



## Vector control in Zika-affected communities: Local views on community engagement and public health ethics during outbreaks

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### ABSTRACT

Aerial spraying of products to kill larvae or adult mosquitoes is a public health measure used to control vector-borne diseases. In some outbreaks, the intervention has evoked controversy and community resistance. This study evaluated how local opinion leaders in US localities affected by Zika think about community engagement in public health policies for outbreak response. In December 2017 through March 2018, 4 focus groups were convened in Houston, TX, New Orleans, LA, Miami, FL, and Brooklyn, NY. They discussed a hypothetical scenario that featured vector control by aerial spraying. Participants (N = 20) more readily accepted this vector control method under 4 conditions: They were informed of alternatives, benefits, and risks for human health and the environment. Public health claims were backed by objective evidence and an authority figure genuinely working in the community's interests. They received timely notice about how to mitigate toxin exposure. And, aerial spraying helped to protect vulnerable individuals. The community engagement requirements of the local opinion leaders resonate with core principles of recent public health ethics frameworks: namely, personal autonomy, transparency, reasonableness, and solidarity. Participants foresaw problems with community consent in an era of growing social media use and mistrust in governmental and scientific authority. They also debated whether health authorities should use moral-based arguments, in addition to science-based ones, to communicate aerial spraying's risks and benefits.

### 1. Introduction

In 2015 to 2017, communities throughout the Americas, including the United States (US), launched public health responses to combat the spread of the Zika virus (Kroelinger et al., 2017; Madad et al., 2016; Murthy et al., 2018; Oussayef et al., 2017). Features of the Zika virus disease and its control complicated the outbreak response; these included multiple modes of viral transmission (mosquito bite, sexual contact, mother-to-fetus); absence of an effective vaccine; prevention via individual behavior modifications and environmental interventions; and uncertain health impacts for affected infants (Oussayef et al., 2017). As a result, public health professionals faced many ethics concerns: Was comprehensive reproductive healthcare available for women (Lancet Global Health, 2016; PAHO, 2016; Saenz, 2016)? What outbreak controls were appropriate when most contagious individuals were asymptomatic (Jamrozik et al., 2018)? Which prevention and treatment studies were morally defensible (Marston et al., 2016; Shah

et al., 2017)?

Community engagement – i.e., the sharing of information, trust, and responsibility between health authorities and affected communities (Schoch-Spana et al., 2007) – was a recurrent theme in the ethics analyses published during the Zika virus outbreak (Nuffield Council on Bioethics, 2016; PAHO, 2016; Tambo et al., 2017). The Pan American Health Organization and Nuffield Council on Bioethics, for instance, advised providing clear, timely, and culturally-aware public information about the health effects including congenital Zika syndrome, local incidence and prevalence, personal protective actions (e.g., repellent use), and public health interventions (e.g., surveillance) (Nuffield Council on Bioethics, 2016; PAHO, 2016). They also urged involving communities in decisions about interventions that may affect them and engendering public trust through two-way communication.

Analyses of the public health ethics of Zika virus vector control demonstrated that community engagement is vital (Jamrozik et al., 2018; Nuffield Council on Bioethics, 2016; Tambo et al., 2017; WHO,

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2017). Interventions seen as out-of-sync with local values could foster community resistance. Releasing genetically modified mosquitoes, for instance, could trigger public worry about unnatural interventions that alter the environment in harmful ways. Accessing private property to identify mosquito habitats, too, could upset residents who cherish their independence, chafe at government interference, and value their property rights. By explaining control alternatives, eliciting community input on acceptable interventions, and sharing the rationale for specific choices, public health professionals have a greater chance of earning the public's confidence and cooperation (Jamrozik et al., 2018; Nuffield Council on Bioethics, 2016; Tambo et al., 2017). Moreover, involving local residents in a coordinated campaign to reduce mosquito habitats at the community level – such as enlisting whole neighborhoods to empty/cover containers with standing water – can raise the likelihood of successful vector control (Jamrozik et al., 2018; WHO, 2017). Control of other mosquito-borne diseases (e.g., Dengue, Chikungunya), has increasingly enlisted community members in decentralized campaigns (Alvarado-Castro et al., 2017; Andersson et al., 2015; Elsinga et al., 2017; Lucena et al., 2018).

