



Libyan Journal of Public Health Practices (LJPHP)

Journal homepage: <https://journals.uob.edu.ly/LJPHP>
ISSN (Online) 3008-1467



Research article

Comparison of Integrated Pest Management Knowledge, Attitude, and Practice among staff members of Four Major Hospitals in Benghazi

Fawzeia H. Elmhalli¹, Samira S. Garboui*¹, Naser H. Ibrahim², Rania N. Ali³, Faiza A. Awad³, Yasmine A. Ibrahim³

¹Department of Infectious Disease, Public Health Faculty, University of Benghazi, Libya

²Department of Nutrition, Public Health Faculty, University of Benghazi, Libya

³Department of Environmental Health, Public Health Faculty, University of Benghazi, Libya

ARTICLE INFO

Article history:

Received 10/8/2024

Revised 20/10/2024

Accepted 26/10/2024

Available online xxxx

Keywords:

IPM

Knowledge

Practice

Attitude

Hospitals

ABSTRACT

Pests in the hospital environment pose a significant risk to the safety of patients and staff. While pesticides are commonly used to control pests, they can lead to additional problems. Therefore, alternative procedures such as Integrated Pest Management (IPM) have gained attention. This study aimed to assess hospital staff knowledge, practice, and attitudes regarding IPM in four major hospitals in Benghazi. A cross-sectional study used a questionnaire and checklist to collect the data from the participants. The results indicated that all hospitals showed low IPM knowledge and practiced widespread pesticide use. The Surgical and Emergency Hospital (SEH) demonstrated significantly higher IPM knowledge, practice, and attitude scores than the other three hospitals ($p = 0.000$), with a mean of 4.56, 2.61, and 10.94, respectively. All studied hospitals experienced pest infestations such as houseflies and roaches. These hospitals rely mainly on chemical control, employing 14 types of pesticides, including five restricted-use pesticides and seven that are banned. In addition, these chemicals can be used without proper supervision and by uncertified users with limited knowledge. .

*Corresponding author.

E-mail address: Samira.Garboui@uob.edu.ly

1. Introduction

Healthcare facilities, including hospitals, face many difficulties in maintaining the highest standard of sanitation while providing for vulnerable people. One of these difficulties is making sure the facility does not become infested with pests, which may pose a range of health risks by spreading disease and contaminating surfaces, medical supplies, and equipment [1]. The risk factors for insect infestations increase with the size of a facility, the movement of staff, the entry of objects from outside, and sometimes the accumulation of garbage and the lack of sanitation [2]. There are too many types of pests in hospitals including rodents, cockroaches, spiders, mosquitoes, fleas, lice, mites, ants, flies, and bed bugs. These pests spread diseases and contaminate surfaces, equipment, and supplies [1]. Many studies and survive shown that many hospitals suffer from infested pests and there are a lot of insect species associated with the hospital's environment, which causes a huge health concern. A study was done between 2015-2016 at Al-Jala Hospital, in Benghazi, showing that the most common types of pests found in the hospital were the cockroach, it was followed by bugs, flies, and rodents [3]. In the same year at the same hospital, a study showed that the building was struggling with certain insects such as cockroaches, followed by bugs, flies, and rodents [4]. The Medical Entomology Department, an arthropod reference laboratory in New South Wales, has over the years investigated numerous instances of pest infestations within the confines of hospitals and associated healthcare facilities [5], particularly vector-borne and food-poisoning diseases. There are many theories confirming the role of insects in the transmission of nosocomial infections [6]. As a result, we often depend heavily on chemicals to treat the symptoms of our pest issues, rather than resolving the

underlying problem that led to the pest presence. This short-sighted approach results in pests being often not managed safely, effectively, or economically [7]. In the process of eliminating pests, healthcare facilities that use pesticides risk exposing patients, staff, and visitors to hazardous substances through Inhalation, ingestion, and absorption of pesticide residues [8].

The best way to manage pests is to create a sterile environment by denying them access to food, water, and shelter. Integrated pest management in general is a science-based decision-making framework that emphasizes pest prevention and least-toxic control measures"[9] also, "integrated pest management in health care facilities is an effective and environmentally sensitive approach to pest management" [10]. One of the earliest studies about IPM was in 1995, in New York surveyed hospitals through questionnaires. Out of the 64% response rate, three hospitals reported not using pesticides, while others mentioned the use of pyrethroids, boric acid, and pyrethrin [11].

