



ISSN: 2348-5906  
CODEN: IJMRK2  
IJMR 2017; 4(3): 38-43  
© 2017 IJMR  
Received: 06-03-2017  
Accepted: 07-04-2017

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## Knowledge, attitude and practices among malaria control program spray-workers in Gezira state, central Sudan, towards the use, application and hazards of insecticides

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### Abstract

Insecticides have serious impact on humans, animals and environment. However, using insecticides in agriculture and public health is considered to be an easy way to control pests. This study was conducted in Gezira state (population 4 million), central Sudan, during the period November 2014- November 2016, investigating the knowledge attitude and practice (KAP) of 394 Malaria Control Program (MCP) workers about the insecticides and the personal protective equipment (PPE). Data was collected via a questionnaire, an interview and observation. The results showed that 65.2% of the spray-men are daily-paid (seasonal), <18 to >51 yr-old. Over 50% of them had education below high school, whereas >15% can hardly read. Those who had training before and during the job were > 96%, while those who were using the PPE properly were 78%. However, around 30.2% of the workers showed symptoms of poisoning, and 12.4% showed symptoms of different diseases that might relate to insecticides effect. Moreover, 24.3% of the spray-men were not under close supervision, consequently, this resulted in 21.6% of them not using all PPE items. Therefore, seasonal workers must be subjected to intensive training and closer supervision before and during the job. MCP must establish training unit that adopts the concept of continuous in-service training and up-dating.

**Keywords:** Knowledge, attitude, practice, KAP, pesticides, spray workers, Gezira state, Sudan, in-service training

### 1. Introduction

Malaria remains one of the most serious public health problems in Africa, causing high morbidity. In highly endemic areas, malaria is responsible for about 20- 30% fever cases. Globally, the malaria situation is serious and getting worse [1]. In the Sudan, also malaria is one of the leading causes of morbidity and mortality. Reported malaria cases accounts for 9.3% of outpatients, clinic visits and approx. 8.7% of hospital admission [2]. The disease proportional mortality is 2.6%, while overall country reported case fatality rate of 0.64%, and an annual reported malaria incidence of 3.57% of population. It is estimated that 75% of the population (*i.e.* 24 million) are at risk of malaria, while the entire population are at risk of malaria epidemic in the country [2, 3]. Transmission is seasonal and depends on rainfall (June/July-October / November), except in urban cities and irrigated schemes, which may have another transmission during winter (December –February). *Plasmodium falciparum* is responsible from >95% of malaria cases in the Sudan. However, an increase in *P. vivax* cases has been reported. Prevalence of malaria in the Sudan has been reduced from 3.7% to 1.8%, in the years 2005 and 2009, respectively, according to community-based surveys. Moreover, malaria cases have been reduced from 7.5 million in 1990 to 1.2 million in 2011 [2-7]. One of the major malaria control methods is using insecticides against the vectors, namely *Anopheles* mosquitoes. However, insecticides proved to have negative impacts on humans, animals and environment. Pesticides are important public health tools that are used to prevent vector-borne disease (VBDs) and to increase food supplies. Studies have demonstrated acutely toxic effects at high doses, as well as chronic effects at low levels of exposure [8]. Being the principle polluters and victims of pollution, farmers, mixers and application worker (spray-men) are at the top of the risk.

The WHO and the UNEP estimated pesticide poisoning rates of 2-3 /min, with approx. 20,000 workers dying from exposure every year; the majority in developing countries [9, 10]. Researchers have concluded that farm workers in developing countries will continue to use pesticides in increasing quantities because of the lack of alternatives, ignorance of the sustainability of pesticide use, and the weak enforcement of regulations and laws on pesticide use [11-13]. The case is not different in public health. Workers' knowledge of hazards is important for the prevention of acute and chronic poisoning. Erroneous beliefs can seriously impair workers' capacity to protect themselves against the risks of pesticides [14, 15]. Various policies have been designed to protect workers and minimize exposure to pesticide residues. These policies regulate the time of re-entry into fields after the application of certain chemicals in agriculture and rely extensively on workers to engage in self-protective behavior, such as wearing protective clothing to minimize their risk of exposure. Most of the results in agriculture and public health showed that workers have reasonably good knowledge, but it still has to see, to what extent that knowledge is being used practically. It could possibly be the useful study in order to make them not to expose pesticides with improper method of usage [2]. Most of the reported symptoms of insecticide use are considered to be common manifestations of acetyl cholinesterase-inhibiting (AChE) insecticides [16-18]. These findings require urgent prevention, intervention, and protection to prevent the risk. The organophosphate (OP) and carbamate insecticides, such as methamidophos, methomyl, dimethoate, omethoate, fenitrothion and malathion were commonly used and these are classified as highly hazardous. EPA has ranked chemical exposures of agricultural workers as one of the most significant environmental hazards affecting human health in the U.S [12].

