Neurological Health Symptoms Associated with Pesticide Exposure among Farmers in Sharkia Governorate Districts

Mryhan Ahmed Adel Hammouda
Community, Environmental, and Occupational Medicine Department, Faculty of Medicine, Zagazig University, Egypt
***Corresponding author:** Mryhan Ahmed Adel Hammouda, **Mobile:** (+20) 01203876554, **E-Mail:** meryadel@yahoo.com

ABSTRACT

Background: Pesticides are widely utilized in agriculture, even pesticides have been outlawed in Western nations for owing to safety concerns remain extensively utilized in Egypt. Even though there are few researches on the neurological symptoms linked to pesticide exposure in Egypt. Recently, around 40% of the workforce in Egypt is worked in agriculture, with a risk of exposure to pesticides.

Objective: This study's objective was to assess the neurological health effects of pesticide exposure among Egyptian farmers in the districts of Sharkia governorate.

Patients and Methods: A case control study was held on 95 farmers and comparable non-exposed controls from different farms in four districts out of thirteen in Sharkia governorate were selected using multistage random sampling technique. Then, during the period between March and July 2020, interviews were conducted to gather demographic information, occupational history, and neurological health problems related to pesticide exposure. Blood samples underwent to acetyl-cholinesterase test to assess the extent of pesticide exposure.

Results: Ninety-four percent of pesticide users claimed to have contact with organophosphate insecticides. The most common neurological symptom reported was a headache (69.5%), which was followed by poor attention (64.2%), a short memory (57.9%), and fatigue (55.8 percent). There was a statistically significant higher depression of AChE activity and its adjusted value (Q level) AChE/Hb level among farmers than their controls.

Conclusion: A high prevalence of neurological symptoms was reported among Egyptian farmers using pesticides, which attributed to pesticide exposure causing severe depression in cholinesterase test. It`s recommended to conduct more informative researches to assess risk factors and improve awareness.

Keywords: Agriculture, Pesticide exposure, Farmers and acetyl-choline esterase activity.

INTRODUCTION

Most of the young men who work as farmers and apply pesticides have no training or awareness of how pesticides affect the environment and human health, and they lack the tools necessary to cope with exposures and their impacts. The adoption of protective measures during the use of pesticides depends on their accessibility, price, level of comfort, and the restrictions that are applicable in small-scale farming regions. Additionally, without adequate protection, the danger of pesticide exposure and the likelihood of negative health effects rise [(1)].

In agriculture, pesticides—toxic chemicals that kill insects and plant pathogens—are frequently utilized. However, they are also utilized in a number of other procedures, including food preservation, sprays, and environmental tasks like the removal of undesired aquatic plants and weeds. Pesticide use has protected about one-third of global agricultural production [(2)]. Occupational exposure happens at several phases of work, from formulating and combining with solvents to applying, like spraying. There are long-lasting cumulative impacts on human health from these chemical active components and their inert counterparts [(1)].

Two to 5 million cases of pesticide poisoning are reported annually globally, according to the World Health Organization (WHO) [(3)], 300 000 of the instances have resulted in fatalities [(4)]. Only poor nations account for almost 99 percent of pesticide poisoning deaths, although using 20 to 25 percent of the world's pesticides [(5)].

Due to improper application methods, outdated or completely unsuitable spraying equipment, inadequate storage procedures, and frequent reuse of old pesticide containers for food and water storage, pesticide users are greatly at risk of exposure to harmful pesticides that are banned or restricted [(6)]**.** When exposed to pesticides, one may experience a number of negative health impacts, including transient acute symptoms including eye discomfort and excessive salivation. Central nervous system (CNS) side effects such agitation, memory loss, seizures, and coma are also typical. It has been extensively documented that several substances cause parasympathetic and sympathetic nervous system side effects, such as respiratory paralysis [(7)].

Additionally, persistent pesticide exposure has been linked to a variety of health issues, including immunological, respiratory, cardiovascular, and reproductive system issues in addition to nervous system damage [(5)].

