

Effect of pesticides on kidney function and serum protein profile of farm workers in Gaza Strip

MAGED MOHAMED YASSIN¹, TAHA ABDULLAH AL-SHANTI²

¹Department of Physiology, Faculty of Medicine, The Islamic University of Gaza, Palestine; ²Medical Technology Department, Faculty of Science, Al-Aqsa University, Gaza, Palestine

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Introduction

Pesticide is a chemical or biological substance that is intended to prevent, repel or destroy pests that may damage or disturb the growth and health of living organisms which may be plants or animals. These pesticides are classified based on their origin or structure or pests they control the mode/ site of action as insecticides, rodenticides and fungicides [1]. Pesticides are being extensively used in agricultural sector in the Gaza Strip. More than 544.4 metric tons of pesticides are used annually in the Gaza Strip, a small highly dense populated area of 365 km² that is divided into five governorates: North, Gaza, Mid-Zone, Khan Yunis and Rafah [2].

Pesticides can enter the human body through inhalation, ingestion and dermal exposure [3]. Older farm workers have been exposed to pesticides for a longer time throughout their life. Toxicity symptoms of pesticides may include respiratory, neurological, gastrointestinal and skin problems [4]. According to World Health Organization, approximately 25 million pesticide poisoning cases occur annually among agricultural workers in developing countries [5]. In the Gaza Strip, several cases of death were reported as a result of pesticide poisoning [6].

Correspondence to: Prof. Maged Mohamed Yassin

Email: myassin@iugaza.edu.ps

ABSTRACT

Objective: To assess the impact of pesticides on kidney function and serum protein profile of farm workers in the Gaza Strip.

Methods: The study included 96 farm workers exposed to pesticides as well as 96 non-exposed controls from different Governorates of the Gaza Strip. Farm workers and controls were age and sex matched. Blood samples were collected from all farm workers and controls to assess kidney function through determination of urea, creatinine and uric acid and to measure serum protein profile including total protein, albumin and globulin.

Results: Kidney function test showed significant elevation in serum urea and creatinine concentrations in farm workers compared to control group ($P < 0.05$). However, uric acid exhibited no significant difference between farm workers and controls ($P > 0.05$). Serum total protein, albumin and globulin were significantly increased in farm workers as compared to controls ($P < 0.05$). In general, serum urea and creatinine concentrations were the function of farm workers' age and work duration.

Conclusion: The results of the present study confirm that pesticides exposure affects farm workers causing alterations with significant values in some biochemical parameters including urea, creatinine, total proteins, albumin and globulin.

KEY WORDS:

Pesticides
Kidney function
Serum proteins
Farm workers
Gaza Strip

Exposure to pesticides may produce biochemical changes even before the clinical health manifestations that may appear in the sprayers [7,8]. These biochemical changes may result from destructive and degenerative changes caused by pesticides in many organs including kidneys [9,10]. In addition, alterations in biomarkers of kidney function were also documented [11]. Various studies had indicated that

farm workers exposed to pesticide showed significant increase in serum concentrations of urea and creatinine [12,13].

The impact of pesticides on protein profile of agricultural farmer workers was also assessed. In general, impairments in protein metabolism as a result of pesticide exposure were documented [14]. However, the results were contradictory. Higher levels of total proteins were found in pesticides-exposed Tunisian agricultural workers as well as in Greek farmers compared with non-exposed controls [15,16]. On the other hand, lower levels of serum total protein and albumin were registered in Indian and Thai pesticides sprayer farmers compared to controls [17,18].

Although pesticide problems have been identified as a major environmental health problem in the Gaza Strip [19], very few studies have assessed the health impact of pesticides on farm workers [20]. To our best knowledge, the present study is the first to investigate the effect of pesticides on kidney function and serum protein profile of farm workers in the Gaza Strip.

