

# Health impacts of bedbug infestation: A case of five towns in Amhara Region, Ethiopia

Daniel Mekonnen<sup>1,2\*</sup>, Yohannes Zenebe<sup>1,2</sup>, Awoke Derbie<sup>1,2</sup>, Yesuf Adem<sup>1,2</sup>, Derese Hailu<sup>3</sup>, Wondemagegn Mulu<sup>2</sup>, Fetlework Bereded<sup>2</sup>, Zewdie Mekonnen<sup>1,4</sup>, Endalew Yizengaw<sup>2</sup>, Begna Tulu<sup>2</sup>, Fantahun Biadglegne<sup>2</sup>, Adane Mihret<sup>5,6</sup>, Ulrich Sack<sup>7</sup>

## Abstract

**Background:** Bedbug is a wingless human blood-sucking bug that generally infests houses and beds. Bedbug infestation is prevalent across the country. Despite its prevalence, however, there is scarce information on the epidemiological, psychological, social and public health impacts of the infestation. This lack may arise from the absence of sufficient research in the area. The impetus for this study arose from this recognition. This study therefore assessed the extent of bedbug infestation in five towns in Amhara Regional State, Ethiopia, and its impact on public health in the areas considered in this study.

**Methods:** A community-based cross sectional study was conducted in five towns of Amhara Regional State from 1 March 2015 to 30 June 2016. Bedbug inspection was done following the Michigan manual for prevention and control of bedbug recommendation. The presence of a living or dead bedbugs, their eggs, their skin discarded in shedding, and their fecal stains or droppings were taken as an infestation. In addition, data from households were collected using pretested, structured and interviewer-administered questionnaire. The data were analyzed using SPSS version 20. Both bivariate and multivariate logistic regressions were computed to identify associated factors.

**Results:** From the 203 residential institutions surveyed, evidence of prevalence of bedbugs was located in 75.9% (154) houses. From among the infested residents, 87%, 83.1%, and 71.4% had faced one or more psychological, social and health impacts, respectively. Residential institutions in Bahir Dar town administration were 3.4 times more likely to be infested by bedbug than those in Amanuel town (AOR: 3.4; 95% CI: 1-11). The chances that residents of Kobo town administration had to be infested by bedbug were 41 times more than that of the residents in Amanuel town (AOR: 41; 95%CI: 8-206). However, no statistically significant difference was observed between the rates of bedbug infestation and the type of residential institutions.

**Conclusions:** Bedbug infestation was found to be a major public health problem in Bahir Dar, Woreta and Kobo towns. A significant psychological, social and health impact was observed in the communities. Thus, aggressive public health promotion campaigns against bedbug are recommended to empower the communities and equip them with preventive strategies. Moreover, an effective pest management strategy also needs to be made a priority health agenda, in the particular areas of study. A larger study is recommended to assess more in-depth impacts of bedbug infestation on public health [*Ethiop. J. Health Dev.* 2017;31(4):251-258]

**Keywords:** Bedbug infestation, Ethiopia

## Introduction

Bedbug belongs to the order Hemiptera and the family Cimicidae. *Cimexlectularius* and *Cimexhemipterus* are the most common bedbugs associated with human bites (4). Bed bug infestations are high in many developing countries. Ethiopia is not an exception.

In fact, it is important to note that bedbug is resurging (2, 3) in the developed world such as America, Australia, and Europe. Several factors explain this resurgence. Widespread insecticide resistance of the pest, population growth, an increase in international travel and expansion in the market for second-hand material (2, 6) are among the few to mention.

Such resurgence of the infestation in the developed world should not, in anyway, discourage any effort to be made to combat bedbug infestation in the developing countries.

A recent report in northwest of Oromia region, Ethiopia, by Karunamoorthi *et al.* (2015) showed that 72.7% (189/260) of the households were bedbug infested. Nearly 97.2% (203/209) of the infected respondents were extremely concerned about the negative consequences of the infestation. Bad odor, itchy bites and social stigma were among the concerns of the respondents in the surveyed area.

