

INCREASING AWARENESS OF AND EDUCATION ABOUT BED BUGS (*CIMEX LECTULARIUS*)

AS A PUBLIC HEALTH ISSUE IN HAWAI'I

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAI'I AT

MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

ENTOMOLOGY

MAY 2014

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By

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DEDICATION

To my husband, who always believes in me even when I struggle to believe in myself.

To caffeine and loud neighbors for allowing me to stay awake and work longer hours.

To my loving family that never hesitated to encourage me.

ACKNOWLEDGEMENTS

My first thanks goes out to my major professor Dr. Helen Spafford. There is no doubt I could not have completed such a task without her guidance, expertise and flexible schedule. She is everything I could have hoped for in a major professor and then some. I would also like to thank my committee members Julian Yates and Opal Buchthal for their input into the design and subsequent manuscript of this project.

I must also acknowledge all the many anonymous attendees and participants who are now data points in this study. Without them, no results would have present. My appreciation also goes out to those who invited me to perform educational outreach to their organization, social club or peers. My graduate colleagues must also be mentioned, specifically Jess Inskeep and Christine Lynch for helping me finish sentences and making sure I remember to have fun every once in a while. Finally, I thank the United States Navy for providing me with the resources to devote my full attention towards attaining my degree in Entomology.

ABSTRACT

Bed bugs (Hemiptera: Cimicidae) are a severe public health issue with difficult and costly eradication methods. The recent resurgence of bed bugs has received considerable attention and increased research efforts. Humans represent a major contributor to the resurgence in bed bug infestations due to faster and more frequent worldwide mobility. This study sought to identify the lack of knowledge and ability to identify bed bugs in Hawai'i by conducting an identification study. Efforts were also focused on raising the self-efficacy among the adult population in Hawaii, on the topic of bed bugs, by providing educational seminars. Accurate identification of an adult bed bug in a vial was 30%, justifying the need for education. The great majority of respondents self-reported an increase in self-efficacy regarding bed bugs. Providing education is an effective prevention measure to help combat the spread of bed bugs by educating the population that contributes toward their dispersal.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	iv
ABSTRACT.....	v
LIST OF TABLES.....	viii
LIST OF FIGURES.....	ix
CHAPTER 1.....	1
INTRODUCTION.....	1
CHAPTER 2.....	8
IDENTIFICATION OF <i>CIMEX LECTULARIUS</i> : A SURVEY.....	8
Introduction.....	8
Materials and methods.....	10
Data analysis.....	15
Results.....	15
Discussion.....	19
CHAPTER 3.....	23
EDUCATIONAL SEMINARS ON <i>CIMEX LECTULARIUS</i>	23
Introduction.....	23
Materials and methods.....	26

Data analysis.....	31
Results.....	31
Discussion.....	34
CHAPTER 4.....	39
EXPERIENTIAL LEARNING BY SEARCHING FOR BED BUGS.....	39
Introduction.....	39
Materials and methods.....	41
Results.....	42
Discussion.....	44
CHAPTER 5.....	47
CONCLUSIONS.....	47
REFERENCES.....	50
APPENDIX.....	58

LIST OF TABLES

Table 2.1. The number and percentage of survey respondents in each demographic group.....	17
Table 2.2. Number of people correctly or incorrectly identifying bed bugs in relation to self-reporting previous experience with bed bugs.....	18
Table 3.1. The number and percentage of survey respondents in each demographic group.....	23
Table 3.2. Percentage of respondents self-rating level of knowledge on bed bugs.....	24
Table 3.3. Percentage of respondents self-rating level of concern on bed bugs.....	27
Table 3.4. Percentage of respondents self-rating ability to identify a bed bug.....	29

LIST OF FIGURES

Figure 2.1. Identification survey given to participants.....	11
Figure 2.2. <i>Cimex lectularius</i> specimen in test vial.....	12
Figure 2.3. Percentage of participants that correctly or incorrectly identified the bed bug specimen.....	16
Figure 2.4. Correct and incorrect identification of a bed bug according to age group.....	18
Figure 3.1. Pre-presentation survey.....	27
Figure 3.2. Page one of the post-presentation survey.....	29
Figure 3.3. Page two of the post-presentation survey.....	30
Figure 3.4. Self-rated level of knowledge of participants after the presentation in relation to level of education.....	24
Figure 3.5. Change in perceived knowledge of bed bugs after participation in an educational workshop.....	25
Figure 3.6. Level of concern in relation to residency in Hawai'i pre-presentation.....	26
Figure 3.7. Change in participant level of concern about bed bugs after the presentation.....	28
Figure 3.8. Change in perceived ability to identify bed bugs after the presentation.....	30
Figure 3.9. Participants' response to how likely they are to search a lodging room for bed bugs.....	31
Figure 3.10. Participants' response to how likely they are to search luggage before and after traveling.....	32
Figure 3.11. Participants' response to helpfulness of workshop.....	33

Figure 4.1 Average searching time of participants who did not find a bed bug in luggage before and after the presentation.....	43
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CHAPTER 1

INTRODUCTION

Bed Bugs (Hemiptera: Cimicidae) are group of insects that feed exclusively on blood (Cassidy et al., 2011). The Cimicidae compromise less than 100 described species. The most common bed bug living in close association with people is *Cimex lectularius* L. and is the only species in Hawaii. An adult bed bug is one-fourth to three-eighths of an inch in length, flat and reddish-brown in color with an absence of wings; resembling an apple seed (Foster, 1999). A female can lay approximately 200-500 eggs during her lifetime, about one year, after mating with a male (“Bed bug”, 2007; Cassidy et al., 2011). Even more troubling is that a female can continue to lay eggs without the further presence of a male as long as she is able to feed. A bed bug must transition through five nymphal instars before reaching adulthood, with a blood meal required by each instar and full development from an egg to an adult taking from 35-48 days (“Bed bug”, 2007; Cassidy et al., 2011).

To detect prey, the common bed bug senses heat and carbon dioxide emitted by humans. Once upon the host, feeding typically lasts for an average of ten minutes for an adult to fully engorge (Reinhardt & Siva-Jothy, 2007; Cassidy et al., 2011). While feeding rates are affected by temperature, digestion rate and host availability, *C. lectularius* was shown to feed approximately every 7 days in laboratory conditions (Reinhardt & Siva-Jothy, 2007). After feeding, the insect moves off the host to a nearby location. Infestations of bed bugs typically occur near the areas where people sleep or spend a significant period of time. Bed bugs can live for several months without feeding and are found across the globe from North and South

America, to Africa, Asia and Europe (“Joint statement on,” 2010). They are classified by the U.S. Environmental Protection Agency (EPA) as “a pest of significant public health importance” under the Federal Insecticide, Fungicide, and Rodenticide Act (“Notice to manufacturers,” 2002).

These urban pests possess a documented relationship with humanity dating back to the era of Aristotle and medieval texts (Rieder et al., 2012). Bed bugs have been discovered at archeological sites dating back more than 3,500 years (Panagiotakopulu & Buckland, 1999). Archeological evidence suggests bed bugs first started plaguing humans when they lived in caves. It is hypothesized that bed bugs fed on bats in caves and began using humans as an alternative host, moving from bats to humans (Usinger, 1966; Lewis et al., 2013). As people became less migratory and built villages, it was easy for bed bugs to maintain constant contact with their new human hosts. Before World War II, bed bug infestations were commonplace. Then, during the 1940s and 1950s, the widespread use of insecticides virtually eliminated the occurrence of bed bug infestations in the United States (Chalupka, 2010). Dichlorodiphenyltrichloroethane (DDT) and other residual insecticides were shown to prevent reinfestation of bed bugs for several months (Kells, 2006; Usinger, 1966). By the mid-1990s, bed bugs were so rare they could not be acquired for medical education purposes (Huntington, 2012; Snetsinger, 1997). The federal government even ceased printing its “How to Control Bed Bugs” publication in 1984 (Jacobs, 2011). Unfortunately, this was not to remain the situation.

Bed bug populations have increased and infestations are becoming a worldwide epidemic (Anderson & Leffler, 2008; Eddy & Jones, 2011). China, the United States, Canada and France represent a few of the nations that have recorded a high increase in bed bug incidence

during the past few years (Durand et al., 2009; Lei et al., 2013; “Major bed bug,” 2009). The extent of the problem is emphasized by a survey conducted by the National Pest Management Association, Inc. (NPMA) and the University of Kentucky, which had respondents from 43 countries. Of 521 responding U.S. pest management companies, 95% reported encountering a bedbug infestation in the past year (Potter, 2010; Manuel, 2010). The small culprits are encountered more and more often in hotels, office buildings, libraries and modes of transport – anywhere the turnover of occupants is continual (Chalupka, 2010; Eddy & Jones, 2011). In response to this critical issue, the EPA and U.S. Centers for Disease Control and Prevention (CDC) (2010) issued a joint statement on the resurgence of bed bugs and the need for control (Lewis et al., 2013). This statement resulted from the first ever National Bed Bug Summit in 2009, hosted by the EPA. The summit was organized and repeated in 2011 to develop recommended courses of action against an insect the nation views as a great threat to the public’s well-being.

Although bed bugs are not a direct cause of mortality, negative effects of bed bug infestations are felt psychologically, physically and financially (Susser et al., 2012). People respond differently to bed bug saliva with a range of reactions from mild to severe irritation, which on rare occasions require hospitalization (Huntington, 2012). Goddard and Shazo studied the magnitude of psychological effects a bed bug can produce: “infestation by bed bugs may produce psychological distress with nightmares, flashbacks of the infestation, hypervigilance (to keep the bugs away), insomnia, anxiety, avoidance behaviors, and personal dysfunction” (2012). In addition, it has been suggested that individuals living in homes with bed bugs can become socially isolated, resulting in further negative psychological impacts (Rieder et al., 2012). Naturally, the negative effects of bed bugs produce a desire to eradicate them immediately,

which presents another problem. A Hawaii state entomologist, Jeomhee Hasty, states that “the problem is, they are very hard to kill,” (Burlingame, 2010). Challenges include the fact that treatment options for bed bugs are limited and costly, making it difficult for certain populations to obtain treatment (Ratnapradipa et al., 2011). Beyond the direct cost of treatment, bed bug infestations have additional financial impact through costs for clinical diagnosis and symptomatic medical treatment of bites as well as indirect costs, including legal fees, awards for damages, decreased productivity and lost wages.

Hawaii has not been spared from the bed bug crisis. A study released in the Hawaii Journal of Public Health noted the increase of incoming calls, from 2006 to 2007, regarding bed bugs to the Hawaii State Department of Health, Vector Control Branch (DOHVCB) and Pest Control Companies (PCCs) in Oahu. The results showed that the DOHVCB recorded a two-fold increase in calls from 2006 (n=30) to 2007 (n=69) (Fickle et al., 2008). Of the eighteen pest management professionals interviewed, 72.0 % reported a strong increase in the number of calls and treatments pertaining to bed bugs they received in 2007 versus 2006. The remaining 28.8% “responded that they will not treat for bed bugs and therefore did not have any record of how many calls were made” (Fickle et al., 2008). A news article written in 2010 (Burlingame) stated that calls to the DOHVCB were once again double what they were the previous year. Oahu pest-control companies also comment on the number of bedbug treatments they are responding to. "The increase has been tremendous, way more than usual," said Frank Gomes, of Diversified Exterminators. "It's just an epidemic" (Burlingame, 2010).

Hawaii’s year round tourism industry puts the state at high risk due to increased bed bug transmission in areas of high traffic. The Hawaii Tourism Authority reports that “total air seats

for February 2013 grew 10 percent from last February to 844,874 seats. Total air seats increased 11.5 percent for Honolulu, Oahu” (Pike, 2013). Not only does Hawaii exhibit a higher risk for infestations, but the local economy has much at stake with its dependency on expenditure by tourists. Total expenditures by visitors to the state in February 2013 rose 9.9 percent (or \$110.2 million) over February 2012, totaling \$1.22 billion (Pike, 2013). Australia and New York are examples of tourist destinations that have already lost income due to the current bed bug crisis. The New Zealand Herald reports, “Australia is suffering a bed-bug epidemic with the tourism industry losing an estimated \$100 million a year because of the blood-sucking insects, a new entomology study says” (“Oz tourism...”). Some travelers who had arranged trips to New York say they are reluctant about staying in hotels and visiting attractions as reports of bedbugs seem to continually pop up (Frazier, 2010). “Officials in Mayor Michael Bloomberg's administration are concerned about the effect on the city's image and \$30 billion tourism industry” (Frazier, 2010). With the possibility of such dire effects, the State of Hawaii, Honolulu County, and other agencies should be implementing measures to limit and reduce the incidence and reports of bed bugs.

To stem the tide of bed bug infestations we must develop effective tools for prevention, early detection, and post-infestation treatment for eradication. Detection and post-infestation treatment needs to be effective and there continues to be significant research efforts devoted in this direction. However, very little research has been conducted towards increasing awareness of and education about bed bugs and how to search for and recognize these insects. Yes, this awareness and ability to identify bed bugs is essential for prevention, early detection and post-treatment monitoring to determine eradication.

