# Social and Behavior Change Guidance for *Anopheles stephensi* in Africa

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# List of Acronyms

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| **ANC** | Antenatal care |
| **ATSB** | Attractive targeted sugar baits |
| **EPI** | Expanded Program on Immunization |
| **IRS** | Indoor residual spraying |
| **ITN** | Insecticide-treated net |
| **LSM** | Larval source management |
| **MDA** | Mass drug administration |
| **PMI** | U.S. President's Malaria Initiative |
| **SBC** | Social and behavior change |
| **SSA** | Sub-Saharan Africa |
| **USAID** | U.S. Agency for International Development |
| **WASH** | Water, sanitation, and hygiene |

# Background

*Anopheles stephensi*, a dominant malaria vector in south Asia and Arabian Peninsula, has been identified in Africa in recent years, and has the potential to threaten malaria control and elimination efforts. Unlike malaria vectors in Africa that use natural habitats, *An. stephensi* shares some similarities with *Aedes aegypti*, a vector of diseases such as dengue, Zika, chikungunya, and yellow fever. These similarities include a preference for developing in artificial containers, such as water storage containers, particularly in urban areas. Social and behavior change (SBC) approaches to promote evidence-based individual, household, and community behaviors to reduce *An. stephensi* populations should play a critical role in the response to this growing threat in Africa.

# Purpose

As countries face the threat of invasive An. stephensi, ministries of health will need to define their response, which may include the scale-up or introduction of interventions such as insecticide-treated nets, indoor residual spraying, care-seeking for fever, household larviciding, community larviciding, regularly finding and removing standing water, and covering water storage containers. The response to An. stephensi should include a corresponding SBC strategy developed to promote the specific interventions selected and associated behaviors. This document provides guidance on the individual, household, and community level behaviors for potential support of An. stephensi mitigation and control interventions in Africa.

While it is outside the scope of this document, malaria SBC strategies should consider interventions at the structural level (i.e., interventions outside the control of individuals, households, or communities), including access to malaria services and quality of services provided. Specific guidance on SBC approaches for malaria service communication and health care provider behavior change can be found in A Blueprint for Applying Behavioral Insights to Malaria Service Delivery.

# Process for identifying and prioritizing interventions

This guidance was developed through a systematic review of peer-reviewed and grey literature. The detailed review methodology is included as Annex 1.

The interventions included in the systematic review were selected through a preliminary desk review and consultations with the U.S. President's Malaria Initiative (PMI) based on the following criteria:

- The intervention has the potential to be effective against *An. stephensi*.
- The intervention is likely to be included in the immediate response to *An. stephensi* in areas where it has been identified and/or those at elevated risk of invasion.
- The intervention has an individual, household, and/or community component.

Based on these criteria, the document includes SBC guidance for promoting core malaria interventions including insecticide-treated nets (ITNs), indoor residual spraying (IRS), and care-seeking for fever, which are already included in SBC strategies across sub-Saharan Africa (SSA). There is reason to believe these interventions may be effective against some *An. stephensi* mosquitoes and *An. stephensi* mosquitoes may co-exist with other *Anopheline* mosquitoes that can be controlled with these interventions. Therefore, this document provides unique considerations for their promotion in areas where *An. stephensi* has been identified or where there is a high risk of invasion.

The document also includes considerations for larval source management (LSM) interventions which have not been as widely applied for malaria control in the sub-Saharan African setting. This includes larviciding at household and community level and finding and removing standing water. Covering water storage containers has also been included in the document because it is being considered as an intervention to address *An. stephensi* response in some contexts in SSA. However, this intervention can be challenging to implement effectively and is therefore not broadly recommended. This document provides guidance on specifications for carrying out the intervention effectively, under circumstances where it is being implemented.

Additional interventions have been used to control *An. stephensi* in other contexts, including larvivorous fish and personal protection measures, but they were not ultimately included in the systematic review or guidance document as they are unlikely to be a part of the current *An. stephensi* response strategy in Africa.

Additional interventions are currently being evaluated for public health impact against malaria more broadly that may be considered for inclusion in the *An. stephensi* response in the future. This includes interventions such as attractive targeted sugar baits (ATSB), spatial repellents, mass drug administration (MDA) of an endectocide to humans and/or livestock, and housing modifications.[1] Both endectocides and ATSBs, for example, have the potential to target indoor and outdoor biting mosquitoes as well as mosquitoes that feed on humans and animals. Integrating relevant SBC considerations for these interventions in the future, if and when they are considered for wider implementation, can help to ensure the effectiveness of these new interventions.

# How to use this document

As a program defines their response to *An. stephensi,* and identifies specific interventions of interest, this document can be used to provide considerations for implementing the SBC aspects of those interventions to maximize effectiveness. Ideally, the information contained in this guidance can be incorporated into SBC aspects of malaria strategies and ongoing program activities. This guidance should be paired with local data to ensure SBC is tailored effectively. Examples of important complementary data include context-specific breeding sites; priority audiences for targeted SBC messages, including higher risk and mobile populations where applicable; and setting-specific psychosocial and contextual factors that influence behaviors of interest. Existing data from sources such as Malaria Behavior Surveys can be used to help inform SBC for core malaria behaviors. Formative research, which includes qualitative and/or quantitative methods to inform program design and implementation, can be helpful to guide SBC for interventions that have not been as widely used for malaria.

The overlap in vector behavior and geographic locations between *An. stephensi* and *Ae. aegypti,* as well as with other mosquito species, presents the opportunity for integrated approaches to vector control and SBC interventions. Where appropriate, programs should consider integrating SBC for *An. stephensi* into existing SBC strategies for malaria and/or arboviral disease control, as well as water, sanitation, and hygiene (WASH) programs, where applicable.

# Social and behavior change considerations for the *An. stephensi* response

## Cross-cutting considerations

**Cross-cutting considerations** for SBC strategies to address malaria transmitted by *An. stephensi* include:

- Ensure target behaviors are feasible in terms of time, skills, and resources.
- Ensure SBC approaches meet the needs of target population(s) by considering
  - Levels of literacy.
  - Local languages and cultural appropriateness.
  - Appropriate channels, including informal communication channels, to reach higher risk and mobile populations, e.g., construction workers, miners, agricultural workers, and daily or seasonal workers, as well as those who frequently move between rural to peri-urban and urban areas. Contextually relevant higher risk groups should be identified in the target area and channels tailored accordingly.
- Identify and engage contextually relevant community leaders and community-based civil society organizations early in the process. This may include religious leaders, faith-based organizations, trade unions, rotary groups, scout groups, and others.
- Promote inter-sectoral collaborations such as municipal, transportation/commerce, education, and employer-based programs to increase engagement and promote target behaviors.
- Promote collaborations across malaria partners for a comprehensive malaria response (e.g., service delivery, SBC, vector control).
- Tailor SBC activities and message framing to communicate in accordance with the level of *An. stephensi* risk.

## Drawing from Risk Communication

To address the threat of *An. stephensi*, it is important to **act early**. In all contexts, it is important to raise awareness about the threat of *An. stephensi* and ensure people have the information and resources necessary to act. Malaria SBC strategies for *An. stephensi* should draw from principles of risk communication to inform communities about this new threat with basic information about the invasive mosquito and why it requires attention at this time. Keeping communities informed about emerging or potential threats is important for building and maintaining trust in the malaria response and creates a foundation for mitigating potential rumors. The information in the box below may be used to craft messages for use in any malaria SBC strategy and should be adapted and used in areas where *An. stephensi* has been detected or areas with elevated risk of invasion.

### Key Information to Communicate: The Emerging Risk of *An. stephensi*

- Malaria can be transmitted by various types of Anopheline mosquitoes.
- The malaria-transmitting mosquitoes that are common in most of Africa prefer to lay eggs in natural water bodies.
- In much of South Asia, such as Pakistan and India, the predominant malaria-transmitting mosquito is called *Anopheles stephensi*. This mosquito prefers to lay its eggs in artificial containers and other human made structures, often present in more urban areas.
- *Anopheles stephensi* is migrating to new areas and has been identified in several African countries recently, posing a new malaria threat.
- *An. stephensi* acts differently than the more common malaria mosquitoes in Africa. It may be prevalent in both rural and urban areas as well as in both rainy and dry seasons. This means that areas with *An. stephensi*, particularly urban areas, may experience greater malaria risk than in the past and could experience malaria outbreaks in dry seasons.
- The *An. stephensi* mosquito [has/has not yet] been detected in this country and the malaria program is monitoring its spread to keep the public informed.
- It is important to follow guidance from your country's malaria program to protect you and your family from this new risk.

## Considerations by invasion status

**In areas where *An. stephensi* has been identified,** it is likely that interventions that have not been as widely implemented, such as LSM, may be utilized. In locations where an intervention is new or less familiar, it is important to let people know why it is being implemented. Additionally, it is necessary to emphasize the importance of maintaining malaria-related behaviors such as ITN use, acceptance of IRS (where relevant), and prompt care seeking for fever in areas where these behaviors are already high and increase them in areas where they are below target levels. Furthermore, it is important to raise awareness that *An. stephensi* can persist in the dry season and therefore it is necessary to promote the practice of these interventions all year long. Increasing awareness of *An. stephensi* threat in these areas, including its ability to transmit malaria year-round in both urban/peri-urban and rural areas, is key to alerting people at risk and ensuring they know why there is a different approach towards this vector.

**In areas at elevated risk of invasion,** it is important to promote and increase core malaria-related behaviors, including prompt care seeking for fever to identify potential spikes in cases. Areas at risk of invasion should also be informed about *An. stephensi* identified in neighboring countries and the associated impacts of the invasion on malaria transmission to highlight the need to engage in malaria-related behaviors. A country's response to the threat of *An. stephensi* will vary based on local context as there is not one set of guidance that is representative of all contexts.

**In areas at low or no risk of invasion,** it is important to continue following current malaria control guidance and SBC best practices. Key resources with general SBC guidance are included by intervention in the tables below.

## Considerations by malaria transmission setting

**In traditionally low or very low transmission settings,** such as urban areas, perceived risk of malaria is often lower and may correspond to lower levels of malaria-related behaviors, such as ITN use, lower levels of acceptance and increased difficulty of IRS implementation, and less frequent care seeking for fever.[2] In these locations, programs need to emphasize why these core malaria-related behaviors, and perhaps new ones, are now critical. *An. stephensi* is particularly relevant to urban areas, and, thus, they might become high transmission settings for *An. stephensi*-transmitted malaria. Consequently, these areas may be where an initial peak in malaria cases are first detected or where the vector is first identified within a country.

**In traditionally moderate to high transmission settings,** such as rural areas, uptake of core malaria interventions tends to be higher. In these settings, it is important to reinforce existing behaviors and continue to promote core malaria interventions, especially where new interventions are being introduced. Initial detection of the *An. stephensi* vector or increases in malaria transmission may be less obvious in these higher transmission settings, however this will be dependent on the local context.

**In all areas,** higher risk groups should be locally defined and targeted with SBC to reinforce uptake of core interventions. Where new interventions are being implemented, SBC should include all affected stakeholders in the intervention areas.

| | An. stephensi identified | At high risk of An. stephensi invasion |
|---|---|---|
| **SBC for core malaria-related behaviors (ITNs, IRS, care-seeking)** | Enhance practice of core malaria-related behaviors with emphasis on continuing practice throughout the dry season as these interventions may be effective against *An. stephensi* and continue to be important in the control of other malaria vectors. | |
| **SBC for new or expanded LSM interventions or other novel interventions** | Inform why novel, expanded, or additional LSM interventions or other novel interventions may be implemented to complement core interventions. Clearly describe the actions expected of individuals, households, and communities, and provide opportunities to practice the behaviors through hands-on trainings and demonstrations between community members and malaria program staff. | Inform about *An. stephensi* identified in neighboring countries and surveillance efforts to monitor its spread to demonstrate public health preparedness. |

# Specific SBC guidance for selected *An. stephensi* interventions

The seven tables below correspond to the interventions selected for the literature review. The tables provide evidence-based SBC guidance for promoting individual, household, and community level behaviors in support of each intervention. In this document, the intervention-specific tables are organized into two broad categories: core malaria interventions (ITNs, IRS, and care-seeking) and LSM interventions (household larviciding, community larviciding, regularly finding and removing standing water, and covering water storage containers). For each intervention-specific table, the following sections are included:

1. Description of the intervention.
2. Behavior overview.
3. Specific steps to effectively carry out the behaviors.
4. Lessons learned from SBC programs (these are specifically drawn from the literature review and focused on areas where *An. stephensi* has been identified or is endemic).
5. Risk framing for messaging (depending on *An. stephensi* risk-level).
6. SBC recommendations (for areas where *An. stephensi* has been identified).

The **behavior overview** provides a snapshot of the behavior along several key categories that can directly inform SBC strategies:

- **Feasibility**: **Easy** – **Moderate** – **Difficult**
  - With increasing difficulty of the behaviors, consider whether the behavior is necessary to promote at this time, and examine any structural barriers that may impede optimal uptake. Addressing these will help provide adequate support and enough guidance for the behavior to be implemented effectively.
- **Overlap with *Aedes aegypti* control**: **Easy** – **No**
  - Where a behavior overlaps with *Aedes aegypti* control, leverage the opportunity to coordinate with *Aedes* control programs to harmonize SBC efforts.
- **Familiarity of behavior in malaria control**: **Broadly familiar** – **Familiar in some areas** – **Novel**
  - Where a behavior is novel or less familiar, emphasize why it is important, build knowledge about the necessary steps to carry it out, and where applicable, provide the opportunity for people to practice the behavior. Test and refine SBC approaches before large scale implementation.
  - Where a behavior is novel and *Aedes aegypti* is present, identify opportunities to integrate behavior promotion with *Aedes aegypti* control programs.
- **Primary audience:** Persons expected to carry out the behaviors
- **Secondary audience:** Persons or groups who are influential to the primary audience
  - Suggested primary and secondary audiences are provided, however, ultimately the selection of audiences should be locally tailored and informed by country data.

