

# Incorporating Ethnographic Methods in Multidisciplinary Approaches to Risk Assessment and Communication: Cultural and Religious Uses of Mercury in Latino and Caribbean Communities

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The potential risk from cultural and religious practices involving mercury in Latino and Caribbean communities raises central methodological and ethical questions for risk assessment and risk communication. Here, specific cultural practices unfamiliar to most risk professionals carry significant inherent risks in the eyes of those professionals but not necessarily in the eyes of practitioners. Practitioners' past experience and history as targets of religious suppression and anti-immigrant sentiment create a reluctance to engage with researchers or public health officials in risk assessment or preventive risk communication efforts. The potential for the risk—in this case mercury contamination in dwellings—to extend beyond the practicing community to future occupants adds to public health concern. Understanding the risks of these practices requires both an understanding of the cultural and political context, beliefs, and behaviors of mercury users and an understanding of the fate and transport of mercury in typical use scenarios. In this study, we employed ethnographic methods (interviews and participant observation) to understand beliefs and behavior about mercury use as well as quantitative modeling and measurement to estimate and assess potential exposures. This represents a new methodology tailored to situations in which traditional activities or observances that are integral components of cultural identity pose risks in and of themselves. Our findings indicate that there are different types of mercury use stemming from different cultural and religious traditions that result in different levels of exposure. Many of the mercury uses that can result in the highest exposures to mercury vapors have previously been attributed to the religious tradition of Santería, but appear instead to have their roots outside of the religion.

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**KEY WORDS:** Culture; ethnography; exposure assessment; mercury; risk communication

## 1. INTRODUCTION

Certain cultural activities can carry inherent risks. Many everyday risks that are part of the majority culture in the United States have been well studied, but

activities that are specific to smaller segments of the population are often overlooked. Cultural and political barriers can get in the way of research on these activities, as can the perspectives of researchers who are outsiders to the communities being studied. This article examines risk from cultural and religious uses of mercury in Latino and Caribbean communities in the United States. Because these risks are generated through activities that are a distinctive element of minority cultures, a number of methodological issues arise that require particular attention.

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The risk literature has focused much attention on risks that exist across cultures but need to be addressed differently in different contexts. For example, HIV prevention is addressed differently in the United States vs. Africa or in Anglo vs. Latino vs. African-American communities in the United States, or in gay vs. lesbian vs. heterosexual communities in the United States.<sup>(1-6)</sup> The risk from eating contaminated fish is different in the general population and subsistence fishing populations, and varies still among subsistence fishing communities.<sup>(7,8)</sup> Differences in risk perception have been studied along lines of gender, race and ethnicity, nationality, and socioeconomic status, with risk areas ranging from environmental health to finance to automobile accidents.<sup>(9-14)</sup>

The risk literature has not extensively considered risks generated specifically by activities that distinguish one culture from another. Such cases are in great need of study because cultural marginality can create an environment vulnerable to government control of the perceived risky behavior, without formal assessment of those risks. For example, state laws banning serpent handling and poison ingestion as part of religious practice in central Appalachia and the Southeast were enacted based on anecdotal evidence of a few deaths (and in some cases on the religious bias of legislators). These laws have been upheld even though they single out one religion, outlawing the very practices that distinguish it from other, similar faiths, and despite the fact that the risk has yet to be quantified.<sup>(15,16)</sup>

There is a need for new methodologies to address risks inherent in cultural practices and place them in proper context relative to other risks faced in the community. This article employs ethnographic methods (interviews and participant observation) to understand beliefs and behavior about mercury use coupled with quantitative modeling and measurement to estimate and assess potential exposures. This represents a new methodology tailored to our specific subject of study, but extendable to many more situations in which traditional activities or observances that are integral components of cultural identity pose risks in and of themselves.

## 2. BACKGROUND: MERCURY USE IN SPIRITUAL AND CULTURAL TRADITIONS

Historically, mercury has found many different uses around the world. Europeans and European-Americans (among others) have used mercury compounds to cure syphilis,<sup>(17)</sup> as homeopathic reme-

dies,<sup>(18)</sup> in dental fillings,<sup>(19)</sup> and as a preservative in vaccines.<sup>(20)</sup> Other medicinal uses are found in Chinese and Tibetan traditions<sup>(21)</sup> and in Mexico for the treatment of empacho, a stomach ailment.<sup>(22)</sup> Mercury compounds (and occasionally elemental mercury<sup>(23)</sup>) are used worldwide as a skin cream additive for lightening or to improve complexion, with documentation in Hong Kong,<sup>(24)</sup> the Mexico/U.S. border region,<sup>(25)</sup> and Saudi Arabia.<sup>(26)</sup> Prasad<sup>(27)</sup> reports a couple from Honduras injecting mercury subcutaneously in order to ward off evil and prevent disease. Specific spiritual/religious uses of mercury exist in Hinduism, Wicca, Magic, and religions of the African Diaspora in Latin America and the Caribbean.<sup>(28)</sup>

