

Public Willingness to Pay for Mosquito Control, Texas

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Katherine Dickinson, an assistant professor of environmental and occupational health in the Colorado School of Public Health. We'll be discussing public willingness to pay for mosquito control in Texas.

Welcome, Dr. Dickinson.

[Katherine Dickinson] Thank you. It's great to be here.

[Sarah Gregory] Your study is about assessing people's willingness to support mosquito control in three Texas counties. Which are they?

[Katherine Dickinson] So we looked at Harris County, which is where Houston is located; Tarrant County, which is where Fort Worth is; and then Hidalgo County—McAllen is one of the cities in Hidalgo County—that's in the Lower Rio Grande Valley, so down near the Mexico border.

[Sarah Gregory] Why did you pick those areas?

[Katherine Dickinson] So our study was looking at willingness to pay for mosquito control and basically looking at public attitudes about mosquito control. And we wanted to look at places that had some variation in their exposure to different types of mosquitoes, also variation in their socioeconomics and in the characteristics of the population there. So we picked three places in Texas that had some of that variation, also variation (that I think I'll get into a little bit later) in the types of mosquito control that are already done in those areas.

[Sarah Gregory] What is the situation with mosquitos in Texas?

[Katherine Dickinson] Well, I think everyone knows that mosquitoes are a pain. Nobody likes to have mosquitoes around. So there's the nuisance factor, and that's one of the things that really influences people's demand for control of mosquitoes. They also spread disease and there are multiple different diseases that mosquitoes can spread. West Nile virus has been a problem in Texas throughout the state and it has had one of the highest rates of West Nile virus between 2002 and 2019. More recently, we're starting to see cases of different diseases that are spread via a mosquito called the *Aedes* mosquito, and those are diseases like dengue, chikungunya, and the Zika virus which got a lot of attention a few years ago. So both the nuisance of mosquitoes and this disease public health threat are major factors in Texas. Texas is actually one of only two states that have had spread of those new *Aedes* dengue and Zika viruses, so it's a major concern in that area.

[Sarah Gregory] I spent a summer in Texas, maybe.... a long time ago, 35 years ago, before I knew anything about public health. And there was an outbreak of equine encephalitis. That was the first time I'd ever heard of a mosquitoborne disease. That was very scary.

Is there much city or county vectorborne control in Texas? I mean, how about on a county basis?

[Katherine Dickinson] Yeah. So it really varies a lot. One of the reasons that we wanted to look in different areas across the state is because it's very localized when it comes to mosquito control. So there's no, you know, statewide program. So some counties...Harris County, for example—again, that's where Houston is and one of the counties that we focused on in our

study—has a relatively large mosquito control program. They do a lot of surveillance and when they find cases, they implement mosquito control programs. Other areas...Hidalgo County, for example—again, along the Lower Rio Grande—there's very little mosquito control and it's very localized, so each city might have somebody who is the dog catcher and sometimes on the weekends will do mosquito control if they need it. So the resources and the activities around mosquito control really vary, and it's very much a patchwork of programs across the state.

[Sarah Gregory] You sort of already touched on this, but why did you decide to do this study?

[Katherine Dickinson] So this is a great example of interdisciplinary science. We were collaborating...so I'm—an environmental economist is my background; I study questions around how people understand different environmental and health risks and how they respond to those. And I was working, and I got connected with an entomologist (a mosquito scientist) who was testing out different ways of controlling some of these mosquitoes, particularly those mosquitoes that transmit the newer diseases like dengue and Zika. His studies have really focused on, does this new control method work; if we put traps around people's homes, do we see a reduction in the number of mosquitoes? Knowing if a new technology works is certainly important, but understanding also if the population wants that technology, if the population has a demand for that technology, if they are afraid of it and what concerns they have, those are all ultimately really important to the success of any public health program. And so we partnered up to look at some of those questions around sort of the social and public support questions related to mosquito control in Texas.

[Sarah Gregory] So how many people are we talking about here? How many people are affected in Texas?

