

# Effect of A Community Health Worker Led Mobile Phone Intervention in Surveillance and Control of Bedbugs in Nakuru County; A Study Protocol

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**Abstract** Globally there has been a resurgence of bed bug infestation after decades of suppression using modern pesticides such as pyrethroids. The dramatic rise in bed bug infestation has been reported in Canada, USA, Australia and Africa causing panic and significant public attention. Bed bug is widely found in temperate and in sub-tropical countries and is broadly distributed in regions north and south of the equator. Bed bug infestation is shallowly studied and thus limited information regarding the parasite especially in developing countries such as Kenya. For instance, in Ethiopia bed bug infestation is one of the most neglected and underreported and understudied Phenomenon due to high diseases burden. Based on a 2015 media report about 4000 homes in Nakuru county were found to be infested by bed bugs. In 2017, 7 estates in Nakuru county were reported to have been heavily infested with bed bugs with about 5000 households being affected. The general objective of this study is to establish effect of a Community Health Worker (CHW) led mobile phone intervention in surveillance and control of bedbugs in Nakuru County. The specific Objectives of this study are to; establish proportion of households infested with bedbugs in Nakuru county, determine socio demographic and socioeconomic factors associated with bed bug infestation among households in Nakuru county, establish the effect of a Community Health Worker (CHW) led mobile based application in detection and reporting (surveillance) of bed bug infestation among household in Nakuru county, and to establish effect of a Community Health Worker intervention in Control of bed bugs infestation among households in Nakuru County. The study design will be a quasi-experiment conducted in intervention and control sites. Flamigo and Kivumbini wards will be the intervention and Menengai ward control sites. Sample size for intervention and control sites has been calculated as 354 and 362 households respectively. Purposive and systematic sampling methods will be used to identify the study participants. Proportions, measures of central tendency, Chi square tests and Odds ratios will be used in data analysis. Difference in Differences, and regression analysis will be used to test study hypotheses. Appropriate tables and graphs will be used for data presentation. This study protocol was subjected to Mt. Kenya University Ethical approval board for review and approval. The study was licensed by the National Council of Science and Technology (NACOSTI) in Kenya.

**Keywords:** community health worker, mobile phone application, bedbug control

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## 1. Introduction

Globally there has been a resurgence of bed bug infestation after decades of suppression using modern pesticides such as pyrethroids [1]. The dramatic rise in bed bug infestation has been reported in Canada, USA, Australia and Africa causing panic and significant public attention [2]. The current resurgence of bed bug infestation has been linked to changes in pest control strategies, international travel, stigma associated with reporting bed bug infestation and presence of insecticide

resistance bed bug strains [3]. However in some countries there have been no resurgence of bed bug infestations and the reasons for the hampered resurgence are still not clear [2].

Bed bug is widely found in temperate and in sub-tropical countries and is broadly distributed in regions north and south of the equator. The temperate conditions facilitate biological functioning as well as normal development of the bed bugs [4]. Before the invention of insecticides such as DDT bed bug infestation was rampant and was regarded as a nuisance pest, their elimination was difficult and treatments used were hazardous to people [5].

The prevalence of bed bug infestation is estimated to be about 33% in London [5]. In Australia a 4500% increase

in bed bug infestation was reported in 2006 [6]. Additionally, in the USA bed bug infestation was reported in all the 50 states of America. For instance in New York city the bed bug complaints to the local authorities rose from 537 in 2004 to 10, 985 in 2009 [7]. In Africa bed bug infestation is still a big menace. In Nigeria the prevalence of bed bug infestation in homes and school hostels is about 50% [8]. Similarly in Sierra Leone the prevalence of bed bug infestation in internally displaced camps is about 98% [9]. There is still limited research regarding bed bug infestation in Africa.

In Kenya about 4000 homes in Nakuru county were found to be infested by bed bugs [10]. Furthermore by 2017 7 estates in Nakuru county were reported to be suffering from bed bug infestation with about 5000 households being affected [11]. Additionally there are other more cases of bed bug infestation in Kenya however they are not well reported.

Several strategies have been put in place to suppress the bed bug infestation. Some of these strategies include use of active monitors, visual inspection, passive monitors and trained canines [12]. Chemicals such as pyrethroids are also widely used in the control of bed bug infestation. Community health worker led interventions have not yet been fully implemented in the reporting and control of bed bug resurgence and infestation. Therefore this study aims to establish the effectiveness of community health worker led intervention on reporting and control of bed bug infestation.