Educational programs are effective in raising awareness and changing human behavior in relation to health issues. For example, the “Back to Sleep” campaign, a public health campaign designed to lower the incidence of sudden infant death syndrome (SIDS), promoted education and awareness. Mass mailings and public service announcements with a message to caregivers that placing infants on their backs to sleep could reduce the risk of SIDS were implemented (Willinger, 2012; Rivara & Johnston, 2013). Over a 15-year period, the number of infants sleeping in the supine position rose dramatically while SIDS mortality plummeted. Canada, one of the many countries experiencing an increase in bed bug infestations, has begun to treat the issue as a public health matter. In March 2011, the Manitoba government implemented a program for responding to bed bugs; “a key plank of the program is a public education campaign that stresses both prevention and eradication” (Shum et al., 2012). Along with grants for assistance and treatment, educational materials are widely distributed including brochures, posters, fact sheets, a website and a phone line. Since the program began, bed bug complaints and treatments have decreased by 60% (Shum et al., 2012).

There are limited resources and training available about bed bugs, in Hawaii. Before its disestablishment, the Hawaii State Vector Control Branch developed a Bed Bug Prevention and Education Campaign in fiscal year 2006. While the campaign provided presentations which included information on the bed bug situation, they were geared towards those with an entomological background: US Army Corps of Engineers FT Shafter, Hawaiian Entomological Society at UH Manoa, and the 2006 Hawaii Pest Control Association. The campaign provided information for the public through their website, the local news and the local newspaper. These venues do target a wide audience; however, they leave no realm for discussion and interaction with the audience; losing their effectiveness.

An extremely limited identification survey was conducted in Hawaii, only given to 16 emergency, transitional, and homeless shelters. The survey, done five years ago, does not record any demographic information that can aid in identifying which populations require more bed bug education. No study has been conducted to evaluate the ability of people in Hawaii to identify bed bugs. Conducting an identification survey to a wide spectrum population, with anonymous demographic information, would provide us with such an assessment and allow education programs to be targeted specifically to populations that can benefit from them. There is a need for educational materials and a workshop to be developed for the public that provides an environment where the population can ask questions, learn behaviors and engage in active bed bug searching exercises. “The way in which instruction is delivered is an important factor that can contribute to an adult learner’s success” (Klein-Collins, 2011).

The purposes of my study were to provide evidence of the lack of knowledge on bed bugs while identifying possible demographic patterns and to demonstrate the benefits of providing interactive workshops on bed bug behavior, identification and preventive practices. The long term goal of the study was to increase self-efficacy among the general population in dealing with bed bugs. Teaching awareness of bed bug characteristics and behaviors encourages the early detection of bed bugs, which creates an easier eradication process, and possible prevention of incurring this public health pest.

CHAPTER 2

IDENTIFICATION OF *CIMEX LECTULARIUS*: A SURVEY

INTRODUCTION

The resurgence of bed bugs has been attributed to multiple causes, including increased resistance to pesticides, changes in pest control methods and more widespread international travel. One possible cause of the resurgence may be low detection of early infestations; this enables a bed bug population to grow and be subsequently transported to new locations prior to any management being implemented. Bed bugs are ordinarily cryptic and thus hard to find, particularly in low-density infestations (Cooper, 2006). An important factor in poor early detection may be the inability of people to identify a bed bug once they encounter one. Poor knowledge among the population of what bed bugs look like will lead to misidentification and possibly use of ineffective or late treatment. Sources speculate that knowledge of the bed bug has declined during the years of low infestations. The decline in bed bug populations, and overall knowledge, in the latter half of the 20th century has also resulted in limited research on the public health effects of bed bugs (Reinhardt & Siva-Jothy, 2007; “Joint statement on,” 2010). Nevertheless, awareness of the public is key to reducing bed bug infestations (Anderson & Leffler, 2008). Proper identification of a bed bug allows individuals to promptly treat and curb the spread of the problem. Recognizing individual bed bugs before the typical signs of fecal spots, cast skins, and large numbers of bugs may help to prevent population growth and the spread of bed bugs from the site of introduction.

There are several factors that may influence a person’s ability to identify a bed bug. A study done in the United Kingdom showed that only a small proportion of people (10.34%)

surveyed were able to accurately identify a bed bug but that older adults were exceedingly better at identifying the common bed bug than any other age group (Reinhardt et al., 2008). This study used a live, unfed bed bug (starved for two weeks) for respondents to identify. The only demographic analyzed was age and sampling was done relative to the population demographic structure of the county. An identification study in Germany demonstrated that only 12.5% of 391 respondents were able to correctly identify a live male bed bug in a vial (Seidal & Reinhardt, 2013). However, overall, relatively few people may be able to identify a bed bug, despite the increasing incidence of infestations.

Studies have shown that previous experience increases the probability that someone would correctly identify a bed bug, but doesn't assure correct identification. Seidal and Reinhardt (2013) also found that of the people who had previous contact with bed bugs ($n = 27$), a majority (59%), but not all, correctly identified bed bugs. An extremely limited identification survey was conducted in Hawai'i, but it only targeted 16 emergency, transitional and homeless shelters of which 68.75% of the shelters had been affected by bed bugs in the last two years (Fickle et al., 2008). When the populations in these shelters were surveyed, the majority of interviewees could correctly identify a bed bug when a series of pictures, of unknown quality, were shown to them. Such results suggest that people who have been in areas where bed bug infestations are likely to be present are more likely to be able to identify them.

In addition, the way an identification survey is conducted may also influence the responses of those surveyed. Seidel and Reinhardt (2013) discussed how efforts to educate audiences on bed bugs or sell products to control them are often done on a multi-media basis using images rather than actual specimens, where size, color and variation are not accurately

represented. They caution that the effectiveness of this method has never been tested and it may be difficult for audiences to recognize a real bed bug after viewing a large one on screen.

In the present study, we sought to assess the ability of the population in Hawai'i to identify bed bugs. To do so, we conducted the first unbiased identification survey in Hawai'i which enables us to assess the need for the development of educational programs about these insects. Furthermore, we sought to evaluate what demographics may influence a person's ability to accurately identify bed bugs. Conducting an identification survey to a wide spectrum population, with anonymous demographic information, would enable education programs to be targeted towards the appropriate audiences.

MATERIALS AND METHODS

IDENTIFICATION SURVEY

A nine- question survey was developed and delivered in hard copy to participants. The first question asked people if they could identify the specimen in a vial (Figure 2.1). The second question requested more general information about household pests (Figure 2.1). The remaining questions requested information about the participant's age, gender, longevity in Hawai'i, travel experience, and educational background.

What is this Insect?

1. Can you identify the insect in the vial?

- ☐ Yes
- ☐ No
- ☐ Uncertain

If yes, please write your answer on the line provided: _____

2. Have you ever had any experiences with household insect pests? **Excluding:** cockroaches, ants, flies, spiders or termites

- ☐ Yes
- ☐ No

If yes, please identify the household pests you had previous experience with on the line provided:

3. Please note your age group:

- ☐ 21 and under
- ☐ 22 to 34
- ☐ 35 to 44
- ☐ 45 to 54
- ☐ 55 to 64
- ☐ 65 and over

4. Are you affiliated with the U.S. military in any of the following ways: active duty, reserves, dependent or retired?

- ☐ Yes
- ☐ No

5. How long have you lived in Hawai'i?

- ☐ 0 months- 1 year
- ☐ 1-5 years
- ☐ 6-10 years
- ☐ 10 years or greater

6. How often do you travel? (Defined as: use of luggage and stay in temporary lodging such as a hotel)

- ☐ Less than one a year
- ☐ 1-2 times a year
- ☐ 3-5 times a year
- ☐ Greater than 5 times a year

7. Where do you travel?

- ☐ Inter-island
- ☐ Within the United States
- ☐ Internationally

8. What is your gender?

- ☐ Male
- ☐ Female

9. What is your highest level of education?

- ☐ Less than High School
- ☐ High School/ GED
- ☐ Some College
- ☐ Two Year College Degree (Associates)
- ☐ Four Year College Degree (BS, BA)
- ☐ Master's, Doctoral or Professional Degree (MS, PhD, MD)

Figure 2.1 Identification survey given to participants 11

The specimens used in the survey were dead adult bed bugs, *Cimex lectularius*, from a colony maintained at the Department of Entomology, University of Ohio. A single specimen was placed in a plastic vial (5.5 cm tall and 2 cm wide at the base) with no other objects or liquid present (Figure 2.2). Dead specimens were chosen to eliminate any risk posed to survey participants and to reduce potential anxiety associated with encountering live bed bugs. Participants were authorized to handle the vial and view the specimen closely without removing the lid.



Figure 2.2 *Cimex lectularius* specimen in test vial

The demographic questions were chosen to analyze possible patterns related to ability to accurately identify bed bug. The identification study done in the United Kingdom demonstrated

that the older the participant, the more likely they were to identify a bed bug (Reinhardt et al., 2008). Therefore, participants were asked to identify their age. The demographic question for age was taken from the profile questionnaire for the American Marketing Association (Mahoney, 2008). Since travel is associated with the spread of bed bugs, a question regarding the frequency of travel was included. The expectation is that the more one travels, the more likely they are to have had experiences with bed bugs and thus, possess the ability to identify one. Also, in relation to travel, a military affiliation question was included due to the transient life style for persons associated with U.S. military operations - the expectation is the same as the higher frequency travelers. The participants were asked to list their experiences with household pests to help test the belief that those who have had previous encounters with bed bugs can more accurately identify a bed bug. We could not ask outright whether the participant had experiences with bed bugs without potentially exposing the identity of the insect. The expectation was that if the participant did have previous experience with bed bugs, they would include it in their response to the question. Gender was included to see if societal gender roles may play a part in the recognition of this household pest. In many cultures, women tend to be responsible for the maintaining the cleanliness of the house and would, therefore, be more likely to notice insect pests within the home. To determine a possible pattern related to socioeconomic status, a question on highest level of education achieved was included. The expectation is that those with higher education will identify the bed bug more often than those with a lower level of education (Reinhardt et al., 2008).

Surveys were conducted throughout the island of Oahu from February 2013 to October 2013. People were contacted at the University of Hawai'i at Manoa campus and at a farmers market located in Honolulu. Efforts to conduct surveys at local businesses were not approved.

Thus, additional participants were surveyed prior to participation in bed bug educational workshop. To address the potential bias inherent in surveying people who are about to attend a workshop, the educational workshops were advertised as addressing general household pests. When participants attended the workshop, they were given an identification survey to complete prior to the beginning of the workshop.

During the survey period, a total of 305 responses were recorded. After an initial survey period the survey instrument was slightly modified. Initially, the response to the first question, asking whether the participant can identify the insect, was listed as “yes” or “no”. Many respondents vocalized their discord by making statements such as, “I am not confident enough to check yes but I think I know what it is,” or “Do I have to be certain to check the yes box?” Therefore, an “uncertain” option was added and all previous surveys were discarded. Furthermore, incomplete surveys were also discarded.

The survey was restricted to persons over the age of 18. Participants signed a consent form ensuring anonymity of their responses as well as the ability to refuse to answer any questions they may not understand or feel uncomfortable responding to. On February 11, 2013, the University of Hawai’i Human Studies Program approved this study as exempt from federal regulations pertaining to the protection of human research participants (CHS # 21004).

DATA ANALYSIS

A total of 230 responses were used in the analysis. Descriptive statistics of ability to correctly identify the bed bug and demographic data were generated. A categorical data analysis was conducted using contingency tables to evaluate the association of the different demographic variables and ability to correctly identify a bed bug.

RESULTS

When participants were asked if they could identify the insect in the vial, 47% (n=107) answered no, 33% (n=77) answered uncertain, and 20% (n=46) answered yes. About half of all participants attempted to identify the insect in the vial (53%; n= 123). Only 30% (n=70) of people were able to accurately identify the bed bug in the vial (Figure 2.3). Only 16% (n=36), of all surveyed, were able to identify the bed bug with confidence (Figure 2.3). Those that attempted to identify the specimen but did so incorrectly, identified it as either a tick (n=16), cockroach (n=8), flea (n=8), insect (n=6) or mite (n=3).

Of the 230 people surveyed, the majority of them were female (Table 2.1). There was no association between gender and ability to correctly identify a bed bug ($X^2 = 0.41$; $df = 1$; $P = 0.51$). Respondents were distributed throughout six different age groups with the most abundant in the 22 to 34 age range (Table 2.1); likely the result of surveying on a college campus. We hypothesized that those in a higher age group would be more adept at identifying bed bugs but no association was found (Figure 2.4; $X^2 = 3.89$; $df = 5$; $P = 0.56$). Only 11% (n=24) were affiliated with the military (Table 2.1); no relationship was found with this population and identification ability ($X^2 = 1.16$; $df = 1$; $P = 0.27$). The vast majority of survey-takers traveled sparingly, with 38% indicating they traveled less than once a year and 45% indicating they

traveled 1-2 times a year (Table 2.1) and again, there was no relationship between frequency of travel and ability to identify a bed bug correctly ($X^2 = 5.94$; $df = 3$; $P = 0.11$).

