

# Prevalence and associated factors of bed bug infestations (*Cimex lectularius*) in lubaga division, Kampala capital city, Uganda

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## Abstract

**Background:** There has been an increasing public health concern as a result of bed bug infestation, with devastating effects on health and quality of life in Uganda. This study provided the first community-based report on the situation of bed bugs in Lubaga division, Kampala Capital City, Uganda.

**Methods:** This was a descriptive cross-sectional study design, in which data was collected using questionnaire, key informant interview guide and a data abstraction tools.

**Results:** Out of the 356 respondents interviewed, 249 (69.9%) had bed bugs in their homes. The study further revealed a significant statistical relationship between the variables of gender, sex, level of education, employment status. The health systems factors that include availability of professional personnel to control bed bugs, use of effective and recommended chemicals, availability of funds, and resistance of bed bugs to insecticides were all found to have an influence on the risk of bed bugs.

**Conclusion:** The study has established the need to strengthen vector control programs in a city suburb.

## Background

Bed bugs (*Cimex lectularius*) are blood-feeding insects that have plagued humans for thousands of years [1]. They have been a household pest issue for more than 3,300 years, dating back to ancient Egypt. During the latter half of the 20th century, this blood-feeding species was almost extinct in many economically developed countries due to the widespread use of synthetic pesticides such as Dichlorodiphenyltrichloroethane (DDT) [2]. In recent years, however, there was a surge of reports of bed bug infestations among the developed countries [2-4]. Bed bugs belong to the Cimicidae family that feed exclusively on the blood of mammals, in particular human beings, or birds [2,5] and this affects the quality of life and is a mechanism of disease transmission and are common public health pests in many parts of Uganda.

Despite efforts to eliminate bed bugs by use of common pesticides and heat, there has been increasing public health problem as a result of bed bug increased infestation in Uganda. Infestation with *Cimex lectularius* is linked to a risk of transmitting *Trypanosoma cruzi*, the etiologic agent of Chagas disease [6]. With increased resistance to common pesticides such as chlorfenapyr, permethrin, and pyrethroids [7,8] it has become a critical challenge. Bed bug infestations can have adverse effects on health and quality of life as victims have been reported to suffer from loss of sleep, psychological distress, as well as allergic reactions [9]. Vigorous scratching and concomitant erosions predispose the skin to secondary bacterial infection, while chronic blood loss and iron-deficiency anemia have also been reported in people who have been continuously exposed to severe bed bug infestations. Bed bug infestations have been reported in places such as homesteads, schools, institutions, hotels, public transport, refugee camps and other

places in Uganda. There is limited epidemiological data on bed bugs in Uganda. We report on the prevalence and risk factors for bed bug infestations in Lubaga division, Kampala capital city, Uganda.

## Materials and methods

### Design

This was a descriptive cross-sectional study design involving purely quantitative method. Data were collected in the following part of Kampala; Busega, Kasubi, Kawaala, Kizito Block Najja II, Kosovo (Bukooza), Lungujja-Kintunzi, Mutundwe, Wabiyinja, Najjanankumbi, Namirembe Bakuli, Namungoona, Nankulabye, Nateete, Ndeeba and Wankulukuku.

### Data collection and management

Data collection tools that were used included a questionnaire, key informant interview guide and a data abstraction tool for the quantitative component of the study.

### Data tools

These included semi-structured researcher administered questionnaires. Respondents were asked questions in languages they understood properly.

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### Ethical consideration

Ethical approval was obtained from Clarke International University (Formerly, International Health Sciences University). In addition, permission was sought from Kampala Capital City Authority (KCCA), Ministry of Health (MOH), Local Councils (I, II and III). At an individual level, written informed consent was obtained from each participant.

### Results

#### Analysis of individual factors

Thirty-one participants (8.7%) were aged 15-20 years, 82(23.0%) 21-25, more than a quarter 96 (27.0%) were aged 26-30 years. Also, 251(70.5%) of the participant were female, 76 (21.3%) had attained primary education, and a half 183 (51.4%) attained secondary level of education. 206 (57.9%) of the respondents were employed while 150(42.1%) were unemployed, details are given in table 1.