<sup>1</sup>Biomedical Research Department;Biotechnology Research Institute; Bahir Dar University, Bahir Dar, Ethiopia, Daniel Mekonnene, +251-912 990288, [nigusdaniel@gmail.com](mailto:nigusdaniel@gmail.com), P.o.Box:1383 Bahir Dar-Ethiopia;

<sup>2</sup>Department of Medical Microbiology, Immunology and Parasitology; College of Medicine and Health Sciences; Bahir Dar University, Bahir Dar, Ethiopia;

<sup>3</sup>Amhara Public Health Institute, Bahir Dar, Ethiopia;

<sup>4</sup>Department of Biochemistry; College of Medicine and Health Sciences; Bahir Dar University, Bahir Dar, Ethiopia;

<sup>5</sup>Department of Medical Microbiology Immunology and Parasitology; College of Medicine and Health Sciences; Addis Ababa University, Addis Ababa, Ethiopia;

<sup>6</sup>Armaur Hansen Research Institute, Addis Ababa, Ethiopia;

<sup>7</sup>Institute of Clinical Immunology; Medical Faculty; University of Leipzig, Leipzig, Germany.

Many earlier studies claim the possibility of bedbug as a vector for tuberculosis, leprosy, typhus, septicemia, Q fever, typhoid fever, and Hepatitis B virus (2, 7-10). However, the studies lack rigor and the claimed associations are not based on statistical epidemiology, microbial or vector investigations (3, 6).

Currently, only limited evidence is available to tell us the role of bedbug in transmitting infectious diseases (3, 4, 10-12). What is clear is, however, that bedbugs leave itchy bites after sucking people's blood. This might lead to secondary infections like methicillin-resistant *Staphylococcus aureus* (MRSA) (13).

Similarly, only very few studies have reported the psychological, economic and social impacts of bedbug infestation (6, 14, 15). Dermatitis, anemia (16), allergens (17) and sleeplessness are the few among the health impacts reported in some studies. Other studies reported anxiety, depression (15), social isolation and phobia as the most common health concerns associated

with bedbug infestation. Clearly, mental and social health impacts have a negative implication for the productivity and quality of life.

In many cultures in Ethiopia, bedbug infestation is not an acceptable topic of discussion in public. Likewise, issues of pests, insects and rodents are something to be held at a household level. This means that communities do not sufficiently work together to tackle infestation-induced problems. On the other hand, studies that particularly focus on bedbug infestation and its impact on public health in the local context are scarce. This study has been designed to fill this gap in the local research.

## Methods

**Study design, setting and period:** A community-based cross-sectional study was conducted in five towns of Amhara Regional State. The towns were: Amanuel, Merawi, Bahir Dar, Woreta, and Kobo. The study was carried out from 1 March 2015 to 30 June 2016.

Table 1: **Geographic description of the Towns considered in the Study, 2017 (19, 20).**

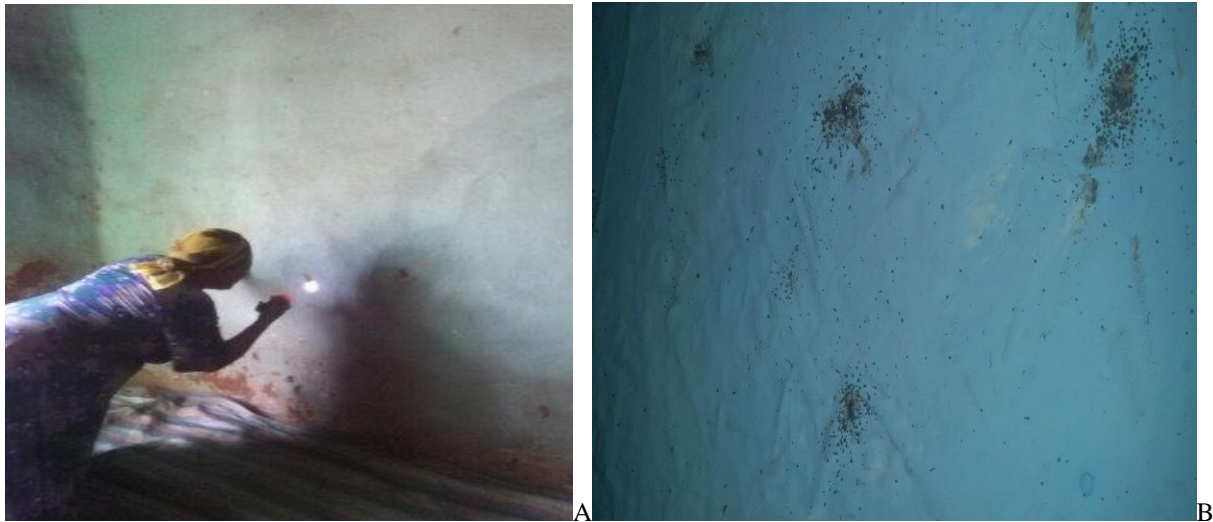
Towns	Latitude and longitude	Elevation above sea level (meter)	Climate zone	Average annual temp. (°C)	Annual rainfall in millimeters
Amanuel	10°20'N 37°43'E	2,446	Dega	16	1270-1280
Merawi	11°24'31"N 37°9'39"E	1901	Woina Dega	22	510-1530
Woreta	11°55'N 37°42'E	1828	Kolla	27	510
Bahir Dar	11°36'N 37°23'E	1,800	Kolla	27	510
Kobo	12°09'N 39°38'E	1468	Kolla	27	510

