

Cockroach Infestation and Their Perceived Importance in Hospitals, Restaurants, and Offices in Indonesia

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Abstract: Cockroaches are significant disease vectors that can transmit pathogenic microorganisms, posing major health risks, especially in hygienic environments. The objectives of this study are to identify cockroach species, analyse their distribution and infestation rates, and examine the relationship between knowledge, attitudes, and practices (KAP) in cockroach control. Cockroach samples were collected using sticky traps in strategic locations such as, toilet, pantries, drainage, and garbage. The traps were inspected bi-weekly for three months. The knowledge, attitudes, and practices of staff in different divisions regarding cockroach infestation were also assessed. The results showed that *P. americana* was most prevalent in garbage and drainage, while *B. germanica* was common in pantries. In hospitals, *P. americana* was found with an average of 76.67 individuals with 60.01% relative abundance. However, *B. germanica* was found with an average of 67 individuals and 39.99% relative abundance. Staff generally had adequate knowledge of cockroaches, but lacked effectiveness in control practices. In hospitals, the environmental health, nursing, and nutrition divisions had the best KAP results, with 87% sufficient knowledge, 66% positive attitudes, and 46% practicing hygiene regularly. In restaurants, quite similarly the cleaning division showed 83% with sufficient knowledge and 53% with positive attitudes, but none practiced hygiene frequently. In offices, division leaders, refractionists, supervisors, and doctors showed 77% moderate knowledge, 71% positive attitudes, and only 20% practiced hygiene regularly. Maintaining cleanliness in critical areas such as toilets, pantries, plumbing systems, and garbage disposals is crucial to reduce infestations and improve institutional health and reputation. Overall, an integrated approach combining toxic and non-toxic methods, along with enhanced staff awareness and training, is necessary for effective cockroach control.

Keywords: American cockroach, German cockroach, healthcare facilities, eatery houses offices, IPM.

1. Introduction

Pest infestation is a major concern in residential areas due to its ability to cause physical and psychological disorders, as well as social and economic impacts (Abbar et al., 2022). One pest often found is the cockroach, an omnivorous insect that can transmit pathogenic microorganisms from various sources such as human and animal waste in addition to other organic waste. The presence of cockroaches is a serious concern due to their role as disease vectors that can cause infections in humans. The health impact of cockroach infestation is significant, especially in environments that require high hygiene standards such as hospitals, restaurants, and offices. High levels of cockroach infestation can damage the reputation of these institutions by giving a negative impression of environmental cleanliness, impacting their image and credibility. Cockroaches are nocturnal insects that are active indoors and outdoors, allowing them to contaminate items or equipment without the occupants realizing it (Hadi, 2019). According to the World Health Organization (2022), there are about 65 types of pathogenic microorganisms that can be carried by cockroaches and cause infectious diseases such as salmonellosis, dysentery, and cholera.

The presence of cockroach as vectors is closely related to human behavior and residence. The most common species of cockroach found in residential areas in Indonesia are American

cockroach, *Periplaneta americana* and German cockroach, *Blattella germanica*. Other species that are rarely found include *P. australasiae*, *P. brunnea*, *Neostylopyga rhombifolia*, *Nauphoeta cinerea*, *Symptloce* spp., and *Blatta orientalis* (Hadi, 2006). *Blattella germanica* and *P. americana* are the most important species and are found in many strategic urban locations. *B. germanica*, better known as German cockroaches, are often found in hotels, restaurants (Shahraki et al., 2013), ships (Alias UK et al., 2018), and hospitals (Baz et al., 2021; Sinulingga, 2020). These cockroaches are often found in environments that provide access to food sources, moisture, and suitable hiding places for their survival. Some common locations include kitchens or food preparation areas, bathrooms, cracks or crevices, trash cans, heating rooms, warehouses, and sewage systems (Wannigama et al., 2014).

Cockroaches play an important role as pathogen vectors, carrying microorganisms such as fungi, bacteria, and viruses on their surfaces and within their bodies (Kasseri & Kazemi, 2012). Research in Iran reported by Jalil et al., (2012) showed that cockroaches can carry 150 species of bacteria, 60 species of fungi, 90 species of protozoa, and 45 species of parasitic worms. Similarly, a study in Nigeria found that bacteria isolated from cockroaches caught in hospitals, residences, and restaurants included *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus*, coagulase-negative *Staphylococcus* spp., *Bacillus cereus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella*

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pneumoniae, *Citrobacter freundii*, *Morganella morganii*, *Proteus vulgaris*, *Proteus mirabilis*, *Enterobacter cloacae*, and *Providencia* spp. (Akinjogunla et al., 2012).

