Knowledge and Attitudes Regarding the Recent Zika Outbreak Among a Sample of South Florida Residents

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KNOWLEDGE AND ATTITUDES REGARDING THE RECENT ZIKA OUTBREAK AMONG A SAMPLE OF SOUTH FLORIDA RESIDENTS

by

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ABSTRACT

South Florida has had the largest number of U.S. Zika infection cases during the recent outbreak. This study aimed at assessing South Floridians' basic knowledge, perceptions of the seriousness and susceptibility to Zika infection, their information sources and needs, as well as their attitudes towards the protective measures proposed by the CDC. We also wanted to assess whether any of those factors have affected the frequency of participants' undertaking of the protective behaviors. To this end, we designed an online questionnaire and surveyed the responses of five hundred South Floridians (Age=18-78 years). We found significant gaps in participants' knowledge about the risk groups, routes of transmission, treatment, and complications of Zika infection. Older age and college education were associated with significantly higher knowledge scores, while the presence of pregnant women in the household was associated with lower scores. About half of the participants perceived Zika to be a profoundly severe health problem, but less than one-third believed that their susceptibility to the infection is high.

Most participants agreed that undertaking the measures that limit exposure to mosquito bites would be effective in preventing infections and that they would be able to carry-out these measures if recommended by the CDC, but a significantly lower proportion had similar responses to the items regarding protection against sexual transmission.

There was a significant association between the frequency of protective behavior undertaking and respondents' beliefs about the seriousness and personal susceptibility to the infection, as well as their beliefs regarding the efficacy of the protective behaviors.

Finally, most participants reported media platforms as their sources of information about Zika, while a minority of them received their information directly from healthcare professionals. These findings suggest that more targeted risk communication efforts are needed to increase South Floridians' awareness about Zika's public health threat.

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INTRODUCTION

Biology

Zika virus (ZIKV) is an arbovirus that belongs to the genus *Flavivirus* of the family *Flaviviridae* [1]. Other members of this genus include the Yellow fever, Dengue, Chikungunya and West Nile viruses[2] .

Cryo-microscopic analysis showed that although Zika shares a similar overall structure to that of other Flaviviruses, it exhibits some differences that might explain its specific cellular tropism and unique ability to survive in the acrid conditions of various body fluids for long periods of time [3]. For instance, the different amino acid sequence surrounding the glycosylation site of Asn^{154} in the envelope protein of ZIKV when compared to other Flaviviruses could influence its predilection for targeting neural progenitor cells [4]. Moreover, Cryo-EM showed that ZIKV possesses a more compact surface and is more thermally stable than other Flaviviruses[3].

However, a recent research reported that, under physiological conditions, ZIKV has not been found to be uniquely heat stable in comparison to other Flaviviruses, thereby putting the previously proposed pathobiological mechanism into question[5].

ZIKV is a Positive-sense single-stranded RNA virus [6]. Its 10,794 nucleotides-long genome contains regions that encode a single polypeptide of about 3419 amino acids flanked by 5' and 3' UTRs[7]. The single polypeptide is cleaved by viral and host proteases to produce three structural proteins (Envelope [E], Core [C], Precursor of membrane [prM]) and seven non-structural proteins (NS1, NS2A, NS2B, NS3, NS4A, NS4B, and NS5)[8].The non-structural proteins play important roles in viral assembly and replication, as well as in circumventing the immune response of the host[9].

Following binding of viral E protein to surface receptors of the host cell, the Virion gains entry

into the host cell through receptor-mediated endocytosis[10]. The low pH inside the endosome

triggers a conformational change in the viral surface proteins, with subsequent fusion of viral and

endosomal membranes[10]. Viral genome is then released into the host cell cytoplasm, and is

translated at the surface of the ER[10]. The immature Virion assembles at the ER, and then is

transported to the Golgi apparatus. Finally, Virion maturation takes place at the trans-Golgi

apparatus when the prM protein is proteolytically modified, and the mature viral particle is

released by exocytosis [10].

Phylogenetic analysis showed that ZIKV strains can be divided into two lineages: Asian and

African[11] . The strains isolated during the recent outbreak belong to the Asian lineage [12].

The African lineage was found in cell culture studies to be more virulent and to cause higher

rates of early cell death than the Asian counterpart[13]. This milder inflammatory response might

provide an explanation for the ability of the Asian lineage strains to cause persistent infections of

fetal neural progenitor cells following trans-placental infection[14].

Routes of Transmission

The virus is mainly transmitted to humans through the bite of the mosquito species: A. aegypti

and A. albopticus . These mosquitoes are also the vectors transmitting other flavivirus infections,

such as Dengue and yellow fever [15]. ZIKV has also been isolated from other Mosquito species,

but their competence as vectors for transmission to humans is yet to be confirmed [16]. In

addition to the vector-borne infection, human to human transmission can also occur. Sexual

transmission is a well-recognized route of ZIKV transmission[17, 18]. The virus is shed in

vaginal secretions and in semen, where it can be detected for several months after the acute

infection [19]. It's also secreted in other body fluids, but there isn't sufficient evidence

supporting transmission via those routes, except for transmission through infected blood[20, 21].

Also, the virus can be transmitted from a pregnant woman to her fetus either trans-placentally or

through contact with vaginal secretions during delivery[22, 23].

<u>Diagnosis & Screening</u>

Viral RNA can be detected in patients' serum for about seven days after the onset of symptoms

using RT-PCR [24]. The same technique can be used to detect viral particles in other body fluids,

such as urine and semen, where they can be detectable for longer periods than in serum samples

[25, 26]. Another possible approach to the diagnosis is by using ELISA kits that detect

antibodies against viral proteins. IgM levels can be detectable in serum for up to twelve weeks

following the onset of symptoms, and IgG levels can be detected as early as two weeks after the

fever onset[24]. While this method is quick and easy, due to the cross-reactivity of those

antibodies with other Flaviviruses, a positive test must be confirmed using plaque reduction

neutralization test [27].

The CDC recommends screening for all pregnant women with possible exposure to ZIKV

regardless of the presence of symptoms, and to all symptomatic patients with possible exposure

[28].

<u>Treatment</u>

There has been a lot of research over the past two years aiming at finding potential therapeutics

for Zika infections. Most of these projects utilized compounds that were previously approved for

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other purposes, and some of these drugs showed good efficacy in vitro and in animal studies[29, 30]. However, as of now, there is no approved specific treatment for Zika infection, and treatment is symptomatic. Acetaminophen can be used to ameliorate the fever and pain in symptomatic patients[31]. But Aspirin, Ibuprofen, and other NSAIDs should be avoided in suspected cases of Zika infection. This is because their use in other Flavivirus infections has been associated with hemorrhagic syndromes [32].

Complications

Congenital Infection

Zika infection during pregnancy can be detrimental to the developing fetus, particularly if the infection is acquired during the first trimester, the period of Organogenesis. The system that is most commonly reported to be affected in congenital Zika infections is the nervous system. ZIKV is neurotropic, with preference for targeting neural progenitor cells [33]. This damage might be attributed to the hyper-activation of TLR 3-mediated immune response, which is known to be a negative regulator of neural progenitor cells' growth [34]. Also, Some Bioinformatics data suggested a similar role for Retinoic acid response elements [35]. The resulting defective brain development can manifest clinically as Microcephaly, defined as a head circumference that's less than two standard deviations below the mean for age, sex, and race [36]. Also, there have been case reports of other neurological manifestations of congenital Zika infection, such as: vision and hearing impairment, abnormal muscle tone and exaggerated reflexes [37, 38]. In addition, congenital Zika infection has been associated with intra-uterine growth restriction (IUGR), pulmonary hypoplasia, and stillbirths [39] . While it is still early to assess the full

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spectrum of long-term complications of congenital Zika infection in humans, experimental animal studies indicate that the virus can cause testicular damage, which subsequent impaired fertility in males [40].

Guillain-Barré Syndrome (GBS)

Another complication that might follow Zika infection in any age group is GBS [41]. It is an autoimmune disease in which antibodies attack the myelin sheaths of peripheral nerves [42]. Clinically, patients present with rapidly progressive ascending muscle weakness and diminished deep tendon reflexes [42]. The most dreadful manifestation of GBS is paralysis of the Diaphragm, which requires management with mechanical ventilation in the intensive care unit [43].

Prevention

Several Zika vaccines that have been developed over the past few years showed promising results in animal studies, and some of them are in the clinical trials phases [44]. These vaccines were generated using methods similar to the previously used techniques for developing vaccines against other Flaviviruses. Vaccine candidates that are in clinical trials include: a live-attenuated vaccine, a DNA-based vaccine, A purified inactivated viral vaccine, mRNA based and viral vector-based vaccines [45]. Until such vaccines become approved for human use, prevention is based on vector control, limiting exposure to mosquito bites, safe sexual practices, and screening of donated blood before use [46].

History

The virus was named after the Ugandian forest in which it was isolated in 1947 from the serum of Rhesus monkeys [47]. A year later, the mosquito species (A. africanus) was identified as a vector for transmission [47].

Antibodies against ZIKV were found in serum samples from residents of several countries in equatorial Africa in the following decades [48-50]. However, only mild febrile illnesses were reported in those patients, and none of the infected individuals required hospitalization[51]. In the late 1960s, the virus was isolated from the mosquito species A.aegypti in tropical Asian regions [52].

The first major documented Zika outbreak occurred in 2007, when an estimated 73% of the population of the Pacific Yap islands in the Federated States of Micronesia were infected [53]. The reason that such an outbreak occurred in the Pacific instead of Asia or Africa might be because the regular exposure to the infection in endemic regions has prevented outbreaks [51] . Also, since the clinical presentation of Zika infection is similar to that of other Flavivirus infections, which are endemic in equatorial Africa and Asia, Zika outbreaks in these regions might have been misdiagnosed as Dengue or Chikungunya infections [51].

In 2013, the second major outbreak occurred in French Polynesia, during which 49% of its population were infected [54]. A 20-fold increase in the incidence of GBS was documented in French Polynesia at the same period, and two cases of perinatal transmission were also reported during this outbreak [22, 55].

 Over the following two years, multiple small-scale outbreaks were documented in other Pacific islands [56].

The Recent Outbreak

In the Americas

The recent outbreak started in Brazil early on 2015, and then spread to other countries in the Americas [57-59]. By the end of 2015, Brazilian health authorities estimated that between 400,000 and 1,300,000 infection cases occurred in the country [60].

The outbreak was associated with a great increase in the incidence of Microcephaly and GBS in the affected regions, which led the WHO on Feb-2016 to declare Zika as a Public Health Emergency of International Concern [41, 61, 62].

WHO's advisory report recommendations included delaying travel to areas with active virus transmission , and safe sexual practices or sexual abstinence for pregnant women who live in these regions [62]. The director-general of the WHO declared on November 2016 the end of the Public Health Emergency of International Concern; emphasizing that Zika infection and its complications remain a significant health challenge that needs a long-term program of work [63].

In the United States

Between 2015 and (January 10, 2018), 5,635 symptomatic ZIKV infection cases were recorded in the U.S., and another 37,123 were recorded in U.S. territories [64]. Most cases in the U.S. were travel related, while the majority of cases in U.S. territories were locally acquired [64]. Among the confirmed infection cases were about 7,000 in pregnant women [65]. Zika-associated birth defects were observed in about 10% of pregnancies with laboratory-confirmed infections [64, 66].

In Florida

96% of the local mosquito-borne Zika infections in the U.S. were in Florida [64]. Four regions in

the state's south had active local transmission in 2016, and Miami-Dade County was designated

as a Zika cautionary travel region until June 2, 2017 [67, 68].

Recent research indicated that the virus was probably introduced to South Florida via travelers

from the Caribbean [69]. The high incidence rate in Miami-Dade might be attributed to the local

abundance of A.aegypti in the county, combined with the fact that Florida received more visitors

from Zika endemic regions than any other state in the past few years [69].

Because of the unavailability of protective vaccines against Zika so far, the public health strategy

in the United States has been to fund research aimed at developing vaccinations and to initiate

aggressive vector control campaigns, in addition to targeted risk communication[70].

According to the UNICEF's guidelines, Zika risk communication and community engagement

campaigns should be based on research assessing public risk perceptions and attitudes towards

the protective behaviors[71]. The guidelines also recommend that the communication be tailored

to the specific needs of different population groups[71]. The aim of this research was to assess

the basic knowledge and risk perceptions regarding the recent Zika outbreak in a sample of

South Florida residents, their information sources and needs, as well as their beliefs about the

efficacy of the proposed protective measures. We also wanted to assess which of these factors, if

any, have affected participants' undertaking of the protective behaviors.

METHODS

Survey Design and Administration

The initial questionnaire was adapted from two previously published survey design guides [72, 73]. Then, the questions were sent to 25 UCF faculty members and graduate students for feedback and modified accordingly. An online survey (Click to access) was subsequently designed using Qualtrics® platform. After obtaining UCF's IRB approval (APPENDIX C: UCF IRB LETTER), links to the survey were sent to 160 UCF students through emails for pilot testing. Next, we started recruiting respondents through Qualtrics® Panel Services team. 500 participants from South Florida who were at least 18 years old were recruited. The amount of time spent answering the questions was used as a quality control measure, and respondents who completed the survey in less than 1/3 the average time for completion of other participants were excluded. Also, a quota was used to get responses with an equal Male: Female distribution. The recruitment was done in the period between (8/30/2017) and (9/20/2017).

