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Original article

Adverse biochemical effects of various pesticides on sprayers of cotton fields in El-Behira Governorate, Egypt

Moustafa A. Abbassy[a], Abd El-Salam Mohamed Marei[b], Mohamed Aatef Mohamed Al-Ashkar[a], Abdel-Tawab H. Mossa[c,*]

[a] Department of Plant Protection, Faculty of Agriculture, Damanhour University, Egypt
[b] Pesticide Chemistry Department, Faculty of Agriculture, Alexandria University, Egypt
[c] Environmental Toxicology Research Unit (ETRU), Pesticide Chemistry Department, National Research Centre (NRC), Tahrir Street, Dokki, Cairo 12311, Egypt

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ABSTRACT

A total of 60 healthy pesticide sprayers (smokers and non-smokers) in cotton fields exposed to different classes of pesticides for many years were compared with controls matched for age with respect to serum cholinesterase (ChE), serum total protein, alkaline and acid phosphatases (ALP and AP), lactate dehydrogenase (LDH), gamma-glutamyl transferase (GGT), creatine kinase (CK), blood glucose, serum hormones FSH, testosterone and L-thyroxine (T4). Significant increase was observed in serum ALP, AP, LDH, GGT, CK, serum hormones FSH, testosterone, L-thyroxine and blood glucose. Significant decrease in serum total protein and ChE. The increase or decrease in the tested biomarkers was more pronounced in the smokers than non-smoker workers. These results suggest that the long-term exposure of various pesticides on sprayers of cotton fields affect the normal functioning of different organ systems and may produce characteristic clinical effects.

1. Introduction

Humans interact with their environments on a daily basis and, as a consequence, are exposed to a broad spectrum of synthesized chemicals present in the food they eat, the air they breathe, and the water they drink. A wide range of synthetic pesticides have been released into the rural environment through the agricultural activities to control the agricultural pests, insect pests, plant pathogens and weeds in both developed and developing countries.

Pesticide formulations are complex mixtures which contain, besides the active ingredient(s), several other components, such as solvent, wetting and emulsifying agents, and additives [1]. Furthermore, it is typical of various agricultural uses of pesticides that different formulations are simultaneously used that varying combinations are applied depending on the time of the growing season [2]. This makes the exposures complex, and the biomonitoring of specific compounds for exposure evaluation may become difficult. The possible combined toxic effects of such complex exposures are not usually known. Thus, toxicity information concerning active ingredients or formulates alone is not sufficient to evaluate the risk of adverse health effects from pesticide exposure [3].

In Egypt, workers involved in spraying are exposed to a number of pesticides during the handling, mixing and filling of pesticide formulations into mixing containers and spraying equipments. They are also exposed to pesticide aerosols in course of their work. Protective devices, such as respirators, gowns, gloves and boots are generally not used. Also, it is exceedingly plausible that less controlled and regulated uses of pesticides may offer the greatest opportunity for exposure to toxicicologically significant quantities. Studies on the adverse effects of pesticides on the Egyptian pesticide sprayers and farm workers are scant.

Most of annually consumed pesticides in El-Behira Governorate, Egypt were used for control of cotton pests. Therefore, this study was carried out to investigate whether the long-term exposure to pesticides, mainly organophosphorus, carbamates and pyrethroids, had harmful effects on the health of the most important factors in development of environment, farm workers and pesticide sprayers in terms of their serum biochemical variables.

2. Materials and methods

2.1. Population and sampling

The current study was conducted at 60 male agriculture workers ranging in age from 30–45 years from Damanhour regions at El-Behira Governorate. The basis of selection was to exclude those with past or present history of liver diseases or past history of

* Corresponding author. Tel.: +202 33371211; fax: +202 33370931.
E-mail addresses: abdeltawab.mossa@yahoo.com, mossa_nrc@yahoo.com (A.-T.H. Mossa).

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previous acute pesticide intoxication. This was achieved by personal interview included questions regarding frequency, extent of occupational, smoking and clinical examination of workers by a physician (Damanhour hospital). The Hospital and University of Damanhour, Human Subjects Review Committee approved the study procedures, and all subjects provided their informed consent. Agriculture workers were divided into three categories, each divided into two sub-categories (smokers and non-smokers) as follow: category (I) pesticide sprayers which directly exposed to pesticide (smokers and non-smokers), category (II) farm workers which partially exposed to pesticide (smokers and non-smokers) and category (III) non-exposed individuals (smokers and non-smokers) and served as control.

2.2. Blood samples

Sample of blood from medial vein was obtained by using sterilized disposable syringes from each selected individual. The blood samples were allowed to be clotted and then centrifuged at 3000 rpm (600 g) for 10 minutes using BOECO model C-28, Germany, to separate the serum. The sera was kept in a deep freezer (−20 °C) until analyzed within one week.

2.3. Serum enzymes

Alkaline phosphatase (ALP) was determined according to the method of Rec [4], lactate dehydrogenase (LDH) according to Cobaud and Warblewski [5], cholinesterase (ChE) according to Waber [6] using Diamond Diagnostics Kits. Acid phosphatase (APs) was determined according to the method of Moss [7] using Quimica Clinica Aplicda S, A. Kits. Gamma-glutamyl transferase (GGT) was determined according to the method of Szasz [8,9] using Linear Chemicals, S. L. Kits. Creatine Kinase (CK) was according to the method of Rosalki [10] using Stanbio Laboratory Kits. The absorbance of each samples were measured using Jenway 6305 UV/Vis spectrophotometer.