Even pesticides that have been outlawed in Western nations for a long time owing to safety concerns are extensively used in Egypt without any safeguards. Currently, 40% of Egyptian workers work in agriculture, which carries a significant risk of chemical exposure [(8)].

Farmers who work in agriculture are at risk for neurological health issues because of pesticide use. In Egypt, nothing has been done about neurological health issues and the dangers of pesticide exposure [(8)].

Acetylcholinesterase (AChE) test, self-reported neurological symptoms linked to pesticide

Received: 01/07/2022
Accepted: 07/09/2022

exposure, and observation of personal protective measures used during pesticide application were used to gauge the severity of pesticide exposure among farmers in specific locations. In order to establish the severity of exposure, the study analysed whole blood cholinesterase activity and performed interviews to identify symptoms associated with pesticide exposure. The utilisation of personal protection equipment was also noted.

The goal of the current study is to evaluate the risk factors for neurological health problems among farmers who use pesticides.

PATIENTS AND METHODS

The sample size was determined using the mean level of acetylcholine esterase for pesticide-exposed employees in the Nepali study of 28.92 ± 3.1 Elman units/g versus the mean level for controls of 30.05 ± 2.66 Elman units/g [(9)], the calculated sample size was 95 for each group at 80% power study power and 95% CI. The sample contained 190 individuals; 95 studied group and 95 control group.

All farmers and control subjects were recruited after obtaining informed consent. A valid consent was taken from each farmer for obtaining medical history, clinical examination and for the permission to take blood samples for biochemical analysis, then collecting socio-demographic and health symptoms related data from 190 participants during the period between March and July 2020. The research subjects were chosen using a multistage random selection process from a list of 382 casual and 716 contractual employees. Four of the governorate of Sharkia's thirteen districts were chosen by lottery. A total of four participating villages were created by randomly choosing one village from each district. Next, eight farms were chosen from four communities. After that lists of farmers hired at these farms were gathered from farm managers and by using systematic random sampling technique a total of 95 study participants were selected. Then a comparative group matched in age and genders to our studied farmers were selected from the selected villages but were not farmers nor exposed to pesticides environmentally.

A pre-structured questionnaire with questions on socio-demographic traits, occupational history, pesticide exposure, the most prevalent kind of pesticide used nearby, and the availability and usage of personal protection equipment was used to interview research participants. The Q16 questionnaire, which has 16 modified items for evaluating neurological health symptoms and can be responded with a "yes" or "no," was used to examine the neurological symptoms [(10,11)]. Additionally, it was advised that individuals who gave more than six affirmative replies to the questions undergo additional testing to rule out organic brain damage brought on by exposure to organic solvents.

The questionnaire was pretested among 10 farmers operating in vegetable farms rather than our chosen group as a pilot sample before data collection, and difficult items were adjusted.

All 190 individuals had their erythrocyte acetylcholine esterase levels tested, which is a sign of exposure to pesticides that block cholinesterase such organophosphates and carbamates. A skilled laboratory worker used a vacuum tube to collect blood samples from each research participant, and blood samples were analyzed at the Health Insurance Authority in Zagazig city. Using a sterile lancing tool, 10 ml of capillary blood from a finger prick was taken and put into the test tube. Then, distilled water was used to dissolve the AChE erythrocyte cholinesterase reagent before it was added to the analyzer. Measurements of hemoglobin, AChE levels, and hemoglobin-adjusted erythrocyte acetylcholine esterase activity were supplied by the analyzer. The following reference values were noted, particularly for AChE and haemoglobin (Hb): Hb = 15.0 g/dL, Q (AChE/Hb) = 31.4 U/GS, and AChE = 4.71 U/mL (N: 2.77 in 5.57 U/mL). The coefficient Q, which is the AChE adjusted for the amount of Hb, was often selected because of the regular increase in anemia in our people [(12)].

Ethical consent:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Zagazig University. Written informed consents were taken from all participants. The study was conducted according to the Declaration of Helsinki.

