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Seasonal Relative Abundance of Peri-Domestic Insects in Owerri Municipality and Surrounding Areas

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Abstract
This study investigated the seasonal relative abundance of medical importance of peri-domestic insects (PDI) in Owerri Municipality and its environs in Imo State, Nigeria. Three major areas were considered: Owerri n Municipality, Owerri West and Owerri North. Three major communities were randomly selected and sampled in each area. Sampling was done two times a week in the wet season and dry season. Different sampling regimes were used to determine the effect of season on the relative abundance of the medical importance of PDI in the area. The sampled sources of Cockroach spp collected were toilets and kitchens while sampled sources of housefly collection include refuse dumps, kitchens, toilets and baits. Two methods were employed to collect mosquito species: indoor and outdoor collection of mosquitoes. Statistical Package for the Social Sciences (SPSS) version 20.0 was used to run the analysis. Data obtained in this study were subjected to simple percentage, frequency table, mean, standard deviation, Pearson Product Moment correlation, contingency coefficient, multiple regression and t-test for independent test at $\alpha = 0.05$. The result found that the relative abundance of medical importance of some PDI between wet and dry seasons was 60.5%and 39.5% in the study area. Hence, medical importance of some PDI was more abundant during the dry season than the wet season. And the mean difference was not significant. There were significant variations in the temperature, relative humidity and rainfall on medically important PDI during the wet and dry season. It was also found that temperature and relative humidity had little effect on medical importance of PDI during the wet and dry seasons in the study area. Climatic factors (such as humidity, temperature and rainfall) and have positive and significant effects on the diseases caused by the medical importance of some peri domestic insects (PDI). Therefore, the present study calls for strategic vector control intervention programmes that will help prevent the surge of medically important peri-domestic insects' density and the consequent scourge of diseases in this area of study and spread to other areas.

Keywords: Insects, Peri-Domestic Insects, Seasonal Relative Abundance, Pests, Surroundings

Introduction

Unlike other insects that simply fly by buildings or enter and exit through open doors and windows, domestic insects live, feed, and reproduce continuously in homes (Breitwart, 2008; Hughes et al., 2012). Among them are cockroaches, ants, fleas, mosquitoes, and other pests found in homes. When food and shelter are available in our homes, these insects are drawn in. We all know that common household pests like ants, cockroaches, and flies are drawn to rooms with food, moisture, or clutter. The kitchen, bathroom, and living room are additional locations where these home pests can be found. Insect pests ranging from peri-domestic to regular domestic are present in large quantities. Both fly species and non-fly species are considered peri-domestic insects. Flying insects possess two sets of wings: one set for flight and the other set for balance, known as halteres, which are partially developed hind wings. The Greek words di-two and pteron-wings give rise to the order of which they are primarily members, Diptera. With roughly 110 families split between them, the order Diptera is split into two suborders (one of which is non-monophyletic).

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An estimated 1,000,000 species are found in these families, which include the common housefly, cranefly, and hoverfly (James, 2006). Despite not being Dipterans, many insects, like butterflies, have the word "fly" in their names. Informally and non-scientifically, the term "fly" can also refer to any small flying insect. But from a scientific standpoint, this is incorrect. In order to clearly indicate that the insect being discussed is a Dipteran, the term "true fly" is employed. Termites, beetles, cockroaches, fleas, lice, bed bugs, butterflies, moths, ants, and wasps are examples of non-fly peri-domestic insects. Regardless of the type of insect (i.e. e. Whether they are fly or not, the medical value of certain peri-domestic insects is related to human health because they coexist with humans. This is one of the topics that the current study is looking into.

Most household insects are small in size; they are, therefore, able to live in places far too small for other animals. In such areas, they find food and shelter from enemies; insects have been inside grains, in the pages of newspapers and books, in woods, and in eggs of other insects and because they are small, they need small food, crumbs, and sometimes participate in a banquet (Greenberg, 2004; Okere, 2018). Many species of insects feed on an apparently endless array of foods. Many garden insects feed on plant-based materials. Differences in the life stages of the insects may lead to differences in feeding habits. For example, the adult butterfly pollinating flowers of crops may have destroyed many vegetables as caterpillar a few weeks earlier. Many peri-domestic insects accept plant and animal matter as food, example the omnivorous cockroaches. Many such as the scavengers not only eat dead plant remains they also turn woody materials into humus (Kronauer & Daniel, 2008; Okere, 2018). The most important point to note here is that feeding habits and activities of peri-domestic insects can impinge on the economy, health and overall welfare of man. This is supported by literature. Briefly, some species of true flies (as peri-domestic insects) are considered dangerous vectors of diseases. They are guided by their senses of smell, sight and temperature to dung, carcasses and other organic remains of human activities. Peri-domestic insects such as fleas and lice are ecto-parasites whereas, mosquitoes are fluid feeders. Male and female mosquitoes feed on nectar in the garden where man also cultivates crops for his survival. Female mosquitoes also feed on human blood for egg development and nourishment. Some mosquitoes prefer to feed on the blood of animals (zoophilic in habit) while some prefer the blood of humans in that circumstance referred to as anthropophilic mosquitoes (Nzewuihe et al., 2021). Termites and wood eaters are not hindered by the difficulty associated with the digestion and assimilation of cellulose, yet some bore into the wood on furniture and structural timber to oviposit and to provide shelter for the growing larva (Kronauer & Daniel, 2008; Okere, 2018). This activity has direct consequence on the economy of man. Moths feed mainly on animal hides and skin, the booklice is found among old books, nibbling at the glue used to fix or bind the books, the wasp exhibits parental care using human habitat as refuge. Its larva needs fresh food. It immobilizes captured bees, caterpillars, grasshoppers and spiders with hypodermic sting. The paralyzed preys are moved into already prepared chambers in the nest where the larvae develop on the paralyzed fresh food. Insects have also adapted to eating everything except glass and metal (Greenberg, 2004). This has put a man under much pressure of struggling to control the obnoxious and notorious peri-domestic insect species or at least contain their nuisance.