- **Behavioral objectives:** *Clear statements about which behaviors to influence.*
  - Behavioral objectives provide clear direction and goals for SBC strategies. Each objective is specific to a single behavior and includes the applicable audience. Behavioral objectives should ultimately be relevant to the local context and align with the monitoring and evaluation indicators of the SBC strategy.

**Key resources:** Refer to the National Malaria SBC Strategy Template and How-to Guide of the RBM SBC Working Group for guidance on SBC strategy development.

# Core malaria interventions

Promoting acceptance and use of core malaria vector control interventions can be a key component of the *An. stephensi* response; the level of importance will depend on local vector behavior. Three core malaria interventions relevant to the *An. stephensi* response in Africa are included in this guidance:

1. **Insecticide-treated nets (ITNs)**
2. **Indoor residual spraying (IRS)**
3. **Prompt care-seeking for fever**

Most countries will already promote behaviors around these interventions in their SBC strategies and should continue to do so in the face of *An. stephensi* presence or threat **in both rural and peri-urban/urban areas**. Malaria programs should continue to implement the SBC strategies that are already in place for these interventions, and a wealth of best practices exist to guide these strategies with ample experience coming from rural areas. However, in urban areas, SBC strategies may need to increase malaria risk perception and target and/or be tailored to groups of people at higher risk for malaria. This may include groups such as migrant or construction workers who move between higher and low transmission areas or whose risk may be increased due to their occupation. Also in urban areas, where malaria transmission tends to be lower, there can be unique considerations for promoting uptake of these core interventions that are highlighted in this guidance. For example, prompt care-seeking for fever, which is not only important for health outcomes, but also is critical for identifying new malaria cases and triggering entomological surveillance, should continue to be emphasized.

The tables below describe the SBC considerations for programs when implementing each of these interventions with populations in areas where *An. stephensi* is present or a risk (both urban and rural), with inclusion of **unique considerations for urban areas**.

| **Category: Core malaria interventions** | |
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| **Intervention: Insecticide-treated nets** | |
| **Description** | **Intervention:** Mosquito nets treated with chemicals either as single products or combinations are to be properly hung over sleeping spaces to protect primarily from nighttime biting mosquitoes.<br><br>**Behavior:** Use ITNs every night, care properly for ITNs and replace them when no longer effective. |

**Behavior overview**

- **Feasibility: Moderate**
- **Overlap with *Aedes aegypti* control*:* No**
- **Familiarity of behavior in malaria control in SSA: Broadly familiar**
- **Primary audience:** Household heads and caregivers of children under five years of age; pregnant women (ITNs delivered at ANC visits); higher risk groups including construction workers and mobile populations.
- **Secondary audience:** Community and religious leaders; antenatal care (ANC)/Expanded Program on Immunization (EPI) clinic staff; construction site employers.
- **Behavioral objectives:**
  - Increase the proportion of individuals that use ITNs every night and all night long.
  - Increase the proportion of travelers that use ITNs every night on trips away from home.
  - Increase the proportion of individuals who properly care for ITNs.
  - Increase the proportion of individuals that replace ITNs when they are no longer effective.

**Steps to effectively carry out behaviors**

**ITN acquisition through available channels**

- Register the household in ITN mass distribution campaigns and obtain ITNs during the campaign.
- Obtain ITNs through other available channels, including health-facility (through ANC and EPI), school and community health workers.
- Acquire enough ITNs to cover all household members through all available channels.

**ITN use**

- Hang nets properly over sleeping spaces upon receipt.
- Carefully tuck in nets around sleeping space.
- Ensure all family members use ITNs every night all year long.
- Use nets regardless of shape or color.
- Sleep under a net indoors and outdoors, as possible.
- Ensure individuals use ITNs at night while traveling away from home.

**ITN care**

- Tie or fold up nets when not in use.
- Handle nets gently and keep them away from playing children and pests.
- Wash nets only when dirty and no more than once every three months.
- Wash nets gently in a basin with water and mild soap.
- Replace ITNs when no longer usable for sleeping under.
- Beneficial repurposing of ITNs at end of life
- Use ITNs that are no longer useful for sleeping to patch other ITNs; e.g., turn them into curtains or window screens or stuff into open eaves.

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| **Lessons learned relevant to SBC programs in urban areas** | In the literature, most publications describing ITN campaigns or programs for malaria control occur in rural areas. As a result, peer-reviewed evidence in this section describing SBC considerations to promote ITN use in urban settings is limited. Findings include:<br>• SBC strategies should promote consistent net use all night long and throughout the year and promote replacement options, emphasizing ongoing net care and replacement as a household responsibility.[3]<br>• Where supplemental vector control interventions (such as LSM) are promoted, it is important to clarify that these are not sufficient to control malaria and to maintain promotion of ITNs and IRS in households where they are part of the existing strategy.[4,5]<br>• Special focus should be given to higher risk groups, including reminding travelers to use ITNs when away from their homes.[5]<br>• ITN use among pregnant women in urban areas is lower than in rural areas in some contexts, highlighting need for increased outreach to pregnant women in urban areas specifically (ANC and radio were recommended).[6]<br>• Two key considerations in urban populations compared to rural populations that may elicit a different response to malaria include an overall lower immunity to malaria at the population level and lower acceptability and/or use of ITNs.[7] |
| **Risk framing** | • In areas of low or very low transmission, increase perceived risk of malaria by raising awareness of the novel *An. stephensi* threat and how this new vector can increase malaria even in areas where rates of malaria have been low. Draw on risk communication best practices to balance raising perceived risk along with the confidence that using an ITN properly all night, every night, will help protect against this risk.<br>• In areas where levels of ITN use are already high, promote continued ITN use as new interventions targeting *An. stephensi* are introduced emphasizing that all interventions are needed to reduce risk.<br>• In areas where levels of ITN use are low or moderate, raise awareness about why this behavior is necessary to address this new threat and ensure people know how to access additional ITNs if they need them.<br>• In all settings, raise awareness that *An. stephensi* can persist in the dry season, and therefore, ITNs should be used all year long, regardless of season. |

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| **SBC recommendations** | • Access to enough ITNs in the household is generally the most important determinant of ITN use; therefore, it is important to ensure high levels of net coverage in affected areas and among higher risk groups.<br>• ITN use is often associated with feeling confident in one's ability to use ITNs, confidence that ITNs are effective, and belief that ITN use is a social norm in one's community.<br>• Promote the non-health benefits of ITNs, such as getting a good night's sleep, privacy, and peace of mind that mosquitoes will not bite one's family.<br>• Regular/nightly reminders can be helpful to maintain ITN use.<br>• Because net care is a maintenance behavior that needs to be practiced even more as nets get older, periodic reminders starting at a mass distribution with increasing frequency at one- and two-years post-distribution may be useful.<br>• Given *An. stephensi* resistance profile, programs that distribute new types of nets may want to ensure their SBC communicates that people are receiving the best type of net for their area and anticipate any rumor mitigation.<br>**In urban areas**<br>• Given the limitations often associated with ITN distribution in urban areas, build demand for ITNs, and emphasize the importance of net acquisition among urban populations, including through private sector and ANC/EPI channels.<br>• Especially in areas of lower malaria transmission, identify higher risk groups (e.g., construction workers, travelers, mobile populations) and target SBC for ITN use to them. Ensure those groups have sufficient access to ITNs to use while working or away from home.<br>• When targeting higher risk groups, such as migrant or construction workers, SBC interventions should consider local languages and effective use of informal communication channels. For those groups whose risk is tied to occupation, involvement of labor employers and building contractors can support effective messaging.<br>• Because pregnant women and children continue to be a vulnerable population for malaria, if ITNs are distributed through ANC and EPI channels, leverage the opportunity for health care providers to emphasize the importance and ease of ITN use with clients.<br>• Where LSM activities are being implemented, emphasize the importance of consistent ITN use as well; these interventions work together to reduce risk. |

**Key resource:** For more general SBC recommendations for ITNs that are relevant to all contexts, please refer *to* Social and Behavior Change for Insecticide-Treated Nets as well as the RBM Consensus Statement on Repurposing ITNs

| **Category: Core malaria interventions** | |
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| **Intervention: Indoor residual spraying** | |
| **Description** | **Intervention:** Application of a residual insecticide to surfaces where malaria vectors rest, such as internal walls, eaves and ceilings of houses or structures (including domestic animal shelters).[7]<br><br>**Behavior:** Accept application of IRS including making structures eligible, remove household belongings, and avoid post-spray wall modification. |
| **Behavior overview** | • **Feasibility: Moderate/Difficult** to prepare household and remove all possessions from household<br>• **Overlap with *Aedes aegypti* control: No**<br>• **Familiarity of behavior in malaria control in SSA: Familiar** in some areas where IRS has been implemented to address other species of Anophelines<br>• **Primary audience:** Heads of households<br>• **Secondary audience:** Community and religious leaders<br>• **Behavioral objectives:**<br>- Increase the proportion of households who accept IRS application in their homes.<br>- Increase the proportion of households who are willing to remove household belongings during IRS.<br>- Increase the proportion of households who avoid post-spray wall modification. |

**Steps to effectively carry out behaviors**

**Before and during spraying**

- Prior to spraying, prepare the home according to community leaders, mobilizers, and spray operator instructions.
- Tether or put away any animals, including guard dogs, keeping them at least 10 meters away from the outer wall of the house.
- Move all removable household items at least 10 meters away from the outer wall of the house, such as food and water, food and water containers, cooking utensils, items hanging on walls, clothing, toys, furniture, and mosquito nets.
- Items that cannot be removed should be moved to the center of the room and covered with a plastic sheet.
- Close all doors and windows.
- Ensure children are kept at least 10 meters away from the house during insecticide mixing and spraying.

**After spraying**

- Wait at least two hours before entering a house that has been sprayed, to allow the walls to dry.
- After two hours, open the doors and windows to let in air for 30 minutes.
- Sweep the floors before other people and animals are allowed to enter the home, and any insects or dirt should be either thrown into a pit latrine or buried in a pit 50 cm deep.
- Domestic animals and pets should not be allowed to feed on any dead insects from the sprayed home.
- The sprayed walls should not be cleaned, painted, or plastered for at least the amount of time specified in instructions.[8]

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| **Lessons learned relevant to SBC programs in urban areas** | Implementation of IRS for malaria control is often limited to rural areas. As a result, the identified peer-reviewed literature in this section describing SBC considerations to promote IRS uptake in urban settings is limited. Findings include:<br>• It is important to understand the unique barriers to IRS acceptance and engage communities and leaders effectively from planning through implementation. Barriers may include logistical or social barriers to removing household possessions, low perceived effectiveness of IRS, perceived increase in other insects, physical side effects, concerns about IRS activities being politically motivated, selection and performance of spray operators, or previous negative experience with IRS campaign.[9,10]<br>• Providing information sessions, opportunities to answer follow-up questions, and active participation of community leaders can help to overcome barriers.[9]<br>• SBC should emphasize the importance of high IRS coverage for promoting both familial and community health and have clear communication and engagement with community leaders during spray operator selection and spray implementation.[10]<br>• A comparative evaluation of a community-based IRS pilot study in Ethiopia found that the community-based IRS was slightly less expensive and was of potentially higher quality compared to the district-based model due to longer one-on-one training of sprayers, more frequent supervision or sprayers, a greater sense of ownership and added diligence of spray by the operators, and increased community trust of the spray operators within the community model compared to the district-based model.[11]<br>• Two key considerations in urban populations compared to rural populations include an overall lower immunity to malaria at the population level and lower acceptability of IRS.[7] |
| **Risk framing** | • If IRS is implemented in any areas of low or very low transmission, increase perceived risk of malaria by raising awareness of the novel *An. stephensi* threat and how this new vector can increase malaria even in areas where rates of malaria have been low. Draw on risk communication best practices to balance raising perceived risk along with the confidence that accepting IRS in their households will help protect against this risk.<br>• In areas where levels of IRS acceptance are already high, promote continued IRS acceptance as new interventions targeting *An. stephensi* are introduced emphasizing that all interventions are needed to reduce risk.<br>• In areas where levels of IRS acceptance are low or areas where IRS may be newly introduced as part of the response to *An. stephensi,* it is important to emphasize this new threat and raise awareness about why IRS is important to address it. |

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| **SBC recommendations** | • Messaging should be tailored to the context based on how new or established the IRS program is to a specific location.<br>• Ensure early engagement with community leaders and promote messages through trusted sources of information.<br>• Provide opportunities for community members to ask questions, e.g., community dialogues (community-based forums and call-in radio shows) to allay concerns about the spray process.<br>• Work with community leaders during selection of spray operators and ensure transparent process. Ensure spray teams (community-based mobilizers and spray operators) comprise respected members of community, including women.[8] |

