



GSJ: Volume 8, Issue 2, February 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

***Cimex*(Bedbugs)Infestation In Human Settlements And Its Health Implications**

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ABSTRACT

Cimex(bedbugs) are blood-sucking ectoparasites of mammals which infest most especially human habitations during which they suck the blood of their human host. Besides their nuisance to the human hosts, their itchy bites also cause some dermatological allergies such as skin irritations and scratching accompanied by development of skin disfiguring rashes sometimes resembling scabies. This study therefore investigated bedbug infestation in selected human settlements in Abuja, Nigeria, and their health impact. Forty homes (i.e., ten from each study communities) of Sabon-gari, Zuma II, Garba and Veritas University, respectively, were randomly selected, marked A to J, and surveyed. Beds, beddings, mattresses, clothings, etc., of the occupants were examined for presence of eggs, nymphs and adult bedbugs. The sexes and species of the bedbug specimens collected were identified using standard morphometric identification keys. The predisposing factors and the degree of infestation were established. The presence of bedbugs and their degree of infestation were established. Six thousand and sixty (6,060) bedbug specimens (comprising 1,648 adults, 875 nymphs and 3,577 eggs) were collected from the 40 apartments of the four communities under study. Thus, Sabon-gari had 1,193/19.8% bedbug specimens, Zuma II recorded 1,651/27.2%, while Garba and Veritas had 1,620/26.7% and 1,596/26.3%, respectively. Dirty environment and poor personal hygiene practices are among the predisposing factors that promote bedbug infestation. *Cimexlectularius* and *Cimexhemipterius* were the two species of bedbugs existing in the area. Minor clinical manifestations such as eczema, urticarial reactions, cellulitis, impetigo, lymphangitis, folliculitis, scabies-like rashes and anaemia in victims of bedbug bites were also recorded. Regular fumigation, use of pesticides, burning of infested beds, beddings and household furniture are recommended for the control of bedbugs. Corticosteroid cream such as diphenhydramine can be used by those exposed to bedbug bites, while victims with signs of anaemia are encouraged to take blood tonic supplements.

Key Words: *CimexLectularius*, *Cimexhemipterius*, Ectoparasite, Infestation, Habitation, Mammals, Beddings

INTRODUCTION

Bedbugs are ectoparasites that live on other warm blooded vertebrates and equally infest human habitations during which they feed on the blood of human hosts when they are sleeping. Entomological studies have revealed that bedbugs are small parasitic insects of the family *Cimicidae* (most commonly known as *Cimexlectularius*). The two species of humans are *Cimexlectularius* and *Cimexhemipterus*, which are globally distributed, through tropical, subtropical and temperate regions (21). Under optimal conditions, the adult bedbug feeds once a week, and their major attractants are human body temperature, carbon dioxide production, human body odour as well as certain chemicals from sweat (15). But of these two species, *Cimexlectularius* is the most common and generally referred to as the species whose preferred food is human blood. Ibrahim *et al.*, (1) reported that bedbugs are often found in beds and beddings such as bedspreads, pillows and pillow cases and in wall cracks, in wood furniture and behind loosened wallpaper. Bugs are usually somewhat nocturnal and elusive and therefore difficult to find. They are most usually found in inconspicuous dark crevices. Eggs may be nicely nestled and attached with a sticky substance in the seams of fabric (1). Human odorants possess great potential as attractant to the bed bugs. Indeed, previous studies of behavioral response to human volatiles have revealed that human sweat alone has a significant attraction for all stages and both sexes of bed bugs. Studies by Harracaet *al.*, (6), have indicated that odors from animal skin emanations are also attractive to bed bugs. The efficient olfactory system of bed bugs plays an important role in their host-detection process. The olfactory sensilla of the antennae of bedbugs carry olfactory receptor neuron which is responsible for detecting human odors.