The findings highlighted varying approaches to pest management in hospitals, with some adopting non-chemical methods and others relying on specific pesticides. Many natural substances have a relatively low mammalian toxicity and degrade rapidly in the environment, properties that make them attractive alternatives to many synthetic pesticides currently in use [12-13-14]. A study done in Saudi Arabia by Nouredin et al [15] indicates that the IPM used against the German cockroach in Jeddah is a successful program and should always be used to control cockroach infestations in the residences in Jeddah. This study aims to assess knowledge, practice, attitude, and influencing factors related to Integrated Pest Management (IPM) adoption

and pesticide use in four hospitals in Benghazi. Including identifying the types of pests present, determining the IPM strategies employed, evaluating the effectiveness of pest control programs, and examining pesticide application records. This research will involve direct examinations, questionnaires, and a comparison of results with previous studies.

2. Methodology

2.1. Study area and Study design

The study was conducted in four major hospitals in Benghazi city, including the Surgical and Emergency Hospital (SEH), Benghazi Medical Centre (BMC), Nephrology, Dialysis Centre (NDC), and Benghazi Cardiac Centre (BCC), over three months from March 1st to June 15th, 2023. A cross-sectional descriptive research approach was employed to describe the knowledge, attitude, and practice regarding IPM of the population under investigation. The sample size was determined using a formula ($N = [Z^2 \times P(1 - P) / e^2] / [1 + (Z^2 \times P(1 - P) / e^2)]$), [16-17], that took into account the total population of 1423 from the four hospitals, with a desired confidence interval of 90% and a standard deviation of 0.5. Based on this calculation, a sample size of 400 participants was deemed sufficient to detect variations between hospitals, and questionnaires were administered to 400 ± 1 individuals accordingly.

2.2. Data Collection Tools

Two data collection tools were developed for the study. Part 1, is a structured online questionnaire designed to evaluate the use of the Integrated Pest Management (IPM) program. This questionnaire was formulated by

a published study in which the validity and reliability were tested. The questionnaire included socio-demographic information such as gender, age, education, workplace, and years of experience, along with assessments of knowledge, practices, and attitudes regarding IPM and pesticide control in hospitals [18]. It encompassed 54 domains related to IPM knowledge and was administered to infection control specialists, cleaning staff, nurses, kitchen staff, and doctors via Google Sheets through personal interviews. Part 2, an observational checklist was utilized to monitor and inspect the types of pests and the pesticides/IPM methods employed for their control. This checklist was sourced from the Integrated Pest Management Toolkit [19].

2.3. Statistical analysis

The study's data were analysed using version 25 of the Statistical Package for the Social Sciences (SPSS) software. Normality tests were conducted, and the analysis included descriptive statistics, cross-tabulations, and one-way ANOVA. Results were deemed statistically significant when the P-value was less than 0.05.

3. Results and discussion

3.1. A structured online questionnaire result

a- Demographic characteristics of participants

The distribution of participants in each hospital based on their job description is showed in Table 1. The data reveals that the BMC had the highest percentage of participants (39.85%) among the four hospitals, as it is the largest facility. Conversely, the BCC had the lowest percentage of participants (16.79%) as it is the smallest hospital. Furthermore, nurses

accounted for the highest number of participants (53.38%) across all four hospitals, based on their respective job roles. The respondent demographics show a majority of females across all four hospitals, reflecting the higher participation of female nurses at 63%. The age group of 31–40 years was the most prevalent, comprising 41.9% of respondents, while those aged above 51 represented only 0.4% of the total. Additionally, the institute category was the most common educational background among participants, constituting 43.8% in Figure 1.

b- Assessments of knowledge, practices, and attitudes results regarding IPM and pesticide control in hospitals

Table 2 shows the level of knowledge regarding IPM among hospital participants.

SEH demonstrated the highest average IPM knowledge score (4.56 out of 6), significantly surpassing other hospitals ($p = 0.000$). This good score is attributed to its skilled infection control staff, while BCC exhibited the lowest mean score at 3.73. In terms of participant attitudes (with a maximum score of 4). SEH had the highest mean score (2.61), indicating a positive attitude towards IPM, significantly higher than the other hospitals ($p = 0.008$). Conversely, NDC had the lowest mean score (2.19) (Table 2). Regarding IPM Practices, the highest score recorded was 14, with SEH obtaining the highest score, with a mean of 10.94, indicating an acceptable level of IPM practice (Table 2). In contrast, BCC had the lowest practice score at 9.22, reflecting a notably substandard level of IPM adherence.