**Key resource:** For more general SBC recommendations for IRS, please see the VectorLink training curriculum modules on community mobilization and VectorLink pocket guide.

| **Category: Core malaria interventions** | |
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| **Intervention: Prompt care-seeking for fever** | |
| **Description** | **Intervention:** Early care seeking for fever to enable appropriate management of malaria cases.<br><br>**Behavior:** Seeking care within the same day or next day (i.e., 24–48 hours) of fever onset |
| **Behavior Overview** | • **Feasibility: Moderate**<br>• **Overlap with *Aedes aegypti* control**: **Yes**<br>• **Familiarity of behavior in malaria control in SSA: Broadly familiar**<br>• **Primary audiences:** Caretakers of children under 5; higher risk groups for malaria e.g., mobile populations, construction site workers; pregnant women<br>• **Secondary audiences:** Community and religious leaders; health care facility staff; construction site employers<br>• **Behavioral objective:**<br>- Increase the proportion of individuals who seek care at a health facility for febrile illness within 24–48 hours of symptom onset. |

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| **Steps to effectively carry out behaviors** | • Recognize the signs and symptoms of malaria which include fever, chills, fatigue, sweating, nausea, and/or diarrhea.<br>• Seek care within 24–48 hours of symptom recognition with a community health worker or at a local health care facility to be tested for malaria.<br>  - Prompt care-seeking for fever is especially important for children under five years old.<br>• Following a positive malaria test result take the full course of antimalarial medication provided.<br>• Following a negative malaria test result, continue to monitor symptoms and follow the advice of the health care provider. |
| **Lessons learned relevant to SBC programs in urban areas** | In the literature, most publications describing prompt care seeking for fever occurred in rural areas. As a result, the peer-reviewed evidence in this section for SBC considerations to promote prompt care seeking for fever in urban settings is limited. Findings include:<br>• Construction sites can create breeding sites for *An. stephensi*. There is a need to intensify malaria SBC activities for construction site workers for *An. stephensi* control.[12]<br>• Use of SBC materials in local languages, use of informal communication methods, and involvement of labor employers and building contractors can support effective SBC efforts aimed at migrant worker populations.[12]<br>• SBC programs should focus on the importance of seeking care early and awareness of danger signs.[13]<br>• In urban areas, many health professionals operate in both the public and private health sectors leading to a multiplicity of care delivery points and sources of information for the public. This complexity makes behavior change communication and action around treatment-seeking behavior and health care delivery in urban areas intricate and dynamic.[7] |
| **Risk framing** | • In areas of low or very low transmission, increase perceived risk of malaria by raising awareness of the novel *An. stephensi* threat and how this new vector can increase malaria even in areas where rates of malaria have historically been low and during dry season. Inform that fevers that may not have previously been thought to be malaria, could now be.<br>• Draw on risk communication best practices to balance raising perceived risk along with the confidence that seeking prompt care for fever with a qualified health care provider is the best way to obtain a malaria test and a correct diagnosis and treatment. |

**SBC recommendations**

- Reinforce the importance of continued prompt care-seeking for fever as new interventions targeting *An. stephensi* are introduced.
- Communicate about the importance of an accurate diagnosis from a qualified health provider for the cause of fever, as cases of malaria require medication but antimalarials will not cure other illnesses.
- Convey the urgency of seeking care for fever quickly, especially in children, as malaria can quickly become severe and life-threatening without prompt treatment.
- If community health workers are equipped to test and treat for malaria, conduct SBC to inform about the availability of this service and build demand for it.
- Prompt care-seeking for children with fever is often associated with feeling confident in one's ability to take this action, having correct knowledge about how and when to seek care, discussing malaria with a spouse or others, and the perception that prompt care-seeking for fever is a social norm in one's community. SBC programs can be designed to increase these key factors and improve care-seeking behavior.
- Ensure health workers are informed of *An. stephensi* threat, including risk in urban areas and during dry season, to ensure prompt testing and appropriate SBC are provided in health facilities.
- On worksites where malaria risk is a concern, SBC programs should collaborate with worksite managers to support their workers to seek care for fever including getting a malaria test.

**In urban areas**

- Because malaria transmission tends to be low in many urban areas, it is important to raise awareness about the threat of *An. stephensi*, increase recognition of malaria danger signs, and promote prompt care-seeking (see risk framing above).
- Context-specific higher risk groups living in or traveling to and from urban areas should be the focus of urban malaria SBC strategies and formative data on these groups will be necessary for approaches to be strategic.
- Recognizing that some groups in urban areas may be at higher risk for *An. stephensi* malaria due to their occupation, involve employers where possible, including building contractors, to produce SBC materials in the language of workers (if migrants), and consider the need to use less formal communication networks or methods to reach them.

**Key resource:** For more general SBC recommendations for case management, please refer to Monitoring And Evaluation For Social And Behavior Change Communication: Guidance Tailored to Malaria Case Management Interventions and Desk Review and Qualitative Assessment of Case Management SBCC Strategies in Four Countries

# Larval source management

Four LSM interventions are included in this guidance:

1. **Household larviciding**
2. **Community larviciding**
3. **Regularly finding and removing standing water**
4. **Covering water storage containers**

For many countries in Africa, all but community larviciding may be novel to the population, while some may be promoted in specific areas where diseases transmitted by *Aedes aegypti* are a concern. In other words, experiences in both promoting and performing these behaviors will vary greatly across contexts. Malaria SBC programs will need to take this into account and decide on whether it will be appropriate for an SBC strategy for *An. stephensi* malaria to be integrated with other mosquito control efforts.

The tables below describe the SBC considerations for programs when implementing each of these interventions with populations in areas where *An. stephensi* is present or at risk. The necessary risk framing for each intervention will depend on its context.

| **Category: Larval source management** | |
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| **Intervention: Household larviciding** | |
| **Description** | **Intervention:** Consists of trained vector control technicians or household members applying larvicide to containers in and around people's homes and/or monitoring insecticides post-application. Larvicide is applied to containers that hold standing water not used for drinking and which cannot be effectively covered, dumped, or removed.[14] The interval of larvicide application is regular and will vary by type of product used.<br><br>**Behavior (technician-applied):** Accept application and monitoring of larvicide to household water containers or other larval sources by vector control technicians and follow instructions of vector control technicians on the maintenance of water containers in between larvicide applications.<br><br>**Behavior (household-applied):** Conduct application and monitoring of larvicide to household water containers or other larval sources and follow instructions of vector control technicians on the maintenance of water containers in between larvicide applications. |

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| **Behavior overview** | • **Feasibility: Moderate (when technician-applied)**; **Difficult** (when household applied)<br>• **Overlap with *Aedes aegypti* control**: **Yes**<br>• **Familiarity of behavior in malaria control in SSA: Novel**<br>• Primary audiences: Persons who manage water in households in larvicide program areas and heads of household<br>• **Secondary audiences:** Community leaders<br>• **Technician-applied behavioral objectives:**<br>- Increase the proportion of households who accept larvicide application in household larval sources by vector control technicians.<br>- Increase the proportion of households that properly maintain treated household larval sources between larvicide applications by vector control technicians.<br>• **Household-applied behavioral objectives:**<br>- Increase the proportion of households or community members that correctly and consistently apply larvicide to household larval sources.<br>- Increase the proportion of households that actively monitor household larval sources between larvicide applications. |

**Steps to effectively carry out behaviors**

- **Technician-applied:**
  - With technician, identify water storage containers and other larval sources for larviciding in and around the home.
  - Follow indications on whether the larvicide being used is safe for animal and human drinking water.
  - Between larviciding interventions monitor larvicide post application to ensure no larvae are present in previously treated larval sources or water containers.
  - Do not remove larvicide product from the water storage containers or other treated larval sources.
  - Notify technician of new larval sources in and around the household.
  - Contact technician if questions arise.
- **Household-applied:**
  - Participate in training with vector control technicians to identify water storage containers in and around one's home and learn to apply larvicide.
  - Identify water storage containers or larval sources for larviciding in and around the home.
  - Apply larvicide to water sources based on instructions.
  - Follow indications on whether the larvicide being used is safe for animal and human drinking water.
  - Do not remove larvicide product from the water.
  - Reapply according to instructions.
  - Identify new water-storage containers or household larval sources in and around the household.
  - Monitor larvicide post application to ensure no larvae are present in previously treated containers.
  - When product supply runs out, follow instructions provided for restocking.
  - Contact technician if questions arise.

**Lessons learned from the literature relevant to SBC programs**

There is limited literature describing the implementation or promotion of household larviciding for *An. stephensi* specifically. As a result, much of the peer-reviewed literature identified on household larvicide programs in this section comes from literature on *Aedes aegypti*, dengue, and/or Zika control programs, rather than *Anopheles stephensi* or malaria-specific literature.

Findings include:

- Access to breeding sites within households and private compounds is crucial to the success of technician-applied or technician-assisted household larviciding but can pose a significant challenge especially in urban areas.[15–17]
- Early and meaningful engagement with communities and use of technicians that are trusted by the community can help to overcome barriers to entering homes.[15,16,18,19]
- Use or refill of water between larvicide applications could dilute the product,[15] suggesting the need for clear messaging about how to manage water containers between larvicide applications.

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| **Risk framing** | • Household or technician-led larviciding will likely only be implemented in areas where *An. stephensi* has been identified. Communication in these areas should explain the novel threat, why this intervention, which may be new to them is important, and the overall safety of larvicide. Draw on risk communication best practices to balance raising perceived risk along with the confidence that participating in household larviciding will help reduce the family's exposure to malaria vectors.<br>• Neighboring countries to the ones where the vector has been identified should be made aware of the new threat so that they can act early should *An. stephensi* be identified. |
| **SBC recommendations** | **Technician-applied:**<br>• From an SBC programmatic lens, the application of larvicide by technicians in and around homes is an intervention with many parallels to IRS; therefore, lessons learned from engaging communities in IRS will be applicable.<br>• Ensure early and consistent engagement with the community, including community leaders.<br>• Ensure clear messaging about the specific steps for household members to follow.<br>• Use mass media or other appropriate channels to inform communities in advance of when vector control technicians will be in their area.<br>• Ensure trusted messengers deliver SBC information and conduct community engagement.<br>• When possible, ensure technicians are trusted members of the community.<br>• Ensure visits are timed around when heads of households, or representatives, will be available.<br>**Household-applied:**<br>• Need early and consistent engagement with community, including community leaders.<br>• Ensure clear messaging about the specific steps for household members to follow.<br>• Ensure trusted messengers deliver SBC information and conduct community engagement.<br>• Increase self-efficacy to apply and monitor larvicide for example through trainings that provide opportunities to practice application and receive feedback from vector control technicians. |

| Category: Larval source management | |
|---|---|
| **Intervention: Community larviciding** | |
| **Description** | **Intervention:** Larviciding entails the regular application of biological or chemical insecticides to artificial and natural water bodies within a community to eliminate mosquito larvae.[7]<br><br>**Behavior:** Support efforts to identify all community breeding sites and accept application of larvicide in identified breeding sites. |
| **Behavior overview** | • **Feasibility: High**<br>• **Overlap with *Aedes aegypti* control: Yes**<br>• **Familiarity of behavior in malaria control in SSA: Familiar in some areas** where larviciding has been applied to target other species of Anopheles<br>• **Primary audience:** Civil society organizations; community leaders; construction site managers; school leadership; pastoralist communities<br>• **Secondary audience:** District health teams<br>• **Behavioral objectives:**<br>- Increase the proportion of individuals who participate in the community effort to identify all community breeding sites.<br>- If in applicable contexts, increase the acceptance of larvicide application in identified community breeding sites. |
| **Steps to effectively carry out behaviors** | • Accept application of larvicide by vector control technicians to the identified breeding sites.<br>• In applicable contexts, with technicians, individuals can contribute to the identification and mapping of all community breeding sites, including construction areas, empty lots, schools, health posts, community centers, and others.<br>– At these sites, identify water sources that are stagnant and cannot be emptied or removed, such as cisterns, wells, gutters, and fountains.[20] |

**Lessons learned from the literature relevant to SBC programs**

There is limited literature describing the implementation or promotion of community larviciding for *An. stephensi* specifically. As a result, the peer-reviewed literature identified on community larvicide programs in this section comes from literature on *Aedes aegypti*, dengue, Zika, or broader malaria control programs.

- Building trust and utilizing community-based systems have been shown to increase acceptance and impact for community larviciding. Examples include implementation through community-based staff or task forces or through engagement with specific sub-communities such as rice farming cooperatives or pastoralist communities.[4, 21–23]
- Emphasizing safety as well as demonstrating personal and community benefit can help to increase acceptance. This can include not only benefits for malaria control but also reduction in nuisance biting.[24–27]
- Ensuring sufficient training, particularly in habitat and larval identification, is important to the success of community larviciding programs.[18, 28]
- Iterative cycles of research, feedback, and discussion can help inform SBC and social engagement strategies and build the relational capital needed to make community-directed larvicide a viable approach.[29]

**Risk framing**

- Community larviciding may already be implemented for other *Anopheles* mosquitoes, or it may be newly implemented in areas where *An. stephensi* has been identified. Communication in these areas should explain the novel threat and why this intervention is important. Draw on risk communication best practices to balance raising perceived risk along with the confidence that seeking participating in community larviciding will help reduce the community's exposure to malaria vectors.
- Neighboring countries to the ones where the vector has been identified should be made aware of the new threat so that they can act early should *An. stephensi* be identified.