[Katherine Dickinson] Well, so the entire population of Texas would be affected. That's about 29 million people across the state. All of them—I think you could ask pretty much anybody in Texas, and they would tell you that mosquitoes are a problem. Again, whether it's just the nuisance that they're concerned about or if they know somebody who's had West Nile or read all the news about the Zika outbreak a few years ago, I think in some way or another the entire population of Texas is affected.

[Sarah Gregory] Okay. And what are the economic tradeoffs?

[Katherine Dickinson] These new mosquitoes, particularly the ones that spread—again, dengue and Zika and this other virus called chikungunya—these *Aedes* mosquitoes have evolved with humans and so they're really good at.... actually, the places that they breed are almost entirely human-made environments—so containers, tires, houseplants. In some ways, we could just say, well everyone needs to take care of their own property and make sure that they don't have mosquitoes breeding there. The problem is that mosquitoes don't really care where your property line is. So if you're doing a really good job of controlling the mosquitoes on your property, but neighbors around you have a bunch of containers around and maybe don't have the time or the knowledge to do that, then you're still going to be at risk from some of these diseases. And so, mosquito control really is a public good. And so, in environmental economics we think a lot about sort of the role of society and government in helping to provide public goods because it doesn't really make a lot of sense for every individual to pay for something that has these collective benefits. Clearly, there is an economic cost to doing increased mosquito control, but there also is an economic cost.... I think all of us are understanding in this time of the COVID pandemic that there are major economic costs to having big public health outbreaks and diseases.

So I think the question is, you know, what's the right balance, what's the right investment in programs like mosquito control that provides for the public good and protect public health so that we can all have health and prosperity.

[Sarah Gregory] And how would people pay? Because clearly people are going to have to pay one way or another.

[Katherine Dickinson] You know, lots of programs, again, if we think about this as a public good, there are many public goods that our society provides, whether we're talking about education or roads and bridges and infrastructure, right? So typically, we pay for those things by having taxes or fees or some mechanism that allows people to pay in and then have centralized distribution that could be statewide, I think in most places it probably makes sense to have this be county or kind of regional. Because if you think about Texas, the types of mosquitoes that exist in the Lower Rio Grande Valley, for example, are different than the makeup of the mosquito population in Tarrant County—so some variation. But again, I think the idea would be, yeah, having some taxes or fees. There are states that have implemented a tire tax, right? So used tires (abandoned tires) are a major mosquito habitat, and so that's one creative way of sort of looking at what are the ways that we could fund this. And just to say that there is variation across states—so places like California have much more extensive mosquito control, Florida has programs. So I think there are examples that a place like Texas could look to, to find creative ways of funding these programs.

[Sarah Gregory] Okay. So we talked about the economical payoff. What's the environmental payoff?

[Katherine Dickinson] So I think we want to think about, again, the public health side of this. And as an environmental health researcher, I think understanding the ways that our environment and our health are linked are really important. And certainly, the public health side of things is one of the major motivators for looking at how to expand mosquito control efforts.

I'm not an entomologist. As I said before, my background is in economics. But I work with a lot of entomologists, and my entomologist friends...I'd ask them, you know, if we got rid of all of the mosquitoes, what would be the effects of that on the environment? Is that going to decimate the bird population or the bat population that relies on those? You would want to fact check this with entomologists, but the response that I've gotten is that most of the things that eat mosquitoes also eat other things. And so we could probably get rid of most of the mosquitoes and not have major ecological consequences to that.

The other environmental consideration here, which I think we'll get into is, you know, what's the environmental impact of control methods, right? And that really depends on how the control is done. So yeah, I think we don't want to just be spraying a toxic pesticide everywhere and getting rid of mosquitoes but creating other environmental problems.

[Sarah Gregory] Okay. Well, let me use that to lead in here. So what advances have there been with pesticides used since DDT was banned in 1972?

[Katherine Dickinson] That's a great question. So yeah, we are not, you know, when we're talking about expanding mosquito control—to be very clear, we're not saying let's go back to spraying DDT everywhere. There have been some really great advances in the types of pesticides that are available and insecticides that are available for mosquito control. So a lot of the work that's now done uses synthetic pyrethroids, which is a group of insecticides that mimic a

compound found in Chrysanthemums. So they're trying to use sort of biologically based mechanisms for doing that. So there was an epidemic in the Dallas area in 2012 of West Nile virus and pyrethroids were the insecticide that was used for aerial spraying campaigns to control that epidemic, for example. So permethrin and pyrethroids, they're not considered probably carcinogens by the EPA, and they seem to be less persistent so they don't stick around in the environment as much.