Statistical analysis:

Statistical Package for Social Science (SPSS) version 16.0 was used to computerize and statistically analyze the data obtained (SPSS Inc., Chicago, IL). Frequencies and percentages were used to depict qualitative data. Mean and standard deviation were used to express quantitative data. To compare patient and control data, the chi-square test (X^2), Fisher exact, and independent sample t-test were used. When p value is less than 0.05, the test findings were considered significant, or high significant when the value is less than 0.001.

RESULTS

The general characteristics of both farmers and controls are presented with no statistically significant differences between both groups, as they were matched, 78.9% of studied farmers were on contract and 21.1% were casual hired in the farms, 72.6% worked with spraying pesticides for more than eight hours per day and 31.6% worked with pesticides for more than 10 years. Organophosphate and carbamate were the commonest type of pesticides used and only 12.6% of the studied farmers used personal protective equipment (PPE) during spraying (Table **1**).

Table (1): Socio-demographic characteristics and occupational history among both studied groups:

Variables	Farmers (n=95)	Controls (n=95)	P#
	No. (%)	N (%)	
Age group (years)			
<20	25 (26.3%)	22 (23.2%)	0.413
20 - 40	33 (34.7%)	27 (28.4%)	
>40	37 (39.0)	46 (48.4%)	
Gender			
Males	86 (90.5%)	79 (83.2%)	0.133
Females	9 (9.5%)	16 (16.8%)	
Educational level			
Illiterate	29 (30.5%)	25 (26.3%)	0.373
Primary education	61 (64.2%)	60 (63.2%)	
Secondary education	5 (5.3%)	10 (10.5%)	
Smoking	76 (80.0%)	75 (78.9%)	0.857
Employment			
On contract	75 (78.9%)	-----	-----
Casual	20 (21.1%)	------	
Working hours\ day			
<8 hours	26 (27.4%)	18 (18.9%)	0.169
>8 hours	69 (72.6%)	77 (81.1%)	
Work duration (pesticide exposure)			
<5 year	14 (14.7%)	----	
5-10 Years	51 (53.7%)	----	------
≥10 years	30 (31.6%)	-----	
Environmental exposure	42 (44.2%)	33 (34.7%)	0.182
PPE use during spraying	12 (12.6%)	------	-----
Types of pesticides used			
Organophosphates	89 (93.7%)	-----	------
Carbamates	6 (6.3%)	-----	

#Chi-Square test

Farmers' exposure to organophosphate (OP) and carbamate pesticides is evident by the statistically significant decline in AChE activity; the mean average of Q level (AChE/Hb) among farmers was higher by 27.51 U/g in comparison to their controls, who had a mean concentration of 32.12± 2.25 U/g. (Table **2**).

Table (2): Levels of AChE assessed among farmers and control group:

AChE (U/ml)	Farmers (N=95)	Controls (N=95)	P value#
AChE (U\ml)	2.85 ± 0. 62	3.62 ± 0.45	<0.001
Q (AChE/Hb), U/g	27.51± 1.87	32.12 ± 2.25	<0.001
Hemoglobin g\L	11.81± 2.55	12.33 ± 2.76	0.02

#Independent t-test statistically significant at p ≤ 0.05

This study revealed that 55.8% of studied farmers felt abnormally tired during their days, 44.2% had palpitations regularly even without exertion, 47.4% had painful tingling, 64.2% complained of problems with concentration and 57.9% complained of short memory versus 33.7%, 12.6%, 15.8%, 9.5% and 26.3% respectively among their controls with a high significant difference among both groups. Moreover 55.8% of studied farmers had more than 6 positive neurological symptoms versus 3.2% only of their controls (Table **3**).