Incidentally, nearly all non-field activities of man are carried out in shelters/ buildings. Many insect orders are adapted to living with man, from the temporary hut of coastal fishermen to long-distant farms accessed through mobile caravans to the twenty-first-century high-rise building. Many of these insects are tiny, barely a few millimeters long. Their presence in human dwellings is not usually obvious because of their sizes. This makes their control a heavy liability since size, habits and attitudes favour their survival. Furthermore, grains or dry fish have been largely turned into whitish or yellowish powder in several homes by bruchids or dermestid beetle pests. It is usual to observe several protein-based food items get infested by maggots before use, especially in poor and rural communities that rely on drying and salting as a preservation method. Soldier ants (peri-domestic insects of the insect order hymenoptera) have precisely followed the traits of palm oil broth to invade homes. Tell tales of insect presence come from discarded insect wings, insect droppings or termite runways along the walls of buildings (Okere, 2018). These are all notable records. However, apart from the role peri-domestic insects play as pests, vectors and nuisance, some species have been found quite beneficial (Hughes et al., 2012; Okere, 2018). Some peri-domestic insects provide ecosystem services. Bees and butterflies pollinate our flowers and ensure that we have fruits to eat and seeds to plant. Many peri-domestic insects such as praying mantids and ladybird beetles are biological control agents; predating on many obnoxious pests of gardens, and thus preventing the populations of pests from reaching alarming status (Harzsch & Hafner, 2006; Greenberg, 2004; Kronauer & Daniel, 2018). Many are known for their decomposition of organic matter. House flies for instance have been tested to degrade pig manure to reduce foul odor. Flies feed on bio-waste

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and transform it into high quality nutrients used in agriculture. The soil dwelling insects enrich the soil with their wastes and dead bodies. The soil termite recycles organic matter, improves the soil organic-carbon content, improves the pH of the soil, enhances soil porosity to water and creates favourable conditions for primary productivity. Some peri-domestic insects such as termites, beetles and their larvae serve as food for man and lower animals. They serve as food for geckos, dragonflies, toads, birds and bats (Okere, 2018).

The farming of insects is becoming attractive to science in the search for alternative sources of animal protein and peri-domestic insects are not out of the list. Insects are drought-resistant and therefore, use much less water than conventional livestock. For centuries, insects were known to be popularly eaten especially in Africa, Asia, and Latin America. It is estimated that about two billion individuals currently eat insects annually. Insects are eaten as a staple, for taste, or as a delicacy. They are eaten in various forms and may be ground into powder/paste or incorporated into other foods. Recently entomophagy (the science of consumption of insects) has aroused interest among research institutes, chefs, food industries, and food agencies (Okere, 2018). As more information emerges, it is now known that about 2000 species of insects from mainly eight insect orders are consumed worldwide. Peri-domestic insects such as beetles, caterpillars, bees, wasps, ants, grasshoppers, crickets, true bugs, termites and dragonflies form part of the insect food items for man. Some of these insects are amenable to mass rearing to feed man, as well as pets, birds, pigs, pond fish (trout, catfish, tilapia) (Okere, 2018). Mealworms and maggots are reared on poultry, pig or cattle manure. Their activities reduce manure mass, moisture content, offensive odour and the pollution potential of manure as well as other associated harmful bacteria (Greenberg, 2004). Compared with meat and fish, insects provide high-quality protein and other nutrients. They are rich in fibre and micro-nutrients such as copper, iron, magnesium, manganese and phosphorous. Domestication and semi-domestication of the grasshopper and palm weevil lance can solve the problem of protein and iron deficiency in pregnant woman and in school children. They can also serve as veritable food supplements in cases of emergency such as in the case of internally displaced people (IDP) camps in Nigeria.

The control of peri-domestic insects and the management of diseases transmitted by those with vectorial capacity become a heavy burden because human population, industrial activities and urbanization and household material consumption expansion (WHO, 1997). It is important to identify the medical importance peri-domestic insects prevalent in the study area as the first step towards controlling the species that act as pests and vectors of different diseases. It is known that peri-domestic insects fluctuate with season and incidentally, certain human activities are seasonal too.

Unfortunately, local knowledge and best practices are poor, culminating in human activities and attitudes that culminate in the build-up of medical importance peri-domestic insects at home. Therefore, in this study, the relative seasonal abundance of the peri-domestic insects is of great concern. High abundance of peri-domestic insect vectors implies an increased prevalence of the diseases they transmit. This however is not often the case because other environmental factors may mitigate or contain predicted public health implications. There is a need to clarify this through a comparison of the relative abundance of medical importance of prey-domestic insect vectors with the prevalence of the diseases they transmit by matching with hospital records in the environment under investigation. This study is necessary to determine the geographical and localized distribution of different medical importance peri-domestic insect species in the study area and determine the seasonal effect of temperature, humidity and rainfall on medical-importance peri-domestic insects in the study area.

Aim and Objectives

This study aims to examine the seasonal variations in the relative abundance of medically significant peri-domestic insects (PDI) in Owerri Municipality and its surrounding areas in Imo State, Nigeria. This study aims to achieve the following specific objectives:

i. To ascertain peri-domestic insect (PDI) seasonal relative abundance in the research area.
ii. To ascertain the impact of humidity, rainfall, and temperature on a few peri-domestic insects (PDI) within the study region.

Research Questions

The following research questions guided the study:

1. What is the seasonal relative abundance of peri-domestic insects (PDI) in the study area?

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2. What are the effects of temperature, humidity and rainfall on some peri-domestic insects (PDI) in the study area?

Hypotheses

The following hypotheses were tested in this study at $p<0.05$ alpha level:

1. There is no significant difference in the medical importance of some peri-domestic insects (PDI) caught during the wet and dry season in Owerri Municipality and its environs.
2. There is no significant difference in the relative abundance of medical importance of some peri-domestic insects (PDI) during the wet and dry season.
3. There is no significant variation in the mean temperature on the medical importance of some peri-domestic insects (PDI) during the wet and dry season in the study area.
4. There is no significant variation in the mean relative humidity on medical importance of some peri-domestic insects (PDI) during the wet and dry season in the study area.
5. There is no significant joint contribution of temperature and relative humidity to the variation observed in the number of medical importance of some peri-domestic insects (PDI) abundance.