I think it's important, though, to also talk about the fact that just using a single tool—so for example, just using these insecticides that kill adult mosquitoes—it's probably not going to be as effective as what people call integrated vector management. That would be using a combination of approaches that might include larvicides that kill mosquito larvae in the water. There's actually fish that have been introduced to ecosystems that eat those larvae, or there are bacteria that you can put in the water that are harmless to other organisms that will go after those mosquito larvae.

As I mentioned, my colleagues that I was working with here were also experimenting with things like mosquito traps that you would put in your home. So they would have something that would attract those mosquitoes and trap them on this sticky paper, for example. Also, I mentioned controlling mosquito breeding habitats. So doing campaigns to drain stagnant water, to dump out those tires, all of that can be part of a strategy as well. And then one of the newer methods that we asked some questions about in our survey have to do with modified mosquitoes. There are various different ways, both genetic modification and then radiation that can modify a mosquito so that, for example, they can make sterile male mosquitoes that are released out in the environment, breed with the females, and then the offspring aren't viable. All of these are different strategies that could be used alone or, preferably, in combination to control mosquitoes and ideally have a smaller ecological footprint.

[Sarah Gregory] So what kinds of controls were offered in your study?

[Katherine Dickinson] So our study was a hypothetical study. What we did is we did a survey of households in these three counties that we mentioned, and we described different methods to control mosquitoes and then asked people questions about those methods. We had two types of key questions. The one was, say there was a program in your area that would reduce the number of mosquitoes by half; would you pay a fee of X dollars for that program? So that was how we would measure the willingness to pay. And we vary that dollar amount that we were asking people if they would be willing to pay, and that gave us sort of a range of willingness to pay for each person who took the survey. We had a second set of questions that described individual methods like the ones I mentioned above—larvicides, adulticides, traps, and different modified mosquito techniques—and we asked people if they support or oppose a program in their area that used that method.

[Sarah Gregory] So how did you go about conducting this study, though? How did you ask these questions? How did you contact people?

[Katherine Dickinson] We looked at a few different ways of doing this. We did some pretesting of the survey in Tarrant County. In 2019, we went around actually to a couple of, you know, shopping malls and centers and just kind of pulled people off the street and then ask them some of these questions. And that really helped us to make our survey better, to see what questions were working and which ones weren't.

To do our full study, what we decided to do—because we wanted to make sure that we had a representative sample across these three counties—was we worked with a survey firm called Qualtrics. And what they do is they work with companies that recruit people to take surveys for both research and marketing purposes. So they've got a lot of people who are sort of enrolled in these survey panels, they're called. And we contracted with them to say, alright, we want to sample a certain number of people in each of these three counties, and we want to make sure that our sample is roughly representative of the socioeconomic and demographic characteristics of those counties. So we were able to set quotas for gender, for race/ethnicity, and for medium household income. So ultimately, we had the survey administered to just over 1,800 people (about 600 from each of the three counties) between October and November of 2019. And we also had an option for participants to take the survey in either English or Spanish.

[Sarah Gregory] And ultimately, do people want the control?

[Katherine Dickinson] So on average, what we found is that people were willing to pay \$53 per year for these expanded mosquito control programs—again, for a hypothetical program—that would cut mosquitoes in half in their county. About 16% of respondents were not willing to pay anything, so they said no to kind of all of the questions that we asked. If you do the math there, 84% were willing to pay something above zero, and about 10% of our sample were willing to pay \$100 dollars or more. So we see definitely a range. And it's helpful to compare that to the current expenditures, again, in these three different counties on mosquito control. So in Harris County, current mosquito control activities work out to about \$2 per person per year invested, whereas in Tarrant County it's about \$0.30 per person per year, and in Hidalgo County it's about \$0.05 per person per year. So this \$53 willingness to pay is obviously way higher than what is currently being spent on these control efforts.