Survey Items

The first page is the informed consent page. On this page, a brief description of the aims and general structure of the survey is provided, and participants are informed about the procedures that will maintain the confidentiality and anonymity of their responses. Then, respondents are asked to confirm that they are at least 18 years old and that they agree to participate in the study. The next series of questions are about demographics. These include respondents' age, gender,

educational level and residence. In addition, following the suggestions of WHO's guide, questions about the number of women of child-bearing age and the number of pregnant women in the household were included in this section. In the following question, respondents are asked about the sources of their information about Zika. The (Knowledge) section begins with a question assessing participants' subjective evaluation of the sufficiency of their information about Zika. Then, participants' basic knowledge is assessed with questions about the risk groups, routes of transmission, symptoms, treatment, complications of Zika infections, as well as the availability of a vaccine against the virus. The next section evaluates respondents' perception of the seriousness of Zika infection on a scale from 1 to 10 (Perception of severity). To provide a comparative context, the same question included items for five other diseases, the severity of which should be familiar to any adult U.S. citizen. Then, respondents are asked to rate the likelihood that they will get infected with Zika if they do not undertake any protective measure (Perception of susceptibility). After that, participants are asked about the frequency with which they undertook the protective measures against Zika that were proposed by the CDC. A five-point Likert item format (from NEVER to ALWAYS) was used to assess the frequency of undertaking for each of the six protective behaviors. Next, Respondents' beliefs about the effectiveness of those proposed measures (Response efficacy beliefs), and about their ability to carry-out those measures (Self-efficacy beliefs) were assessed using Likert items with five-point scales (From STRONGLY DISAGREE to STRONGLY AGREE). In the final question, respondents are asked about the information that they want to get about Zika.

<u>Data Analysis</u>

Intellectus ® and SPSS 24® are the softwares that were used for statistical analysis. Tables and graphs were designed using Microsoft Excel 2016®.

Knowledge score was calculated as follows: The questions were divided into six groups, and a correct answer to each of the groups' questions was assigned a total score of 1 point. These question groups included: Risk groups [Q12] (0.16 point for each correct answer choice), Routes of transmission [Q13] (0.11 point for each correct answer choice), Symptoms (Q14), Treatment (Q15, Q16) [0.5 point for each question], Complications (Q17, Q18) [0.5 point for each question] and Vaccination (Q19).

RESULTS

Descriptive Statistics

Demographics

500 participants from South Florida completed the survey. The female to male ratio was 1:1. The age range was between 18-78 years old, and about half of the respondents (49%) were between 18-38 years old (Figure 1). About two-thirds of the participants (61%) have a college degree, while only 3% haven't graduated from High School (Figure 2). 58% of those who completed the survey reported having at least one woman of child-bearing age living in the household, but only 10% of them had pregnant women in their households(Figure 3,Figure 4).

Knowledge Questions

About two-thirds of the participants (61%) thought that they had enough information about Zika. However, Objective evaluation revealed significant gaps in their knowledge about the infection. For instance, an average of 33% of the respondents did not know that humans, other than pregnant women and their babies, can get infected with Zika (Figure 5). Also, while the vast majority (96%) correctly identified Mosquito bites as a route of transmission, more than half of the participants (56%) did not know that the infection can be sexually transmitted (Figure 6). Most participants (79%) recognized that Zika infections are often asymptomatic (Figure 7). In terms of treatment,42% of the surveyed mistakenly thought that Antibiotics can treat Zika infections, and only 32% knew that Aspirin and other NSAIDs should not be used to treat the pain and fever in Zika suspected cases(Figure 8). Microcephaly was recognized as a possible

complication of Zika infection during pregnancy by about 90% of the participants, but 34% of them didn't know that the other major complication, *Guillain-barré syndrome,* can follow Zika infection regardless of the age and gender of the infected individual (Figure 9, Figure 10). Another significant misconception among the respondents was with regard to vaccination availability, with 40% of them mistakenly thinking that there is an FDA-approved vaccine against Zika infection (Figure 11).

Next, we calculated the proportion of respondents who had misconceptions in each of the categories of (Knowledge) questions, defined as selecting at least one incorrect answer choice. The proportion of participants with misconceptions ranged between 20% and 87%, with more than half of them having misconceptions regarding the risk groups, routes of transmission, and treatment of Zika infections (Table 1).

Perception of Zika Infection Severity

Of the six diseases we asked about, Zika ranked 3rd in terms of perceived severity, preceded only by: Having a Heart attack (1st), and contracting HIV infection (2nd). Zika infection severity rating was similar to that of Diabetes. More than half of the participants (55%) thought that getting infected with Zika would be a highly serious health problem for them, while only 23% perceived the infection to be of low seriousness (Figure 12).

Perception of Personal Susceptibility to Zika Infection

Only 16% of the respondents perceived a high personal likelihood for contracting the infection in the following year, and another half (49%) thought that their chances of getting infected with

Zika are low, even without undertaking any measures to protect themselves (Figure 13). The mean score for the (Perception of susceptibility) question was 4.1/10 (SD= 2.4).

Frequency of Protective Behavior Undertaking

The majority of respondents reported undertaking the Four measures that aim at protecting against vector-borne transmission at least sometimes since they learned about the recent Zika outbreak. (range = 63% to 79%). A different result, however, was observed for the behaviors that target limiting sexual transmission, with more than two-thirds (75% & 70%) of the participants reporting that they seldom or never have undertaken those measures (Figure 14).

Response Efficacy Beliefs

With the exception of the (Sexual protection) items, the majority of participants agreed that the proposed measures can protect against Zika infection. The proportion of respondents who believed that the other four measures can be protective ranged from 66% for the (Wearing long-sleeved clothes) item to 82% for the item regarding limiting travel to areas with reported active transmission (Figure 15).

Self-Efficacy Beliefs

When asked about whether they believe in their ability to carry-out the four measures related to limiting exposure to mosquito bites, if the CDC recommended undertaking them, more than 75% of the participants answered positively. On the other hand, less than half of them believed in their

ability to follow the advice regarding protection against sexual transmission (30.4% & 45%) (Figure 16).

Information Sources and Information Needs

Television and Radio were the most reported sources of respondents' information about Zika, while only a minority of them reported getting their information directly from healthcare professionals. Interestingly, the group of respondents who received their information directly from healthcare professionals included a higher percentage of younger respondents (18-38 years of age) than participants from older age groups (Figure 17). Also, compared to participants with other levels of education, a higher proportion of respondents with post-graduate degrees reported healthcare professionals as one of their information sources about Zika (Figure 18). There were no differences in the distribution of reported information sources between female and male participants (Figure 19).

Finally, with regard to the topics about which participants wanted to learn more information, routes of transmission, symptoms, treatment, complications, and prevention of Zika infection were all selected with similar frequencies by the participants (Figure 20).

Inferential Statistics

Knowledge Scores in Different Demographic Groups

Introduction

To determine if the age, gender, educational level, the presence of women of child-bearing age

and of pregnant women in the household were associated with significant differences in

participants' knowledge scores, the mean knowledge scores for each category of these

demographic groups were compared.

Approach

Comparison of the mean knowledge scores among different age groups was made using Analysis

of Variance (ANOVA), while Independent sample t-tests were used to compare other

demographic categories.

 Prior to the analysis, the assumptions of normality and homogeneity of variance were assessed.

A Shapiro-Wilk test was used to determine whether Knowledge scores followed a normal

distribution[74].

The results of the Shapiro-Wilk test were significant, $W = 0.97$, $p < .001$. This suggests that

knowledge scores are unlikely to have been produced by a normal distribution; thus, normality

cannot be assumed. However, according to the Central Limit Theorem (CLT), deviations from

normality will have little effect on the results with a sufficiently large sample size ($n > 50$) [75].

Levene's test was used to assess whether the homogeneity of variance assumption was met [76]. The homogeneity of variance assumption requires the variance to be approximately equal in each category of the independent variable groups. The only demographic item in which this assumption was violated was the (GENDER) item. For this item, Welch's t-test was used instead of the Student's t-test, as the former is more reliable when the two categories of the independent variable have unequal distributions [77].

Results

Age:

The results of the ANOVA were significant, $F(2, 497) = 15.35$, $p < .001$, indicating that there were significant differences in knowledge scores among the different age groups (Table 2). To further examine the differences, t-tests were calculated between each pair of age groups. Tukey pairwise comparisons were conducted for all significant effects. The mean of knowledge score for the (18-38) age group was significantly smaller than the mean score for the other age groups. The means and standard deviations are presented in (Table 3).

Gender:

The result of the independent samples t-test was not significant, $t(491.93) = -1.67$, $p = .095$, indicating that the null hypothesis cannot be rejected. This suggests that the mean knowledge score was not significantly different between female and male participants. (Table 4) presents the results of the independent samples t-test.

Education Level:

The result of the independent samples *t*-test was significant, $t(498) = -3.19$, $p = .001$, indicating that the null hypothesis can be rejected. The mean knowledge score for participants with college degrees was significantly higher than the mean for participants with lower educational levels. (Table 5) presents the results of the independent samples *t*-test.

The Presence of Women of Child-Bearing Age in the Household:

The result of the independent samples *t*-test was not significant, $t(498) = 0.52$, $p = .606$, indicating that participants' knowledge scores were not significantly affected by the presence of women of child-bearing age in the household. (Table 6) presents the results of the independent samples *t*-test.

The Presence of Pregnant Women in the Household:

The result of the independent samples *t*-test was significant, $t(498) = 3.69$, $p < .001$. The presence of pregnant women in the household was associated with a significantly lower mean knowledge score. (Table 7) presents the results of the independent samples *t*-test.

Assessing the Association between the Frequency of Protective Behavior Undertaking and Participants' Perceptions about the Severity and Personal Susceptibility to Zika Infection

Introduction

To assess whether differences in the reported frequency of protective behavior undertaking were associated with differences in respondents' perceptions of the seriousness and/or of their personal susceptibility to Zika infection, the mean scores of the (perception of severity) and (Perception of susceptibility) questions were compared between participants who reported frequent undertaking of the protective measures and other participants.

Approach

First, Participants were divided into two groups: Those who frequently undertook the protective measures (Selected the answer choices OFTEN or ALWAYS), and other respondents. Then, the mean scores of the (Perception of Severity & Perception of Susceptibility) questions for the two groups were compared using independent samples t-Tests.

The same methods described in the previous section were utilized for assumption testing and for selecting the appropriate analytical approach.

Results

The Association between the Frequency of Protective Behavior Undertaking and the Perception of Zika Infection Severity:

The result of the independent samples *t*-test was not significant for any of the six protective measures. This indicates that differences in the perception of Zika infection severity among participants were not associated with significant differences in the frequency of their protective behavior undertaking. (Table 8) summarizes the results of the independent samples *t*-tests.

The Association between the Frequency of Protective Behavior Undertaking and the Perception of Susceptibility to Zika Infection:

The results of the independent samples *t*-test were significant for five of the six protective behavior items. In contrast to other Participants, those who reported frequent undertaking of the protective measures perceived a significantly higher personal susceptibility to the infection. (Table 9) provides a summary of the results.

Assessing the Association between the Frequency of Protective Behavior Undertaking and Efficacy Beliefs

Introduction

The effect of efficacy beliefs on the adoption of the proposed protective measures was examined. Efficacy beliefs included: Response efficacy beliefs, the degree to which the participant believes that the proposed behavior can protect from contracting the infection (Q23), and Self-efficacy beliefs, respondents' beliefs about their ability to carry out the proposed measures (Q24).

Approach

For each of the six proposed protective measures, respondents were divided into two groups based on whether they agreed that the behavior in question can be protective against Zika. The same method was followed to create another dichotomous variable for the (Self-efficacy) question. Then, efficacy beliefs for the group of respondents who reported frequent undertaking of the proposed measures were compared to other respondents. This was achieved using Chi-square tests of association.

Prior to conducting the analysis, the assumption of adequate cell size was assessed, which requires all cells to have expected values greater than zero and 80% of cells to have expected values of at least five [78]. For each of the six protective measures, all cells had expected values greater than zero, and a total of 100.00% of the cells had expected frequencies of at least five.

Results

The Association between the Frequency of Protective Behavior Undertaking and Response Efficacy Beliefs:

The results of the Chi-square test were significant in all the items, indicating that the frequency of protective behavior undertaking was significantly associated with respondents' beliefs about the efficacy of the protective measures. (Table 10 to Table 15) present the results of the Chi-square tests.

The Association between the Frequency of Protective Behavior Undertaking and Self-Efficacy Beliefs:

The results of the Chi-square tests indicated that there was a significant association between the reported frequency of protective behaviors undertaking and respondents' beliefs about their ability to carry-out those behaviors. This result was observed for all the six protective behavior items in the survey. (Table 16 to Table 21) summarize the results of the Chi-square tests.