Materials and Methods

This investigation was conducted in Nigeria's Imo State, specifically in the Owerri Municipality and its surroundings. A few peridomestic insects with potential medical value were gathered in Owerri Municipality and its surroundings between April 2019 and March 2020. Three principal regions were considered: Owerri Municipality, Owerri West, and Owerri North. Three significant streets, locations, or communities were chosen at random and sampled in each area. During both the wet and dry seasons, two samplings were conducted each week. To find the impact of the season on the relative abundance of the area's medically significant peri-domestic insects, various sampling regimens were employed. The following methods were used to sample peri-domestic insects: sweep nets, insecticides, water-retaining containers, and various types of bait. Under the guidance of Imms (1967, and Suleiman et al. (1988), morphological traits were used to sort and identify captured insects. Before they were identified, immature stages were raised to adulthood in a lab. An expert entomologist validated the species of peridomestic insects that the researchers had identified. The analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 20.0. The study's data were subjected to multiple regression, t-test for an independent test at $\alpha = 0.05$, contingency coefficient, mean, standard deviation, frequency table, simple percentage, and Pearson product-moment correlation. Data on cases of diseases transmitted by some medical importance peri-domestic insects and temperature, relative humidity and rainfall were presented in a frequency table. Multiple regression techniques was used to ascertain the significant joint contribution of temperature and relative humidity to the variation observed in the number of some medical importance peri-domestic insect abundance.

Results

The study's summary and data analysis, based on the three Owerri Municipality locations—Owerri West and Owerri North LGAs—is presented in this section. The outcomes of the data analysis are displayed in accordance with the goals of the research.

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Table 1: Seasonal relative abundance of some peri-domestic insects in the study area.

Peri-domestic insects	Species	Owerri Municipality	Owerri West	Owerri North	TOTAL
Houseflies	*Musca domestica*	271	301	344	916
	Musca. sorbens	0	0	130	130
	Caliphora vomitoria	161	305	245	711
	Chrysomya rufifacies	205	485	0	690
	Chrysomya megacephala	720	217	295	1232
Cockroaches	*Periplaneta americana*	383	367	338	1088
	Supella longipalpa	56	0	0	56
	Blatella germanica	74	118	126	318
Mosquitoes	*Anopheles gambiea*	226	178	72	476
	Culex quinquefasciatus.	148	82	137	367
	Aedes aegypti.	112	58	40	210
	TOTAL (%)	**2356(38.0)**	**2111(34.1)**	**1727(27.9)**	**6194**

Table 1 summarizes the distribution of peri-domestic insects sampled from Owerri Municipality and its environs. Owerri Municipality recorded the highest number of medical importance peri-domestic insects (38%) in the study followed by Owerri West which had (34.1%) whereas Owerri North recorded the lowest number of medical importance peri-domestic insects (27.9%). There was no clear pattern in the distribution of peri-domestic insects across the three LGAs. Figure 1 below is the bar chart showing the distribution of medical importance peri-domestic insects in Owerri Municipality and its environs.

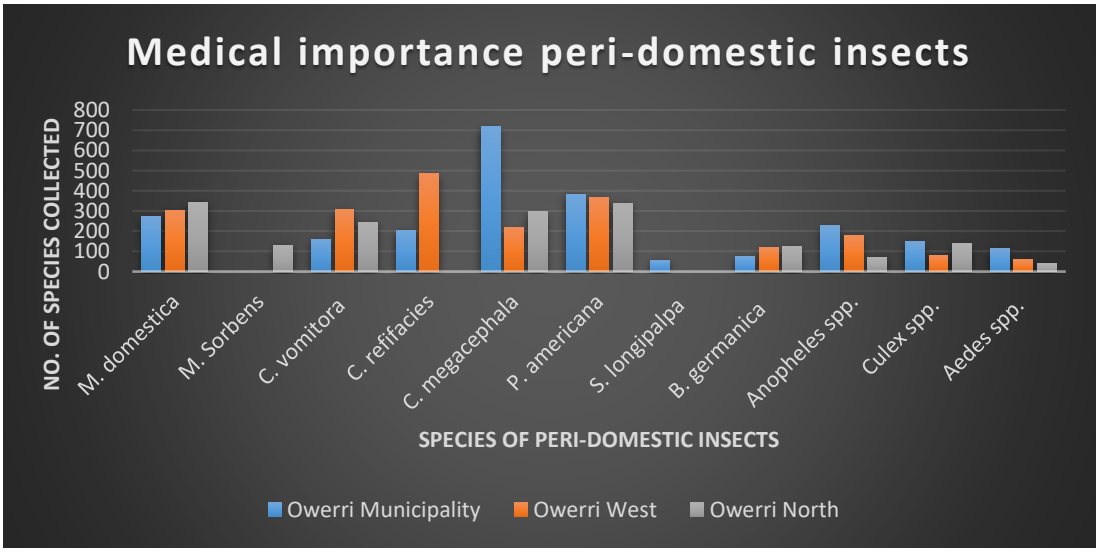

Figure 1: Bar-chart showing the distribution of peri-domestic insects in the study area

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Table 2: Seasonal relative abundance of peri-domestic insects in the study area in Owerri Municipality

Species of Insects	No. collected	Seasonal relative abundance			
		Dry	RA(%)	Wet	RA(%)
Musca domestica	271	169	62.4	102	37.6
Musca sorbens	0	0	0	0	0
Caliphora vomitoria	161	94	58.4	67	41.6
Chrysomya rufifacies	205	119	58	86	42
Chrysomya megacephala	720	425	59	295	41
Periplaneta americana	383	207	54	176	46
Supella longipalpa	56	39	69.6	17	30.4
Blatella germanica	74	41	55.4	33	44.6
Anopheles gambiae	226	144	63.7	82	36.3
Culex quinquefasciatus.	148	88	59.5	60	40.5
Aedes aegypti.	112	68	60.7	44	39.3
Total	**2356**	**1394**		**962**	
Mean		**126.7±34.991**		**87.4±25.190**	
Relative Abundance (%)		**59.2**		**40.8**	
p-value		**.373**			

Table 2 shows the seasonal relative abundance of medical importance peri-domestic insects in Owerri Municipality. The result revealed that the mean difference in medical importance peri-domestic insects caught during the wet (40.8%) and dry (59.2%) seasons was not significant in Owerri Municipality ($p>0.05$). A higher number of peri-domestic insects were trapped during the dry than wet season in Owerri Municipality ($t = .911$, $p = .373$).