[Sarah Gregory] Well, that sounds like next to nothing, what they would actually cost. Wow. Were there differences in who wanted to pay and how much based on gender, age, socioeconomic status, as you mentioned?

[Katherine Dickinson] We did see some differences across respondents in who was willing to pay and how much. So for gender, we found that women were willing to pay about \$9 less than men. We saw differences by education and incomes—so higher education and higher income were both associated with higher willingness to pay. Interestingly, respondents who identified as politically liberal were willing to pay about \$12 more than respondents who identified as moderate. We do know that taxes are a hot button issue. There's a lot of opposition to new taxes in a state like Texas, so that might have been part of the factor coming in there.

So the other thing that we found that really mattered was people's experiences. So people who have reported that they knew someone who had suffered from one of these mosquito-borne diseases like West Nile or dengue were willing to pay \$21 more than those who didn't, and people who noticed a lot of mosquitoes outdoors at the time of the survey said that they were willing to pay about \$12 more than those who didn't. We didn't see any differences by race/ethnicity, no large differences by age either.

[Sarah Gregory] It's interesting that this was done in 2019. I wonder what the respondents would say if it had been done a year later seeing...

[Katherine Dickinson] Yeah. You know, I think so much of this depends on what the risk situation is and what people are really concerned about at the time. So I think it was a good

snapshot of sort of a pre-COVID situation because 2019 was not an abnormally high or low year I think when it came to mosquitoborne diseases. So I think it was sort of an average mosquitoborne disease risk year. Clearly, you know, the landscape is different now and so I think that would need to be considered if we were going to take these results and try to implement new policies today.

[Sarah Gregory] Were there differences in who wanted what kind of mosquito control based on, as we said, gender, age, race, or socioeconomic?

[Katherine Dickinson] Yeah. So we did see some differences there as well. Women tended to be less supportive of these modified mosquito control methods than men, black respondents were less supportive about the sterile male method, and older respondents (respondents over 30) tended to be more supportive of several of the control methods. So there was sort of higher demand among older respondents for different control methods than in the younger respondents. We saw some differences by education, and we also saw some differences by political orientation again. So politically conservative respondents tended to be more supportive of the adulticide in killing the adult mosquitoes. So I think there's more that we could dig into there. There weren't sort of very clear patterns of one type of person overwhelmingly in support of control methods and others not. I think what we saw is that overall, all of the control methods that we asked about, the majority of people were supportive of all of those methods, in fact. But certainly, I think people had more concerns about some of the newer methods, like the modified mosquito methods.

[Sarah Gregory] And...okay, 16% said they don't want to pay anything. Did they say why? Was that part of the question?

[Katherine Dickinson] There are a number of different factors that played into folks not wanting to pay. Some people just aren't bothered by mosquitoes, right? Another thing my entomologist friends have educated me on is that some people are more attractive than others when it comes to mosquitoes, and that's a real thing. There's something about our pheromones. And I know that I am, for example, less attractive than my mother. My mother is very attractive to mosquitoes. And so, my willingness to pay is likely quite a bit lower than hers because mosquitoes just bother her more.

Some people aren't really worried about the disease risk. Some people, as I mentioned, you know, are just really opposed to any new government program or to anything that would raise taxes, for example. And then some folks might just say, this is just a hypothetical study, I'm not really sure why this matters. As survey researchers, we try to combat that and tell people that their responses are meaningful and that these results will be communicated to decision makers. But in the end, it is a hypothetical situation and so some folks may take it more or less seriously than others.

[Sarah Gregory] I see. It's interesting about the attraction. I hardly ever got a mosquito bite. I mean, it's just like they completely ignored me until after I had my daughter. And then, now I'm...you know, if there's seven people in the room and 14 mosquitoes, I get every single one of them, I think. I always wondered what could have happened to my body chemistry through that process.

But anyway, it's also interesting because I've heard before (and I didn't really believe it), and this sort of validates it wasn't true, that some people get bitten just as much as other people. Their bodies just don't respond, so you don't know it.

