## Original Research

# Use of mosquito repellents to protect against Zika virus infection among pregnant women in Brazil

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## ARTICLE INFO

## ABSTRACT

Objectives: To evaluate the use of repellents among pregnant women as a protective measure against infection with the Zika virus.

Study design: Pregnant women (n = 177) were interviewed between November 2016 and February 2017 at Basic Health Units in the city of Propriá, state of Sergipe, Brazil. Two units were located in rural areas and eight in urban regions.

Methods: Data were analysed using descriptive statistical methods, the Chi-squared test or Fisher's exact test and odds ratios. The independent variables were grouped by analysis of the main components, and adherence to the use of the repellent was analysed by the logistic regression method.

Results: A total of 100 women reported using repellents at the time of the interview (56%). The use of repellents was greater among women with higher levels of education (83%) than those with only high school (68%) or elementary school (36%) education. Women assisted by the income transfer programme (Bolsa Família) presented a 2.27 times greater chance of not using repellents compared with pregnant women who were not receiving benefits of the programme. Regarding the logistic regression model, we observed that low economic and social conditions of pregnant women, as well as their lack of advice, had a negative effect on the use of repellents.

Conclusions: Repellents were generally used as a preventive measure in pregnant women with higher levels of schooling and fewer children. The relatively high cost of repellents was the main reason for non-use.

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## Introduction

Zika virus (ZIKV), an arbovirus transmitted by *Aedes aegypti*,[1] has spread rapidly throughout the Americas. Thus, within about 18 months (April 2015 to October 2016), 48 countries reported autochthonous cases of ZIKV infection.[2] In Brazil, compulsory notification of cases of infection with this virus was instituted in February 2016, and by the end of that year, 215,319 cases were registered,[3] in addition to 10,867 suspected cases of microcephaly, of which 2366 were confirmed.[4]

In Brazil, after declaring an international emergency situation,[5] the Brazilian Ministry of Health (BMH) initiated a series of emergency measures for containment, directed mainly at the reduction of *A. aegypti* infestation. The goals of the campaign, called Zika Zero, included the reduction of the index of house infestation by *A. aegypti* to 1% throughout the entire national territory, which is composed of 5570 municipalities.[6] Pregnant women were recommended to undertake a series of individual preventive measures, such as the use of long-sleeved clothing, mosquito nets, screens on doors and windows, vector control measures, and, above all, the use of repellents on a daily basis.[7]

The common active ingredient in many repellents is N, N-dimethyl-meta-toluamide (DEET). DEET was specifically recommended in the guidelines of the ZIKV control programme as the repellent of choice[8] because it acts within the nervous system of the insects and has a low potency of acetylcholinesterase inhibition, which makes toxicity to mammals unlikely.[9] In addition to DEET, repellents based on IR3535 and icaridin were also recommended as a personal protective measure against ZIKV infection.[10,11]

The emergence of ZIKV was accompanied by tragic consequences, especially for women. Given the lack of vaccines or specific treatment for ZIKV and evidence of its association with microcephaly, the focus in Brazil has been on the use of personal protective and preventive measures. Based on this assumption, the purpose of this study was to evaluate whether pregnant women with low incomes use repellents as a preventive measure against ZIKV infection. The study focused on women who are assisted by the Bolsa Família Programme (PBF) (family allowance) and live in the Brazilian municipality of Propriá, located in Northeast Brazil, the region most affected by the epidemic.[3]

## Methods

### Study area

We conducted this study in the municipality of Propriá, state of Sergipe, in Northeast Brazil, which has an estimated population of 28,451 (24,390 urban and 4061 rural) inhabitants and a Human Development Index of 0.661.[12] Propriá has 10 basic health units (BHUs), which are responsible for primary care, monitoring family health, preventing disease and promoting community health. Two of the BHUs are located in the rural zone and eight in the urban zone.