#### Social factors influencing bedbug infestation

Three hundred and forty (N = 340, 95.5%) of the participant had knowledge about bed bugs and had varied skills to identify them. Only 43 (12.1%) used reddish brown spots on the mattresses and furniture to identify presence of bed bugs, 43 (12.1%) used presence of eggs in fabric seams, 33 (9.3%) of them were identified using a foul odor from oily secretions. 35 (9.8%) of the participants identified presence of bed bugs using fecal spots left around points of entry and exit to their hiding places, 84 (23.6%) used bite symptoms to identify presence of bed bugs, 49 (13.8%) used blood smears on sheet and clothes while 37 (10.4%) used moults and 72 (20.2%) identified presence of bed bugs using

physical presence. The study finding also indicated that 154 (43.3%) of the participant agreed that visitors led in to bed bugs infestation in their homes, 68 (19.1%) revealed that it is transferred from school by children in to their homes, 75 (21.1%) agreed that buying second hand clothes leads in to manifestation of bed bugs in their homes. In addition to that, 43 (12.1%) of the respondents agreed that they carry bed bugs from taxis to their home while 115 (32.3%) revealed that it moves from their neighbors and 32 (9.0%) got them from hotels/guest houses. In regard to method used to control bed bugs, 144 (40.4%) of the respondent used application of chemicals, 76 (21.3%) used hot water to burn them, while 59 (16.6%) of the participant washed their clothes and bedding to control bed bug infestation in their homes. Out of 356 participants, almost a half 175 (49.2%) of them agreed that they used insecticides to control bed bugs while 181 (50.8%) did not use insecticides. The social characteristics were analyzed to determine their significant association with bed bugs infestation. The study established that bed bug infestation was significantly influenced by: having knowledge about bed bugs ( $X^2$  8.388,  $p$ -value 0.004), identification with reddish brown spots ( $X^2$ 3.997,  $p$ -value 0.046), Bite symptoms( $X^2$ 4.017,  $p$ -value 0.045), physical presence of bed bugs ( $X^2$ 10.828,  $p$ -value 0.001), visitors ( $X^2$  8.218,  $p$ -value 0.004), neighbors ( $X^2$  9.646,  $p$ -value0.002), burning with hot water ( $X^2$ 4.121,  $p$ -value 0.042) and employment of qualified personnel ( $X^2$ 6.159,  $p$ -value 0.013), these factors are presented in table 2.

#### Results of multivariate logistic regression analysis

Using logistic regression analysis, age category of 15-20years (OR=3.133, 95% CI 1.011-9.703,  $p$ =.048), primary education level (OR 3.863, 95% CI 1.132-13.183,  $p$ =.031), secondary level of education (OR 3.605, 95% CI 1.119-11.610,  $p$ = .032), being employed (OR 2.4.093, 95% CI 1.759-22.078), being a civil servant (OR 4.292, 95% CI 2.204-8.384,  $p$ =.000), presence of bed bug eggs in fabric seams (OR 3.593, 95% CI 1.859-6.944,  $p$ = .000), bite symptoms (OR 2.251, 95% CI 1.172-4.322,  $p$ = .015), visitors as a source of bed bugs (OR= 2.017, 95% CI 1.222-3.329,  $p$ =.006), schools (OR 1.952, 95% CI .984-3.874,  $p$ =.056), neighbors and friends complaining about bed bugs (OR 7.549, 95% CI 4.086-13.945), lack of effective chemicals for bed bugs (OR 2.067, 95% CI 1.065-4.012,  $p$ = .032) and no proper skilled person to spray the bed bugs (OR 2.035, 95% CI 1.197-3.461,  $p$ =.009) were factors that predicted bed bug infestation in Lubaga division. This means that among those aged 15-20 years were 3.1 times more likely to be infested with bed bugs, as shown in table 3.

### Discussion

This study has found an overwhelming 70% prevalence of bed bugs in Lubaga division. Also, 249 (69.9%) had bed bugs in their homes. This is in agreement with a door to door study in a residential census tract of Philadelphia USA by Yage et al. [10]. According to that report, among the 596 respondents, 66 (11.1%) reported having bed bugs in their residence and were classified as reported positive. This also correlates with a study by Eliningaya et al. [11] which indicated that 1370 (51.3%) bed bugs were collected from houses with no bed nets and 980 (36.8%) bed bugs were collected from houses with torn bed nets, since this could be an indicator of the populations' financial capacity to buy and utilize intact bed nets. The high prevalence was attributed to both the individual and health systems factor because there was positive correlation between these factors and bed bug infestation. During the analysis, it was found that the very poor respondents and the economically-disadvantaged individuals had significant increased chances of being infected with bed bugs.

