

Community participation in mosquito control: a community based, multidisciplinary mixed methods approach in Curacao

Abstract

Background: As the arboviral diseases dengue, chikungunya and Zika emerge in the Americas, so does the need for sustainable vector control policies. To successfully achieve mosquito control, joint efforts of both communities and governments are essential. This study investigates this important but by-and-large neglected topic.

Methods: In June and July 2015, a cross-sectional mixed method study applying a survey questionnaire (n=339), in-depth interviews (n=20) and focus group discussions (FDGs) (n=7) was performed in Curacao. The study was designed based on an integrated theoretical framework of the Health Belief Model and the Theory of Planned Behaviour.

Results: Participants showed a good knowledge of, and a high-level performance of mosquito breeding site control (MBC) practices. Personal protection against mosquitoes was perceived as less valuable than MBC practices and was consequently applied to a lesser extent. The study highlights three possible ways of improving community participation in MBC. First, it highlights the need for ongoing media coverage, based on communities' lived realities. Second, it shows a two-directional influence of governments' policies on communities' actions, which should be addressed in campaigns. Third, the presence of key persons in communities, which could be engaged in mosquito control policies to improve MBC in neighbourhoods, is described.

Conclusion: This study reveals gaps between policy and communities' lived realities. These gaps might be overcome with the proposed interventions, resulting in a higher performance of MBC of the community in Curacao. Media sources can communicate the need of community participation in MBC and practical information about individual MBC. Neighbourhood stakeholders can open the collaborative dialogue about personal beliefs, attitudes and practices in individual MBC. Furthermore, this study shows how interdisciplinary mixed methods research can provide important comprehensive and in-depth insights for mosquito control policies.

Authors:

J. Elsinga & H.T. van der Veen (S2350661)

Supervisors:

J. Elsinga & dr. F.M.G. Van Kann

Department of Medical Microbiology,
University Medical Center Groningen, University of Groningen

Faculty of Spatial Sciences,
University of Groningen

Table of contents

Introduction	2
Study methods.....	5
Study design	5
Study site	5
Quantitative data collection	5
Knowledge.....	6
Attitudes and behaviours towards personal protection and mosquito breeding site control.....	6
Qualitative data collection.....	6
Data analysis	6
Ethic statement	7
Results	8
General characteristics of the study population	8
HBM and ToPB constructs.....	9
HBM and ToPB concepts	9
Intervention strategies	10
Intervention 1: Exposure to media sources on chikungunya and dengue	10
Quantitative analysis information sources and etiology	12
Qualitative analysis etiology	12
Intervention 2: Effects of the governments' MBC actions on the individual BIMBC.....	13
Intervention 3: Promoting community participation via stakeholders.....	14
Barriers towards mosquito breeding site control	15
Qualitative analysis barriers mosquito breeding site control.....	16
Community's attitudes and practices towards MBC.....	16
Community's attitudes and practices towards preventing from being stung by a mosquito	17
Qualitative analysis mosquito breeding site control and personal protection	18
Discussion.....	20
Intervention method 1: media coverage, grounded in local realities (cues to action)	21
Intervention method 2: government's action	21
Intervention method 3: stakeholders / community initiatives.....	22
Limitations and strengths	23
Conclusion	24
References	25
Supporting information 1: instrument of ToPB and HBM.....	29
Supporting information 2: tables and figures	35
Supporting information 3: Stimulating community participation in practice	49
Intervention method 1: Exposure to media sources on chikungunya and dengue	49
Intervention method 2: Effects of governments' MBC actions on individual MBC.....	50
Intervention method 3: Promoting community participation via stakeholders.....	51
Integrated approach	51

Introduction

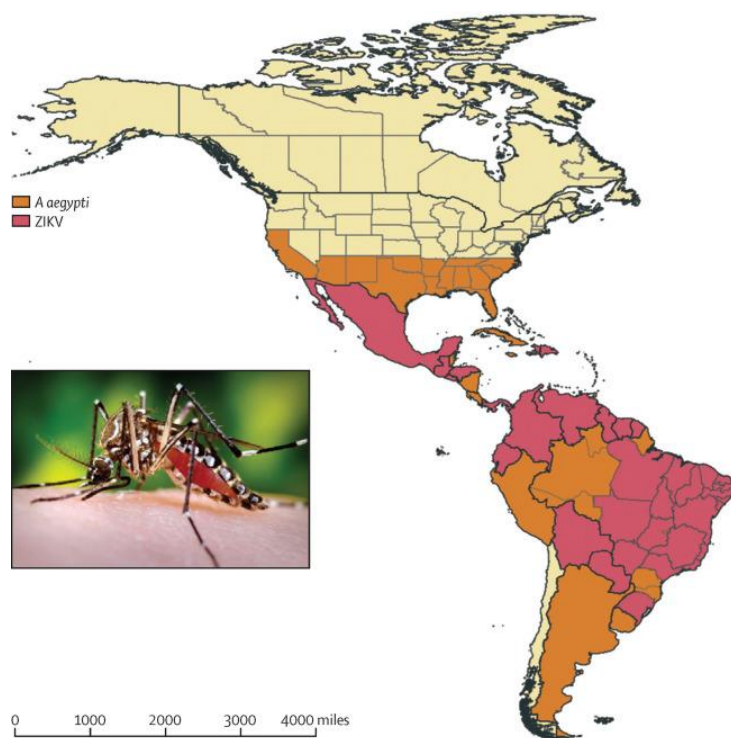


Figure 1: Current distribution of *Aedes aegypti* and suspected distribution of ZIKV (Zika virus) in the Americas (Brazil and USA are shown at state level). Inset: *Aedes aegypti* mosquito shown blood-feeding” (Yakob & Walker, 2016)

Yellow fever, dengue, chikungunya and Zika viruses are diseases with serious impacts on health and quality of life. The Zika virus is ill-famed for its very likely link with microcephaly (De Araújo et al., 2016; ECDC, 2015; Brasil & Nielsen-Saines, 2016; Lover, 2016). Untreated dengue and untreated yellow fever can turn into severe variants of the diseases, and can eventually cause shock or death (WHO, 2016). Chikungunya causes disabling joint pains and long-lasting complaints with major impact on the quality of life (WHO, 2016; PAHO, 2014; Larrieu et al., 2010; Sissoko et al., 2009; Borgherini et al., 2008; Elsinga et al., to be submitted).

These viruses are spread by the mosquito known as *Aedes Aegypti*, that flourishes in large parts of the Americas (Figure 1). This mosquito can cause major outbreaks of these diseases (Roth et al., 2014; Bhatt, 2013), like the Chikungunya epidemic on Curacao in 2014 and 2015 that infected approximately 20% of the population, of which only circa one-third was fully recovered in the summer of 2015 (Elsinga

et al., to be submitted). Since January 2016 the Zika virus is also active on Curacao (Kindhauser et al., 2016). Dengue is endemic for all four serotypes on Curacao (Limper et al, 2016).

Vaccines against dengue, chikungunya and Zika are not available yet, and the vaccine against yellow fever does not completely take away the torment of the disease (Wang et al., 2016). Treatment for the diseases are symptomatic-based. Given the damage that is being caused by the diseases, further research and implementation of vector control is needed, since the disease control is limited to vector control (Rubin, 2016).

Management of the vector is currently relying on either insecticides or the destruction and prevention of larval breeding sites (Yakob & Walker, 2016). However, insecticides provide little hope in efficacy, because of widespread insecticide resistance (Gubler & Clark, 1996; Yakob & Walker, 2016). It even contributes to a false sense of security, which may reduce the effectiveness of measures targeting encouragement of local people to destruct or prevent breeding sites (Bouzid, 2016). On the other hand, destruction and prevention of larval breeding sites is known as a successful method, preferably centralized approaches combined with community-based approaches (Gubler & Clark, 1996).

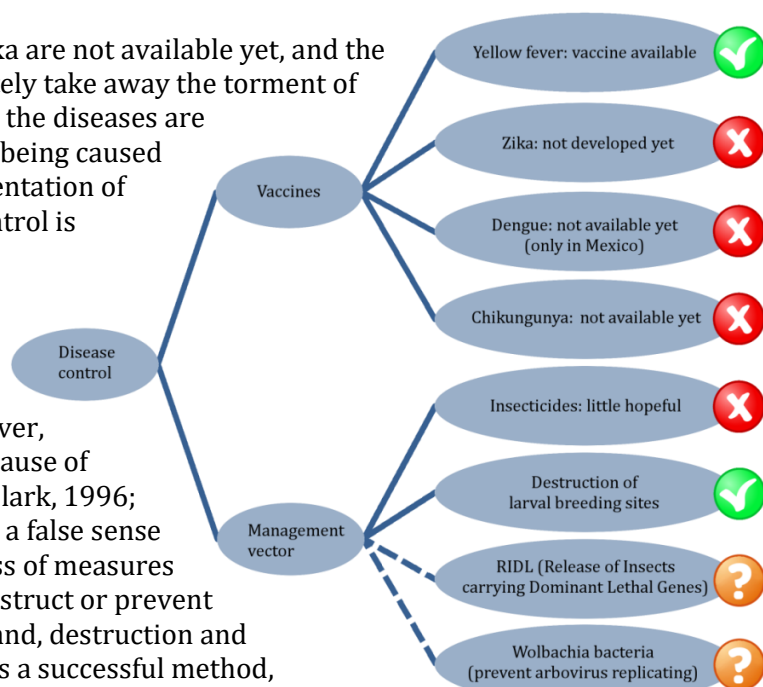


Figure 2: Methods of disease control

Two novel methods of vector control are focussed on genetic manipulation of the *Aedes Aegypti*: RIDL (Release of Insects carrying Dominant Lethal Genes), endosymbiotic bacteria (stops arboviruses within the mosquito from replicating) (Yakob & Walker, 2016). These two methods are not established enough to be fully reviewed yet, so the only option known as successful yet remains destruction of mosquito breeding sites (Figure 2).

Identifying and eliminating standing pools of water on a large scale is impractical, when practised by a government alone (Yakob & Walker, 2016). Reducing the active vectors of the diseases by governments is therefore both expensive and not suitable for a sustainable solution of the problem. However, examples of fighting the mosquito through community participation are successful, in the short term as well as in the long term (Gubler & Clark, 1996; Nam et al., 1998; Sanchez et al., 2009; Atkinson, 2011). Consequently, mutual effort is needed from both centralized instances and the community to achieve effective and sustainable mosquito control (Gubler & Clark, 1996).

In a joint challenge of government and civilians, collaborative planning (Healey, 1997) is an interesting perspective. To get every part of a diverse community moving, diverse ways of communicating, diverse interests and diverse preferences have to be taken into notice. Whereas the goal is inferior to the process in most collaborative planning processes, in this case the goal is non-negotiable: the more community participation in mosquito breeding site control (MBC), the better. Preferably, the whole community performs MBC in their environment. Also the MBC itself is important to be done thoroughly. Since the goal is clearly formulated, the urgency of individual MBC has to be clear and taking away the perceived barriers through communication is essential.

This study aims to explore beliefs, attitudes and behaviour towards MBC and ways of information collecting of the Curacao inhabitants. Besides, it will explore potential interventions to increase the community participation in mosquito population control. The main research question is: how can the community participation in the fight against the *Aedes Aegypti*-borne diseases be stimulated on Curacao?

This study explains the beliefs, attitudes and behaviour of Curacao inhabitants concerning MBC, and the aspects influencing these beliefs, attitudes and behaviour. Furthermore, potential interventions to enhance community participation in MBC on Curacao are proposed. In using two major psychological theories as starting point (Figure 3), this research is comprehensive. The Health Belief Model (Champion & Skinner, 2008) and the Theory of Planned Behaviour (Montaño & Kasprzyk, 2008) shape a solid framework by which the collected data is analysed. Central concepts in the Health Belief Model (HBM) are the 'perceived susceptibility', meaning the perception of the chance of acquiring a condition, and the 'perceived severity' of the condition. Together these concepts lead to the 'perceived threat'. The perceived threat, the perceived benefits and barriers of certain behaviour, the self-efficacy and the cues to action combined lead to the intention. The Theory of Planned Behaviour (ToPH) combines the attitude towards certain behaviour, subjective norms and perceived behavioural control, resulting in certain behavioural intentions and certain behaviour. A study to both theories indicates that a combination of these theories has the most predictable value in behavioural change practises (Gerend & Shepherd, 2012).

This psychological approach makes this study circumnavigate the detachment of theory and practice, established as a problem in the global health research (Abimbola, 2016; Ridde, 2016; Rasanathan & Diaz, 2016). The studies that include research to implementation of knowledge often contain an ethnocentric bias towards the Western hemisphere, making it misleading (Saetren, 2005; Ridde, 2016). The bottom-up approach of this study causes the outcomes of this study to be more ethnocentric objective and highly implementable, also for other mosquito-

borne diseases, like malaria. This study aims to contribute to the global research becoming a “discipline” again, knowing “how to do it”, instead of a “collection of problems”, only knowing “what to do” (Abimbola, 2016; Ridde, 2016).

The bottom-up approach is carried out in the use of multiple methods. Community based surveys have been used to compile a quantitative dataset. Besides, focus group discussions were organised and in-depth interviews took place to aggregate qualitative data. All methods targeted the different concepts of the conceptual model. Altogether, the combination of sociological, psychological and epidemiological approaches makes this study a comprehensive, interdisciplinary mixed-methods study.

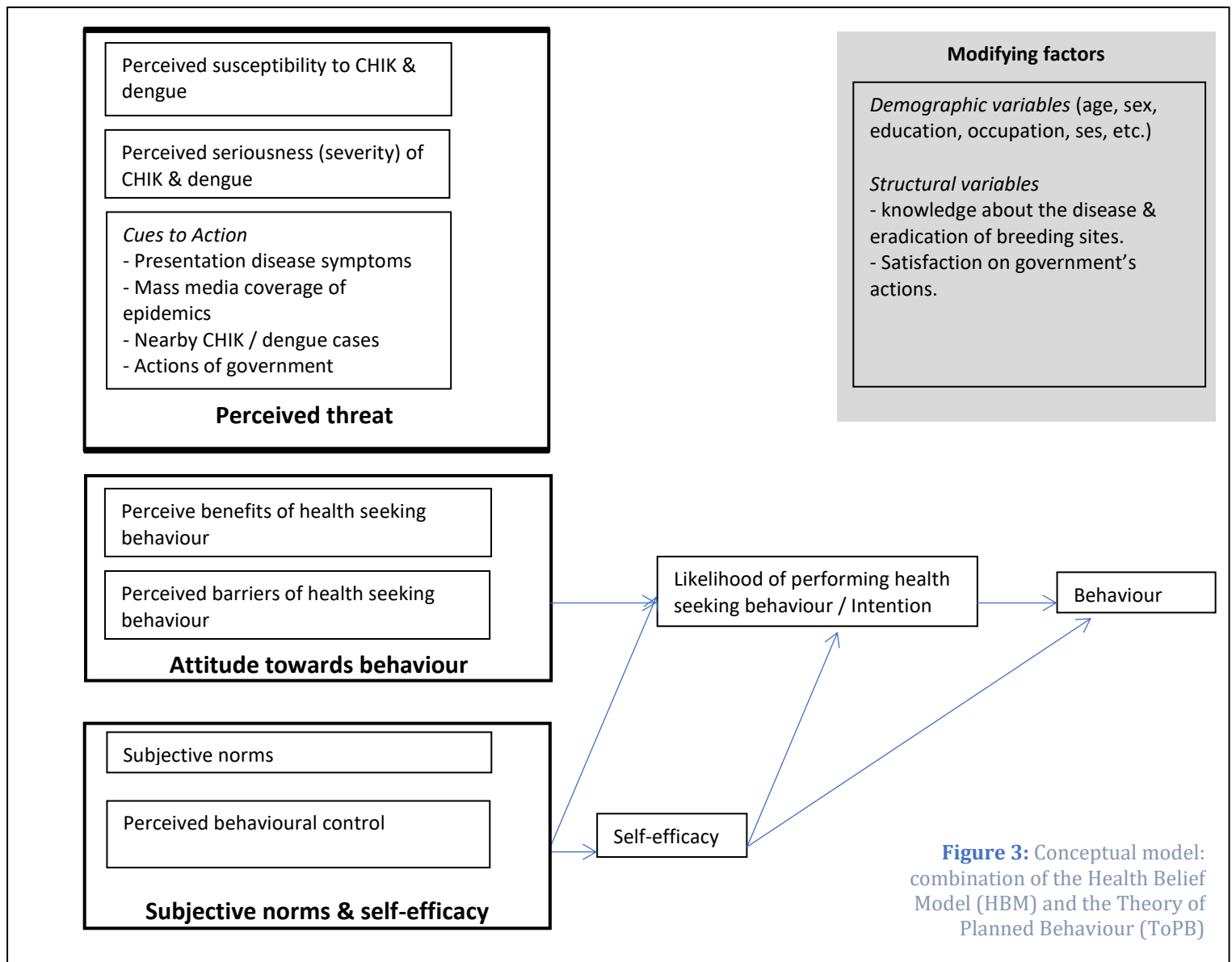


Figure 3: Conceptual model: combination of the Health Belief Model (HBM) and the Theory of Planned Behaviour (ToPB)