[Katherine Dickinson] Yeah. I think both of those things are actually true. I think some people are more attractive and that I think the immune response, which is what we feel, is what we then notice. So my husband has pretty bad seasonal allergies, and so he takes Claritin. And we go up to a family cottage in northern Wisconsin every year, there are lots of mosquitoes there. And what he's noticed is that when he's taking that Claritin regularly, even if he gets bitten by mosquitoes, he won't get the welts (the itchy bumps). So all of that is definitely true as well. When I moved from California to North Carolina when I was going to grad school, the first year that I was there, the mosquito bites (the bumps that I got) were these enormous welts. I think it was new mosquitoes my body had never encountered before, and it was really letting me know that it wasn't happy about these new mosquitoes.

[Sarah Gregory] That's interesting, different mosquitoes would have a different reaction. I would never have thought of that. Huh.

Okay. So why is your study important to public health? I mean, it seems pretty obvious, but why don't you tell us what you think?

[Katherine Dickinson] I alluded to this earlier, but when we think about public health interventions, those depend on having effective technologies and innovations in the tools that we're using to control different public health threats. But they also depend on public acceptance and policy uptake. And I think, again, COVID is a great example of that. So we can have vaccines that are effective at protecting public health from the risk of COVID. Masks can be really effective in reducing the spread. If folks aren't using those tools, if we don't have policies that are enforcing the use of those tools or encouraging the use of those tools, that can lead to situations like the one we are in where the pandemic has persisted.

Similarly, again, when we're thinking about all these different risks of mosquito-borne disease that, like COVID, are coming and going, they're global, they're linked to globalization and travel patterns, and you know, mosquitoes hitching rides on planes and going from one country to another and then bringing diseases along with them, it's really important that we do the kinds of work that my colleagues have done to look at how effective would this be in reducing the spread of these diseases. And also, simultaneously, that we're doing the social science research that tells us what does the public think of these methods, how much would they be willing to pay for a program that would scale those up. I think connecting that to, really, community engagement and understanding the needs and concerns of various different communities, the challenges that exist in implementing this kind of program in some of the unincorporated colonias in the Lower Rio Grande Valley, for example...I think all of that work is really important if we're going to find effective, integrative solutions to these problems.

[Sarah Gregory] What kind of follow up would you like to see?

[Katherine Dickinson] So I think getting this work into policy discussions. There have been various bills proposed in Texas over the past few years, really trying to look at what would it look like to scale up both the data collection...I think that's a really key part of this is monitoring for disease in a coordinated way across the state, testing different control methods, and gathering more information on public attitudes and practices that support. Again, we covered three

different counties, there's certainly more work to be done. As you've alluded to, the public health landscape has changed after a few years of the pandemic...looking at is there more support? Is there more sort of understanding that we need to be really thinking strategically and preventatively about how to prevent these big outbreaks and pandemics? Or are people just so focused on the current threat that it's hard to even pull attention away to focus on vectorborne disease, for example? Yeah, I think more discussion of how to implement control programs that are flexible, that are integrated across different control methods, that are responsive to a changing threat landscape, is work that I'd like to see.

[Sarah Gregory] I have to say here that during 2020, the only place I went the entire year was my backyard. And I have no idea why, but the mosquitoes were so much worse than they had been for a long time. So I was so stressed out from the pandemic, but then I'd go outside and they were following me clear upstairs into my bedroom. And it was like, it's too much stress here. So my take is when you have something like a pandemic, then the added stress of mosquitoes is beyond anything I want to deal with.

Well, tell us about your job and your research, and what you enjoy most about them.

[Katherine Dickinson] I did an earlier study in Madison, Wisconsin, where we were looking at people's willingness to pay for mosquito control. And in that study, what we were able to do was actually sort of tease apart how much of that was due to this nuisance factor, and how much of it was due to disease risk. And what we found in that context was that it was really the nuisance that was driving people's demands for more mosquito control. And that made some sense because the disease risk in Madison at the time was relatively low. You know, West Nile virus wasn't a huge public health risk.