Note: **Dega:** cool zone; **Woina Dega:** subtropical zone; **Kolla:** tropical zone

**Sampling technique and data collection:** Households in each town were purposefully selected for inclusion into the study. Samples of bedbug infestations were collected from each of the households considered. Environmental health technicians visited each house and collected samples of living or dead bedbugs, their eggs as well as discarded skin shedding of bedbugs. Evidence of fecal stains or droppings were also used as indicators of infestation (Figure 1). Data collectors used flashlight to search beds in the households, mattresses, pillows and room perimeters for the data

needed in the study. Data obtained from verbal confirmation of the past history of infestation of the areas were not considered as infestation in the study.

Pretested structured questionnaire was the instrument used to gather demographic information from the household representatives. In addition, Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (21) was employed to assess the psychological and social impact of bedbug infestation in the study sites.



(A) A household looking for bed bugs, (B) Bed bug eggs and droppings on the wall



C: A household helping the technician search for bedbug in the bedroom



D: Bedbugs and their eggs inside the crevices



E: Bed bugs colonizing bed nets and further analysis



F: Bedbug collected with table bag for evidence of infestation

Figure 1: Pictures A-F: bedbugs and residents searching for bedbugs, Amhara Region, Ethiopia, March 2015-June 2016.

**Quality control:** Data for the study were collected by health professionals. Prior to collecting the pilot data, data collectors were given a short training on the purpose of the study and the techniques of data collection. Bedbug inspection was done following the Michigan manual for prevention and control of bedbug recommendations (22).

**Statistical analysis:** Data were entered into Epi-Info 7, cleared and analyzed using SPSS statistical software package (*IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.*). A descriptive statistics was used to describe the characteristics of the study participants. The data were presented using frequencies and percentages. Logistic regression model was used to assess the association of bed bug infestation with the study area and residential types. Associations between variables were determined using odds ratio and 95 % confidence interval (CI). A  $p$ -value of  $<0.05$  was considered as cut-off value for statistical significance.

**Ethics approval and consent to participate:** The study was approved by Amhara Regional Health Bureau Research Ethical Review Committee (RERC). In addition, a support letter was obtained zonal health department and Woreda health Office to carry out house-to-house bedbug survey. In addition, written informed consent was obtained from the participants for their participation. Participants' consent in connection with disclosing their photographs was also obtained. However, it should be noted here that none of the individual data were identified by name in this report. Data obtained from the registry were collected serially. They were kept confidentially and used only for the purpose of the study. After clearing the data, numbers were removed and participants were made anonymous prior to the analysis of the data.

## Results

This study was designed to assess public health impacts of bedbug infestation in five towns in the Amara Regional State. Data for the study were collected from 250 households in the study area. Informed consent for the survey was obtained from 92% of the households prior to the survey. About two-thirds (63.5%,  $n=129$ ) of the study were female participants. Nearly half (48.3%,  $n=98$ ) of the participants were in the age range of 35-54 years old.

