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Endosulfan exposure effects on health of farmers in Sindh Province of Pakistan

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Abstract

Endosulfan usage in agriculture sector may be related to the increasing rate of morbidity in exposed population. Many studies earlier reported its toxicity symptoms in the spray workers but the lack of national research and hard data on farmers has hindered efforts to improve their health. Therefore it was aimed to investigate this problem through some epidemiological and biochemical parameters. Farmers (n=158) exclusively working with endosulfan sprays in agriculture sector and volunteer controls (n=150) unexposed to any pesticides were selected and surveyed for protective measures and symptoms after exposure. Blood and urine samples of both groups were investigated and data obtained were statistically analyzed for t-test.

Present study revealed that 48.24% farmers adapted "respirator" and "sunglasses" for their protection during spray, while symptoms reported by them were remarkable. Findings of the biochemical analysis were highly significant. Total protein, urea, creatinine and calcium levels in the farmers' serum were different as compared to controls. Whereas in urine; protein, creatinine and sodium were also highly significant while calcium values in urine found different at significant level. That indicates the effects of endosulfan on health of the farmers. This work concludes the farmers at greater risk of health hazards in case of endosulfan exposures. Therefore, further use of this pesticide product may be avoided in either condition very intensive care is suggested.

Keywords: Endosulfan, Exposed farmers, Sindh Pakistan

1. Introduction

The massive use of pesticides like endosulfan in farming system in Sindh province, has produced higher yields and greater wealth but on the other hand created many health problems in farmers. Chabra *et al.*, 1970., Proctor and Hughes, 1978., Watterson, 1988., Malik, 1990., Osorio *et al.*, 1991., Pengali *et al.*, 1994., Nicolson 1995., SHEC, 1999, have reported toxicity symptoms often severe and/or lethal, induced by exposure of the pesticide products exclusively and in classified groups. Organochlorine pesticides including endosulfan were being used globally due to its efficacy against a variety of insects. However, due to its toxicity to humans it has been either restricted for use or banned in many countries. Despite this it is reported as the most used pesticide product in Sindh province of Pakistan (Soomro *et al.* 2003a).

As observed the farmers being sprayworkers mostly avoid the protective equipments, therefore, are more prone to pesticide intoxication. Kidd and James, 1991. Smith, 1991, report highly toxic effects of endosulfan necessitating the solid protective measures. Insufficient data are available for sub-acute or chronic exposure to endosulfan in human subjects; however, such toxicity studies of endosulfan in animals suggest that the liver, kidneys, immune system, and testes are the main target organs (ATSDR, 2000). It also causes growth reduction and changes in blood chemistry (Stephen, 2001). Such risks produce the hazards to health, hence the introduction of endosulfan is found responsible for significant number of death among the farmers (Ton, *et al.* 2000 and Tovignan, 2001).

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The lack of national research and data on farmers has hindered efforts to improve their health (NAC1993). This study was aimed at exploring the reasons of declining health status of the farmers. In this connection different approaches exist which detect the effects by epidemiological surveys and testing blood and urine of exposed and unexposed population. Hence the objective of this work was to find out the effects of endosulfan on the health of the farmers by conducting survey for protective measures, toxicity symptoms in the exposed farmers and biochemical investigation of blood and urine samples as ascertain the degree of toxicity (Bertell 1999).

2. Methodology

Farmers (n=158) those who were exclusively the spray workers for 'endosulfan' and the age matched normal volunteer controls (n=150) unexposed to any sort of pesticides were selected from various areas of Sindh province of Pakistan. Both groups were studied during cropping seasons in the year 2004-2005. Initially exposed farmers were interviewed with the help of a questionnaire; asked about the type and tools of protective measures taken by them. While keeping in view the common epidemic symptomatology, all the farmers were questioned about developing symptoms concurrently. Both the groups were mentally prepared and 5 ml of blood was collected by vein-puncture method, transferred to sterilized screw capped glass tubes. It was allowed to clot, and then centrifuged at 3000 G for serum biochemical tests. The farmers and controls were further advised to wash their groin properly and void mid stream urine. After voiding urine in sterilized 50 ml screw capped glass bottles, the samples were analyzed for the proposed tests.