Problems associated with bedbug infestation include lack of sleep, psychological and social distress arising from society's stigma concerning pests (15). Although bedbugs have not been linked to disease transmission, they have been shown to harbor the causative organisms of plague, relapsing fever, tularemia and Q fever. Symptoms from their bites include severe irritation, itching, inflammation, and swelling of the skin (12).

Special nocturnal search is often required as the definitive diagnosis depends upon collection and identification of bedbugs (21).

According to Potter, (16), in the 1980's, bedbugs were considered relatively uncommon in many developed countries, such as the UK probably due to some factors such as better facility management practices, better education, and emphasis on wide use of insecticides. But in developing countries, bedbug infestation is said to have been at a high level (12). Recent observations have shown that urban settings have experienced increased infestation over the past 10 years (14). There are also recent evidences that reveal insecticide resistance in bed bugs in addition to ineffective application techniques (22, 23, 24). Onahet *al.*, (12) in their findings attributed high infestation of bedbugs to increasing poor attitude towards housekeeping and poor hygiene.

MATERIALS AND METHODS

Study Area

The study area was some selected communities in Bwari Area Council, namely, Sabon-gari, Zuma II, Garba and the students' hostels of Veritas University, Abuja, Nigeria. Bwari Area Council is one of the six area councils in Abuja and is located at the North-Eastern part of the Federal Capital

Territory. It is situated between latitude $7^{\circ}23' 0''$ North of the Equator and Longitude $9^{\circ}17'0''$ East with a vast land of 1100km^2 .

It has a guinea savannah type of vegetation, with raining season stretching from April to October and dry season from November to March and the temperature ranges from $30\text{-}37^{\circ}\text{C}$ yearly with the highest temperature experienced in the month of March.

Ethical approval

Before embarking on the study, ethical approval was obtained from the Health Authority of Bwari Area Council, through an application to the Executive Chairman of Bwari Area Council, Federal Capital Territory, Abuja, in which the researchers explained the purpose and significance of the study. The same application was made to the Vice Chancellor of Veritas University, Abuja, for the same purpose, to enable the researchers gain access to the students' hostels.

Ethical consent

Selection of homes in the said communities of the study area was based on individual home owner's interest and willingness to allow his/her home to be surveyed for bedbugs. The rationale and significance of the study were explicitly explained to them after which they were allowed to decide whether to opt out or participate and thus surrender their homes to be used in the study.

Those who volunteered to participate were asked to put their consent and permission in writing.

Sample collection

After obtaining consent and permission of the households, systematic random sampling method was used to select 40 apartments (i.e., 10 from each of the four communities) mapped out to be sampled for presence of bedbugs. These chosen apartments labeled A, B, C, D, E, F, G, H, I, J,

K, and L were visited one after another. Beddings and furniture (bed frames, pillows, mattresses, carpets, bed sheets, cracks and crevices in walls, tables and chairs, mosquito nets and bed bunks) were thoroughly checked for bedbug infestation using the search guide described by Boase (20). A well-structured questionnaire instrument was used to obtain information on respondents' perception about bedbug infestation as well as the control practices they have been adopting. Sampling was conducted weekly for the three months duration of the study from April to June, 2019.

Collection of bed bugs

Physical handpicking and brushing methods were used for collecting the bedbugs and the specific point where the bugs were removed was noted. The bedbugs were collected into specimen bottles containing normal saline. The material from which the bedbug was collected and the number of bedbugs collected from each material were noted. Adult bedbugs, nymphs and eggs were collected. Residents were interviewed on the impact of the bedbug sight and bites as well as the control measures adopted against bedbugs, using oral and questionnaire instruments. Physical examination of the back, neck region and hands of some victims of bedbug bites was also carried out.

Examination and identification of the bedbugs

The bedbugs were then transported in specimen bottles with normal saline, immediately to the Laboratory of the Biological Sciences Department, Veritas University, Abuja, for examination and identification. Their sexes were determined under magnifying lens while species identification was done with the help of the morphometric identification keys of Pratt and Smith, (2005). All the females, males, nymphs and their eggs were counted. The bedbugs were then

mounted on glass slides in saline solution, and viewed under the microscope using X4 objectives lens.