Community engagement has also figured prominently in discussions about an ethics framework to guide public health practice, in general (Lee, 2012; Marckmann et al., 2015; Spike, 2018), and during health emergencies (Gainotti, 2008; Kenny et al., 2010; O'Neill, 2004; Swain et al., 2008). Severe acute respiratory syndrome (SARS), Ebola, Middle East respiratory syndrome (MERS), and pandemic flu each prompted assessment of outbreak ethics (Kim, 2016; Maduka et al., 2015; Singer, 2003). Against this backdrop, our study examined assumptions that local opinion leaders in 4 US localities at high risk of Zika transmission held about community involvement in public health policymaking for outbreak response. They discussed factors shaping community willingness, including their own, to consent to aerial spraying, a controversial outbreak control measure (Biehler et al., 2018; Maxwell, 2003; Tedesco et al., 2010; Thier, 2001).

This study considered two broad questions: Based on community values and procedural expectations that aerial spraying triggers, how can US practitioners best engage the public in future vector control? How do lay community ideals and public health ethics compare in terms of what constitutes a proper outbreak response that involves aerial spraying?

## 2. Materials and methods

### 2.1. Qualitative research approach

We adopted a focus group methodology (Liamputtong, 2011) to explore public views and values on decisions regarding aerial spraying, a controversial intervention. This qualitative approach is typically used to uncover participants' reasoning and interpretations in their own words and insight into "how" and "why" participants feel, think, or behave a particular way (Liamputtong, 2011; Sullivan and Sargeant, 2011). Moreover, the method enables participants to discuss sensitive topics, without being pressured for consensus (Liamputtong, 2011; Sullivan and Sargeant, 2011). Working within the grounded-theory research tradition, our qualitative analytic approach was inductive, that is, allowing understanding to emerge from close study of the focus group data (Bernard, 2011). Study goals were to capture participants' attitudes and ideas as they themselves expressed them, to identify and describe important themes and subthemes, and to discern more complex patterns among the themes (Creswell, 2014).

### 2.2. Participant and locale selection criteria

In December 2017 through February 2018, project team members convened 4 focus groups among local opinion leaders in Houston, TX; New Orleans, LA; Miami, FL; and, Brooklyn, NY. Locale selection criteria were: geographic diversity and Zika infection risk due to

competent vector species and/or travel routes to locations where the Zika virus was circulating during the outbreak (e.g., New York City to Puerto Rico). Local opinion leaders were trusted persons serving in an informal or formal leadership capacity, with influence among fellow residents.

### 2.3. Research subject recruitment

We recruited participants via outreach to community-based organizations associated with different ethnic/racial populations and issues (e.g., economic, cultural, health, environmental, religious, the arts, advocacy). Contact information was obtained via review of electronic public records (e.g., Chamber of Commerce membership rolls) and input from local/state public health advisors. We organized recruitment for gender parity and in proportion to local racial/ethnic demographics. Participants received a \$75 gift card.

### 2.4. Focus group operations

Lasting 2.5 h, each focus group session was held in centrally located hotel meeting space. Participants discussed a 3-part hypothetical aerial spraying scenario (Table 1). The same project team member – a social scientist experienced in focus group methodology – facilitated all sessions. Four project team members – experts in public health preparedness, risk assessment, and risk communication – observed and took notes in at least 1 focus group each. Post-session, participants completed a form evaluating process quality and information intelligibility.

### 2.5. Data analysis

Proceedings were audiotaped, transcribed, and coded using NVivo qualitative analysis software (NVivo qualitative data analysis Software;

**Table 1**

Hypothetical Scenario to Elicit Reactions of US Local Opinion Leaders Convened in Focus Groups (December 2017 to February 2018) to Discuss Aerial Spraying for Mosquito Control in the Zika Context.