Table 1: The percentage of participants in the hospitals according to their job description

Hospital	Job description					Total (%)
	N (%)	IC (%)	CS (%)	KS (%)	Other (%)	
SEH	27 (35.50)	16 (21.05)	7 (9.21)	13 (17.10)	13 (17.1)	76 (19.04)
BMC	75 (47.17)	51 (32.07)	4 (2.51)	27 (16.98)	2 (1.26)	159 (39.85)
BCC	50 (74.63)	9 (13.43)	5 (7.46)	0 (0)	3 (4.48)	67 (16.79)
NDC	61 (62.89)	28 (28.87)	3 (3.09)	0 (0)	5 (5.15)	97 (24.31)
Total	213 (53.38)	104 (26.06)	19 (4.76)	40 (10.03)	23 (5.76)	399

SHE =Surgical and Emergency Hospital, BMC = Benghazi Medical Centre, NDC =Nephrology, Dialysis Centre and, BCC =Benghazi Cardiac Centre
N =Nurse, IC =Infection control, CS= Cleaning Staff, KS =Kitchen Staff

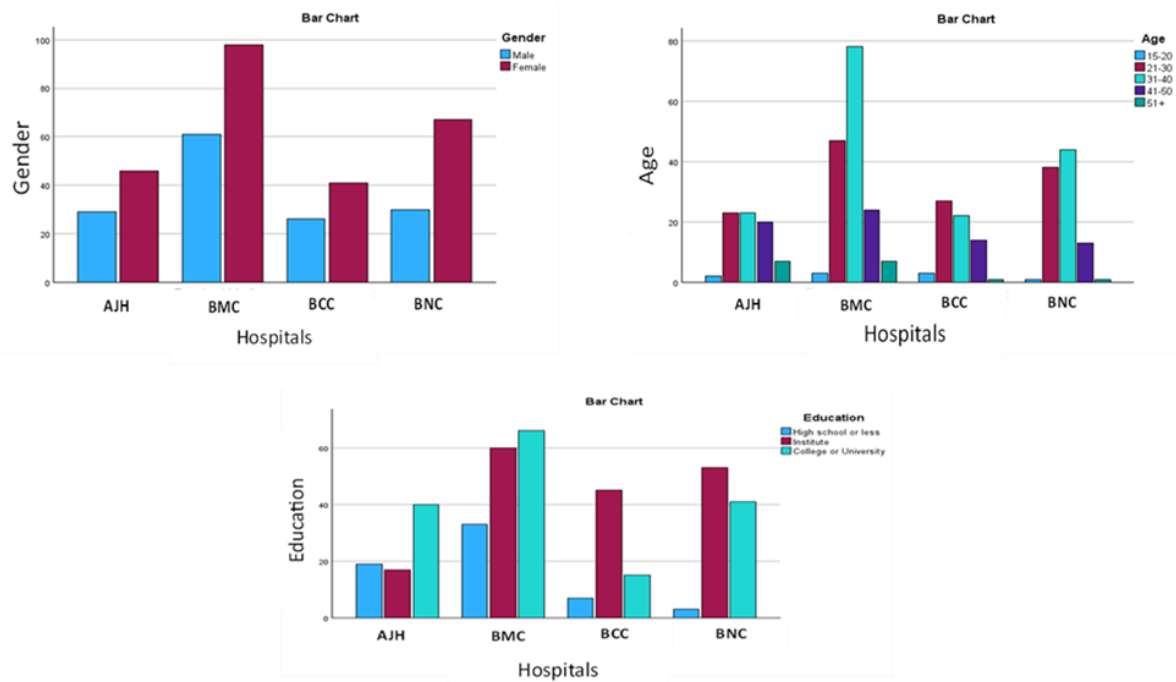


Figure 1. Socio-Demographic characteristics of respondents, A= The gender percentage, B= The ages and, C= The education level, of the participants in in the four hospitals

Notably, the staff at BMC showed a lack of awareness regarding IPM practices, resulting in the responsibility of this task falling on the cleaning company staff. At NDC, where nurses comprised the majority of participants, their level of practice was comparatively lower than that of SEH. Additionally, they exhibited a lack of knowledge on how to prevent insect or rodent infestations. Overall, the findings indicate variations in IPM practice scores among the hospitals, with SEH demonstrating the highest level of practice, while BCC had the lowest, and BMC and NDC faced specific challenges in terms of awareness and implementation of IPM practices.

3.2. Observational Checklist results

The checklist presents the pests mostly found in the hospitals, the commonly used pesticides, and the evaluation of the IPM practice in the hospitals. Type of pests in hospitals are shown in Table 3. The result revealed that the flies was the most common insect found among the hospitals, which was found approximately in all hospital places, infestation was observed

visually and by the personal interviews with the staff of the hospitals. Many studies found that house flies were proven to carry over 130 pathogens, multi-drug resistant pathogens, which are opportunistic to humans and to be a cause of nosocomial infections [20] [21].