Table 2 displays the summary of the demographic profile of the representatives of the surveyed residents.

The study revealed that the prevalence of bedbug infestation in the surveyed households was 154/203 (75.9%). Various kinds of psychological problems including insomnia, anxiety, situational depression and post-traumatic stress disorder were reported to prevail among 134 (87%) of the infested households. Moreover, manifestations of one or more of social issues such as phobia, isolation, and aggression were reported by 128 (83.1%) of the study participants. Close to three-fourths (i.e., 71.4%) of the surveyed respondents also reported facing such health problems as rash, urticarial reactions at the site of the bite, ear infection, allergen and asthma (Table 3).

In the multivariable logistic regression model, Bahir Dar city administration was 3.4 times more likely to be infested by bedbug than Amanuel town (AOR: 3.4; 95%CI: 1-11). Moreover, Kobo town administration was 41times more likely to have bedbug colonization in residential institutions than Amanuel town (AOR: 41; 95%CI: 8-206). However, no association was observed in the rate of bed bug infestation among residential institutions types (Table 3).

Table 2: Demographic, residential institutions types and surveyed towns, Amhara Region, Ethiopia, March 2015-June 2016

Variable	Frequency	Percent
<b>Gender</b>		
Male	74	36.5
Female	129	63.5
<b>Age in groups (year)</b>		
20-34	31	15.3
35-54	98	48.3
55-87	74	36.5
<b>Education</b>		
Illiterate	71	35.0
≤8 <sup>th</sup> Grade	98	48.3
>8 <sup>th</sup> Grade	34	16.7
<b>Occupation</b>		
Government	31	15.3
Private	38	18.7
Farmer	45	22.2
Job Seeker	56	27.6
Other	33	16.3
<b>Study sites</b>		
Amauel	16	7.9
Merawi	33	16.3
Bahir Dar	79	38.9
Raya Kobo	59	29.1
Woreta	16	7.9
<b>Residential-Type</b>		
Rooming house	75	36.9
Dormitory	69	34.0
Apartment	37	18.2
Villa	22	10.8
<b>Total</b>	<b>203</b>	<b>100.0</b>

Table 3: Distribution of the psychological, social and health impact of bedbug infestation (n=154), Amhara Region, Ethiopia, March 2015-June 2016

Variables	Frequency	Percent
<b>Psychological Impact</b>		
No	20	13
Yes	134	87
<b>Social Life Impact</b>		
No	26	16.9
Yes	128	83.1
<b>Health Impact</b>		
No	44	28.6
Yes	110	71.4
<b>Financial Impact</b>		
No	27	17.5
Yes	127	82.5
<b>Total</b>	<b>154</b>	<b>100</b>

Table 4: Bedbug infestation by geographic area and residential type, Amhara Region, Ethiopia, March 2015-June 2016

Variables	Bed bug infestation			COR (95% CI), P	AOR (95% CI), P
	No, (%) N	Yes, (%)N	Total		
<b>Study sites</b>					
Amanuel	62.5 (10)	37.5 (6)	16	1	1
Merawi	42.4 (14)	57.6 (19)	33	2.3 (0.6-7.7),0.2	2.2(0.6-7.8), 0.2
Bahir Dar	27.8 (22)	72.2 (57)	79	4.3 (1.4-13), 0.01	3.4 (1-11),0.04
Kobo	5 (3)	95 (56)	59	31 (6.6-145)0.001	41 (8-206),0.001
Woreta	0(0)	100 (16)	16	-	-
<b>Residential-Type</b>					
Rooming house	29.3 (22)	70.6 (53)	75	1	1
Dormitory	17.4 (12)	82.6 (57)	69	1.9 (0.9-4.3),0.1	2.3 (0.9-6),0.06
Apartment	27 (10)	73 (27)	37	1.1 (0.5-2.7),0.8	0.7 (0.26-2.3),0.6
Villa	22.7 (5)	77.3 (17)	22	1.4 (0.46-4.3), 0.5	0.5 (0.1-2),0.3
<b>Total</b>	<b>42.1 (49)</b>	<b>75.9 (154)</b>	<b>203</b>		

AOR: Adjusted odds ratio; CI: Confidence interval; COR: Crude odds ratio;