Exposure to pesticide residues can be substantial during an agricultural season; as many as 300,000 seasonal workers may experience pesticide-related illnesses during a given year [13]. The few studies that are available on chronic or low-level pesticide exposure suggest that limb-reduction birth defects [19], childhood leukemia [20], brain tumors [21], sterility, spontaneous abortion, and adult lymphomas and lymph sarcomas [22] may be linked to occupational exposure to pesticides. Prolonged low-level exposure to pesticide residues has been associated with an increased risk of various negative health outcomes, including anemia, asthma.

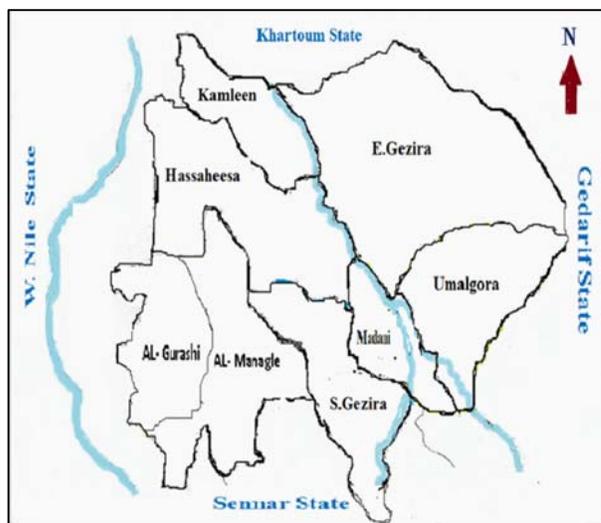
A KAP analysis conducted in India [23] disclosed that, while 70% of respondent's perceived pesticide spraying affects a person's health, only 40% were aware that it affects the environment. Two thirds of the respondents were aware that pesticide enters the body through nose and affects lungs. Awareness on other modes of entry was less. About 42% of farmers had good knowledge regarding pesticide. Between 40 and 70% of respondents was not using any PPE during spraying. Significant association was observed between knowledge of the farmers and their practices related to pesticides. The present work objective was to investigate how MCP workers are benefiting from the in-service training.

## 2. Materials and methods

### 2.1 Study area

The Gezira state (latitude 13 N, and 15 N), lies in the rich savanna region in the central part of the Sudan; a population

of 5,037,586, and its area is 27,549 km<sup>2</sup>. The Gezira agricultural Scheme (2.2 m acres) is irrigated by gravity through a canalization system from Sennar Dam in the south on the Blue Nile river (10,000km of major canals and 30,000 km of minor canals) is the biggest agricultural scheme in the world under one administration. Moreover, there is about seven million acres depend on rains. The main occupation of the inhabitants in the state is agriculture, depending on the short rainy-season from July to mid-October (about 225mm/annum), and on irrigation for the rest of the season. The climate in the state is characterized in the summer by an average daily temperature of 32 °C and relative humidity (RH) of 20%, and cool dry winter from December to March, with an average daily temperature of 22 °C and 30% R.H. [19]. The state (map), is one the largest cotton plantations in the world represented by the Gezira Scheme and the Rahad Agricultural Corporation (RAC; about 300,000 acres). They also grow wheat, sorghum, groundnuts and vegetables. Cotton, vegetables and sometimes wheat receive insecticidal applications. The field crops applications are conducted by aerial spraying under the supervision of the entomologists since season 1950/51. Vegetable farms are sprayed by the farmer himself or by hired labor. Gezira is one of the major endemic areas for malaria [26]. The MCP of the Gezira state is in-charge of controlling the malaria vectors and other insects of medical importance. The MCP covers all the state towns and villages. The habitat in the Gezira is quite suitable for malaria vectors. Irrigation canals, broken water pipes, rain pools and ponds are available most of the year. Moreover, the inhabitants do not have enough awareness about the practices that prevent the breeding of mosquitoes inside their houses (water coolers, water containers, etc.) [25].