Study methods

Study design

In June and July 2015, a community based multidisciplinary mixed method study was set up in Curacao to understand community attitudes and intentions towards MBC and present intervention strategies to policy makers, using the Health Belief Model (HBM) and the theory of planned behaviour (ToPB). Furthermore, we aimed to understand the impact of chronic chikungunya in the same population in another study (Elsinga et al., to be submitted). The recruitment procedure of the quantitative part (the survey) and the in-depth interviews was adapted to the aim of the other study. For the survey, adult subjects with laboratory confirmed or clinically diagnosed chikungunya infection were selected from a representative sample of 20 general practitioners across the country. Eligible individuals were invited via a phone call or a visit at their home. Participants were interviewed at their homes after informed consent. The qualitative methods of the study were in-depth interviews and focused group discussions (FGDs). Participants of the in-depth interviews were adult laboratory confirmed chikungunya patients. Concerning the FGDs, seven representative groups of Curacao based on socio-economic status were selected: 1) residents born in the Netherlands, 2) local youth, 3) interviewers of the survey, 4-7) people from the neighbourhoods Rooi Santu, Seru Fortuna, Souax and Koraalspecht. Participants for the qualitative methods were recruited via snowballing, key-informants and via neighbourhood centres.

Study site

Curacao is a Caribbean island in the southern Caribbean Sea located around 230 km from the Venezuelan coast. Since October 2010, Curacao became an autonomous country within the Kingdom of the Netherlands (CBS, 2016). Curacao has a surface area of 444km² and a population of approximately 150.000 inhabitants (Ter Bals, 2014). There are different ethnic backgrounds, with an Afro-Caribbean majority and minorities such as Dutch, French, Latin American, South- and East-Asian, Portuguese and Levantine people (Limper et al., 2012). Most of the population resides in the capital Willemstad and its surroundings located in the central-south part of the island, the main economic area of the country (Ter Bals, 2014). Curacao has a semiarid climate with a rainy season from September to January and a dry season from February to August. The average precipitation is 601mm per year with an average temperature of 27-29°C throughout the year (CBS Curacao, 2014; Meteorological Department Curacao, 2016).

Quantitative data collection

A questionnaire containing pre-coded questions was designed in Dutch. After a pilot-study, it was adapted and translated into Papiamentu, Spanish and English. Interviewers were recruited via the Central Bureau of Statistics Curacao (CBS). All were local experienced interviewers speaking Papiamentu, Dutch, Spanish and English. Training was provided to the interviewers prior to field mobilization.

The questionnaire addressed the following general characteristics: age, sex, place of residence, education, employment and monthly income. Disease persistency was assessed using the Curacao LTCS-score (Elsinga et al., to be submitted). The concepts of the HBM and ToPB and their modifying variables (satisfaction on governments mosquito control action & etiology of chikungunya and dengue) were measured using multiple 5 point Likert items or binary items which were analysed separately or merged into a Likert-scale after analysis for internal consistency. The behavioural target was defined as follows: 'to check the house and yard for mosquito breeding sites every week and eliminate them if necessary, during the coming rainy season.' From here on in this study, the constructs 'perceived benefits', 'perceived barriers', 'self-efficacy', 'subjective norms', 'perceived behavioural control' and 'attitudes (towards the

behaviour)' refer to the latter targeted behavioural intention. The '(perceived) susceptibility' and the '(perceived) severity' are related to chikungunya and dengue.

Knowledge

Participants indicated from which information sources they sourced their information relating to chikungunya and dengue from among the following media sources: television, radio, newspaper, school/ education, internet sites, campaigns of the government/ GGD (municipal health office), social media. Two 'interpersonal sources' were also assessed: general practitioner and family/ friends/neighbours. Subjects' perception on etiology of chikungunya was tested by asking to indicate all possible etiologies of these diseases among water, coughing/sneezing, bad hygiene, a mosquito bite, the air, sex, (French) kissing, touching a patient, visiting the general practitioner.

Attitudes and behaviours towards personal protection and mosquito breeding site control

To understand communities perceptions and practices on MBC measures and personal protection measures against mosquitoes. The participants rated measures on their perceived effectiveness and usage using a five point Likert item. Actual use of precautions was only assessed if people stated that this precaution was applicable to them (f.e.: only those stating to have flower vases or feeding bowls for pets were taken into account when measuring the actual use of this precaution). All surveyed MBC and personal protection measures were presented in Supporting information 2 Table 9 & 10/ Figure 9 & 10. The precautions 'don't park the car near the house' and 'don't water plants' were defined as nonsense precautions.

Qualitative data collection

Qualitative research consisted of in-depth interviews and FGDs based on the Grounded Theory (Hennink et al., 2011). We aimed to obtain deeper insights on the community perceptions and attitude towards MBC and personal protection against mosquito bites. The HBM and the ToPB were used to develop a conceptual model, which is presented in Supporting information 2 Figure 3. Questions were based on literature where possible (Gerend & Shepherd, 2012; Ajzen, 2006). Interview guides were made based on these theories and adapted after pilot interviews. The FGDs consisted of 4-10 individuals with the same socio-economic backgrounds. The FGDs were applied in Dutch or Papiamentu, depending on participant(s) preferences. The first author (JE) and two professional local social workers were present at the FGDs. JE and one social worker performed the in-depths interviews together. Interviews were recorded, translated, transcribed and analysed with Atlas.ti using codes and code families.

Data analysis

SPSS Data Entry Station (SPSS Inc. 1996-2003, version 4.0.0) was used for quantitative data entry. Data was checked for consistency and analysed anonymously. Participants were divided in geozones (Ter Bals, 2014) (neighbourhoods) based on their addresses, which were analysed using ArcGIS (ArcGIS Desktop: Release 10.3. Redlands, CA: Environmental Systems Research Institute). Associations between categorical variables were analysed using Chi-square test or Fisher's exact test when appropriate. Continues data was compared using a Mann Whitney U test or a Student's T-test. If suited, continues data was converted into categorical data. The concepts of the HBM and ToPB were tested for their internal consistency. If the Cronbach's Alpha was >0.60, the items were summed resulting in a Likert scale representing the measure for the corresponding concept of the HBM/ToPB. This cut-off point (instead of the commonly used cut-off point of 0.70) was used because individual items were mainly based on existing literature and we were confident that the items were representative for different aspects of the measured concept, however some extend of internal consistency was desirable. If Cronbach's Alpha <0.60, items were analysed separately, or only the most representative item to measure the concept

was used. The questions per scale and their Cronbach's Alpha were presented in Supporting information 1 and Supporting information 2 Table 3. The behavioural intention to perform mosquito breeding site control (BIMBC) was measured using a Likert scale, which was categorized in a binary variable: the optimal score (15=highest intention) vs. the rest (≤ 14 =improvable intention). All concepts of the HBP and ToPB and the modifying variables were Z-transformed and correlations were performed using Spearman's rho. A binary logistic regression was performed to identify which concepts of the HBM and ToPB were independently associated with the BIMBC. The latter statistical tests (Spearman's rho and binary logistic regression) were used to draw a directed acyclic graph (DAG). The aim of the DAG was to visualize the relations between the intervention method (media coverage) and its way of influencing the BIMBC of an individual. Causality was, where possible, based on literature (mainly on the HBM and ToPB). Significance was determined at 5% level. Data was analysed using SPSS (SPSS Inc., version 22.0, Chicago, Illinois).

Qualitative data was analysed using Atlas.ti (Atlas.ti GmbH, Berlin parts copyright by Cincom Systems, Inc: version 7.5.4), following the principles of the Grounded Theory: coding, grouping and categorizing (Glaser & Strauss, 1968). Data was examined using codes, which refer to an issue, topic, idea or opinion evident in the data (Paek et al., 2008). The code families used in the analysis of the FGDs represented perceptions towards: actions of the government in mosquito control, personal protection against mosquitoes, etiology of chikungunya, information sources on chikungunya/dengue, community initiatives in mosquito control, barriers of MBC, value of MBC, and waste management.

Ethic statement

This study was approved by the Ethics Review Committee of Curacao. All participants signed written informed consent forms.

Results

General characteristics of the study population

A total of 411 individuals were invited in June and July 2015 to join this study, of which 339 participated (response rate: 82.5%). Supporting information 2 Table 1 presents the reasons for non-contacting and non-response. The score of the behavioural intention to perform mosquito breeding site control (BIMBC-score) ranged from 3 (lowest intention) – 15 (highest intention) (median: 15; Q1-Q3: 12 – 15). Of the participants, 63.0% (n=208) scored the highest possible BIMBC-score. Table 1 presents the socio economic characteristics of the study population, stratified by their BIMBC-score (<15 vs. 15). The characteristics of the participants of the in-depth interviews and FGDs are presented in Supporting information 2 Table 2. The participants of the survey had a median age of 51 years (Q1-Q3: 41-63), ranging from 18-94 years. Females

Table 1: Socio economic characteristics of the study population, stratified by behavioural intention score to perform mosquito control (BIMBC-score)

	Total (n=339)	BIMBC-score < 15 (n=122)	BIMBC-score =15 (max.) (n=208)	p-value ^a
Age				
18-40 years	75 (22.1)	32 (26.2)	43 (20.7)	
41-60 years	172 (50.7)	54 (44.3)	111 (53.4)	
>60 years	92 (27.1)	36 (29.5)	54 (26.0)	0.263
Sex				
Females	247 (72.9)	87 (71.3)	154 (74.0)	
Males	92 (27.1)	35 (28.7)	54 (26.0)	0.590
Education				
Illiterate/primary school	80 (23.6)	25 (20.5)	49 (23.6)	
Secondary school	128 (37.8)	52 (42.6)	75 (36.1)	
Intermediate vocational school	84 (24.8)	30 (24.6)	53 (25.5)	
University (of applied sciences)	47 (13.9)	15 (12.3)	31 (14.9)	0.663
Occupation^b				
Unemployed/student/housewife/voluntary	63 (18.6)	17 (14.0)	44 (21.2)	
Paid job (domestic or manual)	144 (42.6)	53 (43.8)	87 (41.8)	
Paid job (not domestic or manual)	67 (19.8)	25 (20.7)	40 (19.2)	
Retired	64 (18.9)	26 (21.5)	37 (17.8)	0.427
Income^c				
0-999 ANG ^{d,e}	35 (10.5)	15 (12.8)	20 (9.7)	
1000-2499 ANG	136 (41.0)	50 (42.7)	82 (39.6)	
2500-4999 ANG	118 (35.5)	36 (30.8)	78 (37.7)	
>5000 ANG	43 (13.0)	16 (13.7)	27 (13.0)	0.592
Disease status chikungunya				
Recovered	126 (37.2)	44 (36.1)	81 (38.9)	
Mildly affected	121 (35.7)	48 (39.3)	71 (34.1)	
Highly affected	92 (27.1)	30 (24.6)	56 (26.9)	0.635

Legend Table 1: ^a p-value corresponds to the comparison of the proportions between the groups BIMBC < 15 and BIMBC = 15 (maximum score); ^b Total is 338, total <15 group is 121; ^c Total is 332, total <15 group is 117, total 15 group is 207; ^d Antillean Guilder; 1 ANG = 0.56 USD; ^e Minimum wages 2015= 1420 ANG (based on a 40 hours workweek).

represented 72.9% (n=247) of the study population and 38.7% (n=131) had vocational or university education (Table 1). Almost a half earned more than 2500 ANG (Antillean Guilder; 1 ANG = 0.56 USD) and the majority had a paid occupation. At the time of interview, 62.8% of the participants stated still being affected by chikungunya (n=213), either mildly (n=121; 35.7%) or highly (n=92; 27.1%) affected (Elsinga et al., to be submitted). Of all 65 geozones (neighbourhoods) of Curacao, forty-seven (72.3%) were represented in this study. Figure 4 presents the proportion of participants per 1,000 inhabitants for every geozone of Curacao.

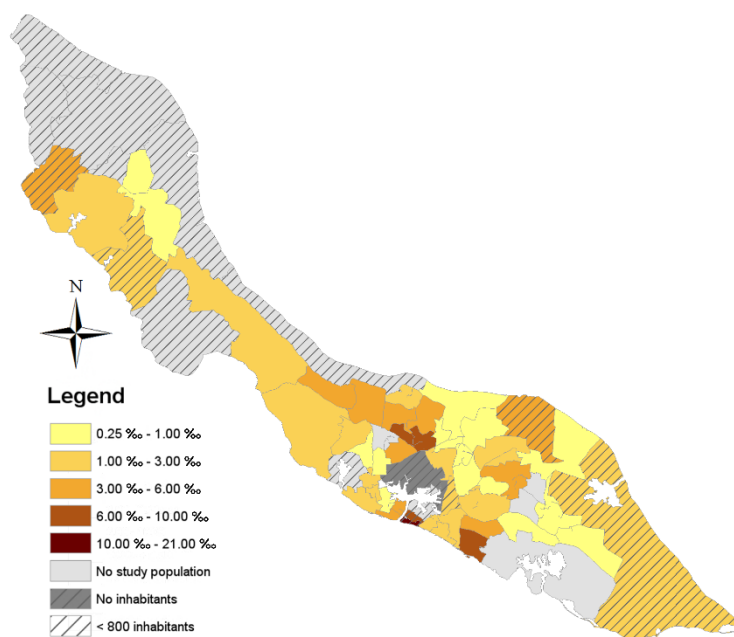


Figure 4: Distribution of the study population among geozones of Curacao, cases per 1,000 inhabitant

HBM and ToPB constructs

The perceived susceptibility to chikungunya and dengue was moderately low (IQR: 13-15-19; range of score: 7 – 35), while the perceived severity of chikungunya and dengue showed moderately high scores (IQR: 35-40-45; range of score: 10 – 50). The scores of the other constructs of the HBM and ToPB were assessed as moderately high or high. Supporting information 2 Tables 3 & 4 show the scores of the constructs of the HBM and ToPB and their Cronbach’s Alpha value.

HBM and ToPB concepts

An univariate analysis on the general characteristics (age, sex, education, occupation, income, disease status CHIK) was performed between those with a BIMBC-score < 15 (improvable intention) vs. those with a BIMBC-score of 15 (maximum intention) (Table 1). The concepts of the HBM and the ToPB were tested with the BIMBC-score using a Mann Whitney U test (Supporting information 2 Table 3). Consequently, a binary logistic regression was performed including the variables associated at a significance level of $p \leq 0.020$. Variables were back-wise eliminated until only significant variables were left. The final model is presented in Table 2.