### Discussion

Unsurprisingly, the study showed that bedbug infestation is a major public health problem. As reported earlier, evidence of bedbug infestations was observed in the majority of cases. In more specific terms, 75.9% of the surveyed residential institutions had evidence of bedbug infestations. However, it is likely that the real prevalence of infestation can be estimated to be even higher than the reported data. This conclusion can generally be drawn from the observation that a large several households refused to give consent for participation in the survey. In addition, houses with low bedbug load infestation could be skipped by surveyors. Yet, another possibility for suspecting a higher level of prevalence of bedbug

infestation arises from the respondents' expressed fear to disclose the extent of their infestation and associated impacts.

The finding of this study agrees with the finding reported by Karunamoorthi *et al* (2015) in the western corner of Ethiopia; 72.7% (5). The households used as data sources in this study range from small and poorly constructed residential institutions to modern apartments and rooming houses.

In fact, causal observation confirms that houses with no cracks in their walls are less likely to harbor pests than poorly constructed houses. This means that residents who live in poorly constructed houses may have a

wider chance of exposure to infestation. This, however, does not undermine the conclusion that bedbug infestation is a nationwide problem.

There are reports from the developed countries with news about the resurgence of bedbug infestation. A report released in New York City in 2009, for example, stated that 10% of the participants who had bedbugs in their home were poor (6). The prevalence of bedbug was observed in only 2.9% of the participants who were reported to have a better living condition in the same study (6). A similar study in Paris also reported that 39.6% of the apartments covered in the study were infested. Slightly over half (i.e., 53; 54.6%) of the 97 residents in the infested apartments reported bedbug bites (23).

Another report released by Toronto Public Health in 2003, documented complaints of bedbug infestations from 46 locations. Well over half of the sources of the complaints (i.e., 63%) were reported to have been from the infested apartments. In the same 2003 report from Toronto Public Health, complaints from shelters were reported to have been 15% while those from rooming houses accounted for 11% of the reported complaints of bedbug infestations (24).

A further report released from Toronto documented bedbug infestation from shelters to be at 30%. In Vancouver Downtown Eastside, bedbug infestation was reported by 31% of the residents (25).

Existence of bedbug in a residence is neither a simple presence nor is it a mere indication of a mutual existence between the host and the pest.

It is rather an active threat to the entire well-being of the community and their lifestyle. Bedbug is, in fact, an unavoidable ecto-parasite that forces people to experience desperate and poor quality of life.

Data obtained for the present study revealed different kinds of impacts of infestation. For example, the majority (i.e., 87%) of the participants reported moderate-to-severe psychological impacts. Insomnia, anxiety states, situational depression and post-traumatic stress disorder were among the reported impacts. While this finding agrees with the finding reported by Karunamoorthi *et al.* (2015) (5), Goddard and Shazo 2011(26), it is much higher than the findings reported by Dogget *et al.* In Dogget *et al.*'s review, 29% of the infested individuals reported insomnia or sleeplessness (6). Following bedbug's bites, respondents' replied the presence of prolonged scratching which can aggravate itchy sensation, sleep disturbance (6, 14, 15), anxiety and depression (15).

In the present study, 71.4% of the respondents reported different kinds of health-related problems. Co-epidemic levels of occurrence of bedbug and skin and soft tissue infection (SSTI) were observed in the study area, particularly in Kobo town (Table 3). This SSTI (cellulitis, impetigo) might be due to secondary bacterial infections as a consequence of the scratching

of the bedbug bite (4, 6, 14). Moreover, participants in the study also reported different kinds of respiratory and systemic infections. In this connection, earlier studies reported that bed bug could be a cause for asthma and iron deficiency anemia (6, 23, 24). Furthermore, in developing countries where bedbug infestation is high, the possible role of the pest as vector for microbes should not be ignored.

In this study, a little over three-fourths of the participants (i.e., 83.1%) reported facing phobias, social isolation, aggression and bad odor. According to different reports obtained from various related studies, large scale infestations have, at one time or another, led to the temporary closure of hospitals. This tremendously threatened the provision of health services and gave rise to various social issues (6) like stigma and irritation (6, 14).