Regarding commonly infested locations, several studies in Indonesia have shown a high prevalence of cockroach infestation in residential neighborhoods and public facilities. Susilawati et al., (2019) reported that in Surabaya, 60% of surveyed households had cockroach infestations, with the dominant species being *Periplaneta americana*. Likewise, Pramudana et al., (2021) in Jakarta found that 55% of restaurants surveyed had cockroach infestations, mostly in the kitchen and food storage areas. The study showed that low standards of sanitation and waste management contributed to the high population of cockroach in these areas. A study by Nurhayati et al., (2020) reported that 45% of inpatient rooms in a regional hospital in Bandung were infested by cockroaches. This condition is very worrying because it can endanger the hygiene and health of patients and health workers. The high infestation of cockroaches in hospitals indicates that pest management has not been optimal, although the importance of sanitation and pest control is understood. These findings suggest that cockroach infestation is not only a problem in domestic settings but also in institutions that require high hygiene standards.

As one of the most common types of cockroaches is the *Blattella germanica*, belonging to the *Blattellidae* family, although native to Africa and East Asia, this type of cockroaches has spread widely throughout the world, inhabiting various types of buildings such as homes, restaurants, food factories, as well as public spaces including hospitals (Bell et al., 2007). This cockroach can reach up to 16 mm in length, is light brown in colour with two longitudinal dark stripes on its pronotum, and can live up to 7 months under ideal conditions. Besides the German cockroach, the *Periplaneta americana* is also a significant species due to its large size and adaptability. It lengths between 30-40 mm, with an oval body shape and a distinctive reddish-brown color. The species is equipped with long antennae, a mouth with strong molars, and sturdy legs; that allow them to chew a wide variety of foods (Bell et al., 2007). According to the taxonomic classification, *P. americana* belongs to the class Insecta (Hexapoda), superorder Dictyoptera, order Blattodea, and family Blattidae. This species prefers moist and dark habitats, often found in sewers, basements, and trash cans. *P. americana* also acts as a pathogen vector, carrying harmful microorganisms that can cause human infections (Kassiri & Kazemi, 2012). Control of *P. americana* is

challenging due to its resistance to several types of insecticides. Effective control approaches include a combination of insecticide use, trapping, and good sanitation practices to reduce cockroach populations in the environment (Ogg et al., 2006).

Blattella germanica, also known as house cockroaches, have important roles in the ecosystem and can be harmful pests. Here are some of the main roles of the *B. germanica*: Food waste eater: They are highly efficient at consuming a wide range of food waste, including human food waste, animal waste, and other organic matter, thus helping to break down and recycle organic matter. Pathogen spread: *B. germanica* can serve as vector disease pathogens, carrying bacteria, viruses and parasites that can cause disease in humans. They can contaminate food and surfaces with pathogens, increasing the risk of disease transmission. Allergens: These cockroaches produce allergens that can cause allergic reactions in some individuals. These allergen particles can be inhaled or come into contact with human skin, causing symptoms such as rashes, hives, and respiratory distress. Indicator of environmental quality: the presence of *B. germanica* can be an indicator of sanitation or hygiene problems. High populations of cockroaches indicate the presence of sufficient food sources and poor sanitary conditions, which can be used as a warning sign to improve environmental hygiene. Scientific research: *B. germanica* is used in scientific research, especially in the fields of ethology, genetics, and neurology. The relatively simple nervous system makes it an ideal subject for research on neural function and animal behaviour (Brenner & Kramer, 2019).

Research on cockroach infestation and control in Indonesia remains limited, while this information is very important for determining hygienic and sanitary standards, as well as pest control policies in various institutions. Therefore, the study of cockroach infestation in various institutions such as hospitals, restaurants, and offices in residential environments is crucial to maintain the reputation of the institution, minimize health risks and ensure compliance with applicable regulations. This research is expected to provide a deeper understanding of the behavior and distribution of cockroach, and support the development of effective centipede infestation control strategies to improve the hygiene and safety of strategic agency environments. This study aims to identify the various types of cockroach, analyze the distribution and degree of cockroach infestation, and analyze the knowledge, attitudes and practices related to cockroach infestation in residential areas of hospitals, restaurants and offices.