	OR (95% CI)	p-value
Barrier: ‘Don’t know how to control breeding sites’	0.77 (0.59 – 0.99)	0.041
Barrier: ‘Government doesn’t control other breeding sites’	0.67 (0.51 – 0.89)	0.005
Attitude towards behaviour	2.14 (1.56 – 2.93)	0.001
Self-efficacy	1.54 (1.17 – 2.04)	0.002
Satisfaction on governmental MBC	0.71 (0.54 – 0.93)	0.012
Believing that dengue is transmitted by a mosquito		
No	1	
Yes	2.93 (1.22 – 7.05)	0.016

*Legend Table 2: *using the normalized value (z-value), OR (95% CI) = 1.38 (1.06 – 1.79); p-value = 0.016*

The attitude towards the behaviour, self-efficacy and the belief that a mosquito transmits dengue were positively related with a maximum BIMBC (score=15). On the other hand, satisfaction on governmental breeding site control, and two barriers ('Don't know how to control breeding sites' and 'government doesn't control other breeding sites') had an independent negative relation with the BIMBC.

Intervention strategies

Based on the presented model (Table 2), the in-depth interviews and the FGDs, we identified and analysed three possible intervention methods to improve the BIMBC:

- 1) Role of media coverage when promoting BIMBC.
- 2) Role of government's actions in promoting BIMBC.
- 3) Role of community stakeholders /neighbourhood centres in engaging the community in MBC.

Intervention 1: Exposure to media sources on chikungunya and dengue

The information sources for chikungunya and dengue are presented in Figure 5 and Supporting information 2 Table 6. The most common information sources were television, radio and the newspaper. The media sources were summed per individual, which resulted in the amount of media sources for chikungunya and dengue for each individual. The media sources ranged from 0 – 13 sources, with a mean of 5.11 and a SD of 3.01 (IQR: 3 – 5 (median) – 8). Separately from the media sources, we also assessed the interpersonal information sources (Figure 5).

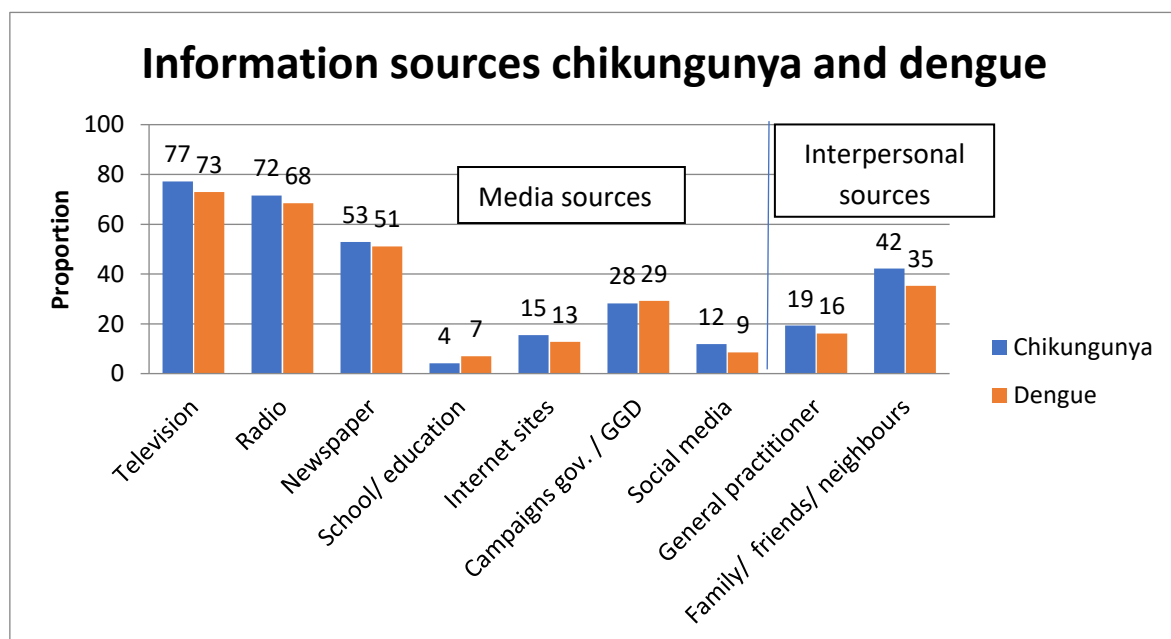


Figure 5: Information sources of chikungunya and dengue

A DAG (directed acyclic graph) pathway was identified, based on the role of media coverage when promoting BIMBC. Only the variables directly associated with the possible intervention method (media coverage) (Supporting information 2 Table 5) were included in the DAG. The latter variables were intercorrelated using a Spearman's rho.

As shown in the DAG (Figure 6), the pathways having their origin in '# media sources', promote the BIMBC through several ways:

1. Via a positive relation of '# media sources' with 'believing that a mosquito transmits dengue'. This pathway might be enhanced by its positive relation with 'believing that a mosquito transmits CHIK'.

2. Via a positive relation of '# media sources' with self-efficacy. This pathway is enhanced by the positive relation of 'believing that a mosquito transmits dengue'.
3. Via a direct negative relation of '# media sources' with the perceived barriers for MBC. These barriers are either independently and/or indirect (via their negative relation with self-efficacy) negatively associated with the BIMBC.

Apart from these enhancing effects on the BIMBC, the amount of media sources also showed uncertain or negative effects:

- Negative effect: Media sources promoted satisfaction on governmental actions on mosquito control, which in turn lowered individuals' BIMBC.
- Both positive and negative effect: Media sources were positively associated with interpersonal sources, which in turn demonstrated both positive and negative associations with the barriers to perform MBC.

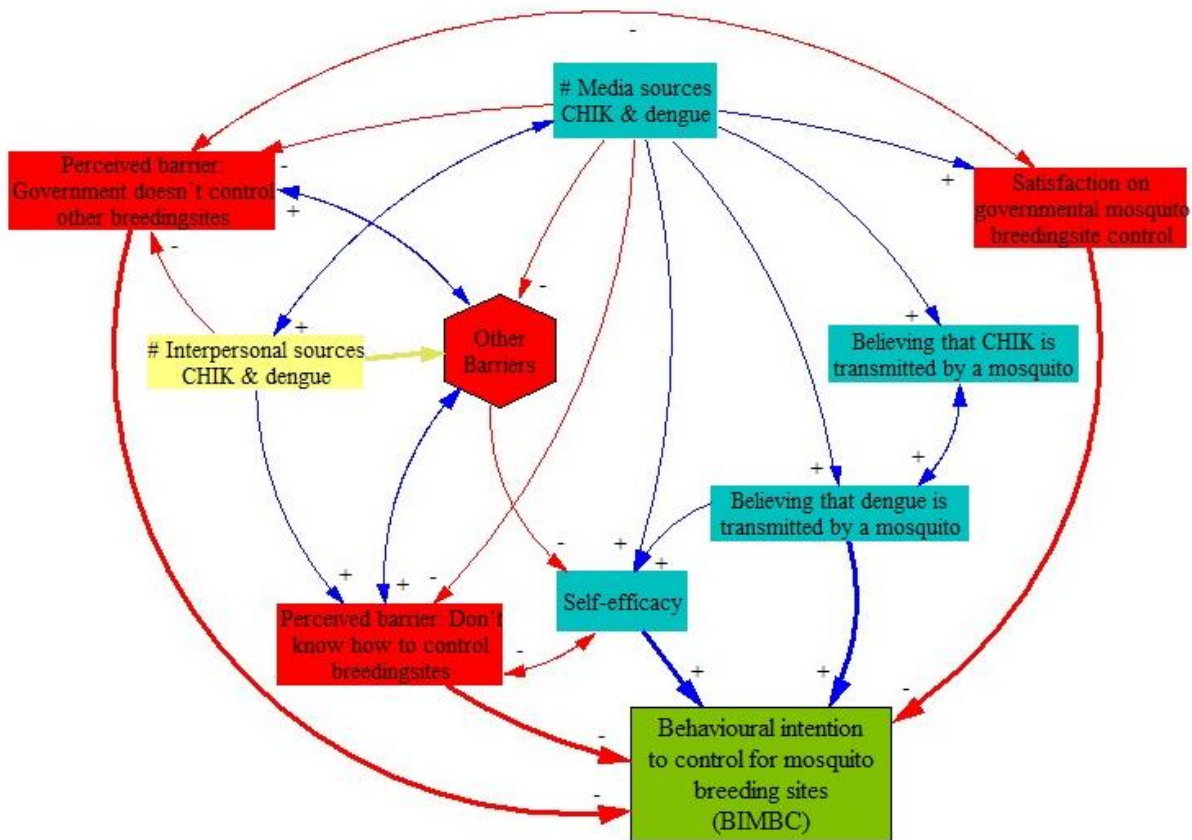


Figure 6: DAG showing the effect of media sources on the individual's BIMBC

Legend figure 6: Only the variables directly associated with '# media sources CHIK (chikungunya) and dengue' were included in the DAG. Causalities were based on the principles of the HBM and the ToPB. The variables in blue boxes have a positive effect on the individual's BIMBC, while the variables in red boxes have a negative effect on the individual's BIMBC. The bold arrows represent independently associated correlations. Red arrows represent a negative association, blue arrows represent a positive association. Yellow variables and arrows indicate a mixed (both positive and negative) association. If causality was not defined, two directional arrows were added indicating that causality could be in both directions. Other barriers represent all other assessed barriers, an association with one of these barriers was indicated with an arrow.

Additional understanding in the community's perceptions on etiology of chikungunya and dengue was obtained via quantitative and qualitative research methods.

Quantitative analysis information sources and etiology

The quantitative analysis showed that most people believed that chikungunya was transmitted by a mosquito (chikungunya: 81.3% & dengue: 90.1%) (Figure 7, Supporting information 2 Table 7). However, only 49.9% and 54.4% of the participants (referring to chikungunya and dengue respectively) believed that this was the only way of transmitting the diseases. The remaining participants believed that next to a mosquito, also other etiology's existed for chikungunya and dengue, of which 'the air' (33.8% & 20.4%), 'bad hygiene' (19.3% & 24.6%) and 'water' (11.0% & 16.2%) were among the most commonly mentioned etiologies of chikungunya and dengue (Figure 7, Supporting information 2 Table 7).

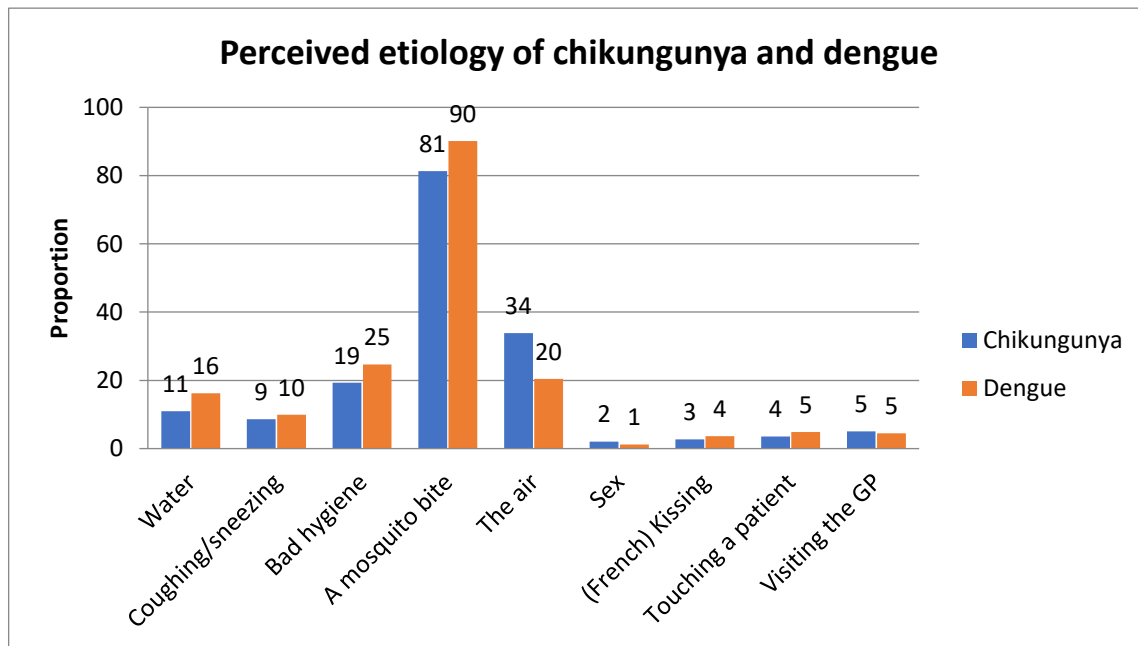


Figure 7: Perceived etiology of chikungunya and dengue

Qualitative analysis etiology

Different opinions about the etiology were expressed in the group discussions. Among the ideas about the etiology of chikungunya, the correct etiology of chikungunya was mentioned:

Women: '...eh, the mosquito did he... didn't he eh.. Stung animals and got infected by that?.. by a virus? ...' (...) *Man: 'Well, compare it with malaria I think. Or knokkel.. (Abbreviated local name for dengue), dengue ehm.'* *Woman: 'Infected people are stung (by a mosquito)'* (...)

Man: 'yes, yes, oke, that is how it proceeds.'

Participants were aware that a mosquito or a virus was among one of the possible etiologies. However, doubts about this theory were expressed, based on personal observations:

Man: 'because always always always we have mosquitoes here. In the last two years we have chikungunya. That surprises the population. Because always, always we have had mosquitoes here.'

People expressed their confusion and tried to understand the etiology of chikungunya by seeking possible explanations for their observations. This resulted in different perceptions on etiology besides the correct etiology (Table 3).

Table 3: Perceptions of the community on etiology of chikungunya	
The air / contagious	- Man: '(...) I think, well.. many people have got it. I don't think that mosquitoes sting so many people. I think that that thing in the air itself so, and that I think.' - Woman: 'It is like when we catch a cold. The air transfers it to other people. (...) someone gets it and the other who lives with him (or her) also gets it (...)'
Hygiene	Woman: 'It are not the mosquitoes. It is our own hygiene. We are the caregivers of ourselves.'
It goes around	Woman: 'I once thought, it is like something that goes around. I feel it in my hand and my knee today and my neighbor a bit further away felt it also in his hand an knee. This is how it goes around. I got dengue and it is not comparable.'
A virus (no mosquito)	- Man: '(...) If it is a thing... let me say we had already mosquitoes and they fly, every day, every moment. A virus is it, it is a snapshot, do you get it? A virus comes and then it goes. But a virus stays in the air an you never know when it will attack you. (...)' - Woman: 'he (chikungunya) gets us in the leg first. It's a virus. (...) Woman (expressing her doubts): 'but that a mosquito can sting everyone in the leg...'
Water	Woman: '(...) Just we had the impression that even the water what we drink, or to wash, can't that bring the virus more easily to people?'

Intervention 2: Effects of the governments' MBC actions on the individual BIMBC

Two independently associated determinants of the BIMBC concerned perceptions on governmental actions in mosquito control. Dissatisfaction demonstrated both negative and positive effects on the BIMBC. The satisfaction on governments' action was moderately low (Q1=1; median=3; Q3=4), and demonstrated an independently negative association with the BIMBC. The lack of governments' action in MBC was perceived as a barrier (Q1=2; median=4; Q3=5), mainly for those with a lower BIMBC (Figure 8). The two latter variables were negatively associated, suggesting that the two effects don't occur in the same individuals but are two independent, different effects.

Qualitative analysis of governments' actions

All FGDs addressed the topic 'waste problem' when asking about MBC. This indicates that the perceived waste problem of Curacao was linked to presence of mosquito breeding sites by the community. In the FGD's, discontentedness on the governmental MBC was expressed. The participants expressed discontentedness regarding governments' role in spraying of insecticides, their role in managing waste in Curacao and the low visibility of the actions they perform against mosquito breeding sites.

Although spraying of insecticides was observed and appreciated by the participants, dissatisfaction existed on how this spraying was performed. This concerned the quantity and the precision of the spraying.

Man: I think that they only have one little trailer with a spray system on Curacao, that drives around the whole island. (Women: Yes! With 90 kilometers an hour, I have seen them.) Man: Buy five extra. Hè? Those things doesn't cost anything. No, it didn't pass my place. (Women: Well it passed ours.) But it does work. It smells.