## 1.1. Problem Statement

There is resurgence of bed bug infestation in Africa coupled by insecticide resistance. Furthermore there has been no coordinated effort or strategy aimed at controlling the resurgence of bedbugs [13]. There is also lack of laws or regulations governing the control of bed bugs in African countries and Kenya in particular. Apart from Africa the resurgence of bed bugs have been reported in Japan, mainland Europe, North America, Australia and Canada [14,15,16,17]. Equally in the USA there has been a recent resurgence of bed bug infestation with the resurgence gaining significant attention from the mainstream media such as the, New York times, Wall street journal and the USA today [18]. Based on a 2015 media report about 4000 homes in Nakuru county were found to be infested by bed bugs [10]. In 2017, 7 estates in Nakuru county were reported to have been heavily infested with bed bugs with about 5000 households being affected [11]. Equally the rate of bed bug infestation in Ethiopia is very high at a rate of 72.2% [19]. Further the degree of bed bug infestation may be underestimated due to ability of bed bugs escaping visual detection [18].

Bed bug infestation is shallowly studied and thus limited information regarding the parasite especially in developing countries such as Kenya. For instance in Ethiopia bed bug infestation is one of the most neglected and underreported and understudied phenomenon due to high diseases burden [19]. Equally in Kenya little studies have been conducted on bed bug infestation and thus why most of the reports on the resurgence have only been documented by the media companies such as the daily nation and standard group [10,11]. Bed bugs infestation causes discomfort, physiological disorders as well as

various phobias thus reducing the quality of life. Victims of bed bug infestation have been reported to suffer from bites, cutaneous and systemic infections [20].

## 1.2. Study Justification

There is no documented organized strategy to combat the resurgence of bed bugs in Kenya and in particular Nakuru county and as a result most individuals take personal initiatives to control the pest [21]. Therefore, this study is aimed at providing an organized strategy aimed at training community health workers who will lead the monitoring and control of the pest in Nakuru county. The success of this project will potentially lead to upscaling the CHW led intervention to other counties in Kenya hence fighting the menace. Additionally the study will provide information on the prevalence and on determinants of bed bug infestation in Nakuru County.

## 1.3. Study Objectives

### 1.3.1. General Objective of The Study

The general objective of this study is to establish effect of a Community Health Worker (CHW) led mobile phone intervention in surveillance and control of bedbugs in Nakuru County.

### 1.3.2. Specific objective

The specific Objectives of this study are to;

1. To establish proportion of households infested with bedbugs in Nakuru county
2. To determine socio demographic and socioeconomic factors associated with bed bug infestation among households in Nakuru county
3. To establish the effect of a Community Health Worker (CHW) led mobile based application in detection and reporting (surveillance) of bed bag infestation among household in Nakuru county
4. To establish effect of a Community Health Worker intervention in Control of bed bugs infestation among households in Nakuru County.

### 1.3.3. Research Questions

1. What is the proportion of households infested with bedbugs in Nakuru county?
2. What are the socio demographic and socioeconomic factors associated with bed bug infestation among households in Nakuru county?
3. What is the effect of a Community Health Worker (CHW) led mobile based application in detection and reporting (surveillance) of bed bag infestation among household in Nakuru county?
4. What is the effect of a Community Health Worker intervention in Control of bed bugs infestation among households in Nakuru County?

### 1.3.4. Hypothesis

1. There is no difference in detecting and reporting (surveillance) of bed bags in intervention site compared to control site.
2. There is no difference in the control of bed bags in intervention site compared to control site.

## 1.4. Scope of the Study

The study will focus on investigating the determinants of bed bug infestation, the effect of CHW led intervention on the reporting and control of bed bug infestation. Additionally, the study will be limited to Nakuru county.