Serum was analyzed for total protein, urea, creatinine and sugar levels while urine samples were analyzed for protein, urea, creatinine and sugar. Both serum and urine specimen were also investigated for the electrolytes which include the calcium, potassium and sodium concentrations.

All the chemical reagents and kits used for biochemical analysis were purchased from Merck Company Germany. Spectronic 20 (Bouch and Lumb) was used for manual determination of each parameters and company suggested protocols were followed accordingly. The electrolytes were determined by flame analyzer (Perkin-Elmer). The experimental data was processed on SPSS version 8.0

3. Results

Epidemiological data show that 48.24% of the exposed farmers adapted only two types of self protection tools during sprays; towel-mask as 'respirator' and 'sunglasses'. Distribution of the farmers for these protective measures is given in Figure 1. Health status of both groups of the farmers recorded in terms of specified symptomatology simultaneously, in existing similar environmental conditions. Table 1 shows number and percentage of farmers with and without symptoms which were observed by author and as stated by study groups. According to present data 94.93% exposed and 18% unexposed controls reported different symptoms during study.

Serum and urine samples of the farmers and controls were examined with help of some biochemical parameters and data obtained were analyzed statistically by t-test. Mean, standard deviation and probability for each test are summarized in Table 2 and 3.

Figure 1. Percentage of farmers for adapting the protective measures

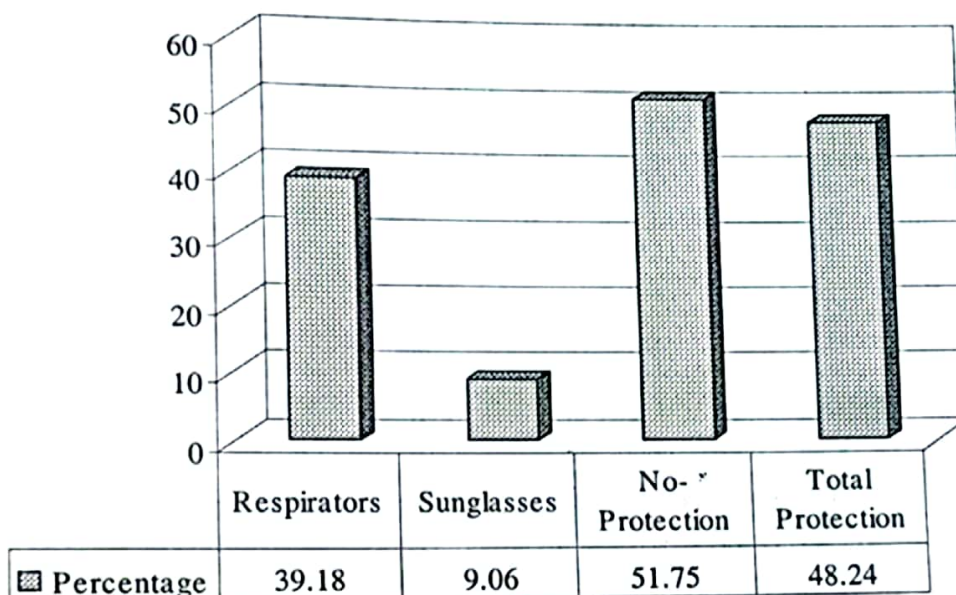


Table 1. Number and Percentage of farmers and Controls with and without Symptoms

Symptoms	Farmers (n=158)	Controls (n=150)
Body itching	13 (8.23)	00
Difficulty in breathing	14 (8.86)	04 (2.67)
Face burning	08 (5.06)	00
Fits	01 (0.63)	00
Flu	06 (3.80)	05 (3.34)
General weakness	15 (9.50)	08 (5.33)
Headache	20 (12.66)	07 (4.66)
Heavy head	20 (12.65)	01 (0.67)
Nausea	05 (3.16)	00
Sinking of heart	14 (8.86)	00,
Unconsciousness	02 (1.27)	00
Vertigo	30 (18.98)	02 (1.34)
Vomiting	02 (1.27)	00
No symptoms	8 (5.06)	123 (82)