### Study design

We conducted a cross-sectional study, using information collected from pregnant women about the use of personal protective measures against ZIKV infection through the bites of the *A. aegypti* mosquito. We interviewed pregnant women during antenatal care visits at the BHUs of Propriá by means of a semistructured questionnaire between November 2016 and February 2017. We conducted two pilot studies with women of different age groups to assess their understanding of the topic and estimate the duration of a typical interview (15−30 min). After the pilot test, we finalised the items on the questionnaire (see supplementary data).

To determine the sample size, we considered a confidence level of 95% and a sampling error of 5%, and the population parameters, P and Q, were set at 50%. The reference for calculation of the number of pregnant women was the sum of live, deceased and aborted births in Propriá during 2015 according to the database of the BMH.[13] A stratified sample was calculated to maintain the proportion of pregnant women living in the rural (20%) and urban (80%) environments, resulting in 174 pregnant women: 34 in the rural area and 140 in the urban area. Each BHU reserves 1 day per week for antenatal care. Thus, the interviewer went to the units on the specified day, and all pregnant women scheduled for that day were invited to take part in the study. It took 4−5 days per BHU to complete interviews of the sample in the urban area and 3−4 days in the rural area.

The inclusion criteria were as follows: (1) pregnant women older than 15 years (mean age for completing junior high school in Brazil); (2) residing in the municipality of Propriá, state of Sergipe, Brazil; and (3) undergoing antenatal care in a BHU of the Brazilian Unified Health System. We compiled information on demographic variables, as well as receipt of the PBF, an income transfer programme that benefits Brazilian families with a monthly income per capita of less than R\$ 120 (US\$ 68).

### Data analyses

Collected data were entered (double data entry) into a spreadsheet using Microsoft Excel 2013 software. Data analyses involved descriptive statistics techniques, Chi-squared or Fisher's exact and odds ratio tests. The confidence level adopted was 95%.

We adjusted a logistic regression model, assuming the response variable—no use of repellents. We selected 20 independent variables, and to solve problems generated by multicollinearity, we used principal component (PC) analysis to transform the variables. We performed statistical analyses using the R software, version 3.4.0.

### Ethical approval

This study was approved by the Research Ethics Committee of the Federal University of Sergipe (Protocol 1,807,743). All pregnant women were informed of the research objectives and invited to sign the Informed Consent Terms, authorising their participation and use of the information granted for

research purposes. All information was kept confidential to maintain the privacy of the interviewees.

## Results

Of 183 pregnant women approached, five were not included because they were aged below 15 years, and one refused to participate in the interview. Thus, we interviewed 177 pregnant women: 34 from rural areas and 143 from urban areas. The median age was 25 years (range: 15–42 years), with a predominance of those who were 15–25 years old (55%). Most of the interviewees (73%) declared themselves to be of brown race and lived with their partners (70%). Only 10% of the sample had either a complete or an incomplete degree and 28% had a job. Most lived in urban areas (86%) (Table 1). Women benefitting from the PBF represented 38% of the

| Table 1 – Demographics, social characteristics and gestational period of pregnant women interviewed in the municipality of Propriá, Brazil (November 2016 to February 2017). | | |
|---|---|---|
| Characteristics | n | % |
| **Location** | | |
| Rural area | 34 | 20 |
| Urban area | 143 | 80 |
| **Race** | | |
| White | 33 | 19 |
| Brown | 130 | 73 |
| Black | 14 | 8 |
| **Age range (years)** | | |
| 15–20 | 51 | 29 |
| 21–25 | 46 | 26 |
| 26–30 | 44 | 25 |
| 31–35 | 22 | 12 |
| 36–40 | 12 | 7 |
| 41–45 | 2 | 1 |
| **Marital status** | | |
| Married | 72 | 41 |
| Single | 52 | 29 |
| Stable union | 51 | 29 |
| Divorced | 2 | 1 |
| **Schooling** | | |
| Incomplete elementary school | 51 | 29 |
| Complete primary education | 21 | 12 |
| Incomplete high school | 21 | 12 |
| Complete high school | 66 | 37 |
| Higher education | 18 | 10 |
| **Occupation** | | |
| Employed | 49 | 28 |
| Unemployed | 128 | 62 |
| **Social assistance (Bolsa Família Programme)** | | |
| Receives benefits | 68 | 38 |
| Does not receive benefits | 109 | 62 |
| **Gestation period (weeks)** | | |
| ≤ 8 | 25 | 14 |
| 9–12 | 21 | 12 |
| 13–16 | 24 | 13 |
| 17–20 | 27 | 15 |
| 21–24 | 25 | 14 |
| 25–28 | 18 | 10 |
| >28 | 37 | 22 |