Table 3: Seasonal relative abundance of peri-domestic insects in the study area in Owerri West

Species of Insects	No. collected	Seasonal relative abundance			
		Dry	RA(%)	Wet	RA(%)
Musca domestica	301	169	56.1	132	43.9
Musca sorbens	0	0	0	0	0
Caliphora vomitoria	305	163	53.4	142	46.6
Chrysomya rufifacies	485	279	57.5	206	42.5
Chrysomya megacephala	217	122	56.2	95	43.8
Periplaneta americana	367	206	56.1	161	43.9
Supella longipalpa	0	0	0	0	0
Blatella germanica	118	85	72	33	28
Anopheles gambiae	178	122	68.5	56	31.5
Culex quinquefasciatus.	82	56	68.3	26	31.7
Aedes aegypti.	58	40	69	18	31
Total	**2111**	**1242**		**869**	
Mean		**112.9±26.441**		**79.0±21.647**	
Relative Abundance (%)		**58.8**		**41.2**	
p-value		**.333**			

Table 3 shows the seasonal relative abundance of medical importance peri-domestic insects in Owerri West. The result revealed that the mean difference in medical importance peri-domestic insects caught during the wet (41.2%) and dry season (58.8%) was not significant in Owerri West ($p>0.05$). A higher number of medical-importance peri-domestic insects were trapped during the dry than wet season in Owerri West ($t = .992$, $p = .333$).

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Table 4: Seasonal relative abundance of peri-domestic insects in the study area in Owerri North

Species of Insects	No. collected	Seasonal relative abundance			
		Dry	RA(%)	Wet	RA(%)
Musca domestica	344	213	61.9	131	38.1
Musca sorbens	130	109	83.8	21	16.2
Caliphora vomitoria	245	157	64.1	88	35.9
Chrysomya rufifacies	0	0	0	0	0
Chrysomya megacephala	295	177	60	118	40
Periplaneta americana	338	204	60.4	134	39.6
Supella longipalpa	0	0	0	0	0
Blatella germanica	126	82	65.1	44	34.9
Anopheles gambiea	72	46	63.9	26	36.1
Culex quinquefasciatus.	137	89	65	48	35
Aedes aegypti.	40	34	85	6	15
Total	**1727**	**1111**		**616**	
Mean		**101.0±23.462**		**56.0±15.864**	
Relative Abundance (%)		**64.3**		**35.7**	
p-value		**.128**			

Table 4 shows the seasonal relative abundance of medical importance peri-domestic insects in Owerri North. The result revealed that the mean difference in medical importance peri-domestic insects caught during the wet (35.7%) and dry season (64.3%) was not significant in Owerri North ($p>0.05$). A higher number of medical importance peri-domestic insects were trapped during the dry than wet season in Owerri North ($t = .992$, $p = .333$).

Table 5: Summary of some peri-domestic insects species caught in the study area

Peri-domestic insects	Species of insects	Seasonal relative abundance		
		No. collected	Dry	Wet
Houseflies	*Musca domestica*	916	551	365
	Musca sorbens	130	109	21
	Caliphora vomitoria	711	414	297
	Chrysomya rufifacies	690	398	292
	Chrysomya megacephala	1232	724	508
Cockroaches	*Periplaneta americana*	1088	617	471
	Supella longipalpa	56	39	17
	Blatella germanica	318	208	110
Mosquitoes	*Anopheles gambiae*	476	312	164
	Culex quinquefasciatus.	367	233	134
	Aedes aegypti.	210	142	68
	Total	**6,194**	**3747(60.5%)**	**2447(39.5%)**

Table 5 shows the summary of the medical importance peri-domestic insects' species caught in the study area. The result revealed that a total of 6194 peri-domestic insects species were collected. Out of which 3747 insects were caught during the dry season and 2447 insects during the wet season. The relative abundance of medical importance peri-domestic insects between wet and dry seasons was 60.5%and 39.5% respectively when compared as depicted in Figure 2. Hence, medical importance peri-domestic insects were more abundant during the dry season than the wet season.

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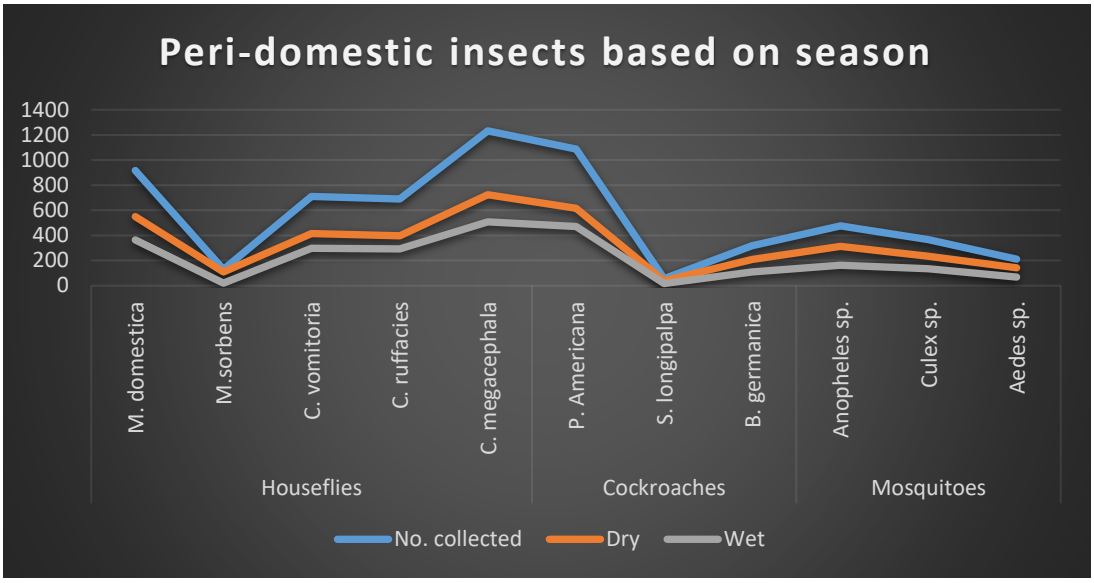

Figure 2: Plot showing the summary of the medical importance of peri-domestic insects species caught in the study area

Mean difference in the seasonal relative abundance of peri-domestic insects in the study area.