Initiatives of the people in the neighbourhoods Souax and Seru Fortuna reflected how their discontentedness on the government actions lead to community actions in mosquito control, guided by (informal) community leaders. One of the participants told the following:

Man: I don't agree with how he (the minister) talks because he places al the responsibility (to clean their neighbourhoods from waste) on the common people, and sidelines the government completely. (...) Ask for assistance of the neighbourhoods and there are many neighbourhoods willing to organize, there are many people who are willing to seriously put effort in this. And we are willing to help. (...) The last time we have fixed the problem ourselves. With a truck and barn etcetera. Without their (the governments') decision we removed the waste, for nothing. But the government doesn't need to think that this is going to be done all the time via us.

In another group, it was believed that more communication and exposure of governments actions against mosquito breeding sites could motivate them to also perform MBC.

Man: another important part is that I also think that the government show keep telling what they do, because maybe there are dammen (natural places where water accumulates) where they put liquids to kill mosquitoes, but you (the common people) don't know. Maybe, if we got to know these things, maybe we also act ourselves.

Although there were explanations of how discontentedness on governments actions in MBC coincided with community initiatives to control mosquito breeding sites, there was a strong call for more action from the governments' side. Out of the FGD's, a topic list was made on the actions that participants wanted the government to do (Table 4).

Table 4: Actions that people want the government to do in mosquito control
More spraying of insecticides
Continuing repetitive media attention
Inform the community on the actions the government does on mosquito control
Active tracing and managing of possible mosquito breeding site places in the neighbourhoods
Clean the garbage dumps in the neighbourhoods
Improve infrastructure
Educate children on schools on mosquito breeding site management
A 'milieu-police', which can be called if illegal waste dump is observed
More attention to prevention: 'act proactive, not reactive'.

Legend table 4: The order of the mentioned topics do not represent importance or frequency.

Intervention 3: Promoting community participation via stakeholders

The participants of the FGDs and in-depth interviews demonstrated willingness to help or cooperate in MBC, or, maybe even perceived as more important: to clean their neighbourhoods. Different initiatives were described where communities were mobilized to clean the neighbourhood. Guided by community stakeholders (which could be individuals or neighbourhood centres), community mobilization was achieved in Souax (described earlier),

Rooi Santu, Seru Fortuna and in Piscadera. In Seru Fortuna, a day was organized to clean the neighbourhood. One of the participants stated that this caused more awareness and willingness to clean houses and garden in the neighbourhood:

Man: We did it. And it was in the news, 'Oh the people of Seru Fortuna have themselves, eh yes, hand in action and they cleaned their part', and then the others in their street also did it (cleaned their properties). Ooh it is like that, positive, it reaches others: 'I am also going to clean my part (property)'. This time I am late (referring to the cleaning of his own property).

The participant expressed that more initiatives to clean Seru Fortuna were planned, also targeting the involvement of youth and kids. These days would be made as attractive as possible to involve more people by providing food, drinks and a pleasant experience.

Another initiative to involve local youth in the cleaning from a street was initiated by an individual. He narrated how he was cleaning one street where a lot of waste is dumped:

Man: It is 'street keep Curacao clean'. I am cleaning a street where is now a lot of garbage. (...) And these (street)signs I am going to hang up.

A school was invited to draw the (street)signs of the street in different languages: 'keep Curacao clean'. In this way, local youth were involved and made aware of the negative consequences of poor waste management.

The initiatives described above were initiatives from communities or individuals, independent from coordination of the government.

Barriers towards mosquito breeding site control

The scores of the perceived barriers towards MBC (1:no barrier at all – 5:fully agree *that the issue is a barrier*) for the community are presented in Figure 8 and Supporting information 2 Table 8. The assessed barriers were in general not perceived as major issues (Figure 8), except for the barrier: 'Government doesn't control other breeding sites' (Q1: 2 – median: 4 – Q3: 5).

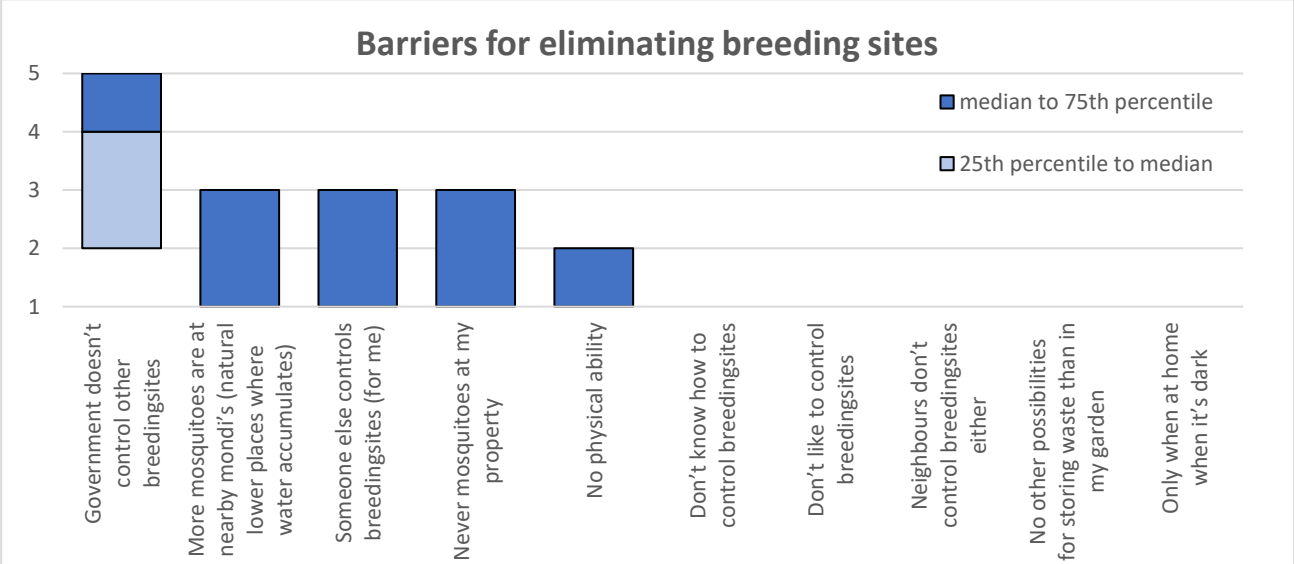


Figure 8: Perceived barriers in eliminating larval breeding sites

Legend Figure 8: The blue bar represents the score to what extent the variable is perceived as a barrier for eliminating breeding sites, in which 1 means "Not agree at all" and 5 means "Fully agree". The bottom edge shows the 25th percentile, the top edge shows the 75th percentile and separation of light and dark (blue or orange) shows the median. When the lighter part is not visible, the median and the 75th percentile coincide in the same value. When darker part is not visible, the median and the 75th percentile coincide in the same value.

Two of the barriers were independently negatively associated with the BIMBC, namely 'Don't know how to control breeding sites' and 'Government doesn't control other breeding sites' (Table 2). The remaining 'other barriers' (consisting of all barriers which were not independently associated with the BIMBC) were negatively associated with the variables that directly enhanced the BIMBC. In Supporting information 2 Figure 4, the individual associations of the other barriers with the independently associated variables of the BIMBC are visualised.

Qualitative analysis barriers mosquito breeding site control

In addition to the survey's barriers, people expressed to be afraid of being stung by a mosquito when approaching the breeding sites.

In the FGD's the discussion on MBC went beyond personal level to community level. As stated before, the participants related the mosquito breeding site problems to the waste problem they perceived on Curacao. As was also reflected in the section above, the lack of governments' actions on MBC and management of waste in public spaces (mondi's: bosses & dammen: natural lower places where water accumulates) was perceived as an important limitation in MBC in Curacao. Another issue in MBC were neighbours who didn't clean their properties. In this way, mosquitoes would be present anyway, even if there were no breeding sites at an individuals' property. Some participants stated that they discussed this with their neighbours, but this didn't always lead to better cleaning. Others mentioned not to dare discussing this issue with their neighbours.

Some participants who had their gardens cleaned and maintained gardens clan by regular workers or 'drug addicts' perceived that the people who offer these services dumped the waste in nature or public spaces, instead of bringing them to the official waste dump.

Woman 2: And there is now also another phenomenon, you (the hired cleaner) go ehm.. clean a house, garden etcetera but you don't go to the landfill (official waste dump).. (...)

Woman 1: I experienced it (...) she (the worker) threw the waste at the dam (natural lower place where water accumulates). I have to pass by that (place) every day..

Woman 2: You discover: Hey, those are mine!

Woman 1: .. I say I say that is mine! I said well this... there are two possibilities: you come to clean this and come (to work) again next month, or you don't clean it and you don't come (to work) anymore. So then I paid someone (else) 50 guilders to clean that (the garbage) and bring it away.

Moreover, participants pointed to the 'mentality' of common people from Curacao and expressed that managing waste is just not part of the system of Curacao. A habit that leads to more potential mosquito breeding sites.

Community's attitudes and practices towards MBC

Different possible precautions preventing mosquitoes from breeding and preventing people from being stung by mosquitoes were assessed on effectiveness and actual use. The answers were ordered by actual use and presented in Figure 9 & 10, Supporting information 2 Table 9 & 10. Concerning the MBC measures, people valued those precautions preventing stagnant water as most effective. The majority stated to exercise these precautions 'often' (score=4) or 'always' (score=5). Those who possessed car tires indicated to remove care tires irregularly (median: 2 'sometimes'), while in general this was perceived as a very effective precaution. Spraying insecticides, scrubbing away mosquito eggs and adding Abate to water containers were perceived as effective precautions, but to a lesser extent. Consequently, they were also performed to a lesser extent. The two nonsense precautions ('don't park the car near the house' and 'don't water plants') were recognized as nonsense by the community, which was reflected in the low scores (Figure 9 on page 17, Supporting information 2 Table 9).

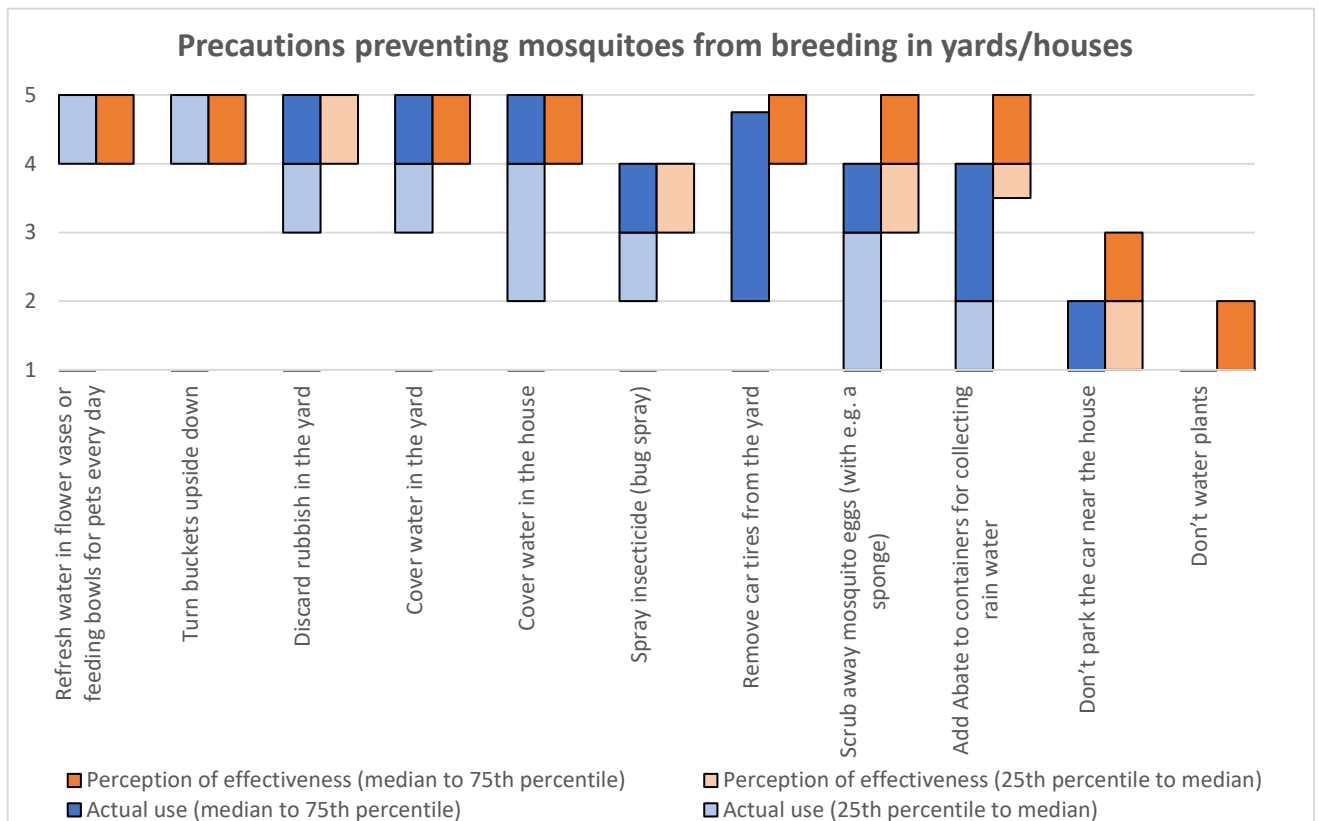


Figure 9: Precautions taken by the community preventing mosquitoes from breeding in yards/houses (perceptions of effectiveness and actual use)

Legend Figure 9: The blue bar represents the actual use of the precaution (1=never; 2=sometimes; 3=regularly; 4=often; 5=always), whereas the orange bar represents the perceived probability that the precaution prevents mosquitoes from breeding (1=not at all; 2=does not; 3=maybe; 4=does; 5=definitely). The bottom edge shows the 25th percentile, the top edge shows the 75th percentile and separation of light and dark (blue or orange) shows the median. When the lighter part is not visible, the median and the 75th percentile coincide in the same value. When darker part is not visible, the median and the 75th percentile coincide in the same value.

Community's attitudes and practices towards preventing from being stung by a mosquito

In general, people perceived the precautions to prevent themselves from being stung as less efficient than the precautions to prevent mosquitoes from breeding (Figure 9 & 10, Supporting information 2 Table 9 & 10). The precautions prevent the mosquito from stinging were ordered based on the actual use, and presented in Figure 10. The majority of the participants reported to prevent themselves from being stung at least 'regularly' (score \geq 3) by eliminating mosquito breeding sites, using a fan, eating healthy, spraying with insecticides and by using insecticides in house and garden (Supporting information 2 Table 10). The perception of effectiveness of the precautions to prevent oneself from being stung showed no major variances between the different precautions. The 25th - 75th percentile of the effectiveness of all precautions scored between 'does not' (score=2) and 'does' (score=4). The only exceptions of this were 'don't water plants', which was considered as nonsense precaution, and 'Eliminate mosquito breeding sites in the house and yard' (Figure 10 on page 18).