sample. Most interviewees had only completed elementary school (63%) and were not engaged in any paid activity (84%).

Regarding preventive measures, 100 (56%) women claimed to use repellents and 77 (44%) did not. The use of repellents showed a higher frequency among women with higher levels of education (83%) than among those with only high school (68%) or elementary school (36%) education. Among the repellents used, those based on DEET (94%) with a concentration of less than 10% (85%) were the most frequently used (Table 2).

The economic factor was the main justification (48%) for the non-use of repellents both in urban and rural areas. Among pregnant women who benefited from the PBF, this justification reached 68%, and they were 2.2 times less likely to use repellents compared with those who did not receive PBF benefits (Table 3). Even among those who used repellents, 46% applied it only once daily, 17% applied it twice and 28% applied it three times a day. Among those who did not receive the PBF, the frequencies of daily application were 17%, 36% and 32%, once, twice and three times a day, respectively.

Women in early pregnancy were twice as likely to refrain from the use of repellents as pregnant women in the last trimester. The following factors were positively associated with the use of repellents: having fewer children, seeing a baby with microcephaly during pregnancy, the presence of a washing machine in the household and being in the last trimester (Table 3). All women aged 28 years and above, who were married and pregnant for the first time reported the use of repellents. On the other hand, all pregnant women with four or more children, who were assisted by the PBF, reported that they did not use repellents.

Among women who used repellents, 49% were not advised by health professionals but received family counselling (18%) or used repellents of their own accord (31%). Women who did not receive health guidance on ZIKV were 18.9 times less likely to understand ZIKV-related risks and 3.3 times less likely to use repellents. In addition, a lack of exposure to the media through advertisements, reports and images meant that these women were 3.5 times more likely to be uninformed about ZIKV and therefore 2.4 times less likely to use repellents.

Nausea from the scent of the repellent was the most frequently mentioned adverse effect. However, the use of repellent in specific areas, such as the face and neck, were not associated with nausea. In addition, age group, diagnostic history of arboviruses and residence in a rural environment did not influence the use of repellents (Table 3).

For the logistic regression analysis, only the first seven components were used as independent variables in the model, maintaining 59.69% of the total variation of the data set (Table 4).

Women in low economic conditions (PC1—unemployed women with low levels of schooling, who lacked a washing machine at home) were 2.5 times less likely to use repellents. Those in low social conditions (PC2), which included women assisted by the PBF, having a greater number of children, were 1.78 times less likely to use repellents than pregnant women who did not received benefits of any assistance programme and who were pregnant for the first time (Table 5).

Women who were <5 months pregnant and who lacked professional advice (PC3) [either from professionals or the media] were 2.2 times less likely to use repellents than

**Table 2 – Characterisation of the repellents used by pregnant women, Propriá, Brazil (November 2016 to February 2017).[a]**

| Repellent brand | Active ingredient | Concentration (%) | Label duration of repellency (h) | Average reported price (US$)[b] |
|---|---|---|---|---|
| OFF Family | DEET | <10 | 2.0 | 4.27 |
| Repelex | DEET | <10 | 2.0 | 4.12 |
| Mosquitoff | DEET | 10 | 2.5 | 3.82 |
| SBP | Icaridin | 15 | 5.0 | 4.51 |
| OFF kids | DEET | <10 | 2.0 | 3.56 |
| Muriel | DEET | <10 | 2.0 | 2.34 |
| Exposis | Icaridin | 25 | 10.0 | 10.74 |

DEET, N,N-dimethyl-meta-toluamide.
[a] Six pregnant women did not remember the name of the repellent used.
[b] 1 dollar = 3.73 real (14th January 2019).

pregnant women further along in pregnancy and who received more information about the disease. On the other hand, the PC4 component, which included people with deleterious habits (e.g. alcoholism and smoking), did not present a significant relationship with non-use of repellents (P = 0.94).