Materials and methods

Study population

The study population comprised farm workers using pesticides and non-exposed controls from different governorates of the Gaza Strip: North, Gaza, Mid-Zone, Khan Yunis and Rafah Governorates. The Sample size included 96 farm workers and 96 controls aged between 20-60 years. Farm workers and controls were age and sex matched.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Local Ethics Research Committee. All subjects provided written informed consent prior to the study.

Blood sampling and processing

Venous blood samples (about 5 ml) were taken by venipuncture from each subject into vacutainer tubes from the exposed farm workers as well as from controls. Samples were left without anticoagulant to allow blood to clot. Se-

rum samples were obtained by centrifugation at room temperature by Rotina 46 Hettich centrifuge, Japan at 4000 rpm/10 minutes. Serum samples were then used for biochemical analysis.

Biochemical analysis

Serum urea was determined by using colorimetric test using DiaSys reagent kits [21]. Serum creatinine was measured by kinetic test without deproteinization using DiaSys reagent kits [22]. Serum uric acid was determined by enzymatic photometric test with TBHBA (2, 4, 6-tribromo-3-hydroxybenzoic acid) using DiaSys reagent kits [23]. Serum total protein was measured by means of the Biuret reaction using DiaSys reagent kits [24]. Serum albumin was measured with bromocresol green using DiaSys reagent kits [25]. Serum globulin was calculated according the following formula: Globulin= Total protein – Albumin

Statistical analysis

Data were computer analyzed using SPSS/ PC (Statistical Package for the Social Science Inc. Chicago, Illinois USA, version 18.0) statistical package. The independent sample t-test procedure was used to compare means of quantitative variables by the separated cases into two qualitative groups such as the relationship between farm workers and controls urea. The one-way ANOVA test was applied for analysis of variance. The results were accepted as statistical significant when the p-value was less than 5% ($p < 0.05$). The percentage of change was calculated using means of controls - farm workers / controls x 100. Excel program 2007 was used for chart graphs plotting.

Results

Effect of pesticides on serum urea, creatinine and uric acid

Table 1 and figure 1 indicate the effect of pesticides exposure on serum urea, creatinine and uric acid concentrations of farm workers in Gaza Strip. The mean levels of urea and creatinine were significantly increased in farm workers compared to controls. However, uric acid showed no significant difference between farm workers and controls. The most affected farm workers were from Rafah Governorate.

Table 1. Serum urea, creatinine and uric acid concentrations of controls and farm workers in different Governorates of Gaza Strip.

Governorate	Group	Urea (mg/dl)	Creatinine (mg/dl)	Uric Acid (mg/dl)
North	Control	23.6 ± 5.2	0.75 ± 0.10	4.5 ± 0.6
	Farm workers	31.2 ± 5.5	0.81 ± 0.10	4.4 ± 0.1
	% of change	32.2	8.0	-2.2
	P value	< 0.05	< 0.05	N.S.
Gaza	Control	23.5 ± 3.9	0.76 ± 0.11	4.6 ± 1.1
	Farm workers	28.2 ± 3.9	0.82 ± 0.10	4.2 ± 1.4
	% of change	20.0	7.9	-8.7
	P value	< 0.05	N.S.	N.S.
Mid-Zone	Control	24.7 ± 5.9	0.7 ± 0.09	5.2 ± 1.1
	Farm workers	29.4 ± 3.4	0.9 ± 0.12	4.9 ± 1.2
	% of change	19.0	28.6	-5.8
	P value	< 0.05	< 0.05	N.S.
Khan Yunis	Control	24.4 ± 5.8	0.8 ± 0.09	4.9 ± 1.2
	Farm workers	29.2 ± 3.5	0.9 ± 0.11	4.8 ± 1.3
	% of change	19.7	12.5	-2.0
	P value	< 0.05	< 0.05	N.S.
Rafah	Control	21.6 ± 4.3	0.71 ± 0.10	4.6 ± 1.0
	Farm workers	31.9 ± 4.8	0.92 ± 0.13	5.0 ± 1.6
	% of change	47.7	29.6	8.7
	P value	< 0.05	< 0.05	N.S.
Gaza Strip (total)	ANOVA	1.888	3.504	1.265
	P value	N.S.	<0.05	N.S.
	Control	23.4 ± 5.1	0.74 ± 0.10	4.75 ± 1.03
	Farm workers	30.1 ± 4.6	0.87 ± 0.11	4.68 ± 1.27
	% of change	25.0	16.1	-1.5
	P value	< 0.05	< 0.05	N.S.