A report on the average amount of money incurred by the study participants to fight against bedbug infestation could have fairly revealed the economic impact of the infestation on the society. Money matters, apparently due to difficulties associated with the culture of financial record keeping as a whole, has been excluded from the reported impacts of infestation. However, it needs to be pointed out that the cost incurred to eliminate bed bugs might be significantly higher than the cost of eliminating other pests. Overall, bedbug infestation has an extensive economic implication.

Findings of this study revealed that infestations were significantly higher in Bahir Dar and Kobo town administrations than in Amanuel town. Moreover, all the sixteen residential institutions inspected in Woreta town were infested with bedbug (Table 4). The study indicated that areas with hot climate are more likely to have bedbug than the areas with colder climate. In addition, infestation was observed to prevail more in dormitory type residential institutions than in other types of residence surveyed in the present study. Most dormitories surveyed were rooms for rent. Given the high rate of renter turnover in towns in Ethiopia, in general, it is likely for bedbugs to be transported by renters from house to house as quickly as the renters themselves change their residence.

On the other hand, in their attempt to fight bedbugs, residents apply chemicals to their houses. They may do this without first cleaning the houses and putting their household furniture in the order that protection against pests requires. Attempts such as this neither kill pests nor check their travelling pace inside a house. Bedbugs frequently travel between units, either by direct transport by humans or through voids in the walls.

A number of tribal groups elsewhere use bedbug in traditional medicine for the treatment of ringworm, epilepsy, piles, alopecia, urinary disorders, snake bites and fevers (6). However, no history of using bedbugs for the treatment of any illness has been reported in this study.

**Conclusions:**

A high rate of prevalence of bedbug infestation was documented in the towns considered in the study. The towns can even be considered as a huge reservoir with the highest potential to spread the pest to other areas, given the current rate of increase in the pace of urbanization. It is thus important to note that bedbug infestation is a severe, but at the same time, a neglected psychological, social and public health problem in Ethiopia.

A long term solution may call for a much better understanding of the impact of infestation on public health. This can perhaps be undertaken by a larger and a more coordinated study that involves expertise from various fields including the humanities, the social sciences, and public health. Until then, however, as a quick response to the imminent threat, a search for an integrated pest management protocol may be a desirable course of action.

**Competing interests:** The authors declare no competing interests.

**Funding:** This research received full funding from Biotechnology Research Institute, Bahir Dar University.

**Acknowledgements**

The researchers are grateful to Biotechnology Research Institute, Bahir Dar University, for funding the project. Moreover, the cooperation received from the Zone Health Departments and Woreda Health Offices in the study sites deserves our appreciation. We also like to extend our sincere thanks to the communities that participated in the survey.