2. Research Method

Cockroaches' Samplings and Identification

Cockroaches samplings were carried out at several points of the observation, namely in toilet, pantries, drainage, and garbage areas in each research location in hospitals (healthcare facilities/building), restaurants (eatery houses), and offices. The selection of these observation points was based on the characteristics of the environment that often become cockroach nests and the possibility of infestation. Collections were carried out for three months, from March to June 2024 with a capture frequency of twice a month at hospitals, restaurants, and offices located in Bekasi and Jakarta with three locations each. Preservation and identification of cockroach will be carried out at the Laboratory of Medical Entomology, School of Veterinary Medicine and Biomedical sciences, IPB University.

The collection began by spraying insecticide into cracks and crevices in the pantry, toilet, drainage, and garbage, with an inter-location distance of 1-2 m in an area under 100 m². After that, the cockroaches that came out were collected into collection containers/plastic bottles. Additionally, collection was also done by setting up green killer® (cockroach trap) traps, each location having four traps for 24 hours in the pantry, toilet, drainage, and trash areas. The sampled cockroaches were labeled according to the observation points and times. The samples were then killed using chloroform and subsequently preserved or pinned. Morphological identification of the cockroaches was carried out under a stereo microscope (Keyence VHX-970F) and with identification keys from Pratt (1966), Hadi and Soviana (2017) and Cochran (1999).

Knowledge, Attitudes, and Practices (KAP)

Sample collection was conducted using purposive sampling to obtain relevant respondents concerning knowledge, attitudes, and practices (KAP) of cockroach infestation and control in hospitals, restaurants, and offices. This study involved 90 respondents selected based on their positions, work experience, and direct involvement in cockroach control. Before data collection, respondents were given an explanation of the objectives and procedures of this study, along with a confirmation of their willingness to participate, emphasizing the confidentiality

of the data. Data were collected through direct interviews using questionnaires and analyzed to obtain an accurate picture of KAP concerning cockroach infestation and control in the three environments. This method is expected to produce representative data and support the research objectives.

Data Analysis

The research data were descriptively analyzed and presented in tables and figures. In addition, the measurement of cockroach species diversity, namely calculating the Shannon diversity index (H'), relative abundance, frequency and dominance of species refers to (Odum 1993). The degree of cockroach infestation is measured based on the categories of low (0-5 cockroaches), moderate (6-20 cockroaches), high (21-100 cockroaches), and very high (> 100 cockroaches) according to Ogg et al. (2006). Additionally, the categories of good (<2) and bad (≥2) are referenced from the Ministry of Health's Environmental Health Quality Standards (EHQS) no 55 of 2023, and the relationship between knowledge, attitudes and practices with cockroach infestations and their breeding development with direct interviews with staff at agencies (Werthmann et al., 2021). Spearmans statistical analysis of inferential was carried out to determine the correlation between the knowledge, attitudes, and practices of the respondents, as well as the value of the cockroach population using Minitab version 19.

3. Results and Discussion

Cockroaches in The Hospital

The total number of cockroaches caught in the hospital was 431 individuals, consisting of *P. americana* (230, 53%) and *B. germanica* (201, 47%). The average number of *P. americana* was 76.67, and *B. germanica* was 67.00. The relative abundance of *P. americana* was 60.01% and *B. germanica* was 39.99%. The capture frequency of *P. americana* was higher (0.78), and the dominance of *P. americana* was greater (49.59%) compared to *B. germanica*. The diversity index of *P. americana* (0.26) was higher compared to *B. germanica*. Further data is presented in Table 1 and Table 2

Table 1. Species variety, abundance, dominance and diversity index of cockroaches in hospitals from March - June 2024.