**SBC recommendations**

- If community larviciding is done on a seasonal schedule, it is important that programs explain clearly to communities the rationale behind the seasonal schedule and when they should expect larviciding activities to take place.
- From an SBC programmatic lens, the application of larvicide in communities is an intervention with many parallels to IRS, therefore lessons learned on engaging communities in IRS will be applicable.
- Ensure early and consistent engagement with community, including community leaders.
- Ensure trusted messengers deliver SBC information and conduct community engagement.
- Use mass media or other appropriate channels to inform communities in advance of when vector control technicians will be in their area.

| Category: Larval source management | |
|---|---|
| **Intervention: Finding and removing standing water** | |
| **Description** | **Intervention:** Regularly removing unintentional standing water both inside and outside of the house and in communal areas.<br><br>**Behavior description:** Identify mosquito breeding sites in and around both the home and community and remove them according to recommendations. Communal breeding site removal often requires collective action among community members and coordination with authorities, such as those responsible for trash collection. |
| **Behavior overview** | • **Feasibility: Moderate**<br>• **Overlap with *Aedes aegypti* control**: **Yes**<br>• **Familiarity of behavior in malaria control in SSA: Novel**<br>• **Priority audience:** Adults and children (household level); community leaders, religious leaders, neighborhood associations, civil society organization leaders, and construction site managers (community level)<br>• **Behavioral objectives:**<br>- Increase the proportion of individuals that participate in the regular identification of mosquito breeding sites in and around both the home and community.<br>- Increase the proportion of individuals that participate in the regular removal of mosquito breeding sites in and around both the home and community.<br>- Increase the number of community members and coordinating authorities that collectively work together to remove communal breeding sites. |
| **Specific behaviors to promote** | • Search around the premises of the home and communal spaces for areas and items that collect standing water not intended for storage.<br>• Turn over, empty, modify (e.g., slash tires, drill holes, add sand), put away (e.g., in dry covered place or under roof), or throw away any identified potential breeding sites in or around the home or throughout the community.<br>• Organize efforts at both the household and community level to search for and remove breeding sites on a weekly basis. |

**Steps to effectively carry out behaviors**

- Trained vector control technicians, health promoters, and/or trained community volunteers should conduct an initial household visit where they accompany family members in the initial identification of household breeding sites.
  - During the initial household visit, family members should learn about the most important *An. stephensi* breeding sites in the area and focus search and elimination efforts on those areas between checkup visits.
  - Following the initial household visit trained technicians should conduct checkup visits on a regular basis to answer any questions and help in identifying any new breeding site in and around one's home.
- Following adequate instruction on identification of potential breeding sites in and around the home, households should dedicate 15 minutes each week to identify and eliminate the mosquito breeding sites in and around the home and especially the yard. Look for any standing water, e.g., water not intended for storage.[30]
- Turn over, empty, modify (e.g., slash tires, drill holes, add sand), put away (e.g., in dry covered place or under roof), or throw away any identified potential breeding sites in or around the home or throughout the community. Items that cannot be discarded can be stored upside down or in a dry, covered place. Water for animals should be emptied and refilled often.
  - Tires are particularly challenging to empty of water and are preferably removed from the community. When removal of tires is not possible, place them under a roof to avoid rainwater or pierce holes in the tire to prevent collection of water.[31]
- Use a white plastic container to inspect water from potential breeding sites for larvae.[30]
- Use a list of typical *An. stephensi* breeding sites based on entomological data from the local context to focus efforts. Search for breeding sites in areas that are typical to the area, prioritizing artificial breeding sites. Documented *An. stephensi* breeding sites include:
  - Cement tanks, flowerpots, cisterns, roof gutters, overhead water tanks, water compartments in air conditioners, domestic water-storage containers, catch basins, stream margins and stream beds.[32–35]
  - In Pakistan, *An. stephensi* breeding sites identified included: water tanks, wells, fishponds, rice fields, canal seepage pools, irrigation channels, street pools, animal ponds, drains, and also wide range of tolerance for organically pollutant habitats.[36]
  - Do not limit the search to only water habitats that are clean, as *An. stephensi* has been found to adapt in areas high in organic content).[36] Know that the most favorable places for mosquito breeding are those containers exposed to rainwater, especially if under shade or where organic matter accumulates (e.g., leaves).[30]
- At the community level, pay attention to flood-prone areas, construction sites, and irrigation areas.[34] It is especially Important to monitor habitats in construction sites and around buildings to ensure new ones are not created.[37]
- At the community level, commit to weekly breeding site search and elimination brigades to work together.[30]

**Lessons learned relevant to SBC programs**

Limited literature describes the implementation or promotion of household and/or community level programs for finding and removing standing water for *An. stephensi* specifically. As a result, much of the peer-reviewed literature identified in this section comes from literature on *Aedes aegypti*, dengue, and/or Zika control programs rather than *An. stephensi* or malaria specific literature.

Findings include:

**Household level**

- General clean-up campaigns in which communities are informed they should clean their yards or communal areas without specificity on targets for removal often are limited in effectiveness.[38]
- In Kenya, source reduction was found to not be an individual issue, but a household and community issue, so SBC messages need to engage entire households and communities for long-term change. Caregivers were an appropriate focal point for the intervention due to their primary responsibilities related to water collection and storage but adhering to new container management requires commitment from entire households.[39]

**Community level**

- Removing standing water in the community should focus on where the breeding sites are located, avoiding general community cleanings, as efforts are diluted and less effective for eliminating mosquito breeding sites.[30]
- Mapping the breeding sites in the community under the leadership of community authorities and entomologists is a fundamental activity to ensure this behavior is focused on reducing the mosquito population.[30]
- The use of community maps is critical to focus the search on areas where stagnant water or rainwater tend to accumulate. It is recommended to focus the community search of breeding sites on schools, health posts, cemeteries, structures, or houses under construction, empty lots, and community centers (*Ae. aegypti* specifically).[30]
- Where there are limited resources and a need to select certain containers to be eliminated or modified, use entomological information to decide which to focus on. There is an argument to be made for managing permanent human-made containers first.[40]
- Community members should not only be provided with educational material for container elimination campaigns in their community, but also trained on how to prevent specific containers in and around their home from harboring mosquitoes.[41]
- Results from a study in urban slums in Pakistan assessing the role of positive deviants on community knowledge and acceptance of dengue control interventions such as finding and removing potential breeding sites indicate that locally identified solutions and community-made communication materials had strong ownership and acceptance from the community, and therefore may be a powerful community engagement tool.[42]

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| | • People may feel more empowered to act at the household level than to take collective action at the community level. For removal of tires and discarded containers at the community level often municipal and community cooperation is necessary for successful implementation. This can be a demotivating factor for persons who do not see action by their fellow community members or municipal leaders.[43]<br>• In Brazil, domestic garbage cans are a common location for *Aedes* larvae therefore, community engagement efforts that focus on waste reduction, allied with appropriate removal of garbage, would decrease the availability of these breeding sites and, potentially, *Ae. aegypti* density.[44]<br>• The support of local authorities, the environmental sector and non-governmental organizations is important for communal breeding site removal such as closing abandoned wells and covering active wells to prevent mosquito egg laying.[45]<br>• Effective implementation of a seven-point action plan where mosquito proofing of potential breeding habitats in every household is mandatory was recommended to sustain control of vector density and reduce perennial transmission of malaria in Chennai, India. The seven-point action plan, implemented and initiated through the state government, includes legislative measures and fines for non-compliance in mosquito proofing or removing all breeding sites. The plan recommends that special attention be given to construction workers and sites including ensuring any new construction is approved through the health department.[15]<br>• Because construction sites are in constant evolution, it is important to monitor larval habitats in construction sites to make sure new ones are not created.[37] |
| **Risk framing** | • Finding and removing standing water may already be promoted in some areas for other mosquito borne diseases or may be newly promoted in areas where *An. stephensi* has been identified. Communication in these areas should explain the novel threat and why this new intervention is important. Draw on risk communication best practices to balance raising perceived risk along with the confidence to take action to reduce the community's exposure to malaria vectors.<br>• Neighboring countries to the ones where the vector has been identified should be made aware of the new threat so that they can act early should *An. stephensi* be identified. |

| SBC recommendations | |
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| **SBC recommendations** | • For successful removal of breeding sites in and around the home, significant collaboration between vector control teams, SBC stakeholders, and other implementing partners is crucial to ensure individuals are provided with adequate support and specific instruction to effectively carry out the behavior.<br>  - For example, it is essential that technicians, health promoters, and community volunteers who conduct home visits accompany family members through the house and yard to identify breeding sites together, explain their life cycle and guide them on how to search for and eliminate larvae.[30]<br>• Families should be empowered with practical information about the life cycle or behavior of the mosquito.[30]<br>• People may be discouraged to remove breeding sites around their home if their neighbors do not do the same. Entire neighborhoods or contiguous housing blocks can be mobilized together for this purpose. In addition, to motivate individuals to act irrespective of their neighbors, SBC programs can explain that breeding sites in the yard of their own house are those that most put the family at risk.[30]<br>• Promote a "family detective" attitude to search for breeding sites, inform people of the characteristics of preferred *An. stephensi* breeding sites, and promote awareness of the possible variation in location of breeding sites in and around the home from week to week.[30]<br>• At the community level, it is necessary to motivate and mobilize action of the community and its leaders to organize brigades for elimination of breeding sites. This requires a pledge and weekly commitment by community members/neighbors potentially through a weekly breeding site search and elimination brigade.[30]<br>• Neighbors can be recognized at a community assembly for their work and positive results achieved. Community members should be encouraged to share their learning about elimination of breeding sites with their neighbors to increase community commitment for everyone.[30]<br>• SBC programming efforts should ensure that vulnerable populations, such as ones that live in flood-prone areas, are reached as they are at a higher risk for malaria. Areas of frequent floods, such as Somalia, Sudan, and Yemen, account for increased risk for malaria, especially in urban and suburban areas.[46]<br>**In urban areas**<br>• This highly communal behavior may require additional considerations for engaging with local leadership and mobilizing communities in urban areas which may not be needed in areas with stronger communal networks, such as rural areas.<br>• Consequently, there is a need to tailor SBC strategies for promotion of this behavior in urban contexts using the existing structures of influence on the community. |

**Key resources:** Zika Prevention Behavior Matrix, Technical Specifications Content Guide For Behaviors With High Potential To Prevent Zika, Promoting Social And Behavior Change During The USAID Zika Response

**Covering water storage containers** is difficult to implement effectively; if it is not done well, it has the potential to cause harm by creating new breeding sites. Therefore, this is not a recommended behavior for *An. stephensi* control. However, given the popularity of covering water storage containers and potential benefits for WASH programs, the table below provides specific conditions under which covering water storage containers can be effective for preventing mosquito breeding.

| **Category: Larval source management** | |
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| **Intervention: Covering water storage containers** | |
| **Description** | **Intervention:** Covering of water storage containers with effective lids to prevent mosquitoes from entering the containers to lay eggs.<br><br>**Behavior:** Cover infrequently accessed (i.e., less than once per week) water storage containers in and around the home with a lid that prevents mosquitoes from entering. |
| **Behavior overview** | • **Feasibility: Difficult** based on difficulty to access effective covers and challenges with effective covering<br>• **Overlap with *Aedes aegypti* control**: **Yes**<br>• **Familiarity of behavior in malaria control in SSA context**: **Novel**<br>• **Primary audience**: Persons who manage stored water in homes<br>• **Secondary audience**: Community leaders; WASH programs; municipality-level water regulators<br>• **Behavioral objective:**<br>- Increase the proportion of households who cover their infrequently used household water containers with an effective lid. |
| **Specific behaviors to promote** | • Cover infrequently used water storage containers at all times with a cover that is tight fitting and does not warp or touch the water or collect water itself.<br>• Monitor and replace lids when cracked, warped, or leaking.<br>• For large, elevated, or underground tanks, obtain the services of maintenance professionals to effectively cover them, if resources permit.<br>• Monitor tanks for leaks and make repairs as needed. |

**Steps to effectively carry out behaviors**

**1. Identify the appropriate containers for covering:**

- Identify the containers in and around the home that are used to store **infrequently accessed water**. This is the water that is **accessed occasionally,** i.e., once a week or less frequently.
  - Often, these are **fixed containers**, such as tanks, cisterns, barrels, water tanks, and large buckets.
  - It is worth covering only the long-term and fixed water storage containers and among them, those that present a more favorable environment for mosquitoes to lay their eggs. These locations can be identified with the help of vector control personnel.
- Once the long-term water storage containers have been detected, evaluate if they can be covered with a tight-fitting lid.
  - Ensuring a tightly sealed lid depends on the type of container. Some containers cannot be covered well, such as large concrete water storage tanks. Barrels and round tanks are better suited for a lid that seals very tightly.

**2. Cover with an effective lid:**

- For the lid to be effective, ensure the following characteristics:
  - The lid should make a very tight seal. By not sealing well, the lid can have the opposite effect, providing shade over the water, making the water container more favorable for mosquitoes to lay eggs.
  - The lid should not touch the water, especially if it is a cloth cover because these can create small pools where the mosquito can lay its eggs.
  - If the cover is made of cloth, the fabric must allow rainwater to pass through it, so as to not accumulate water and convert the cover into a breeding site.
  - The lid should not have a rim that might accumulate water and create a breeding site.
  - The lid must be made of a material that does not crack or warp in the heat or sun.
  - A metal mesh with holes smaller than the size of an adult mosquito may be used, if it seals tightly.
  - Installing a tight cover and a tap on a water storage container can help keep the container free of mosquitoes and keep it clean for drinking. A tap can have the additional benefit of reducing the frequency of disturbance of the cover, thus possibly reducing wear and tear and opportunities for an open container to attract ovipositioning mosquitoes.