All values are expressed as mean ± SD. P = probability, P < 0.05: significant, P > 0.05: not significant (N.S).

Effect of pesticides on serum total protein, albumin and globulin

Table 2 and figure 2 revealed that the mean levels of serum total protein, albumin and globulin of pesticides-exposed farm workers were significantly higher than those of controls. Farm workers from the North Governorate were the most affected.

Effect of pesticides on serum urea, creatinine and uric acid of farm workers with regards to their age.

Serum urea, creatinine and uric acid concentrations of pesticide-exposed farm workers in the Gaza Strip with regards to their age are illustrated in table 3. Significant increases in urea and creatinine concentrations were found in all age

categories of farm workers compared to controls. On the other hand, there were significant decreases in uric acid concentrations in farm workers groups of less than 30 years and more than 45 years.

Effect of pesticides on serum total protein, albumin and globulin of farm workers with regards to their age.

Table 4 points out the effect of pesticides on serum protein profile of farm workers in the Gaza Strip with regards to their age. The mean levels of total protein and globulin were significantly increased in all age groups of farm workers compared to controls. This significant increase was observed for albumin but in farm workers groups aged less than 30 years and 31 - 45 years.

Table 2. Serum total protein, albumin and globulin of controls and farm workers in different Governorates of Gaza Strip.

Governorate	Group	Total protein	Albumin	Globulin
North	Control	6.5 ± 0.4	4.0 ± 0.3	2.5 ± 0.5
	Farm workers	7.2 ± 0.3	4.4 ± 0.2	2.8 ± 0.2
	% of change	10.8	10.0	12.0
	P value	< 0.05	< 0.05	< 0.05
Gaza	Control	6.8 ± 0.4	4.2 ± 0.2	2.6 ± 0.4
	Farm workers	7.0 ± 0.3	4.3 ± 0.2	2.7 ± 0.2
	% of change	2.9	3.4	3.8
	P value	N.S.	N.S.	N.S.
Mid-Zone	Control	6.6 ± 0.3	4.1 ± 0.1	2.5 ± 0.4
	Farm workers	6.9 ± 0.2	4.2 ± 0.2	2.9 ± 0.3
	% of change	4.5	2.4	16.0
	P value	< 0.05	N.S.	< 0.05
Khan Yunis	Control	6.7 ± 0.4	4.0 ± 0.2	2.7 ± 0.4
	Farm workers	7.0 ± 0.2	4.1 ± 0.1	2.9 ± 0.2
	% of change	4.5	2.4	7.4
	P value	< 0.05	N.S.	< 0.05
Rafah	Control	6.6 ± 0.4	4.0 ± 0.1	2.7 ± 0.4
	Farm workers	7.0 ± 0.2	4.3 ± 0.6	2.8 ± 0.5
	% of change	6.0	7.5	3.7
	P value	< 0.05	< 0.05	N.S.
Gaza Strip (total)	ANOVA	4.039	4.553	2.161
	P value	< 0.05	< 0.05	N.S.
	Control	6.6 ± 0.37	4.04 ± 0.17	2.59 ± 0.41
	Farm workers	7.4 ± 0.25	4.50 ± 0.31	2.83 ± 0.29
	% of change	11.4	10.8	8.9
	P value	< 0.05	< 0.05	< 0.05

All values are expressed as mean ± SD. P = probability, P < 0.05: significant P > 0.05: not significant (N.S).

Table 3. Effect of pesticides on serum urea, creatinine and uric acid concentrations of farm workers in Gaza Strip with regards to their age.