**References**

- Haddis A, Ethiopia Public Health Training Initiative, The Carter Center, the Ministry of Health, and the Ministry of Education. Control of Insects and Rodents. Addis Abbaba: Carter center Ethiopia; 2004.
- Adelman ZN, Miller DM, Myles KM. Bed bugs and infectious disease: a case for the arboviruses. *PLoS pathogens*. 2013;9(8):e1003462.
- Barbarin AM, Hu B, Nachamkin I, Levy MZ. Colonization of *Cimex lectularius* with Methicillin-resistant *Staphylococcus aureus*. *Environmental microbiology*. 2014;16(5):1222-4.
- Delaunay P. Human travel and traveling bedbugs. *Journal of travel medicine*. 2012;19(6):373-9.
- Karunamoorthi K, Beyene B, Ambelu A. Prevalence, Knowledge and Self-Reported Containment Practices about Bedbugs in the Resource-Limited Setting of Ethiopia: A Descriptive Cross-Sectional Survey. *Health*. 2015;7(09):1142.
- Doggett SL, Dwyer DE, Peñas PF, Russell RC. Bed bugs: clinical relevance and control options. *Clinical Microbiology Reviews*. 2012;25(1):164-92.
- Burton GJ. Bedbugs in relation to transmission of human diseases: Review of the literature. *Public health reports*. 1963;78(6):513.
- Sandes TL. The mode of transmission of leprosy. *British medical journal*. 1911;2(2644):469.
- Wills W, London WT, Werner B, Pourtaghva M, LAROUZÉ B, Millman I, et al. Hepatitis-B virus in bedbugs (*Cimex hemipterus*) from Senegal. *The Lancet*. 1977;310(8031):217-9.
- Delaunay P, Blanc V, Del Giudice P, Levy-Bencheton A, Chosidow O, Marty P, et al. Bedbugs and infectious diseases. *Clinical Infectious Diseases*. 2011;52(2):200-10.
- Goddard J. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. *Jama*. 2009;301(13):1358-66.
- Ho D, Lai O, Glick S, Jagdeo J. Lack of evidence that bedbugs transmit pathogens to humans. *Journal of the American Academy of Dermatology*. 2016;74(6):1261.
- Wieczner J. Bedbugs invade hospitals: Market Watch; 2013 [cited 12 August 2017]. Available from: [http://www.marketwatch.com/story/bedbugs-rack-up-hospital-bills-2013-04-22?link=MW\\_home\\_latest\\_news](http://www.marketwatch.com/story/bedbugs-rack-up-hospital-bills-2013-04-22?link=MW_home_latest_news).
- Joint statement on bed bug control in the United States from the US Centers for Disease Control and Prevention (CDC) and the US Environmental Protection Agency (EPA) USA: US Department of Health and Human Services, Atlanta; 2010. 1-7]. [cited 12 August 2017]. Available from: [http://www.cdc.gov/nceh/ehs/publications/bed\\_bugs\\_cdc-epa\\_statement.htm%5Cnpapers2://publication/uuid/EF3D4652-C07B-4F23-B8E2-3E75EEA424](http://www.cdc.gov/nceh/ehs/publications/bed_bugs_cdc-epa_statement.htm%5Cnpapers2://publication/uuid/EF3D4652-C07B-4F23-B8E2-3E75EEA424).
- Susser SR, Perron S, Fournier M, Jacques L, Denis G, Tessier F, et al. Mental health effects from urban bed bug infestation (*Cimex lectularius* L.): a cross-sectional study. *BMJ open*. 2012;2(5):e000838.
- Pritchard MJ, Hwang SW. Severe anemia from bedbugs. *Canadian Medical Association Journal*. 2009;181(5):287-8.
- Price JB, Divjan A, Montfort WR, Stansfield KH, Freyer GA, Perzanowski MS. IgE against bed bug (*Cimex lectularius*) allergens are common among adults bitten by bed bugs. *The Journal of allergy and clinical immunology*. 2012;129(3):863.
- Mumcuoglu KY, Shalom U. Questionnaire survey of common bedbug (*Cimexlectularius*) infestations in Israel. *Israel J. Entomol*. 2010;40:1-0.
- Ethiopia Meteorology agency. Climate of major cities Addis Ababa: Ethiopian National Meteorology Agency; 2016 [cited 2017 20 June]. Available from: [http://www.ethiomet.gov.et/climates/climate\\_of\\_major\\_cities](http://www.ethiomet.gov.et/climates/climate_of_major_cities).
- Teklehaimanot T. Ethiopian Treasures 2016. [cited 2017 20 June]. Available from: <http://www.ethiopiantreasures.co.uk/pages/climate.htm>.

21. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5®): American Psychiatric Pub; 2013.
22. Chrysler D, Foster E, Reik R, Schwartz A, Signs K, Stobierski MG. Michigan Manual for the Prevention and Control of Bed Bugs. USA: Michigan Department of Community Health; 2010.
23. Durand R, Cannet A, Berdjane Z, Bruel C, Haouchine D, Delaunay P, et al. Infestation by pyrethroids resistant bed bugs in the suburb of Paris, France. *Parasite* (Paris, France). 2012;19(4):381.
24. Hwang SW, Svoboda TJ, De Jong IJ, Kabasele KJ, Gogosis E. Bed bug infestations in an urban environment. *Emerging infectious diseases*. 2005;11(4):533.
25. Lowe CF, Romney MG. Bedbugs as vectors for drug-resistant bacteria. *Emerging infectious diseases*. 2011;17(6):1132.
26. Goddard J, de Shazo R. Psychological effects of bed bug attacks (*Cimex lectularius* L.). *The American journal of medicine*. 2012;125(1):101-3.