Setting
In [insert city], you turn on the television to watch the morning news and hear that health officials are planning to employ mass aerial spraying of an insecticide called Dibrom that has been in use for over 50 years. They want to make a quick assault against Zika-carrying mosquitoes that are very difficult to control in an urban environment because of their scattered and hidden breeding spots. The usual means of mosquito control – delivering pyrethroids, a different insecticide, by trucks and backpacks – will not work fast enough. Health authorities argue that in the small doses they propose to use, the chemical would be low risk. However, the news report also includes an interview with a different scientist who warns that Dibrom can be toxic to children and infants, butterflies and bees, and some fish.
<b>Segment A: The Risks of Disease Weighed against the Risks of Its Control</b> Interrupting the mosquito transmission of Zika comes with the potential cost of releasing small doses of a toxin in the environment. What would make you more comfortable with the mass spraying that the health authorities recommend? What would make you less comfortable? What kinds of additional information would you be seeking?
<b>Segment B: Split Scientific Opinions and Deciding Whom to Trust</b> You are listening to a local health authority who advocates mass spraying of Dibrom to stop Zika and to a local environmental activist who cautions against the widespread aerial release of Dibrom. Whom do you trust more and why? What would you do if they both quoted from different scientific studies supporting each of their viewpoints? What would sway your opinion from one viewpoint to the other?
<b>Segment C: Eliciting the Consent of Publics Affected by the Mosquito Control Policy</b> The local health authority argues that in the case of Zika they are protecting you and your community's wellbeing by killing mosquitoes through mass aerial spraying. Do you think that they need to get your permission to do this? Why or why not? If so, then what would getting your permission look like? What actions would they have to take? What kinds of information would they have to offer?

QSR International Pty Ltd. Version 11, 2015). Four team members reviewed all transcripts. Themes were informed by findings on public reactions to aerial spraying in past outbreaks (Maxwell, 2003; Thier, 2001) and then modified based on discussion and notes review among the project team. Each team member was assigned a specific set of themes and subthemes with which to review the transcript database. The project team analyzed coded data to produce findings, which collaborators from the US Centers for Disaster Control and Prevention (CDC) helped interpret based on their Zika response experiences.

2.6. Ethical considerations

The Johns Hopkins Bloomberg School of Public Health Institutional Review Board (IRB) and the CDC Human Research Protection Office (HRPO) reviewed and approved the study protocol (IRB No. 00007824 and HRPO No. 6979). Participants received the requisite and approved information for obtaining informed consent throughout the course of contact with the researchers including initial recruitment outreach via phone or email, follow up letter delivered via email, and in-person oral consent prior to the start of the focus group discussion.

3. Results

Twenty local opinion leaders representing diverse perspectives participated (Table 2). Thematic findings follow.

3.1. Providing the public with a complete health picture

Having all relevant health facts about Zika virus and its control through environmental means put the local opinion leaders at greater ease with a public health decision involving aerial spraying.

**Pesticide efficacy and risks for participants, dependents, and the environment were pressing topics.** One attendee noted, “I would want to know exactly what would happen if you inhale this toxin?” Several wanted to understand the risks over time, including the

Table 2

Attributes of US Local Opinion Leaders Participating in Focus Groups Convened December 2017 to February 2018 to Discuss Aerial Spraying in the Zika Context.

Attributes	Houston, TX	New Orleans, LA	Miami, FL	Brooklyn, New York	Total
Persons recruited	6	7	6	4	23
Persons attended	5	7	4	4	20
<b>Gender</b>					
Female	4	7	4	2	17
Male	1	0	0	2	3
<b>Race/Ethnicity</b>					
White	2	3	3	1	9
African-American	3	4	0	1	8
Other	0	0	1	2	3
Hispanic or Latino*	0	0	2	2	4
<b>Community Focus</b>					
Business	2	0	2	0	4
Communications	1	0	1	0	2
Education	0	1	0	0	1
Environment	0	1	0	1	2
Gay/Lesbian	0	0	0	1	1
Health	2	0	1	2	5
Housing	0	2	0	0	2
Immigrants	0	1	0	0	1
Politics/Voters Rights	0	2	0	0	2

\*Participants who specified Hispanic or Latino in addition to White, African-American, or Other categories.

pesticide’s persistence in the environment. For example, “[B]eing the mother of small children and having animals, I would want to limit their exposure...if it can linger for a certain amount.” Participants also wanted to know if aerial spraying was an effective intervention. For example, “Besides all of the projected and studied environmental effects, I’d want to know, was this successful before?”