Parameter	Type	Hospital 1	2	3	Average
Number of cockroaches	Pa	79.00	81.00	70.00	76.67
	Bg	7.00	82.00	112.00	67.00
relative abundance (%)	Pa	91.86	49.69	38.46	60.01
	Bg	8.14	50.31	61.54	39.99
type frequency	Pa	1.00	0.50	0.80	0.78
	Bg	0.30	0.00	0.00	0.11
Dominance (%)	Pa	91.86	24.85	32.05	49.59
	Bg	3.00	0.00	0.00	0.90
diversity index (H')	Pa	0.08	0.35	0.37	0.26
	Bg	0.19	0.29	0.22	0.23

Description: Pa = *P. americana*, Bg = *B. germanica*

Table 2. Distribution and degree of infestation of cockroach in hospitals from March – June 2024

Institution	Area	Number of cockroaches		Degree of cockroach infestation (Ogg et al., 2006)		Degree of cockroach infestation (EHQS, 2023)	
		Pa	Bg	Pa	Bg	Pa	Bg
Hospital	Toilet	40	0	high	low	Bad	Good
	Pantry	0	201	low	very high	Good	Bad
	Drainage	73	0	high	low	Bad	Good
	Garbage	117	0	very high	low	Bad	Good

Description : Pa: *P. americana*, Bg: *B. germanica*

The distribution and degree of cockroach infestation in the hospital showed marked variations in each observation area, reflecting the hygiene and sanitation conditions in each location. The hospital is in a densely populated area with shophouses, suboptimal waste disposal, large amounts of stagnant water in the sewage lines, and garbage and food waste around the hospital environment. In addition, less restricted access between the hospital room and the outside environment contributed to the high infestation of cockroaches in the area. In the toilet, *P. americana* was found in greater numbers than *B. germanica*, with a higher degree of infestation according to Ogg et al., (2006), indicating poor hygiene conditions. The EHQS assessment (2023) showed that *P. americana* infestation was bad, while *B. germanica* was not found, indicating that this species is not well established in the area.

In pantries, *B. germanica* dominated with very high numbers, while *P. americana* was not detected. Ogg et al., (2006) classified the infestation of *B. germanica* in pantries as very high, indicating this species' preference for environments with many food sources. The EHQS assessment (2023) also noted bad hygiene in this area. In drainage and garbage *P. americana* was more dominant, with the highest numbers found in garbage, indicating poor sanitation. The EHQS assessment (2023) indicated that the

infestation of *P. americana* in polling stations was bad, in line with the finding that these cockroaches were more common in areas with poor sanitation. Overall, *P. americana* was found more frequently in areas with poor sanitation, such as drains and garbage, while *B. germanica* was found in areas with food sources, such as pantries. This confirms the importance of better hygiene and sanitation management to reduce cockroach infestation (Akinjogunla et al., 2012; Ogg et al., 2006; EHQS, 2023).

Cockroaches in The Restaurant

A total of 233 cockroaches were caught in the restaurant, consisting of *P. americana* (168 individuals, 72%) and *B. germanica* (65 individuals, 28%). The average number of *P. americana* found was higher (56.00 individuals) than *B. germanica*. The relative abundance of *P. americana* reached 72.16%, with a capture frequency of 0.78 and dominance of 57.29, which were also higher than those of *B. germanica* (Table 3). This finding indicates the dominance of *P. americana* in the restaurant, which may be related to the presence of food sources that support its survival (Akinjogunla et al., 2012).

Table 3. Diversity, abundance, dominance, and diversity index of cockroaches in the restaurant, from March – June 2024.

Parameter	Type	Restaurant			Average
		1	2	3	
Number of cockroach	Pa	49.00	77.00	42.00	56.00
	Bg	22.00	3.00	40.00	21.67
Relative abundance (%)	Pa	69.01	96.25	51.22	72.16
	Bg	30.99	3.75	48.78	27.84
type frequency	Pa	0.80	0.80	0.70	0.78
	Bg	0.00	0.00	0.00	0.00
Dominance (%)	Pa	57.51	80.21	34.15	57.29
	Bg	0.00	0.00	0.00	0.00
diversity index (H')	Pa	0.26	0.04	0.34	0.21
	Bg	0.34	0.11	0.36	0.27

Description Pa = *P. americana*, Bg = *B. germanica*

Table 4. Distribution and degree of cockroach infestation in restaurant, from March – June 2024