## 2. Literature Review

### 2.1. Overview of Bedbug Resurgence

Globally bed bug has become a relatively uncommon parasite particularly in the developed countries from the period beginning 1950 to the start of the 21<sup>st</sup> century. However the degree of resurgence of the parasite was unexpected. For instance in Australia pest managers reported a 4500% increase in bed bug infestation in 2006 [6]. In the USA bed bug has become a big problem with cases of bed bug infestation being reported in all the 50 states of America [7]. Among the most infested cities in USA includes New York, Chicago, Detroit and Philadelphia. For instance in New York city the bed bug complaints to the local authorities rose from 537 in 2004 to 10, 985 in 2009. Bed bugs have thus become a widespread societal pest. In addition to hotels and homes bed bugs infestations have been reported in offices, health, cinemas and transport sector [22]. Equally in the United Kingdom bed bug resurgence has been reported. The cause of the resurgence is not yet clear however it has been attributed to lack of awareness, ineffective monitoring and control tools, international travel and bedbug resistance to insecticides [23].

In Africa bed bug infestation is widespread. For instance the infestation rate in Nigeria has been reported to be at 50%. Similarly in Benue state of Nigeria heavy bed bug infestation was reported in school hostels and homes [8]. Equally based on a study conducted in Sierra Leone in internally displaced camps about 98% of the rooms were infested by bed bugs [9]. Studies have documented poor hygiene and housekeeping practices as major factors influencing the resurgence of bedbug infestation in Africa. Additionally overcrowding especially in slum dwelling and poor sanitation has also been attributed to the resurgence of bedbug infestation in Africa [24].

### 2.2. Factors Associated with Bed Bug Infestation

#### 2.2.1. Education Level

The level of education influences the access to information as well as positive reception to health education messages which results to improved health practices [25]. Based on a study conducted in Argentina high education level was associated decreased levels of household infestation with bed bugs [26]. Similarly low levels of education was associated with increased severity of Chagas disease [27]. Equally based on a study conducted in Ethiopia to investigate the prevalence, knowledge and self-containment practices reported a significant association between the level of education and

the rates of bed bug infestation [19]. Studies have also documented that less educated people are more exposed to bed bug infestation as compared to highly educated individuals [28]. High level of education influences the awareness level which is a major social determinant of health. Level of awareness significantly contributes towards public health promotions against bed bugs [19].

#### 2.2.2. Gender

Gender has been linked to bed bug infestation. Based on a study conducted in USA women were reported to more likely report about bed bug infestation as compared to men [29]. Furthermore studies have documented that more men are exposed to bed bug infestation as compared to women [28]. Women have a low exposure rate to bed bugs presumably due to their high levels of hygiene and cleanliness as compared to men.

#### 2.2.3. Socio Economic Status

Bed bug infestation has been linked to the socio economic status of residents. For instance based on a study conducted in the USA bed bug infestation was more predominant among low income dwellers as compared to the middle and upper income dwellers [30]. The low income dwellers lack financial resources to pay for high quality pest control services and furthermore there is low levels of cooperation in the community which contributes to the persistence of bed bugs in their dwellings [31]. Similarly based on a study conducted in the USA bed bug infestation was reported to predominantly occur among low income households [32]. In New Jersey a community wide inspection discovered that low income households experienced a resurgence of bed bug infestation and an overall high rate of infestation [29].

#### 2.2.4. Settlement and Housing Patterns

Poor housing has been associated with bed bug infestation. For instance based on a study conducted in Toronto USA high rates bed bug infestation was reported in apartments (63%) followed by shelters (15%) and the least in rooming houses (11%) [29]. Furthermore in Nigeria overcrowding in residential areas and poor sanitation conditions were associated with bed bug resurgence [24]. The presence of many apartments with multiple tenants also was documented to facilitate the dispersion of bedbugs from one location to another, this is due to the closeness of units to one another Bed bug infestation has been reported to be common among people living in poor living conditions and in urban places [9]. The bed bug distribution in apartments is characterized by clustering of bedbugs in one building and free bedbug infestation in neighboring apartments [30]. In addition studies have reported social interactions such as visit to homes and exchange of furniture as factors facilitating the spread of bedbugs [33].

#### 2.2.5. Migration and Travel

Migration and travelling has been significantly associated with the resurgence of bedbug infestation. For instance based on a study conducted to investigate the resurgence of bedbug infestation in apartments in New Jersey reported high rates of bed bug infestation among

new tenants as compared to old tenants [29]. Furthermore the movement of local traders from different countries to Benue state of Nigeria has been attributed to be the major cause of bed bug resurgence of in Nigeria [24]. Similarly based on a study conducted in Australia bed bug resurgence was attributed to increased international travel [3]. In Australia the resurgence of insecticide resistance bed bugs have been primarily associated with influx of bed bugs from overseas [34]. Based on a survey conducted in Singapore and Malaysia between 2005 and 2008 about 54 public accommodation places and hotels were reported to be infested with bed bugs [35]. Additionally in Kuala Lumpur which is a major transport hub bed bug infestation was reported in almost all the hotels with an exception of a few private homes [34].