Table 6: Comparing the seasonal relative abundance of peri-domestic insects in the study area

Peri-domestic insects	**Species of insects**	**Seasonal relative abundance**		
		No. collected	**Dry**	**Wet**
Houseflies	*Musca domestica*	916	551	365
	Musca sorbens	130	109	21
	Caliphora vomitoria	711	414	297
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	Supella longipalpa	56	39	17
	Blatella germanica	318	208	110
Mosquitoes	*Anopheles gambiae*	476	312	164
	Culex quinquefasciatus.	367	233	134
	Aedes aegypti.	210	142	68
Total		**6194**	**3747**	**2447**
Mean			**340.64±66.767**	**222.45±52.619**
Relative Abundance (%)			**60.5%**	**39.5%**
p-value			**0.180**	

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Table 6 shows the comparison between the seasonal relative abundance of medical importance peri-domestic insects in the study area. The result revealed that the mean difference in medical importance peri-domestic insects caught during the wet and dry seasons was not significant ($p>0.05$). A higher number of peri-domestic insects were trapped during the dry than wet season ($t = 1.390$, $p = 0.180$).

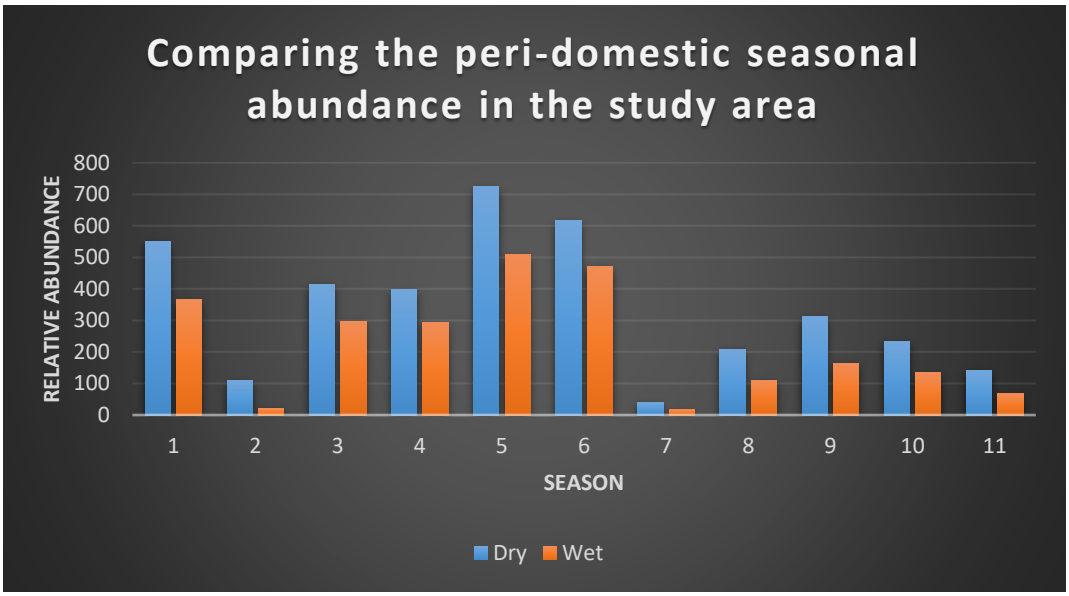

Figure 3: Seasonal relative abundance of peri-domestic insects in the study areas

From the Figure 3, it shows that the relative abundance of peri-domestic insects during the wet and dry seasons indicated higher abundance during the dry season. This confirmed the presence and the abundant distribution of peri-domestic insect populations with marked seasonal fluctuations in the study area.

Seasonal effect of temperature, humidity, and rainfall on peri-domestic insects in the study area.

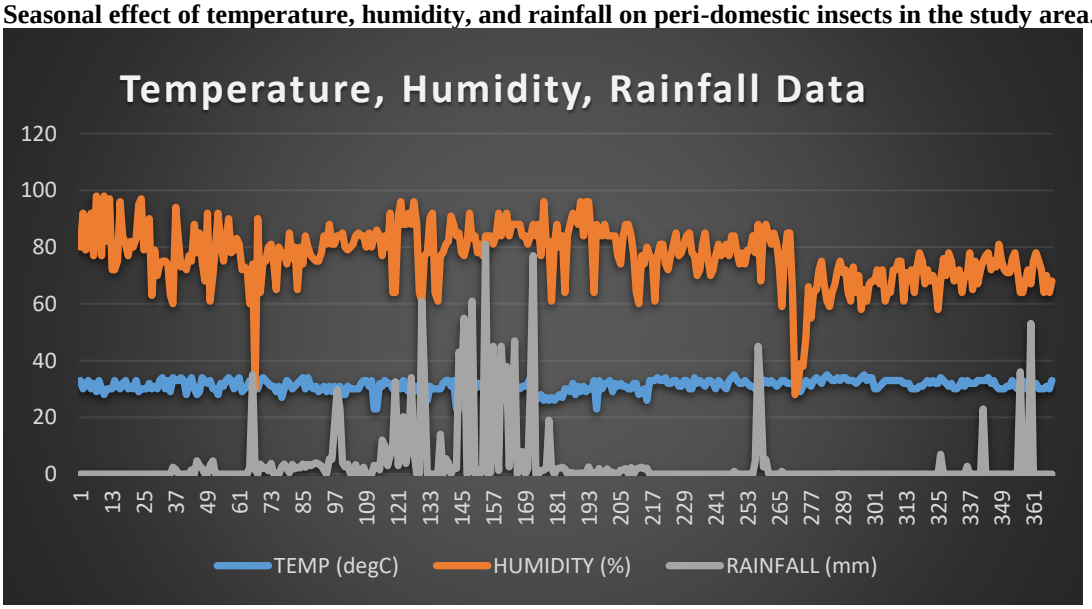

Figure 4: Plot showing temperature, humidity and rainfall reports

From Figure 4, it is observed that there is variations in the temperature, relative humidity and rainfall due to seasonal effect on medical importance peri-domestic insects in the study area.