DISCUSSION

Knowledge assessment has revealed several patterns in participants' misconceptions about Zika infection. One of these patterns was in the items related to the transmission of the infection. For instance, a large proportion of the respondents didn't recognize the possibility of acquiring the infection through sexual contact and via infected blood, while identifying the vector-borne transmission route. A possible explanation for this might be related to the finding that media platforms constituted the primary source of respondents' information. Previous research has found that most media reports about Zika didn't address the non-vector-borne routes of transmission [79, 80]. Another topic that was found to be excluded from discussion in the media was the treatment of Zika symptoms, and our results revealed significant misconceptions in that area as well [80]. Also, media coverage was mostly focused on the negative consequences of Zika infection during pregnancy [80]. This might help in explaining our finding that a large proportion of participants didn't recognize the possibility of acquiring the infection and developing complications in other age groups and in males.

Another potential example for the effect of information sources on respondents' knowledge is the significantly higher knowledge scores for participants with college education when compared to participants with no college degrees. In contrast to other participants who reported media platforms as their primary information source, healthcare professionals were the most frequently reported source of information for respondents with college education. However, the higher knowledge scores for older participants and participants with no pregnant women in the

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household cannot be accounted for by the variance in information sources. A possible factor that might help explaining the knowledge differences in these demographic groups could be the socioeconomic status. Previous research has found a significant impact for participants' socioeconomic status on their knowledge about other diseases [81, 82].

Attitudes toward protective behaviors are influenced by attitude-relevant knowledge [83].

A large proportion of respondents in our study didn't identify sexual transmission as a route of contracting Zika infection. Similarly, negative attitudes toward sexual protection measures were observed among a large proportion of participants.

According to the Protection Motivation Theory (PMT), several cognitive processes mediate the intention to follow a proposed protective behavior against a threat. These include: the perception of the seriousness or severity of the threat, the perception of personal susceptibility to that threat, the beliefs about the efficacy of the proposed behavior in neutralizing the threat, and self-efficacy beliefs, the extent to which a person believes that she/he can competently undertake the behavior [84, 85]. This theory has been extensively used as a framework to understand the determinants of protective health behavior. Meta-analyses of studies measuring PMT components have revealed that all the components had significant effects on health behavior intentions and undertaking [86, 87]. In this study, we found that the perceptions of susceptibility to Zika infection, beliefs about the efficacy of the proposed behaviors and self-efficacy beliefs were associated with significant differences in the frequency of protective behavior undertaking. Because the survey was administered in the second half of 2017, we chose to assess the frequency of undertaking of the protective behaviors rather than the intentions to engage in these behaviors.

Some limitations should be taken into account when interpreting the results of this research. For instance, the method utilized for recruiting participants might have limited the representativeness of the study sample to the general population of South Florida. To minimize the effect of the sampling approach, we used quotas to ensure that the sample included participants of different age groups, genders, and educational levels.

Another limitation of this study is the statistical analysis approach. While the statistical tests we used (t-Tests, Chi-square, ANOVA) can assess whether a significant association was present between two variables, they do not assess the strength of that relationship. Moreover, this approach tests the effect of each independent variable on the dependent variable separately, without considering the possible interaction between the multiple independent variables.

CONCLUSION

The findings of this study suggest that more risk communication efforts are needed to increase

South Floridians' awareness about Zika's public health threat. Also, we identified some

demographic groups that would benefit from Zika awareness campaigns. Besides, the

identification of participants' preferred information sources and the factors that were associated

with more frequent adoption of the protective behaviors can aid in selecting the key risk

communication messages as well as in choosing the channels to deliver these messages.

APPENDIX A: FIGURES
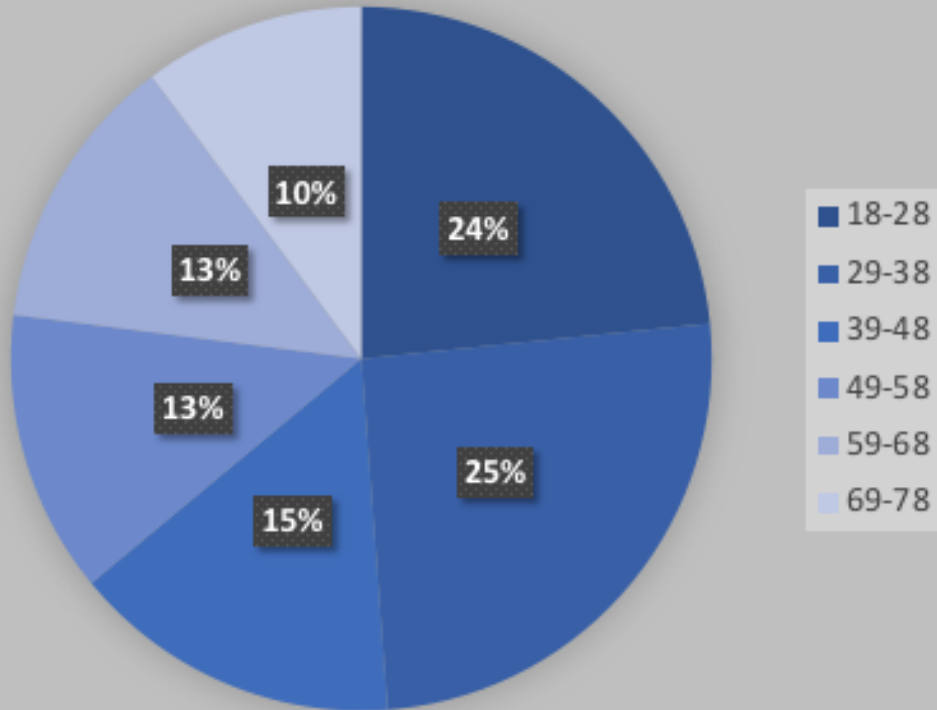
Figure 1: Respondents' age
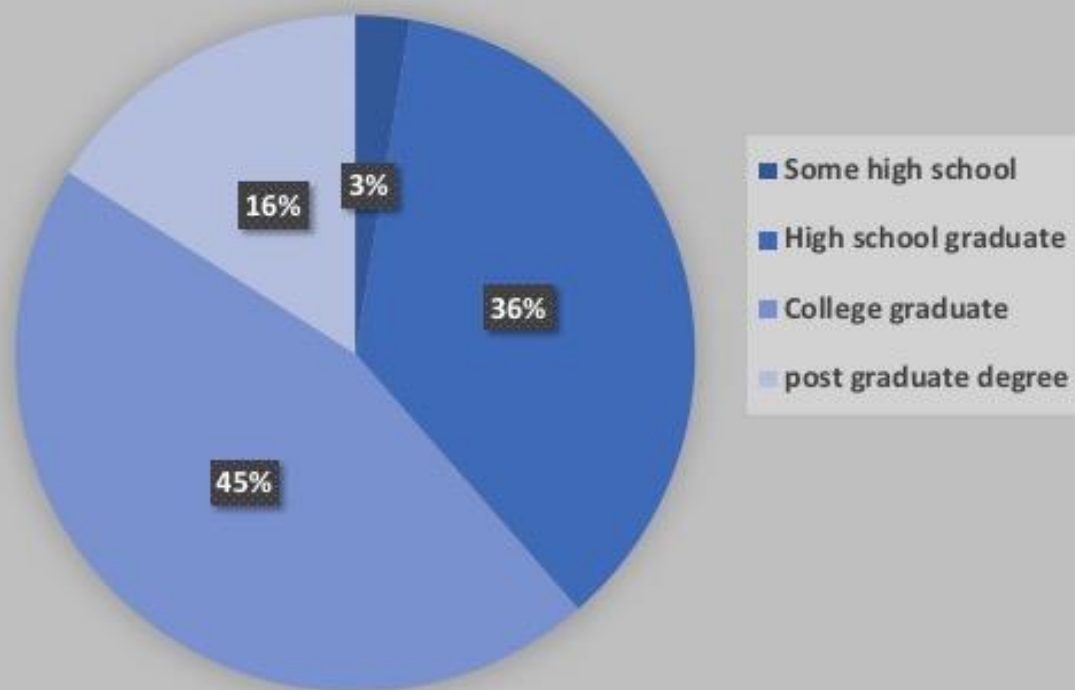
Figure 2 : Respondent's levels of education
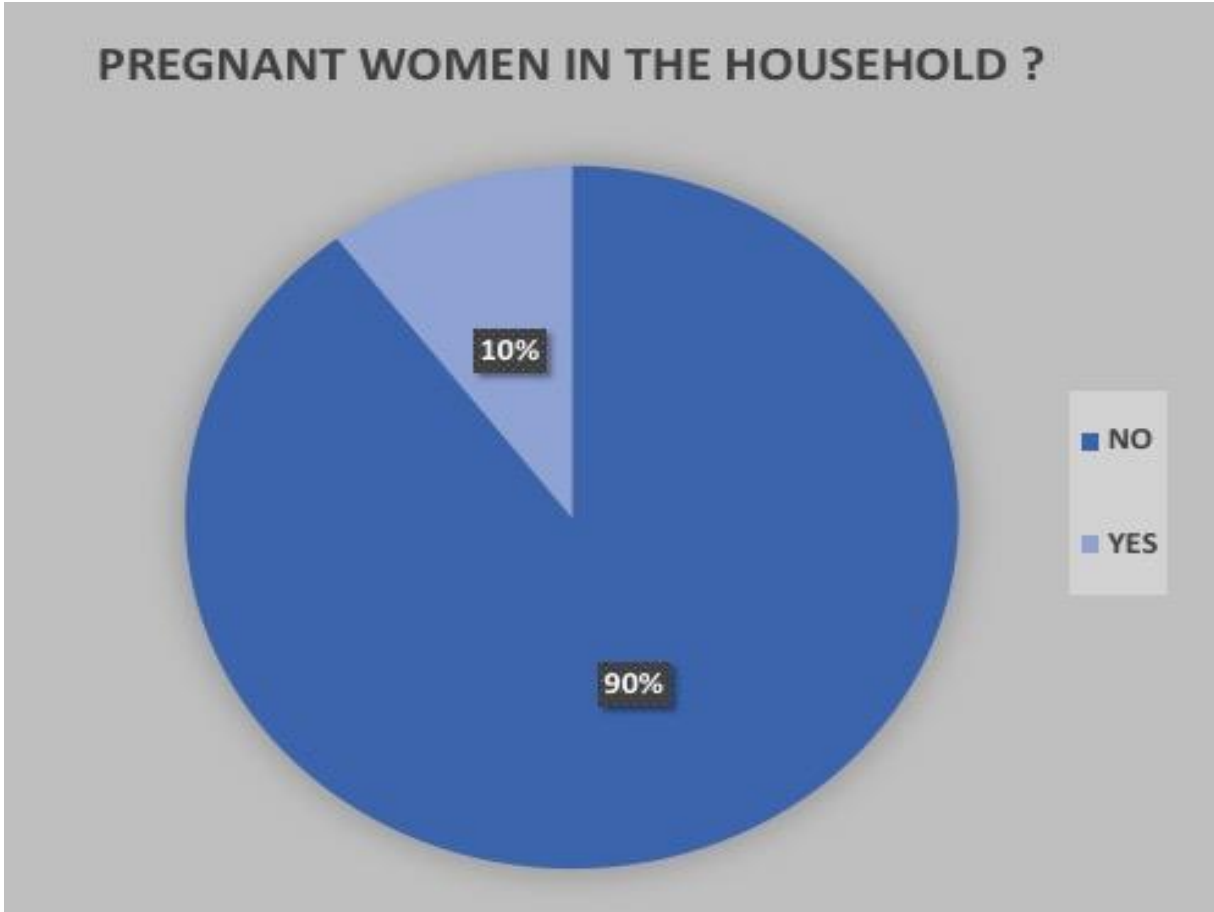
Figure 3 : Respondent groups based on the presence of pregnant women in the household
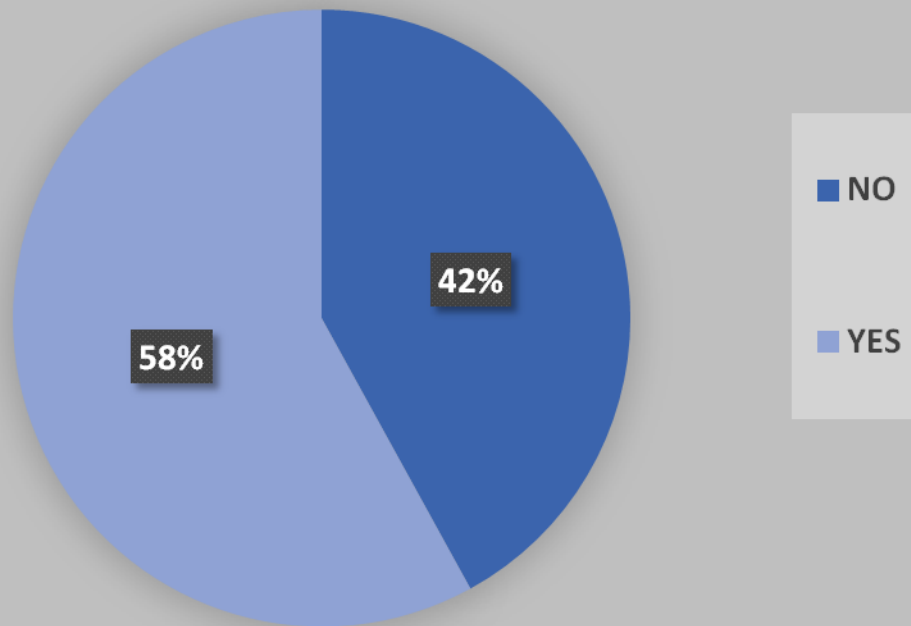
Figure 4 : Respondent groups based on the presence of women of childbearing age (15-45) in the household
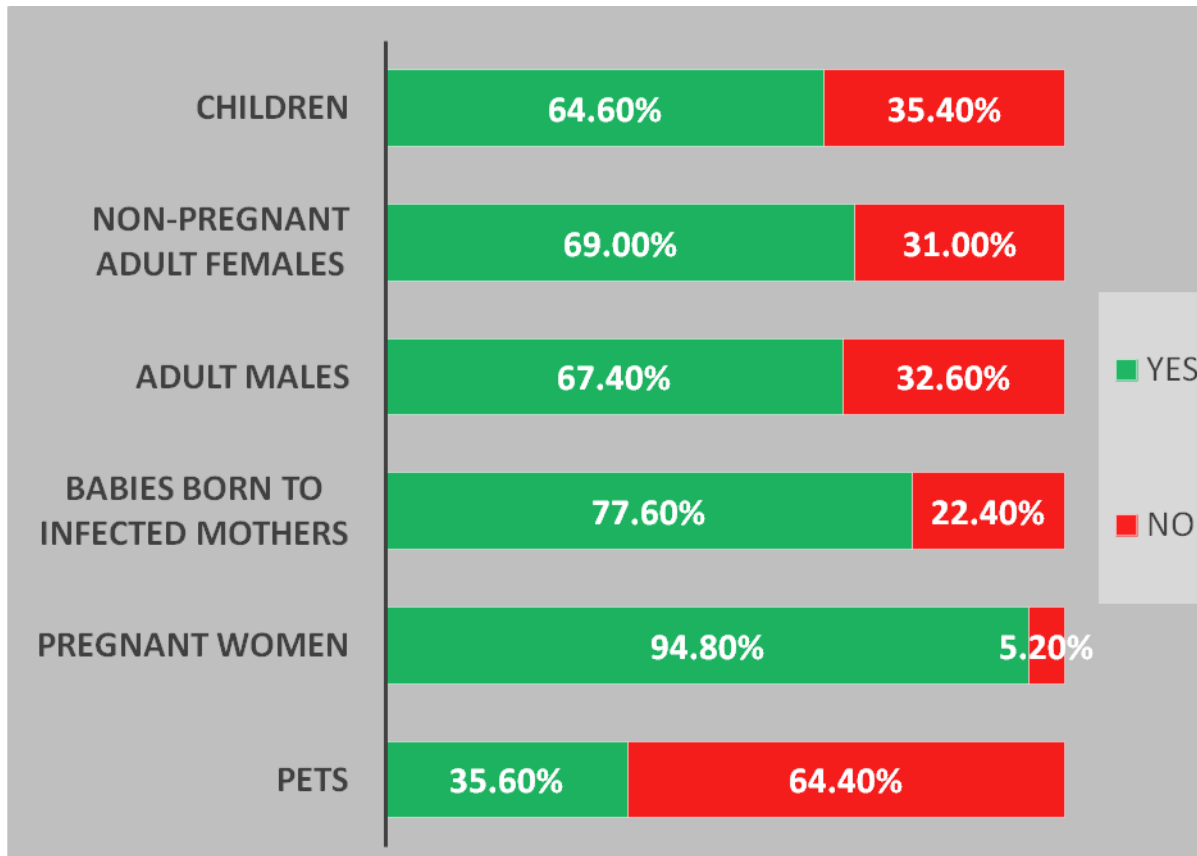
Figure 5 : : Respondents' answers to the question "Who can get infected with Zika?"