These results highlight the importance of house flies as a vector in sensitive places such as hospitals. Followed by cockroaches, studies confirmed that the most prevalent pest species found in hospitals is the cockroach [3-4],

Both studies conducted in the same hospital yielded consistent results. Based on our observations, the abundance of cockroaches in the hospital may be attributed to the poor condition of the building infrastructure. Multidrug resistant Gram-negative bacteria including *E. coli* and *K pneumoniae*, are resistant to multiple antibiotics [22-23-24].

At BMC, kitchen staff reported notable cockroach infestations, exacerbated by cracks and open manholes nearby. Infection control staff also emphasized their ongoing battle against these pests within the hospital. Mosquitoes were spotted at SEH hospital, especially near windows and water accumulation from air conditioners, with

Table 2: The average knowledge, attitude, and practice of the participants in the four hospitals

The average knowledge scores of the participants								
Hospital	Mean	N	Std. Deviation	Std. Error of Mean	Sum	Minim	Maxum	Harmonic Mean
SEH	4.5658	76	1.14700	.13157	347.00	2.00	6.00	4.2066
BMC	4.1761	159	1.17750	.09338	664.00	1.00	6.00	3.7767
BCC	3.7313	67	.80870	.09880	250.00	2.00	6.00	3.5481
NDC	3.7423	97	1.05355	.10697	363.00	1.00	6.00	3.2697
Total	4.0702	399	1.12758	.05645	1624.00	1.00	6.00	3.6701
The average attitude scores of the participants								
Hospital	Mean	N	Std. Deviation	Std. Error of Mean	Sum	Min	Max	Harmonic Mean
SEH	2.6184	76	.99287	.11389	199.00	.00	4.00	-
BMC	2.4214	159	.78259	.06206	385.00	1.00	4.00	2.1271
BCC	2.3731	67	.67050	.08191	159.00	1.00	4.00	2.1848
NDC	2.1959	97	.74497	.07564	213.00	.00	4.00	-
Total	2.3960	399	.81047	.04057	956.00	.00	4.00	-
The average practice scores of the participants								
Hospital	Mean	N	Std. Deviation	Std. Error of Mean	Sum	Min	Max	Harmonic Mean
SEH	10.9474	76	2.52927	.29013	832.00	4.00	14.00	10.2094
BMC	9.7987	159	2.24392	.17795	1558.00	4.00	14.00	9.2499
BCC	9.2239	67	2.43597	.29760	618.00	4.00	14.00	8.5215
NDC	9.5464	97	2.33640	.23723	926.00	3.00	14.00	8.6754
Total	9.8596	399	2.41339	.12082	3934.00	3.00	14.00	9.1352

SHE =Surgical and Emergency Hospital, BMC = Benghazi Medical Centre, NDC =Nephrology, Dialysis Centre and, BCC =Benghazi Cardiac Centre

Table 3.The most common types of pests found in the hospitals studied

PEST	SEH	BMC	NDC	BCC
Cockroaches	All hospital places	Kitchen Bathrooms	Around the hospital	Bathrooms, Storage room, and outside area
Flies	In and around the hospital	Around the hospital	Around the hospital	Around the hospital
Rodents	Medical supplies storage room, bathrooms, outside area	0	Outside area	Outside area
Bed Bug	Doctor's room	Patient's rooms	0	0
Flea	0	Patient's rooms	0	0
Ants	outside area, front of the doors	outside area	outside area	outside area
Mosquito	outside area	0	outside area	0

SHE =Surgical and Emergency Hospital, BMC = Benghazi Medical Centre, NDC =Nephrology, Dialysis Centre and, BCC =Benghazi Cardiac Centre

reports of widespread presence from nurses at NDC. At BMC, kitchen staff reported notable cockroach infestations, exacerbated by cracks and open manholes nearby. Infection control staff also emphasized their ongoing battle against these pests within the hospital. Mosquitoes were spotted at SEH hospital, especially near windows and water accumulation from air conditioners, with reports of widespread presence from nurses at NDC. Knowledge about their impact on humans is limited. Rodents were often seen at SEH, attributed to an opening beneath the medical supplies storage door, despite a prior study showing low infestation rates [3]. Bed bugs were reported in doctors' rooms and the surgery section at BMC, with immediate management actions taken, though details were unclear. A study highlighted the need for IPM in hospitals due to these infestations [3]. Bed bugs are not known to transmit infectious agents to humans, though evidence is lacking [25]. A flea infestation occurred at BMC when a patient brought in infested clothing, leading

to the spread of fleas throughout the facility. No infestations were reported in the other three hospitals. Ants were found in all hospitals, and a study in 2018-2019 at BMC indicated that ants may could act as mechanical vectors for pathogenic bacteria, potentially spreading them directly to people or indirectly via medical equipment [26]. Further research is needed to confirm the association between bacteria carried by ants and those present on surfaces in the same environment. Table 4 shows the most commonly used pesticides in the hospitals, revealing a total of 14 different types. Alarmingly, 7 of these have been banned by the World Health Organization [27], while only 4 are approved for use. The study also found that 3 pesticides had unknown sources, raising safety and effectiveness concerns. The educational level of those responsible for pesticide application was crucial, as many lacked knowledge [3-4]. Additionally, Boric