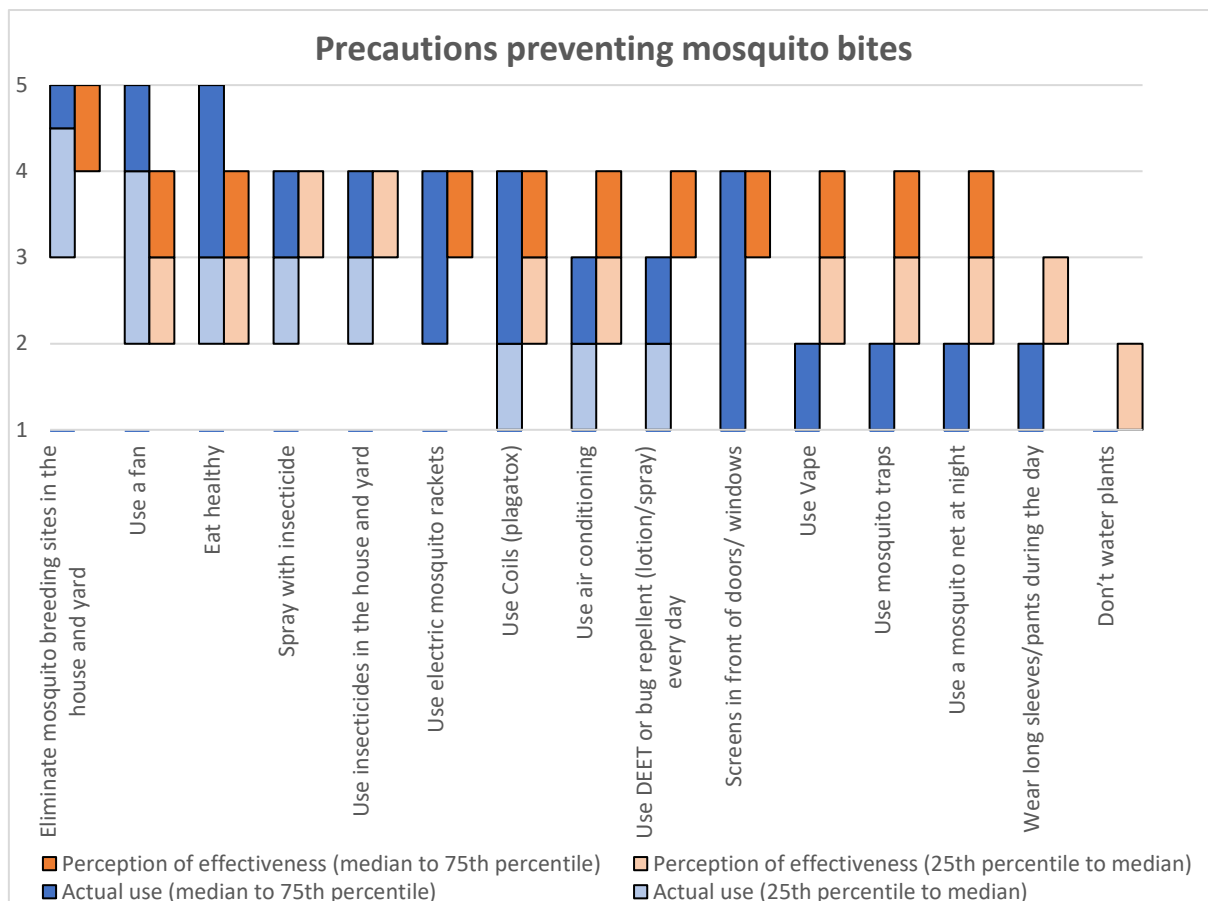


Figure 10: Precautions taken by the community preventing themselves from being stung by mosquitoes (perceptions of effectiveness and actual use)

Legend Figure 10: The blue bar represents the actual use of the precaution (1=never; 2=sometimes; 3=regularly; 4=often; 5=always), whereas the orange bar represents the perceived probability that the precaution prevents the mosquitoes from biting them (1=not at all; 2=does not; 3=maybe; 4=does; 5=definitely). The bottom edge shows the 25th percentile, the top edge shows the 75th percentile and separation of light and dark (blue or orange) shows the median. When the lighter part is not visible, the median and the 75th percentile coincide in the same value. When darker part is not visible, the median and the 75th percentile coincide in the same value.

Qualitative analysis mosquito breeding site control and personal protection

The participants of the FGD’s demonstrated good knowledge on mosquito breeding sites. The general opinion was that mosquitoes breed everywhere where stagnant water is. However, other perceptions of mosquito breeding places existed, including ‘at green (natural) places’, or ‘in the slurry pit’ and ‘in garbage’.

Regarding mosquito repellent participants expressed different opinions. Some mentioned to use it always. Others stated to have stopped using repellents, because of the effort it took to buy and use it, while the repellent only protected them for a relatively short time or not have worked at all. Repellent was also used after being stung to prevent oneself from further threats:

Man: (...) If I get stung then I put a little bit (repellent) on it and then I dip on it and after a little while it shows its effect. It does itch I think that it works against the venom at that moment, and after it (the itch) goes away.

Participants expressed disadvantages considering wearing long clothes: the mosquitoes stung through the clothes and it was too warm to wear long clothes.

Not all participants believed that a mosquito transmits chikungunya, and consequently didn't protect themselves against mosquito bites. Some stated that eating healthy for a good immune system would help them against chikungunya. Vitamin C and natural herbs were believed to contribute in this:

Man: Well me myself, I don't really protect myself. I don't do it to be honest. I don't care about what other people say. Like the girl says to buy a spray or paracetamol before it (chikungunya) comes... (laughing) All medication, lemon water... I am used to, like the elderly say, just eat a lot of fruit for example..

Other strategies mentioned to prevent from mosquito bites were: candles, making a fire, closing doors and windows at the times when mosquitoes come.

Discussion

This study used a multidisciplinary mixed methods approach, to understand perceptions and attitudes of the community towards mosquito breeding site control (MBC). Furthermore, it provided possible intervention methods and a theoretical basis for these intervention methods to improve community participation in MBC, based on constructs of the ToPB and the HBM.

Individuals recognized water source management as an effective way to reduce mosquito breeding sites, and stated to perform them often. This reflects a good knowledge on -, and a high reported performance of MBC, or more specifically: water source management. Notable was the discrepancy between the high perceived effectivity of removing car tires from the yards when reducing mosquito breeding sites, and the relatively low reported performance of this preventive behaviour. Car tires provide conditions where mosquito breeding sites flourish, while being difficult to clear from water (Marina et al., 2012). It has been recognized that car tires may greatly contribute to a mosquito population (Yee, 2008). Hence, car tires in gardens may still facilitate the mosquito population on Curacao. People expressed average confidence and average usage of personal protection against mosquito bites. Repellents containing DEET, or wearing long clothes are widely recommended in health promotion campaigns for personal protection (WHO, 2017; Centre of Disease Control, 2012), but were not used often because of inconvenience and doubts on effectivity. Further health messages concerning repellents and long clothes might have little value, if the latter two concerns cannot be addressed. Interesting was the widespread belief that 'eating healthy' would prevent people from being stung by mosquitoes. This belief might promote false feelings of safety for those people who eat healthy, and could therefore be targeted in future health interventions.

The behavioural intention to perform mosquito breeding site control (BIMBC) was high. Accordingly, the scores of the HBM and ToPB constructs expected to positively influence BIMBC were scored as high and vice versa, apart from the susceptibility to chikungunya and dengue. All constructs of the ToPB were significantly associated with the BIMBC. Significant constructs of the HBM were barriers and self-efficacy. It is notable that the knowledge on-, and preparedness of the community to perform MBC correspond to a great extent with the messages of campaigns from the government of Curacao. This suggests that the campaigns reach a major part of the population of Curacao. However, it is vital to improve the preventive behaviours of specifically these households where little MBC is performed. The vector (*Aedes* species) usually has a relatively short fly range of about 30 metres (LaCon et al., 2014). Under some circumstance the fly range can be up to 400 metres (Garelli et al., 2013), making one household with mosquito breeding sites a threat for all who live close to this area.

The multivariate analysis revealed the constructs and variables independently associated with the BIMBC, namely attitudes towards MBC, self-efficacy, believing that a mosquito transmits dengue, satisfaction and dissatisfaction on government's actions. The strongest independent predictor of the BIMBC was the attitude towards MBC. Attitudes towards behaviour addresses an evaluation of a wide variety of issues concerning this behaviour, influenced by the behavioural beliefs and the evaluations of behavioural outcomes (Montaño, 2008). The presented qualitative data addressing antecedents of community's attitudes gave in-depth insights in these attitudes. The self-efficacy, which is the belief that a person is capable of performing the behaviour, has shown to be in particular important for repeated health behaviours (Brewer & Rimer, 2008). This study shows the same regarding MBC. Barriers were negatively associated with self-efficacy, which is in line with the belief that self-efficacy is needed

to overcome perceived barriers towards behaviour (Gerend & Shepherd, 2012). The multivariate analysis, together with the qualitative data were the basis for three possible intervention strategies to improve the BIMBC: 1) media coverage (cues to action), 2) government's action and 3) use of community stakeholders. Further elaboration on these three intervention methods can be found in Supporting information 3, where also an integrated approach is introduced, based on the intervention methods.

Intervention method 1: media coverage, grounded in local realities (cues to action)

Media coverage promoting preventive measures and warning for epidemic serve as cue to action for the community, making them aware that the targeted action could promote health. The low perceived barriers and a higher perceived benefit & severity demonstrated in this study, might contribute to higher favourable impact of cues to action (media) (Champion & Skinner, 2008). Literature lacks a thorough description of the role of cues to action in health behaviour. Some studies describe cues to action to be directly associated with behaviour (Saywell et al., 2003), while others suggest that cues to action promote behaviour indirectly, via the enhancement of other constructs (Gerend & Shepherd, 2012; Abraham & Sheeran, 2005). The latter was the case in the present study, showing that more reported media sources for chikungunya and dengue promoted BIMBC via their positive association with self-efficacy and 'believing that a mosquito transmits dengue/ chikungunya' and their negative association with the barriers of MBC (Figure 6).

Based on our findings, messages to the public should include the etiology of chikungunya and dengue. Half of the participants believed that the only way of transmitting dengue or chikungunya was via a mosquito, while the remaining participants believed that (apart from a mosquito) other etiologies existed like transmission via the air, water or through bad hygiene. Not recognizing that mosquitoes could transmit dengue had direct negative consequences on BIMBC and on the self-efficacy regarding MBC. Since knowledge on etiology of chikungunya and dengue were correlated, targeting both diseases in campaigns may have a favourable effect on mosquito breeding site practices. As was stated by the WHO (2012), it is vital to understand local beliefs regarding etiologies of diseases to effectively deliver the message. Qualitative analysis revealed different underlying attitudes and beliefs which could specifically be targeted in media campaigns (Table 4). For example, a reason for denying that mosquitoes transmit chikungunya was the observation that mosquitoes always have lived in Curacao, and that it could not be that they suddenly cause chikungunya. A message targeting this belief could state that previously 'healthy' mosquitoes got 'ill' by a virus, which they transmit to human when biting.

Intervention method 2: government's action

Cooperation in water source management between community and government is crucial in mosquito control (Gubler & Clark, 1996). This study shows that satisfaction- and perceptions on MBC actions of the government may influence the BIMBC of an individual in two different ways: both 1) Satisfaction on governments actions, or 2) a perceived lack of governments' MBC of public spaces can lead to a lower BIMBC. Messages to the public could potentially tackle these phenomena. Firstly, people should be aware that, although crucial, MBC measures of the government are often not enough to eradicate the mosquito population. This means that even if an individual is satisfied with governmental actions, its own MBC remains crucial. Secondly, the government should be aware that their actions in MBC have potentially direct and indirect positive effects in mosquito control. A direct effect is achieved via the governments water source management of public spaces. A potential indirect effect may be reached via the media coverage of the MBC performed by the government, which in turn lowers the barriers for individuals to perform MBC. Again, these messages will have higher impact if grounded in local realities

(WHO, 2012). The results of the qualitative research of this study can be used to achieve this (f.e. Table 4).

Intervention method 3: stakeholders / community initiatives

The described individual and community initiatives driven by neighbourhood centres regarding waste management demonstrated the presence of stakeholders in Curacao, willing to participate in enhancing community participation in MBC. The use of local stakeholders has been recognized as vital in preventive health behaviours. Neighbourhood centres and stakeholders in a neighbourhood are potential important motivators of their community in MBC (WHO, 2012). Involving these centres and persons may additionally improve MBC of individuals in Curacao. Stakeholders may serve as 'ambassadors' of MBC in their community by raising awareness and initiating mosquito breeding site initiatives. Furthermore, they may provide valuable information to the government concerning community realities in regarding MBC. Collaborative planning perspective (Healey, 1997) is an interesting point of view in this intervention method. To get diverse communities in different neighbourhoods moving, diverse ways of communicating, diverse interests and diverse preferences have to be practised. Therefore, the stakeholders should be properly trained to talk openly about the attitudes, or even sense the attitudes, and strike the right chord in order to change the attitudes, when necessary.

Innes (2016) shows seven conditions which makes a collaborative process rational. Following are these seven conditions and the potential to meet the conditions in the collaborative process aiming for a better BIMBC:

1. Participants are diverse in points of view on the issues.
2. The concerning problem is of interest to all.
3. Participants articulate their interests in the issue and are discouraged to take a stand at first.
4. The participants meet in an equal setting, face to face.
5. Experts and communities are both enabled to share their knowledge, since information plays a central role in the collaborative dialogue.
6. Everything is on the table, because the ideas initially assessed as impossible can often break stalemates, and the dialogue can reframe the issues.
7. The participants work through the issues, looking for a way to satisfy as many concerns as possible.

The first two conditions can be met, since the participants together comprise the total population of curacao, and the total population benefits from more individual MBC. Well organised meetings, possibly organised by potential neighbourhood stakeholders, can meet the third, fourth, fifth, sixth and seventh condition. However, the negotiable sense of the process, especially seen in the last condition, has to be brought into reality differently, since the goal of the process is clear and non-negotiable: as much community participation in MBC as possible. The negotiable part can be shifted to the ways to reach that goal, the process. For example, the boundaries of the responsibility of the community and the responsibility of (the ambassadors of) the government is open for negotiation. In opening the collaborative dialogue, the potential of neighbourhood stakeholders are far-reaching.

Further elaboration about the three intervention methods and the planning practice of community participation in MBC can be found in Supporting information 3. A integrated approach, based on the three intervention methods, is presented. Besides, the possible role of therapeutic planning (Erfan, 2017) and the evaluation model of Slootweg et al. (2001) is explained.

This study was set up using a conceptual model based on the constructs of the HBM and the ToPB. As was suggested earlier, a combination of these theories could lead to a higher predictive power of the final model (Gerend & Shepherd, 2012). Therefore we focused on how the different constructs of the ToPB and the HBM predicted the BIMBC, rather than comparing predicting

values of the individual models. In the ToPB, behavioural intentions are the most important antecedents of behaviour. Also, it has been argued that constructs of the HBM are antecedents of behavioural intention and self-efficacy, rather than a direct predictor of behaviour (Abraham & Sheeran, 2005). This study identified constructs of both dominant health theories as independent predictors for the BIMBC, showing that a combination of these theories provides comprehensive understanding of the health behaviours (in this case: the BIMBC).

This study used a mixed method approach. Qualitative data was used to understand community's attitudes and beliefs regarding mosquito breeding site control. Furthermore, it served as a guide in the analysis and the development of the proposed interventions. The possible intervention method 'media sources' was explored, and 'satisfaction on governmental actions in MBC' was added to the analysis based on qualitative data from the FGDs & in-depth interviews. The qualitative and quantitative research approaches were based on one conceptual model (Supporting information 2 Figure 3). This made the qualitative and quantitative data highly consistent and provided a comprehensive insight into the community's preparedness to control for mosquito breeding sites.

Limitations and strengths

This study was limited by its cross-sectional design, consequently the relations in the DAG (Figure 6) represent correlations rather than causations, if no . However, the causal assumptions from the DAG were based on the conceptual model of the HBM and ToPB, and the assumption that cues to action enhances the constructs of the ToPB and HBM (Abraham & Sheeran, 2005; Gerend & Shepherd, 2012). Interpretation of the DAG should be based on the latter nuances. While the behavioural intention is recognized as the best predictor for behaviour, it is no substitute for actual behaviour. This study did assess the reported performance of the different MBC practices. However, actual mosquito control practices are better assessed with entomological research methods, and could assess if intentions are realize in effective preventive behaviours. Furthermore, the study population of the survey consisted only of people who were (clinically or via serology) chikungunya confirmed patients, which could be considered as a cue to action. This might have given an overestimation of the BIMBC. However, it is important to mention here that around 50-75% of the population of Curacao was expected to be infected with chikungunya in the first epidemic (I. Gerstenbluth, personal communication) (Struik et al., 2015). Therefore, nearly all inhabitants of Curacao had closely experienced the effects chikungunya. Furthermore, the study population consisted of more females than males. This latter notion might not be a major issue, since woman are mainly responsible for housekeeping in Curacao. A strength of this study was the multidisciplinary, mixed methods approach of this study. This approach, based on health behaviour theories, is unique in the field of MBC. Furthermore, a population representing all socio-economic and demographic groups of Curacao was included in this study. Finally, participants were interviewed in a safe environment, chosen by themselves. The results are considered to be representative for the community of Curacao.