Institution	Area	Number of cockroaches		Degree of cockroach infestation (Ogg et al., 2006)		Degree of cockroach infestation (EHQS, 2023)	
		Pa	Bg	Pa	Bg	Pa	Bg
Restaurant	Toilet	9	0	Moderate	Low	Bad	Good
	Pantry	0	65	Low	High	Good	Bad
	Drainage	69	0	High	Low	Bad	Good
	Garbage	90	0	High	Low	Bad	Good

Description: Pa: *P. americana*, Bg: *B. germanica*

Table 4. The distribution and degree of cockroach infestation in the restaurant show variations that reflect the cleanliness and sanitation conditions in each area. In the toilet, 9 individuals of *P. americana* were found, with no presence of *B. germanica*. According to Ogg et al., (2006), the infestation of *P. americana* in the toilet was assessed as moderate, while the infestation of *B. germanica* was considered low. The EHQS assessment (2023) indicated that the infestation of *P. americana* in the toilet was poor, while *B. germanica* was considered good. In the pantry area, only *B. germanica* was found, with 65 individuals. The EHQS assessment (2023) rated the infestation of *B. germanica* in the pantry as poor, while *P. americana* was not detected, indicating better cleanliness in this area. In the drainage, *P. americana* dominated with 69 individuals, while *B. germanica* was not detected. Ogg et al., (2006) categorized the infestation of *P. americana* in the drainage as high, indicating an environment that supports this species. The EHQS assessment (2023) also rated the infestation of *P. americana* in the drainage as poor, while the infestation of *B. germanica* was considered good.

In garbage *P. americana* was recorded in the highest number, with 90 individuals, and no presence of *B. germanica*. Ogg (2006)

categorized the infestation of *P. americana* in garbage as high, and the EHQS assessment (2023) rated the infestation of *P. americana* in garbage as bad, while *B. germanica* was still rated as good. Adedeji et al. (2021) also showed that the presence of cockroach is influenced by supportive environmental conditions, such as cleanliness and access to food.

Cockroaches in The Office

The total number of cockroaches caught in the offices was 178 individuals, consisting of *P. americana* 166 (93%) and *B. germanica* 12 (7%). The average number of *P. americana* was found to be higher in offices compared to *B. germanica* (55.33). The relative abundance of *P. americana* was 93.72%, significantly higher than *B. germanica* (6.28%). The capture frequency of *P. americana* was 0.67, while *B. germanica* was recorded at 0.00. The dominance of *P. americana* was also higher compared to *B. germanica*, with a dominance value of 0.00 for *B. germanica*. The diversity index was higher for *B. germanica* (0.12) across all offices compared to *P. americana*. (Table 5)

Table 5. Diversity, abundance, dominance, and diversity index of cockroaches in the Office, from March – June 2024.

Parameter	Type	Office			Average
		1	2	3	
Number of cockroach	Pa	54.00	39.00	73.00	55.33
	Bg	1.00	3.00	8.00	4.00
Relative abundance (%)	Pa	98.18	92.86	90.12	93.72
	Bg	1.82	7.14	9.88	6.28
type frequency	Pa	0.50	0.80	0.70	0.67
	Bg	0.00	0.00	0.00	0.00
Dominance (%)	Pa	49.09	77.38	60.08	62.18
	Bg	0.00	0.00	0.00	0.00
diversity index (H')	Pa	0.02	0.07	0.09	0.06
	Bg	0.05	0.11	0.20	0.12

Description: Pa = *P. americana*, Bg = *B. germanica*

The distribution and degree of cockroach infestation in offices are significantly influenced by sanitation conditions, environmental factors, and the cleanliness management practices in these areas. The species *P. americana* and *B. germanica* show different habitat preferences, which are influenced by the ecological characteristics and behaviors of each species (Table 6)

Table 6. Distribution and degree of cockroach infestation in offices, from March – June 2024

Institution	Area	Number of cockroaches		Degree of cockroach infestation (Ogg et al., 2006)		Degree of cockroach infestation (EHQS, 2023)	
		Pa	Bg	Pa	Bg	Pa	Bg
Office	Toilet	7	0	Moderate	Low	Bad	Good
	Pantry	0	12	Low	Moderate	Good	Bad
	Drainage	113	0	Very high	Low	Bad	Good
	Garbage	46	0	High	Low	Bad	Good

Description: Pa: *P. americana*, Bg: *B. germanica*

In the toilet area, 7 individuals of *P. americana* were found without any *B. germanica*. According to Ogg et al., (2006), the category infestation degree was moderate for *P. americana* and

low for *B. germanica*, the EHQS, (2023) rated *P. americana* as bad and *B. germanica* as good. This result suggests that *P. americana* thrives in poor sanitation conditions, whereas *B. germanica* does

not inhabit this area. Ogg's research (2006) further supports this observation, indicating that *P. americana* is commonly found in damp and unclean environments, such as poorly maintained toilets.