Administration of questionnaire instruments

Two hundred (200) copies of well-structured questionnaire instrument which has been tested for viability and reliability were administered to occupants of the bedbug infested apartments (i.e., 5 copies per apartment) to help sample their feelings about the infestation and its attendant health impart, if any. They were left with respondents two days for careful study. The contents of the questionnaire were translated into different local dialects of the non-literate respondents to enable them understand and respond appropriately. At the expiration of the 2 days the 200 copies of (completed) questionnaire were retrieved and collated accordingly for analysis.

RESULTS



Result of survey of apartments

A total collection of 6,060 bedbug specimens (comprising 1,648/27.0% male and female adults, 875/14.0% nymphs and 3,577/59.0% eggs) was made during the survey of apartments in the selected communities of the study area. Of this, 419/25.4% adults, 62/7.1% nymphs and 712/10.9% were collected from apartments in Sabon-gari community, 505/30.6% adults, 166/18.9% nymphs and 1,020/28.5% were got from Zuma II apartments. Garba and Veritas communities recorded 439/26.6% adults, 256/29.3% nymphs and 925/25.9% eggs, and 285/17.3% adults, 391/44.7% nymphs and 920/25.7% eggs, respectively. The result also showed that Zuma II and Garba communities recorded the highest bedbug infestation with overall totals

of 1,621 and 1,620 numbers of adults, nymphs and eggs, while Sabon-gari and Veritas community apartments had milder infestations (Table 2).

Table 1a: Bedbugs (*Cimexlectularius*) collection from the apartments in Sabon-gari in Bwari Area Council

Stage of Bedbug	Sex of Bedbug	Apartments											Total	
		A	B	C	D	E	F	G	H	I	J	K		L
Adult	Male			12	-	24	-	36	27	-	63	28	4	194
	Female	-	-	26	-	12	-	44	73	-	37	26	7	225
Nymphs		-	-	10	-	15	-	6	9	-	11	6	5	62
Eggs		-	-	30	-	42	-	146	152	-	156	126	60	712
Total		-	-	78	-	93	-	232	261	-	267	186	76	1,193

Table 1b: Bedbugs (*Cimexlectularius*) collection from the apartments in Zuma II, Bwari Area Council.

Stage of Bedbug	Sex of Bedbug	Apartments											Total
		A	B	C	D	E	F	G	H	I	J	K	

Adult	A	B	C	D	E	F	G	H	I	J	K	L	
Male	17		7	-	6	19	-	27	73	63	-	4	216
Female	13	-	6	-	11	15	-	73	127	37	-	7	289
Nymphs	42	-	18	-	33	35	-	9	13	11	-	5	166
Eggs	132	-	109	-	109	122	-	152	180	156	-	60	1,020
Total	204	-	140	-	159	191	-	261	393	267	-	76	1,691

Table 1c: Bedbugs (*Cimexlectularius*) collection from the apartments in Garba, Bwari Area Council

Stage of Bedbug	Sex of Bedbug	Apartments											Total	
Adult		A	B	C	D	E	F	G	H	I	J	K	L	
	Male	12	10	-	-	-	-	36	27	-	63	28	4	180
	Female	43	29	-	-	-	-	44	73	-	37	26	7	259
Nymphs		116	103	-	-	-	-	6	9	-	11	6	5	256
Eggs		152	133	-	-	-	-	146	152	-	156	126	60	925
Total		323	275	-	-	-	-	232	261	-	267	186	76	1,620

Table 1d: Bedbugs (*Cimexlectularius*) collection from Veritas University hostels