**Pesticide risks elicited greater discussion, but Zika virus facts influenced participants’ comfort with aerial spraying.** Some desired to hear more about the disease’s origins and prior control, for example, “[H]ow long has it been around? Has it been studied enough? Were there things used in the past to... combat it before?” Others wanted specifics about health impacts, including rates of sickness, birth defects, and deaths. Participants also wondered about local relevance: “[T]here’s a lot of international travel...out of Houston...[I]s that why we’re at a higher risk...or is it because the mosquitoes that are carriers are actually here?”

**Participants wanted to know the risk tradeoffs between Zika virus infection and pesticide exposure.** For example, “I want to know a clear balance of the risks involved if we don’t spray versus if we do.” Information desired for side-by-side comparison were specific health effects, probability of poor outcomes, and number of people affected. People who saw Zika as a threat to their own health considered pesticide risks less worrisome, for example, “I was more concerned about Zika than I was about the chemical spraying....Obviously because I was pregnant.”

**Could “less toxic” methods reduce mosquito populations was a question of interest.** For example, “What can we do that would be safer for the environment and for the public?...If it’s just about big aerial spraying because it’s fast and it’s cheap and it’s successful...[then] I’m not always sure that...method is the right way and the safest way.” Commitment to comprehensive mosquito control – including less-toxic, more labor-intensive methods – made a decision to use aerial spraying more acceptable. For example, “We’re already doing these other public health measures, but this is going to be the most effective last resort we can take.”

3.2. Genuinely acting in the local community’s best interests

When judging the legitimacy of either aerial spraying advocates or detractors, local opinion leaders indicated greatest trust in experts whom they saw as acting in the community’s best interests.

**Some participants felt that authorities deciding about aerial spraying had community interests at heart, because they held public offices obligating them to protect constituents.** For example, “If we’re...electing the right people, then we have to trust that whoever makes the decision is going to do the right thing.” Another stated that health departments often have “objectives that have to be met from a prevention standpoint,” thus benefiting the community at-large. Some noted their tendency to judge scientists or medical experts as having community safety foremost in mind.

**An authority figure’s proximity to the community mattered.** Participants often cited local (versus national) officials as more trustworthy advocates of aerial spraying. For example, one said agencies like CDC or EPA must often make “blanket judgments” for multiple states to control large outbreaks; benefiting one location, the same recommendation might hurt another. In contrast, someone who “breathes the same air that you breathe” would make decisions in a community’s best interests. However, one participant advocated listening to local and national viewpoints, saying people might embrace aerial spraying more readily if they learned about its use in other places.

**Participants worried that economic and political interests could influence aerial spraying decisions.** Noting chemical companies’ power, many wanted to know more about funding sources for pesticide safety studies. For example, “[I]f we get into the question of quoting scientific studies. Who funded those studies?” Some felt that chemical manufacturers might also financially support politicians

endorsing pesticides. Another participant, a travel industry employee, noted that local authorities seemed to agree to aerial spraying to please out-of-state tourists, not to benefit the community itself.

### 3.3. Helping the public to adjudicate competing facts

Local opinion leaders acknowledged declining trust in scientific authority and proliferating information sources made sorting aerial spraying facts hard.

**Validating health information was seen as increasingly difficult due to growing news media content, mass communication platforms, and suspicion toward science.** For example, “There’s a shift in our culture where at one time we kind of trusted the medical community...the scientific process...and then all of a sudden, people started writing blogs [and became] a source of information.” Eroding faith in public institutions also exacerbated uncertainty about the science behind health and environmental policies. As someone observed, “I take almost everything with a grain of salt....I just don’t trust that the information that has been available [on a government website] in the past is the same...available today.”