### 2.2 Sampling Strategy and Sample Size

The study covered all insecticide spray-men/workers (394) of MCP, covering the eight administrative localities after receiving the ethical approval from Ministry of health of the state.

### 2.3 Data Collection

Data was collected using a questionnaire, observations and interview. The questionnaire dealt with knowledge, attitudes and practices (KAP) among the 394 workers, who are spraying insecticides, whether in the houses (IRS) or the

breeding sites (larviciding). Observations during the campaigns were taken and when needed photographed. Interview with some officials of MCP was conducted to be more acquainted with the policy and practices of the ministry

**2.3.1 The questionnaire**

This was constructed to have three sections. These were: General information about the worker, his knowledge (K) and understanding in the area of the insecticides, and his practices (P) during and after spraying.

The first part (general) covered the age, the state of his job (permanent or seasonal / daily paid), the educational level, and the diseases he is suffering from, if applicable, whether acute or chronic.

The second section focused on his knowledge about the hazard of these chemicals and the consequences of the misuse and abuse of such toxic compounds; the training he received before and/or during his job (in-service training), and the importance of the personal protective equipment (PPE).

The third section of the questionnaire was about his actual practices during his work, e.g. his commitment to the PPE, punishment in case not abiding by the regulations concerning PPE, washing hands with water and soap before eating or drinking, taking a bath after finishing his job, washing his spraying garment after spraying, and if he had experienced any poisoning symptoms before.

**2.3.2 Observations**

During the campaigns, i.e. IRS or the breeding sites, observations were taken regarding the PPE, practices, the conduct and behavior during mixing, loading of sprayer, spraying method, post-spraying, cleaning the sprayer after finishing the job, etc. Photographs were taken for better demonstration and documentation of the cases to be discussed later.

**2.3.3 Interview**

This was conducted with MCP officials in the HQ, focused on whether or not the administration avails all the required PPE items and provides it to all worker? Also about the follow-up to see to it if the workers are using them or not. Moreover, the interview focused on the training type, contents, regularity and especially regarding the equipment, the use, the hazard and risk of insecticides, in addition to, to what extent the program is satisfied with the workers performance regarding the use of PPE, the equipment and the handling of the insecticides.

**2.4 Data Analysis**

Data was analyzed manually in terms of percent of the total and presented in tables

**3. Results**

The study revealed the that 3.3% of the workers are in the age group <18 yr; 50% between 31 and 50 yr, followed by the age-group 18-30 yr-old (30.7%). That is to say around 80% of them are older than 18 yr and younger than 50yr. Those who are above 51 yr-old were 16% (Table 1). The table also revealed that 65.2% of these workers were not permanent workers (seasonal or daily-paid) and 34.8% of them were permanent. Regarding the educational background, the table showed that 4.1% of the workers were illiterate, 11.2% Kahlua education (religious education), 35% of them with basic/

primary education (up to 8<sup>th</sup> grade), 36.5% at least completed their high school education, and 13.2% of them with higher degrees, viz. under-graduate diploma. Regarding their current health condition, >87% confessed that they have no diseases or at least did not complain of any of the specified diseases. Allergies scored 9.6%; skin and eye diseases percentages were very low (0.5%), however, the cancer cases did not exceed 0.25%, i.e. one worker only.