**3. Maintain the cover in place and in good condition**

- A good lid is most effective when utilized always: **every day and every hour.**
- The lid must be kept in excellent condition and replaced if it begins to get warped or cracked.
- It is better not to cover the water containers, than to cover them partially or inconsistently or with a lid that does meet all the specifications above.

### Lessons learned relevant to SBC programs

There is limited literature describing the implementation or promotion of covering water storage containers for malaria prevention or *An. stephensi* specifically. As a result, much of the peer-reviewed literature identified on covering water storage containers in this section comes from literature on *Aedes aegypti*, dengue, and/or Zika control programs.

Findings include:

- While it tends to be culturally well-accepted, there is mixed evidence on the effectiveness of covering water storage containers to reduce mosquito breeding.[47–49] Partially or incorrectly covered containers have been found to favor mosquito larvae.[47, 50]
- This intervention seems to be effective only under specific conditions that require active involvement of and maintenance by household members and communities who may not be familiar with the specific conditions needed. Therefore, a strong SBC component is crucial.
- Covering short-term water storage containers has less potential efficacy, as frequent lid use can result in wear and tear and render the lids ineffective or counterproductive.[38]
- To remain effective, covers must be kept in excellent condition and replaced if they begin to get warped or cracked. The lid should make a very tight seal, should not touch the water inside, and be made of a material that does not accumulate water, and does not crack or warp in the heat or sun.[30]
- Households may opt to only cover water used for drinking or food preparation, as proper lids for those smaller containers may be easier to access or more affordable. Similarly, covering containers may be best limited to the household level given the perception that joint action to maintain covers on community water sources is difficult.[43]
- Covering large, elevated tanks may be too burdensome for household members, requiring sustained effort and cooperation by the community,[15] and there may be a demand for local trade persons in the mosquito proofing of such tanks.[51]

### Risk framing

- Covering water storage containers may already be promoted in some areas for other mosquito borne diseases or WASH programs or may be newly promoted in areas where *An. stephensi* has been identified. Communication in these areas should explain the novel threat and why this new intervention is important and may need to be practiced differently to ensure that covers are mosquito-proof. Draw on risk communication best practices to balance raising perceived risk along with the confidence to take action to reduce the community's exposure to malaria vectors.
- Neighboring countries to the ones where the vector has been identified should be made aware of the new threat so that they can act early as needed should *An. stephensi* be identified.

| | |
|---|---|
| **SBC recommendations** | • Promote tight-fitting, long-lasting covers with the specific characteristics noted above. Recognize that covering water storage containers to prevent contamination of water-borne diseases may be a familiar behavior, although existing covers already in use may not meet the specifications above to be mosquito proof, and these may need to be replaced or modified by users. Collaboration with WASH programs on these efforts is recommended.<br>• Cover containers that are infrequently used and are feasible to cover correctly in the local context. Household members should focus efforts on infrequently used water storage containers (long-term storage), or water that is accessed occasionally (less than once per week).[30]<br>• Local, context-specific, and community-driven promotion is recommended:<br>- Covers should be specific to the types of containers prevalent in the local context.<br>- The covers that have the greatest potential to be effective are those developed through a long-term intervention with community participation, in which covers are designed specifically for local containers that favor the development of mosquito breeding sites.[30]<br>• Because some of the studies reviewed implemented multi-faceted interventions, combining covering water storage containers with scrubbing the internal walls of containers with detergent and with the elimination of mosquito breeding sites in communal areas, this behavior should likely be promoted as part of a package of behaviors to reduce mosquito populations.[30]<br>• As a novel behavior to be promoted for malaria control, SBC programs will need to follow risk communication best practices to introduce a new behavior among the population, acknowledging a new risk and new prevention methods to mitigating as well as addressing risk perception and self-efficacy simultaneously.<br>• Consider public-private partnerships in which local water tank professionals or construction workers are trained in sourcing, installing, and maintaining effective mosquito proof covers for water storage containers in their community. This effort could also be integrated with housing modification initiatives under integrated vector management programs. |

**Key resources:** Zika Prevention Behavior Matrix, Technical Specifications Content Guide For Behaviors With High Potential To Prevent Zika, Promoting Social And Behavior Change During The USAID Zika Response

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# Annexes

# Annex 1 – Literature Search Strategy

**_An. Stephensi_ Literature Search Strategy**

## Overview

A desk review was conducted to identify interventions used to control An. stephensi across various settings. This included peer-reviewed and grey literature (e.g., global guidance and national reports) presenting a wide range of interventions and SBC promotional materials currently in use for *An. stephensi* control. Following consultations with the PMI, interventions were included in the systematic review based on the following criteria:

1. The intervention has the potential to be effective against *An. Stephensi*.
2. The intervention is likely to be included in the immediate response to *An. stephensi* in areas where it has been identified and/or those at elevated risk of invasion.
3. The intervention has an individual, household, and/or community component.

The prioritized interventions that met these criteria were then categorized into two groups that underwent tailored search strategies based on their relevance to the immediate response for addressing *An. stephensi* in sub-Saharan Africa as well as the level and type of additional information needed to inform the SBC guidance. The search categories were as follows:

**Full Review:** Interventions that were most likely to support PMI's strategy to address *An. stephensi* in the near-term underwent a full review. The focus of the full review were larval source management interventions, namely larviciding, with a focus on the role of households and communities.

**Targeted Review:** Interventions, which may support PMI's strategy to address *An. stephensi* but for which there was already substantial evidence available, underwent a targeted review to identify unique SBC considerations relevant to addressing *An. stephensi*. This included:

1. Core malaria control interventions (ITNs, IRS, and prompt care-seeking for fever), which are already included in national malaria control strategies. These interventions underwent a targeted review to identify any unique SBC considerations, particularly for urban contexts and promotion among higher risk groups/mobile populations.
2. Interventions with strong Aedes aegypti overlap, for which a review has already been conducted, had a targeted review focusing on updates over the past five years since the original review was conducted. This included regularly finding and removing standing water, covering water storage containers, and scrubbing water storage containers.

## Formal Peer Reviewed Literature Search

### Databases

The selection of databases below were informed by guidance from the Johns Hopkins University Library informationist and selected because they are comprehensive, broad databases that should include all potential references noted in other databases including BASE and Web of Science.

a. **PubMed** - Citations for biomedical literature from MEDLINE, life science journals, and online books.
b. **Embase** – European database providing access to the biomedical literature.
c. **Global Health** – Database that brings together the Public Health and Tropical Medicine database and the human health and diseases information extracted from CAB Abstracts.
d. **Global index Medicus** – Provides articles from international sources, including WHO regional indexes

### Search Strategy: Full Review Interventions

The full review included interventions that were likely to be important to the planned response to *An. stephensi*. Based on consultations with PMI experts and findings from the desk review, the focus was on larval source management interventions, namely larviciding. This intervention is potentially important to the planned response and PMI strategy for countries affected by or at high risk of *An. stephensi* invasion.

For the full literature review interventions, specific search terms were developed for each of the interventions based on key considerations of the intervention and related behaviors for malaria control. These search terms were then searched in all the above databases and duplicates across databases were removed.

The articles were then screened for inclusion, beginning with the title. Articles that clearly did not meet one or more of the inclusion criteria were excluded, the remaining were further screened by abstract and full text review. The inclusion criteria included the following overarching criteria in addition to intervention-specific inclusion criteria developed based on the key considerations listed in the table below:

1. Published within specified date range.
2. Include description of intervention of interest.
3. Include description of community, household, or individual behavior and/or participation in the intervention.
4. Published in English.
5. Not a duplicate article.
6. Includes intervention-specific key considerations.
7. Full text available.

After identifying the articles that passed the full text screening, the references and "cited by" of these identified articles were further searched for additional peer-reviewed articles to include in the final synthesis of findings.

Below is the table of the full review interventions with key consideration and search terms:

| Intervention | Key considerations | Search Terms (2000-2021) |
|---|---|---|
| 1. Household Larvicide | Water storage containers | ((((An stephensi) OR (*Anopheles stephensi*)) OR (Aedes aegypti)) AND (larvicid*)) AND (water container)<br><br>Filters: from 2000 - 2021 |
| 2. Community Larvicide | Natural bodies of water (ponds, lakes, streams) | ((Anopheles [MESH] OR anopheles [tw]) AND (larvicide OR larvicid*))<br><br>Filters: from 2000 - 2021 |
| 3. Covering water storage containers | Household & communities | (((An stephensi) OR (*Anopheles stephensi*)) AND ((lid OR lids) OR (cover))<br><br>Filters: from 2000 - 2021 |

## Search Strategy: Targeted Review Interventions

A targeted review was conducted using the same databases for the following categories of interventions: (1) Core malaria control tools and (2) Interventions to be integrated with existing Aedes SBC literature. These categories of interventions underwent a different search strategy based on existing SBC information and key considerations for each intervention. However, they both underwent the same inclusion criteria, screening format, and reference searching process as the full review interventions detailed above.

1. **Core malaria control tools**
   a. This category of interventions includes ITNs, IRS, and prompt care-seeking for fever.
   b. These are well established and effective malaria control interventions that are already promoted or included in malaria SBC strategies.
   c. A targeted literature review focusing on key SBC considerations for each intervention that may be specific to *An. stephensi* such as promotion in urban areas and among higher risk/mobile populations was undertaken.

2. **Integration with *Aedes* SBC literature**
   a. Johns Hopkins Center for Communication Programs conducted a literature review previously for Zika, which included removing unintentional standing water, covering water storage containers, and scrubbing of water storage containers for Aedes control. To avoid duplicative efforts, a targeted review for these behaviors and related SBC considerations was conducted.

b. This targeted review included a search of both peer reviewed and grey literature published since the previous Aedes literature review (2016–present).

c. Findings from the previous Aedes literature review and technical specifications were also synthesized to incorporate into the SBC guidance for these interventions.

Below is a table of the interventions in the targeted review category with key considerations and tailored search terms:

| Intervention | Key considerations | Search Terms |
|---|---|---|
| **Core vector control tools 2000-2021** | | |
| 1. Use of ITNs | Pyrethroid-piperonyl butoxide (PBO) or dual active ingredient<br>Urban areas | (“Insecticide-Treated Bednets”[Mesh] OR “Insecticide-Treated Bednets” [tw] OR “Treated Mosquito Nets” OR “Treated Mosquito Nets” [tw] OR “ITNs”) AND ((urban) OR (city))<br><br>Filters: from 2000 – 2021 |
| 2. 2. IRS | Urban areas<br>Homes vs animal shelters | ((indoor residual spraying) AND ((urban) OR (city)))<br><br>Filters: from 2000 – 2021 |
| 3. Prompt care seeking for fever | Urban areas<br>Higher risk groups (e.g. mobile populations) | (Care-seeking) OR (sought treatment) OR (health-seeking) OR (treatment seeking) AND (Fever OR Malaria) AND ((urban) OR (city))<br><br>Filters: from 2000 – 2021 |
| **Integration with Aedes SBC literature 2016–present** | | |
| 1. Regularly finding and removing (unintentional) standing water | Update to *Aedes* behavior prioritization literature review from 2016-present<br><br>Household, communities & construction sites | (((((((An stephensi) OR (Anopheles stephensi)) OR (Aedes aegypti))) AND (breeding sites OR stagnant water OR standing water)))) AND (remov* OR fill OR drain OR find))<br><br>Filters: from 2016 – 2021 |
| 2. Covering water storage containers | Update to *Aedes* behavior prioritization literature review from 2016-present<br><br>Households and communities | ((Aedes aegypti) AND (lid OR lids) OR (cover))<br><br>Filters: from 2016-2021 |
| 3. Scrubbing water storage containers | Update to *Aedes* behavior prioritization literature review from 2016-present | ((aedes aegypti) AND (water container)) AND ((scrub) OR (clean))<br><br>Filters: from 2016 - 2021 |