Acid, which has long been banned, was still being used in SEH 's kitchen as of 2023. In BMC, sticky traps were employed in the kitchen, while SEH utilized fly sticky traps

throughout the facility, except in the kitchen where electric fly traps were used. The use of baits indicates a positive approach towards integrated pest control, which emphasizes the

Table 4: Types of Pesticides Used in Hospitals, Their Composition, And Product Status

Pesticides	Chemical Ingredient	Product Status*	Restricted Use*	Hospitals
Delta-Vam 5 Sc	Deltamethrin 5%	Approved	Yes	BMC
Top Bait Gold	Fipronil 0.5g/Kg, Hydramethylnon, Imidacloprid, Indoxcarb	Banned	No	BMC, SEH . NDC & BCC
Cyper X	10% Cypermethrin, 2% Tetramethrin	Banned	No	BMC
Rek Rok	47% Boric Acid	Banned	No	BMC & SEH
Fly Giue Traps	Imidacloprid	Approved	Yes	BMC, SEH , NDC &BCC
Cemort	Cyfluthrin	Banned	No	SEH
Maxifly	10% Cyphenothrin	Banned	No	BMC
Tornado-Forte	Lambda-Cyhalothrin 10%, Tetramethrin 5%, Piperonyl Butoxide 5%.	Banned 5%	No	SEH
Mr. Fly Granular Bait	Imidacid 2%	Unknown	No	SEH
Arisban Ariashimi	Chlorpyrifos Ethyl 2.5%	Banned 2020	No	SEH
Duracid	Permethrina Pura 6g, Tetrametrina Pura 3g, Piperonilbutossido 6g, Coformulanti 100g	Approved	Yes	NDC
Cockroac-Killing Bait	1% Grenil	Unknown	Unknown	NDC
Rat & Mouse Killer	Brodifacoum, Coumarin.	Approved	Yes	NDC
Attracide Df	Phenoxybenzyl, Cyclopropanecarboxylate, Phenothrin, Butoxyethoxy, Piperonyl Butoxide	Unknown	Yes	NDC

SHE =Surgical and Emergency Hospital, BMC = Benghazi Medical Centre, NDC =Nephrology, Dialysis Centre and, BCC =Benghazi Cardiac Centre

integrated pest control, which emphasizes the use of localized and less toxic pesticides. This approach aims to minimize the widespread application of pesticides and instead focuses on targeted solutions like baits. Regarding the pyrethroid group of pesticides, the study found the usage of deltamethrin 5%, cypermethrin 2%, tetramethrin, cyfluthrin, and cyphenothrin in hospitals. This is consistent with the study demonstrated that cypermethrin, deltamethrin, and cyfluthrin were used in six hospitals in Benghazi [4]. Pyrethroids have been widely used as insecticides in agriculture and household applications. Studies indicates that pyrethroids can easily cross the blood-brain barrier, directly impacting the central nervous system [28]. They can damage mitochondrial function, and cause neurotoxicity [29]. Furthermore, exposure to pyrethroids has been associated with haematological cancers, reproductive developmental toxicity, and immune disorder [30].

4. Conclusion

The study found that SEH exhibited higher knowledge levels compared to the other hospitals, possibly attributed to the qualifications of their infection control specialists. Despite this, the implementation of IPM strategies in these hospitals still falls within the lower range, indicating the necessity for further enhancements and improvements. Nevertheless, all hospitals had pest infestations and improper pesticide use by unqualified personnel. Further improvements are needed across all hospitals, including enhanced IPM practices and mandatory training programs for all staff. Additionally, maintaining hospital structures is crucial to effective pest control. Further research exploring the influencing factors on IPM adoption and the effectiveness of different IPM strategies would be beneficial.

Acknowledgment

The authors would like to express their greatest appreciation to the health workers who participated in the study conducted in the

four hospitals and the infection control officers for their invaluable assistance.

Conflict of Interest and Financial Disclosure

The authors have not declared any conflicts of interest and confirm that they do not receive any financial support for this research.

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