Table 2. Effect of endosulfan on Serum Biochemical Parameters

S. No.		Farmers Mean \pm S.D	Controls Mean \pm S.D	p - value
1	Total protein m/dl	2.88 \pm 0.52	7.44 \pm 1.33	0.001
2	Urea mg/dl	61.13 \pm 11.54	29.70 \pm 5.46	0.001
3	Creatinine mg/dl	3.32 \pm 0.53	0.87 \pm 0.21	0.001
4	Sugar mg/dl	95.91 \pm 10.90	99.71 \pm 16.10	N.S
5	Calcium mmol/l	1.40 \pm 0.30	2.27 \pm 0.25	0.001
6	Sodium mmol/l	146 \pm 7.91	140 \pm 4.17	N.S
7	Potassium mmol/l	4.95 \pm 0.59	4.15 \pm 0.88	N.S

N.S = Non-significant

Table 3. Effect of endosulfan on Urine Biochemical Parameters

S. No.		Farmers Mean \pm S.D	Controls Mean \pm S.D	p - value
1	Protein mg/24 hr	74.88 \pm 5.75	38.53 \pm 10.81	0.001
2	Urea g/24hr	37 \pm 2.48	28 \pm 6.25	N.S
3	Creatinine g/24hr	12.22 \pm 2.34	1.67 \pm 0.30	0.001
4	Sugar mg/dl	17.40 \pm 1.73	9.98 \pm 3.30	N.S
5	Calcium mmol/l	8.13 \pm 1.88	9.78 \pm 3.18	0.01
6	Sodium mmol/l	120.77 \pm 21.09	142.4 \pm 31.68	0.001
7	Potassium mmol/l	34.18 \pm 3.81	58.70 \pm 15.92	N.S

N.S = Non-significant

4. Discussion

Findings of this work show that the self protective measures were ignored by farmers. Figure 1 indicates that 48.24% of farmers protected themselves by cloth mask (respirator) and/or sunglasses only which indeed were insufficient, whereas rest of them did not apply any sort of protection during complete process of pesticide sprays. Hence, it was not possible to wear 'protective kit' that is commonly recommended and adapted in advanced countries. Therefore the poor protecting behavior shown by the local farmers was their compulsion that is commonly reported in third world countries (Kishi, *et al.*, 1995), though not encouraging.

Endosulfan dermal absorption is rapid and its bioaccumulation increases due to its lipophilic property. This could be one reason for change in biochemistry and development of symptoms in the exposed farmers. In present work thirteen symptoms were recorded in the farmers while control group has six similar symptoms which were in lower percentage. Therefore symptoms reported in the farmers under this work can be considered as effects of endosulfan consistent with the reports by Merck (1993) and Venkateswarlu *et al.* (2000).

In biochemical investigation, serum total protein and urine proteins were analyzed and their values found significantly different as

compared to the controls (Table 2 and 3). Proteins by their functions undergo variations in different physiological and pathological conditions as studied by some authors (Alper, 1974 and Anderson, *et al.* 1997). This work shows serum total proteins decreased, which indicate the disruption of protein metabolism in the farmers. Such depletion has been reported in line with many pesticides induced in various animals (Mehle, *et al.* 1971., Kozlovskaja, *et al.* 1979., Swarup, *et al.* 1981., Murthy, *et al.* 1982.)