The PC5 component, which included women with health problems and who presented red spots on the body during pregnancy, had a 1.48 times greater chance of non-use of repellents, compared with those who had no health problems or any other serious issues during their pregnancy. A higher level of knowledge about ZIKV and the act of seeing children with microcephaly (PC6) acted as protective factors, favouring the use of repellents. Furthermore, the adoption of preventive habits (PC7), such as changing routines and remaining at home to minimise exposure to the vector, also favoured repellent use (Table 5).

## Discussion

The is a lack of epidemiological studies on the use of repellents to prevent arbovirus infection, although this issue has long been addressed in the case of malaria..[14–16] The ZIKV and microcephaly epidemic led to a 49% jump in sales of repellents in 2016, compared with 2015 in Brazil;[17] the same was true for the United States.[18] This unprecedented association between an apparently benign course of arboviral infections and epidemics of brain malformations *in utero,* as well as the possibility of late-onset neurological alterations in childhood[5,1] and neurological complications in adults (e.g. Guillain-Barré Syndrome),[9] has changed daily life, especially for pregnant women.

The high risk for the foetus meant that Brazilian women with low incomes used products that were considered expensive. Nevertheless, the economic factor was the main justification cited for the non-use of repellents, especially among women with very low economic and social conditions. Those who used repellents mostly applied a DEET repellent with a concentration of up to 10%, once a day, which was insufficient to protect pregnant women, even if applied three times a day, as indicated by the BMH.[19–21] Up until the ZIKV epidemic, products with a concentration higher than 10% or with other active ingredients were not common in Brazil.[20]

A behavioural change in pregnant women might have been evident regarding the use of repellents in relation to the stage of pregnancy. Women whose pregnancy began around the time of the ZIKV pandemic (i.e. during the first four months of 2016) were more greatly influenced by the intense prevention campaigns in all the media. Images of mosquitoes became an integral part of the Brazilian visual landscape,[22] and confusing communication caused speculation and fear of pregnancy during this period.[23] Also, those women who had seen infants with microcephaly, whether in hospitals or public places, may have increased fear and doubts about the outcome of their own pregnancy and may have fostered greater adherence in the use of repellents, even among those women who were assisted by the PBF.

In contrast to observations in Qatar[4] and Nigeria,[5] increasing age showed no significant increase in knowledge about ZIKV or increased use of repellents. However, level of schooling was one determinant that increased the chances of repellent use and a more diligent quest for information from health professionals in the BHUs. In the United States, higher levels of schooling were correlated with an increased search for information on the topic.[6]

Personalised professional advice promoted greater adherence to the use of repellents and healthcare services. Nurses were among the most frequently mentioned professionals to offer this counselling. Although pregnant women who were assisted by the PBF attended the same health services as those who did not receive PBF benefits, there was no mention of medical guidance being received by PBF recipients during the interviews. This indicates that although pregnant women of lower socioeconomic status were examined by doctors, following the Brazilian Basic Healthcare protocol, apparently no education or health information was offered to this group of women.

Contrary to what might be expected, living in rural areas had no significant difference on the use of repellents. This was evident, despite the lower levels of interaction with health professionals and the reduced number of antenatal consultations, owing to the difficulty of access. This may indicate that mass media campaigns were important sources of information for women,[22] regardless of location. The advertisements reached the entire population and were therefore the second most important source of advice on the use of repellents, as reported by the women in this study.