Age	Group	Urea	Creatinine (mg/dl)	Uric Acid
Less than 30	Control	22.7 ± 3.2	0.70 ± 0.1	4.8 ± 1.0
	Farm workers	29.1 ± 4.3	0.89 ± 0.1	4.2 ± 1.3
	% of change	28.2	27.1	-12.5
	P value	P < 0.05	P < 0.05	P < 0.05
31 - 45 year	Control	24.6 ± 4.8	0.81 ± 0.1	4.8 ± 1.1
	Farm workers	30.7 ± 6.5	0.94 ± 0.1	5.0 ± 1.2
	% of change	24.8	16.0	4.2
	P value	P < 0.05	P < 0.05	N.S.
More than 45	Control	19.2 ± 2.4	0.69 ± 0.1	4.9 ± 1.3
	Farm workers	30.1 ± 4.6	0.91 ± 0.1	4.4 ± 0.7
	% of change	56.8	31.9	-11.4
	P value	P < 0.05	P < 0.05	P < 0.05
	ANOVA	1.060	1.501	4.732
	P value	N.S.	N.S.	P < 0.05

All values are expressed as mean ± SD. P = probability, P < 0.05: significant, P > 0.05 not significant (N.S).

Table 4. Effect of pesticides on serum total protein, albumin and globulin of farm workers in Gaza Strip with regards to their age.

Age	Group	Total protein	Albumin (gm/dl)	Globulin (gm/dl)
Less than 30	Control	6.6 ± 0.4	4.1 ± 0.2	2.6 ± 0.4
	Farm workers	7.1 ± 0.2	4.2 ± 0.3	2.9 ± 0.3
	% of change	7.6	2.4	11.5
	P value	P < 0.05	P < 0.05	P < 0.05
31 - 45	Control	6.6 ± 0.4	4.0 ± 0.2	2.6 ± 0.4
	Farm workers	7.0 ± 0.3	4.2 ± 0.2	2.8 ± 0.2
	% of change	6.1	5.0	7.7
	P value	P < 0.05	P < 0.05	P < 0.05
More than 45	Control	6.7 ± 0.3	4.1 ± 0.1	2.5 ± 0.3
	Farm workers	7.1 ± 0.2	4.2 ± 0.5	2.8 ± 0.4
	% of change	6.0	2.4	12.0
	P value	P < 0.05	N.S.	P < 0.05
	ANOVA	0.622	0.267	0.360
	P value	N.S	N.S	N.S

All values are expressed as mean ± SD. P = probability, P < 0.05: significant, P > 0.05 not significant (N.S).

Table 5. Serum urea and creatinine of farm workers in relation to work duration of pesticides use in Gaza Strip.

Work duration	Group	Urea	Creatinine
Less than 7	Control	23.4 ± 5.1	0.70 ± 0.10
	Farm workers	28.4 ± 3.9	0.83 ± 0.10
	% of change	21.4	18.6
	P value	P < 0.05	P < 0.05
7 - 14	Control	23.3 ± 5.1	0.70 ± 0.10
	Farm workers	30.0 ± 4.6	0.88 ± 0.11
	% of change	28.8	25.7
	P value	P < 0.05	P < 0.05
More than 14	Control	23.4 ± 5.1	0.69 ± 0.10
	Farm workers	31.9 ± 4.1	0.90 ± 0.12
	% of change	36.3	30.4
	P value	P < 0.05	P < 0.05
	ANOVA	36.723	30.653
	P value	P < 0.05	P < 0.05

All values are expressed as mean ± SD. P= probability, P<0.05: significant.

Effect of pesticides on serum urea and creatinine of farm workers in relation to work duration.

As demonstrated in table 5, there were significant increases in the mean concentrations of urea and creatinine of farm workers during all work duration intervals < 7, 7 - 14 and > 14 years compared to controls. The longer the work duration, the higher percentage of increase in urea and creatinine concentrations was observed.