Stage of Bedbug	Sex of Bedbug	Female Hostels						Male Hostels						Total
		A	B	C	D	E	F	G	H	I	J	K	L	
Adult	Male	9	7	12	-	18	-	11	9	10	-	13	-	89
	Female	17	13	19	-	32	-	23	39	27	-	26	-	196
Nymphs		31	89	92	-	66	-	38	29	13	-	6	-	391
Eggs		101	108	112	-	123	-	115	128	112	-	121	-	920
Total		158	217	235	-	239	-	187	205	162	-	166	-	1,596

Table 2: The stages, number and percentages of the bedbugs collected from each community in the study area

Stage of bedbug	Number and percentage (%) collected from each part of the study area					Total
	Sex	Sabon-gari	Zuma II	Garba	Veritas hostels	
Adults	Males	194/46.3	216/42.8	180/41.0	89/31.23	679/41.2
	Females	225/53.7	289/57.2	259/58.9	196/68.77	969/58.8
	Sub-Total	419	505	439	285	1648/100
Nymphs		62/7.1	166/18.9	256/28.3	391/44.7	875/100
Eggs		712/19.9	1020/28.5	925/25.9	920/25.7	3,577/100
	Grand Total (adults, nymphs & eggs)	1,193/19.8	1,651/27.2	1,620/26.7	1,596/26.3	6,060

Result of sex and species of bedbug identification

Based on the entomological morphometric identification keys of Pratt and Smith, (2005), the bedbugs were identified into male and female sexes by the finding that males have pointed abdomen whereas the females have blunt rounded abdomen. Similarly, two species of bedbug found during the study were *Cimexlectularius* and *Cimexhemipterus*, and they were identified by

the fact that *Cimexlectularius* has an upturned lateral flange on the margin of the pronotum on the thorax making it (i.e., the thorax) relatively broader more broader than that of *Cimexhemipterus*. Of the 1,648 adult bedbugs, 1,087 were *Cimexlectularius* while 561 were *Cimexhemipterus* species. The distribution among the communities sampled indicated that Sabon-gari had 236/56.3% *C. lectularius* and 183/43.7% *C. hemipterus*, Zuma II had 348/68.9% *C. lectularius* and 157/31.1% *C. hemipterus*, Garba recorded 311/70.8% *C. lectularius* and 128/29.2% *C. hemipterus* while in Veritas hostels 192/67.4% *C. lectularius* and 93/32.6% were from collected. These are the globally common bedbugs species associated with mostly human habitations because of the peculiar human attractant factors such as exhaled CO₂, body heat, body odour and other various compounds usually emitted via the skin.

Table 3: Distribution of bedbug species in the study area

Selected Community	Species, number and percentage (%) of bedbugs present		Total
	<i>Cimexlectularius</i>	<i>Cimexhemipterus</i>	
Sabo-gari	236/56.3	183/43.7	419/100
Zuma II	348/68.9	157/31.1	505/100
Garba	311/70.8	128/29.2	439/100
Veritas Hostels	192/67.4	93/32.6	
285/100Total	1,087/65.9		561/34.1
1,648/100			

Result of questionnaire administration.

Of the 200 respondents, 157/78.5% acknowledged that they have seen bedbugs before whereas 43/21.5% of them claimed that they had never seen bedbugs. One hundred seventy (170/85.0%) respondents reported that they can recognize and distinguish bedbugs from other ectoparasitic insects, but 30/15.0% they cannot.

Similarly, 167/83.5% respondents admitted to have experienced bedbug infestation before, but 33/16.5% of them stated that they have not experienced it at all. Also, while 147/73.5% of the respondents reported that they have not suffered bedbug bites before, the rest 53/26.5% accepted that they had suffered bedbug bites before. On the common sensation that accompanies bedbug bites, 77/38.5% respondents bite sensation as itchy, 49/24.5% said it is a discomforting and rashly and irritating, 31/15.5% said the bite comes with reddish spots, and yet 43/21.5% claimed they cannot describe the bedbug bite sensation.