**Table 3 – Associations among the use of repellents and socio-economic and behavioural variables in pregnant women of the municipality of Propriá, Brazil (November 2016 to February 2017).**

| Variable | Use of repellents [n (%)] | | OR (95% CI) | P-value |
|---|---|---|---|---|
| | Yes | No | | |
| **Education level** | | | | |
| Elementary School | 46 (59.74) | 26 (26.00) | 8.85 (2.34; 33.43) | <0.001 |
| High school | 28 (36.36) | 59 (59.00) | 2.37 (0.63; 8.87) | |
| Higher education | 3 (3.90) | 15 (15.00) | 1 | |
| **Geographic area** | | | | |
| Rural | 18 (23.38) | 16 (16.00) | 1.6 (0.76; 3.39) | 0.2971 |
| Urban | 59 (76.62) | 84 (84.00) | 1 | |
| **Social assistance (Bolsa Família Programme)** | | | | |
| Yes | 38 (49.35) | 30 (30.00) | 2.27 (1.22; 4.22) | 0.0136 |
| No | 39 (50.65) | 70 (70.00) | 1 | |
| **Ownership of a washing machine** | | | | |
| No | 55 (71.43) | 37 (37.00) | 4.26 (2.25; 8.07) | <0.001 |
| Yes | 22 (28.57) | 63 (63.00) | 1 | |
| **Age group in years** | | | | |
| >=20 | 24 (31.17) | 27 (27.00) | 1.11 (0.47; 2.62) | 0.8884 |
| 21–25 | 18 (23.38) | 28 (28.00) | 0.80 (0.33; 1.95) | |
| 26–30 | 19 (24.68) | 25 (25.00) | 0.95 (0.39; 2.31) | |
| 31–42 | 16 (20.78) | 20 (20.00) | 1 | |
| **Offspring** | | | | |
| Yes | 57 (74.03) | 41 (41.00) | 4.10 (2.15; 7.83) | <0.001 |
| No | 20 (25.97) | 59 (59.00) | 1 | |
| **Wear clothing with long sleeves and long trousers** | | | | |
| Yes | 54 (54.00) | 46 (46.00) | 0.36 (0.19; 0.68) | 0.0022 |
| No | 23 (29.87) | 54 (70.13) | 1 | |
| **Carry repellents when travelling** | | | | |
| Yes | 1 (1.30) | 84 (84.00) | 0.00 (0.00; 0.02) | <0.001 |
| No | 76 (98.70) | 16 (16.00) | 1 | |
| **Had seen a baby with microcephaly** | | | | |
| No | 74 (96.10) | 69 (69.00) | 11.08 (3.24; 37.9) | <0.001 |
| Yes | 3 (3.90) | 31 (31.00) | 1 | |
| **Had any arboviral infections** | | | | |
| No | 58 (75.32) | 80 (80.00) | 0.76 (0.37; 1.56) | 0.5747 |
| Yes | 19 (24.68) | 20 (20.00) | 1 | |
| **Drinks alcohol** | | | | |
| No | 63 (81.82) | 82 (82.83) | 0.93 (0.43; 2.03) | 1 |
| Yes | 14 (18.18) | 17 (17.17) | 1 | |
| **Smoker** | | | | |
| No | 63 (81.82) | 93 (93.00) | 0.41 (0.09; 1.76) | 0.0729 |
| Yes | 5 (6.49) | 3 (3.00) | 1 | |
| **Received professional health advice** | | | | |
| No | 78 (52.35) | 7 (25.00) | 3.30 (1.32; 8.22) | 0.0142 |
| Yes | 71 (47.65) | 21 (75.00) | 1 | |
| **Gestation period** | | | | |
| <5 months | 50 (64.94) | 47 (47.00) | 2.09 (1.13; 3.85) | 0.0261 |
| >6 months | 27 (35.06) | 53 (53.00) | 1 | |
| **Avoids leaving home** | | | | |
| Yes | 11 (14.29) | 31 (31.00) | 0.37 (0.17; 0.80) | 0.0158 |
| No | 66 (85.71) | 69 (69.00) | 1 | |
| | Information about ZIKV | | | |
| | No | Yes | | |
| **Exposure to media advertisements** | | | | |
| No | 48 (36.92) | 4 (14.29) | 3.51 (1.15; 10.73) | 0.0257 |
| Yes | 82 (63.08) | 24 (85.71) | 1 | |
| **Received professional health advice** | | | | |
| No | 33 (67.35) | 5 (9.80) | 18.98 (6.32; 56.96) | <0.001 |
| Yes | 16 (32.65) | 46 (90.20) | 1 | |
| | Face and Neck | | | |
| | No | Yes | | |
| **Protection perception** | | | | |
| Ineffective | 12 (16.90) | 2 (6.67) | 2.00 (0.22; 17.89) | 0.3005 |
| Excellent | 6 (8.45) | 2 (6.67) | 1 | |