**Conducting their own research was how some participants would verify credible aerial spraying information.** Participants mentioned Google, WebMD, CDC, and trusted medical professionals as sources. One described testing the veracity of health information: “What articles are they citing? Is it peer-reviewed? Another corroborated this approach, “I would Google the [expletive] out of Dibrom [note: mosquito adulticide] .... [N]o one source, even if it is all accurate, has all the answers. So, I’d be looking for those websites that say, ‘no aerial spraying dot com.’”

**Participants worried that parsing scientific information required sophistication and resources.** Unequal access to a good education and income meant not everyone shared the same capacity to interpret health information – e.g., scientific literacy, research skills, internet access. One participant remarked, “[T]he first time you read a study...you’re like, ‘what is this?’ Especially if you’re a person who [doesn’t] have a scientific background.” Here, participants proposed enlisting trusted leaders as science translators: “If you have somebody in the community who can explain it to them on their level...that will make a big difference.”

**Several people reported using faith or religion to weigh competing health facts about mass spraying.** For example, “I’m big on my belief in the creator...[W]hen it comes down to science and...both sides have proof to verify their opinion...[then] I lean towards more the religious side.” One participant observed that science did not sway some community members: “[T]he Lord will take care of them no matter what. So, that’s an attitude.”

### 3.4. Creating the conditions for community consent to aerial spraying

Participants outlined conditions that would make them more open to aerial spraying, although they were differently convinced that such a decision would always be made for the public’s benefit.

**Participants expressed an uneven belief that public concerns actually mattered when authorities were deciding to spray.** Some entrusted authorities to weigh risks properly and then communicate decisions prior to spraying. “I deserve that information as a voter, as a citizen, as a human being, but I’ve elected you. Go do your thing.” Others preferred that officials address public concerns before deciding to spray: for example, “[E]xposing you to health risks is...a no brainer. They have to get your opinion.” Still others felt community input would be meaningless, in that officials had their own agenda.

**Participants advocated that authorities be transparent about aerial spraying decisions.** For example, “Full disclosure. Just spill it.” Timing as well as content was important. “Like if we were informed and then they were going to start this spraying tonight at nine, I’d be like, ‘Wait a minute...Have we really considered all of the ramifications?’”

Outreach to people typically left out of the loop was necessary. “[W]e don’t want to have a disparity....So, making sure we’re going to populations that are not going to see the billboard or...be at these places.” One participant argued for steady, on-going Zika communication: “That way people get in the habit so when it is June or July, it’s like, ‘Well, I know I need to go do this, so let me go do this now.’”

**Advance notification respected personal autonomy and enabled independent protective actions.** Priority topics included information such as when and where spraying would take place so they could leave and how long residue would linger before they let their children and pets outside. Personal choice was a frequent theme. In the spraying context, one could prepare to avoid exposure or ignore that possibility. “As an individual, you do have the liberty so say, ‘Well, I’m going to leave my windows open.’” Authorities who proceeded with spraying despite public protest, argued some, quashed personal choice. “They’re taking away the decision from the people who don’t want to be exposed to the toxin, so they have no choice.”

**Personal choice could yield to societal needs around aerial spraying.** For example, “I love my child. I love my dog. And I don’t want to put either at risk, but I also feel like...with the whole vaccine thing....there’s a real issue here of greater good versus individuals.” A participant argued similarly from a faith perspective, “Sometimes you have to sacrifice personal freedom for what the body of Christ needs to come together and do.” Along this vein, a participant worried about people without the means to protect themselves. “[T]here are some people who can’t go out and buy bug-spray or who can’t control what they have to wear...outside. So, I think that...is worth the risk of putting the toxins out there.”

## 4. Discussion

Local opinion leaders from Zika-affected communities shared their expectations about public health control of the vector-borne disease. Their conditions for supporting an aerial spraying decision resonate with many principles, conveyed below, that recent public health ethical frameworks incorporate. Knowing the circumstances under which these leading residents would embrace aerial spraying, moreover, helps point to specific strategies and tactics that health authorities can adopt to foster the climate of trust, understanding, and cooperation necessary to sustain control of vector-borne disease (Table 3). These measures incorporate more traditional, “passive forms of community participation,” such as centralized risk communication and one-way information provision, as well as “more active forms of community participation” such as sustaining a dialogue about an overall mosquito management plan, enlisting respected intermediaries to inform and involve a diverse populace, and establishing a community-centric view of outbreak prevention and control (Castro et al., 2017).