Nineteen respondents (8% of all surveyed) self-reported previous experience with bed bugs (Table 2.2). Those that listed previous experience with bed bugs were more likely to correctly identify a bed bug than those who did not have previous experience ($X^2 = 13.86$; $df = 1$; $P = 0.0019$). Despite this, of those respondents that self-reported previous experience with bed bugs: only 53% ($n=10$) correctly identified a bed bug with confidence; 4% of the total survey population.

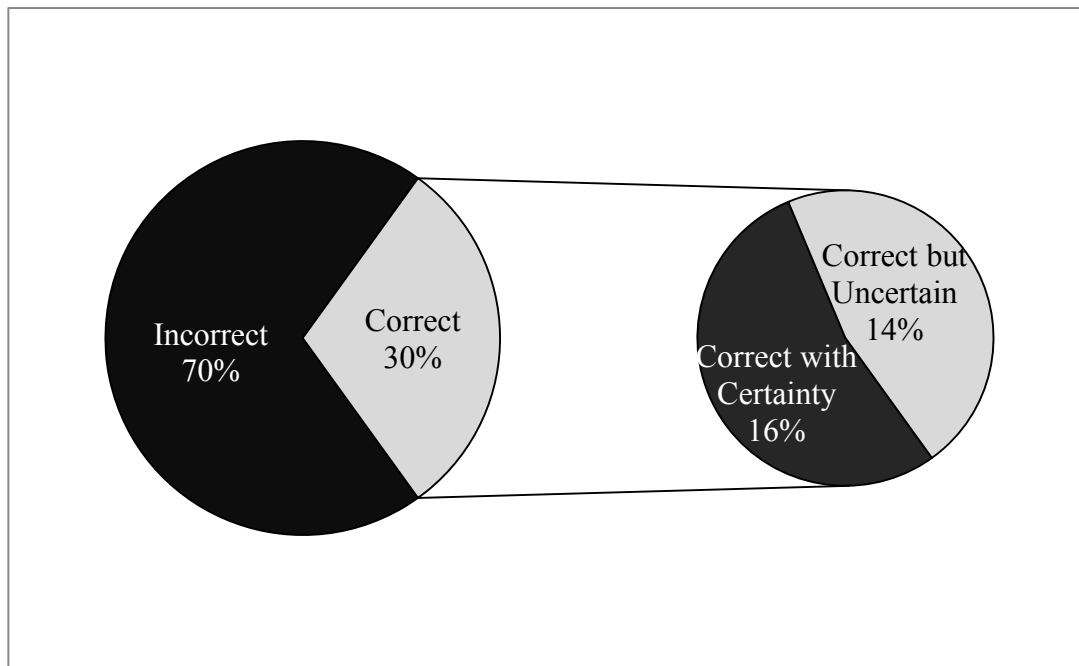


Figure 2.3 Percentage of participants that correctly or incorrectly identified the bed bug specimen

Demographic	Number (%) in Demographic category					
Gender	Male	Female				
	80 (36.2%)	141 (63.2%)				
Age	21 and under	22 to 34	35 to 44	45 to 54	55 to 64	65 and over
	32 (14.3%)	70 (31.4%)	35 (15.7%)	16 (7.2%)	24 (10.8%)	46 (20.6%)
Education	Less than High School	High School/GED	Some College	Two Year Degree	Four Year Degree	Professional Degree
	8 (3.6%)	30 (13.6%)	51 (23.1%)	32 (14.4%)	64 (29%)	36 (16.3%)
Length of Residency in Hawai'i	0 Months - 1 Year	1 - 5 Years	6 - 10 Years	10 Years or greater		
	36 (16.2%)	56 (25.2%)	21 (9.5%)	109 (49.1%)		
Military Affiliation	Yes	No				
	24 (10.9%)	195 (89.1%)				
Travel Frequency	Less than once a year	1 - 2 Times a year	3 - 5 Times a year	Greater than 5 times a year		
	84 (38%)	100 (45.2%)	32 (14.5%)	5 (2.3%)		
Travel Destinations	Inter-Island	Within the U.S.	International			
	61 (20%)	126 (41.3%)	118 (38.7%)			

Table 2.1 The number and percentage of survey respondents in each demographic group

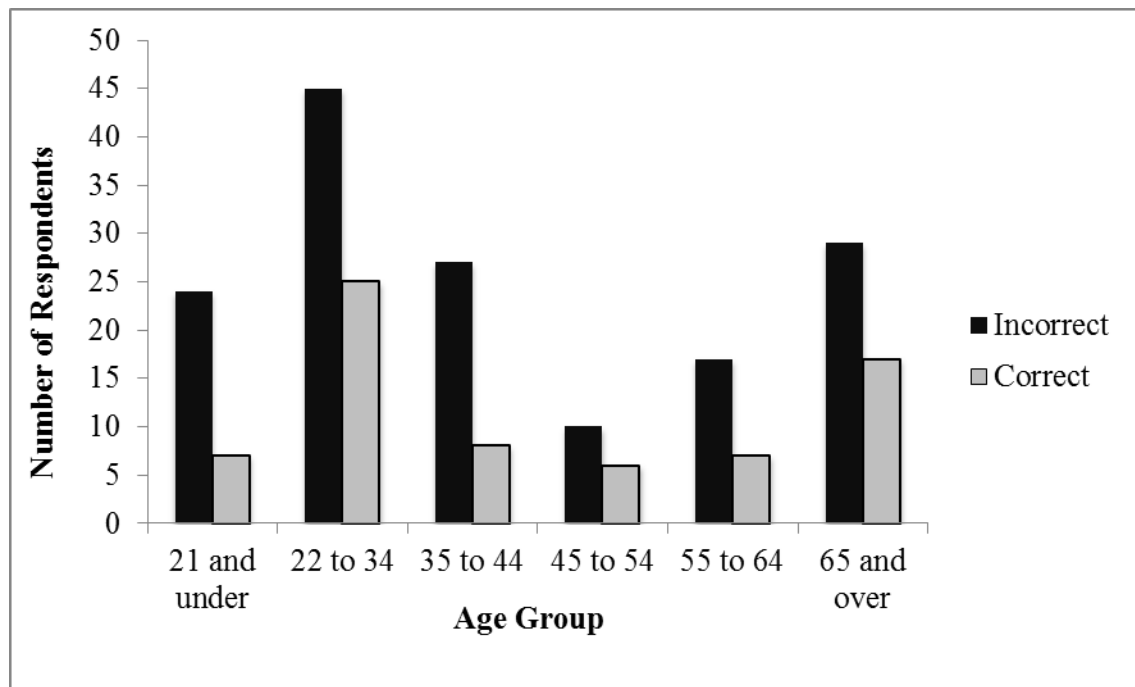


Figure 2.4 Correct and incorrect identification of a bed bug according to age group

	Previous experience with bed bugs		
Correct identification	No	Yes	Grand Total
No	154	6	160
Yes	57	13	70
Grand Total	211	19	230

Table 2.2 Number of people correctly or incorrectly identifying bed bugs in relation to self-reporting previous experience with bed bugs

DISCUSSION

With only 30% of the population able to accurately identify a bed bug, this suggests that 70% of bed bug incidences in private homes may not be recognized early, if at all. The need for education is clearly demonstrated. In addition, our study utilized possibly the most recognized stage of a bed bug, the adult phase, for identification. We predict rates of recognition would likely be even lower if nymphs had been used in the identification study.

Results do suggest that those who reported previous experience with bed bugs are more capable of identifying a bed bug than those who have not had experience with bed bug infestations. Of those that listed previous experience with bed bugs, their responses suggested exposure arose from an infestation. Seidel and Reinhardt (2013), found that “learning about bed bugs as a result of experiencing an infestation, appears to be a long-lasting effect: the last time the respondents had contact with bed bugs did not differ much between those that did recognize bed bugs (35 years ago) compared with those that did not recognize them (30 years ago).” Therefore, the relationship between previous experience and identification ability indicates how effective it may be to use real bed bugs as an educational tool.

Troubling is the 53% of people who reported previous experience with bed bugs, yet still could not identify the insect with certainty as well as those who guessed other insects. One contributing factor, also noted by Seidel and Reinhardt (2013), could be the out of context setting of the bed bug, being shown in a vial. If the specimen had been placed in a bedroom or on a mattress, it is possible that more people would have correctly guessed a bed bug. However, bed bugs are found in diverse locations such as single family homes, multi-unit dwellings, hotels, schools, hospitals, shelters, and public transportation (Wang et al., 2010); therefore recognition

of bed bugs in isolation is important. Further studies should include questioning participants on what basis they made their specimen identification guess.

“Bed bugs became very rare in many industrialized countries soon after World War II because of the widespread use of synthetic insecticides.” (Harlan, 2006). A study done in the United Kingdom (Reinhardt et al., 2008) demonstrated increased accuracy in identification of bed bugs as age of the participant increased. These authors suggested that the result “may be explained by an increased likelihood of older people to have encountered a bed bug live or in the media” (Reinhardt et al., 2008). Therefore, the expectation was that older respondents in our study, i.e. those who are likely to have had more experience with bed bugs, would be more adept at identifying a bed bug, however no such pattern was evidenced. There were 45 people (21%) in the 65 and over age group, those who were expected to have had some exposure to bed bugs prior to the rapid decline in the level of infestation following World War II and the rise in insecticide use. Despite this hypothesized increase in exposure, the proportion of correct identification in this group was no different than in any other group. Correct identification across age groups suggests another factor might influence the probability of correct identification. However, none of the demographic variables evaluated in our survey relate in any way to a person’s ability to correctly identify a bed bug.

The goal of bed bug management is eradication of an infestation, not simply reduction in number. It is generally accepted that bed bug infestations are difficult to eradicate. Recent cancellation of most indoor organophosphate and carbamate insecticide usage has decreased the arsenal of effective bed bug products (Osteen & Livingston, 2006). Furthermore, of those remaining products (principally pyrethroids), the prospect for resistance is worrisome (Potter, 2006). Other methods of treatment such as thermal treatment and bed bug detectors/monitors are

relatively less effective and many require constant monitoring and vigilance (Huntington, 2012). Consequently, bed bug control efforts by residents themselves or by a contracted pest control professional are often ineffective (Wang et al., 2010). Eradication efforts are only made harder by encountering a well-developed infestation.

Bed bugs possess a great potential to spread, once again necessitating the need to identify a potential infestation early. Doggett and Russell (2008) reported that the number of bed bug-infested units in a 320-room medical facility increased from 1 to 68 rooms in 50 months. Another study came to similar conclusions, finding that bed bug infestations have potential to spread into many rooms within a building after introduction, bed bugs frequently disperse through entry doors to hallways and a large percentage of residents may be unaware of extant bed bug infestations in their apartments (Wang et al., 2010). This is of particular concern in large facilities such as dormitories, hospitals, and hotels. Bed bug infestations may frequently go unnoticed until too late, i.e., until customer complaints or compensation claims (Sharkey, 2003). Public tolerance for bed bug bites today is almost zero, and lawsuits are becoming common (Donaldson, 2006). Industries can also be faced with adverse publicity, therefore it is in their best nature to prevent or eradicate an infestation very early on

Thus, the key to eradication is early and accurate identification. Our study has shown that a large proportion of the population in Hawai'i cannot accurately identify a real bed bug. Furthermore, half of those who report previous experience with these pests still cannot accurately identify a real bed bug.

It is our recommendation that further identification studies should be done using the nymphal stages as well as the adult stage of a bed bug. A relationship between previous experience with bed bug and identification ability was evidenced but should be investigated

further. It may be that age and residence time in Hawai'i were confounding factors and consequently we did not detect a pattern related to these variables. These may also have been related to socioeconomic status and employment. We did not gather employment information for respondents to recognize if any were employed in the hotel or travel industry. We recommend including questions about employment or socioeconomic status. The potential also exists to extend the identification survey to the outer islands to gather a representative sample of the entire State of Hawai'i and to examine patterns of ability that may relate to demographics and location within the state. Ideally, the identification survey should take place completely separate of the educational workshops; more connections need to be made to identify surveying locations with open access to the public.

CHAPTER 3

EDUCATIONAL SEMINARS ON *CIMEX LECTULARIUS*

INTRODUCTION

Identifying a bed bug is only part of the solution to the bed bug resurgence. People also need reliable information about bed bug biology and management. According to Henrikson, (2012) when a large university in the Midwest experienced a bed bug infestation, those living in university housing were discouraged from reporting the presence of bed bugs. Eventually the housing areas eventually required treatment for 200 rooms. While identification ability was present, an effective response was not. Henrikson (2012) goes on to say school administrators should develop a bed bug action plan.

“The plan should educate staff, teachers and students on the following: basic bed bug biology and habits, especially their hitchhiking nature, which enables them to easily go from home or hotel to school and residence halls; how to recognize bed bugs, their evidence and their bites; the responsibility and roles regarding bed bugs and school response; and actions to reduce the risk of future infestations or incidents.”

I argue this plan is not only necessary for those living in university housing but for anyone at risk of incurring a bed bug infestation. In current times, this could mean nearly everyone involved with the social, fast-paced lifestyle common today.