Table (3): Reported neurological health effects as regard Q16 answers:

Variables	Farmers (n=95)	Controls (n=95)	P
	No. (%)	N (%)	
1- Tiredness abnormally	53 (55.8%)	32 (33.7%)	0.002*
2- Palpitations even with no exertion.	42 (44.2%)	12 (12.6%)	<0.001*
3- Painful tingling in some body parts.	45 (47.4%)	15 (15.8%)	<0.001*
4- Irritated without any reason	12 (12.6%)	0 (0.0%)	0.512#
5- Depressed without any particular reason.	12 (12.6)	0 (0.0%)	0.512#
6- Problems with concentrating.	61 (64.2%)	9 (9.5%)	<0.001*
7- Feels to have short memory.	55 (57.9%)	25 (26.3%)	<0.001*
8- Perspiration without any particular reason.	15 (15.8%)	5 (5.3%)	0.02*
9- Find a problem with buttoning\ unbuttoning.	12 (12.6%)	2 (2.1%)	0.01#
10- Hardly get the meaning of written ideas.	9 (9.5%)	2 (2.1%)	0.091#
11- Relatives told you about your short memory.	43 (45.3%)	15 (15.8%)	<0.001*
12- Feel of oppression	22 (23.2%)	5 (5.3%)	<0.001*
13- Make notes to remember	52 (54.7%)	23 (24.2%)	<0.001*
14- Go back to check things you`ve done	62 (65.3%)	25 (26.3%)	<0.001*
15- Headache once a week at least	66 (69.5%)	33 (34.7%)	<0.001*
16- Less interested in sex than normal	5 (5.3%)	0 (0.0%)	0.213#
Yes answers >6 questions	53 (55.8%)	3 (3.2%)	<0.001#

*Chi-Square test #Fisher exact test

The relationship between AChE and symptoms multiplicity was statistically significant as level of enzyme depletion was higher among farmers having 6 or more neurological symptoms with mean level of 25.71 U/g (AChE/Hg) versus 28.01 U/g among farmers with less symptoms (Table **4**).

Table (4): Levels of AChE assessed among farmers with more than 6 positive neurological symptoms and other group:

AChE (U/ml)	Farmers with >6 yes symptoms (N=53)	Farmers with <6 yes symptoms (N=42)	P* value
AChE (U\ml)	2.52 ± 0.61	2.92 ± 0.33	0.003
Q (AChE/Hb), U/g	25.71± 2.87	28.01 ± 2.45	<0.001
Hemoglobin g\L	10.51± 2.33	11.54 ± 1.12	0.01

*Independent t-test statistically significant at p ≤ 0.05

DISCUSSION

When compared farmers to controls who were not exposed to pesticides at work, our study showed that farmers had a much higher frequency of neurological health complaints, which is likely due to pesticide exposure with a high risk of cholinesterase inhibition. The purpose of this study was to evaluate the neurological health problems linked to pesticide exposure in farmers who use pesticides.

In our study, the majority of the studied farmers and their controls were men (90.5 percent and 83.2 percent, respectively), and because both groups were matched, there was no statistically significant difference between them. In addition, 72.6 percent of the studied farmers worked in the agricultural field for more than eight hours per day, and 31.6 percent of them had used pesticides for more than ten years. Only 12.6% of the farmers in the study wore personal protective equipment (PPE) while spraying pesticides, the most frequent chemicals being organophosphate and carbamate. (Table **1**). In line with our study, a study conducted in the central Republic of Benin discovered that 94.32 percent of farmers were men and 5.68 percent were women. It attributed this to the unique cultural and rural beliefs, according to which only men were required to engage in farm work while women were responsible for housework [(12)]. Another study conducted in Brazil by **Pasiani *et al.*** [(13)] revealed that 99.1% of the farmers investigated were men. According to a research by **Hinson *et al.*** [(12)], farmers do not find it comfortable to use PPE at all, with only 4.15 percent of them using gloves and 3.4 percent wearing face masks.