In the pantry area, a population of 12 individuals of *B. germanica* were found with no presence of *P. americana*. According to Ogg et al., (2006) the infestation degree for *P. americana* was classified as low, while it was moderate for *B. germanica*. The EHQS. (2023)) categorized *P. americana* as good and *B. germanica* as bad. These findings suggest that *B. germanica* is more reliant on the availability of human food waste compared to *P. americana*. Akinjogunla et al. (2012) noted that *B. germanica* prefers environments with high humidity and plentiful food sources.

In the drainage areas, 113 individuals of *P. americana* were found, and indicating a significant infestation of this species. The results suggest that these environment strongly supports the abundance of *P. americana*. Adedeji et al., (2021) noted that drainage areas, with their damp conditions and food residues, provide ideal habitat for *P. americana*.

At the garbage, 46 individuals of *P. americana* were discovered. This species heavily depends on the accumulation of organic waste as their food source. EHSQ (2023) reported a significant infestation of *P. americana* at the garbage, highlighting the importance of proper waste management to prevent further infestations. The findings indicate that *Periplaneta americana* is more commonly found in areas with poor sanitation, such as drainage ditches and garbage, which create ideal conditions for their proliferation. In contrast, *Blattella germanica* is more frequently located in spaces with readily available food sources, like pantries. Research conducted by Akinjogunla et al., (2012) and Abudin et al., (2023) emphasizes that a lack of environmental cleanliness often contributes to cockroach infestations. Therefore, implementing stricter cleanliness management is essential to control cockroach populations in offices.

Distribution of Cockroach Infestation in Various Institutions Based on Sanitation and Environmental Cleanliness Conditions

The distribution and degree of infestation of *Periplaneta americana* and *Blattella germanica* in hospitals, restaurants, and offices are closely linked to sanitation conditions and environmental cleanliness. In hospitals, *P. americana* was predominantly found in drainage areas (63 individuals) and garbage (75 individuals), indicating a preference for locations with poor cleanliness, such as those with high humidity and food residues. In contrast, *B. germanica* was absent in hospital areas, suggesting that this species is less capable of adapting to cleaner and more enclosed environments.

In restaurants, *P. americana* was found in toilets, drainage areas, and garbage, with the largest numbers in drainage areas (46 individuals) and garbage (58 individuals), while *B. germanica* was more frequently found in pantries, which provide human food sources. The dominance of *B. germanica* in pantries suggests suboptimal cleanliness in these areas, despite more frequent maintenance. This indicates that *B. germanica* is more attracted to poorly managed food sources, while *P. americana* prefers areas with poor sanitation.

In offices, *P. americana* was also more commonly found in drainage areas (75 individuals) and garbage (43 individuals), while *B. germanica* appeared only in small numbers in pantries (9 individuals). These findings reflect that cleanliness conditions in offices influence the habitat preferences of each cockroach species. *P. americana* is more frequently found in areas with humidity and organic waste that can support their proliferation, such as drainage and garbage, while *B. germanica* is less frequently found in pantries despite access to food sources. This underscores the importance of stricter cleanliness management, especially in areas that can become hiding places or food sources for cockroaches.