| Table 3 — (continued) | | | | |
|---|---|---|---|---|
| Variable | Use of repellents [n (%)] | | OR (95% CI) | P-value |
| | Yes | No | | |
| **Adverse event** | | | | |
| No | 41 (53.95) | 21 (70.00) | 0.50 (0.20; 1.24) | 0.1963 |
| Yes | 35 (46.05) | 9 (30.00) | 1 | |
| CI, confidence interval; OR, odds ratio; ZIKV, Zika virus. | | | | |

Concerning knowledge about the disease and its consequences for the foetus, professional guidance was more effective than information in the media alone. Individual antenatal care probably facilitated adjustment of the language to suit individual needs and minimised doubts regarding medical information. The information presented through the media is more globalised and standardised and unable to address regional differences. Nevertheless, other studies on knowledge of ZIKV among women have shown that information in the media had a greater impact[24–26] than individual antenatal care advice.

Mosquito-borne diseases disproportionately affect the underprivileged majority of the Brazilian population,[22] as these populations are more likely to be subjected to a lack of basic sanitation, owing to irregularities in both water supply and garbage collection. About eight in 10 babies with congenital malformations associated with ZIKV in the Northeast of Brazil were born to mothers of black or brown race and of low economic status.[27]

Although the ZIKV load decreased in 2017, transmission of the virus persists, and levels of house infestation by A. aegypti remain high. Government failure to use collective and effective measures compel women to use individual protective measures, as the state policies does not sufficiently provide basic sanitation and infrastructure for the control of arboviruses.[28] The cost of this lack of Government investment is particularly high among the population deprived of education and financial resources.[29] If financial conditions were the main impediment to the widespread use of repellents, then increased adherence should be proportionate to the measure of donation of repellents, initiated by the Federal Government in 2017 for women registered with the PBF. However, the root of the problem, based on collective protective measures continues to be neglected, and the responsibility for reducing mosquito-borne diseases still rests with the population.

The main limitation of this study is the fact that it evaluated the population of a small city in the Northeast of Brazil, which may not represent the reality of medium and larger Brazilian cities. However, this also represents one of its strengths, as the study showed that even pregnant women of low-income status, with lower levels of schooling, who were dependent on public assistance, who had little interaction with health professionals and limited access to information