This investigation discovered widespread usage of WHO Class II moderately dangerous pesticides with little or no personal protective equipment or even hygiene standards. Even though they possessed the necessary information about the potential risks associated with pesticide use, agricultural workers had poor levels of pesticide handling hygiene standards, in accordance with **Pasiani *et al*** study [(13)] and other studies carried out in low-income nations that have revealed the PPE's rare use [(14, 15)]. According to studies, the poor usage of PPE may be a result of low money, lack of training, low education level, pesticide dealers that do not promote or sell PPE, limited awareness, and discomfort [15, 16].

The statistically significant substantial decline in AChE activity is a glaring indicator of farmers' exposure to carbamate and organophosphate (OP) pesticides. According to the current study, farmers' mean average Q level (AChE/Hb) was lower than that of their controls, who had a mean concentration of 32.12 ± 2.55 U/g. (Table 2). The findings were in agreement with a study done in Nepal on acute intoxication of pesticide use among vegetable farmers, whereby the mean was 28.92 U/g versus 30.1 U/g among their controls [9], and also another study done in Arusha region on flower and onion pesticide applicators showing a higher depletion of AChE level among onion farmers with mean level of 25.15 U/g due to lack of hygienic protective measures [17].

Our study sheds light on the use of pesticides by farmers in the Sharkia governorate areas and the associated neurological health concerns. Moreover, half of the farmers in the study (55.8%) had six or more types of neurological health complaints associated to pesticide use. This result was supported by the results of a study on pesticide use practices and safety issues conducted in Nigeria and another study on flower and onion farmers conducted in the Arusha region of Tanzania, which both reported that, respectively, about 80% and 75% of farmers experienced discomforts like headaches, fatigue, loss of concentration, short-term memory loss, tingling, vomiting, nausea, and skin problems, especially after using pesticides [17, 18].

This current study revealed that 55.8% of studied farmers felt abnormally tired during their days, 44.2% had palpitations regularly even without exertion, 47.4% had painful tingling, 64.2% complained of problems with concentration and 57.9% complained of short memory versus 33.7%, 12.6%, 15.8%, 9.5% and 26.3% respectively among their controls with a high significant difference among both groups (Table **3**). These results were similar to those of a study on the health effects of agrochemicals conducted in Zimbabwe's Kwekwe district, where farm workers in commercial farms reported headache (66.7 percent), cold/flu (62.2 percent), weakness (45.9 percent), dizziness (41.1 percent), and skin irritation (39 percent)[19]. Additionally, the research in the Arusha region discovered that a group of pesticide applicators from onion fields who had been exposed to high levels of pesticide had greater rates of physical weakness (91.1%), headaches (58.9%), dizziness (53.6%), and irritability (46.4 percent)[17].

The relationship between AChE and symptoms multiplicity was statistically significant as level of enzyme depletion was higher among farmers having 6 or more neurological symptoms with mean level of 25.71 U/g (AChE/Hg) versus 28.01 U/g among farmers with less symptoms (Table 4). In a research on onion farms pesticide applicators conducted in Tanzania, it was discovered that out of the 24 pesticide applicators who reported feeling unusually fatigued, 20 (83.3%) had AChE levels below the normal range and 4 (28.6%) had levels within the normal range. Additionally, among the floral pesticide applicators with AChE levels below the normal range, excessive perspiration (45.6%), body heaviness (36.8%), and headaches (26.5%) happened more often [17].

CONCLUSION

According to our study, Egyptian farmers have a significant frequency of neurological problems that could be caused by pesticide exposure. Farmers had a lower mean hemoglobin-adjusted AChE level than the controls. The frequency of symptoms and low level of AChE were explained by working in the agriculture industry, which requires direct contact with pesticides combined with less training, less understanding, less PPE use, and longer exposure times.

Financial support and sponsorship: Nil.
Conflict of interest: Nil.