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Table 7: Seasonal effect of temperature, humidity and rainfall on peri-domestic insects in the study area.

Variables	Season	N	Mean	Std. Dev	SEM	p-value
Temperature	Wet	215	30.53	2.289	.156	.000
	Dry	153	32.12	1.323	.107	
Humidity	Wet	215	80.79	9.104	.621	.000
	Dry	153	71.54	9.503	.768	
Rainfall	Wet	215	5.65	13.269	.905	.000
	Dry	153	1.37	6.921	.560	

From Table 7, the mean seasonal temperature values recorded were 32.1°C (dry season) and 30.5°C (wet season), with mean seasonal relative humidity values of 71.5% (dry season) and 80.8% (wet season) respectively, while the mean rainfall was 5.65 (wet season) and 1.37 (dry season). There was a significant variation ($p \leq 0.05$) in the mean temperature as well as in the mean relative humidity and rainfall over the two seasons. This implies that there are significant variations in the mean temperature, relative humidity and rainfall on medical importance peri-domestic insects during the wet and dry season in the study area. See Figures 5, 6 and 7 below showing the graphical illustrations.

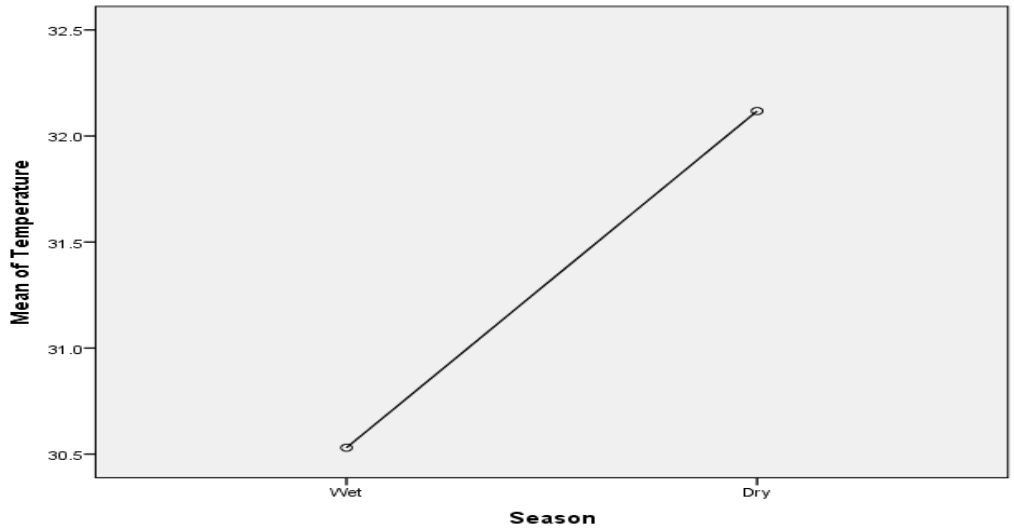

Figure 5: Plot showing mean temperature and season

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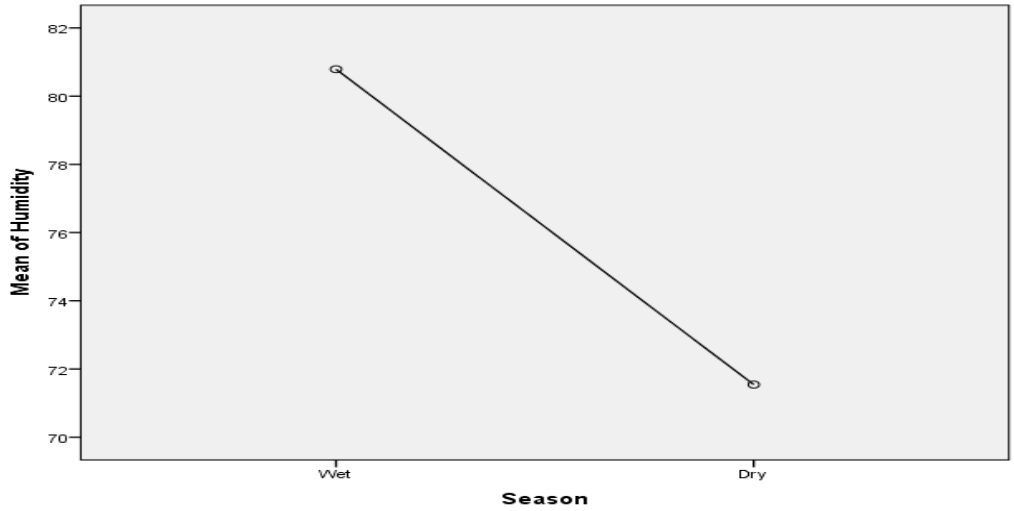