Table 4. Abundance of *P. americana* and *B. germanica* Cockroaches in Hospitals, Restaurants, and Offices from March to June 2024

No	Institution	Area	cockroach <i>P. americana</i>				cockroach <i>B. germanica</i>			
			A	N	O	%	A	N	O	%
1	Hospital	Toilet	31	9	0	17	0	0	0	0
		Pantry	0	0	0	0	101	95	5	100
		Drainage	63	10	0	32	0	0	0	0
		Garbage	75	42	0	51	0	0	0	0
		Total	169	61	0	100	101	95	5	100
2	Restaurant	Toilet	7	2	0	5	0	0	0	0
		Pantry	0	0	0	0	35	29	1	100
		Drainage	46	23	0	41	0	0	0	0
		Garbage	58	32	0	54	0	0	0	0
		Total	111	57	0	100	35	29	1	100
3	Hospital	Toilet	6	1	0	4	0	0	0	0
		Pantry	0	0	0	0	9	3	0	100
		Drainage	75	38	0	68	0	0	0	0
		Garbage	43	3	0	28	0	0	0	0
		Total	124	42	0	100	9	3	0	100

Desc : A = Adult, N = Nymph, O = Ooteca

Knowledge, Attitudes, and Practices (KAP) Towards Cockroach Infestation in Hospital, Restaurant, and Office Environments

The analysis of data regarding knowledge, attitudes, and practices (KAP) related to cleanliness and cockroach infestation control in hospitals shows varying results among three job positions/divisions (Table 4). In the technician and maintenance division, only 59% of respondents had sufficient knowledge about cleanliness and cockroach control, and 53% showed a positive attitude towards cleanliness. However, 37% of respondents performed cleaning only occasionally, indicating a gap between knowledge and practice. This is consistent with the research by Lin et al. (2019), which found that despite high knowledge, cleanliness practices were not always consistent due to time constraints and technical task priorities.

The cleaning, security, and garden division showed better results, with 69% of respondents having adequate knowledge and 53% showing a positive attitude towards cleanliness. Their cleanliness practices were also good, with 53% of respondents performing them routinely, although 18% still did them sporadically, which risks reducing the effectiveness of cockroach control. The environmental health, nursing, and nutrition division showed the best results, with 87% of respondents having sufficient knowledge and 66% having a deep attitude towards cleanliness. Their cleanliness practices were also quite routine, with 46% of respondents performing them consistently. To improve the effectiveness of cockroach control, training and communication between divisions need to be strengthened.

Table 5. Knowledge, Attitudes, and Practices (KAP) Related to Cleanliness and Cockroach Infestation Control Based on Position/Division in Hospitals

Hospital										
Division	Knowledge (K)			Attitude (A)				Practice (P)		
	Agree	Disagree	No idea	Totally agree	Agree	Disagree	disagree strongly	Frequently	Some times	Rare
Technician, Maintenance	11.83	3.17	5.00	2.17	2.67	0.17	0.00	1.33	1.83	1.83
Cleaning, Security & Garden	59%	16%	25%	43%	53%	3%	0%	27%	37%	37%
En. Health, Nurse & Nutritionist?	13.75	2.38	3.88	2063	2000	0,38	0,00	2.63	1,50	0.88
	69%	12%	19%	53%	40%	8%	0%	53%	30%	18%
	17.38	0.93	1.75	3.31	1.44	0.25	0.00	2.31	1.06	1.63
	87%	5%	9%	66%	29%	5%	0%	46%	21%	33%

The knowledge, attitudes, and practices (KAP) related to cleanliness and cockroach infestation control in restaurants show variation across positions/divisions, which affect the control of cockroach infestations (Table 5). In the serving, cashier, and kitchen divisions, 75% of respondents had sufficient knowledge, but cleanliness practices varied, with only 27% performing regular cleaning. This inconsistency can exacerbate infestations, as found by Williams et al. (2015). The cleaning division showed better results, with 83% of respondents having good knowledge and

100% performing regular cleaning, emphasizing their crucial role in cockroach infestation control (Bingham et al., 2023). Meanwhile, the cook and supervisor divisions had sufficient knowledge, but only 16% showed a positive attitude towards cleanliness. Cleanliness practices in these divisions varied, reflecting the need to increase awareness of kitchen cleanliness (Islam et al., 2024).