However, the endosulfan exposures have increased the protein in urine with significant difference in its values (Table 3) in the farmers as compared to the controls. This appeared to indicate the effects of endosulfan on glomerular functions of the kidneys in farmers rather than the other organs.

Urea the end product of protein metabolism, excreted out in urine, falls in acute renal impairment while its concentration at serum level rises rapidly. In the intrinsic renal disease, the glomerular filtration rate diminishes and leads to urea retention that may rise its serum level. Decrease in serum urea is seen in severe liver disease with destruction of cells leading to impairment of the urea cycle (Alan, 1996). Endosulfan turn up the serum urea increase in the farmers at highly significant level ($p < 0.001$) as shown in Table 2, hence urea values in urine statistically were not affected (Table 3). Therefore, this reveals the toxic effect of endosulfan on renal functions only. That is seen in animal studies indicating kidney damage with increased level of urea in serum samples (Shakoori, *et al.* 1987).

Above parameters indicated the renal effects of endosulfan in the exposed farmers since creatinine is more a reliable guide of renal function as it is almost completely filtered at the glomerulus and is not reabsorbed in renal tubules. Reduction in creatinine values is caused by conditions of acute glomerulonephritis, shock, hypovolemia and nephrotoxic chemicals. In present work the serum and urine creatinine concentration is

shown increased in the endosulfan exposed farmers at highly significant level ($p < 0.001$) as revealed in Table 2 and 3. In comparison with control values this increase has confirmed the renal impairment in the farmers under this study.

Glucose is main carbohydrate substrate, stored as glycogen in muscle and liver. When peripheral tissues need it the glycogen is converted to glucose and transported to them via blood. The endosulfan intoxication has been reported for hyperglycemic effects in animals (Bhatia, *et al.* 2002) and in the suicide attempting farmers (Soomro, *et al.* 2003b). Satish, *et al.* (1972) studied the organochlorines group of pesticides and reported the impairment in the uptake of glucose by the tissues during acute intoxication in rats. Both the reported conditions indicate significant toxicity, whereas this study on farmers dismantles the endosulfan effects as non-significant (Tables 2 and 3). Therefore previous reports and present results indicate that the chronic and/or continuous exposure to endosulfan do not induce gluconeogenesis or glycogenolysis which may change its blood concentrations.

Among electrolytes; calcium is an important constituent of blood, its ionized form is of great value in the function of heart, nerves and in permeability of membrane (Nicholas, 1932. and Logan, 1940). Kanis (1996) reported that 'stress' causes transient increase in plasma parathromone and calcium. Presently, reduced calcium concentrations in farmers' serum and urine were at significant level as shown in Tables 2 and 3. This recorded effect may be due to endosulfan exposures.

Sodium is major action, which maintains the osmotic pressure of body fluids and regulates the acid base balance thus protects the body against excessive fluid loss (Harper, 1971). Hamilton (1982) reported that total body fluids volume depends on sodium and potassium ions present in fluids. Table 2 shows that the endosulfan exposures have not affected the sodium concentration in serum. But the differences in its values in urine found highly significant ($p < 0.001$) as shown in Table

3, which indicates the physiological changes towards the toxic effects of this pesticide in the farmers.

Serum potassium increases in adrenal cortical insufficiency, renal failure, anemia, dehydration and cellular break down. Its greater concentration (hyperkalemia) was seen as a direct complication of acute poisoning. In an animal study Rangwaswamy (2002) reported significant alterations in the ionic compositions of the blood including potassium at sub-lethal doses of endosulfan. In this work no significant differences in the values of serum and urine potassium were detected between farmers and the controls as revealed in the Tables 2 and 3.

5. Conclusion

Farmers under study were seen at greater risk of health hazards in case of endosulfan exposures. Increasing rate of toxic effects was due to inadequate protective measures, which can be observed from the reported symptoms and significant biochemical changes in the studied population. Therefore this work may be considered as indicator to avoid further use of endosulfan, in either condition very intensive care is suggested.

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