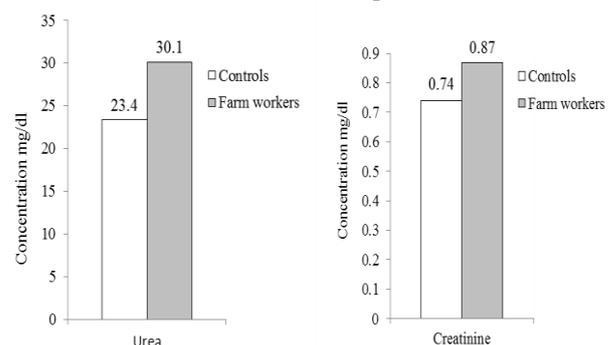
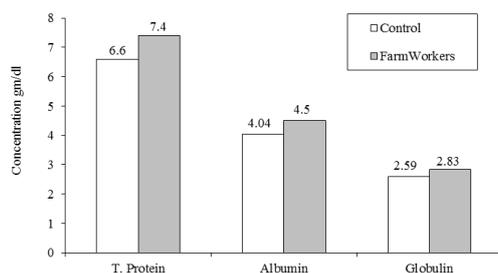
Figure 1. Serum urea and creatinine concentrations of controls and farm workers in Gaza Strip.

Figure 2. Serum total protein, albumin and globulin of controls and farm workers in Gaza Strip.



Discussion

The role of pesticides in the development of diseases in humans is still controversial, despite their important use and their widespread diffusion. In the present study, information of health effects of pesticides on farm workers in the Gaza Strip was provided. The mean levels of urea and creatinine were significantly elevated in pesticide-exposed farm workers compared to controls. However, uric acid showed no significant difference between farm workers and controls. The most affected farm workers were from Rafah Governorate. Previous studies reported significant elevation in serum urea and creatinine concentration in pesticide-exposed workers and such elevation was referred to renal damage and disturbance of kidney function [12,13, 26]. Serum levels of urea and creatinine were shown to be of clinical value that denotes renal impairment in pesticide-exposed farmers [27]. Urea is formed by deamination of amino acids in the liver, and then it is transported by blood to the kidneys where it is excreted with urine [28]. Elevation of serum urea observed in the present study in response to pesticides exposure may be explained by: 1) impairment in its synthesis as a result of impaired hepatic function, 2) disturbance in protein metabolism as found in the present results and 3) decrease in the filtration rate of the kidney. In this context, it was documented that excessive exposure to pesticides caused cytotoxic changes in the hepatic and renal biochemical markers which were positively correlated with pesticide residue [29].

Creatinine is a waste product that is normally filtered from the blood and excreted with urine. Increase in creatinine level in response to pesticide exposure indicates renal disease and may be a result of impaired glomerular function [11,30]. In the same context, several authors attributed the

elevation of urea and creatinine in pesticide-exposed workers on the basis of tubular renal insufficiency, impaired glomerular filtration, urinary tract obstruction and kidney damage [26,31].

Concerning protein profile, the results demonstrated a significant increase in the mean levels of serum total proteins, albumin and globulin of farm workers exposed to pesticides compared to controls. Farm workers from the North Governorate were the most affected. These findings are in agreement with that obtained by other researchers who reported higher levels of total proteins in pesticide-exposed agricultural workers compared with non-exposed controls [15, 16]. However, other authors reported lower levels of serum total protein and albumin in pesticides sprayer farmers [17, 18]. Nevertheless, the present results do confirm impairments in protein metabolism as a result of pesticide exposure. Serum protein concentrations may be altered due to the toxic effects of pesticides through impairment of protein synthesis by hepatocytes and disturbance of kidney function [26,32].

As indicated in the present results, serum urea and creatinine concentrations were the function of farm workers' age and work duration i.e. the older the farm workers and the longer the work duration, the higher the percentage of increase in urea and creatinine was observed. Similar results were reported in the literature [12,15]. The older farm workers tend to be engaged in pesticide activities for a longer period throughout their life. It is accepted that, the risk of illness increases as the concentration (strength) of the pesticide and duration (length) of exposure increase [33].

Conflict of Interest

We declare that we have no conflict of interest.

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