Another study in Germany published results demonstrating the troubling lack of knowledge on how to respond to a bed bug infestation. In responding to a survey question, “How

do you think you can get rid of bed bugs?” Only 15% of respondents elected to call a professional pest controller, possibly the only effective solution (Seidel & Reinhardt, 2013). In Indiana, among surveyed residents of a bed bug infestation in a high-rise apartment building, 40% of the 40 surveyed used chemicals to control bed bugs themselves (Wang et al., 2010). Furthermore, the study noted that efforts by residents themselves are often ineffective in eliminating bed bug infestations (Wang et al., 2010).

Education is not only beneficial for teaching effective responses but also for teaching audiences how to lower their risk of incurring bed bugs. It is not uncommon for bed bug infested items to be placed on the street; those unaware of the risks could pick up the items and unknowingly contribute to bed bug distribution (Cooper, 2006). Second hand furniture is popular for use in multi-unit buildings such as dorms or apartments, especially in low-income areas, and likewise could contain bed bugs. A property manager in Hawai'i made the following statement:

“I got a call from a tenant late at night. I usually don't answer it but since it was so late in the evening I thought it was an emergency. She told me that her daughter's whole body has been covered with bites and that something needed to be done. As it turned out, earlier that day she had purchased a bed off of craigslist and it was contaminated with bed bugs.” (Spafford, personal communication, April 15, 2014).

Multi-unit dwellings are already at risk of spreading bed bug infestations due to the proximity of living quarters, the popularity of second hand or rented furniture only increases the risk.

Since bed bugs feed at night and hide during the day (Reinhardt & Siva-Jothy, 2007), the ability to identify a bed bug alone is not enough to recognize an infestation. Early stages of infestation are difficult to identify without knowledge of bed bug biology. The only evidence of an infestation may be the fecal stains or cast skins. Even the name “bed bug” can be deceiving in that some may think bed bugs are only present in residences near beds. This results in many being unaware that they are just as at risk on public transportation, movie theaters and lobbies. Therefore, people must be taught bed bug biology as well, in an effort to promote early detection of an infestation.

Countless expert sources are, and have been, calling for bed bug education to be implemented. Richard Cooper (2006) emphasizes “the desperate need for both basic and applied bed bug research, as well as community outreach efforts aimed at increasing public awareness.” Education efforts should first seek to provide the public with knowledge to avoid an infestation but also provide valuable materials for anyone falling victim to an infestation. “In addition, education can encourage individuals to report infestations to government agencies, thereby improving tracking...” (Ratnapradipa et al., 2011). Instituting a reporting system could encourage and guide funding for educational outreach on bed bugs.

Public seminars and workshops are one of many potential approaches to educating people about particular issues. The workshop approach allows for people to interact with each other, gain hands-on experience, and get immediate answers to questions. If a workshop is designed effectively it will lead to an increase in self-efficacy or confidence with respect to the issue. A rise in self-efficacy can influence various factors of human behavior, including the goals they

strive for, effort inputted toward achievement of goals, and likelihood of attaining particular levels of behavioral performance (Carey & Forsyth, n.d.).

For the bed bug problem, development of a hands-on workshop could help increase identification ability, awareness and other skills in participants, all of which can aid in prompt treatment or even prevention. This study reports on the response of participants to the development and delivery of a workshop on bed bug identification, biology and preventative behaviors. By providing this information on bed bugs, it is anticipated that the confidence level, or self-efficacy, of participants on the subject of bed bugs will increase. The perception of benefits of attending an educational workshop was also assessed. The relationship between various demographics and participant attitudes was also assessed. Identifying such factors could allow efforts to be directed towards the appropriate audiences.

MATERIALS AND METHODS

A one-hour workshop on bed bugs was developed. During the workshop, participants received information about bed bug biology, bed bug behavior and human behaviors to help prevent the incidence of bed bugs. Participants were asked to complete a survey at the beginning of the workshop, prior to and following a presentation. The workshop, and corresponding surveys, were approved by the University of Hawai'i Human Studies Program on February 11, 2013 (CHS # 21004).

Pre-survey

Before the start of the presentation, participants were asked to answer three questions on a scale of 1 to 5 (Figure 3.1). Explanations of number values were indicated under numbers 1, 3, and 5 to avoid possible confusion for any survey taker. These questions served as a baseline and were asked again following the workshop.

1. On a scale of 1 to 5, how would you rate your knowledge of bed bugs?				
1	2	3	4	5
I know nothing about bed bugs		I know some information on bed bugs		I know a great deal about bed bugs
2. On a scale of 1 to 5, what is your level of concern about bed bugs?				
1	2	3	4	5
Not concerned		Some concern		Very concerned
3. On a scale of 1 to 5, how would you rate your ability to identify a bed bug?				
1	2	3	4	5
Cannot identify		Probably identify		Can definitely identify
<u>Please stop here.</u>				

Figure 3.1 Pre-presentation survey

Presentation

The information was delivered through a traditional lecture format supported with a Power Point presentation (Microsoft 2010; Appendix).

The main objectives of the presentation were to:

- a. increase awareness of the rise in bed bug infestations
- b. teach people how to recognize a bed bug at different life stages
- c. dispel misunderstandings about bed bug transmission and infestations
- d. teach people how to look for bed bug infestations
- e. teach people how to reduce the probability of transporting bed bugs to their homes

Seidel and Reinhardt (2013) found that a 7-fold higher number of people identified bed bugs correctly if they had prior experience with bed bugs than those who had not. Our identification survey also demonstrated a relationship between positive identification and previous experience (Chapter 2). These results suggest that using real bed bugs could be effective in improving recognition and should be used in educational seminars. Therefore, workshop participants also had an opportunity to view and handle bed bug specimens. Dead adult bed bugs were placed in vials measuring 5 cm tall and 2 cm wide.

Post-presentation survey

Following the presentation, attendees were asked to complete another survey. The three questions from the pre-presentation survey were repeated; and additional questions were added (Figure 3.2, 3.3).

5. On a scale of 1 to 5, how would you rate your knowledge of bed bugs?				
1	2	3	4	5
I know nothing about bed bugs		I know some information on bed bugs		I know a great deal about bed bugs
6. On a scale of 1 to 5, what is your level of concern about bed bugs?				
1	2	3	4	5
Not concerned		Some concern		Very concerned
7. On a scale of 1 to 5, how would you rate your ability to identify a bed bug?				
1	2	3	4	5
Cannot identify		Probably identify		Can definitely identify
8. On a scale of 1 to 5, how helpful did you find this workshop?				
1	2	3	4	5
Not helpful		Semi-helpful		Very helpful
9. How likely are you to check your luggage before and after traveling?				
1	2	3	4	5
Will not use behavior		Probably use behavior		Will use behavior
10. How likely are you to search your lodging room for bed bugs?				
1	2	3	4	5
Will not use behavior		Probably use behavior		Will use behavior

Figure 3.2 Page one of the post-presentation survey

11. Please note your age group:

- ☐ 21 and under
- ☐ 22 to 34
- ☐ 35 to 44
- ☐ 45 to 54
- ☐ 55 to 64
- ☐ 65 and over

12. Are you affiliated with the U.S. military in any of the following ways: active duty, reserves, dependent or retired?

- ☐ Yes
- ☐ No

13. How long have you lived in Hawaii?

- ☐ 0 months–1 year
- ☐ 1-5 years
- ☐ 6-10 years
- ☐ 10 years or greater

14. How often do you travel? (defined as: use of luggage and stay in a temporary lodging such as a hotel)

- ☐ Less than once a year
- ☐ 1-2 times a year
- ☐ 3-5 times a year
- ☐ Greater than 5 times a year

15. Where do you travel? (may select any that apply)

- ☐ Inter-island
- ☐ Within the United States
- ☐ Internationally

16. What is your gender?

- ☐ Male
- ☐ Female

17. What is your highest level of education achieved?

- ☐ Less than High School
- ☐ High School/GED
- ☐ Some College
- ☐ Two Year Degree (Associates)
- ☐ Four Year Degree (BS, BA)
- ☐ Master's, Doctoral or Professional Degree (MS, PhD, MD)

18. Do you have any recommendations for this workshop?

Figure 3.3 Page two of the post-presentation survey

Workshops were given from March 2013 through October 2013; fifteen workshops were completed during this time. The first three educational workshops were scheduled by contacting a local non-profit organization that provided housing assistance. After the initial three workshops, requests for workshops were received by phone or email from various groups who had heard of the outreach program through word of mouth. No request was denied until data collection was finished. Groups that received outreach included adult education learning centers, businesswomen groups, real estate companies, and non-profit organizations. Locations varied throughout the island of Oahu.

DATA ANALYSIS

Approximately 500 people participated in the workshops. Of these 297 pre and post-presentation surveys were completed and analyzed. For each of the three paired pre- and post-presentation survey questions, the response of each participant was scored as either an increase, decrease or no change percentages. The relationship between demographic variables and survey responses were analyzed using contingency tables and chi-square tests (Excel, Microsoft 2010).

RESULTS

Workshop participants varied across the different demographic criteria (Table 3.1).

Demographic	Number (%) in Demographic category					
Gender	Male	Female				
	75 (27.8%)	195 (72.2%)				
Age	21 and under	22 to 34	35 to 44	45 to 54	55 to 64	65 and over
	26 (8.9%)	28 (9.8%)	55 (19%)	39 (13.5%)	55 (19%)	86 (29.8%)
Education	Less than High School	High School/GED	Some College	Two Year Degree	Four Year Degree	Professional Degree
	19 (7.1%)	55 (20.5%)	57 (21.3%)	29 (10.8%)	74 (27.6%)	34 (12.7%)
Length of Residency in Hawai'i	0 Months - 1 Year	1 - 5 Years	6 - 10 Years	10 Years or greater		
	32 (11.6%)	52 (18.9%)	18 (6.6%)	173 (62.9%)		
Military Affiliation	Yes	No				
	28 (10.4%)	240 (89.6%)				
Travel Frequency	Less than once a year	1 - 2 Times a year	3 - 5 Times a year	Greater than 5 times a year		
	102 (37.5%)	115 (42.3%)	44 (16.2%)	11 (4%)		
Travel Destinations	Inter-Island	Within the U.S.	International			
	98 (24.3%)	167 (41.3%)	139 (34.4%)			

Table 3.1 The number and percentage of survey respondents in each demographic group

Level of Knowledge

Prior to the presentation, the majority (53%) of participants rated themselves as having some knowledge or no knowledge (23%) of bed bugs ($X^2 = 210$; $df = 4$; $P\text{-value} < 0.0001$); Table 3.2). A few self-rated as knowing a great deal about bed bugs (5%) (Table 3.2). There was a statistically significant relationship between gender and self-rated knowledge before the presentation ($X^2 = 15.9$; $df = 4$; $P\text{-value} = 0.003$). More men (9%) claimed to know a great deal about bed bugs than women (3.6%). There was not a statistically significant relationship between level of education and self-rated knowledge of bed bugs before the presentation ($P\text{-value} > 0.05$). However, it is notable that the majority of those who claimed no knowledge of bed bugs reported their highest level of education as high school/GED (29%). Whereas those who had at least a four-year degree claimed to know some (31%), moderate (25%) or a great deal (21%) about bed bugs. There was no relationship with pre-presentation knowledge and any of the other demographic variables tested ($P\text{-value} > 0.05$)

Following the presentation, the majority of participants (43%) rated themselves as knowing a great deal about bed bugs ($X^2 = 164.5$; $df = 4$; $P\text{-value} < 0.0001$; Table 3.2). Statistical analysis demonstrated that gender had no impact on post-presentation level of knowledge ($X^2 = 1.83$; $df = 4$; $P\text{-value} = 0.76$), however level of education did ($X^2 = 51.56$; $df = 20$; $P\text{-value} = 0.00013$; Figure 3.4). In general, those who had some tertiary level of education (i.e. post-high school/GED education) rated their knowledge of bed bugs as higher than those who had not had any tertiary level education (Figure 3.4).