**Table 1.** Bivariate analysis of the individual attributes on bedbug infestation

Variable	Infested with bedbugs			Statistical test	
	Yes	No	Total	X <sup>2</sup>	p-value
Age category					
15-20	16(6.4)	15(14.0)	31	12.566 <sup>a</sup>	.028
21-25	52(20.9)	30(28.0)	82		
26-30	65(26.1)	31(29.0)	96		
31-35	64(25.7)	17(15.9)	81		
36-40	25(10.0)	6(5.6)	31		
<40	27(10.8)	8(7.5)	35		
Total	249	107	356		
Sex					
Female	182(73.1)	69(64.5)	251	2.666 <sup>a</sup>	.103
Male	67(26.9)	38(35.5)	105		
Total	249	107	356		
Level of education					
Primary	52(20.9)	24(22.4)	76	7.914 <sup>a</sup>	.095
Secondary	124(49.8)	59(55.1)	183		
High school (HSC)	22(8.8)	8(7.5)	30		
Tertiary	19(7.6)	12(11.2)	31		
No education	32(12.9)	4(3.7)	36		
Total	249	107	356		
Employment status					
Employed	136(54.6)	70(65.4)	206	3.582 <sup>a</sup>	.058
Unemployed	113(45.4)	37(34.6)	150		
Total	249	107	356		
Type of employment					
Civil servant	39(15.7)	35(32.7)	74	17.528 <sup>a</sup>	.000**
Business person	97(39.0)	44(41.1)	141		
Peasant	113(45.4)	28(26.2)	141		
Total	249	107	356		

<sup>a</sup>Statistically significant  $p < 0.05$

**Table 2.** Influence of social factors on bed bug infestation

Variables	Home infested with bed bugs		Total	Statistical test	
	Yes	No		X <sup>2</sup>	p-value
Do you know bed bug					
Yes	243(97.6)	97(90.7)	340	8.388*	.004**
No	6(2.4)	10(9.3)	16		
Total	249	107	356		
Signs used to identify bed bugs					
Reddish brown spots on mattress/furniture	62(25.5)	15(15.5)	77	3.997	.046**
Presence of eggs	107(44.0)	16(16.5)	123	22.770	.000
Foul odor	18(7.4)	8(8.2)	26	.069	.792
Excrement (fecal spots)	21(8.6)	7(7.2)	28	.186	.666
Bite symptoms	65(26.7)	16(16.5)	81	4.017	.045*
Blood smear	52(21.4)	21(21.6)	73	.003	.960
Moults (shed skins)	31(12.8)	17(17.5)	48	1.300	.254
Physical presence	128(52.7)	70(72.2)	198	10.828	.001*
What leads to bed bugs infestation					
Visitors	120(48.2)	34(31.8)	154	8.218*	.004*
School transfer	54(21.7)	14(13.1)	68	3.584*	.058
Buying second hand	53(21.3)	22(20.6)	75	.024*	.878
Taxi	28(11.2)	15(14.0)	43	.542	.462
Neighbors	93(37.3)	22(20.6)	115	9.646*	.002*
Hotels	20(8.0)	12(11.2)	32	.927*	.336
Methods used to control bed bugs					
Chemicals	129(55.4)	43(87.8)	172	17.853	.000
Burning with hot water	93(39.9)	12(24.5)	105	4.121	.042 **
Washing with hot water	59(25.3)	8(16.3)	67	1.809	.179
Use insecticides					
Yes	129(51.8)	46(43.0)	175	2.328*	.127
No	120(48.2)	61(57.0)	181		
Total	249	107	356		
Type of insecticide					
Don't know	220(88.4)	93(86.9)	313	4.014*	.547
Aerosols	8(3.2)	6(5.6)	14		
Organophosphates	3(1.2)	2(1.9)	5		
Pyrethroids	12(4.8)	4(3.7)	16		
Carbamates	4(1.6)	0(0.0)	4		
Organochlorides	2(.8)	2(1.9)	4		
Total	249	107	356		
Employ qualified person					
Yes	12(4.8)	13(12.1)	25	6.159*	.013
No	237(95.2)	94(87.9)	331		
Total	249	107	356		
Challenges do you find in control					
Don't die	94(37.8)	81(75.7)	175	46.416*	.000
Return very fast	146(58.6)	21(19.6)	167		
No enough money	9(3.6)	5(4.7)	14		
Total	249	107	356		