Green portions represent the percentages of participants with correct answers

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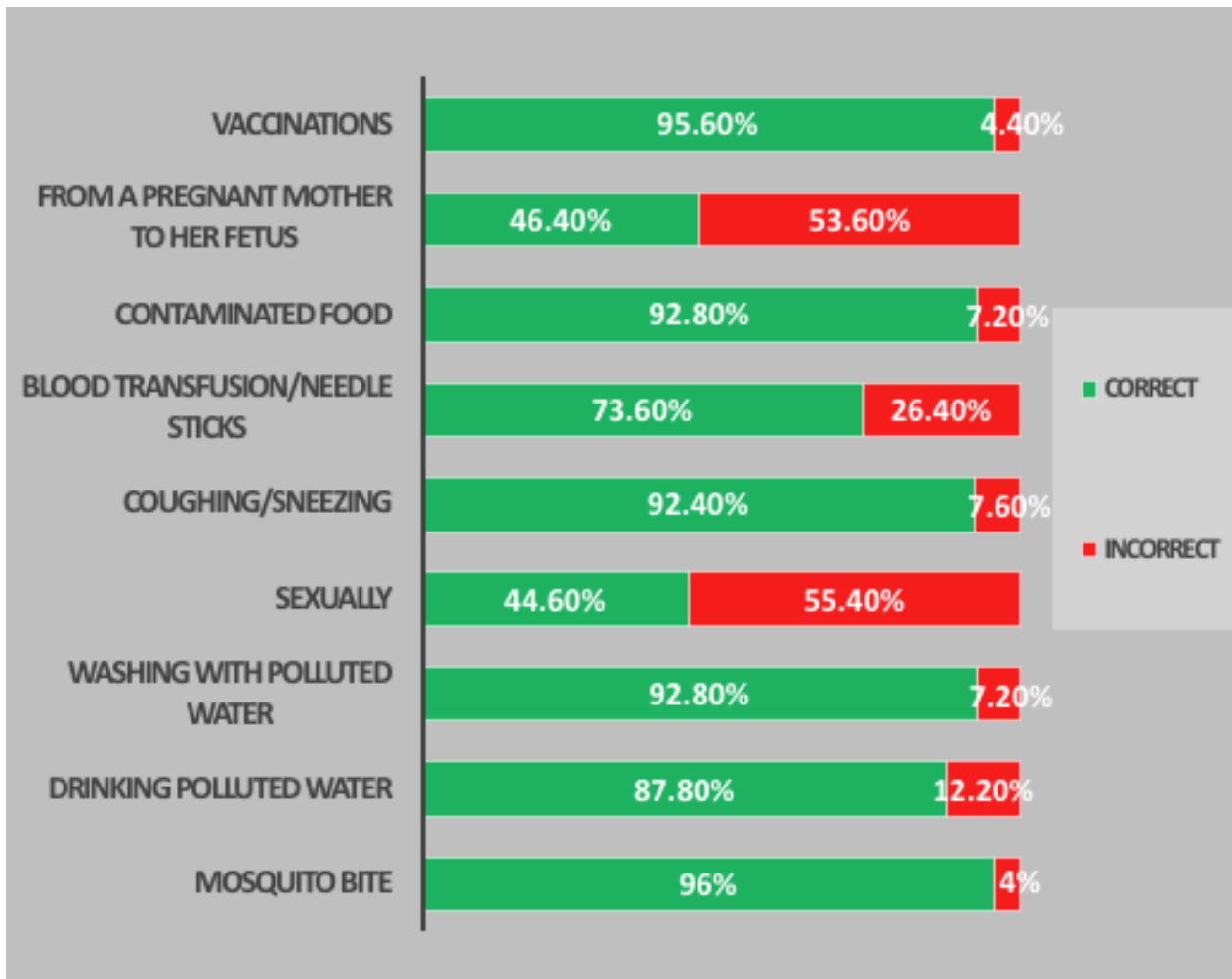
Figure 6 : Respondents' answers to the question "How does a person get infected with Zika ?"

Green portions indicate the percentages of respondents with correct answers
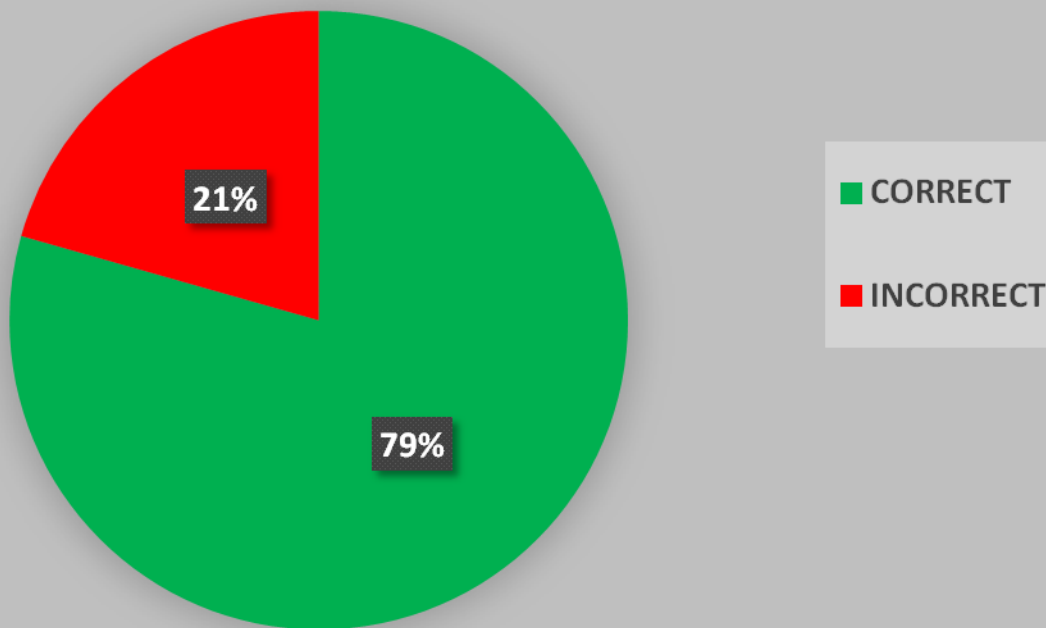
Figure 7 : Respondents' answers to the question regarding Zika infection symptoms.

The green portion represents the percentage of participants with correct answers
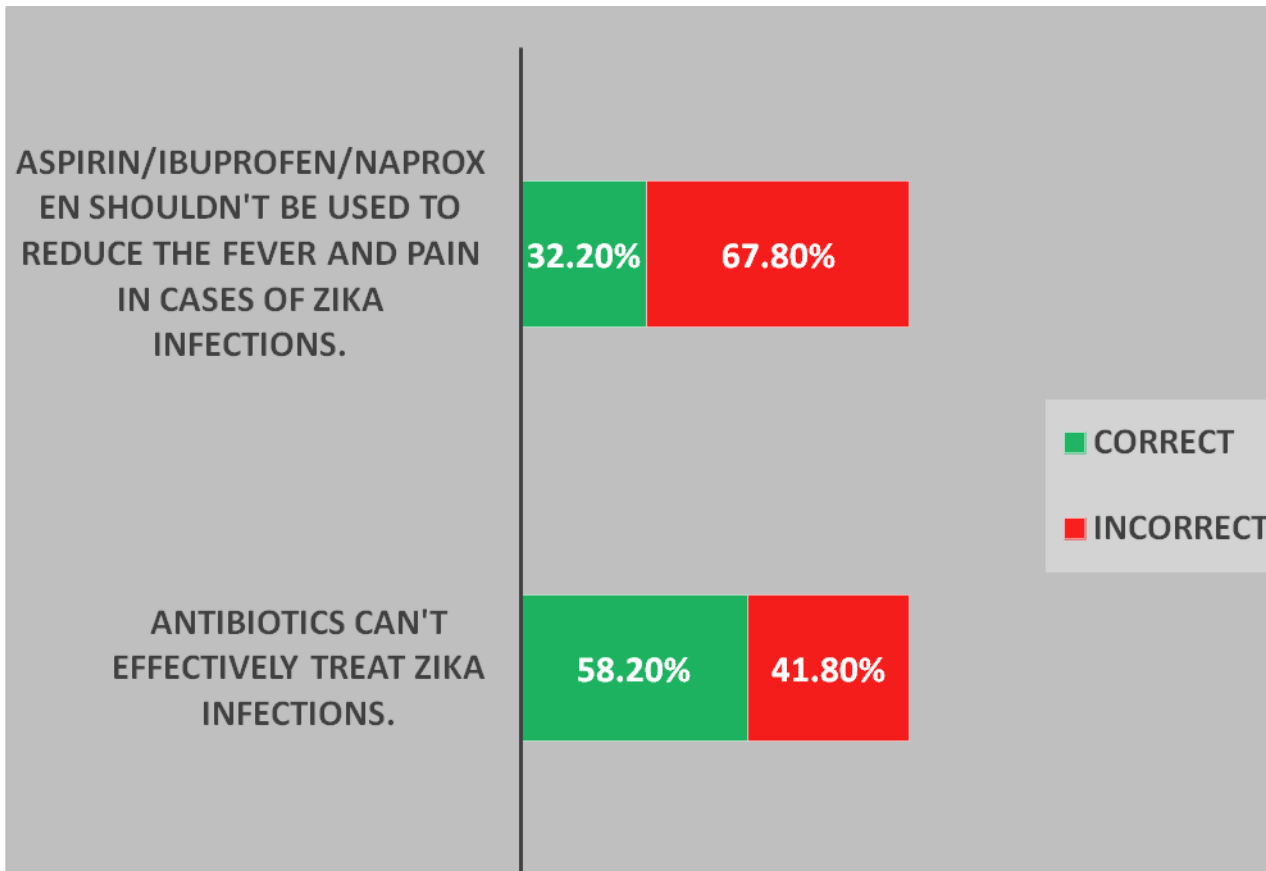
Figure 8 : Respondents' answers to the questions regarding the treatment of Zika infections