The results of this study show how health belief theories serve to understand community participation in MBC. The outcomes of this study can be used for health policies in Curacao, and the proposed interventions can be used in intervention studies. The qualitative research provided in-depth understanding of quantitative associations, which helps to target the public in an efficient and cultural sensitive way. To close the gap between science, implementation and community reality, it is important that similar mixed-method approaches in different countries will be conducted to promote one of the most effective strategies in MBC: community participation.

Conclusion

A study population, considered representative for the population of Curacao expressed relatively high intentions to control for mosquito breeding sites. However, 37% showed an improvable behavioural intention for mosquito breeding site control (BIMBC). Constructs of the HBM and ToPB were independent predictors of the BIMBC. The attitude towards mosquito breeding site control (MBC) was the strongest predictor for the BIMBC. Three intervention targets were proposed based on quantitative and qualitative analysis: 1) ongoing media attention, addressing community's reality, 2) visibility of governments' policies, accompanied with messages to the public stating that their MBC is as important as the governments' MBC, 3) engagement of stakeholders in communities, capable of community mobilization. Qualitative interviews provided in-depth understanding of the attitudes towards MBC, and revealed important gaps between policy and reality. Furthermore, it shows the potency of the (scarcely performed) interdisciplinary mixed method research to provide important comprehensive and in-depth insights for mosquito control policies.

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Supporting information 1: instrument of ToPB and HBM

Survey instrument ToPB & HBM, ordered by concept
(cues to action and knowledge are described in 'Methods')

The titles of the survey instruments were different from the titles presented here.

Behavioural intention to perform mosquito breeding site control (BIMBC)

The coming rainy season, check my house and yard for mosquito breeding sites every week and eliminate them if necessary...

	1	2	3	4	5	
I will definitely not do	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I will definitely do
I will not even try	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I will definitely try
I'm not planning to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I am planning to

Susceptibility (chikungunya and dengue)

Check to what extent you agree with the following statements:

	1	2	3	4	5
I expected to get chikungunya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think I had a greater chance of getting chikungunya compared to others.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Everyone in Curaçao runs a great risk of getting chikungunya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think I run the risk of getting chikungunya once more.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think I have a greater chance of getting dengue compared to others.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Everyone in Curaçao runs a great risk of getting dengue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I think I run the risk of getting dengue (once more)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Severity (chikungunya and dengue)

Check to what extent you agree with the following statements:

	<i>Don't agree at all</i>					
	1	2	3	4	5	<i>Fully agree</i>
Chikungunya is a serious disease.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
People who get chikungunya can die of it.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
People who have chikungunya are limited in their social activities.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
An infection with chikungunya leads to loss of income.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
An infection with chikungunya costs the patient a lot of money.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dengue is a serious disease.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
People who get dengue can die of it.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
People who have dengue are limited in their social activities.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
An infection with dengue leads to loss of income.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
An infection with dengue costs the patient a lot of money.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Perceived benefits

If, during the coming rainy season, I check for mosquito breeding sites and eliminate them from my house and yard if necessary, ...

	1	2	3	4	5	
I will not get chikungunya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I will get chikungunya
My family will not get chikungunya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	my family will get chikungunya
My neighbors will not get chikungunya	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	my neighbors will get chikungunya
I will not get dengue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	I will get dengue
My family will not get dengue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	my family will get dengue
My neighbors will not get dengue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	My neighbors will get dengue

Perceived barriers

During the coming rainy season I will **not** check for mosquito breeding sites and eliminate them if necessary because...

	1	2	3	4	5
I don't know how to check for breeding sites.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I don't like to eliminate breeding sites.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Neighbors don't do it either, so it makes no sense for me to do it.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I never have mosquitoes in my house or yard.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are many other breeding sites the government does nothing about.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I cannot get rid of my garbage/debris/rubbish at another place than in my yard...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I live near a mondi/dam where more mosquitoes come from than from my yard.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Someone else from my family will do it already.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I don't have the physical ability to check my yard every week.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I'm only at home when it is dark and I cannot see the breeding sites then.....	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Don't agree at all
 1 2 3 4 5
Fully agree

Self-efficacy

Checking my house and yard for mosquito breeding sites every week and if necessary eliminating them during the coming rainy season....

	1	2	3	4	5	
is absolutely impossible for me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is absolutely possible for me
Is not manageable for me, even if I want to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is doable for me, if I want to

Attitudes towards behaviour

Checking for mosquito breeding sites and if necessary eliminating them from my house and yard during the coming rainy season, for me is...

	1	2	3	4	5	
Unnecessary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Necessary
Tedious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Fun
Bad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Good
Stressful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Relaxing
Harmful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Beneficial
Worthless	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Valuable

Subjective norms

My weekly checking for mosquito breeding sites and eliminating them from my house and yard during the coming rainy season will be

	1	2	3	4	5	
Disapproved of by people who are important to me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Approved by people who are important to me
Advised against by people whose opinion I value	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Advised by people whose opinion I value
Discouraged by my neighbours	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Encouraged by my neighbours
Not be expected from me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Expected from me
Not be stimulated by the government	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Stimulated by the government

Whether I will check for mosquito breeding sites and if necessary eliminate them from my house and yard during the coming rainy season,

	1	2	3	4	5	
is not dependent on what other people think of it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Depends on what other people think of it

Checking house and yard for mosquito breeding sites every week and if necessary eliminating them during the coming rainy season,

	1	2	3	4	5	
Is never done by people whose opinion is important to me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is always done by people whose opinion is important to me
Is never done by people who are important to me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is always done by people who are important to me
Is never done by my neighbors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is always done by my neighbors

Perceived behavioural control (recode: 1=5; 2=4; 3=3; 4=2; 5=1)

Whether I will check for mosquito breeding sites and if necessary eliminate them from my house and yard during the coming rainy season,

1 2 3 4 5

is **not** dependent on help from other people

is dependent on help from other people

Satisfaction on governmental mosquito breeding site control

The government does enough to prevent and eliminate breeding sites

1 2 3 4 5

Don't **agree** at all

Fully agree

Supporting information 2: tables and figures

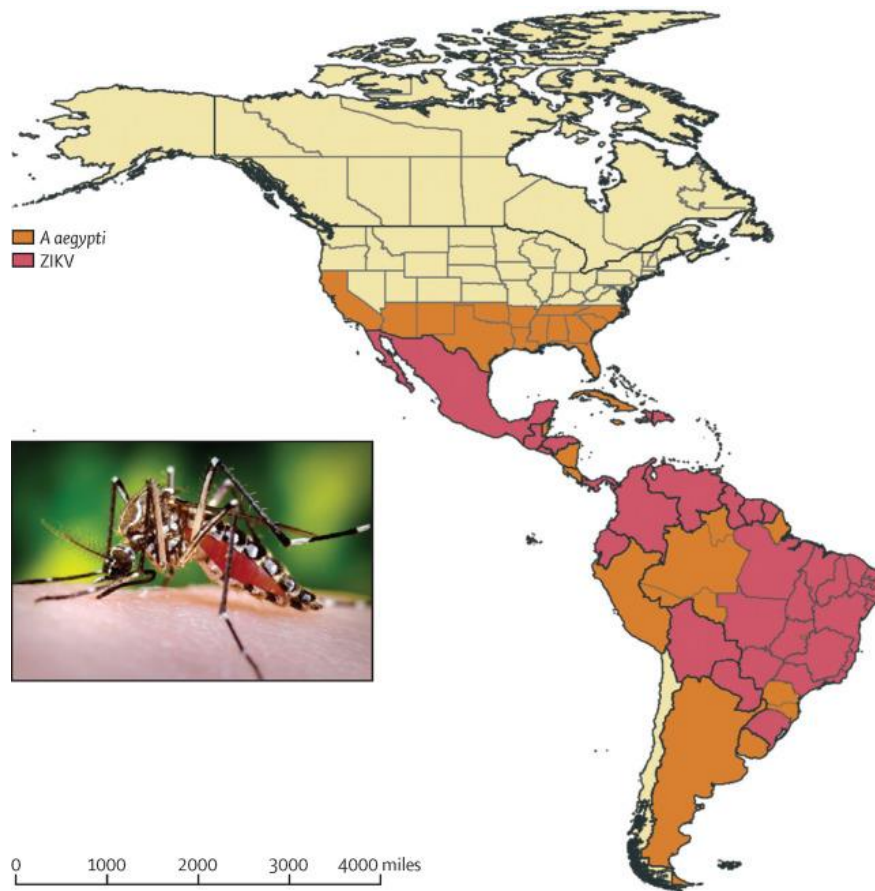


Figure 1. Current distribution of *Aedes aegypti* and suspected distribution of ZIKV (Zika virus) in the Americas (Brazil and USA are shown at state level). Inset: *Aedes aegypti* mosquito shown blood-feeding” (Yakob & Walker, 2016)

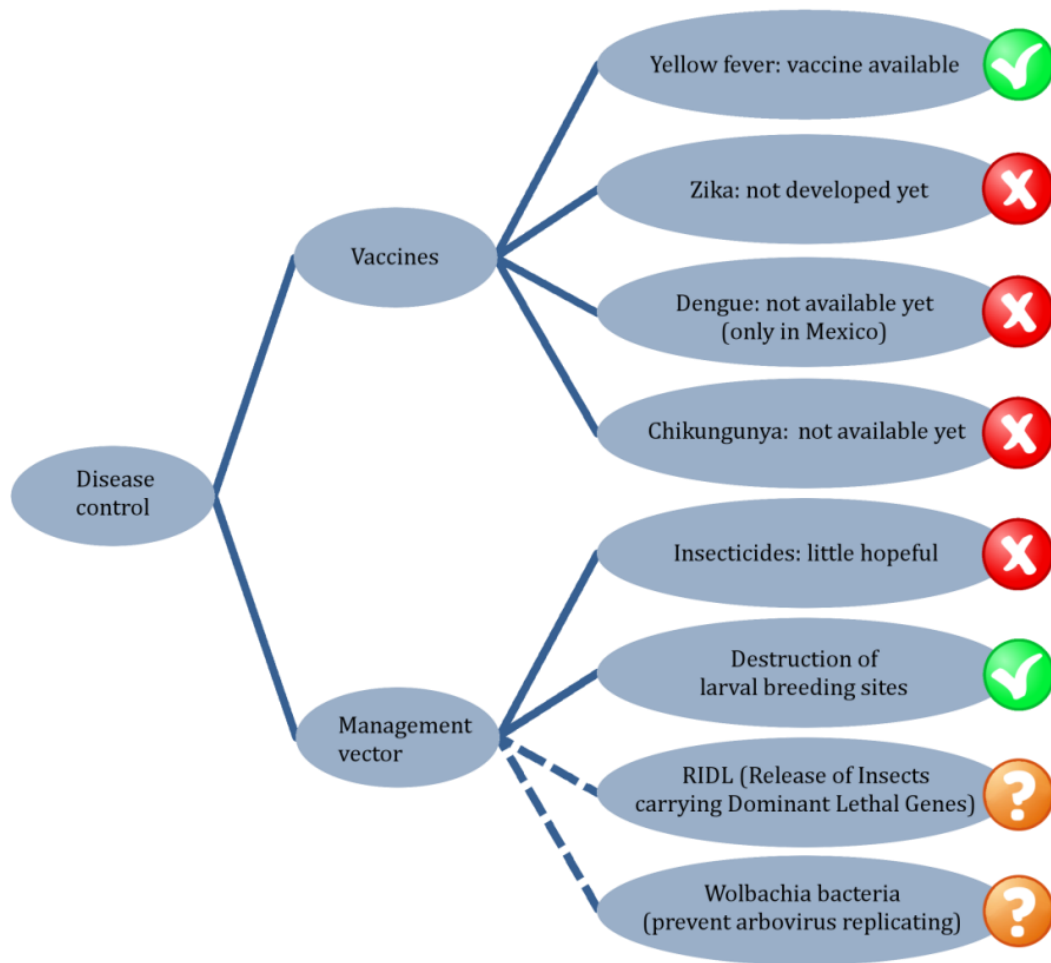


Figure 2. methods of disease control

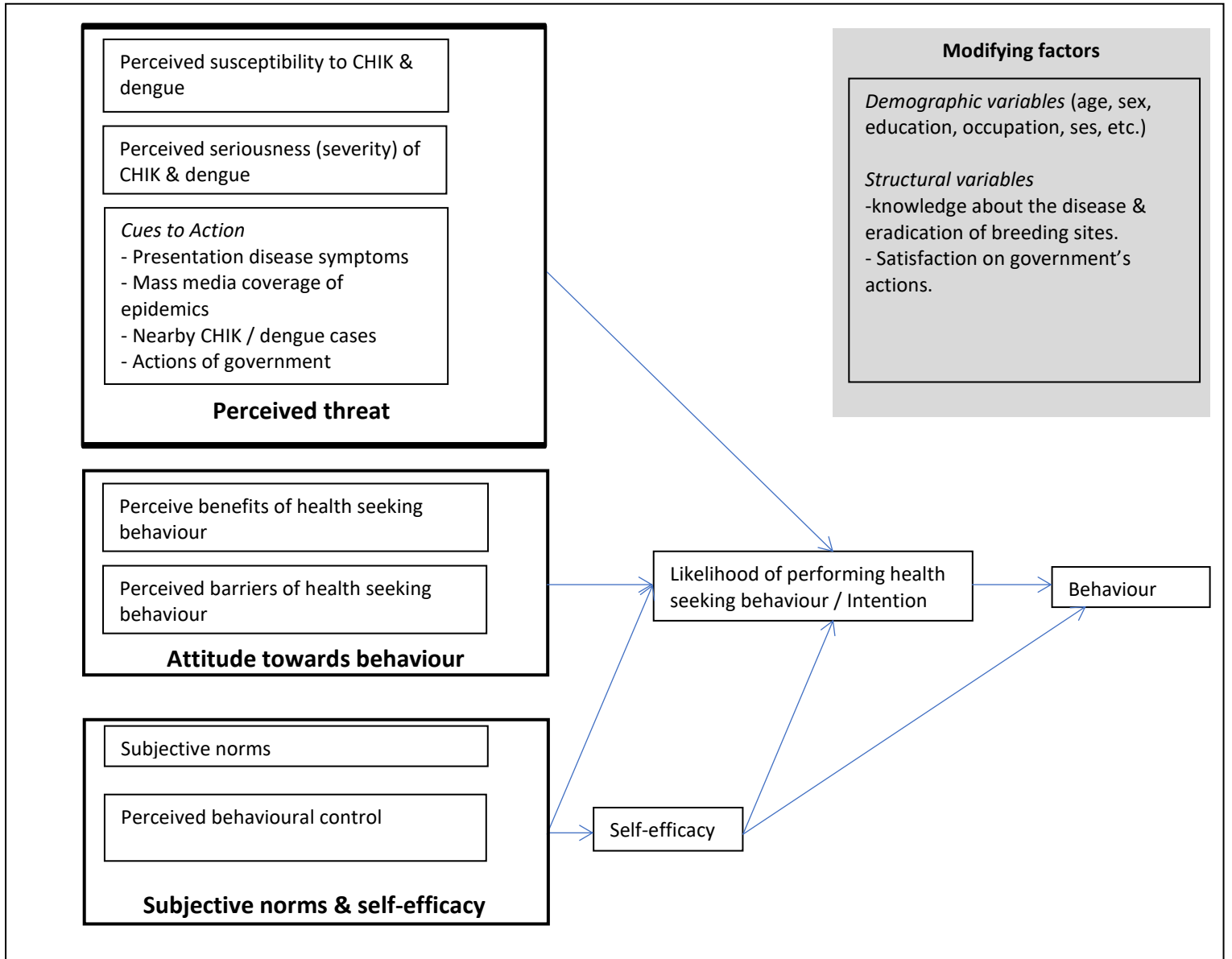


Figure 3. Conceptual model HBM and ToPB

Table 1. Overview of participants' selection procedure	
Selected participants	n=535
Contacted participants	n=411
Consenting participants	n=339
Reasons for non-contacting	
No attempt was made	n=25
Participant was not reached by phone and visit	n=68
Non-participant circumstances prevented interviewer from (completing) interviewing	n=9
Participant was on holiday/ abroad	n=20
Participant died	n=2
Reasons for non-response	
Refusal of participation	n=36
After contacting no interview due to circumstances	n=25
Participant had already participated in other local chikungunya study	n=6
Individual stated never had been infected by chikungunya virus (CHIKV)	n=5

