it was determined that the percentage of farmers who reported two or more APP symptoms within 24 hours after spraying was 8.8% (80/910), which is close to the prevalence found by this study (29). The prevalence of APP in various studies varies widely between 1 and 93% (1, 2, 9, 12, 16, 19, 20, 22). Increasing the number of studies in which standardized case definitions are used may provide better comparisons between studies. However, APP is a prevalent problem in developing countries where regulations to protect workers, and public health services are insufficient. In these countries, farmers with less severe cases of APP may not seek health care. Therefore, APP cases may be underreported (9, 14, 17, 19). Indeed, in our study population, about a quarter of subjects reported the symptoms of APP but did not receive health care from any health institution.

The APP risk was 2.5 times higher in the illiterate farmers. That is because the illiterate farmers could not read hazard warnings on pesticide labels,

Table 4 - Association of pesticide poisoning with selected independent variables

Variables	Acute Pesticide Poisoning		Statistical analysis				
	Yes	No	Univariate		Multivariate		
	n (%)	n (%)	χ^2	p	OR	95% C.I.	p
Age group							
20-39	11 (11.5)	85 (88.5)	1.573	0.456			
40-59	49 (12.0)	359 (88.0)					
60 and above	4 (6.6)	57 (93.4)					
Residential area							
District Centre	2 (3.6)	54 (96.4)	3.723	0.054			
Village	62 (12.2)	447 (87.8)					
Education level							
Illiterate	17 (34.0)	33 (66.0)	28.073	0.000	2.5	1.1-5.7	0.031
Primary school and above	47 (9.1)	468 (90.9)			ref		
Marital status							
Married	37 (9.0)	375 (91.0)			ref		
Single	27 (17.6)	126 (82.4)	8.343	0.004	1.0	0.5-2.0	0.998
Monthly income**							
349 USD and below	14 (12.0)	103 (88.0)	0.06	0.807			
Above 349 USD	50 (11.2)	398 (88.8)					
Smoking							
Yes	44 (14.5)	260 (85.5)	6.486	0.011	1.6	0.8-3.0	0.164
No	20 (7.7)	241 (92.3)			ref		
Having chronic diseases							
Yes	17 (13.4)	110 (86.6)	0.691	0.406			
No	47 (10.7)	391 (89.3)					
Farming experience (years)							
1-14	36 (18.7)	157 (81.3)	15.661	0.000	3.3	1.7-6.2	0.000
15 and over	28 (7.5)	344 (92.5)			ref		
Reading the label on the pesticide							
Yes	20 (4.7)	405 (95.3)			ref		
No	44 (31.4)	96 (68.6)	74.87	0.000	6.4	3.4-12.0	0.000
Wearing gloves when preparing pesticides							
Yes	52 (10.9)	424 (89.1)	0.489	0.484			
No	12 (13.5)	77 (86.5)					
Wearing overalls during spraying							
Yes	36 (9.7)	336 (90.3)	2.952	0.086			
No	28 (14.5)	165 (85.5)					
Wearing gloves during spraying							
Yes	54 (12.3)	385 (87.7)	1.856	0.173		w	
No	10 (7.9)	116 (92.1)					
Wearing boots during spraying							
Yes	54 (12.8)	369 (87.2)	3.467	0.063			
No	10 (7.0)	132 (93.0)					

(continued)

Table 4 - Association of pesticide poisoning with selected independent variables

Variables	Acute Pesticide Poisoning		Statistical analysis				
	Yes	No	Univariate		Multivariate		
	n (%)	n (%)	X^2	p	OR	95% C.I.	p
Wearing protective glasses during spraying							
Yes	28 (8.6)	296 (91.4)			ref		
No	36 (14.9)	205 (85.1)	5.454	0.020	1.2	0.6-2.2	0.619
Wearing a mask during spraying							
Yes	31 (9.8)	286 (90.2)	1.724	0.189			
No	33 (13.3)	215 (86.7)					
Wearing a hat during spraying							
Yes	44 (10.2)	386 (89.8)	2.148	0.143			
No	20 (14.8)	115 (85.2)					
Contact with liquid medicines when preparing pesticides or spraying							
Yes	44 (18.8)	190 (81.2)	22.22	0.000	2.3	1.2-4.2	0.011
No	20 (6.0)	311 (94.0)			ref		
Consuming food during spraying							
Yes	23 (10.0)	208 (90.0)	0.731	0.393			
No	41 (12.3)	293 (87.7)					
Smoking while spraying							
Yes	21 (9.4)	202 (90.6)	1.339	0.247	1.5	0.8-2.8	0.268
No	43 (12.6)	299 (87.4)			ref		
Hand washing after spraying							
Yes	49 (9.9)	448 (90.1)			ref		
No	15 (22.1)	53 (77.9)	8.863	0.003	1.5	0.5-4.3	0.447
Taking a shower after spraying							
Yes	46 (9.7)	429 (90.3)			ref		
No	18 (20.0)	72 (80.0)	8.016	0.005	1.1	0.4-3.1	0.788