| Table 4 — Structure of the independent variables in the composition of the main components in the regression analysis of pregnant women in the municipality of Propriá, Brazil (November 2016 to February 2017).[a] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variable | Weight of each variable for composition of each component[b] | | | | | | |
| | PC 1 | PC 2 | PC 3 | PC 4 | PC 5 | PC 6 | PC 7 |
| Residing in urban area | −0.32 | 0.03 | 0.13 | 0.27 | **0.38** | −0.14 | 0.55 |
| Age | −0.16 | **0.70** | −0.21 | −0.08 | 0.22 | 0.23 | 0.18 |
| Stable union | −0.05 | 0.13 | 0.23 | 0.17 | 0.01 | **0.63** | 0.06 |
| Occupation | **−0.52** | 0.16 | −0.12 | −0.03 | 0.16 | 0.44 | −0.18 |
| Education level | **−0.72** | −0.24 | −0.08 | −0.26 | 0.11 | 0.04 | −0.05 |
| Social assistance (Bolsa Família Programme | 0.32 | **0.75** | 0.00 | 0.17 | −0.05 | −0.11 | −0.02 |
| Drinks alcohol | 0.07 | −0.12 | −0.06 | **0.75** | 0.00 | 0.02 | 0.03 |
| Smoker | 0.08 | 0.19 | −0.01 | **0.74** | 0.10 | 0.02 | −0.12 |
| Contact with people presenting with erythema and fever | 0.11 | −0.05 | −0.03 | 0.03 | **0.68** | 0.19 | −0.03 |
| Health problems | 0.01 | 0.18 | 0.01 | 0.03 | **0.66** | −0.21 | 0.10 |
| Red spots on the body | −0.02 | −0.27 | −0.31 | 0.19 | **0.36** | 0.04 | −0.33 |
| Had seen a baby with microcephaly | −0.02 | −0.24 | −0.16 | −0.16 | 0.07 | **0.59** | 0.29 |
| Received professional health advice | −0.04 | 0.05 | **−0.60** | 0.07 | 0.03 | 0.15 | 0.31 |
| Avoids going out | 0.07 | −0.04 | −0.27 | −0.16 | −0.03 | 0.16 | **0.69** |
| Own washing machine | **−0.86** | −0.09 | −0.02 | 0.05 | −0.14 | 0.07 | 0.07 |
| Own laundry tub | **0.87** | 0.08 | 0.05 | 0.04 | 0.12 | −0.08 | −0.08 |
| Have children | 0.15 | **0.78** | −0.02 | −0.01 | 0.00 | −0.08 | −0.09 |
| Knowledge of the disease | −0.25 | −0.09 | −0.32 | −0.02 | −0.15 | **0.59** | −0.09 |
| Media orientation | −0.09 | −0.01 | **−0.63** | −0.17 | 0.22 | 0.08 | −0.11 |
| Gestation period | −0.04 | 0.13 | **−0.65** | 0.17 | −0.16 | −0.13 | 0.08 |

[a] Bold values indicate the main component in which the variable was inserted.
[b] PC 1 (Economic condition), PC 2 (Social condition), PC 3 (Advice), PC 4 (Deleterious habits), PC 5 (Health condition), PC 6 (Knowledge of Zika virus), PC 7 (Preventive habits).

Table 5 – Adjustment of the multiple logistic regression model for the non-use of repellents among pregnant women served by the public network of the municipality of Propriá, Brazil (November 2016 to February 2017).

| Variables | Parameters | OR | Standard error | P-value |
|---|---|---|---|---|
| Intercept | −0.590 | — | 0.212 | 0.0053 |
| PC 1—Economic condition | 0.919 | 2.506 | 0.221 | 0.0000 |
| PC 2—Social condition | 0.578 | 1.782 | 0.19 6 | 0.0032 |
| PC 3—Guidance | 0.831 | 2.296 | 0.215 | 0.0001 |
| PC 4—Deleterious habits | 0.012 | 1.012 | 0.180 | 0.9467 |
| PC 5—Health condition | 0.395 | 1.484 | 0.204 | 0.0525 |
| PC 6—Knowledge of ZIKV | −0.690 | 0.502 | 0.233 | 0.0031 |
| PC 7—Preventive habits | −0.414 | 0.661 | 0.200 | 0.0386 |

OR, odds ratio; ZIKV, Zika virus.

used repellents as a form of protection against mosquitoes, even at significant expense.

In summary, our study showed that during the Zika epidemic, the majority of pregnant women, even those of low-income status, adopted behavioural change and spent income to purchase repellents. Nevertheless, the products used had an insufficient duration of action and were applied less frequently than is required for daily protection. The relatively high cost of the repellents was the main reason for non-use. Personal care and level of education were the main determinants of repellent use. This study also highlighted the role of nurses as key professionals involved in the assistance and guidance of pregnant women in the public health system of Brazil.

## Author statements

### Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

All authors contributed to the planning, writing and revision of the manuscript. All authors read and approved the final manuscript.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2019.04.002.

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