## Grey Literature Search

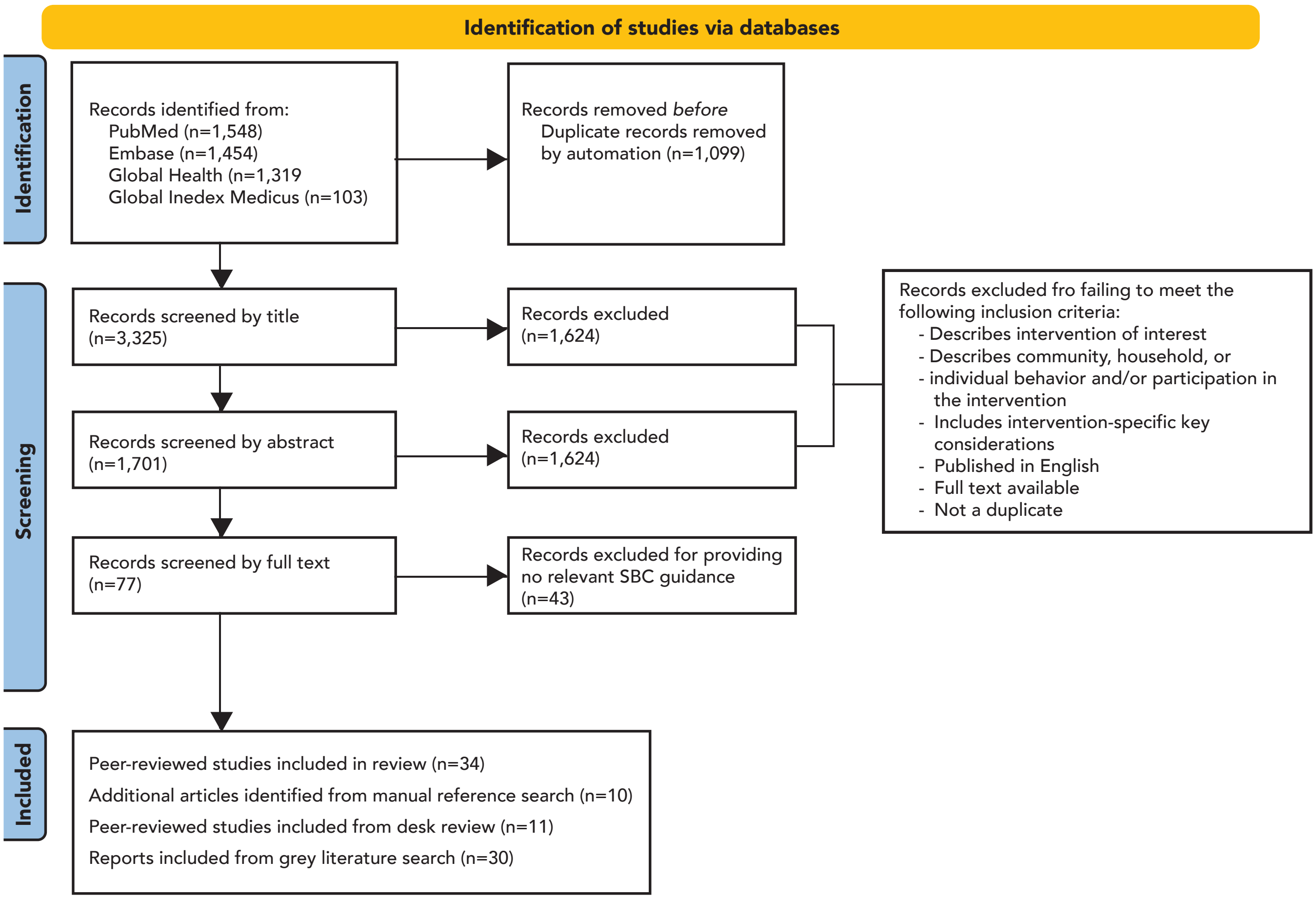
**Search strategy**

The grey literature search was conducted to identify additional evidence specific to *An. stephensi*. For this search, the term "stephensi" was searched in the below sources, where a broad array of documents, ranging from meeting reports and presentations to non-peer reviewed articles, were identified. Following the identification of *An. stephensi* relevant articles, these articles underwent a screening process identifying relevant SBC guidance and where applicable these findings were included in the guidance document.

### ONLINE SEARCH SOURCES

- Development Experience Clearinghouse-USAID storage of all reports.
- American Society of Tropical Medicine and Hygiene (ASTMH) meeting abstracts from 2019, 2020, and 2021.
- ASTMH's Deep Dives webpage on LSM and urban malaria.
- WHO online library (Global Malaria Programme).
- WHO Institutional Repository for Information Sharing (IRIS), which included all searches from 2000 to 2022.
- RBM Vector Control Working Group (VCWG) annual meeting archives, which included meeting summary reports, presentations, and posters presented in all meetings from 2003 to 2022.
- Seminal literature or pre-existing literature reviews for the more established control tools.

# Annex 2 – PRISMA Diagram




Information: **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Website**

# Annex 3 – Summary of Supporting Literature for Each Intervention

**Intervention 1:** Insecticide-treated nets

**Summary of the Literature Findings:**

**General Considerations**

- ITNs are more likely to reduce malaria transmission where the vectors bite indoors and at night when people are asleep, rest indoors, and bite mainly humans.[1]
- A research update publication on the distribution of An. stephensi in Ethiopia stated that new types of nets, such as PBO nets, may be useful vector control tools for use against An. stephensi in the face of high levels of resistance to many insecticides used on ITNs. Further work is needed to understand An. stephensi susceptibility to chlorfenapyr and pyriproxyfen, additional insecticides used in dual-treated nets.[2]
- The effectiveness of ITNs and of ITNs versus IRS may vary substantially in urban versus rural settings.[3]
- An International Centers of Excellence for Malaria Research (ICEMR) multi-country report on approaches to urban malaria control found that in settings where LSM activities may be less effective, additional preventive strategies may include specific education to remind travelers to use ITNs when away from their homes.[3]
- According to the WHO Global framework for the response to malaria in urban areas two relevant considerations in urban populations compared to rural populations that may elicit a different response to malaria include an overall lower immunity to malaria at the population level and lower acceptability and/or use of ITNs.[4]

**Household-level considerations**

- Study results from focus group discussions in urban Tanzania identified behaviors seen to compromise the effectiveness (and subsequent usage) of bed net use in urban settings and specific targets for SBC promotion. This included bed net sharing by two or more people, people sleeping with body touching the net, seasonal bed net usage (during rainy season only) and going to bed after already being bitten outdoors at night.[5]
- A retrospective cross-sectional survey of pregnant women in Nigeria found that pregnant women in urban locations were found to have lower usage than in rural areas. Consequently, the authors suggested the need for constant reminders of ITN use through messages delivered at ANC and radio advertisements to pregnant women in urban areas specifically.[6]

**Community-level considerations**

- A mixed-methods study in eastern Rwanda investigating community awareness, acceptance, and participation in a community-based larviciding intervention suggested there is a critical need for on-going community sensitization for the use of ITNs and acceptance of IRS at the household level when other community level interventions (such as LSM are promoted) to ensure ongoing use and acceptance among community members.[7]
- A qualitative study among male heads of households, female caregivers, and community health workers in Uganda concluded that while the protection of malaria remains a powerful motivator, SBC strategies should promote consistent net use throughout the year and emphasize the non-malaria benefits of net use that provide a long-term rationale for consistent use. Furthermore,

SBC campaigns should promote replacement options, emphasizing ongoing net care and replacement as a household responsibility, thus reducing dependence on free distributions.[8]

- According to the Ethiopian Public health institute, as summarized in research on the distribution of An. stephensi in Ethiopia, ITNs and IRS are not currently conducted in urban areas by the National Malaria Elimination Program due to the documented low risk of malaria, resource limitations, and low community acceptance.[2]

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**Intervention 2:** Indoor residual spraying

**Summary of the Literature Findings:**

- According to the WHO Global framework for the response to malaria in urban areas, there are two relevant considerations in urban populations compared to rural populations which may elicit a different response to malaria. This includes an overall lower immunity to malaria at the population level and lower acceptability of IRS.[1]
- A mixed-methods study in eastern Rwanda investigating community awareness, acceptance, and participation in a community-based larviciding intervention suggested a critical need for ongoing community sensitization for the use of ITNs and acceptance of IRS at the household level, when other community level interventions (such as LSM) are promoted to ensure ongoing use and acceptance among community members.[2]
- A qualitative study utilizing in-depth household interviews across rural and urban areas of Tanzania found the primary reasons for refusal of IRS included initial ignorance about the reasons for IRS, uncertainty about its effectiveness, increased prevalence of other insects, potential physical side effects, odor, rumors about the chemical affecting fertility, embarrassment about moving poor quality possessions out of the house to be seen by neighbors, logistical difficulties, and the belief that the implementation of IRS was politically motivated. In order to improve IRS uptake, authors recommended a more comprehensive, better streamlined education process to community members. They suggest, rather than just handing out informational materials, general information meetings could be held focused entirely on IRS, and local NGOs could host follow up meetings to answer additional questions from those who are still skeptical or want more information. Furthermore, there should be a focus on encouraging community leaders to educate their constituents rather than threaten them with punishments for noncompliance.[3]
- A cross-sectional study across rural and urban areas of Mozambique found that refusal of IRS in urban areas was more likely to occur among those who were skeptical of IRS, had secondary or higher education levels, or shared a desire to see a tangible impact in terms of reduced mosquitoes and malaria transmission—something they did not think occurred with IRS. This study identified the main barriers to IRS acceptance among this group to be associated with selection and performance of spray operators, negative experiences from previous campaigns, political-partisan conflicts, difficulty in removing heavy or numerous household assets, and preference for insecticide-treated nets over IRS. Therefore, this study recommends SBC should emphasize the importance of high IRS coverage for promoting both familial and community health, specify that IRS prevents the mosquitoes that cause malaria, and have clear communications and engagement with community leaders during spray operator selection and spray implementation to help reduce barriers to IRS acceptance.[4]
- In a comparative evaluation of community-based IRS versus district-based IRS pilot study across 20 kebeles in Kersa district, Ethiopia found that the community-based IRS was slightly less expensive than the similar-sized activity implemented through the district-based model. This was due to hiring a larger number of community-based spray operators which reduced the period of performance. Furthermore, feedback from community and program stakeholders found that the overall quality of spraying in the community-based pilot area was possibly better than the district-based model due to longer one-on-one training of sprayers, more frequent supervision or sprayers by kebele leaders, a greater sense of ownership and added diligence of spraying by the operators, and increased community trust of the spray operators within the community model compared to the district-based model.[5]

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**Intervention 3:** Prompt care-seeking for fever

**Summary of the Literature Findings:**

- An ICEMR multi-country report on approaches to urban malaria control suggests testing for malaria may be delayed or unavailable if people have assumed that malaria is rare or nonexistent in urban areas.[1]
- According to the WHO Global Framework, many health professionals in urban settings operate in both the public and private health sectors leading to a multiplicity of care delivery points and sources of information for the public. This complexity makes behavior change communication and action around treatment-seeking behavior and health care delivery more intricate and dynamic compared to rural areas.[2]
- A cross-sectional study among housewives with children under five years of age in urban Sudan found that participants had adequate knowledge of malaria, but their decisions when selecting available treatment options as a response to fever depended largely on the intensity of fever, as did their choice of antimalarial drugs. Consequently, the authors concluded this was likely to lead to a delay in the treatment of malaria and unfortunate consequences. The authors recommended that health education programs should focus on the importance of seeking early advice, compliance with prescribed treatment, and awareness and handling of danger signs.[3]
- Additionally, a cross-sectional study among caregivers in urban Bangladesh found that children from the poorest families were least likely to seek care from trained healthcare providers; boys were more likely to be taken to trained healthcare providers; and a decreased level of consciousness acted as trigger for caregivers to seek healthcare from trained healthcare provider. To reduce child mortality in the short term, the authors suggested that health education and behavior-change communication interventions should target low-income caregivers to improve their recognition of danger-signs.[4]
- A cross-sectional study among construction site workers in urban Mangaluru, India identified an urgent need to intensify and streamline ongoing malaria SBC activities for construction site workers for Anopheles stephensi control. While knowledge of the cause, symptoms, and availability of free diagnostic and treatment facility in public health sector for malaria was satisfactory in the study population, the knowledge of simple malaria preventive measures was not. Furthermore, male workers and those who reported suffering from malaria within one year were associated with more comprehensive malaria knowledge and favorable treatment-seeking patterns. Consequently, to increase care-seeking among construction site workers, the authors suggest an emphasis on gender equity at every stage of the program implementation, use of health educational materials in local languages and effective use of informal communication channels. Involvement of labor employers and building contractors in this regard is imperative.[5]
- In urban areas, treatment seeking commonly occurs in the private sector.[6]

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**Intervention 4:** Household Larviciding

**Summary of the Literature Findings:**

**Household-level considerations**

- Similar to other LSM interventions to reduce Ae. aegypti vector breeding in water storage containers in Latin America, larvicide efforts should focus on the most productive breeding water storage containers in the home and given context, as identified by entomologists1–3 and summarized in the Zika Prevention Behavior Matrix.[4]
- In the context of Aedes aegypti control programs in Latin America, household larvicides are advised to be applied by vector control technicians, rather than household members, so control over implementation of this behavior does not lie at the household level.[5]
- A review article on achievements of Anopheles larval control in Africa found that experiences with Bti or Bs granules or briquettes did not require special equipment to apply and therefore might be safely conducted by households or community volunteers.[6]
- Despite weekly larvicidal treatment of overhead water tanks in India, An. stephensi larvae were collected from around 50–65% of tanks surveyed throughout the year. Potential factors contributing to the limited effectiveness include tolerance, resistance or too low of dosage of the larvicide, inability to access tanks through households due to lack of ladders or step-stones, making it difficult for control personnel/staff to undertake anti-larval measures as well as potential dilution of larvicide after replenishment or refilling of tanks for domestic usage.[7]
- A large-scale larviciding intervention conducted in urban centers in Dar es Salaam, found the most common challenge with household larvicides applied by technicians was gaining access to larval habitats inside individual households, compounds, and behind fences of private property.[8,9]
- A household larviciding intervention in urban areas of Argentina found that when vector control personnel were made up of women from the same community there was a very low mean fraction of households that denied entry to premises (approximately 3%), even in neighborhoods whose residents frequently did not allow the labor of municipal agents inside house premises.[10]
- Multiple studies have claimed that community understanding, interest, and involvement are critical to successful larval control programs to improve acceptability and access to breeding sites.[7,9,11]
- A review article on achievements of Anopheles larval control in Africa found that public acceptance and involvement in household larval control programs may be influenced by the impacts of malaria control interventions on general nuisance biting such that persistence of nuisance mosquitoes has led to dissatisfaction with existing control efforts.[6]
- An ICEMR multi-country report on approaches to urban malaria control found that larviciding in artificial water containers in homes is less successful in settings where natural, rain-fed bodies of water or irrigation channels also serve as significant breeding sites for An. stephensi. In those settings, it is important to also promote other preventive measures among the population, such as the use of ITNs.[12]