Regarding what brought about or the suspected source(s) of the bedbug infestation, many different opinions were proffered. But majority of the respondents (126/63.0%) guessed that the bedbugs may have come through visitors from bedbug endemic homes or communities, 58/29.9% opined that the bedbugs infestation may be the aftermath of filthy environment coupled with poor housekeeping attitude, and yet another 16/8.0% attributed the infestation to poor hygiene (both personal and group) of the inhabitants of the affected apartment.

Different biting periods were also reported by respondents. While a few of them (9/4.5%) alleged that bedbugs bite mostly in the early hours of the morning, 72/36.5% claimed that bedbugs bite only in the night, but 119/58.5% respondents pointed out that bedbugs have no specific biting time but once there is contact human host.

Respondents also highlighted many different types of habitats in the human living apartment where bedbugs are found including wooden/iron beds/bunks (91/45.5%), in the beddings (49/24.5%), in furniture/behind loosen wallpaper (38/18.0%) and in wall cracks/crevices (32/16.0%)

On the other hand, respondents also expressed various control measures they have been adopting to curb the menace of this monstrous bedbugs infestations in their homes. Seventy four (74/37.0%) stated that they used insecticide/pesticides such as Snipper, Raid, etc., 57/29.5% respondents adopted the destruction by burning of the infested furniture and other household items. The use of laundering and treatment of infected bedbugs with 'Hypo' solution were reported by 45/24.5%, while 34/17.0 responded that they use hot sun-drying method to drive away the adult bedbugs from the infested materials.

On the health impact of the bedbug infestation, respondents reported some cases of health effect suspected to be due to bedbug bites. Some respondents (62/31.0%) alleged that they have suffered eczema and urticarial infection following exposure to heavy bedbug bites, 27/13.5% reported of being victim of cellulitis, impetigo, 86/43.0% complained of lymphangitis and folliculitis and anaemia (mild and severe) in 33/16.5% respondents.

DISCUSSION

This study has been able to establish not only the presence of bedbugs in the selected communities of Bwari Area Council of Abuja, the Federal Capital Territory, Nigeria, but also their high infestation in the entire area. Six thousand and sixty (6,060) bedbug specimens (comprising 1,648 adults, 875 nymphs and 3,577 eggs) collected from the 40 apartments of the four communities selected as study locations. A further breakdown showed that 1,193/19.8%

bedbug specimens came from Sabon-gari, 1,651/27.2% were from Zuma II, while Garba and Veritas had 1,620/26.7% and 1,596/26.3%, respectively. The study confirmed that dirty environment and poor personal and group practices are among the predisposing factors that promote bedbug infestation. This finding has conformed with the reports of the previous studies by Okwa and Ominiyi (5) in Lagos, southwest, by Omudu (10) and Omudu and Kuse (7) in Gboko and Gbajima in Benue, North-Central, Nigeria, where occurrence of bedbug was investigated and its infestation rates was found to be high; ranging between 6.3% to 53 %. Similar to the reports of those previous studies, this survey revealed equally that except Veritas hostels all other study locations where bedbug infestations were high, are areas dominated by indigenes. More importantly, through this study the particular species of bedbugs that exist in this part of the world have been uncovered.

One thousand and eighty seven (1,087/65.9%) were *Cimexlectularius* while 561/34.1% were *Cimexhemipterus* species, with the distribution among the communities sampled showing that Sabon-gari had 236/56.3% *C. lectularius* and 183/43.7% *C. hemipterus*, Zuma II had 348/68.9% *C. lectularius* and 157/31.1% *C. hemipterus*, Garba recorded 311/70.8% *C. lectularius* and 128/29.2% *C. hemipterus* while Veritas hostels recorded 192/67.4% *C. lectularius* and 93/32.6%.

This finding agreed with reports of previous studies by Doggett *et al.*, (2); Reinhardt and Siva-Jothy, (21) Doggett *et al.*, (9) which states that *C. lectularius* and *C. hemipterius* are species that are very commonly associated with human habitations because they are endowed with olfactory sensory receptors for detecting human exhaled carbondioxide (CO₂), human body heat and odour and other various compounds often emitted by humans via the skin.