Level of Knowledge	Pre-presentation	Post-presentation
1 (I know nothing about bed bugs)	23%	2%
2	13%	3%
3 (I know some information about bed bugs)	53%	27%
4	6%	25%
5 (I know a great deal about bed bugs)	5%	43%

Table 3.2 Percentage of respondents self-rating level of knowledge on bed bugs

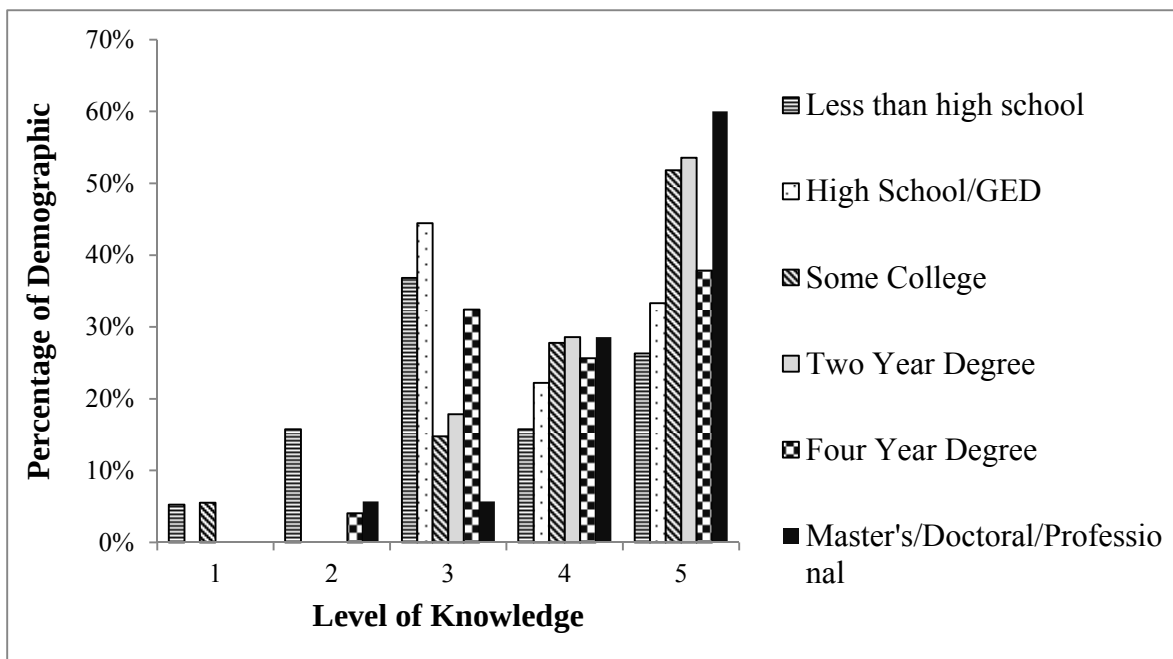


Figure 3.4 Self-rated level of knowledge of participants after the presentation in relation to level of education

Of the 297 surveys collected, 273 responses were included in the analysis of change in knowledge before and after the presentation. The overall self-rating of knowledge increased in 76% of participants (Figure 3.5).

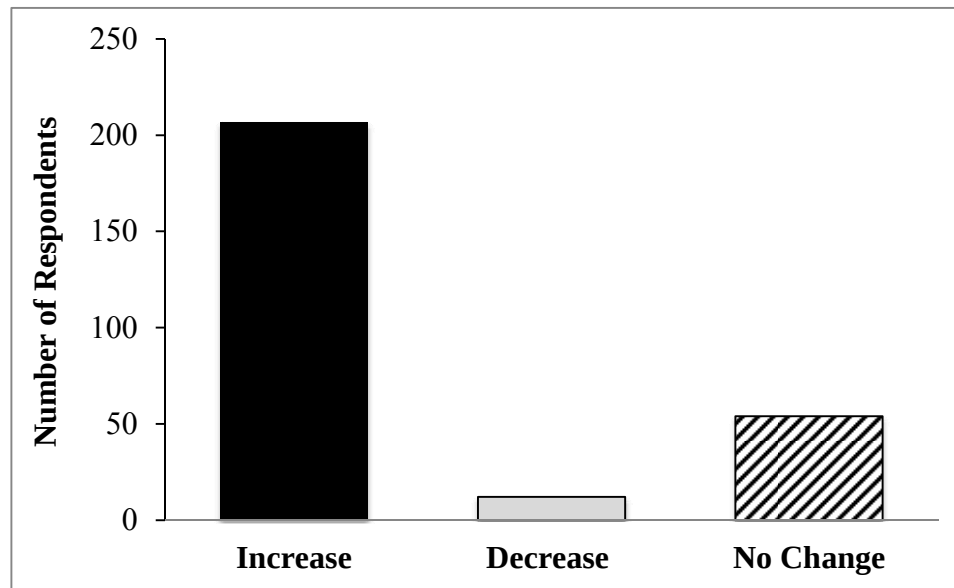


Figure 3.5 Change in perceived knowledge of bed bugs after participation in an educational workshop

The greatest increase in knowledge (20%) was evidenced in those self-rating some knowledge of bed bugs (3) pre-workshop to knowing a great deal about bed bugs (5) post-workshop. Of those that indicated no change in knowledge (Figure 3.5), 22% of these already had self-rated as knowing a great deal about bed bugs and remained in that group. A small proportion of people indicated a decrease in knowledge (Figure 3.5). No relation between any demographic variables and an increase in knowledge was evidenced ($P\text{-value} > 0.05$).

Level of Concern

Level of concern about bed bugs was initially rated very high among the majority of participants (44%) ($X^2 = 148.5$; $df = 4$; $P\text{-value} < 0.0001$; Table 3.3). The initial level of concern was related to age ($X^2 = 39.7$; $df = 20$; $P\text{-value} = 0.005$). The majority (44%) of respondents in the lowest age group, 18 to 21 years old, indicated some concern; whereas the majority (54%) of those in the highest age group, 65 years and older, rated themselves as very concerned. Concern was also related to the time spent living in Hawaii ($X^2 = 33.2$; $df = 12$; $P\text{-value} = 0.0008$). The longer someone has lived in Hawai'i the greater concern they felt about bed bugs (Figure 3.6).

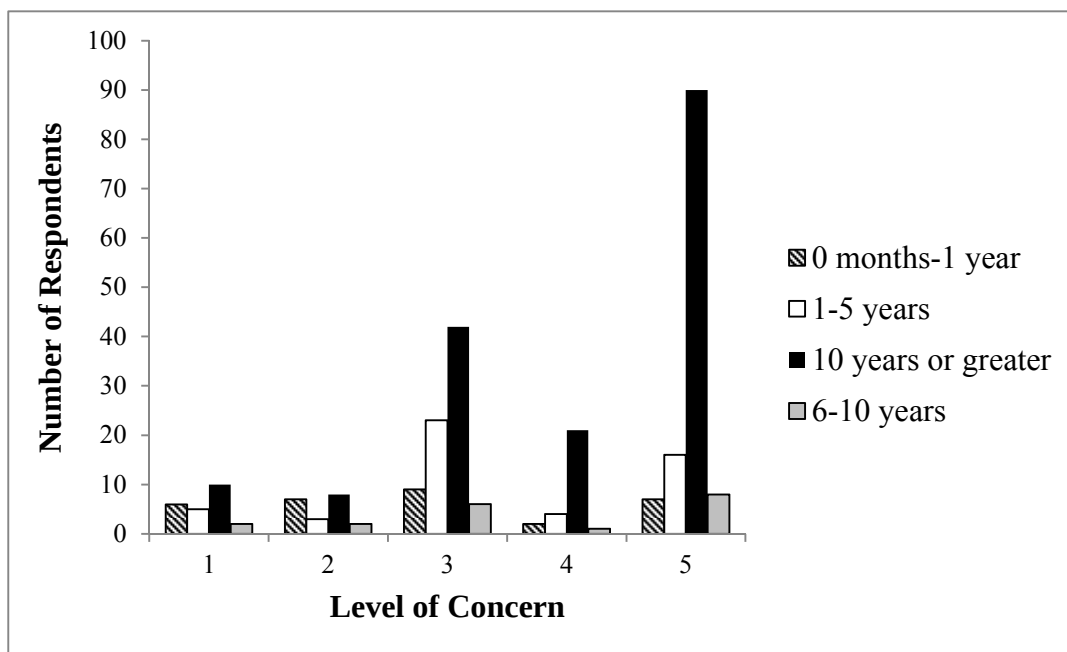


Figure 3.6 Level of concern in relation to residency in Hawai'i pre-presentation

Following the presentation, participant concern about bed bugs remained high (Table 3.3; $X^2 = 244.9$; $df = 4$; $P\text{-value} < 0.0001$) and appeared to increase. The same relationship between level of concern and time spent living in Hawaii was evidenced in the post-presentation survey ($X^2 = 26.6$; $df = 12$; $P\text{-value} = 0.0086$).

Level of Concern	Pre-presentation	Post-presentation
1 (Not concerned)	8%	2%
2	7%	4%
3 (Some concern)	30%	25%
4	10%	16%
5 (Very concerned)	44%	54%

Table 3.3 Percentage of respondents self-rating level of concern on bed bugs

Analyzing the change in level of concern yielded results quite different from the previous question. Once again, 273 responses were used in this analysis. In this case, 61% of participants felt no change in their level of concern from before the workshop to the conclusion of the workshop (Figure 3.7). A large percentage (40%) of the total number of respondents did not indicate a rise in level of concern because they were and remained very concerned before and after the presentation (Figure 3.7). The remaining percentage (21%) of those with no change were mostly (12%) composed of those rating a 4 on the pre-presentation survey and a 4 on the post-presentation survey. Of those participants that did change their level of concern, the majority (10%) progressed from some concern to very concerned.

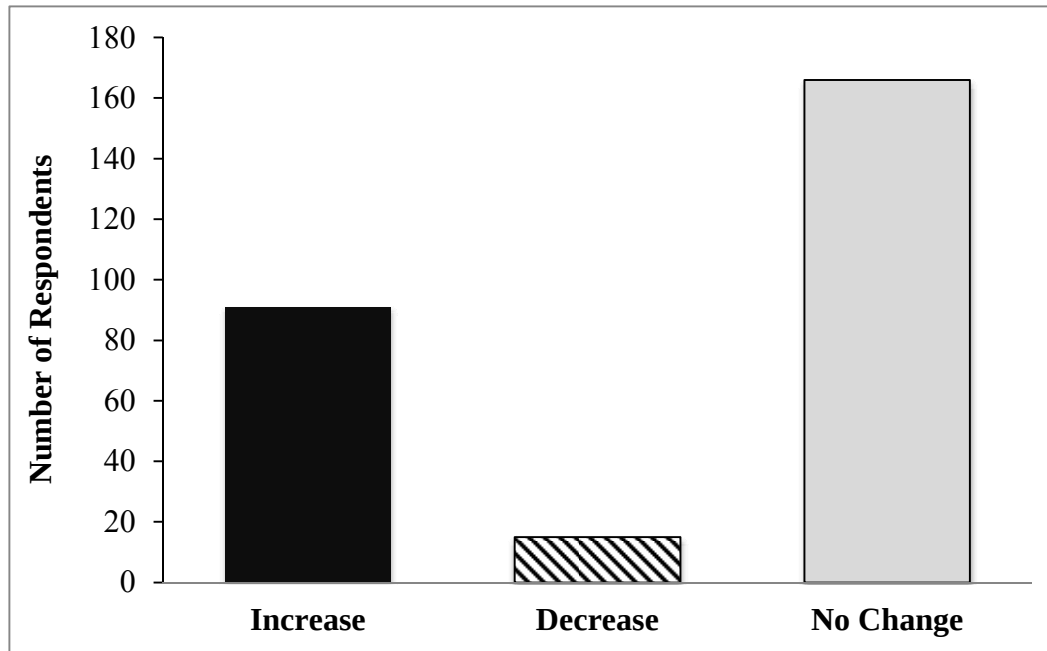


Figure 3.7 Change in participant level of concern about bed bugs after the presentation

Level of Identification Ability

Participant's self-rated ability to identify a bed bug was generally very low prior to the presentation ($X^2 = 80.7$; $df = 4$; $P\text{-value} < 0.0001$; Table 3.4). The pattern of responses for this question appears different than the other measures of self-efficacy (Tables 3.2 and 3.3) with the majority of responses being in the lowest skill level (31%; Table 3.4). There was a relationship between age and ability to identify a bed bug ($X^2 = 38$; $df = 20$; $P\text{-value} = 0.008$). The majority of those in the 55 to 64 group (37%) and those in the 65 and over group (38%) rated their ability to identify as "cannot identify". However, those in the other age groups rated their ability higher. The baseline ability to identify was also related to gender ($X^2 = 19.7$; $df = 4$; $P\text{-value} = 0.0005$); with the majority (39%) of females rating their ability to identify as probably identify and the majority (23%) of males rating their ability to identify as cannot identify.

At the completion of the presentation, the majority (39%) of respondents felt they could definitely identify a bed bug ($X^2 = 124.2$; $df = 4$; $P\text{-value} < 0.0001$; Table 3.4). The ability to identify, post-presentation, demonstrated a relationship with the length of residence in Hawai'i ($X^2 = 30.9$; $df = 12$; $P\text{-value} = 0.001$). Of participants rating their identification ability as “can definitely identify”, 68% have been living in Hawai'i for 10 years or longer.

Ability to Identify	Pre-presentation	Post-presentation
1 (Cannot identify)	31%	4%
2	13%	5%
3 (Probably identify)	35%	29%
4	11%	22%
5 (Can definitely identify)	10%	39%

Table 3.4 Percentage of respondents self-rating ability to identify a bed bug

270 respondents rated their ability to identify a bed bug before and after the workshop. Results were similar to responses from level of knowledge on bed bugs, with the majority self-rating an increase in their ability (Figure 3.8). The majority of participants shifted from probably identify (35%) to can definitely identify (39%) following the workshop (Table 3.4). However, the group perceiving the largest benefit was those living in Hawai'i for longer than 10 years; 71% of this group reported an increase in their identification ability.