**Community-level considerations**

- A review on the effectiveness and operational feasibility of bacterial larvicides on malaria vector control in sub-Saharan Africa identified multiple studies monitoring the acceptability of microbial larvicide interventions to community members in rural areas and concluded that they were highly accepted by the general community.[9]
- A quasi-experimental intervention on community mobilization for dengue control in urban Cuba found that creating local task forces at the neighborhood level of community working groups in which interests of all direct stakeholders, including vector control workers, are represented to build a local government-community partnership is imperative to community-based source reduction approaches. They found such actions can have a direct impact on reducing household risk for disease by demonstrating a capacity to resolve problems of mutual concern. However, the longer-term sustainability of this approach remains to be demonstrated.[13]
- A quantitative report on the strategy and effectiveness of a household larviciding program for dengue control in Taiwan found that taking into consideration the vector ecology, the subculture of the community, and cultural background for the promotion of community based integrated vector control programs enhance community cooperation and acceptance of the programs. The concept of integrated control must be seeded deeply into the community structure; therefore, it is important to continually educate the community that mosquito control is everybody's responsibility.[14]
- Larviciding, habitat modification and manipulation is supported by community participation and intersectoral collaboration.[15]

**General Considerations for household and community larviciding**

- When removal (e.g., filling in of disused wells) or modification (e.g., installation of hermetically sealed lids to water storage containers) of breeding sites are not feasible, treatment with larvicides becomes an option.[16]
- Furthermore, the CDC states that larvicide can be applied to containers that hold standing water not used for drinking and that cannot be effectively covered, dumped, or removed.[17]
- An ICEMR multi-country report on approaches to urban malaria control recommended in urban hotspots in Senegal that malaria control strategies should focus on active breeding sites and should begin before the number of adult vectors and the prevalence of human infection begin to increase after the seasonal rains begin.[12]
- A review article on achievements of Anopheles larval control in Africa concluded that in all larval control methods, the community should be involved, at a minimum, in the identification and monitoring of permanent and transitory breeding sites of the malaria vector.[6]

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**Intervention 5:** Community Larviciding

**Summary of the Literature Findings:**

**Community-level considerations**

- According to the WHO Guidelines for Malaria, community-based larviciding entails the regular application of biological or chemical insecticides to artificial and natural water bodies within a community to eliminate mosquito larvae.[1]
- A study in rural Tanzania, found high potential in recruiting pastoralists to locate hard to find and farthest apart dry-season water bodies to be further treated with pyriproxyfen by research teams. They found the combination of optimal timing for larviciding when habitats are few and fixed (i.e., dry season) and exploiting existing community practices and/or knowledge to locate those habitats that are farthest apart offer a cost-effective approach to conduct larviciding at a wider scale.[2]
- A mixed-methods study in Tanzania identifying challenges for community-based mosquito control program in urban Dar es Salaam found community-owned resource persons (CORPS), trained to identify and treat larval habitats in the community, underreported anopheles larvae, especially in habitats where larvicides had been applied previously. They found that not reporting larvae was likely due to insufficient dipping, examination, or training in mosquito identification rather than not visiting the site. The authors suggest these findings call for special emphasis upon directed strategies, ensuring a more compliant operational team and engagement of the community in holding these teams accountable, as well as allowing area-wide access to plots and compounds.[3]
- A mixed-methods study in eastern Rwanda found that community awareness and support for LSM increased following community-based Bti application. They also found a high effectiveness of Bti in terms of reduction of mosquito abundance and nuisance biting was perceived by the community. Furthermore, they found that embedding Bti activities into rice farming cooperatives in the same way as has been done for chemicals and fertilizers used by rice farmers was deemed critical to its sustainability. Similarly, trust between rice farmers and their cooperative leaders facilitated their acceptance level of the intervention and subsequently affected their confidence on the safety and effectiveness of Bti.[4]
- A mixed-methods study assessing acceptability of community microbial larviciding in rural areas of southern Tanzania found high community acceptance despite low knowledge levels. However, a high level of acceptance among community members with very low knowledge on biolarviciding does not assure sustained acceptance.[5]
- Similar findings from a one-time cross-sectional survey of households in Malawi led to recommendations that education should focus on the community benefits and safety of biolarviciding, together with regular application of biolarviciding at a level that can reduce malaria, which may help win the acceptance and support of the intervention among community members, particularly in rural areas.[5,6]
- Additionally, these studies both suggested that groups which have demonstrated less trust in community larvicide should be carefully engaged in these efforts, such as small-scale (crop) farmers in rural areas.[5,6]
- Results from key-informant interviews assessing awareness and perceptions regarding the national rollout of larviciding for malaria control in both urban and rural areas of Tanzania found

that larviciding was widely supported by both community members and designated malaria control officials. However, there were gaps in technical knowledge, implementation, and public engagement. To improve the overall impact of the program the authors recommend (1) intensifying training efforts, particularly for identifying habitats of important vectors, (2) adopting standard technical principles for applying larvicides or larval source management, (3) improving financing for local implementation, and (4) improving public engagement to boost community awareness and participation.[7]

- Similarly, in a review of an article evaluating the implementation of a pilot study that developed a culturally competent approach to LSM in a small town in northern Haiti, authors concluded that iterative cycles of research, feedback, and discussion can help inform SBC and social engagement strategies and build the relational capital needed to make community-directed larvicide a viable approach.[8]
- An impact evaluation study describing the principles and practices for implementing, monitoring, and optimizing routine larviciding in urban Tanzania where the responsibility for routine mosquito control through community larvicide application and surveillance was delegated to modestly paid community members, known as CORPS, found that the implementation of the program through local community-based staff led to high community acceptance and support. Furthermore, one year of community-based larviciding reduced anopheline larval abundance by 96% in the intervention areas resulting in a 31% reduction in malaria transmission by the primary malaria vector, Anopheles gambiae s.l. (95% C.I. = 21.6–37.6%; $p = 0.04$). Additionally, community larviciding was associated with an overall reduction of 40% ($p < 0.001$) of P. falciparum infection prevalence in the study population where the highest impact was achieved during the dry season of 2006.[9]
- A qualitative study using focus group discussion and key informant interviews to assess community perception and acceptance of biological larviciding for malaria control in rural Burkina Faso found that the acceptance of larviciding in and around the villages was high. However, the authors suggest further increasing the perceived success, and hence acceptance, of future larviciding campaigns in rural areas of Burkina Faso, pit latrines, and other breeding sites within compounds predominantly infested with Culex and Aedes mosquitoes. They claim that although a reduction of those mosquito genera does not ameliorate the malarial situation, it will largely reduce mosquito nuisance, which is beneficial to the local communities' perception of success.[10]
- A mixed-methods study in eastern Rwanda investigating community awareness, acceptance, and participation in a community-based larviciding intervention found that participants were concerned about emphasizing community larvicide programs and the potential to reduce use of existing individual preventive measures, such as ITNs, among community members.[4]
- A study conducted in Kenya, used an experimental simulated auction approach to assess participants' willingness to pay for a community-based larviciding intervention and found that nearly all participants were willing to pay at the lowest bid price of the biopesticide. The majority of them expressed great interest in pooling resources to facilitate biopesticide application in the community. Furthermore, males and those in urban areas were more willing to pay compared to their female or rural counterparts, suggesting more awareness and training is needed for female residents and in rural areas. The authors indicate these findings may imply high adoption potential of the technology and the need to devise inclusive policy tools, especially those that enhance collective action, resource mobilization, and capacity building to empower both men and women and stimulate investment in malaria prevention.[11]

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**Intervention 6:** Finding and Removing Standing Water

**Summary of the Literature Findings:**

**General Considerations**

- In urban Ethiopia, larvae of An. stephensi was more commonly found in permanent rather than temporary human-made containers, and co-inhabitants of these containers were Aedes aegypti and culicine mosquitoes. Adult An. stephensi mosquitoes were mainly found in animal shelters. Therefore, when resources are limited, identifying and eliminating permanent human-made containers should happen first.[1]
- Control measures when removal of breeding sites is not possible include placing old tires under a roof to avoid rainwater, piercing a hole in the tire to prevent collection of water, as well as turning bowls, containers, and buckets upside down and storing them in a dry, covered place.[2]
- Treat containers with larvicides when removal or modification is not feasible.[3]

***Anopheles stephensi* specific breeding sites**

- *An. stephensi* is one of the few malaria vectors capable of breeding in closed spaces with neither light nor vegetation. Many potential breeding sites are by-products of construction, irrigation, or other human activities. Even air conditioners may have water compartments where An. stephensi can breed in.4 Therefore, it is important to monitor larval habitats in construction sites and around buildings to make sure new ones are not created.[5]
- Areas of frequent floods, such as Somalia, Sudan, and Yemen, account for increased risk for malaria, especially in urban and suburban areas.[6] With that, populations in flood-prone areas are particularly vulnerable.
- Common breeding sites of An. stephensi in urban areas in Asia include cisterns, wells, gutters, and fountains. The water present in these sites can be polluted or brackish water, and Anopheles species do not usually breed in moving waters.[7]
- An. stephensi can also be found in rural settings, both in clean and organically polluted water habitats. Breeding sites identified in Pakistan include rice fields, water tanks, wells, fishponds, canal seepage pools, irrigation channels, street pools, animal ponds, and drains, as well as organically pollutant habitats.[8]
- An. stephensi larvae can be found in freshwater pools, stream margins and stream beds, catch basins, seepage canals, wells, and domestic water storage containers.[9]
- In India, cement tanks and flowerpots were found to be preferred for An. stephensi over other breeding sites evaluated in this study.[4]
- In India, small cement tanks containing clean and turbid water attached to mosques and community lavatories were found to be An. stephensi's breeding sites.10
- An. stephensi often breeds in wells, ponds, cisterns, and containers used for storage of drinking-water.[2]
- In India, An. stephensi has been found to breed in wells, cisterns, roof gutters, tanks, and all kinds of containers.[11]
- Breeding sites of An. stephensi include urban cisterns, wells, gutter, polluted water, rural grassy pools, and alongside rivers.[12]
- Interventions for control of vectors such as An. stephensi and Aedes aegypti in Pakistan included environmental management (vegetation removal) of water holding ponds and construction of water holding ponds with vertical, circular walls.[13]

### Household-level considerations

- A household- and school-based cluster randomized controlled trial in Kenya concluded that source reduction was not an individual issue, but rather a household and community issue, so interventions need to engage entire households and communities for long term change. Furthermore, this study identified caregivers as an appropriate focal point for the intervention due to their primary responsibilities related to water collection and storage, but it found that adhering to new container management requires commitment from entire households.[14]
- Extracted from various literature on source reduction for Ae. aegypti control, recommendations in the Zika technical specifications content guide for the removal of breeding sites around the home state it is essential that technicians, health promoters, and community volunteers who conduct home visits accompany family members through the house and yard to identify breeding sites together, guide them on the search and ways to eliminate larvae. Additionally, families should be empowered with practical information about the life cycle or behavior of the mosquito, promote attitudes of "family detectives," inform them of characteristics of preferred breeding sites, and promote awareness of variation in location of breeding sites around the home from week to week. Finally, it recommended that family members should dedicate 15 minutes each week to identify and eliminate mosquito breeding sites around the home.[15]

### Community-level considerations

- General clean-up campaigns in which communities are informed they should clean their yards or communal areas without specificity on targets for removal often are only effective if they target the most productive breeding sites.[16–19]
- The Zika Technical Specifications Content Guide f recommends basing this work on motivating and mobilizing action at the community. Its leaders should organize brigades for elimination of breeding sites. This requires a pledge and weekly commitment by community members/neighbors potentially through a weekly breeding site search and elimination brigade. The efforts of neighbors can be recognized at the community assembly for their work and positive results achieved. Community members should be encouraged to share their learning about elimination of breeding sites with their neighbors to increase community commitment for everyone. Furthermore, these recommendations suggest the use of community maps helps with focusing the search on areas where stagnant water or rainwater tend to accumulate. A white plastic container should be used to obtain and inspect water from each possible breeding site to see if it contains larvae.[15]
- Additionally, various studies recommend focusing the community search for Ae. aegypti specific breeding sites on schools, health posts, cemeteries, structures or houses under construction, empty lots, and community centers.[19–21]
- Findings from participant focus group discussions in urban and peri-urban areas of Guatemala suggest, higher collective efficacy perceived to take these actions at the household-level, whereas at the community level often municipal and community cooperation is necessary for successful implementation. This can be a demotivating factor for people who do not see action by their fellow community members or municipal leaders. Therefore, it may be most productive to prioritize household level implementation of the intervention over community level removal of tires and discarded containers. Additionally, this same study recommended further engagement of community leaders, government organizations, the private sector, and community-based civil society organizations to take an active role in vector control and to be vocal about their collective efforts to reduce larval habitats in communal areas.[22]