2.4. Blood glucose

Blood glucose was measured colorimetrically using the Glucose meter Accoutered alpha apparatus. Complete drop of blood was dropped on to the yellow test pad without touching the yellow mesh directly and the blue color was measured directly with the apparatus. Sugar concentration was expressed as mg/dL. A normal value for fasting blood glucose is considered as 70–110 mg/dL.

2.5. Total protein

Total protein was determined according to the method described by Henry [11] using Boehringer Mannheim Gmbh Diagonstics Kits. This method depends upon a photometric determination of protein forms where, a colored complex with cupric ions in an alkaline medium is formed.

2.6. Serum hormones

Follicle stimulation hormone (FSH) was determined according to the method of Rebar et al. [12], testosterone according to Tietz [13] and L-thyroxine (T4) Hormone according to [14] using International Immuno Diagnostics Kits.

2.7. Statistical analysis

The results were expressed as means ± S.E. All data were done with the Statistical Package for Social Sciences (SPSS 17.0 for windows). The results were analyzed using one way analysis of variance (ANOVA) followed by Duncan's test for comparison between different treatment groups. Statistical significance was set at $P \leq 0.05$.

3. Results

Serum alkaline and acid phosphatases (ALP and APs) were found to be significantly elevated in smoker pesticide sprayers (269.20 vs. 115.00 u/L and 11.66 vs.4.60 u/L) and non-smokers (229.96 vs. 128.50 u/L and 9.20 vs. 5.56 u/L) and smoker farm workers (204.83 vs. 115.00 u/L and 10.06 vs. 4.60 u/L) and non-smokers (169.40 vs. 128.50 u/L and 7.39 vs. 5.56 u/L), respectively (Table 1). ALP activity in serum of pesticide sprayers showed 2.34 and 1.78 folds increase in comparison to control subjects, respectively. The mean value of serum LDH was found to be significantly elevated only in smoker pesticide sprayers (222.66 vs. 181.20 u/L) and farm workers (196.26 vs. 162.06 u/L) and all of the obtained LDH values were inside its normal values (120–240 u/L) in normal persons (Table 1).

The mean values of serum GGT were found to be significantly elevated in smoker and non-smoker pesticide sprayers and smoker farm workers (30.70 vs. 11.60 u/L, 21.30 vs. 10.23 u/L and 26.86 vs. 11.60 u/L) when compared to controls. GGT activity in serum of smoker and non-smoker pesticide sprayers showed 2.64 and 2.08 folds increases, while smoker farm workers showed 2.62 fold in comparison to control subjects (Table 1). Serum ChE activity was found to be significantly decreased in smoker and non-smoker pesticide sprayers and smoker farm workers (1837.20 vs. 2186.10 u/L, 1996.33 vs. 2276.23 u/L and 1993.33 vs. 2186.10, respectively) compared to controls (Table 1). However, the differences in mean values of serum ChE levels in control groups of smoker and non-smokers were statistically significant (2186.10 vs. 2276.23 u/L), respectively (Table 1).

Results of glucose in serum showed that the mean value of glucose was significantly elevated in the serum of smoker and non-smoker pesticide sprayers (110.00 vs. 81.33 mg/dL and 98.66 vs. 87.00 mg/dL) and farm workers (104.00 vs. 81.33 mg/dL and 84.33 vs. 87.00 mg/dL, respectively). On the other hand, there were significant differences in glucose content between the smoker and non-smoker groups (81.33 vs. 87.00 mg/dL) and all of the obtained values were inside its normal values in normal persons (Fig. 1). Results in Fig. 2 revealed that total protein was significantly decreased in smoker and non-smokers of pesticide sprayers and farm workers (4.68 vs. 7.26 and 6.29 vs. 7.7 mg/dL and 6.53 vs. 7.26 and 7.00 vs. 7.7 mg/dL), respectively. Total protein was significantly decreased in smoker controls compared to non-smoker controls (7.26 vs. 7.70 mg/dL). Serum creatine Kinase activity was found to be significantly increased in smoker; non-smoker

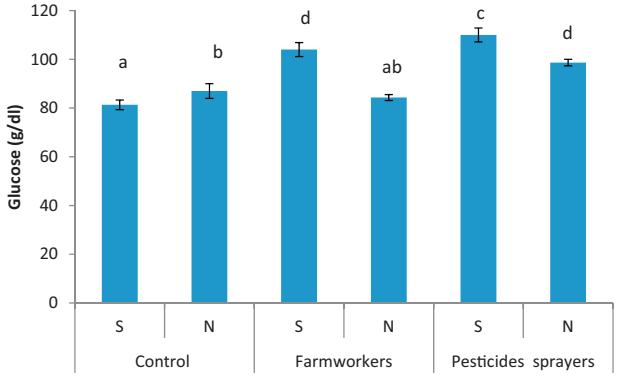

Fig. 1. Serum glucose (g/dL) of agriculture workers from Damanhour regions at El-Behira Governorate, Egypt. S: smoker; N: non-smokers. Bars represent the group means ± S.E., $^{a, b, c, d}$ values are not sharing superscripts letters (a, b, c, d) differ significantly at $P \leq 0.05$.