Green portions indicate the percentages of respondents with correct answers
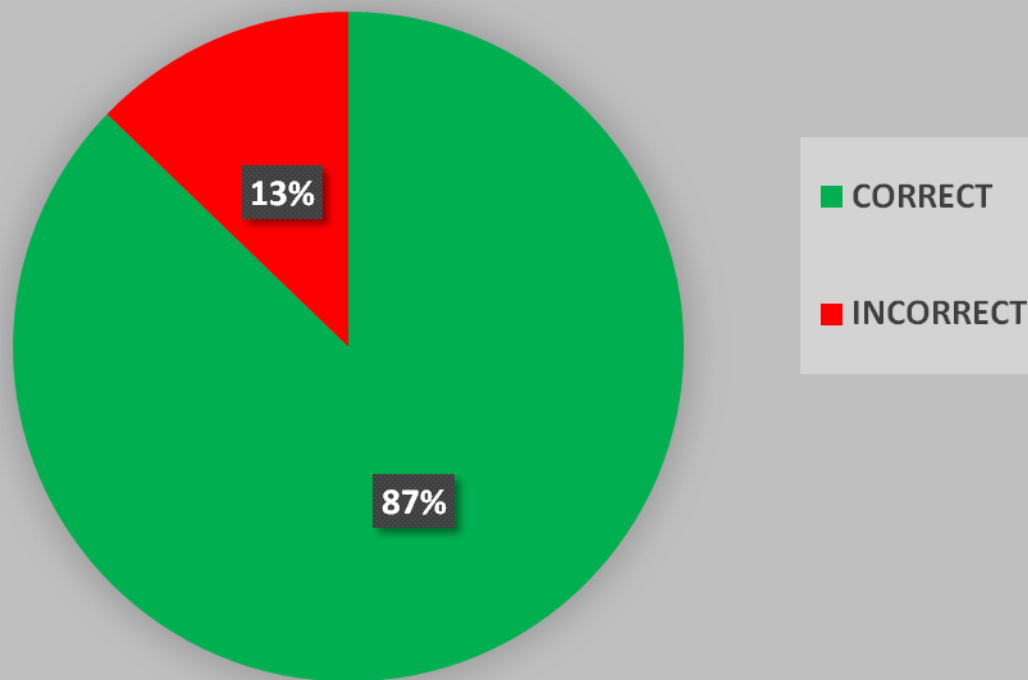
Figure 9 : Respondents' answers to the question regarding Microcephaly

The green portion represents the percentage of participants with correct answers
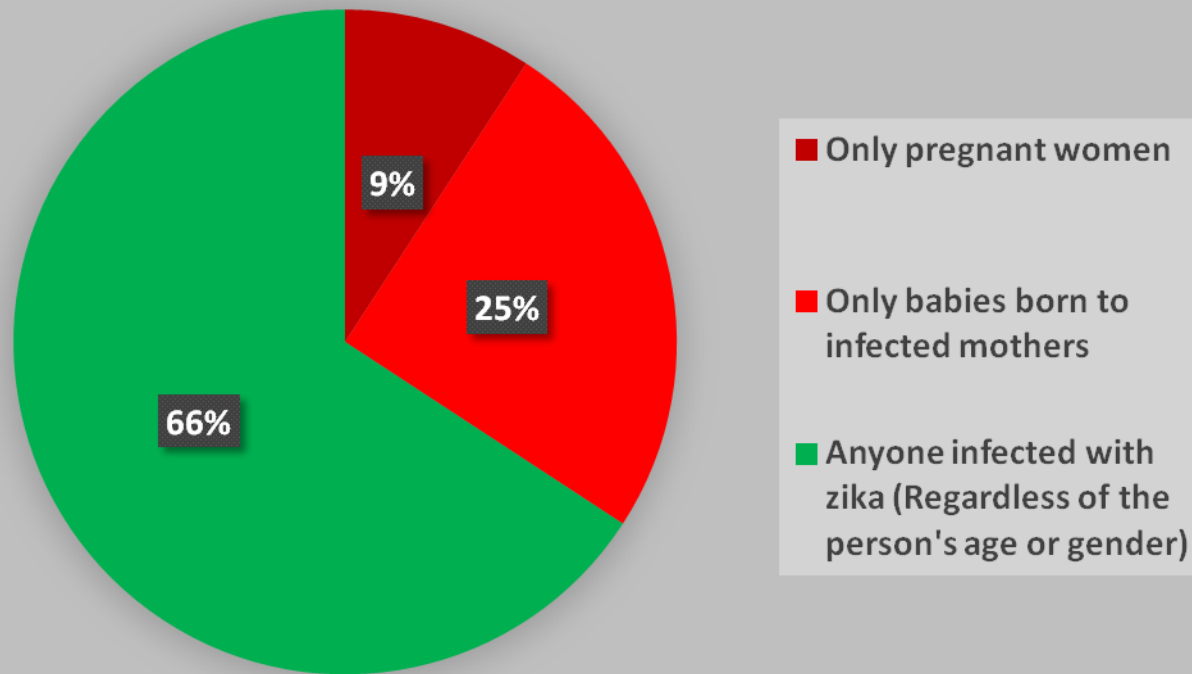
Figure 10 : Respondents' answers to the question regarding GBS

The green portion represents the percentage of participants with correct answers
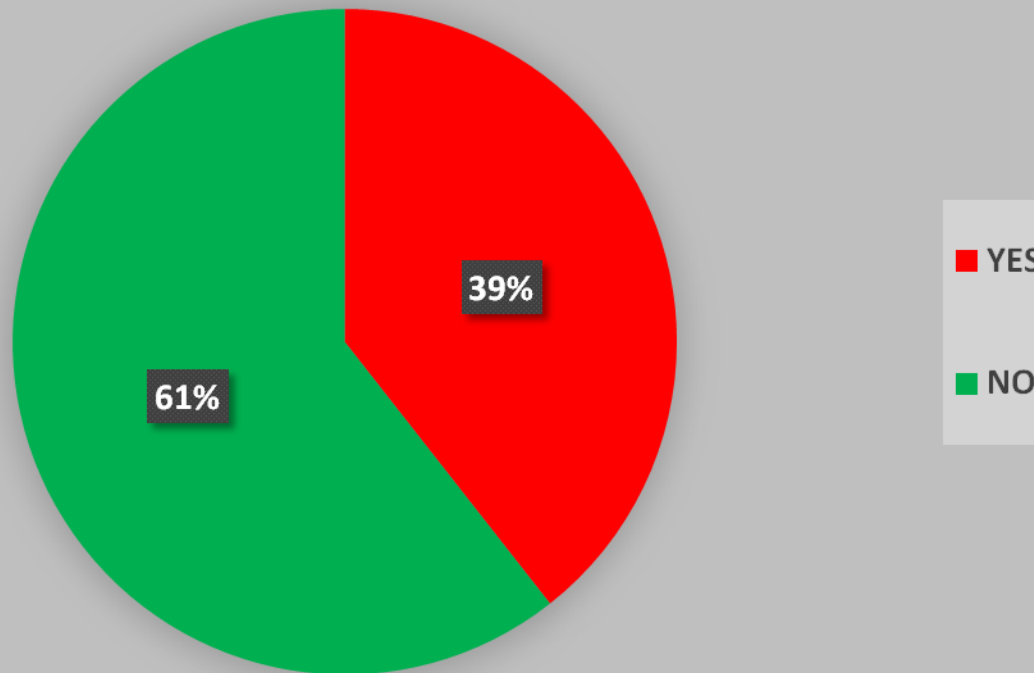
Figure 11 : Respondents' answers to the question regarding Zika vaccine availability