- A strength identified by authors of a cross-sectional study in urban areas of Honduras was that community members were not only provided with educational materials for container elimination campaigns in their community, but they were also trained in how to prevent specific containers around their home from harboring mosquitoes.[23]
- Results from a study in urban slums in Pakistan, which assessed the role of positive deviants on community knowledge and acceptance of Dengue control interventions, indicate that locally identified solutions and community-made information, education, and communication materials had strong ownership and acceptance from the community, and therefore may be a powerful community engagement tool for future vector control efforts.[24]
- In Brazil, a household intervention for Ae. aegypti control identified that most receptacles containing Aedes larvae were small containers (i.e., domestic garbage cans) and therefore suggested that community engagement efforts that focus on waste reduction, allied with appropriate removal of garbage, could decrease the availability of these breeding sites and, potentially, vector density.[25]
- Recommended strategies to control An. stephensi in Sri Lanka included closing abandoned wells and covering wells to prevent mosquito egg laying. These were identified as interventions that can be carried out by the local population if a behavioral change awareness campaign were to be introduced in this context. In addition to the health sector, the support of local authorities, the environmental sector and non-governmental organizations is of paramount importance in practicing these An. stephensi control interventions.[26]
- Findings from an observational study identifying and assessing the role of potential An. stephensi breeding habitats on vector density in India suggested that effective implementation of a seven-point action plan where mosquito proofing of potential breeding habitats in every household is mandatory and implemented at the state and local level can help in sustained control of vector density, compared to the labor intensive and reoccurring costs of larviciding, and reduce perennial transmission of malaria in Chennai, India.[27]
    - Additional details on the seven-point action plan are to be initiated and implemented by the state government through inter- and intra-departmental coordination including the state health departments, water supply departments, horticulture departments, fisheries department, and government engineering departments. Legislative measures and fines are to be given for non-compliance in mosquito proofing or all breeding habitats. Furthermore, any new construction must be approved through the health department to ensure no new breeding sites are established. The action plan also entails eliciting participation of mosquito control with individuals, schools, NGOs, and other voluntary organizations by providing education programs and mass media materials. Specific attention should be given to construction workers and construction sites such that all incoming labor is screened for malaria and provided with treatment as needed and that all construction sites remain free of mosquito breeding to prevent outbreaks.

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**Intervention 7**: Covering Water Storage Containers

**Summary of the Literature Findings:**

**General Considerations**

- A study on water storage container covers in urban/peri-urban areas of Latin America defined an ***effective*** cover as one having no observable holes, which sealed the container, and had no water accumulated on it. Using an effective lid versus no lid was associated with a 94% decrease in odds of larval presence in long-term water storage containers however, similar impacts were not observed for washbasins.[1]
- A study in Thailand found that correctly covering containers with lids was effective in reducing larval infestation (AOR: 0.1–0.25) when used on jars for storing drinking water, but that covering is not enough. Containers must be correctly covered as 34.9% of larvae were identified in incorrectly or uncovered jars compared with 7.8% in containers covered correctly.[2]
- Promotion recommendations from the Zika Prevention Content Guide suggest that covers with the greatest potential to be effective are those developed through a long-term intervention with community participation, in which covers are designed specifically for local containers that favor the development of mosquito breeding sites. It is important that the lids seal well and have all the features mentioned above.[3]
- A study in Mexico found covering long-term water containers, combined with community mobilization and scrubbing containers, was associated with lower risk of presence of aedes larvae or pupae (OR 0.22, 95% CI: 0.15, 0.27) after controlling for Temephos use.[4]
- Findings from an observational study identifying and assessing the role of potential An. stephensi breeding habitats on vector density in India suggested that for national vector control programs, the greatest emphasis needs to be directed towards arresting vector breeding by ultimately mosquito proofing overhead tanks in a more permanent way to reduce recurring expenditure on larvicides and human resources. This, however, requires sustained effort and cooperation by the community.[5]

**Household-level considerations**

- A pre-post intervention quantitative study in rural India found the intervention village, where tanka (household underground water storage tanks) lids were replaced with improved mosquito-proof polyvinyl chloride plastic lids resulted in "complete absence of mosquito breeding" with reduction of 94.9% and 97.9% of Anopheles stephensi larvae in the post intervention and at the one year follow up, respectively.[6]
- Similarly, a study in suburban villages of Laos and Thailand conducting cross-sectional household entomological surveys, found that household containers with lids were significantly less likely to be infested with aedes larvae than those without lids (IRR = 0.3, 95% CI: 0.10–0.90) and (IRR = 0.1, 95% CI: 0.04–0.40) respectively.[7]
- Results from a cross-sectional study investigating risk factors for the presence of Ae. aegypti and Ae. albopictus in domestic water-holding containers in Laos suggesting that the effect of covers is diminished or potentially reversed for containers used frequently informed recommendations in the Zika Technical specifications guide that household members should focus covering efforts on infrequently used water storage containers (long-term storage), or water that is accessed occasionally (less than once per week).[8]
- Likewise, in the context of Aedes Aegypti control programs in Latin America, covering long-term water storage containers were found to have moderate potential efficacy in reducing breeding sites if a tight-fitting, long-lasting lid is available. On the other hand, covering short-term water

storage containers has less potential efficacy, as frequent lid use can result in wear and tear and render the lids ineffective or counterproductive.[9]

- Further recommendations from the Zika Technical specifications guide suggest that the lid must be kept in excellent condition and replaced if it begins to get warped or cracked. Additionally, the lid should make a very tight seal, should not touch the water, and be made of a material that is not cloth and does not crack or warp in the heat or sun.[7]
- Focus group discussions in urban and peri-urban areas of Guatemala identified challenges with access to proper or effective covers, as most evident for water storage drums, reducing people's perceptions of feasibility of the intervention. Therefore, this study suggested households may opt to only cover water used for drinking or food preparation, as proper lids for those smaller containers may be easier to access or more affordable.[10]

**Community-level considerations**

- Findings from participant focus group discussions in urban and peri-urban areas of Guatemala suggest covering containers may be best limited to household use given that covers in a communal context may be harder to maintain.[10]
- Findings from a cluster non-randomized controlled trial assessing the effectiveness of an Eco-bio-social strategy for Aedes control in sub-urban areas of Brazil, evidenced that for large, elevated tanks, household members tend to neglect and delegate responsibility of repair and proper lid fitting to professionals who repair water pump parts as they had little time to worry about vector control and rather focused on ensuring immediate livelihood. Therefore, this study recommended training for professionals working in the maintenance of large, elevated tanks in mosquito-proof covering.[11]
- A pre-post intervention quantitative study in rural India found that the active engagement of villagers in the lid replacement process during the study increased knowledge of the importance of proper lids and mosquito proofing of underground tankas.[6]

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## Annex 4 – Example Images of *An. stephensi* larval sources and interventions for control

### Section 1: An. stephensi Larval Sources

**Figure 1.** Plastic barrels in Sudan

**Source:** Wilson A. (2021). Controlling Emergent Anopheles stephensi in Ethiopia and Sudan. Presented at 16th Annual RBM Vector Control Working Group Meeting.

**Figure 2a.** Water tankers in Ethiopia

**Source:** World Health Organization Global Malaria Programme. (2019). Technical consultation on the spread of *Anopheles stephensi*. Retrieved from Malaria Policy Advisory Committee Meeting October 2019. WHO. https://www.who.int/docs/default-source/malaria/mpac-documentation/mpac-october2019-session7-an-stephensi-presentation.pdf?sfvrsn=3e54db3d_2

**Figure 2b.** Concrete cistern in Ethiopia

**Source:** World Health Organization Global Malaria Programme. (2019). Technical consultation on the spread of *Anopheles stephensi*. Retrieved from Malaria Policy Advisory Committee Meeting October 2019. WHO. https://www.who.int/docs/default-source/malaria/mpac-documentation/mpac-october2019-session7-an-stephensi-presentation.pdf?sfvrsn=3e54db3d_2

**Figure 3.** Domestic well in Jaffina City, Sri Lanka

**Source:** Surendran SN, Senthilnanthanan M, Jayadas TTP, Karunaratne SHPP, Ramasamy R. Impact of salinization and pollution of groundwater on the adaptation of mosquito vectors in the Jaffna peninsula, Sri Lanka. Ceylon Journal of Science. 2020;49(2):135–50. DOI: http://doi.org/10.4038/cjs.v49i2.7734

**Figure 4a.** Less "typical sites" including ponds along rivers and sewage overflows

**Figure 4b.** Less "typical sites" including flooded areas

**Source:** Ahmed A, Irish SR, Zohdy S, Yoshimizu M, Tadesse FG. Strategies for conducting *Anopheles stephensi* surveys in non-endemic areas. Acta Trop. 2022 Dec;236:106671. doi: 10.1016/j.actatropica.2022.106671. Epub 2022 Sep 1. PMID: 36058292.

**Figure 5.** EMRO capacity building activities for vector surveillance: training on entomological surveillance in yemen

**Source:** Samira Al-Eryani. (2020). Strengthening Vector Surveillance and Control. Presented at 15th Annual RBM Vector Control Working Group Meeting.

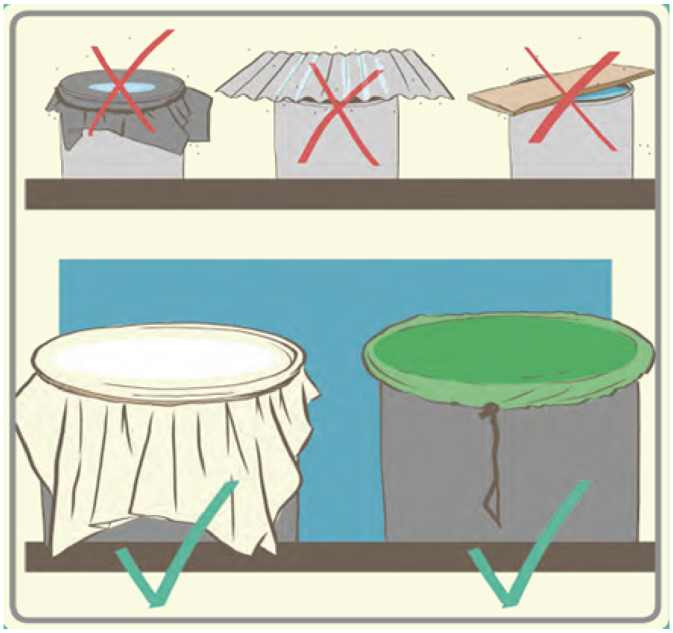
**Figure 6a.** Community training/demonstration of mosquito proof lid replacement on underground water tanks "tankas" in India"

**Source:** Singh, H., Gupta, S.K., Vikram, K. *et al*. The impact of mosquito proof lids of underground tanks "*tanka*" on the breeding of *Anopheles stephensi* in a village in western Rajasthan, India. *Malar J* **20**, 412 (2021). https://doi.org/10.1186/s12936-021-03939-0

**Figure 6b.** Polyvinyl mosquito proof lid in India

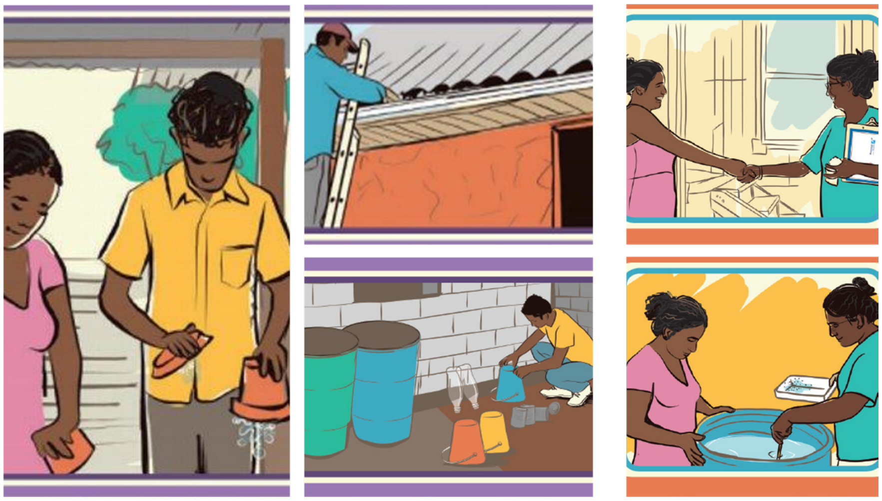
**Source:** Singh, H., Gupta, S.K., Vikram, K. *et al*. The impact of mosquito proof lids of underground tanks "*tanka*" on the breeding of *Anopheles stephensi* in a village in western Rajasthan, India. *Malar J* **20**, 412 (2021). https://doi.org/10.1186/s12936-021-03939-0

**Figure 7.** Example SBC materials illustrating covering water storage containers to reduce breeding sites for *Aedes aegypti*



Source: Breakthrough ACTION. (2019, September). *Key tips for the prevention of zika: A guide for home visits.* Zika Communication Network. Retrieved from https://zikacommunicationnetwork.org/sites/default/files/resource_files/English-JA.pdf

**Figure 8.** Example SBC materials illustrating finding and removing breeding sites for *Aedes aegypti*



**Source:** Breakthrough ACTION. (2019, September). *Key tips for the prevention of zika: A guide for home visits.* Zika Communication Network. Retrieved from https://zikacommunicationnetwork.org/sites/default/files/resource_files/English-JA.pdf