Table 6. Knowledge, Attitudes, and Practices (KAP) Related to Cleanliness and Cockroach Infestation Control Based on Position/Division in Restaurants

Restaurant										
Division	Knowledge (K)			Attitude (A)				Practice (P)		
	Agree	Disagree	No idea	Totally agree	Agree	Disagree	disagree strongly	Frequently	Some times	Rare
Server, Cashier	15.00	1.47	3.53	2.00	2.47	0.53	0.00	1.35	2.12	1.53
Dan Kitchen	75%	7%	18%	40%	49%	11%	0%	27%	42%	31%
Cleaner	16.67	1.00	2.33	1.33	3.67	0.00	0.00	0.00	2.00	3.00
	83%	5%	12%	7%	18%	0%	0%	0%	10%	15%
Chef, Supervisor	14.90	1.00	4.10	1.70	3.20	0.10	0.00	0.80	1.80	2.40
	75%	5%	21%	9%	16%	1%	0%	4%	9%	12%

The knowledge, attitudes, and practices (KAP) related to cleanliness and cockroach infestation control in restaurants show significant variation across divisions, which affects the effectiveness of cockroach infestation control (Table 5). In the security, collector, and cleaning divisions, although 74% of respondents had sufficient knowledge, there was inconsistency in cleanliness practices. About 40% of respondents performed regular cleaning, while 54% did it occasionally, risking worsening the cockroach infestation. The maintenance, cashier, and sales divisions showed good knowledge, with 76% of respondents understanding cleanliness, but varied practices, with 38% performing regular

cleaning and 38% occasionally, potentially increasing the risk of infestation. The leader, refraksionis, supervisor, and doctor divisions had a highly supportive attitude towards cleanliness (71%), but only 20% performed regular cleaning. These findings support the research by Williams et al. (2015), Bingham et al. (2023), and Islam et al. (2024) which showed that inconsistency in cleanliness worsens pest infestations. Enhanced training and regular monitoring are needed to improve cleanliness practices in all divisions.

Table 7. Knowledge, Attitudes, and Practices (KAP) Related to Cleanliness and Cockroach Infestation Control Based on Position/Division in Offices

Offices											
Division	Knowledge (K)			Attitude (A)				Practice (P)			
	Agree	Disagree	No idea	Totally agree	Agree	Disagree	disagree strongly	Frequen	Agree	Disagree	
Security, Collector & Cleaner	14.71	1.29	4.00	2.71	2.14	0.14	0.00	2.00	2.71	0.29	
	74%	6%	20%	54%	43%	3%	0%	40%	54%	6%	
Maintenance, Cashier & Sales	15.25	1.33	3.42	2.33	2.42	0.25	0.00	1.92	1.92	1.17	
	76%	7%	17%	47%	48%	5%	0%	38%	38%	23%	
Leader, Refractions, Supervisor & Docter	15.45	1.27	3.27	3.55	1.36	0.09	0.00	1.00	1.82	2.18	
	77%	6%	16%	71%	27%	2%	0%	20%	36%	44%	

The correlation analysis between knowledge, attitudes, and cleanliness practices in hospitals, restaurants, and offices shows significant differences (Table 7). Hospitals: A significant positive correlation between knowledge and attitudes (0.538, $p = 0.002$) suggests better attitudes follow increased knowledge. However, inconsistencies arise with a negative correlation between knowledge and practices (-0.289, $p = 0.122$) and attitudes and

practices (-0.380, $p = 0.039$). Restaurants: No significant correlation was found. Offices: A significant negative correlation between knowledge and practices (-0.364, $p = 0.048$) indicates that knowledge does not always lead to good practices. These findings highlight the need for training and policies to improve cleanliness consistency

Table 7. Correlation Between Knowledge, Attitudes, and Cleanliness Practices in Hospitals, Restaurants, and Offices.

Characteristic	Knowledge - Attitudes		Knowledge - Practice		Attitude - Practice	
	Koef Correlation	P Value	Koef Correlation	P Value	Koef Correlation	P Value
Hospital	0.538	0.002*	-0.289	0.122	-0.380	0.039*
Restaurant	0.101	0.597	0.221	0.241	-0.121	0.523
Offices	0.314	0.091	-0.364	0.048*	-0.049	0.795

*Significantly correlated at the test level 5 % ($\alpha = 0.05$)

4. Conclusion

The distribution of *P. americana* infestation has the highest abundance and frequency values in all institutions both in hospitals, restaurants and offices. The relationship between the degree of infestation of cockroach with knowledge, attitudes and practices, in the staff group both hospitals, restaurants and offices have a good level of knowledge about cockroach infestation, but the application of cockroach control practices still needs to be improved to achieve more effective results.

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