\*Statistically significant  $p < .05$

There was a significant relationship found between the gender of the respondent ( $X^2$  12.566 p-values .028) and bedbug infestation. This could be attributed to the different lifestyles. The females tend to have congested rooms due to an increased number of clothes which agrees with a publication by Pest management Consultancy in United Kingdom, (2008). This study reported that congested domestic premises make bed bug control difficult while the males could be attributed to the question of personal hygiene. The results indicated age categories of 26-35 participated more in the study, 96 (27.0%) were aged 26-30 years, 81 (22.8%) were between 31-35 years. These were all household heads or guardians with responsibility of the home. With the high prevalence of bed bugs in their homes, it implies that this age group is most at

risk. This was confirmed by a significant causal relationship between age category 15-20 years (OR=3.133, 95% CI 1.011-9.703,  $p=.048$ ) and bedbug infestation. The age group is believed to be that of a lower income status which proves the argument that bed bugs affect more of the poor people in communities. There was a correlation between level of education and bed bug infestation. The majority of participants had primary level of education which further indicated a causal relationship (OR 3.863, 95% CI 1.132-13.183,  $p=.031$ ), and secondary level of education (OR 3.605, 95% CI 1.119-11.610,  $p=.032$ ). Generally, there is an association of bed bug infestation with both low income levels and the education status. The confirmation that the low-income communities experienced high bed bug infestation trajectory agrees

**Table 3.** Results of multivariate analysis

Variable	Sig	OR	Lower	Upper
Age group (15-20 years)	.048	3.133	1.011	9.703
Age group (21-25 years)	.258	1.764	.660	4.718
Education level (Primary)	.031	3.863	1.132	13.183
Education level (Secondary)	.032	3.605	1.119	11.610
Education level (High school certificate)	.297	2.157	.509	9.133
Education level (Tertiary)	.058	3.879	.958	15.712
Employment status (Employed)	.007	2.292	1.259	4.173
Type of employment (Civil servant)	.000	4.299	2.204	8.384
Sign of bed bugs (eggs in fabric seams)	.000	3.593	1.859	6.944
Sign of bed bugs (Bite symptoms)	.015	2.251	1.172	4.322
Source of bed bugs (visitors)	.006	2.017	1.222	3.329
Source of bed bugs (school)	.056	1.952	.984	3.874
Challenges in controlling bed bugs(they don't die easily)	.216	3.164	.511	19.582
Neighbors complaining about bed bugs	.000	7.549	4.086	13.945
Use of Chemical to control bed bugs	.240	1.969	.636	6.089
Department (Lubaga health office)	.292	1.808	.601	5.445
Department (village health teams)	.213	3.414	.494	23.596
Department (NGOs)	.193	2.014	.701	5.787
Why bed bugs persist (lack of effective chemicals)	.032	2.067	1.065	4.012
Why bed bugs persist (no proper skilled people)	.009	2.035	1.197	3.461
Why bed bugs persist (resistance of bed bug)	.086	1.817	.918	3.596

\*Statistically significant  $p < .05$

with earlier literature [12]. With low income levels, people cannot afford to employ professional personnel to help in controlling bed bugs from their homes; neither can they afford to buy the recommended insecticides to spray. The employment status ( $X^2$  3.582  $p$ -value .058) was also found to have a significant correlation. This could be attributed to the fact that both the employed and the unemployed are involved in the transmission of the bed bugs. The employed could acquire them from different work places while the unemployed could acquire them from home visitations. Therefore, this leaves both at a significant risk of being infested with bed bugs. The study confirmed that being employed (OR 2.4.093, 95% CI .759-22.078), was associated with bed bug infestation. The type of employment showed a positive correlation ( $X^2$  17.528,  $p$ -value .000) with bedbug infestation. For example, being a civil servant (OR 4.292, 95% CI 2.204-8.384,  $p$ =.000) was associated with bedbug infestation. This is probably attributed to the large numbers of people they directly come into contact with and the unmatched low level of hygiene.

There was a positive correlation between bedbug infestation and knowledge (identification with reddish brown spots ( $X^2$ 3.997,  $p$ -value 0.046), bite symptoms ( $X^2$ 4.017,  $p$ -value 0.045), physical presence of bed bugs ( $X^2$ 10.828,  $p$ -value 0.001). This could be related to the multiple exposures of the communities, and thus have full recognition. This agrees with Goddard and deShazo [13], who indicated that bed bugs plague humans and Bonnefory et al. [2] who described the common bed bugs as having a light cream appearance, but progressively becoming reddish-brown in color. This proves that bed bugs are a serious problem in Lubaga division and many of them never hesitated to admit into their houses research assistants to see how badly off they are with hope that one day, they will be saved from this nuisance biter. Majority of respondents used bite symptoms to identify presence of bed bugs in their homes followed by the physical presence of bed bugs and blood smears on bed sheets (OR 3.593, 95% CI 1.859-6.944,  $p$ =.000). Bed bugs have very painful bites as indicated by a significant number of respondents who indicated that the biting symptoms (OR 2.251, 95% CI 1.172-4.322,  $p$  = .015) were used to identify these bed bugs. Sometimes one can develop red spots at the bite site due to body