The green portion represents the percentage of participants with correct answers
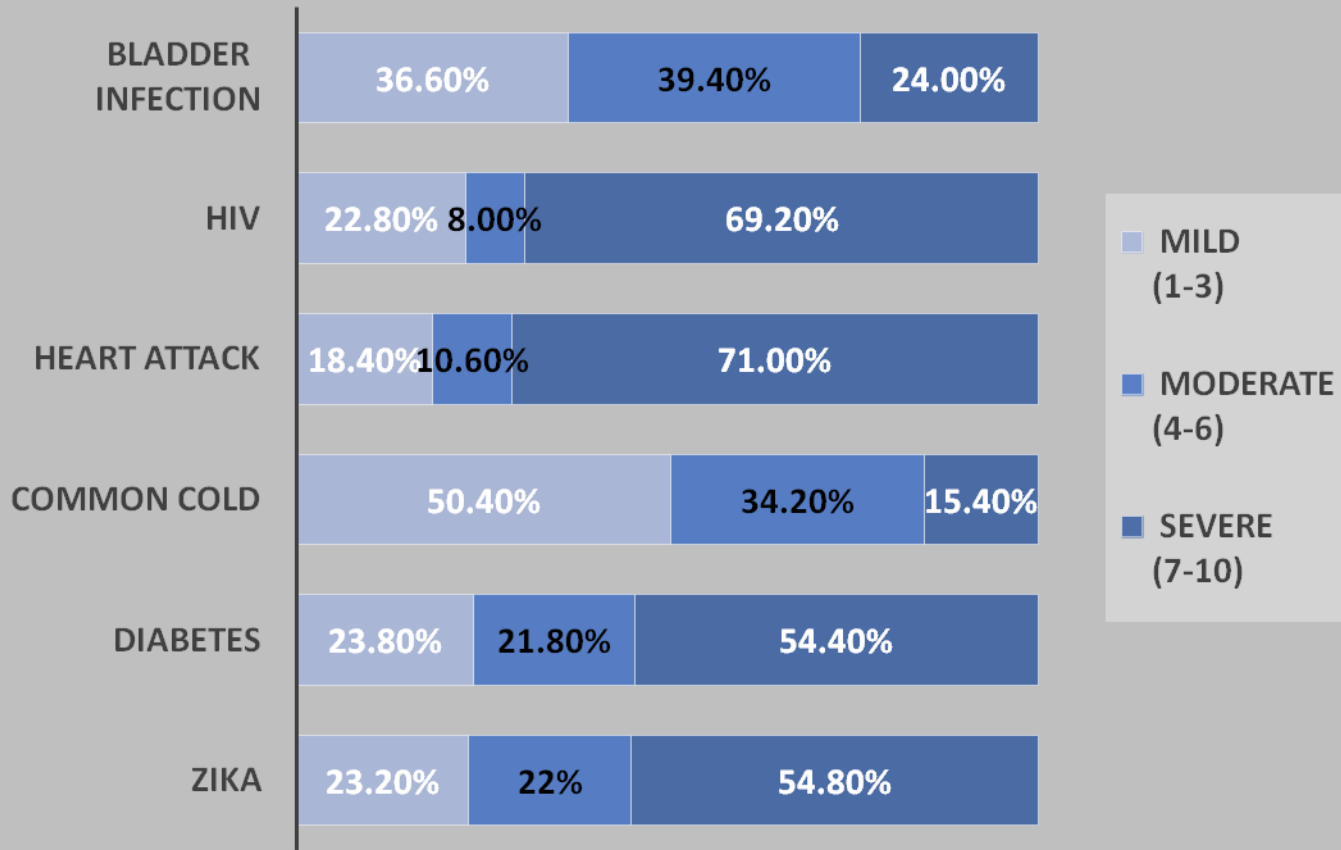
Figure 12 : Respondents' answers to the question "On a scale from 1 to 10, how serious would it be for you to contract the following disease(s) in the following year?"
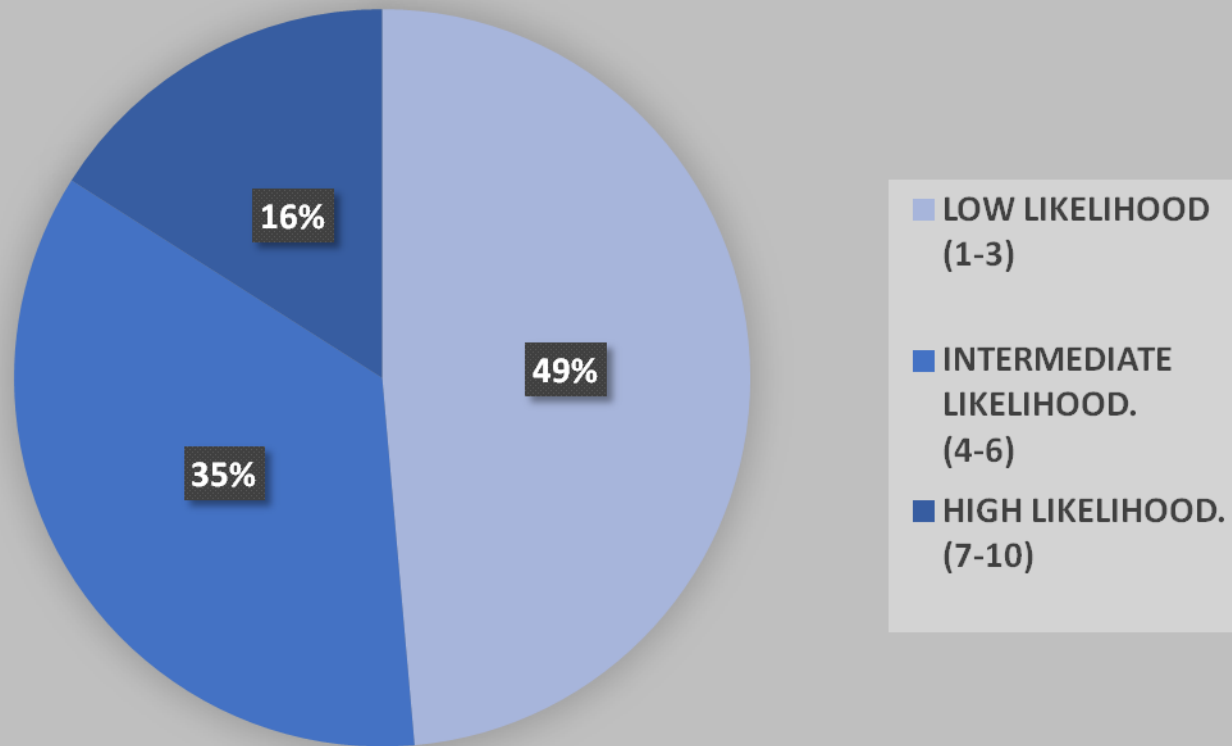
Figure 13 : Respondents' answers to the question ""Suppose that you haven't taken any protective measures against Zika . On a scale from 1 to 10,What do you think your chance of contracting the infection in the coming year is?
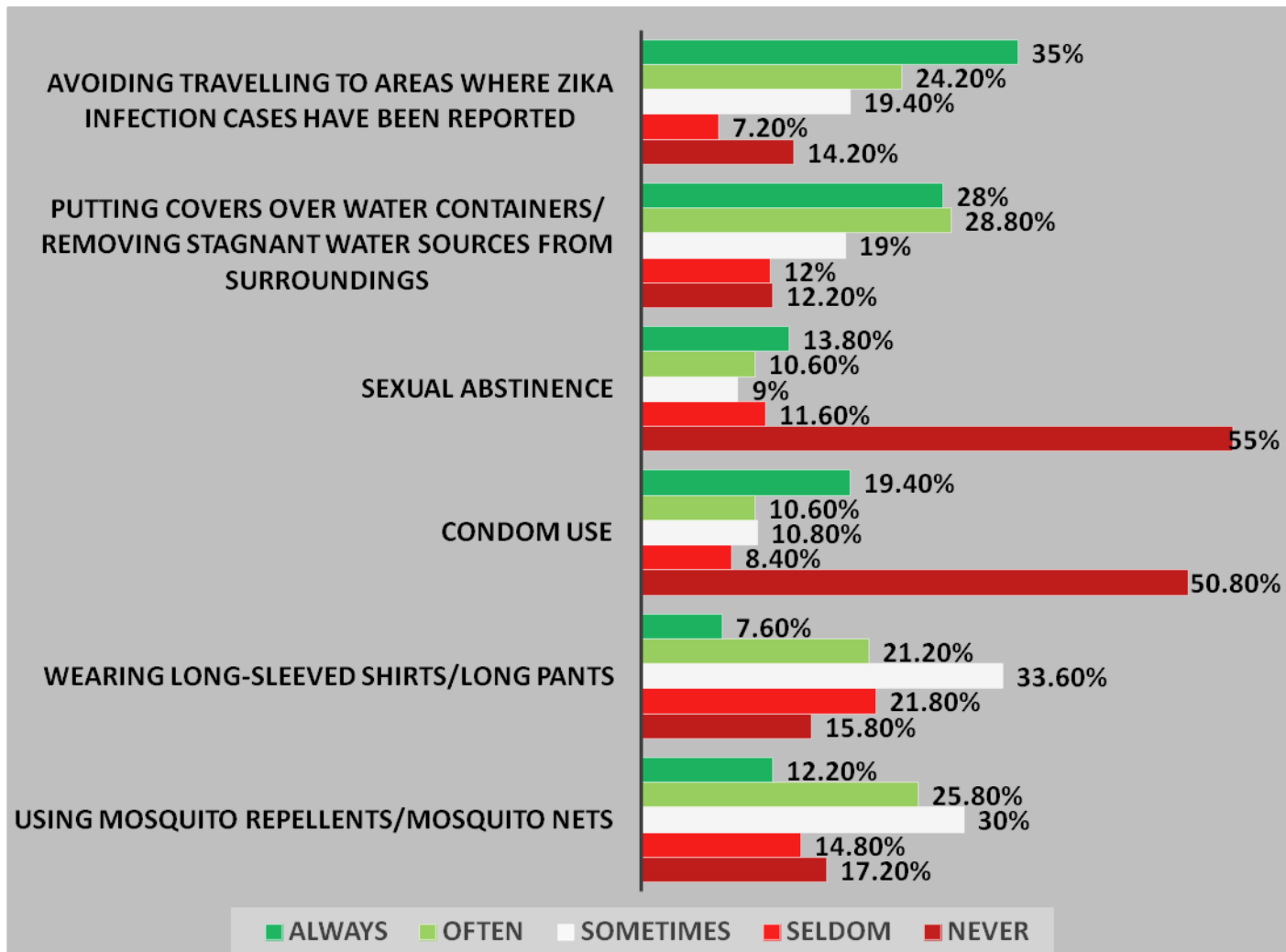
Figure 14 : Distributions of Respondents' reported frequencies of protective behavior undertaking
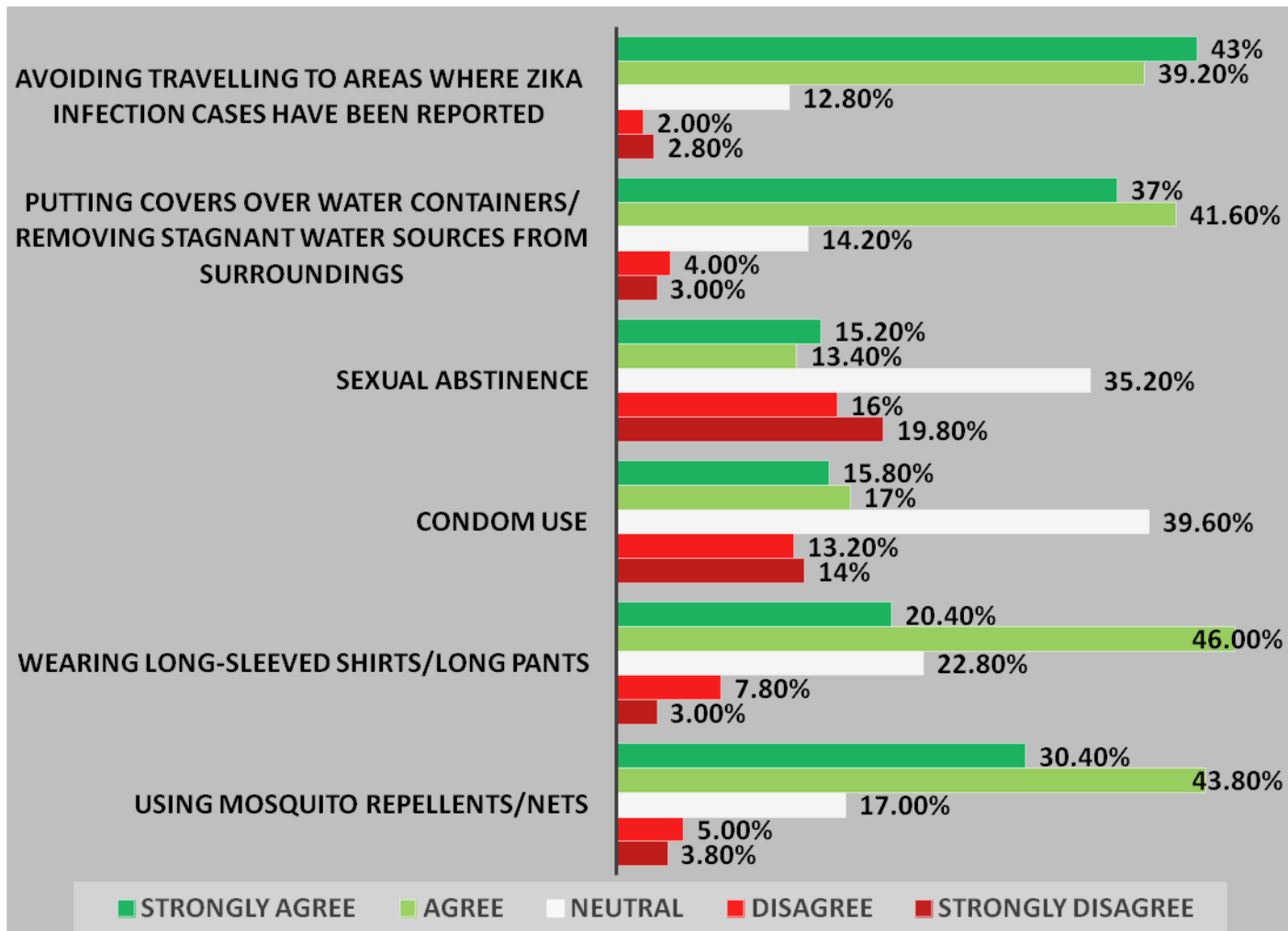
Figure 15 : Responses to the statement "I believe that the following measure(s) can effectively protect against Zika infection:"