### 4.1. Balancing an intervention’s health benefits and health risks

Protecting the public from serious harm is a foundational principle of public health ethics (Lee, 2012; Marckmann et al., 2015; Spike, 2018). Practitioners communicating about an intervention need to define the intended health outcome, specify expected benefits (i.e., magnitude and likelihood), and provide evidence supporting these claims (Marckmann et al., 2015). And, because a beneficial intervention may itself hold certain health risks and social burdens, practitioners are equally compelled to assess the magnitude, likelihood, and scientific validity of potential harms, while identifying risk reduction methods.

Similarly, local opinion leaders signaled that health officials should ground aerial spraying decisions in solid evidence and reasoning, outlining the “net-benefit.” They wanted to know the risk tradeoffs between Zika virus disease and pesticide usage, including comparison of health impacts, risk probabilities, and total people affected. They wondered about the pesticide’s short- and long-term human and ecological effects. They also cautioned that proliferating social media,

**Table 3**  
 Requisite Conditions for the US Study’s Local Opinion Leaders to Embrace Aerial Spraying and Practical Implications for Community Engagement in Vector Control during a Future Outbreak\*

Requisite Condition	Sample Quotes	Practical Implications for Future Vector Control*
<b>Health Facts</b> – If the community receives a full, meaningful and verifiable account of the intervention’s alternatives, benefits, and risks	“[W]hat would happen if you inhale this toxin....What sickness am I going to have? What’s going to happen to my children?” “I’d want to look at those findings and I’d want to measure them against any other findings that might appear contrary and try and understand that myself.”	<ul style="list-style-type: none"> <li>● Be ready to compare side-by-side health impacts, chance of poor outcomes, and total # affected people (pathogen vs. pesticide)</li> <li>● Address aerial spraying’s impacts on human health and the environment, and short- and long-term effects for both</li> <li>● Provide corroborating evidence to support the decision</li> </ul>
<b>Shared Reasoning</b> – If authorities show how aerial spraying fits into a comprehensive approach to vector control and adequately explain why it is needed now	“There’s full disclosure. There is a community forum. There’s public health officials. There’s Q&A time.” “It can’t just be like, ‘We’re going to spray and that’s it.’ This should be kind of like a last resort.”	<ul style="list-style-type: none"> <li>● Explain the limited circumstances and aims for aerial spraying in light of the locality’s overall plan for mosquito management</li> <li>● Review risk tradeoffs and explain aerial spraying’s net-benefit for the community’s health</li> <li>● Communicate regularly about the locality’s mosquito management approach, not just during the crisis period</li> </ul>
<b>Trustworthy Authority</b> – If the advocate(s) for aerial spraying are an unconflicted public health expert and/or a locally invested leader who may be affected by the spraying	“[...]they’re in the trenches with you. Somebody who’s local is, ‘Look, I breathe the same air that you breathe.’” “I want to know where the money’s coming from. Where’s the funding [for pesticide safety studies] coming from?”	<ul style="list-style-type: none"> <li>● Stress how the aerial spraying decision is a result of the local official’s responsibility to local public health</li> <li>● Remedy misinformation and eroding faith in expertise by providing verifiable, credible public health information on a routine basis</li> </ul>
<b>Personal Autonomy</b> – If all affected individuals are given timely, substantive, and culturally appropriate notice that enables them to take personal steps to mitigate pesticide exposure	“You can do things to draw them [the community], to get them to come to you, but at some point, you have to go to where they actually are.” “They [health authorities] give you a heads up and say, ‘Hey, we’re going to be spraying such-and-such dates. So, do this; take whatever measures you need.”	<ul style="list-style-type: none"> <li>● Issue timely, substantive, and culturally appropriate notice to allow for individuals to prepare adequately for personal mitigation</li> <li>● Design ways to engage individuals who lack scientific literacy, cannot access internet, and/or rely on faith to guide behavior</li> <li>● Enlist trusted local opinion leaders to help translate scientific information into meaningful terms for diverse residents</li> </ul>
<b>Solidarity</b> – If mass spraying helps protect individuals who, due to life circumstances, have few or no other ways to prevent mosquito bites	“[A]s a body we should come together and do this...So that’s kind of how I see it with this. Like we have to care for the least, the last, and the lost.”	<ul style="list-style-type: none"> <li>● Relate how aerial spraying affects collective well-being and provides a needed layer of protection for especially vulnerable people</li> </ul>