Meanwhile, in a place like Madison, Wisconsin, you get this sort of limited, beautiful few months where you're able to be outside and enjoy the outdoors, and that corresponds to the time when there are a lot of mosquitoes around. And so, I think you're right that spending time outside, we know that that is a key factor in people's health and wellbeing. And so, I think that's another really important thing not to discount, right? Even though it's not a disease, that nuisance preventing me from enjoying outdoor time is significant and is also a public health concern.

[Sarah Gregory] Right, yeah.

So tell us about your job and your research and what you enjoy most about them?

[Katherine Dickinson] I'm an assistant professor at the Colorado School of Public Health. I get to teach environmental policy to Masters of Public Health Students, and I do research that looks at a wide range of topics related to how people understand and react to environmental risks, as well as the impact of environmental policies. And a lot of my work really focuses on questions of equity and environmental justice.

What I love most about my job is that I'm always learning, and I get to meet and work with new people who have all kinds of different expertise. So in this study in particular, we worked with Nina Dacko (who was one of the coauthors on this paper), which she works at Tarrant County Public Health, and is just a delightful person, really doing amazing, innovative work when it comes to mosquito surveillance and control efforts in Tarrant County. We also got to work with Ester Carbajal. She's one of the research team members in the Hidalgo County area, and her lived experience of being a part of the communities in the Lower Rio Grande Valley and her knowledge, her ability to work with these colonias and help the teams get access to some of

those communities that do work testing mosquito traps in those areas. They're just delightful people with, again, really diverse types of expertise and experience. Yes, I'm never bored. I don't do the same thing ever, day to day. It's always something different and always working with people who really teach me and inspire me.

[Sarah Gregory] And speaking of doing something different, I understand you were involved in the aftermath of the terrible fires that struck Colorado recently. You want to tell us about that?

[Katherine Dickinson] At the very end of 2021, a difficult year capped off by the most devastating wildfire (really, a grassland fire) that the state had ever seen came right through my hometown of Louisville as well as our neighboring towns of Superior and Boulder County. We had to evacuate our house with very little notice. We had a whole menagerie: my brother and his husband, our kids, our dogs, our cats, our chickens, even the fish out of the fish tank came with us. We had several very scary hours of not knowing whether our house would still be here when we came back, followed by the relief of knowing that our house was okay but also the guilt and the devastation once we knew that so many others in our community had lost their homes. There were 1,000 homes destroyed in the matter of hours. So it was really devastating and it has been a lot to process. We are understanding that it's a very long recovery road that we've got ahead of us, and for me it has been really challenging to try and find the right balance between all these different hats that I wear—so being a Louisville resident and a neighbor who is really concerned and wants to help out in my community, and then facing this, you know, being a mom and trying to navigate how to make sure that my kids are okay and help them kind of process what we're all going through. My husband happens to be on City Counsel, and so trying to support him and understand the work that he's a part of in terms of setting the course for this long recovery road, and then my role as a researcher. So there are a lot of tools that I have. I'm starting to connect with some folks from the city and other research teams to do a survey of residents to understand are people thinking about rebuilding or not, what are the factors that are affecting that choice? It has been challenging to know sort of how to be as helpful as possible in the face of something really difficult, and I think the positive side is just seeing how much people in the community want to help, want to give, how much expertise and knowledge there is here. You know, I'm hopeful that our experience can be a lesson to other communities that are going to face similar challenges.

[Sarah Gregory] What are you doing to relax in the face of all these environmental woes, including COVID?

[Katherine Dickinson] I love spending time with my kids. They really are resilient, and they give me a lot of hope. I have three daughters and, yeah, they definitely keep me entertained. I do love to be outside. I love to go on hikes in our beautiful mountains here in Colorado, and yeah, just spend time outside. I do yoga and like to play board games.

[Sarah Gregory] Thank you so much for taking the time to talk with me today, Dr. Dickinson.

[Katherine Dickinson] You're welcome. Yes, thanks for getting this out there. We're excited to tell people about the work we've been doing.

[Sarah Gregory] And thanks for joining me out there. You can read the February 2022 article, *Public Acceptance of and Willingness to Pay for Mosquito Control, Texas, USA*, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

[Announcer] For the most accurate health information, visit [cdc.gov](https://www.cdc.gov) or call 1-800-CDC-INFO.