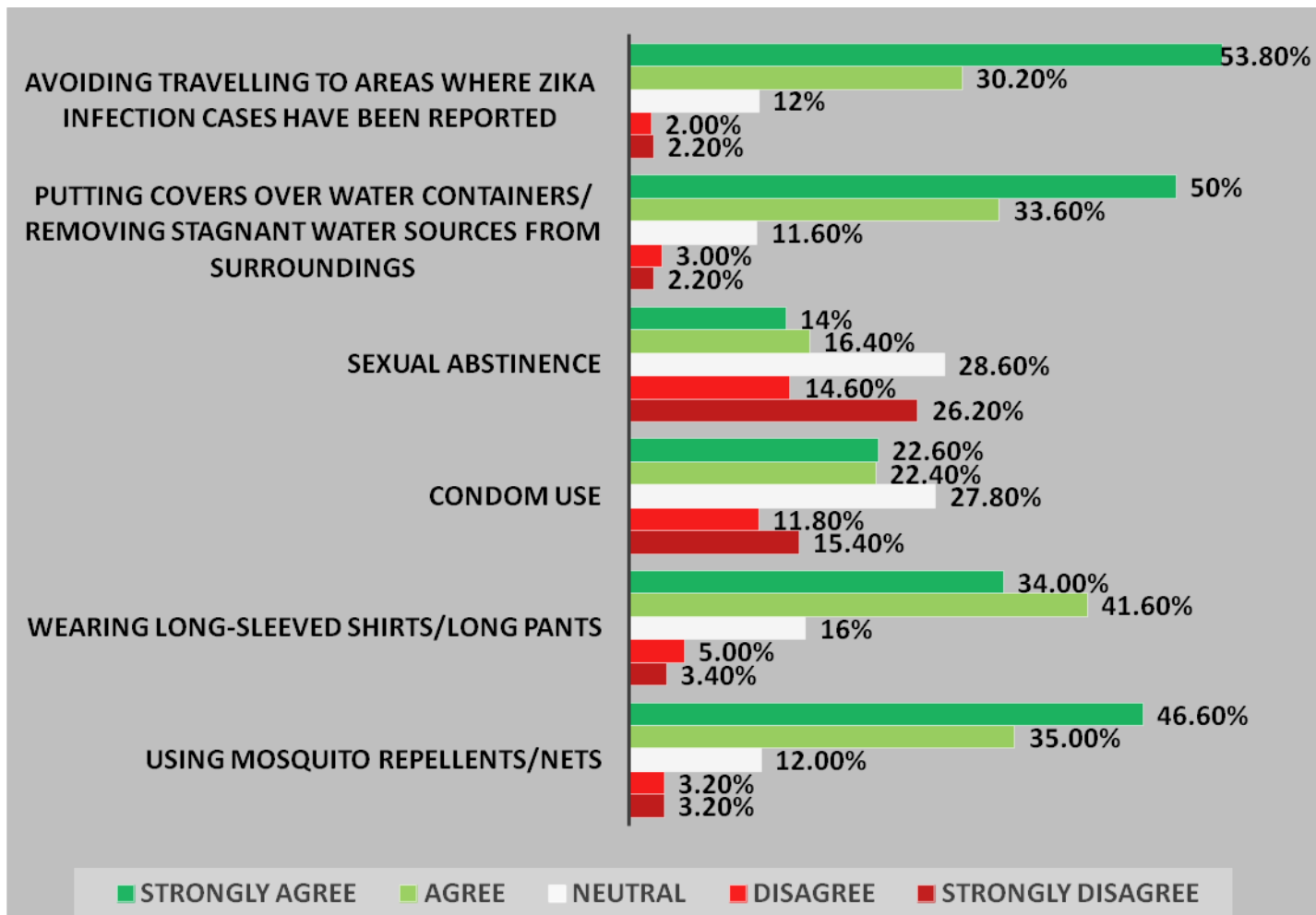
Figure 16 : Responses to the statement "If recommended by the Centers for Disease Control, I'm confident that I will be able to take the following measure(s):"
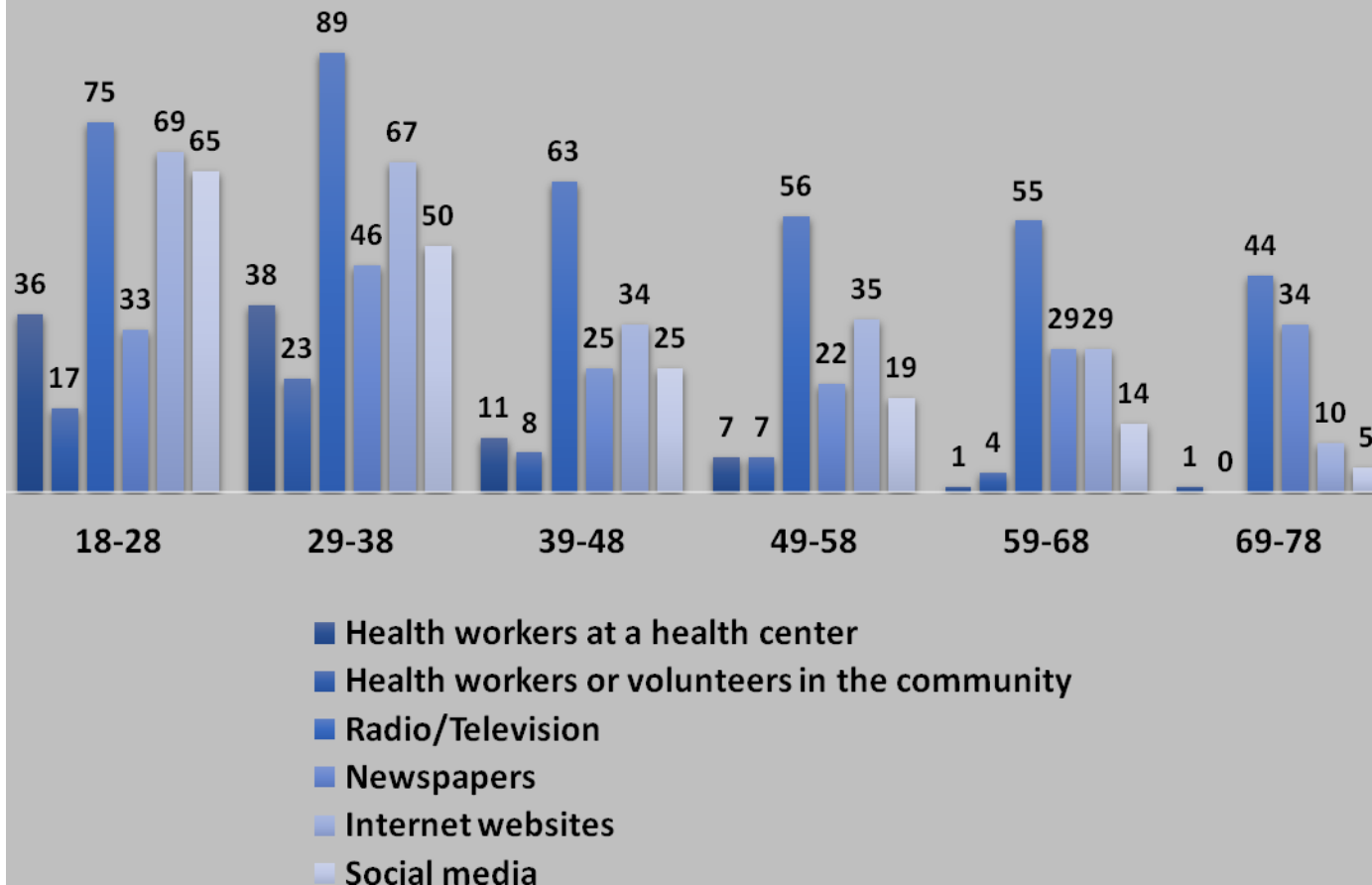
Figure 17 : Reported sources of information about Zika for different age groups
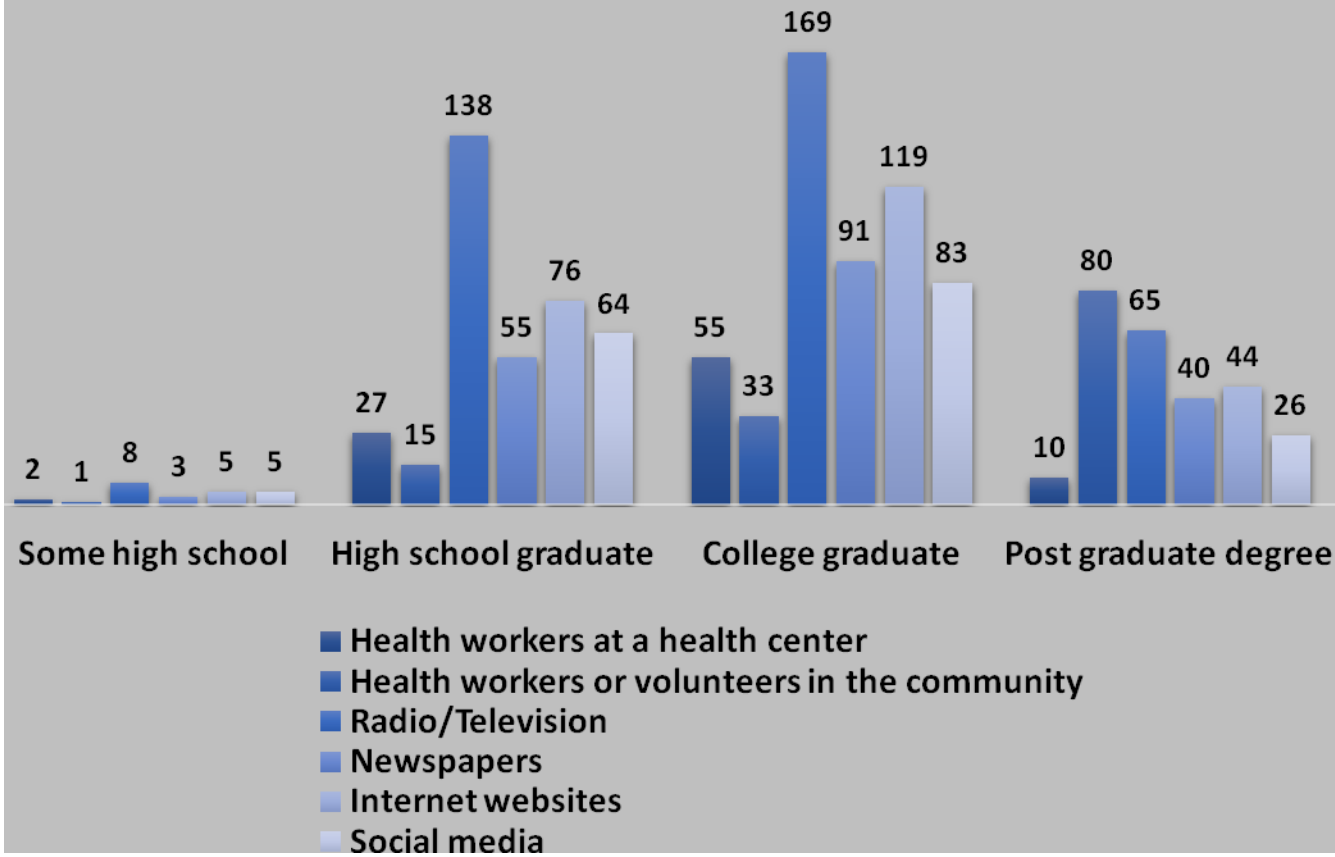
Figure 18 : Reported sources of information about Zika categorized by participants' education levels
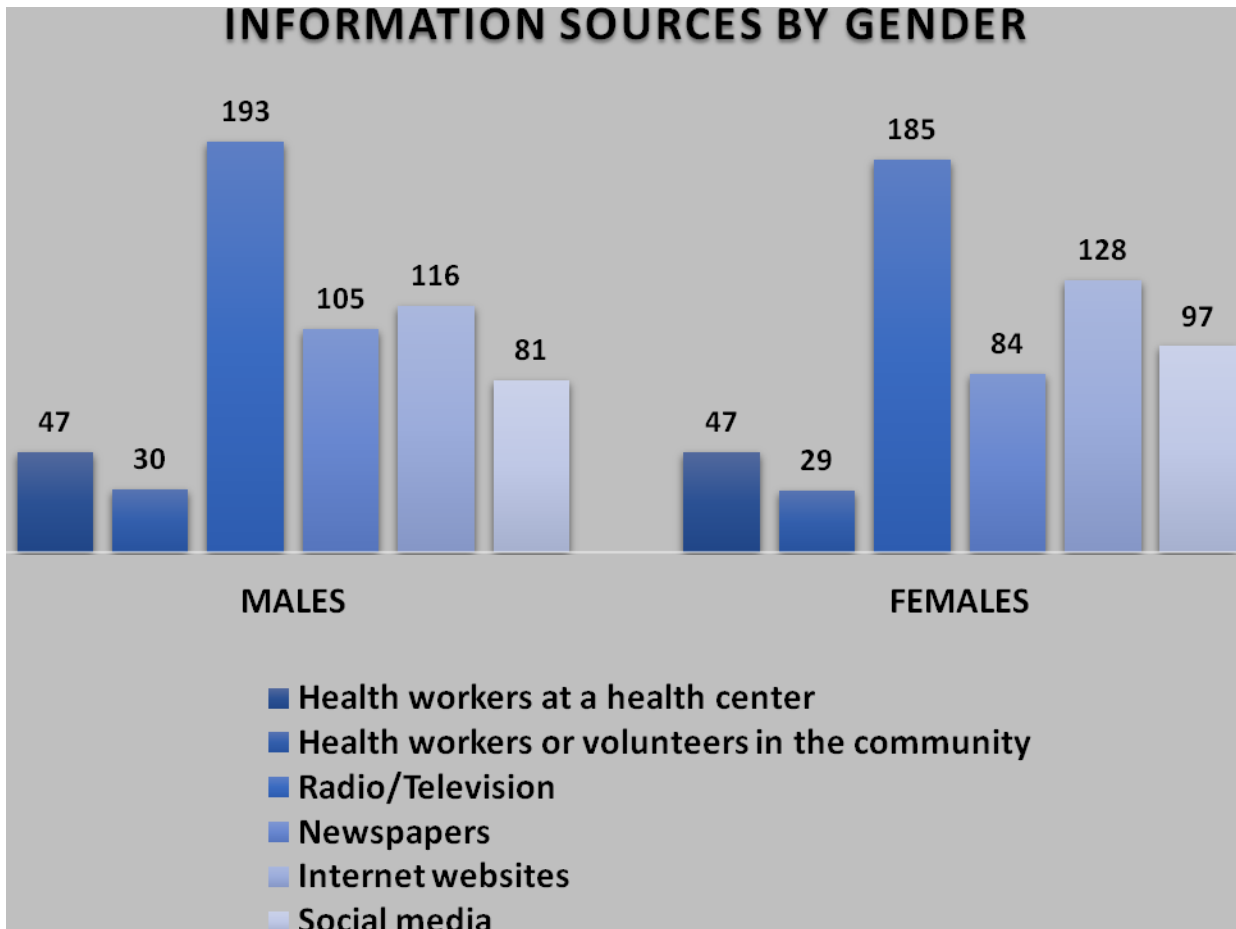
Figure 19 : Reported sources of information about Zika for different genders
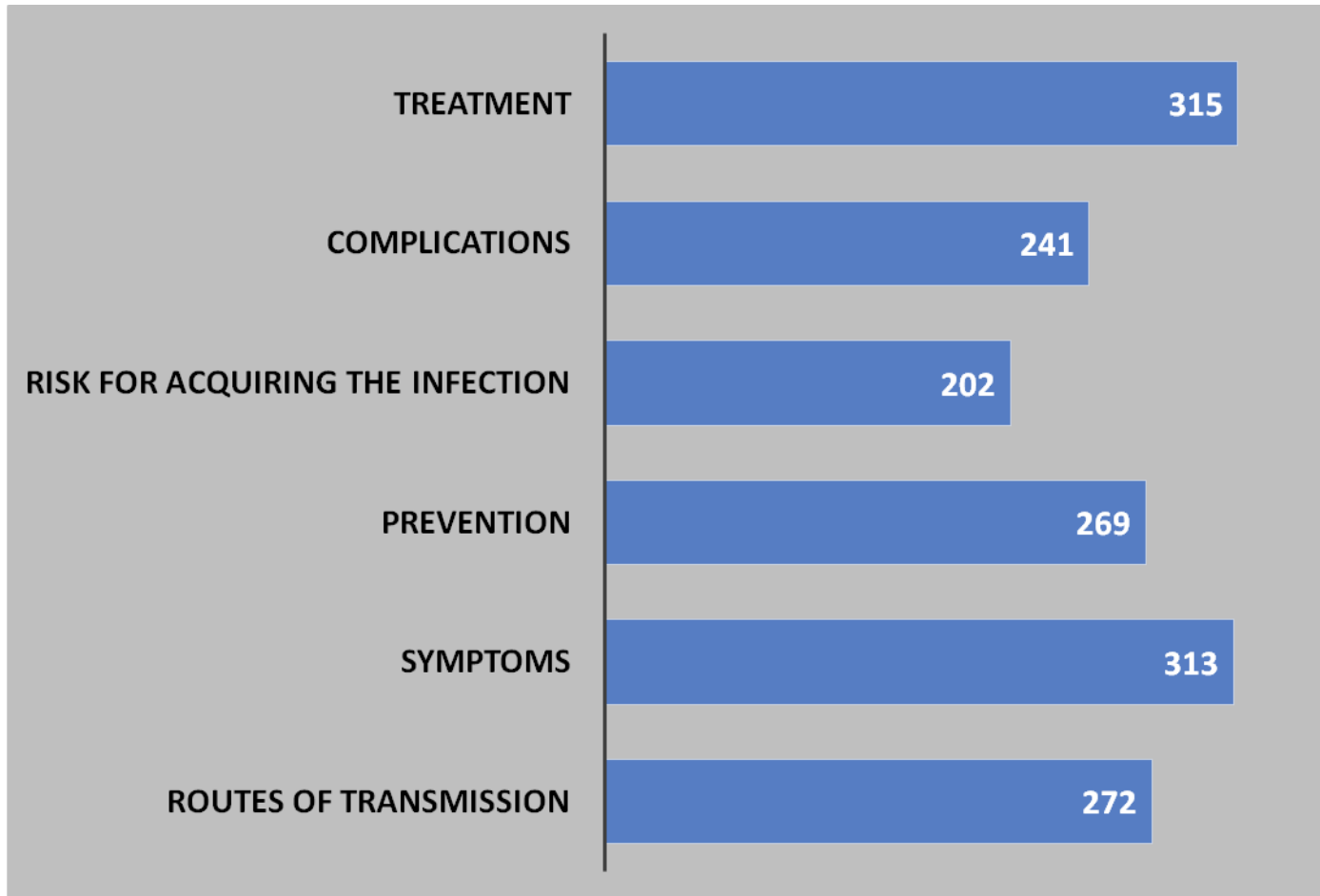
Figure 20 : Respondents' answers to the question "Regarding the current Zika outbreak, what are the most important topics about which you want to receive information at this time?"