#### 2.2.6. Insecticide Resistance

Pyrethroid insecticides have been globally used for the control of bedbug infestation. The use of other insecticides such as carbamates, DDT and organophosphates has been restricted by regulations. Studies have reported the development of pyrethroid resistance bed bug strains [34]. In the United Kingdom, Australia and Africa pyrethroid resistant strains of bed bugs have been identified [36,37]. Furthermore high resistance against deltamethrin and lambda-cyhalothrin which are the active ingredients found in insecticides have been reported in bed bugs collected in the USA [23].

### 2.3. Strategies to Fight Bed Bug Infestation

#### 2.3.1. Use of Technology in Bed Bug

Early detection of bed bugs will enhance faster elimination. Several technologies have been put in place which enhances the early detection of bed bugs. Some of these technologies include use of active monitors, visual inspection, passive monitors and trained canines [12]. Active monitoring employs chemicals which attract the bed bugs, carbon dioxide or heat or different combinations of chemicals, carbon dioxide and heat to capture bed bugs [38,39]. Passive monitors are usually a pit fall type and have adhesive characteristics to trap the bed bugs [12]. The inadequacies in bed bug detection influence the reporting of bed bug infestation. Technologies such as mobile applications could be utilized in enhancing reporting of bed bug infestation. The technology can be spear headed by community health workers.

#### 2.3.2. Chemicals

Several chemicals are used in the control of bed bug infestation. Before the invention of DDT extracts from pyrethrum flowers were used in the control of bed bugs [40]. The introduction of DDT in 1944 significantly reduced rates of bed bug infestation with bed bugs being uncommon in the last half of the 20<sup>th</sup> century. Over the past 35 years synthetic pyrethroids have been globally used as the major chemical control of bed bug infestation [41]. The pyrethroids are extremely effective in eliminating bedbugs in comparison to pyrethrins due to their enhanced toxicity. The pyrethroids have also good are less photolabile as compared to plant extracts hence resulting to a good residual effect [42]. However there is a

resurgence of insecticide resistant bed bugs which implies a need for development of new chemicals to fight the resurgence of bed bug infestation.

### 2.4. Research Gaps

There has been a resurgence of bed bug infestation in Kenya. High rates of bed bug infestation have been reported among households in Nakuru County. Factors associated with the resurgence include international travel as well as emergence of an insecticide resistance bed bug strain. Bed bugs infestation causes discomfort, physiological disorders as well as various phobias thus reducing the quality of life. Victims of bed bug infestation have been reported to suffer from bites, cutaneous and systemic infections [20]. However there has been lack of a well-coordinated reporting system of bed bug infestation in Kenya.

## 3. Methodology

### 3.1. Study Area

This study will be conducted in two wards in Nakuru County. Flamigo ward will be the intervention site while Kivumbini Ward will be the control site. Maps of intervention and control sites are represented in the following figures.

### 3.2. Study Design

This will be a quasi-experiment with one pretest and one post-test survey in both intervention and control sites. The surveys will be conducted to collect data on socio-demographic and economic characteristics of the respondents, baseline and end term data on proportion of households with bed bugs, and baseline and end term data on detection and reporting of bedbugs in both intervention and control sites.

### 3.3. Elements of CHW Led Mobile Application Intervention for Surveillance and Control of Bedbugs

The following are the key elements of the CHW led mobile application for Surveillance and Control of bedbugs;

- i. Development and testing of a mobile application to help in reporting detected bedbugs at household level
- ii. Procuring mobile phones for use in the project
- iii. Procurement of pesticides for control of bedbugs
- iv. Identifying and training CHWs on the following;
  - a) Visual detection of bedbugs.
  - b) Reporting of households in which bedbugs have been detected.
  - c) Use of pesticides in the control of detected bedbugs.

