Evidence Review Summary of Findings for Zika Prevention Behaviors

Personal Protection

Behavior 1: Application of mosquito repellant (DEET, Picaridin, IR3535, or oil of lemon eucalyptus, only) by pregnant women, using each product as directed, for duration of the pregnancy, to reduce risk of CZS

Review of the evidence:

- Overall, DEET is considered the gold standard compared to other insect repellents on the market (Wong, 2016; Lupi, 2013). It showed >95% efficacy for 5-11 hours (Lupi, 2013). Safety and toxicity reviewed by EPA show low acute toxicity and no significant health risk; safe and currently recommended for use in pregnancy (concentration of 30% or less, avoiding products combined with sunscreen) (Wylie 2016; Paumgartten 2016).
- The three additional repellents (Picaridin, IR3535, and oil of lemon eucalyptus) found to be of comparable efficacy and safety according to CDC recommendations[1] and USAID documentation although fewer studies conducted on these non-DEET compounds (Lupi, 2013; 2016 Zika Control Programmatic PERSUAP).
- Wearing repellent is highly effective in controlled settings, however, no studies identified of repellent use in Zika endemic settings. Studies show that temperature/climate as well as activities that may dilute the repellent (for example, swimming, sweating, washing, rubbing by clothes) can vary the duration of effectiveness and need for reapplication (Lupi, 2013).

Behavior 2: Use of condoms to prevent sexual transmission of Zika in pregnancy

- Condom use is considered a highly effective measure for preventing sexually transmitted infections, including ZIKV, when used consistently and correctly. All studies and guidelines reviewed from CDC[2], UNICEF[3], and WHO[4] promote condom use as an effective prevention measure against sexual transmission of Zika, particularly during pregnancy.
- No studies to date have calculated the prevention of ZIKV using condoms, however studies show it is persistent in semen for at least 92 days, leading to the recommendation of 180 days of protected sex after a partner's infection (Duarte, 2017). High virulence recorded so likely to be transmitted sexually without condoms (Haddow et al, 2017).
- Programmatic challenges: Several studies in Latin America and Puerto Rico cited many barriers to condom use promotion, including sexuality-related stigma, low levels of self-efficacy, poor quality sex education, low levels of reproductive planning, limited access to contraception, high rates of gender-based violence, low rates of condom use among women, and negative religious messaging around use of contraceptives (Pacheco, 2017; Rodríguez-Díaz, 2017; Davis, 2016 ; Zorrilla, 2016; Hodge, 2016).
- Particularly low utilization reported of condom use during pregnancy (Marteleto, 2017; Zorrilla, 2017; D'Angelo et al, 2017; Fraiz et al, 2018). One study of pregnant women specifically found 56% of women noted condom utilization to be rated as some level of difficulty, in a study in the United States (Fraiz, 2018). A recent survey in Puerto Rico found only 38.5% of pregnant women reported using condoms (D'Angelo, 2017).
- Mathematical modeling studies found the sexual transmission attack rate to range from 4%-5% of total ZIKV transmission (Roa, 2017; Coelho, 2017).

Behavior 3: Adopt a modern family planning method if you are not planning on getting pregnant

II. Household and Community Vector Control

<u>Behavior 4</u>: Regularly remove (unintentional) standing water both inside and outside of the house, and communal areas

- Stagnant water management (cleaning/removal) interventions are the most widespread practice and have been used for decades, although systematic reviews have found a mixed effect on reduction of larval indices (Bowman, 2016).
- Although findings in a meta-analysis point towards reduced vector densities where interventions involving removing standing water were applied, removal of unintentional standing water was rarely the sole focus of the study (Alvarado-Castro, 2017). The majority of effective water management programs were paired with community engagement, educational campaigns, or pesticide use.
    - In Singapore, removal of stagnant water was associated with an over 70% reduction in adult mosquitoes when conducted through a door to door campaign (Audraud, 2013).
    - In a quasi-experimental design study in Cuba found house index reduced from 3.7% to 0.61% using community mobilization campaigns for source reduction (Perez, 2005).
- Knowledge of the behavior: Studies demonstrated that improving awareness and knowledge is a key component of almost all water-removal interventions. One study showed that an increase of knowledge was associated with an increase in behavior performance (pre-test 20%, post-test 92%) (Sugunadevi & Dharmaraj, 2017). Another reported 67.3%-89.2% of participants answered questions correctly related to breeding sites in water, stagnant water cleaning practices, and ways to clean containers after a campaign (Suwanbamrung etal, 2013). Carrying out cleaning is linked to perceived risk, as the behavior is less likely to be done if perceived risk is low (Wong, 2013).
- Effectiveness + cost-effectiveness: This intervention is most effective if the highest risk/vector density items are targeted, some studies aimed to identify what these are but may be context specific (Mahfodz, 2017). Identification of, and targeted action towards, 'productive' container types (i.e. those that are assessed as contributing the greatest burden of pupae, relative to other containers in the area) can potentially enable more cost effective larval control (Bowman, 2016).
- Unintended consequences: one study found that even with source removal some households did not lower vector density because the household inadvertently created other breeding sites in their yards by adding containers (Doling, 2013).