Table 2. Characteristics of the focus groups				
Focus group	# participants	# female	# self-reported (former) chikungunya patients	Mean age
Residents from the Netherlands	8	6	6	67
Local youth	4	2	0	21
Interviewers of the survey	4	3	0	65
Rooi santu	8	4	7	67
Seru Fortuna	9	8	8	60
Souax	9	4	1	48
Koraalspecht	10	10	9	69
In-depth interviews	20	12	20*	64

*Legend Table 2: *All participants of the in-depth interviews had a laboratory-confirmed chikungunya infection.*

Table 3. Univariate analysis of the concepts of the Health Belief Model and Theory of Planned Behaviour vs. the BIMBC (<15 vs. 15).						
		# of items	Range of items	Crombachs Alpha	P-value ^a	Association ^b
Behavioural intention to perform mosquito breeding site control (BIMBC)		3	1 - 5	0.774	n/a	n/a
Health Belief Model						
Perceived threat	Susceptibility (CHIK and dengue)	7	1 – 5	0.669	0.320	-
	Severity (CHIK and dengue)	10	1 – 5	0.814	<u>0.074</u>	+
	Cues to action					
	# of media sources (CHIK and dengue)	2	0 – 7	0.807	0.213	+
	# of 'peer' sources (CHIK and dengue)	2	0 – 2	0.628	0.446	-
Perceived benefits		6	1 – 5	0.956	0.836	+
Perceived barriers	Don't know how to control breedingsites	1	1 – 5	n/a	0.000	-
	Don't like to control breedingsites	1	1 – 5	n/a	0.012	-
	Neighbours don't control breedingsites either	1	1 – 5	n/a	0.035	-
	Never mosquitoes at my property	1	1 – 5	n/a	0.379	-
	Government doesn't control other breedingsites	1	1 – 5	n/a	<u>0.051</u>	-
	No other possibilities for storing waste than in my garden	1	1 – 5	n/a	<u>0.102</u>	-
	More mosquitoes are at nearby mondi's	1	1 – 5	n/a	0.486	-
	Someone else controls breedingsites (for me)	1	1 – 5	n/a	0.996	=
	No physical ability	1	1 – 5	n/a	0.005	-
	Only when at home when it's dark	1	1 – 5	n/a	0.308	-
Self-efficacy		2	1 – 5	0.873	0.000	+
Theory of planned behaviour						
Attitude towards behaviour		6	1 – 5	0.632	0.000	+
Subjective norms		9	1 – 5	0.771	0.001	+
Perceived behavioural controls		1	1 – 5	n/a	0.001	+
Modifying factors						
Knowledge	Believing that CHIK is transmitted by a mosquito	1	0 – 1	n/a	0.954	+
	Believing that dengue is transmitted by a mosquito	1	0 – 1	n/a	0.002	+
Satisfaction on governmental mosquito breedingsite control		1	0 – 5	n/a	<u>0.116</u>	-

Legend Table 3: ^aThe p-value corresponds to the comparison between the maximum vs. an improvable BIMBC. ^bThe correlation of the BIMBC and the tested concept was positive (+), negative (-) or neutral (=)

Table 4. Scores of concepts of the Health Belief Model and Theory of Planned Behaviour				
		<i>Range of score</i>	<i>Mean (SD) N</i>	<i>Quartiles 25 – 50 – 75</i>
Behavioural intention to perform mosquito breeding site control (BIMBC)		3-15	13.45 (2.58) 330	12 – 15 – 15
Health Belief Model				
Perceived threat	Susceptibility (CHIK and dengue)	7-35	16.16 (5.06) 332	13 – 15 – 19
	Severity (CHIK and dengue)	10-50	39.69 (6.99) 331	35 – 40 – 45
	Cues to action			
	# of media sources (CHIK and dengue)	0-14	5.11 (3.01) 328	3 – 5 – 8
	# of 'peer' sources (CHIK and dengue)	0-4	1.13 (1.12) 328	0 – 1 – 2
Perceived benefits		6-30	21.67 (6.25) 333	18 – 20 – 30
Perceived barriers	Don't know how to control breedingsites	1-5	1.41 (0.94) 333	1 – 1 – 1
	Don't like to control breedingsites	1-5	1.38 (0.90) 333	1 – 1 – 1
	Neighbours don't control breedingsites either	1-5	1.35 (0.83) 333	1 – 1 – 1
	Never mosquitoes at my property	1-5	1.74 (1.10) 332	1 – 1 – 3
	Government doesn't control other breedingsites	1-5	3.45 (1.61) 333	2 – 4 – 5
	No other possibilities for storing waste than in my garden	1-5	1.34 (0.85) 333	1 – 1 – 1
	More mosquitoes are at nearby mondi's	1-5	2.10 (1.51) 332	1 – 1 – 3
	Someone else controls breedingsites (for me)	1-5	2.19 (1.46) 333	1 – 1 – 3
	No physical ability	1-5	1.65 (1.13) 333	1 – 1 – 2
	Only when at home when it's dark	1-5	1.31 (0.79) 333	1 – 1 – 1
Self-efficacy		2-10	8.73 (1.78) 332	8 – 10 – 10
Theory of planned behaviour				
Attitude towards behaviour		6-30	27.12 (2.77) 332	26 – 28 – 30
Subjective norms		9-45	34.65 (5.39) 333	31 – 35 – 39
Perceived behavioural controls		1-5	3.96 (1.37) 333	3 – 5 – 5
Modifying factors				
Knowledge	Believing that CHIK is transmitted by a mosquito	0-1	0.81 (0.39) 337	1 – 1 – 1
	Believing that dengue is transmitted by a mosquito	0-1	0.90 (0.30) 333	1 – 1 – 1
Satisfaction on governmental mosquito breedingsite control		0-5	2.70 (1.45) 333	1 – 3 – 4

Table 5 – Spearman’s correlation matrix of concepts significantly associated with ‘# media sources’.

		# media sources	# peer sources	Barrier 1	Barrier 2	Barrier 3	Barrier 4	Self-efficacy	Mosquito CHIK	Mosquito dengue	Satisfaction on government
# media sources	Correlation Coefficient										
	p-value										
	n										
# peer sources	Correlation Coefficient	,185**									
	p-value	,001									
	n	328									
Barrier 1	Correlation Coefficient	-,128*	,140*								
	p-value	,021	,012								
	n	324	324								
Barrier 2	Correlation Coefficient	-,133*	,002	,495**							
	p-value	,016	,972	,000							
	n	324	324	333							
Barrier 3	Correlation Coefficient	-,132*	,030	,305**	,264**						
	p-value	,018	,590	,000	,000						
	n	324	324	333	333						
Barrier 4	Correlation Coefficient	-,130*	-,196**	-,021	-,006	,117*					
	p-value	,019	,000	,708	,919	,033					
	n	324	324	333	333	333					
Self-efficacy	Correlation Coefficient	,127*	-,095	-,266**	-,162**	-,140*	,033				
	p-value	,023	,090	,000	,003	,011	,545				
	n	323	323	332	332	332	332				
Mosquito CHIK	Correlation Coefficient	,191**	,026	-,013	,018	-,103	-,037	,041			
	p-value	,001	,639	,820	,749	,061	,506	,459			
	n	328	328	332	332	332	332	331			
Mosquito dengue	Correlation Coefficient	,133*	,075	-,025	,042	,054	,012	,144**	,393**		
	p-value	,016	,174	,657	,444	,330	,827	,009	,000		
	n	328	328	327	327	327	327	326	332		
Satisfaction on government	Correlation Coefficient	,123*	,001	,005	,045	-,079	-,204**	-,052	-,032	,002	
	p-value	,027	,980	,929	,418	,149	,000	,347	,561	,970	
	n	324	324	333	333	333	333	332	332	327	

Legend Table 5: *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); Negative significant associations are highlighted in red; Positive significant associations are highlighted in green; Barrier 1 = Don’t know how to control breedingsites; Barrier 2 = Don’t like to control breedingsites; Barrier 3 = Neighbours don’t control breedingsites either; Barrier 4= Government doesn’t control other breedingsites;

Table 6. Information sources of chikungunya and dengue

Information sources Chikungunya n=337; dengue n=329	Chikungunya (n=337)		Dengue (n=329)	
	n	(%)	n	(%)
<i>Media sources</i>				
Television	260	(77.2)	240	(72.9)
Radio	241	(71.5)	225	(68.4)
Newspaper	178	(52.8)	168	(51.1)
School/ education	14	(4.2)	23	(7.0)
Internet sites	52	(15.4)	42	(12.8)
Government campaigns/ GGD	95	(28.2)	96	(29.2)
Social media (Twitter/Facebook etc.)	40	(11.9)	28	(8.5)
<i>Peer sources</i>				
From the general practitioner	65	(19.3)	53	(16.1)
Family/ friends/ neighbours	142	(42.1)	116	(35.3)

Legend Table 6: More answers were possible.

Table 7. Etiology of chikungunya and dengue

Etiology Chikungunya n=337; dengue n=333	Chikungunya (n=337)		Dengue (n=333)	
	n	(%)	n	(%)
Water	37	(11.0)	54	(16.2)
Coughing/sneezing	29	(8.6)	33	(9.9)
Bad hygiene	65	(19.3)	82	(24.6)
A mosquito bite	274	(81.3)	300	(90.1)
The air 'airu'	114	(33.8)	68	(20.4)
Sex	7	(2.1)	4	(1.2)
(French) Kissing	9	(2.7)	12	(3.6)
Touching a (chikungunya/ dengue) patient	12	(3.6)	16	(4.8)
Visiting the general practitioners office	17	(5.0)	15	(4.5)

Legend Table 7: More answers were possible.

Table 8. Barriers for eliminating breeding sites

	<i>Mean (SD) N</i>	<i>Quartiles 25 – 50 – 75</i>
Don't know how to control breedingsites	1.41 (0.94) 333	1 – 1 – 1
Don't like to control breedingsites	1.38 (0.90) 333	1 – 1 – 1
Neighbours don't control breedingsites either	1.35 (0.83) 333	1 – 1 – 1
Never mosquitoes at my property	1.74 (1.10) 332	1 – 1 – 3
Government doesn't control other breedingsites	3.45 (1.61) 333	2 – 4 – 5
No other possibilities for storing waste than in my garden	1.34 (0.85) 333	1 – 1 – 1
More mosquitoes are at nearby mondi's	2.10 (1.51) 332	1 – 1 – 3
Someone else controls breedingsites (for me)	2.19 (1.46) 333	1 – 1 – 3
No physical ability	1.65 (1.13) 333	1 – 1 – 2
Only when at home when it's dark	1.31 (0.79) 333	1 – 1 – 1

Legend Table 8: Barriers were assessed with a 5 point Likert item (1:no barrier at all – 5:fully agree that the issue is a barrier).

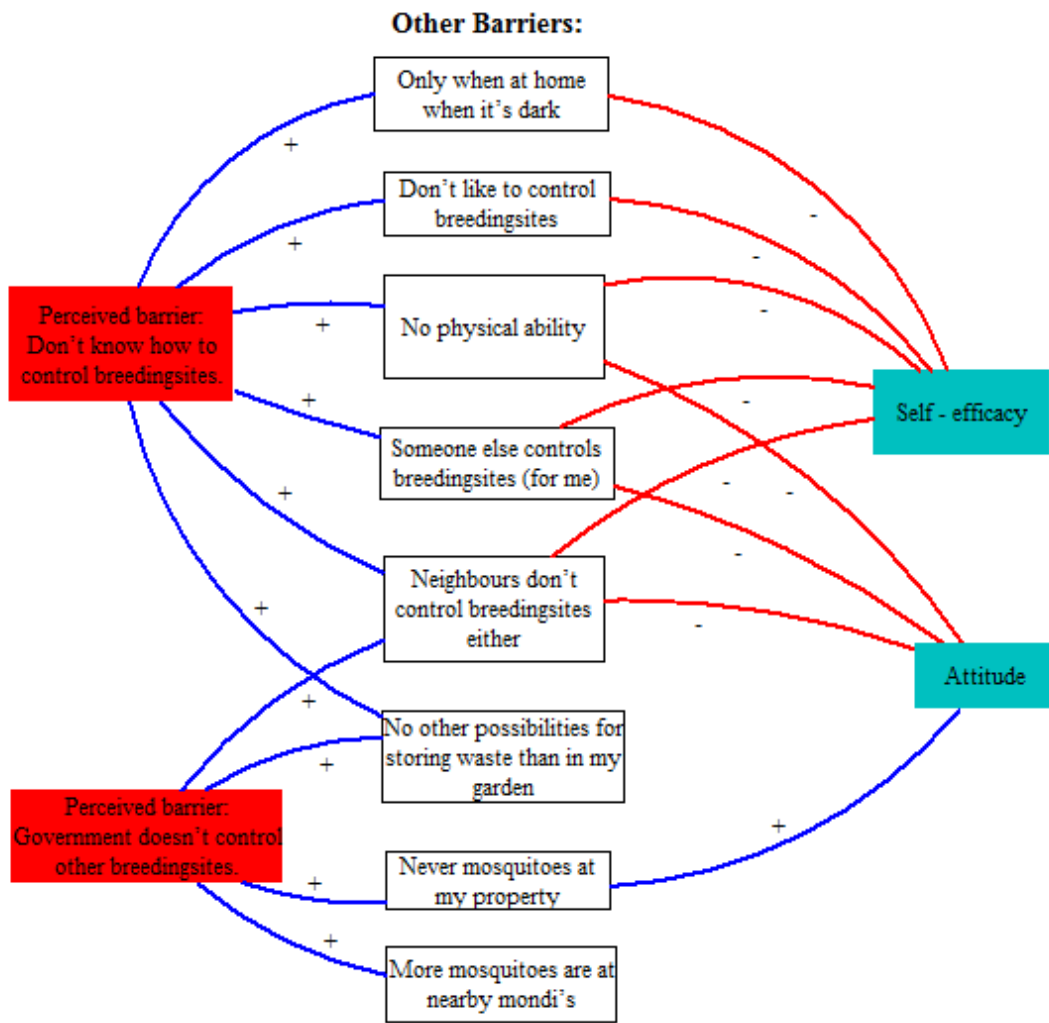


Figure 4. Associations of 'other barriers' with the direct predictors for the BICMB.

Legend figure 4: The univariate associations between 'other barriers' and the variables independently associated with the BICMB were presented. The variables in blue boxes were independently positively associated with an individual's BICMB, while the variables in red boxes were independently negatively associated with the individual's BICMB. Red arrows represent a negative association, blue arrows represent a positive association.