The study also supported the findings that bedbug generally can passively disseminate themselves from one room to another through various unsuspecting means such as movement via electrical wiring through ventilation openings, clothings, second-hand furniture, beddings, books and luggages. In this study, victims have attributed sources of bedbug infestation to human movements ranging from displacement due to either, insurgencies, disputes, inter-communal clashes, to deliberate normal relocation from old to a new residence which may involve carriage or transfer of household property in luggages. Socio-cultural factors also play substantial role in bedbug infestation. The cultural lifestyle of the indigenous Gbagyi and Hausa tribes as demonstrated in their congested pattern of settlement and housing facilitate the spread of bedbugs. It is also suggested that social factors such as urbanization which had compelled people to immigrate into some of these study locations for acquisition of cheap accommodation, or job opportunities, or academic pursuit, etc., may have contributed to the bedbug infestation and dissemination in those places.

Although earlier researches on bedbug has dismissed the suspicion that bedbugs are infectious disease vectors for want of evidence (15, 4, 13, 3) bedbug bites have been associated with some minor health issues which have however been described as insignificant by certain authors. The result of this study has also highlighted cases of allergic urticarial reactions in victims of bedbug bites. There were also manifestations of minor reactions such as pruritic skin lesions, erythematous, firm papule or rashes arising from the itching bites. These observations agreed with the earlier findings of Delaunay *et al.*, (11) who reported similar manifestations from bedbug bites but which carry with them firm papule having a central vesicle or haemorrhagic crust at the point of bite. Situations also arose whereby some victims of bedbug bites experience severe itching and scratching leading to complications that take the form of scabies. This

observation corroborates the findings of Benac, (8) who in his study reported of similar experiences by those who were said to have been bitten by bedbugs. It is suspected that these complications cannot just be ordinary but may be due to secondary infections by opportunistic bacteria from around the site of the bedbug bites. Secondly, beside the euphoria and nuisance arising from heavy bedbug infestation, sleeplessness, anxiety, incessant headaches, fatigue, stigmatization and insomnia may result thereby impacting negatively on the victim's concentration and psychology and overall performance in school at home, or workplace (17).

Conclusions

The study has established the presence of bedbugs in the four selected communities of the study area with all of them showing high infestation. The study has also established that even though bedbugs are said not to be vectors of any transmissible human diseases, their infestation may bring about some mild health issues.

Recommendations

As a way of checking bedbug infestation and their possible spread, the following control measures are recommended for adoption.

- Proper public enlightenment campaign to create/or increase awareness can yield positive results in bedbugs control.
- Adequate, personal and group hygiene practices together with environmental sanitation in and around the residential quarters is eminent.
- All infested household furniture, beds, beddings, and mattress, should be destroyed completely by burning while the infested places should be adequately fumigated by before replacement of the household items.

- Use of pesticides-containing creams such as diphenhydramine, corticosteroid cream should be introduced for use by victims of bedbugs
- Regular fumigation coupled with regular inspections can make great impact in bedbug control. .

Acknowledgement

The researchers wish to appreciate all those who have contributed to the success of this study. First in the list are the Executive Chairman, Bwari Area Council, Abuja, and the Management of Veritas University, Abuja, for the ethical approval granted us. Also worthy of appreciation are the Community Heads of Sabon-gari, Zuma II, Garba, the Dean of Students' Affairs of Veritas University, Abuja and all those who volunteered to participate in this research either as study subjects or surrendered their homes/apartments to be surveyed for bedbugs. We wish also to acknowledge the expertise contributions of the Laboratory staff of the Department of Biological Sciences, Veritas University, Abuja, especially for their assistance in bedbug specimens collection and preservation in the field. To them all, we say Thank you and God bless.

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