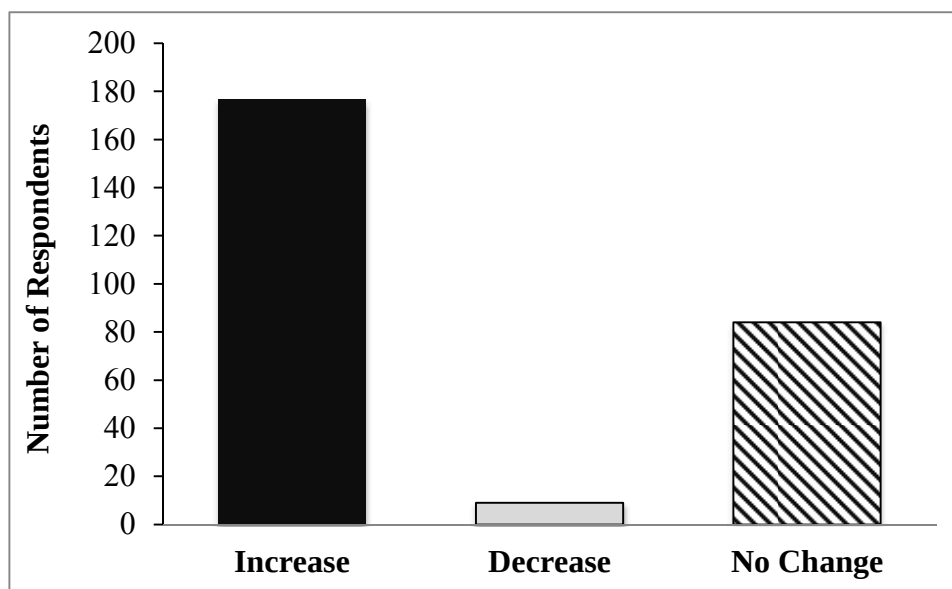


Figure 3.8 Change in perceived ability to identify bed bugs after the presentation

Willingness to Engage in Taught Behaviors

We also assessed whether participants felt they would adhere to taught behaviors following the workshop. Such behaviors included searching a hotel room or luggage when traveling. Once again the participants responded on a scale of 1 to 5, 5 being the highest level of adherence. Following the workshop presentation, 60% of participants indicated a high likelihood of searching a room (Figure 3.9). The majority of all respondents rated their willingness to search a lodging room as a “will use” behavior, except those in who have lived in Hawai’i for 6 to 10 years; the majority (65%) of this group rated their willingness as “will probably use” behavior.

Willingness to search a lodging room was also related to those who reported an increase in level of knowledge ($X^2 = 12.5$; $df = 4$; $P\text{-value} = 0.01$). Of those that self-reported “will use”

behavior, 83% were those who reported an increase in knowledge after attending the presentation. No relationship was seen between willingness to search a lodging room and an increase in concern or an increase in identification ability ($P\text{-value} > 0.05$).

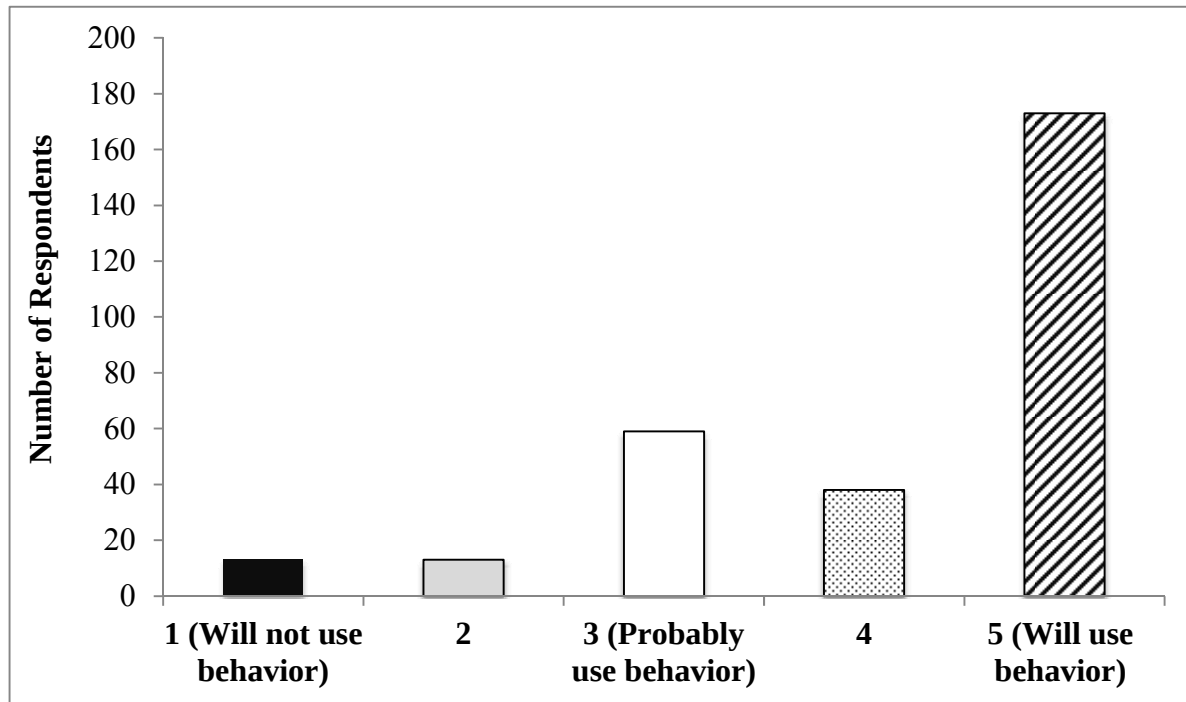


Figure 3.9 Participants' response to how likely they are to search lodging room for bed bugs

A similar number of respondents indicated that they would also search luggage before and after traveling (Figure 3.10). Willingness to search luggage was related to the length of residency in Hawai'i ($X^2 = 33.1$; $df = 12$; $P\text{-value} = 0.0009$). Of those who indicated they will search luggage, 74% had been living in Hawai'i for 10 years or more. As above, willingness to search luggage had no relation to the participants' increase in level of concern or perceived ability to identify, but willingness was related to an increase in knowledge ($X^2 = 12.8$; $df = 4$; $P\text{-}$

value = 0.01). Of those that self-reported “will use” behavior, 76% had an increase in knowledge after attending the presentation.

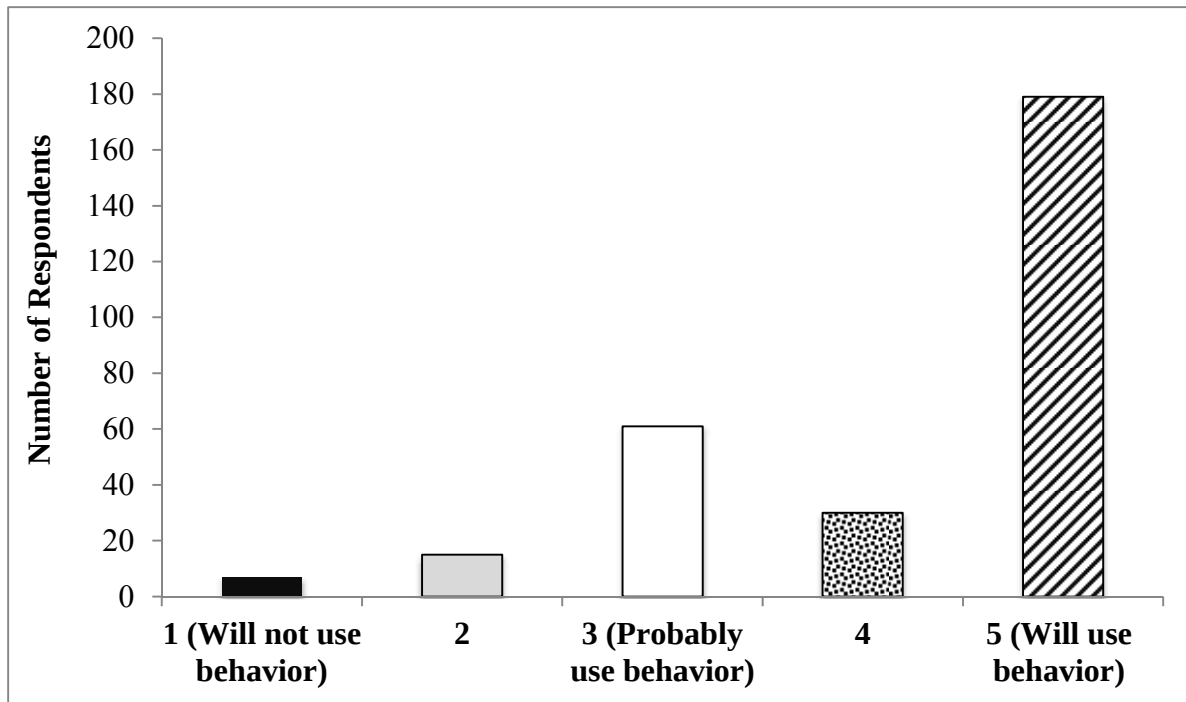


Figure 3.10 Participants' response to how likely they are to search luggage before and after traveling

Helpfulness of Workshop

Lastly, participants were asked to rate the helpfulness of the workshop. An overwhelming majority (75%) rated the helpfulness of the workshop as very helpful (Figure 3.11).

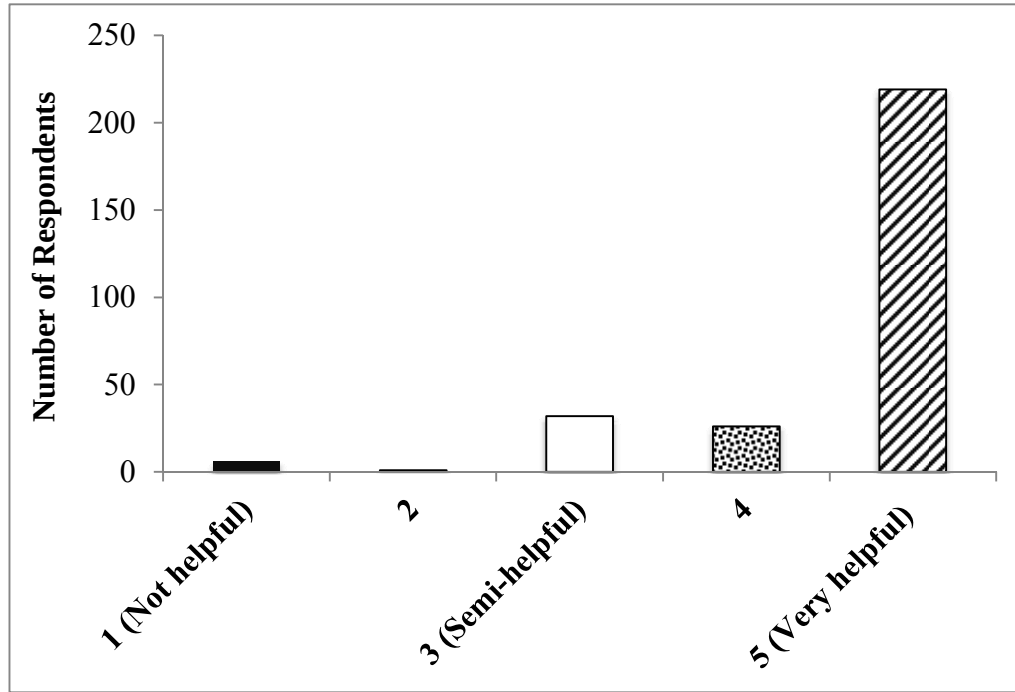


Figure 3.11 Participants' response to helpfulness of workshop

There was a relationship between the workshop rating and age ($X^2 = 40.6$; $df = 16$; P-value = 0.0006), length of residency in Hawai'i ($X^2 = 48.4$; $df = 12$; P-value = 0.000002), and gender ($X^2 = 15.5$; $df = 4$; P-value = 0.003). Most people in all age groups rated the workshop as very helpful. However, the majority (60%) of the 2% rating the workshop as not helpful were 65 years of age and over. The majority (73%) of those that rated the workshop as very helpful living in Hawai'i for 10 years or more. More females (81%) rated the workshop as "very helpful" than males (64%).

Those who indicated that they are highly likely to searching a lodging room also indicated a high rating of workshop helpfulness ($X^2 = 110.7$; $df = 16$; $P\text{-value} < 0.0001$). Similarly, those who found the workshop most helpful were also those most likely to search luggage ($X^2 = 50.2$; $df = 16$; $P\text{-value} = 0.00002$).