**Table 1:** General information about the workers participated in the questionnaire (345 worker)

		Number	%
Age	< 18 yr	13	3.3
	18 – 30 yr	121	30.7
	31 – 50yr	197	50.0
	> 51yr	63	16.0
Job	Daily paid	257	65.2
	Permanent	137	34.8
Level of education	Illiterate	16	4.1
	Kahlwa (religious Education)	44	11.2
	Basic (1-8 yr)	138	35.0
	Secondary school (11 yr)	144	36.0
	Higher education (Diploma or B.Sc.)	52	13.2
Current Diseases	Allergies	38	9.6
	Cancer	1	0.25
	Eye diseases	2	0.5
	Skin diseases	2	0.5
	Hair color change	6	1.5
	No disease	345	87.6

Table (2) revealed that 85.0% of workers described insecticides as toxic and dangerous substances, and 13.7% of them said that insecticides may cause some health problem(s). However, 0.5% said that they don't know about the toxicity of the insecticides. Three of this population (0.8%) were quite sure that insecticides are not harmful and may not cause harmful effects on their health.

The study showed that 96.7% of the group (Table 2) were trained theoretically and practically by the MCP about the requirements of this job before starting to deal with these insecticides and actually participate in any campaign. Approximately 3.3% claimed that they did not have any kind of training before handling the job. Regarding the reasons behind wearing the PPE during spraying, table (2) also showed that 72.8% of the respondents used PPE to protect their body from insecticide danger, and 24.1% used PPE as a uniform". However, 3% stated clearly that they don't know exactly why they are wearing it.

**Table 2:** Awareness, types of training and importance of using personal protective equipment (PPE).

	Response	Number	%
Awareness about toxicity of the insecticide used	Toxic and dangerous	335	85.0
	May cause some health problems	54	13.7
	No harmful effect on health	3	0.8
	I don't Know	2	0.5
Type of Training received	Theory	381	96.7
	Practical	381	96.7
	None	13	3.3
Importance of PPE	Body protection from insecticides danger	287	72.8
	Just a uniform	95	24.2
	Don't Know exactly	12	3.0

Table (3) showed that 74.4% of the workers stated that they are using all the PPE items to protect themselves from the insecticide danger, and 5.1% confessed that they do not use all the recommended PPE items. Those who opted to say "sometimes" are 20.5% of this group. In response to the question of whether they will be subjected to some sort of punishment, in case they did not use the PPE,

**Table 3:** Practices of the workers during the job

Practice	Response	Number	%
Use of PPE	Yes, I do	293	74.4
	Sometimes	81	20.5
	No	20	5.1
Punishment if not using PPE	Yes	298	75.6
	Sometimes	86	21.8
	No	10	2.5
Reasons for washing hands	To avoid reaching to stomach	330	83.7
	For eating	51	12.9
	Just habit	13	3.3
Bathing after finishing the job	Yes	332	84.3
	Sometimes	44	11.2
	No	18	4.6
Washing coveralls / garments	Yes, every day	355	90.1
	Sometimes	35	8.9
	No	4	1.0

75.6% stated that they were actually subjected to punishment, whereas 2.5% claimed that they were not subjected to any kind of punishment. However, 21.8% of the spray-men said "sometimes".

When it comes to the issue of hand-washing, table (3) also revealed that 83.7% of the workers reasoning for washing hands after spraying was to remove any insecticides from their hands so as to prevent the insecticide from reaching their gut, and 12.9% of the workers said they wash their hands for eating as usual. Some of the respondents (3.3%) said "it is just a habit", i.e. has nothing to do with using insecticides.

The results also showed that 84.3% of these workers claimed taking a bath after finishing their work, and 4.6% are not. The rest stated that sometimes they do so (Table 3). When it comes to washing the suite/ garment, part of PPE items, after each working day, table(3) showed that 90.1% of them indicated that they are washing their garments on daily-basis after the end of the daily work and 1.0% are not.

The answer for the rest (8.9%) of the workers was sometimes they wash it. Regarding the symptoms of insecticides poisoning among this group of spray- men, 20% indicated that they suffered from headache, 8.4% suffered from vomiting and 69.8% did not suffer from any symptoms of insecticides poisoning (Table 4).