\*These recommendations are based on the expert opinions of the study participants (n = 20).

competing truths about aerial spraying, and uneven scientific literacy could undermine public health’s ability to influence community members equally by quoting the science.

4.2. Improving population health while acknowledging individual rights

Public health practitioners should not execute their duty to whole populations single-mindedly (Alvarado-Castro et al., 2017; Andersson et al., 2015; Spike, 2018). Encroachment on personal liberty should be limited to extraordinary circumstances, i.e., less restrictive measures have been exhausted, the threat’s gravity calls for a commensurate response, and curtailed freedom is not applied discriminatorily (Thompson et al., 2006). Respect for autonomy involves providing for the health literacy and awareness of affected individuals, permitting individuals to opt out of an intervention after being informed, and, if that is not possible, assuring that the decision to proceed is made in a democratically legitimate process (Marckmann et al., 2015).

Local opinion leaders, too, wanted individuals’ rights preserved in the aerial spraying context. They desired high-quality information about why spraying was justified and its potential harms and benefits. They argued that extra measures would be necessary to assure that diverse individuals were all properly informed. They demanded timely and substantive notice about aerial spraying so that residents could take their own steps to avoid pesticide exposure. In the vein of using the least restrictive yet still effective intervention, the local opinion leaders wanted health authorities to share the limited conditions and specific purposes to which aerial spraying would apply in light of the community’s comprehensive approach to mosquito management. As a gauge of whether restricted freedom was truly warranted, they judged an official

willing to subject themselves to the same pesticide exposure risk as more trustworthy.

4.3. Engaging the affected community in intervention decision-making

Public health interventions influence people’s well-being and autonomy. Therefore, people expect to participate in decision-making that affects them. To establish public trust and an intervention’s legitimacy, practitioners should elicit the input of potentially affected parties in a timely manner, base their decision in sound evidence and reasoning, and revisit the decision as information evolves (Lee, 2012; Marckmann et al., 2015). Principles of procedural justice, inclusivity, and transparency align with the core public health activities of communication and community engagement (Lee, 2012; Marckmann et al., 2015; Spike, 2018; Thompson et al., 2006; WHO, 2017).

Community leaders expressed more or less faith in the legitimacy of a public health decision to apply aerial spraying and the importance of community input. At one extreme, officials were seen as authorized to act on the community’s behalf, minimizing the need for public input; at the other, officials were presumed to push their own agenda whether they entertained public concerns or not. Trusting or skeptical, participants wanted authorities to alert the community prior to spraying. Given mosquitos’ seasonality and Zika virus’s impacts, some advocated risk communication early and often, versus one-off alerts.

4.4. Leveraging the intervention for equity and solidarity impacts

Public health’s core duty is to community health. Accordingly, the field’s ethics typically acknowledge health’s social nature: an

individual's well-being depends on people around them. Principles deriving from this communal aspect are equity, justice, and solidarity (Kenny et al., 2010; Lee, 2012; Marckmann et al., 2015; Swain et al., 2018). They oblige professionals to ensure that no one group disproportionately shares in benefits or risks, improve life and health conditions for society's worst-off members and generate public goods benefiting the entire community (e.g., safe food) (Marckmann et al., 2015; Spike, 2018).