reactions. Bed bugs are shy to light and sound vibrations. It is therefore not very easy to observe physical presence of bed bugs unless when the infestation is considerably high. According to the study findings, majority of participants agreed that visitors to their homes (OR= 2.017, 95% CI 1.222-3.329,  $p$ =.006), were the leading source of bed bugs into their homes followed by the close neighborhoods, second hand clothes and schools where children. This is in line with findings from a report by the Pest management Consultancy in United Kingdom, (2008). This was also confirmed by respondents who indicated that the neighbors and friends were complaining about bed bugs (OR 7.549, 95% CI 4.086-13.945). In regard to methods used to control bed bugs, most respondents 144 (40.4%) used application of chemical to control them, while 76 (21.3%) used hot water for burning them. The use of hot water is probably due to lack of enough knowledge in bed bug control because eggs of the species *Cimex lectularius* are quite resistant to hot temperatures. In view of the above, out of 356 study participants, almost a half 175(49.2%) of them agreed that they used insecticides to control bed bugs while 181(50.8%) did not use insecticides. This implies that residents of Lubaga division believe that with effective chemicals, bed bugs can be eliminated. Nevertheless, majority of them did not use these insecticides probably because they are not available, affordable or accessible. With reference to type of insecticides used to control bed bugs, majority (N=313, 87.9%) did not know the type of the insecticides they could use to control bed bugs. This confirms a knowledge gap about the various insecticides in control of bed bugs. This calls for the relevant authorities to sensitize the community about the dangers of insecticides and the safest ways to administer pesticides. Most participants (N=331, 93.0%) disagreed that they had qualified people to help in control of bed bugs. This concurs with previous research [10], who maintained that inadequate training of pest control technicians contributes greatly to the resurgence and spread of bed bugs. The challenges faced in control of bed bugs according to the study indicated that 175(49.2%) of the respondents agreed that the bed bugs don't die, 167(46.9%) revealed that it comes back very fast and 14(3.9%) agreed that they don't have money to control them. This is probably because of the lack of knowledge in bed bug prevention and control and the ineffective chemicals. Further, poor techniques of chemical application and the equipment used was found wanting. Many respondents revealed that they could buy any unknown chemicals from street vendors and use bottles with punctures to apply the chemical to kill the bed bugs. One of the respondents said that "*Bwetufuyiyla nga tukozesa obukebe buno, ebiku tebifa. Ate abayitamun nga bafuyiyla oyinza okulowooza nti babyoogedde bwongezi busuungu kutuluma. Bafuyiyla mazzi meerere*". Literally meaning that, "*when we spray using the punctured bottles, bed bugs don't die. And it's as if the people who pass through our villages spraying only excite them to bite us the more. It seems they use water to spray bed bugs*". There is a correlation between bed bug infestation and visitors ( $X^2$ 8.218,  $p$ -value 0.004) and neighbors ( $X^2$ 9.646,  $p$ -value 0.002) as they are carried by humans in seams of clothes. This agrees with the fact that bed bugs can rapidly spread to neighboring units and cause high infestation rates in multiunit dwellings [4,7]. These studies also asserted that in most cases, bed bugs are transported from infested areas to non-infested areas when they cling onto someone's clothing, or crawl into luggage, furniture or bedding that is then brought into homes. This justifies the relationship between the visitors, neighbors and bedbug infestation. The study found that the methods of bedbug control among the community was lacking. This was for example justified by the strong relationship between infestation of bedbug and use of burning with hot water ( $X^2$ 4.121,  $p$ -value 0.042) as a method of controlling bed bugs. This is attributed to the limited knowledge



considering the fact that they were employing unqualified personnel ( $X^2$  6.159,  $p$ -value 0.013) to control the bed bugs.

## Conclusion

Based on these, bed bugs represent a very big challenge to public health in Lubaga division and Uganda at large as evidenced by the high prevalence (70%). The study has further established the need to strengthen vector control programs in a city suburb.

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We did not receive funding for this study.

## Availability of data and materials

We have not obtained permission to share data obtained from the Lubaga division. However, the data set can be availed on request from the corresponding author.

## Ethics approval and consent to participate

We received ethical approval from International Health Sciences University Research Ethics Committee (REC). All respondents provided written informed consent after receiving detailed description of the study. Eligible participants were consented in privacy and no incentives were given. Anonymity of the respondents was ensured at all stages of data analysis.

## Competing interests

The authors declare no conflict of interest in this work.

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