DISCUSSION

The great majority of participants self-rated an increase in their knowledge of bed bugs after attending the workshops. By self-rating this increase, they attest that the workshop taught them awareness of the resurgence issue, bed bug biology, and bed bug behavior. The small percentage that self-rated a decrease in knowledge is estimated to be the result of a communication barrier, experienced while workshops were delivered to English as second language (ESL) students. Most demographics had no relation to post-presentation knowledge except education, suggesting that participants without secondary education may benefit from a different learning/presentation style. Interestingly, the largest increase in knowledge was not seen in those with baseline knowledge of knowing nothing about bed bugs. The largest increase in knowledge was evidenced in those progressing from some knowledge on beds bugs pre-presentation to knowing a great deal about bed bugs post-presentation. I hypothesize that knowing some information about bed bugs pre-presentation evokes awareness and susceptibility to the attendee, thus they are more likely to view the material as relevant. Malcolm Knowles, a leader in adult learning theory, stresses that adult learners need to see the links between the content they are learning and the applicability to their lives; this stimulates the learning process (Knowles, 1980).

Level of concern was a question on the pre and post-workshop survey to help determine one's level of awareness of the current bed bug epidemic. The hypothesis is that if one indicates a high level of concern, they are aware of the recent spike in bed bug infestations. If they indicate a low level of concern, they may not be aware of the dire bed bug situation or they may not feel susceptible. Interestingly, 61% of respondents reported no change after attending the workshop. Of those in the no change category 83%, or 51% of the total, self-rated the highest level of concern, very concerned, on the pre-workshop and post-workshop survey. This indicates they had awareness of the bed bug epidemic. In addition to that, we also witnessed one third of participants self-rate an increase in their level of concern. A high level of concern spawns a higher level of watchfulness and vigilance on the battle against bed bugs. Those in the older age group demonstrated higher concern than younger respondents which may be the result of more exposure due to more life experience. Level of concern was higher in those with the longest residency in Hawai'i before and after the presentation. Such results could support the hypothesis that those living in an area longer put more emphasis on current local issues. As witnessed above, the largest increase in level of concern was not seen in those with a baseline feeling of no concern. The largest increase in concern was seen in those with some concern, during the pre-presentation, to a level of very concerned during the post-presentation. Rating an initial level of some concern, on bed bugs, indicates a feeling of susceptibility, thus the information on how to avoid an infestation is viewed as relevant to the adult participants.

The majority self-rated an increase in their ability to identify a bed bug after attending the workshop as well. By presenting photographs of bed bug at all life stages as well as actual specimens, noting their distinct physical characteristics, it results in audiences feeling more confident in their identification ability. Equipped with this ability, participants can identify

possible infestations early on, increasing the chance of successful eradication. Initial identification ability was rated higher in those younger than 64 suggesting that younger respondents may be more confident their capabilities, however age had no influence on actual correct identification. Females also felt more confident in their initial identification ability possibly due to societal roles involving the maintenance of the living space. Once again the largest increase in self-efficacy was evidenced in participants entering the presentation with some ability and progressing to “can definitely identify” following the presentation. Such a pattern with all three measures of self-efficacy indicates that those entering the workshops with some baseline knowledge, on the topic of bed bugs; demonstrate the most improvement in confidence.

Willingness to engage in taught behaviors resulted in a great majority expressing adherence. In regards to searching a lodging room, the majority of all respondents rated their willingness to search a lodging room as high, except those in who have lived in Hawai’i for 6 to 10 years; the majority (65%) of this group rated their willingness as moderate. Of those living in Hawai’i for 6 to 10 years, the majority (41%) travel less than once a year. Therefore, searching a lodging room could be viewed as irrelevant to this group; resulting in a lower rate of adherence. A high rate of adherence was also related to participants that self-rated an increase in their level of knowledge following the workshop, which I attribute to relevance again. Since perceived relevance of material stimulates the adult learning process (Knowles, 1980), those that rate an increase in knowledge perceive the workshop to be applicable and/or relevant. This same feeling of relevancy can also increase willingness to engage in taught behaviors.

In regards to searching luggage before and after traveling, the majority (75%) of those living in Hawai'i for 10 years or greater rated their willingness as will use behavior. Those living in Hawai'i for longer amounts of time are mostly composed of older age groups. I suspect that those living in Hawai'i for 10 years or greater, and in an higher age group, rated a high adherence to searching luggage because of its demonstration during the workshop and it's increased ease in comparison to searching an entire lodging room. Willingness to engage in this taught behavior was also related to participants who self-rated an increase in their level of knowledge after the presentation. I hypothesize that more females rated the workshop as very helpful than males because of their societal role in the household and possibly because the workshop was delivered by a female.

Helpfulness of the workshop was perceived a very high by all age groups. The majority of those rating the workshop as very helpful were from the same age group, 65 and over, as the majority of those rating the workshop as not helpful. I estimate this anomaly to be attributed to the fact that the majority of all respondents were in the 65 and over age group. It is not surprising to note the majority (73%) of those that rated the workshop as very helpful have lived in Hawai'i for 10 years or greater because the workshop provided data and background significance tailored to the state of Hawai'i.

Overall, the results support the fact that educational workshops delivered to the public are beneficial in raising participants self-efficacy. Self-efficacy is not only raised by educating one on a topic but also by addressing the outcome expectations of being informed of such knowledge. Having a positive outcome of action such as, preventing a bed bug infestation, acts as a motivator and contributes to a raise in self-efficacy. Given skills, positive outcome

expectations, and personally valued outcomes, self-efficacy is theorized to influence much of human behavior (Bandura, 1989). Raising self-efficacy is a known driver of behavioral change. As a large contributor to the distribution of bed bugs, humans need to alter their behavior to help combat the bed bug epidemic we face today. Therefore, the development and delivery of a workshop that incorporates the elements described herein has demonstrated capacity to increase self-efficacy that could lead to changes in behavior to stem the tide of bed bugs.

CHAPTER 4

EXPERIENTIAL LEARNING BY SEARCHING FOR BED BUGS

One must learn by doing the thing, for though you think you know it-you have no certainty, until you try” -- Sophocles, 400 B.C.¹

INTRODUCTION

Learning theory postulates that teaching through diverse learning activities that use a range of print, visual, experiential, and human resources enables a greater number of people to learn the desired material or skill (Chickering, 2006; Kolb & Kolb, 2009). Kimvy Calpito (2012) corroborated this theory by stating “...having the opportunity to also practice active participation helps the learner get a better understanding of the content after formal education is provided.” This method of learning involving experience is not novel, has been researched in depth by many and goes by multiple terms. John Dewey (Dewey & Dewey, 1915) discussed “learning by doing,” while Wolfe and Byrne (1975) used the term “experienced-based learning.” The term “trial and error” learning is used to explain inductive learning processes (Gentry, 1990). Probably the most widely used term is experiential learning, developed by David Kolb in 1975.

“Experiential learning theory draws on the work of prominent 20th century scholars who gave experience a central role in their theories of human learning and development notably John Dewey, Kurt Lewin, Jean Piaget, William James, Carl Jung, Paulo Freire, Carl Rogers and others to develop a holistic model of the experiential learning process and a multilinear model of adult development” (Kolb, 1984).

Dewey (1938) believed that experience enabled learners to think reflectively during their learning process. The impact of reflective thinking develops great potential to lead to the

¹ As cited by Gentry 1990.

occurrence of common, simple and everyday informal learning (Lai, Wu & Li, 2011), which in turn leads to higher rates of behavior change. There is a discrete difference between learners who primarily watch the educator while learning compared to learners who react and participate (Green, 1995).

It is well known that adults learn differently than children (Kuhn & Pease, 2006). Adult learning is thought to be influenced by different goals, responsibilities, motivations, and physical brain characteristics (Calpito, 2012). These aspects must be considered when providing education to adult audiences with the expectation that the audience not only retains, but maintains the newly taught knowledge. New material being taught to adults should contain multiple components to make the lesson relevant and/or useful and thus increase the likelihood of retention and application.

We sought to incorporate this aspect of learning theory into an educational workshop developed to educate people about bed bugs. After providing information on the cryptic nature of bed bugs, their feeding habits and physical characteristics, we sought to teach people how to physically search for bed bugs. Teaching adult audiences such a skill may help to promote early identification of an infestation and reduce the probability of transferring bed bugs from one location to another. By employing an active searching activity, the workshop became multi-faceted with hands on techniques, written and visual materials; all of which are expected to enhance adult learning. However, the data gathered during the searching exercise may enable us to determine possible influences of the educational workshop on searching behavior.

MATERIALS AND METHODS

Prior to the start of the presentation, following the survey, participants were invited to take part in the searching exercise. The exercise involved searching a piece of luggage for the presence of bed bugs. The same participants who searched before the beginning of the presentation were asked to search the luggage at the end of the presentation. The time spent searching for each participant was recorded for both searching events, as well as whether the participant found the bed bug.

Adults engage more in the learning process when the perceived relevance is high (Kolb, 1984) therefore, the searching exercise also needed to replicate a potential real-life situation. While searching a furnished bedroom is the ideal setting for searching bed bugs, the situation lacks mobility, a necessity for a workshop situation. Many bed bugs are dispersed by travelers with their luggage, "...bed bugs are frequently found in dwellings with a high rate of occupant turnover, such as hotels, motels, hostels, dormitories, shelters and apartment complexes" (Jones, 2004). Therefore, in an effort to mimic an applicable situation, the searching protocol was developed with the use of luggage.

Four identical pieces of luggage were provided for the searching exercise at each workshop. Thus a maximum of four people could engage in searching simultaneously. Each piece of luggage was a red Protege Monticello upright measuring 40.64 centimeters long, 24.13 centimeters wide, and 63.5 centimeters high; purchased at a local department store. Each piece of luggage had a designated hiding location for the bed bug specimen known only to the workshop presenter. Since the method involved multiple participants searching at the same time, we wanted to discourage the possibility of one participant discovering the bed bug simply by copying another nearby searching participant. Thus, the bed bug was hidden in a different

location in each of the four pieces of luggage. However, the same hiding locations were used in subsequent workshops.

Bed bugs were laminated in clear plastic and trimmed in a circle averaging 1.5 centimeters wide to prevent damage to the insects and aid in reducing possible fear of participation. In order to demonstrate what they would be searching for, the laminated specimens were presented to the audience. Participants were not informed whether bed bugs were present in the luggage but if there were, there would only be one specimen present. If they found the specimen they could discontinue searching.

No bed bugs were placed in the luggage during the pre-presentation search. Participants were timed until they voluntarily discontinued searching. In the post-presentation search there was one bed bug hidden inside each piece of luggage. Participants were timed until they either voluntarily discontinued searching or successfully found the bed bug.

RESULTS

Few participants were willing to engage in the searching activity ($n=16$). The average time participants spent searching during the pre-presentation search was 151 ± 51 seconds (mean $\pm$ S.E.M.). Searching time ranged from 20 seconds to over 5 minutes.

The average time participants spent searching during the post-presentation search was $230 \text{ seconds} \pm 34 \text{ seconds}$ with a range of just over one minute (61 seconds) to just over 9 minutes (546 seconds). Five of the 16 participants (32%) found the hidden bed bug. Of these, four participants exhibited a shorter searching time during the second search. Searching time was reduced an average of 118 ± 65 seconds. The remaining participants who found the bed bug searched three times longer than during the initial search.

Eleven participants did not find the bed bug during the second search. Overall, the time spent searching was longer (T-value -2.78; p-value = .019), almost three minutes (178 ± 57 seconds) longer on average, following the presentation than before the presentation (Figure 4.1). Those who did not find a bed bug in the luggage continued to search from 109 seconds to 546 seconds. There were two people who did not spend longer searching even though they did not find a bed bug, but nine of the eleven 81.8% (n=9) searched longer following the presentation than before.

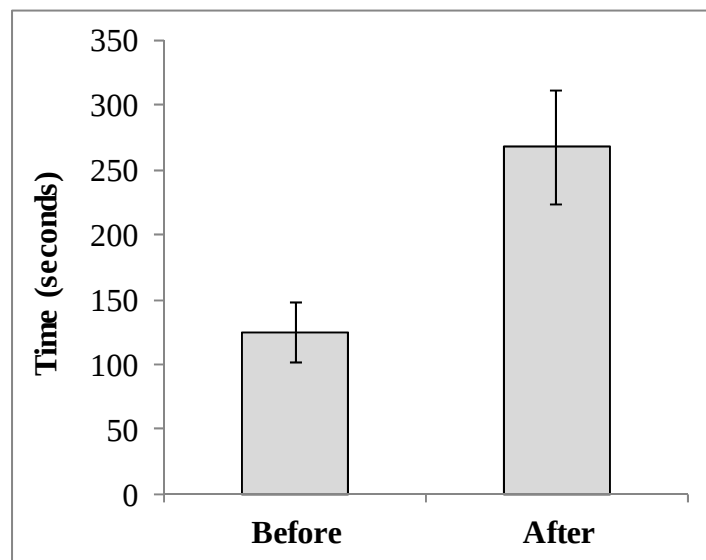


Figure 4.1 Average searching time of participants who did not find a bed bug in luggage before and after the presentation

Ten attendees total, who did not take part in the searching exercise before the workshop, expressed interest in searching the luggage after the workshop. This behavior was encouraged due to the scientifically-based benefits of experiential learning. Times were not recorded for these late participants because there was no preliminary searching time for comparison.