REFERENCES

1. **Kapeleka J, Lekei E, Hagali T (2016):** Pesticides exposure and biological monitoring of Ache activity among commercial farm workers in Tanzania: A case of tea estates. Int J Sci Res., 5(9): 1708–1713.
2. **Ngowi A, Mrema E, Kishinhi S (2016):** Pesticide health and safety challenges facing informal sector workers. New Solut., 26(2): 220–240.
3. **World Health Organization (WHO): (2004):** Children are facing high risks from pesticide poisoning. Geneva, Switzerland: WHO. https://apps.who.int/mediacentre/news/notes/2004/np19/en/index.html
4. **Buckley N, Karalliedde L, Dawson A *et al.* (2004):** Where is the evidence for treatments used in pesticide poisoning? Is clinical toxicology fiddling while the developing world burns? J Toxicol Clin Toxicol., 42:113–116.
5. **De Jong K, Boezen H, Kromhout H *et al.* (2014):** Pesticides and other occupational exposures are associated with airway obstruction: The Life Lines cohort study. Occup Env Med., 71(2): 88–96.
6. **Perry M (2008):** Effects of environmental and occupational pesticide exposure on human sperm: A systematic review. Hum Reprod Update, 14(3): 1–10.
7. **Mhauka A, Mdegela R, Nonga E (2014):** Assessment of pesticide exposure pathways on humans in Mang'ola ward, Karatu District – Arusha. https://www.suaire.sua.ac.tz/handle/123456789/615.
8. Diane R, Ahmed A, Gaafar A *et al.* (2014): Characterizing exposures and neurobehavioral performance in Egyptian adolescent pesticide applicators. Metabol Brain Dis., 29(3): 2-5.
9. Dinesh N, Erik J, Lars B (2014): Pesticide use, erythrocyte acetylcholinesterase level and self-reported acute intoxication symptoms among vegetable farmers in Nepal: a cross-sectional study. Environ Health, 13: 98.

https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-13-98

10. **Bast-Pettersen R (2006):** Self-reported conceptions of memory and concentration in comparison with the neuropsychological test performance of manual workers. Scand J Work Environ Health, 2(2): 41–46.
11. **Lundberg I, Hogberg M, Michelsen H *et al.* (1997):** Evaluation of the Q16 questionnaire on neurotoxic symptoms and a review of its use. Occup Environ Med., 54: 343–350.
12. **Hinson A, Dossou F, Lawin H *et al.* (2017):** Risk Factors of Pesticide Poisoning and Pesticide Users' Cholinesterase Levels in Cotton Production Areas: Glazoué and Savè Townships, in Central Republic of Benin. Environ Health Insights, 11: 1-10.
13. **Pasiani J, Torres P, Silva J *et al.* (2012):** Knowledge, attitudes, practices and biomonitoring of farmers and residents exposed to pesticides in Brazil. Int J Environ Res Public Health, 9:3051–3068.
14. **Atreya K, Sitaula B, Overgaard H *et al.* (2012):** Knowledge, attitude and practices of pesticide use and acetylcholinesterase depression among farm workers in Nepal. Int J Environ Health Res., 22(5):401–415.
15. **Khan D, Shabbir S, Majid M *et al.* (2010):** Risk assessment of pesticide exposure on health of Pakistani tobacco farmers. J Expo Sci Environ Epidemiol., 20:196–204.
16. **Esechie J, Ibitayo O (2011):** Pesticide use and related health problems among greenhouse workers in Batinah Coastal Region of Oman. J Forensic Leg Med., 18(5):198–203.
17. **Suten G, Ezra J, Aiwerasia V *et al.* (2018):** Health Symptoms Associated with Pesticides Exposure among Flower and Onion Pesticide Applicators in Arusha Region. Ann Glob Health, 84 (3): 369-379.
18. **Tijani A (2006):** Pesticide use practices and safety issues: The case of cocoa farmers in Ondo State, Nigeria. J Hum Ecol., 19: 183–190.
19. **Magauzi R, Mabaera B, Rusakaniko S *et al.* (2011):** Health effects of agrochemicals among farm workers in commercial farms of Kwekwe District, Zimbabwe. Pan Afr Med J., 9: 26. doi: 10.4314/pamj.v9i1.71201.