**Table 4:** Disease symptoms described by participants, which they attributed to the nature of their job (viz. insecticides)

Symptoms of	No. of workers suffering	%
Headache	79	20.0
Vomiting	33	8.4
Fainting	2	0.5
Dizziness and imbalance	5	1.3
none	275	69.8

The interview results with officials of the MCP in the Gezira State, the officials claimed that all the PPE items are available, every worker is provided with one set and trained

about their importance and usage. The officials also emphasized that they train all the workers about their job requirements, pesticides, spraying techniques, hazards, risks, etc. When something new becomes available, up-dating is conducted. The officials also, according to the structure of the administration, have supervisors who are in-charge of the teams. Their job is to see to it that the workers are using the PPE properly, performing the IRS and the larviciding following the standard instruction, evaluating the performance of each worker, correcting those who are not following the instructions, revising the dose, etc.

The observations during the campaigns showed that some of the spray-men are abiding by the instructions starting from preparing the dose up to the washing of their garments. Several photographs were taken showing all the mistakes, especially when it comes to the use of all PPE items, boots, masks, gloves, in addition to the coveralls (garments) where some of them are leaving the first buttons near the neck unbuttoned because of the heat. Moreover, some workers were spraying the room without removing all the furniture or the cooking utensils.

**4. Discussion**

Malaria control worker anywhere, especially in the developing countries, are working under very risky and difficult conditions. As expected, most of them are not educated. Gezira state workers are no exception (Table 2 ).Their knowledge about pesticides is very weak. Even some of them do not believe that these chemicals are toxic. Several studies were conducted in the Sudan, especially with agricultural sector workers. Such level of educational background (Khalwa, elementary or high school) is not expected to make such group of workers appreciate the health-effect of these toxicants, their importance, benefits, hazard, health and environmental impact, etc. Most of the seasonal workers do not think that they need to be trained, because "it is just a temporary job". But the question is, what is the role of the MCP in such a case? Most of these workers are not acquainted with The Code of Conduct of pesticides (WHO and FAO. The present work revealed that 80.7% of these workers are between the age 18-50 (Table 1), which means that they are mature enough to be properly trained. Even if not trained, they should have asked to be trained, before dealing with pesticides. However, the issue of being a permanent or daily-paid or a seasonal worker is an important issue from the viewpoint of experience and accumulation of it by time. The authorities must deal with it seriously. According to CAC [27], Sacramento, employees must be trained before handling pesticides. Moreover, CAC stated that training must be continually updated to cover any new pesticides before handling, and repeated at least every 12 months. The training must be performed by qualified persons and covers all required outlines. The results of the observations showed several mistakes. These could be attributed to the type of training, contents of the training, delivery of the contents or the trainee himself. Therefore, it really important to look at these seriously since it is expected that exposure will increase with the increase of mistakes, wrong-doings or ignoring the instruction. Consequently, the death or disease incidence might be increasing, especially for the chronic diseases. It was also noted that First-Aid Kits were not available with teams.

In the study conducted in the Northern State of the Sudan during April to September (2008) by Abdalla [2], 99% of the spray-men received training before conducting IRS campaigns. The author stated that their performance in general is weak in all aspects of chemical insecticide applications (larviciding, residual and space spraying).

The collected data (Table 1) indicated that 65.2% of the workers were not permanent workers. Consequently, they will need to be subjected to the required intensive training regarding the insecticides they will be using, their formulations, toxicities, application and application rates, IRS, larviciding, protection and precautionary measures, *etc.* This is the responsibility of the MCP from the viewpoint of protecting them as humans, and protecting the community by catering for the expected mistakes and mishaps and accidents by such workers. Training is time-consuming and costly. It is a waste of time and money to train seasonal or daily-paid worker, since they may leave the job any time. Knowledge is cumulative, especially for those who have a permanent job. Therefore, it is preferred that the MCP to have permanent spray-men, who can be trained and up-dated while they are in-service. It is also important to have training unit or division within this administration with personal files for each worker showing the training he received and the future required research for him as a requirement for quality control and quality assurance. Fortunately, the results showed that 84.7% of the worker in the Gezira are at an acceptable level of education (Basic, secondary and Diploma, Table 1), which will help and must encourage the administration to conduct continuous training sessions to improve the performance and avoid the mistake noted in the observations section of the results. Such a level of education allows the worker to read the label (in Arabic) at least and color coding system [28, 29].