DISCUSSION

In the before-presentation search, insect specimens were left out of the luggage but in the after-presentation search all of the bags had a bed bug. In both cases, there was a wide range of search times but the length of time spent searching was shorter before the presentation than after the presentation. This suggests that there may have been an increase in self-efficacy, confidence, or increased understanding of the need to and where to search for bed bugs following the presentation. However, results must be interpreted with extreme caution because the behavior or the searchers may have been influenced by a number of different factors not necessarily related to the information in the presentation.

Only about a third of participants found the bed bug despite the longer period of time spent searching. Those who found the bed bug did so in less time than they spent in the before-presentation search. Again, suggesting that following the presentation they had a better idea of where to look for the bed bug. Of course, it is possible that some people may have found a bed bug in a short time if one had been placed in the luggage for the before-presentation search. A different study design could better disentangle the issue of efficiency based on knowledge and the other factors that might influence this.

While the majority of participants did not locate the hidden bed bug specimen during their second search, they were willing to search for a longer amount of time. Once again implying there may have been an increase in self-efficacy, or confidence, in their searching ability as the result of being educated on bed bug behavior. Awareness of the magnitude of the bed bug epidemic could have also fueled longer searching time in volunteers. This possibility is further supported from the actions of participants who initially expressed unwillingness to engage in the

searching exercise before learning about bed bugs, but were willing to search after receiving education.

The results of this study must be interpreted cautiously. The searching exercise was given in an artificial setting and thus exposed volunteers to a variety of factors that would not be evidenced in real-life scenarios. Competition between participants and peer-pressure and the assumption that bed bugs were present in the bag may have been factors influencing overall search time. While observing the searching exercises, I recorded one comment made by one participant to another during their second search of the luggage, “You found your bed bug? I’m not stopping until I find mine.” Searching was performed in front of all attendees of the educational workshop. While no specific comments regarding peer pressure or performance anxiety were observed, the assumption can be made that some participants may have experienced some level of those feelings.

It was difficult to recruit participants for the searching exercise. The lack of participation for this exercise was most likely due to fear associated with bed bugs and/or insects in general. “Insect and spider phobics actively avoid the feared object and ultimately avoid any activity that might force a confrontation with it.” (Hardy, 1988). Participants avoided searching with statements such as, “That is a real bed bug; I will not search the luggage” and “I wouldn’t know what I was doing.” The majority of attendees made statements based on fear while three statements were recorded regarding competency. Performance anxiety could have also impacted willingness to participate.

In conclusion, while participation was low, the searching exercise provided data that may help support the effectiveness of educational workshops to improve understanding and motivate people to search for and develop skills to reduce bedbug infestations. Future studies should

develop a searching exercise in a secluded environment to limit the influence and/or competitiveness of other members present. Since inferences had to be made on what factors influenced and discouraged attendees participation in the searching exercise, it would be useful to invite participants to record reasoning or motivation for their decisions about whether to participate in searching or not and why they ceased searching when they chose to. Overall, it does appear that incorporating a searching exercise in a workshop on this topic is an effective form of experiential learning.

CHAPTER 5

CONCLUSIONS

Bed Bugs (Hemiptera: Cimicidae) are group of insects, comprising less than 100 described species, that feed exclusively on blood (Cassidy et al., 2011). The most common bed bug living in close association with people is *Cimex lectularius* L. and is the only species in Hawai'i. Infestations of bed bugs typically occur near the areas where people sleep or spend a significant period of time ("Joint statement on," 2010; Foster, 1999). Bed bugs are found across the globe from North and South America, to Africa, Asia and Europe ("Joint statement on," 2010). They are classified by the U.S. Environmental Protection Agency (EPA) as "a pest of significant public health importance" under the Federal Insecticide, Fungicide, and Rodenticide Act ("Notice to manufacturers," 2002). Bed bug populations have increased and infestations are becoming a worldwide epidemic (Anderson & Leffler, 2008; Eddy & Jones, 2011). China, the United States, Canada and France represent a few of the nations that have recorded a high increase in bed bug incidence during the past few years (Durand et al., 2009; Lei et al., 2013; "Major bed bug," 2009). Nevertheless, sources speculate that knowledge of the bed bug declined during previous years of low infestations (Reinhardt & Siva-Jothy, 2007; "Joint statement on," 2010). While multiple factors contribute to the recent resurgence of bed bugs, many sources claim awareness of the public and community outreach efforts are fundamental in combatting the spread of bed bugs (Anderson & Leffler, 20008; Cooper, 2006).

The first study I carried out served to determine the current level of public knowledge in Hawai'i on bed bugs. By developing an identification survey, I was able to quantify what percentage of the adult population was able to identify a bed bug while also collecting demographic information. Results demonstrated that identification rates were low, only 30% of

the population was able to accurately identify a bed bug, suggesting that 70% of bed bug incidences in private homes may not be recognized early, if at all. Such results clearly demonstrate the need for education. No relationship was evidenced between any demographics and identification ability except previous reported experience with bed bugs. Therefore, all audiences can benefit from community outreach on bed bugs. Those who reported previous experience with bed bugs, likely from an infestation, were more capable of identifying a bed bug than those without previous experience. Seidel and Reinhardt (2013) found that “learning about bed bugs as a result of experiencing an infestation, appears to be a long-lasting effect...” This indicates how effective it may be to use real bed bugs as an educational tool.

The main objective of my second study was to evaluate the benefits of providing education workshops to the public on bed bugs. Overall, the results supported the hypothesis that educational workshops delivered to the public are beneficial in raising participants self-efficacy. These results are significant because self-efficacy is theorized to influence much of human behavior (Bandura, 1989). Humans need to alter their behavior to help combat the bed bug epidemic we face today, my findings suggest that educational workshops are an effective way of helping people to identify, understand how bed bugs infestations occur and how they might prevent or reduce the probability of infestation.

The third study investigated the utility of teaching adult audiences how to search for bed bugs in an effort to promote early identification of an infestation. The skill was taught as a hands-on activity to promote effective adult learning. While participation was low, the searching exercise provided data supporting the effectiveness of educational workshops while simultaneously strengthening adult education through the use of a hands-on activity. The majority of participants searched for a longer amount of time after receiving education

potentially as the result of an increase in self-efficacy or increased awareness of the bed bug epidemic although these results must be interpreted cautiously given the conditions under which the study was conducted. Nevertheless, the increase in self-efficacy was further evidenced by participants who initially expressed unwillingness to engage in the searching exercise before learning about bed bugs but were willing to search after receiving education. Due to the possible social influences at work in this particular study, in future work, I would develop a searching exercise in a secluded environment to limit the influence and/or competitiveness of other members present. Since inferences had to be made on what factors influenced and discouraged attendees participation in the searching exercise, I would request further information about their decision making process.

Findings from all studies indicate that educational outreach on bed bugs is not only needed Hawai'i but is beneficial, towards all groups. Continued efforts have been focused on refining tools for detection and post-infestation treatment however, very little research has been conducted towards increasing awareness of and education about bed bugs and how to search for and recognize these insects. Teaching awareness of bed bug characteristics and behaviors encourages the early detection of bed bugs, which creates an easier eradication process, and possible prevention of incurring this public health pest.

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APPENDIX

POWERPOINT PRESENTATION DELIVERED DURING WORKSHOPS

BED BUGS

ELIZABETH JABLONSKI

BED BUGS AT ALL STAGES

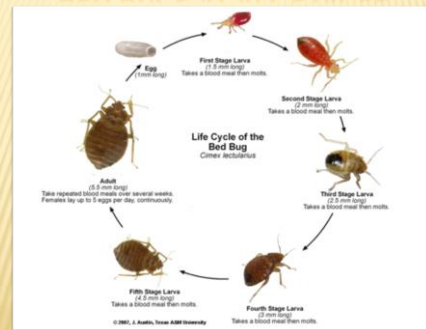


Photo by: Elizabeth Jablonski, UH Manoa



Photo by: Elizabeth Jablonski, UH Manoa



Cockroach

Photos by: Elizabeth Jablonski, UH
Manoa

WHERE ARE BED BUGS FOUND?

- ✗ Bed bugs are found across the globe (CDC, 2013).
- ✗ Bed bugs have recently been spreading rapidly in parts of the United States (CDC, 2013).
- ✗ Bed bugs infestations usually occur on or near where people sleep.

WHO GETS BED BUGS?

- ✗ Bed bugs will choose to nest and feed wherever there are blood sources and places to hide—hygiene has nothing to do with it.
- ✗ EVERYONE is susceptible to bed bugs.
- ✗ Bed bugs are “hitch hikers”.

DO BED BUGS SPREAD DISEASE?

- ✗ At this time, no research has shown that bed bugs spread disease.
- ✗ They can pick up diseases from their host.
- ✗ Bed bug bites typically cause a small welt and an itchy sensation.



<http://hotels.about.com/od/hotelsecrets/g/BedbugBites/Anna.htm>

SIGNS OF BED BUGS

- ✗ Presence of the bed bugs' exoskeletons after molting
- ✗ Bed bugs in the fold of mattresses and sheets
- ✗ Rusty-colored blood spots
- ✗ A sweet musty odor



<http://bedbugs.net/how-to-inspect-your-hotel-room-for-bed-bugs/>

PREVENTIVE MEASURES

- ✗ Bed bugs are extremely difficult to eradicate. Prevention and early detection are the most effective methods.
- ✗ There are simple, cost-effective measures you can perform to prevent the chances of bed bugs occurring in your home.



CONTROL WHAT YOU BRING HOME

- ✗ Remember bed bugs like to hitchhike?
- ✗ They can be found in public areas such as: on furniture in lobbies, public transportation, hotels, and movie theaters.
- ✗ Do an inspection of your clothing when you return home to make sure you didn't pick up any of these hitchhikers!

WHEN YOU TRAVEL

- ✗ Use the luggage rack in your room. Do not put items on the floor.



- ✗ Carefully inspect drawers (in the cracks) before storing clothes in dresser.
- ✗ Check the bed for bed bugs, pulling bed away from headboard. Check any upholstered furniture in the room. Pay special attention to seams.

WHEN YOU TRAVEL

- ✖ When you return home. Unpack your clothes directly from your luggage to the washer. Wash and dry on high heat settings.
- ✖ Inspect your luggage. Steam clean if possible or dry luggage in dryer on high heat for 2 cycles.



<http://www.shoppingblog.com/blog/315201213>

WHEN YOU TRAVEL

- ✖ Place a garbage bag over your luggage before you enter your hotel room.
- ✖ Remove bag from around luggage after you leave the room and do your bed bug inspection.

BED ENCASEMENTS

- ✖ This is a light colored cover that will fit over the mattress and box spring together, reducing places for bed bugs to hide.
- ✖ If bed bugs are present, an encasement will trap them in there.
- ✖ If bed bugs are not present, the light colored encasement will make spotting them easy if they occur.
- ✖ Not a cure for a current infestation...

REDUCE CLUTTER

- ✖ Anything you can do in the home to make it easier to clean and inspect will benefit your bed bug prevention efforts.
- ✖ When tables and cabinets are full of clutter, you are less likely to move it all and do a really good inspection of your home.

SECOND HAND FURNITURE

- ✖ If you are planning to take in any second hand furniture or clothing, do a very THOROUGH inspection.
- ✖ Do not share vacuum cleaners.



REGULAR INSPECTING

- ✖ Inspect your home frequently.
- ✖ Reduced clutter helps to make inspection easier.
- ✖ Make sure any cracks in walls are sealed.
- ✖ Examine baseboards.
- ✖ Check screw holes in furniture.



<http://www.pestcontrol-phx.com/426422/2012/04/20/a-bed-bug-shedding-its-skin-in-a-screw-hole.html>

LAUNDRY/CLEANING SUPPLIES

- ✖ When transporting laundry to common laundry areas, keep laundry contained.
- ✖ Do not let laundry touch any surfaces.
- ✖ If there is concern for bed bugs, wash and dry clothes on high heat settings. Dry on high heat for 2 cycles or one hour.
- ✖ Dip household cleaning items such as a broom or mop in bleach or alcohol. Fully submerge the item.

PETS

- ✖ Bed bugs can prey on pets but prefer humans.
- ✖ Maintain your pets and their bedding as you would maintain yours.
- ✖ Wash and dry on high heat and/or use steam heat.

ENCOUNTERING A PROBLEM

- ✖ Wash all bedding and clothing. Seal items in bags. Do not reuse the bags.
- ✖ Notify resident manager immediately, if applicable.
- ✖ Many over-the-counter bed bugs treatments have been proven ineffective.

ENTERING A KNOWN BED BUG INFESTATION

- ✖ Wear shoe covers
- ✖ Wear shoes that can be thrown in dryer and have minimal tread
- ✖ Wear simple clothing (reduced buttons or pockets)
- ✖ Do not sit on upholstered furniture
- ✖ Bring a small mirror to do a self inspection
- ✖ Dry your work clothes on high heat
- ✖ Stomp feet after leaving the area

FOLLOW-UP

- ✖ Bed bugs are extremely difficult to eradicate.
- ✖ They can live for many months without being fed.
- ✖ After bed bug treatment, follow-up maintenance is necessary.
- ✖ Follow-up inspections should occur 2-3 weeks later and again 6 months later.

Questions?