APPENDIX B: TABLES

Table 1 : Proportions of Participants with misconceptions about Zika

	RESPONDENTS WITH MISCONCEPTION(S)*	PROPORTION	Lower 95% CL	Lower 95% CL
Risk groups	358	**0.716**	0.675	0.754
Routes of transmission	436	**0.872**	0.840	0.898
Symptoms	103	**0.206**	0.173	0.244
Treatment (Antibiotic use)	209	**0.418**	0.376	0.462
Treatment (NSAIDS use)	339	**0.678**	0.636	0.717
Complications (Microcephaly)	64	**0.128**	0.102	0.160
Complications (*Guillain-Barre* syndrome)	171	**0.342**	0.302	0.385
Vaccination availability	197	**0.394**	0.352	0.437

Table 2 : Analysis of Variance Table for Knowledge score by Age group

Term	*Sum of Squares*	*Degrees of Freedom*	*F*	*p*
Age group	31.01	2	15.35	< .001
Residuals	501.99	497		

Table 3 : Means, Standard Deviations, and Sample Size for Knowledge score by Age group

AGE GROUP	*M*	*SD*	*n*
18-38	3.79	1.05	244
39-58	4.29	0.95	141
59-78	4.3	0.97	115

Table 4 : Independent Samples t-Test for the Difference in knowledge scores between Genders

	MALES		FEMALES				
Variable	*M*	*SD*	*M*	*SD*	*t*	*p*	*d*
Knowledge score	3.97	1.09	4.13	0.97	-1.67	.095	0.15

Note. Degrees of Freedom for the *t*-statistic = 491.93. *d* represents Cohen's *d.*

Table 5 : Independent Samples t-Test for the Difference in Knowledge score by levels of education

	OTHER PARTICIPANTS		PARTICIPANTS WITH COLLEGE DEGREES				
Variable	M	SD	M	SD	t	p	d
Knowledge score	3.86	1.08	4.16	0.99	- 3.19	.001	0.29

Note. Degrees of Freedom for the *t*-statistic = 498. *d* represents Cohen's *d*.

Table 6 : Independent Samples t-Test for the difference in knowledge scores by the presence of women of childbearing age in the household

	Women of childbearing age in the household?						
	NO		YES				
Variable	M	SD	M	SD	t	p	d
Knowledge score	4.08	1.11	4.03	0.98	0.52	.606	0.05

Note. Degrees of Freedom for the *t*-statistic = 498. *d* represents Cohen's *d*.

Table 7 : Independent Samples t-Test for the difference in knowledge scores by the presence of pregnant women in the household

	Pregnant women living in the Household?						
	NO		YES				
Variable	M	SD	M	SD	t	p	d
Knowledge score	4.11	1.03	3.55	0.91	3.69	< .001	0.57

Note. Degrees of Freedom for the *t*-statistic = 498. *d* represents Cohen's *d*.

Table 8 : Independent Samples t-Tests for the association between the frequency of protective behavior undertaking and respondents' perception of Zika infection severity

VARIABLE	FREQUENTLY UNDERTOOK THE PROTECTIVE BEHAVIOR?							
	NO		YES					
	M	SD	M	SD	t	p	d	TEST USED
USING MOSQUITO REPELLENTS	6.30	3.17	6.49	3.13	-0.67	**.503**	0.06	Student's t-Test
WEARING LONG-SLEEVED CLOTHES	6.41	3.10	6.28	3.28	0.43	**.665**	0.04	Student's t-Test
CONDOM USE	6.36	3.17	6.41	3.12	-0.18	**.855**	0.02	Student's t-Test
SEXUAL ABSTINENCE	6.48	3.14	6.06	3.18	1.28	**.202**	0.13	Student's t-Test
REMOVING STAGNANT WATER FROM SURROUNDINGS	6.07	3.17	6.60	3.12	-1.86	**.063**	0.17	Student's t-Test
AVOIDING TRAVELLING TO AREAS WITH REPORTED INFECTION CASES	6.05	3.18	6.59	3.12	-1.89	**.059**	0.17	Student's t-Test

Note. d represents Cohen's *d.*

Table 9 : Independent Samples t-Tests for the association between the frequency of protective behavior undertaking and respondents' perception of personal susceptibility to Zika infection

	FREQUENTLY UNDERTOOK THE PROTECTIVE BEHAVIOR?							
	NO		*YES*					
VARIABLE	*M*	*SD*	*M*	*SD*	*t*	*p*	*d*	**TEST USED**
USING MOSQUITO REPELLENTS	3.81	2.29	4.34	2.56	-2.34	**.020**	0.22	Welch's t-test
WEARING LONG-SLEEVED CLOTHES	3.86	2.31	4.38	2.61	-2.06	**.040**	0.21	Welch's t-test
CONDOM USE	3.76	2.26	4.59	2.64	-3.39	**<.001**	0.34	Welch's t-test
SEXUAL ABSTINENCE	3.88	2.32	4.39	2.63	-2.04	**.042**	0.21	Student's t-Test
REMOVING STAGNANT WATER FROM SURROUNDINGS	3.66	2.18	4.27	2.55	-2.88	**.004**	0.26	Welch's t-test
AVOIDING TRAVELLING TO AREAS WITH REPORTED INFECTION CASES	3.93	2.37	4.06	2.44	-0.63	.531	0.06	Student's t-Test

Note. d represents Cohen's *d.*

Table 10 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Using mosquito repellents/mosquito nets)

	Believe that the behavior can be effective?	
Frequently Undertook the behavior?	**No**	**Yes**
No	**107 [80]**	203 [230]
Yes	22 [49]	**168 [141]**

Note. $X^2(1) = 32.37$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 11 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Wearing long-sleeved clothes)

Frequently Undertook the behavior?	Believe that the behavior can be effective?	
	No	**Yes**
No	**141 [120]**	215 [236]
Yes	27 [48]	**117 [95]**

Note. $X^2(1) = 19.99$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 12 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Condom use)

	Believe that the behavior can be effective?	
Frequently Undertook the behavior?	**No**	**Yes**
No	**266 [234]**	84 [116]
Yes	68 [100]	**82 [50]**

Note. $X^2(1) = 44.53$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 13 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Sexual abstinence)

Frequently Undertook the behavior?	*Believe that the behavior can be effective?*	
	No	**Yes**
No	**304 [270]**	74 [108]
Yes	53 [87]	**69 [35]**

Note. $X^2(1) = 61.77$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 14 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Removing stagnant water from surroundings/Covering water containers)

Frequently Undertook the behavior?	*Believe that the behavior can be effective?*	
	No	**Yes**
No	**81 [46]**	135 [170]
Yes	25 [60]	**259 [224]**

Note. $X^2(1) = 60.48$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 15 : Chi-Square test of association between the frequency of undertaking and response efficacy beliefs for (Avoiding travel to areas where infection cases were reported)

Frequently Undertook the behavior?	*Believe that the behavior can be effective?*	
	No	**Yes**
No	**63 [36]**	141 [168]
Yes	25 [52]	**271 [244]**

Note. $X^2(1) = 41.92$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 16 : Chi-Square test of association between the frequency of undertaking and self- efficacy beliefs for (Using mosquito repellents/mosquito nets)

Frequently Undertook the behavior?	*Believes in his/her ability to undertake that behavior?*	
	No	**Yes**
No	**76 [57]**	234 [253]
Yes	16 [35]	**174 [155]**

Note. $X^2(1) = 20.32$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 17 : Chi-Square test of association between the frequency of undertaking and self- efficacy beliefs for (Wearing long-sleeved clothes)

Frequently Undertook the behavior?	*Believes in his/her ability to undertake that behavior?*	
	No	**Yes**
No	**109 [87]**	247 [269]
Yes	13 [35]	**131 [109]**

Note. $X^2(1) = 25.91$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 18 : Chi-Square test of association between the frequency of undertaking and self- efficacy beliefs for (Condom use)

Frequently Undertook the behavior?	*Believes in his/her ability to undertake that behavior?*	
	No	**Yes**
No	**246 [193]**	104 [158]
Yes	29 [83]	**121 [68]**

Note. $X^2(1) = 110.14$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 19 : Chi-Square test of association between the frequency of undertaking and self-efficacy beliefs for (Sexual abstinence)

	Believes in his/her ability to undertake that behavior?	
Frequently Undertook the behavior?	**No**	**Yes**
No	**309 [262]**	69 [115.67]
Yes	38 [84.67]	**84 [37]**

Note. $X^2(1) = 111.19$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 20 : Chi-Square test of association between the frequency of undertaking and self-efficacy beliefs for (Removing stagnant water from surroundings/Covering water containers)

	Believes in his/her ability to undertake that behavior?	
Frequently Undertook the behavior?	**No**	**Yes**
No	**64 [36]**	152 [180]
Yes	20 [48]	**264 [236]**

Note. $X^2(1) = 44.78$, $p < .001$. Items in brackets represent expected cell frequencies.

Table 21 : : Chi-Square test of association between the frequency of undertaking and self-efficacy beliefs for (Avoiding travel to areas where infection cases were reported)

	Believes in his/her ability to undertake that behavior?	
Frequently Undertook the behavior?	**No**	**Yes**
No	**64 [33]**	140 [171]
Yes	16 [47]	**280 [249]**

Note. $X^2(1) = 60.59$, $p < .001$. Items in brackets represent expected cell frequencies.

APPENDIX C: UCF IRB LETTER

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Saleh A Naser** and Co-PI **Mohtashem Samsam**

Date: **June 12, 2017**

Dear Researcher:

On 06/12/2017, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Knowledge and Attitudes regarding the Recent Zika outbreak in Florida
Investigator:	Saleh A Naser
IRB Number:	SBE-17-13140
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Renea C Carver on 06/12/2017 04:35:21 PM EDT

IRB Coordinator

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