With regard to the diseases, 87.6% of the workers in the Gezira State MCP stated that they did not complain from any diseases since they started in this job (Table 1). But, 12.4% showed some diseases, which can be attributed to ignoring the use of the PPE in full or some items. The diseases were in terms of symptoms, headache (*ca.* 20%), vomiting (approx.. 8%), and fainting (0.5%; Table 4). These symptoms are shared with other diseases, *e.g.* malaria. It is worth mentioning that 5% of this group stated that they don't know that insecticides are dangerous, even though 96.7% of them confessed that they were trained theoretically and practically. Training must deal with this area with elaboration. Khartoum state study by Edris [3] revealed that >7% also do not know about insecticides toxicity. These results, compared to the agriculture workers [27], reflected that by far the MCP workers are in a better position.

Edris [3] in his assessment of the use of safety protective measures (PPE) among spray workers in Khartoum State (the capital of the Sudan) revealed that only 41% of the staff were medically examined before joining MCP and only 42% of them were doing cholinesterase (ChE) tests annually. However, 91% of the respondents of Khartoum group said that they are aware of the importance of using PPE, as well as the availability of PPE was for 67.7% only in Khartoum State. The study showed that a number of 449 (69.1%) of the respondents used PPE, whereas the present study showed only 74.4% use in the Gezira, >20% use it "sometimes", and *ca.* 5% do not use it at all. The author reported that 71.5% of Khartoum workers clean their clothes regularly. About 32.9%

of the spray- workers clean their clothes every day. In the Gezira, approx.90% claimed to wash every day, around 9% said "sometimes", and 1% said "no". In Khartoum, surprisingly, 6.2% of the respondents said that they buy PPE, because it protects them. This is logical since 92.6% of the respondents in Khartoum believe that insecticides are hazardous chemicals, compared to 85% in the Gezira State, where no one claimed to have bought any of the PPE components. Moreover, to our surprise, 27.2% of spray-men in the Gezira group stated that they do not know the reason behind giving them the protective clothes. This is a significant percentage of these workers, and must be considered during the training process.

Some items of the PPE were either ignored purposely or not properly used as shown in some photographs during the campaign, *e.g.* the masks, the gloves, the foot-ware. Some worker were wearing slippers (locally known as *sefinja*) when spraying in the presence of the supervisors and their feet were fully covered with the color of the insecticide (dermal exposure). Others were not protecting their chests as a result of not using the buttons of the top of the coveralls because of the heat. So it is very important to make all spray-men appreciate the importance of each item, and the health consequences of not using them. The issue of heat can be resolved with the textile industry.

The supervisors are expected to be responsible of all the activities and the personnel during the campaigns. They must check before- hand the workers, if they are abiding by the regulations and the PPE. However, our results revealed that 24.3% of the spray- men are not as expected. That is, they are not using the PPE regularly or partially. Moreover, they are sure that they will not be punished. This issues also must be dealt with seriously by the MCP officials.

Workers, during the day, before finishing their assignments, need to eat, drink, *etc.* Table (3) showed that 83.7% of the spray- men wash their hands before eating to remove insecticides residues from reaching their stomach. However, 12.9% stated that they do it for eating, the rest (3.3%) said they do it as a habit. Soap must be available during the campaign, otherwise, washing with water only is not enough for removing pesticides from different chemical groups and different formulations from their hands or skins. The supervisor must make sure that the worker is using the soap in washing his hands [23].

The results (Table 3) also showed that only 84.3% of the workers take a path after the end of the daily work. These worker confessed that sleeping with their contaminated clothes and bodies will cause to them a very serious diseases or poisoning. However, the 15% of the workers who are not washing their bodies after their work or those who said "sometimes" must be dealt with both administratively and during the training sessions. It is not a small percentage to be ignored. The same must be applied with the 9.9% who stated that they do not care about washing the spraying suit/coveralls (Table 3) at the end of the working day. It is preferable that they take the bath immediately after finishing their work in the nearest place, *e.g.* the last house to be sprayed.

According to their response to the questionnaire, 30.2% of workers said they had symptoms of insecticides poisoning. The symptoms were mentioned above and the diseases they complained from allergies, skin diseases, eye diseases, and only one of them is suffering from cancer (0.25%).

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