Table 9. Precautions preventing mosquitoes from breeding in yards/houses

	Perception of effectiveness		Actual use	
	Mean (SD) N	Quartiles 25 – 50 – 75	Mean (SD) N	Quartiles 25 – 50 – 75
Refresh water in flower vases or feeding bowls for pets every day	4.21 (0.76) 338	4 – 4 – 5	4.34 (1.01) 179	4 – 5 – 5
Turn buckets upside down	4.32 (0.79) 338	4 – 4 – 5	4.23 (1.14) 283	4 – 5 – 5
Discard rubbish in the yard	4.46 (0.64) 338	4 – 5 – 5	4.13 (0.99) 326	3 – 4 – 5
Cover water in the yard	4.28 (0.78) 338	4 – 4 – 5	3.65 (1.55) 324	3 – 4 – 5
Cover water in the house	4.06 (0.87) 338	4 – 4 – 5	3.61 (1.51) 337	2 – 4 – 5
Spray insecticide (bug spray)	3.62 (0.96) 338	3 – 4 – 4	3.09 (1.25) 338	2 – 3 – 4
Remove car tires from the yard	4.36 (0.77) 338	4 – 4 – 5	2.93 (1.49) 44	2 – 2 – 4.75
Scrub away mosquito eggs (with e.g. a sponge)	3.82 (1.00) 337	3 – 4 – 5	2.87 (1.54) 337	1 – 3 – 4
Add Abate to containers for collecting rain water	3.92 (0.96) 337	3.5 – 4 – 5	2.68 (1.56) 122	1 – 2 – 4
Don't park the car near the house	2.25 (1.00) 338	1 – 2 – 3	1.71 (1.32) 253	1 – 1 – 2
Don't water plants	1.58 (0.72) 338	1 – 1 – 2	1.19 (0.61) 295	1 – 1 – 1

Legends Table 9: The score on 'perception of effectiveness' reflects the perceived probability that the precaution prevents mosquitoes from breeding (1=not at all; 2=does not; 3=maybe; 4=does; 5=definitely). The score of the actual use represents the actual use of the precaution (1=never; 2=sometimes; 3=regularly; 4=often; 5=always).

Table 10. Precautions preventing mosquito bites

	Perception of effectiveness		Actual use	
	Mean (SD) N	Quartiles 25 – 50 – 75	Mean (SD) N	Quartiles 25 – 50 – 75
Eliminate mosquito breeding sites in the house and yard	4.28 (0.82) 337	4 – 4 – 5	4.07 (1.14) 336	3 – 4.5 – 5
Use a fan	3.16 (1.00) 337	2 – 3 – 4	3.43 (1.31) 338	2 – 4 – 5
Eat healthy	2.71 (1.24) 336	2 – 3 – 4	3.07 (1.52) 337	2 – 3 – 5
Spray with insecticide	3.53 (0.95) 337	3 – 4 – 4	3.15 (1.26) 338	2 – 3 – 4
Use insecticides in the house and yard	3.53 (0.97) 337	3 – 4 – 4	2.72 (1.25) 337	2 – 3 – 4
Use electric mosquito rackets	3.34 (0.99) 337	3 – 3 – 4	2.70 (1.34) 338	2 – 2 – 4
Use Coils (plagatox)	3.22 (1.05) 336	2 – 3 – 4	2.35 (1.34) 337	1 – 2 – 4
Screens in front of doors/ windows	3.26 (0.98) 337	3 – 3 – 4	2.30 (1.54) 337	1 – 1 – 4
Use air conditioning	2.85 (1.13) 337	2 – 3 – 4	2.24 (1.44) 337	1 – 2 – 3
Use DEET or bug repellent (lotion/spray) every day	3.38 (1.00) 337	3 – 3 – 4	2.21 (1.21) 337	1 – 2 – 3
Use Vape	3.06 (0.97) 335	2 – 3 – 4	1.84 (1.17) 337	1 – 1 – 2
Use mosquito traps	2.77 (1.07) 335	2 – 3 – 4	1.81 (1.20) 334	1 – 1 – 2
Wear long sleeves/pants during the day	2.63 (0.98) 336	2 – 3 – 3	1.77 (1.03) 336	1 – 1 – 2
Use a mosquito net at night	3.18 (1.03) 337	2 – 3 – 4	1.48 (0.98) 337	1 – 1 – 2
Don't water plants	1.68 (0.79) 336	1 – 2 – 2	1.20 (0.64) 338	1 – 1 – 1

Legends Table 10: The score on 'perception of effectiveness' reflects the perceived probability that the precaution prevents from mosquito bites (1=not at all; 2=does not; 3=maybe; 4=does; 5=definitely). The score of the actual use represents the actual use of the precaution (1=never; 2=sometimes; 3=regularly; 4=often; 5=always).

Supporting information 3: Stimulating community participation in practice

An integrated approach for implementation of the intervention methods

This supporting information will provide guidance how to raise people’s willingness to join the prevention and destruction of mosquito breeding sites individually (BIMBC) on Curacao. Firstly, the three developed intervention methods are explained. Afterwards, an integrated approach will be presented, based on the intervention methods.

Intervention method 1: Exposure to media sources on chikungunya and dengue

The first intervention method aims to the influence of media sources. Several media sources were identified that were successful in spreading information about chikungunya and dengue: television, radio and the newspaper were appointed as the most common information sources.

Different pathways from media sources to the BIMBC can be distinguished (Figure 11). Firstly, the belief in and satisfaction on governmental mosquito breeding site control (MBC) can be enhanced (or the perceived barrier can be lowered by media sources, although the effects of this on the BIMBC are ambiguous (see Intervention method 2 for further explanation). Secondly, the media sources can positively influence the personal convictions of the know-how in performing MBC (lowers the perceived barrier) and self-efficacy towards MBC, which both leads to a more positive behavioural intention. Lastly, the belief that dengue is transmitted by mosquitoes can be stimulated by media sources, eventually leading to a higher BIMBC. This pathway is positively influenced by the belief that chikungunya is transmitted by mosquitoes, which also can be stimulated by media sources.

In short, the media information spreading is associated with a lot of personal attitudes and believes, which are connected to the BIMBC (Figure 11). So, indirectly the media sources together (especially television, radio and the newspaper) encircle an important way to heighten the BIMBC.

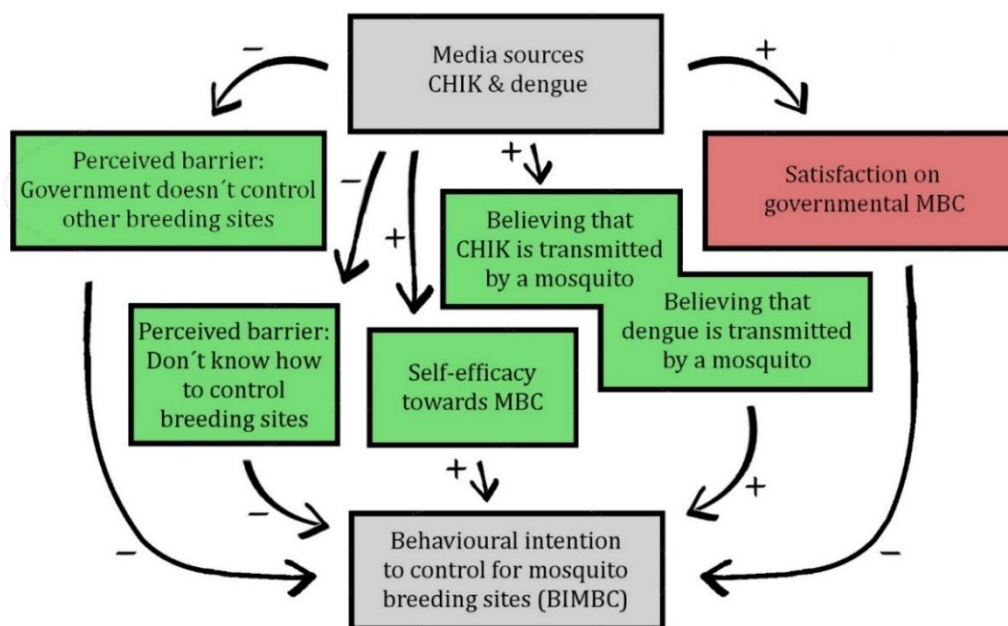


Figure 11: DAG showing the effect of media sources on the individual’s BIMBC

Intervention method 2: Effects of governments' MBC actions on individual MBC

The qualitative data indicate two different groups whose BIMBC are influenced by governmental MBC (Figure 12). In this intervention method, these two groups are targeted. The first group contains the people that perceive the lack of government action in MBC as a barrier for performing MBC themselves (left pathway in Figure 12). The second group acts upon a feeling of dissatisfaction on governmental MBC (right pathway in Figure 12). This group will tend to neglect individual MBC when their satisfaction on governmental MBC grows. So enhancing the visibility of governmental MBC will lead to both a higher and a lower BIMBC. This implicates that more sophisticated measures are needed to reach the preferable outcome of a more motivated community in performing MBC. The visibility of governmental MBC has to be enhanced (for group 1) without taking away the perceived necessity of individual MBC, or even heighten the perceived necessity of individual MBC (for group 2). Of course it is preferable to enhance this visibility through actual intensification of governmental MBC, for it causes additional direct effects.

To reach an enhanced visibility of governmental MBC as well as an enhanced perceived necessity of individual MBC, the communication should be very precise alongside the intensification of central coordinated MBC. The message should include that individual MBC is still needed and governmental MBC is more effective when individual MBC is performed at the same time. Good ways to spread this message are the media sources (intervention method 1) and the stakeholders (intervention method 3).

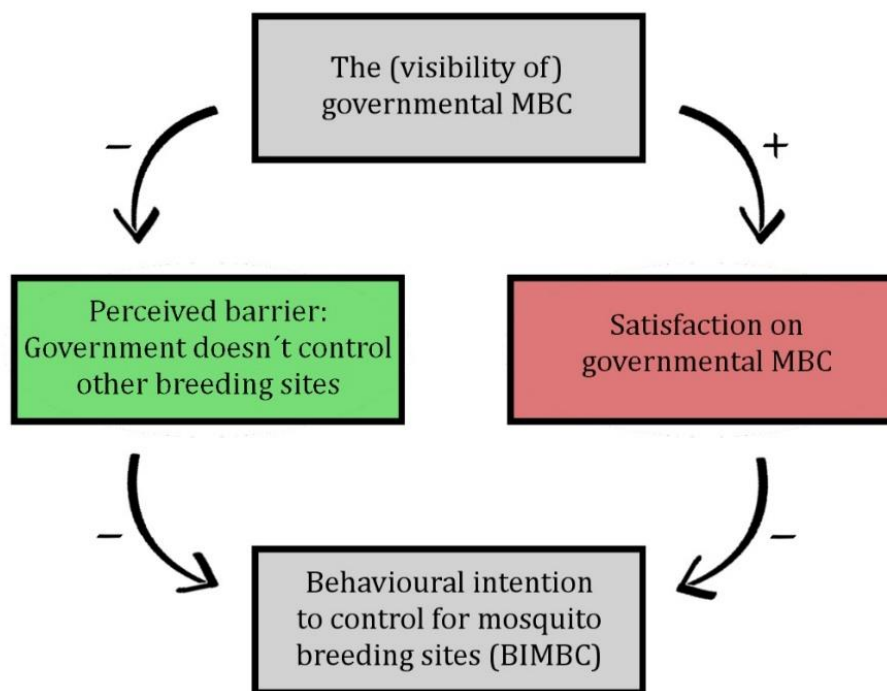


Figure 12: DAG showing the effects of the (visibility of) governmental MBC on the individuals BIMBC

Intervention method 3: Promoting community participation via stakeholders

There is a more local and practical intervention method to encourage Curacao citizens in individual MBC. The recommendation of this method is based on earlier, successful experiences, especially experiences in cleaning the neighbourhood. Several examples can be given from individuals that organised successful days where citizens gather together to clean up their neighbourhood. Cleaning garbage is an successful method to destruct potential mosquito breeding sites, but can be more even effective when the days are actually targeting MBC. One can imagine the effectivity of these organised days when stakeholders in the neighbourhood are recruited as an representative of the Curacao government (in exchange for a compensation if necessary), sharing effective ways of MBC and organising days of cleaning and MBC. These neighbourhood stakeholders can be trained in involving more people and carrying out practical knowledge of effective MBC. Beyond that, local stakeholders are cut out for fulfilling the personal embodiment of the governmental exertion.

Collaborative planning can be a powerful tool in the hands of neighbourhood stakeholders. Although, the negotiable sense of the process, especially seen in the last condition, has to brought into reality differently, since the goal of the process is clear and non-negotiable: as much community participation in MBC as possible. The negotiable part can be shifted to the ways to reach that goal, the process. In opening the collaborative dialogue, the potential of neighbourhood stakeholders are far-reaching.

Integrated approach

Ideally, planners use an approach in which the three intervention methods are combined and finetuned in combination with each other. Media sources and community stakeholders are used for communication, meanwhile the governmental MBC is intensified. Media sources, especially television, radio and the newspaper, are good channels through which messages can be prominently promoted. Besides, local stakeholders are effective to encourage people in different, more personal ways.

In the current media messages the personal protection against mosquito stings is the first priority. The individual MBC is communicated secondary and like an additional option for fanatics. However, the message should be spread that individual MBC (in combination with governmental MBC) is simply a necessity in gaining control over mosquito population and eventually over the spread of the diseases on Curacao. In addition, the governmental MBC should be promoted, together with the message that truly effective MBC requires both governmental and individual MBC. That way both groups of which the BIMBC is influenced by governmental actions (see Intervention method 2) are pushed in the right way. Both media sources and local stakeholders should carry out these messages.

The results showed that the lack in trust in the governmental MBC is perceived as a barrier. This can result in a negative attitude towards governmental actions, barricading positive outcomes of potential mutual cooperation. When the previously described measures don't have the desired outcomes, planners can take communicative planning to the next level: therapeutic planning. This can heal wounds of civilians, caused by past experiences with the government in planning processes (Erfan, 2017).

This integrated approach should provide a significant change in the outcome of the effort to control the mosquito population and reduce the spread of chikungunya, dengue and Zika. To evaluate the outcomes of interventions, planners can use the model of Sloomweg et al. (2001) (Figure 13). This model takes both the biophysical and social aspects into consideration, as well as the interaction between these. Though the model can be a clever handle, it is important to

keep an open mind in the evaluation process, since a 'checklist' can prevent from thoroughly thinking through the mechanisms behind the changes (Vanclay, 2002).

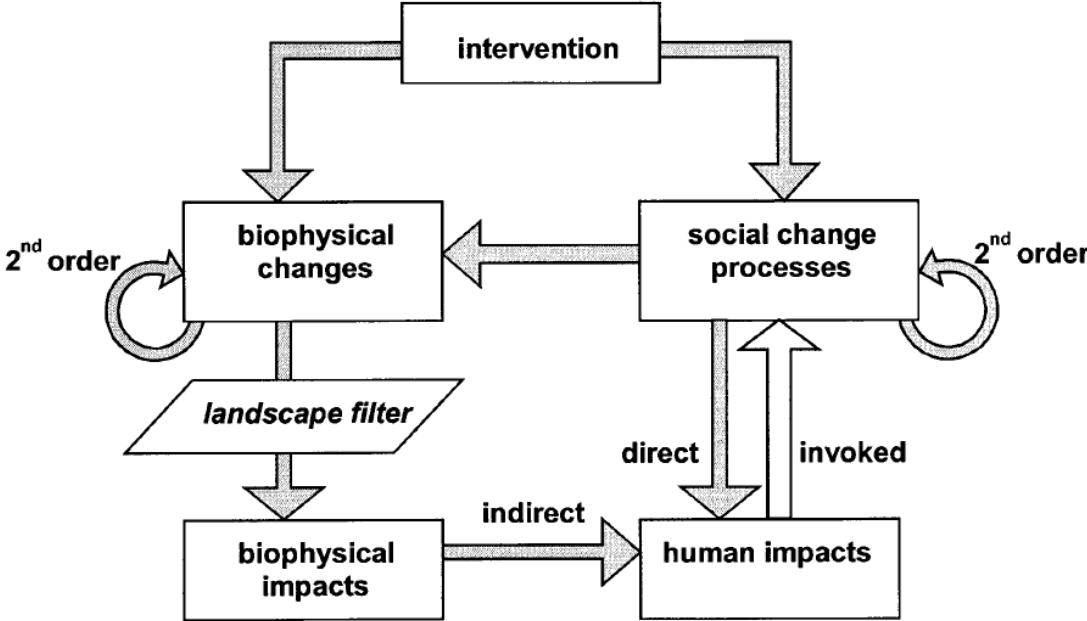


Figure 13: model for evaluation of interventions (Slootweg et al., 2001)