Figure 6: Plot showing mean relative humidity and season

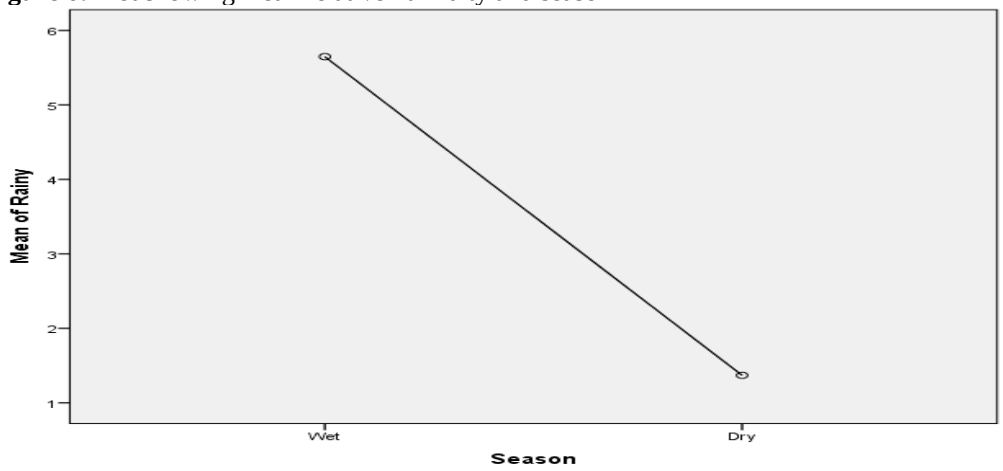

Figure 7: Plot showing mean rainfall and season

Table 8: Correlation matrix of temperature, humidity and rainfall

		No. collected	Temperature	Humidity	Rainfall
Pearson correlation	No. collected	1.000	-.016	.060	.
	Temperature	-.016	1.000	-.325	.
	Humidity	.060	-.325	1.000	.
	Rainfall	.	.	.	1.000
p-value	No. collected	.	.465	.370	.000
	Temperature	.465	.	.032	.000
	Humidity	.370	.032	.	.000
	Rainfall	.000	.000	.000	.

The correlation analysis in (Table 8) of the number of medical importance peri-domestic insects caught and the variation in temperature and relative humidity indicated a positive relationship between relative humidity and the number of peri-domestic insect abundance. A non-significant ($p \leq 0.05$) weak positive correlation was also found between relative humidity and the number of medical-importance peri-domestic insects caught. This by implication goes to show that there is no significant variation in the relative humidity on medical importance peri-domestic insects during the wet and dry season in the study area. However, the correlation analysis of temperature and number of

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trapped peri-domestic insects showed that temperature inversely varies with peri-domestic insect abundance. Furthermore, a non-significant ($p \leq 0.05$) negative correlation was found between temperature and abundance of the peri-domestic insects. This implies that there is no significant variation in the mean temperature of medical-importance peri-domestic insects during the wet and dry seasons in the study area.

Table 9: Significant joint contribution of temperature and relative humidity to the number of peri-domestic insect abundance

Variable	Multiple-R	R-square	p-value	Decision
Temperature				
Humidity	0.060	0.004	.947	Not Sig.
No. collected				

$$No.of\ insects = 86.559 + 0.423Temperature + 1.067Humidity$$

From Table 9 and the regression equation, the multiple regression analysis results revealed that temperature and relative humidity jointly accounted for only about 0.4% of the variation observed in the number of medical importance peri-domestic insect abundance. The contribution is not significant as attested to by the multiple regression analysis carried out ($F = 0.054$, $p > 0.05$). This implies that both temperature and relative humidity had little effect on medical importance peri-domestic insects during the wet and dry seasons in the study area.

Table 11: Effect of humidity, temperature and rainfall on peri-domestic insects based on hospital records

Climate Variables	Malaria	Cholera	Yellow Fever	Diarrhoea	Total
Temp	2277	43	1	115	2436
Humidity	5616	106	1	284	6007
Rainfall	286	6	0	15	307
Total	8179	155	2	414	8750

$$\chi^2_{cal} = 0.604;\ \chi^2_{tab} = 12.8; df = 6; c = 0.0083$$

Table 11 shows a contingency table for the effect of humidity, temperature and rainfall on the diseases caused by medical importance peri-domestic insects based on hospital records. The result revealed a positive and significant relationship between climatic factors (humidity, temperature and rainfall) and diseases caused by medical importance peri-domestic insects. This indicates that climatic factors (such as humidity, temperature and rainfall) have positive and significant effects on the diseases caused by medical importance peri-domestic insects. By implication, it goes to show that an increase in climatic factors (humidity, temperature and rainfall) would increase the number of cases of diseases caused by medical importance peri-domestic insects based on hospital records.

Discussion

From the findings of this study, three species of cockroaches were identified: Blatella *germanica*, *Supella longipalpa*, and *Periplenata americana. Musca domestica*, *Musca sorbens*, *Calliphora vomitoria*, *Chrysomya rufifacies*, and *Chrysomya megacephala* were the species of housefly that were identified, whereas *Anopheles gambiea*, *Culex quinquefaciatus*, and *Aedes aegypti* were the species of mosquito. This demonstrated that peri-domestic insects of various species with potential medical value were present in the studied area. According to the study, there were 60.5% and 39.5%, respectively, of medically significant peri-domestic insects in the study area during the dry and wet seasons. This indicates that medical importance peri-domestic insects were more abundant during the dry season than the wet season. The relative abundance of medical importance peri-domestic insects during the wet and dry season indicated higher abundance during dry season. This collaborates with the findings of Lukaw et al. (2015) who reported significantly higher catches of medical importance peri-domestic insects in dry than the wet season in Kajo-Keji County South Sudan. Globally, it has been revealed that the population of medical importance peri-domestic insects significantly varies with seasons (Abah et al., 2019). The mean difference in this medical importance peri-domestic insects caught during the wet and dry season was not significant in the study area. It was found in this study that the mean seasonal temperature values recorded were 32.1°C (dry season) and 30.5°C (wet season), the mean seasonal

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relative humidity values were 71.5% (dry season) and 80.8% (wet season) while the mean rainfall was 5.65 (wet season) and 1.37 (dry season). The hypothesis revealed significant variations in the temperature, relative humidity and rainfall on medical importance peri-domestic insects during the wet and dry season in the study area. A similar case was reported by Okoh et al. (2011), who opine that environmental parameters create suitable conditions for the survival and flourishing of medical-importance peri-domestic insects. The findings of this study also found that temperature inversely varies with peri-domestic insect abundance. This implies that an increase in temperature would decrease the number of medical-importance peri-domestic insects in the study area. It was found that temperature and relative humidity jointly accounted for only about 0.4% of the variation observed in the number of medical importance peri-domestic insect abundance. This by implication goes to show that temperature and relative humidity had little effect on medical importance peri-domestic insects during the wet and dry seasons in the study area. Previous studies highlighted also that the combination of many factors such as vegetation density, the presence of nutrient and hosts could explain the high density of medical importance peri-domestic insects in any specific area (Abah et al., 2019).