### 3.4. Variables in the Study

In the Quasi Experiment, the Quasi-independent variable will be the CHW led Mobile application Intervention. The dependent variables in the experiment will be bedbug detection and reporting (surveillance) and



control of bedbugs. This will be variables for study objective three and four. Study objective 2 which seeks to establish socio-demographic and socio-economic factors influencing bedbug infestation will have a different set of independent and dependent variables. The independent variables will be the socio demographic and socio-economic factors influencing bed bug infestation while the dependent variables will be bedbug infestation.

### 3.5. Study Population

The study population will be households in Nakuru County. The Study target population will be households in Kivumbini and Flamingo wards.

### 3.6. Study Inclusion and Exclusion Criteria

#### 3.6.1. Inclusion Criteria

All household heads from the study area that that will show willingness to participate in the study by signing the informed consent shall be included as participants in this study.

#### 3.6.2. Exclusion Criteria

Any household head in the study area who is not willing or not able to participate in the study will be excluded from taking part in this study.

### 3.7. Sample Size Determination

The total number of households in Kivumbini and Flamingo wards is 4600 and 6400 respectively. Sample size will therefore be determined by using a formula used by Fisher *et al.*, 1998 formula. The following is the adopted formula as used by [43]

The formula is as follows;

$$n = \frac{Z^2 pq}{d^2}$$

Where;  $n$  = is the desired sample size (when the study target population is over 10,000)

$Z$  - is the standard normal deviate=1.96. (Corresponding to 95% Confidence Interval)

$p$  - Proportion of the target population estimated to have the desired characteristics.

$q = 1.0 - p$

$d$  = Degree of accuracy required usually set as 0.05

$p = 50/100$  or 0.50

$q = 1-p = 1- 0.50 = 0.50$

Hence, the desired sample size ( $n$ ) has been calculated as follows.

$$n = \frac{Z^2 pq}{d^2} = \frac{1.96^2 \times 0.50 \times 0.50}{(0.05)^2}$$

$$n = \frac{0.9604}{0.0025}$$

$n = 384.16$  which is approximately 384.

Now that the total population ( $N$ ) is less than 10,000 in both intervention and control sites Fisher *et al* 1998 proposes application of a second formula to further make the sample size representative;

$$N_f = n/1 + (n/N)$$

Where  $N_f$  = the desired sample size (when population is less than **10,000**)

$n$  = the desired sample size (when the population is more than 10,000).

$N$  = the estimate of the population size (in this case we have used 6400

**Sample size for intervention site**  $N_f = 384/1 + (384/4600$  households) = 354 households

**Sample size for control site**  $N_f = 384/1 + (384/6400) = 362$  households

Sample size for intervention and control sites will be **354** and **362** households respectively.

Data on surveillance of bedbugs will also be collected from Nakuru East subcounty office records. This data will focus on bedbug surveillance. i.e number of households visited with the aim of conducting visual detection of bedbugs and total number of reported bedbug cases in both intervention and control sites (Both intervention and control sites are in Nakuru East sub county.

### 3.8. Sampling Procedures

Purposive and systematic sampling methods will be used. Purpose sampling will be used to identify the intervention and control sites. Purposive sampling will also be used to sample subcounty public health officers to collect data on detection and reporting of Bedbugs by CHWs. Systematic sampling will be used to identify the households in the study sample.

### 3.9. Data Collection Tools

Data will be collected using a structured questionnaire and an Observation checklist. The structured questionnaire and observation checklist are in appendix 1 and II respectively.

### 3.10. Piloting of the Study Tools

The study will be piloted at Kaptegega ward before implementation of the study. Piloting data will be subjected to Cronbach Alpha to test whether the coefficient of reliability is within the recommended limits.

### 3.11. Data Management, Analysis and Presentation

Data will be managed using SPSS version 20. Proportions, measures of central tendency, Chi square tests and Odds ratios will be used to analyze data. Difference in Differences, and regression analysis will be used to test study hypotheses. Appropriate tables and graphs will be used for data presentation.

### 3.12. Research Ethical Considerations

The researcher shall observe ethics throughout the whole study. The required permits shall be sought before the study that is ethical approval from Mount Kenya University Ethics and Research Committee (ERC),

NACOSTI and County Government (County Commissioner, Director of Education and Department of Health). Confidentiality shall also be observed throughout the study and unwilling respondents shall be treated with dignity and their views shall be respected. Findings from this study will be disseminated to the public and relevant stakeholders through relevant channels after approval by the necessary authorities

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