Local opinion leaders were similarly attuned to health's interconnectedness. They argued that health officials should use grassroots ombudsmen to translate complex science into meaningful terms, giving diverse laypeople an equal chance to comprehend aerial spraying's risks and benefits. Noting a moral obligation to others, they expressed a willingness to suppress personal anxieties about spraying so that others could benefit from fewer Zika-carrying mosquitos, including people who had no money to buy repellent or spent a lot of time out-of-doors (e.g., the homeless, landscape workers).

Participant willingness to accept the burden of aerial spraying if that sacrifice translated into greater protections for more vulnerable community members (e.g., the unborn, outdoor laborers) raises an important question for public health practitioners: should they give equal weight during ethical deliberations to the views of individuals, regardless of whether they are more or less vulnerable to the impacts of Zika infection?

#### 4.5. Limitations and future research

Limitations included small sample size and over-representation of women. Larger sample size and further input from men could have yielded additional themes or more nuance to current findings. Nonetheless, given their social positions, the grassroots leaders queried had the capacity for a broad perspective on local sensibilities about aerial spraying. Despite its limits, the study establishes an important foundation for future inquiries. The thematic analysis may serve as the first phase of an explanatory sequential mixed methods design that would build to quantitative data collection and analysis (Creswell, 2014). For instance, quantitative explorations of the same topics could better ascertain the frequency of attitudes, opinions, and perceptions and allow researchers to generalize more broadly (Liamputtong, 2011; Sullivan and Sargeant, 2011).

Future comparative research is also possible. For instance, one could examine how community members approach these same matters during a "steady state" (no active threat) versus a "crisis state" (Zika and pesticide risks are both present); varying risk perceptions could influence how people absorb, approve, and act on individual and collective protective measures. In addition, *Aedes* species mosquitoes (*Ae. aegypti* and *Ae. albopictus*) the primary Zika vectors prefer to bite people and live both indoors and outdoors in close proximity to people (US Centers for Disease Control and Prevention, 2019a). For vector control, health authorities might also consider targeted residual spraying in areas where screens and air conditioning are uncommon (US Centers for Disease Control and Prevention, 2019b). Thus, one could investigate community views and values regarding this more intimate and immediate form of spraying.

## 5. Conclusions

Local opinion leaders outlined certain community engagement requirements for a public health policy of aerial spraying in the Zika context; these resonated with values that recent public health ethics frameworks contain, including personal autonomy, transparency, reasonableness, and solidarity (Lee, 2012; Marckmann et al., 2015; Spike, 2018). Participants' comments also help to inform concrete ways for practitioners to operationalize these ideals in future vector control campaigns (Table 3). Congruence between scholarly treatments of public health ethics and practical expectations of local community

members bodes well in terms of where front-line practitioners are headed.

The local opinion leaders also raised unanticipated issues. They foresaw problems for authorities' in eliciting community consent in an era of competing truths, proliferating social media, and skepticism toward government. If and how the ethical principle of community involvement should evolve given advancing communication technologies and extreme social polarization are open questions. Moreover, current ethics enjoin practitioners to impart the science behind benefits and harms. Yet, faith-based and other belief systems were important in this study, raising the question whether morally-based rationale are appropriate when engaging the community in decisions about a public health intervention – an approach now being weighed in health and risk communication (Miller, 2017).

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## 7. Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Use of trade names and commercial sources is for identification only and does not imply endorsement by the Centers for Disease Control and Prevention, the Public Health Service, or the U.S. Department of Health and Human Services.

## CRediT authorship contribution statement

**Monica Schoch-Spana:** Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing. **Crystal Watson:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Writing - original draft, Writing - review & editing. **Sanjana Ravi:** Data curation, Formal analysis, Investigation, Resources, Writing - original draft, Writing - review & editing. **Diane Meyer:** Data curation, Investigation, Formal analysis, Resources, Writing - original draft, Writing - review & editing. **Laura E. Pechta:** Formal analysis, Writing - review & editing. **Dale A. Rose:** Formal analysis, Writing - review & editing. **Keri M. Lubell:** Formal analysis, Writing - review & editing. **Michelle N. Podgornik:** Formal analysis, Writing - review & editing. **Tara Kirk Sell:** Conceptualization, Formal analysis, Funding acquisition, Project administration, Resources, Supervision, Writing - original draft, Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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