For one thing, this study has provided empirical evidence to support the fact that peri-domestic insects are abundant in Owerri Municipality and its environs in Imo State, Nigeria. The high abundance of peri-domestic insects in humid tropical areas of which Imo State, Nigeria is part has been well-documented (Onyido et al., 2007; Okere, 2018). The findings of this study further revealed that sampling site impacted on the abundance of the peri-domestic insects, but the season did not have a significant effect on the relative abundance of the species of peri-domestic insects sampled. This suggests that other factors of habits, nature of activities within human habitation and human activities generally, may play important roles in the relative abundance of peri-domestic insects. This could be probably true because Nzewuihe et al. (2021) have recently implicated domestic habits and human activities in the prevalence of mosquitoes and incidentally, mosquitoes are peri-domestic insects. Therefore, environmental interventions to reduce population densities of peri-domestic insect vectors are necessary to minimize public health implications of their existence. In many countries of the world, there is public awareness to minimize unwarranted activities that attract peri-domestic insect vectors to human habitations (Udonsi, 1999). Notably, majority of these peri-domestic insect vectors are true flies. Amaechi et al. (2017) sampled fly vectors, inclusive of *M. domestica*, assessed their epidemiological implications in Owerri Imo State and revealed that some of the flies were infected with the pathogens they transmit. In this study, houseflies showed relatively high abundance throughout the season regimes and most of the sampled flies were caught from refuse dumpsites this corresponds with the works of Onyido et al. (2007), who reported that houseflies were the most abundant (48.1%) flies in undisposed refuse dumps in Awka town, Anambra State, Nigeria. From these statistics, it appears that houseflies as peri-domestic insect occurs in high abundance irrespective of location. Suffice it to say that house flies are nuisance pests because of their ubiquitous nature, supported by the warm climatic condition of the tropics and this makes them live in close association with human beings and has been implicated in the mechanical transmission of pathogenic diseases.

The findings of this study also revealed that mosquitoes sampled in the study were relatively highly abundant and belong to the generaAnopheles, *Culex* and *Aedes*. The mosquito species collected are of medical importance and transmit diseases deleterious to man. It was revealed that Owerri Municipality had the highest percentage of mosquito larvae and this is not surprising. In course of survey, blocked drainage systems were noticed in Owerri Municipality. Unfortunately, blocked drainage systems retain water and serve as an excellent breeding site for mosquitoes. Furthermore, many fairly used and poorly discarded automobile tyres were littered in and around Owerri Municipality Council and this also serve as an excellent breeding site for mosquitoes of various species. From the above findings, it is easy to conclude that environmental sanitation is one of the major factors that influenced the relative abundance of peri-domestic insects in sampled areas. Nzewuihe et al. (2019) stressed that a combination of factors such as temperature, pH, dissolved oxygen, relative humidity, conductivity and anthropogenic factors contribute to the increasing abundance of mosquitoes in the environment they occur. The occurrence of *Aedes*, *Anopheles* and *Culex* is suggestive of the prevalence of vector-borne diseases such as malaria, typhoid fever and other harmful diseases in both man and some of his livestock. There was a relatively high occurrence of *Culex*species in the study. The predominance of *Culex* species over *Anopheles* species and *Aedes* species, especially in Owerri Municipality, may be associated with the variation in larval habitat requirements of the species. *Culex* species usually breed profusely in polluted gutters, blocked drains and other water retention habitats with organic matter, unlike *Aedes* and *Anopheles* mosquitoes which prefer clean ground pools and man-made containers respectively (Abdurasheed, 2017). The

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sampled locations in Owerri Municipality and its environs have many polluted gutters which could have provided a favourable environment for rapid breeding of *Culex* species.

More so, the findings of this study revealed that the total number of patients with diseases within the period is 8,750 with malaria recorded the highest occurrence (93.5%), followed by diarrhoea (4.7%), cholera (1.8%) and yellow fever (0.02%). Further analysis revealed a positive and significant relationship between climatic factors (humidity, temperature and rainfall) and diseases caused by medical importance peri-domestic insects. This indicates that climatic factors (such as humidity, temperature and rainfall) have a positive and significant effect on the diseases caused by medical importance peri-domestic insects. By implication, it goes to show that an increase in climatic factors (humidity, temperature and rainfall) would increase the number of cases of diseases caused by medical importance peri-domestic insects based on hospital records. This is not surprising because climatic change is increasing the risk of vector-borne diseases. It seems that climate change is improving the climatic and environmental conditions for the transmission of many transmission seasons. This collaborates with the findings of Amaechi et al. (2017) who determined the abundance of flies concerning diseases.

Conclusion

The study confirmed the presence and the abundant distribution of medical importance peri-domestic insects with marked seasonal fluctuations in Owerri Municipality and its environs in Imo State, Nigeria. Also, findings of this study revealed significant variations in the temperature, relative humidity and rainfall on medical importance peri-domestic insects during the wet and dry seasons in the study area. It could mean that environmental parameters create suitable conditions for the survival and flourishing of medical importance peri-domestic insects. Further analysis revealed a positive and significant relationship between climatic factors (humidity, temperature and rainfall) and diseases caused by medical importance peri-domestic insects.

Recommendations

Based on the findings of this study, the following commendations were made to control the population of medically important peri-domestic insects and to mitigate the spread of diseases in Owerri Municipality and its environs Nigeria:

1. Improve waste management practices, particularly in refuse dump size, to reduce the breeding grounds for houseflies and other peri-domestic insects.
2. Establish vector control program to monitor and control of peri-domestic insect populations.
3. Conduct public awareness campaigns to educate residents on the importance of maintaining a clean environment and preventing peri-domestic insect infestation.
4. Collaborate with local authorities, healthcare providers, and community leaders to implement effective vector control strategies.
5. Conduct regular surveillance of peri-domestic insect population to monitor seasonal fluctuations.
6. Enhance healthcare infrastructure to improve disease diagnosis, treatment and management.

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