<u>Behavior 5</u>: Cover water storage containers at all times with a cover that is tight fitting, does not warp or touch the water

- Studies suggest that correct use of lids on water storage containers can significantly reduce pupal infestation, for containers used infrequently (correct use identified as fully covered, without spaces for mosquitoes to enter) (Phuanukoonnon, 2005). In a meta-analysis including a randomized trial, water tank covers significantly reduced the number of tanks positive for immature stage *Ae. aegypti* (Bowman, 2016).
- Two studies from Thailand suggest correct covering water containers is associated with decreased larval infestation (Vannavong, 2017; Phuanukoonnon, 2005). Container lids are not an absolute barrier and must be tightly fitted to prevent gravid females entering for oviposition (Vannavong, 2017).
    - Correct lid use is critical: in Thailand, effectiveness varied with correct container coverage (34.9% larvae in incorrectly or uncovered jars, 7.8% in covered correctly) (Phuanukoonnon, 2005).
    - Infrequent use is better: One study found that frequent use of containers reduced the effectiveness of lids; while weekly emptying can interrupt the mosquito life cycle, removing lids too often reduced effectiveness (Phuanukoonnon, 2005).
- In addition to plastic covers, some covers are fine cloth, mesh or long-lasting insecticide treated nets (LLITNs) as lids (as long as the mesh is fine enough to prevent adult mosquitoes). Two studies found LLTIN's are effective as lids at reducing larval indices (Quintero et al, 2015; Seng et al, 2008). Main reasons for declining use and efficacy is if the mesh covers get dirty or damaged (Vanlerberghe et al, 2011).

For LLITN magnitude of effect diminishes over time due to gradual reduction of insecticidal effect (Seng et al, 2008).

Behavior 6: Scrub walls of water storage containers once a week to remove eggs

- One of the most important factors associated *Ae. aegypti* infestation is frequency of container washing/cleaning/changing water; a study in Colombia found monthly or never washed containers were 4x more likely to be infested than those washed weekly (Overgaard, 2017). In another study, infestation rates were 17.2% in containers cleaned weekly vs 39.1% in those cleaned monthly and 43.7% in those cleaned annually (Phuanukoonnon, 2005). In a third study, containers not used in the last 7 days were associated with higher pupal production in both rainy and dry season but more significant in the dry season (Quintero, 2014). In a fourth study, draining jars of water and cleaning once per week effectively killed larvae and pupae (Hiscox, 2013).
- Cleaning with bleach: In addition to washing/changing water, cleaning is recommended - manual cleaning less effective than the Untadita method according to a randomized evaluation, which found that proper implementation of this cleaning method with chlorine bleach + 10 mins of scrubbing with a brush (steps outlined in article) reduced infestation significantly (Fernandez, 1998).
- Cleaning guidelines are different if bti larvicide is applied in the water; the container should not be fully emptied and no scrubbing in order to maintain residual bti larvicide in the container. Bleach can be applied as long as the concentration matches the recommendation for potable drinking water (Carolina Gutierrez, personal communication, year?).
- Container type: Containers in frequent use for hygiene, cooking, and drinking purposes less likely to be breeding sites (Hiscox, 2013). Also variation by material (plastic vs barrels, etc) and by season (Quintero, 2014). This has implications for program effectiveness as the most productive containers should be targeted for this intervention (Betancourt, 2015; Tran, 2014; Quintero, 2014; Dom, 2013).
- Water access and storage issues: In one study, 82% of houses surveyed (in Colombia) stored water and gave the reasons as interruption of water services, poor water pressure, or to save money (Garcia-Betancourt, 2015). Cost-benefit argument may be needed, as in one qualitative study many people don't wash their tanks often because of the costs associated with water access (Suarez, 2009; Garcia-Betancourt, 2015).
- Elimination of breeding in containers could reduce pupal production by approximately one-third, leading to reduced adult mosquito population and risk of disease transmission in models (Hiscox, 2013).

Enabling Behaviors:

Behavior 7: Seek prenatal care to monitor pregnancy and discuss Zika risk and prevention

Behavior 8: Allow vector control teams into your home and community to apply larvicide

[1] Centers for Disease Control and Prevention. Avoid Mosquito Bites. Link: https://www.cdc.gov/features/StopMosquitoes/
[2] CDC. Sexual transmission and prevention. Link: https://www.cdc.gov/zika/prevention/sexual-transmission-prevention.html
[3] UNICEF (2016). Risk Communication and Community Engagement for Zika Virus Prevention and Control. Link: https://www.unicef.org/cbsc/files/Zika_Virus_Prevention_and_Control_UNICEF_English.pdf
[4] World Health Organization (2016). Prevention of sexual transmission of Zika virus: Interim guidance update. Link: http://apps.who.int/iris/bitstream/10665/204421/1/WHO_ZIKV_MOC_16.1_eng.pdf