ref= Reference variable *Chi-Square Test ** According to the 20 June 2019 exchange rate

and therefore did not know how to avoid exposure and failed to follow recommended safety and enforcement guidelines. However, in an Iranian study, contrary to the present study, the education level was determined not to affect the APP risk (2). In a study involving 300 agricultural workers in India regarding the safe use of pesticides, the participants' knowledge scores on the safe use of pesticides increased significantly according to the education level. However, in the same study, the level of

education did not account for differences in terms of applying safety measures (13). In the current study, the frequency of APP was 16.1% in farmers employed for less than 15 years, whereas it decreased to 7% in farmers with longer experience. In the logistic regression analysis, less than 15 years of farming experience was found to increase the APP risk by 3.0 times. Similarly, the incidence of APP was reported to be higher in younger and less experienced farmers in Nicaragua (11). As the farming

experience increases, the ability to understand the dangers of pesticides and to apply protective measures may be positively affected. Although not presented in the findings, the rate of implementing protective measures such as reading the pesticide label, wearing protective clothing (gloves, work overalls, masks, hats, glasses) was higher in those with 15 years and more farming experience. However, in the Iranian study, the risk of APP was 0.3 times less among farmers with 31-40 years of farming experience, while it was 2.4 times higher among farmers with 21-30 years of spraying experience. In the same study, it was emphasized that increased experience did not guarantee better health outcomes or protective practices (2). For the safe use of pesticides, it is crucial to follow the label instructions on the pesticide packaging. In the present study, 75.2% of the participating farmers read the label on the pesticide boxes and the APP risk increased 6.3 times in those who did not understand the label. Other studies consistently reported the relationship between reading the instructions on the pesticide label and the risk of APP. In Jamaica, the frequency of poisoning decreased in those who read the instructions in pesticide bags before applying pesticides. Fifty per cent of the farmers who reported poisoning had read the instructions on the label before using pesticides. In contrast, a higher percentage (86%) of farmers who did not report poisoning had read the label. In the same study, it was also reported that reading instructions on pesticide use before each use of pesticides reduces the risk of acute poisoning among farmers by 0.12 times (19). In South Korea, the risk of poisoning increased by 1.61 times in those who did not read the pesticide label (12). Another variable that increased the risk of APP in the current study was the contact with liquid pesticides while pesticides were prepared and sprayed. Among farmers who reported the contact with pesticides, the risk of APP was doubled. When someone works with pesticide products, it is an expected result that contamination caused by direct contact of the skin, nose, mouth or eyes will increase his/her APP risk. To prevent direct contact with pesticides, when pouring and mixing the concentrated product, and to prevent splashing or spillage on the skin or clothing, it is recommended

that every effort be made, by promptly washing out the pesticide in case of contact with the body and by carefully cleaning the contaminated clothing (6). Implementation of preventive measures by the farmers in the present study was relatively higher than in other studies (8, 21, 22). However, contrary to the expectations, farmers' use of protective equipment and other individual hygiene behaviours displayed by them did not affect the risk of APP. The farmers may have preferred to declare socially approved behaviours, rather than their actual behaviours. In other words, the actual rate of protective equipment use was lower than was that they reported, or they stated that they used protective equipment correctly although they did not. Protective equipment may not be effective in preventing pesticide exposure if not appropriately used (10). Contrary to our study, in South Korea, it has been shown that the risk of pesticide poisoning increases if gloves (OR 1.29) or masks (OR 1.39) are not worn as personal protective equipment during pesticide spraying (12).

The present study has several limitations. Its main limitation is that the data on APP and related factors were collected based on the farmers' statements. Recall bias may have led to an inaccurate estimation of the APP prevalence and the farmers' behaviours. The farmers may also have tended to report approved behaviours, particularly about protective measures. Another significant limitation is that APP symptoms are not specific and may represent other health conditions. A third limitation is that in the current study, comprehensive information about the intensity and duration of each farmer's pesticide use, pesticide types, or the technical process of pesticide preparation and spraying was not collected. More detailed information on APP risk factors and farmers' behaviours can be obtained by conducting more comprehensive studies that include data from health institution records. Finally, due to the study's cross-sectional design, it is not useful for making causal inferences. Despite these limitations, the current study provides essential information about APP prevalence and its risk factors in Turkey. It also offers comparable data for studies in which the WHO case classification matrix is used.

CONCLUSIONS

Our study indicates that 11.3% of the farmers who applied pesticides in the past year suffered occupational acute pesticide poisoning. Illiteracy, less than 15 years of farming, not reading the instructions on the label on the pesticide packaging, contact to pesticide during its application were identified as the main risk factors that increased the risk of APP. The first step in preventing APP cases is to establish an effective surveillance system and capture all cases. Next, training interventions should be planned and monitored to improve farmers' understanding of the dangers of pesticides and improve their use of preventive measures when they work with pesticides.

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