Because of its tendency to volatilize at room temperature, and because inhalation is the most effective exposure pathway for elemental mercury, its release in confined spaces emerges as a major concern.<sup>(29-35)</sup> Latino and Caribbean communities have become one focal point for concern about mercury, due to the potential for some activities to result in high levels of exposure.<sup>(23)</sup> Inhalation of elemental mercury vapors can cause short-term respiratory effects at high doses. Chronic low-dose exposure can cause long-term neurological effects, including tremors, insomnia, memory loss, and deteriorated cognitive function.<sup>(36)</sup>

### 2.1. Availability and Use

Mercury's availability in Latino and Caribbean communities has been documented through a number of studies, summarized in Table I.<sup>(23,37-41)</sup> In Latin American and Caribbean cultural traditions, mercury (usually called *azogue*) is used to bring luck, love, or money, as a cleanser, to ward off evil, for cosmetic purposes, to treat intestinal disorders, and in specific acts of divination or religious initiation. Previously reported uses include carrying it as an amulet, placing it in a candle or oil lamp, adding it to perfumes, creams, bathwater, or soap for cleaning floors, or sprinkling it around a room or baby's crib. Herbal pharmacies/religious supply stores known as *botánicas* sell mercury most commonly in gelatin capsules, but also in other containers of numerous sizes and shapes, including plastic baggies.<sup>(23)</sup> *Botánicas* or individuals can obtain mercury from various sources, including informal local delivery,<sup>(23)</sup> metals recyclers,<sup>(42)</sup> *botánica* wholesalers, consumer products such as thermometers, and amounts accumulated historically in homes, schools, or at industrial sites.

**Table I.** Availability and Use of Mercury in Latino and Caribbean Communities

Author	Availability	Community	Uses
Wendroff <sup>(37)</sup>	99 of 115 botánicas	U.S., Puerto Rico (attributed to Santeria and Voodoo)	Sprinkling, adding to soapy water
Zayas and Ozuah <sup>(38)</sup>	38 of 41 botánicas	Bronx, NY (attributed to Espiritismo)	Sprinkling (29%), amulet in pouch (49%) or pocket (32%)
Chicago DOH <sup>(39)</sup>	16 of 16 botánicas	Chicago	
Johnson <sup>(40)</sup>	44% of Caribbean, 27% of Latin American respondents (total <i>N</i> = 203)	NYC	Amulets, sprinkling, perfume, lotions, bathwater, candles
JSI <sup>(41)</sup>	40% used/knew of use <i>N</i> = 898 Latinos	Lawrence, MA (attributed to Espiritismo, Santeria, and Voodoo)	10% in drink, 16% on skin, 17% in candles, 12% sprinkled around baby's crib
Riley <i>et al.</i> <sup>(23)</sup>	"almost all" of 15 botánicas	NY, NJ, Philadelphia	Placing mercury with other items in closed containers

**2.2. Extent of Exposure**

Clinical exposure data related to cultural practices are sparse, with the most common reports related to skin-lightening creams containing mercury compounds.<sup>(24-26)</sup> Forman *et al.*<sup>(43)</sup> report exposure of nine children and their mother to mercury vapor, after children played with elemental mercury they took from a neighbor, who "reportedly operated a business preparing mercury-filled amulets for practitioners of the Afro-Caribbean religion Santeria." Mercury poisoning has also been documented in infants in Los Angeles fed mercury as a folk remedy for gastroenteritis.<sup>(22)</sup> Prasad<sup>(27)</sup> reports elevated blood mercury in one of two patients who had subcutaneously injected elemental mercury in Honduras to ward off evil and disease while traveling to the United States. Ozuah *et al.*<sup>(44)</sup> report a 3% prevalence rate of elevated mercury levels (> 10 mcg/L) in the urine of 100 children in the Bronx. Sources of their exposure were not investigated, but the authors suggest cultural and spiritual mercury use as one possibility.

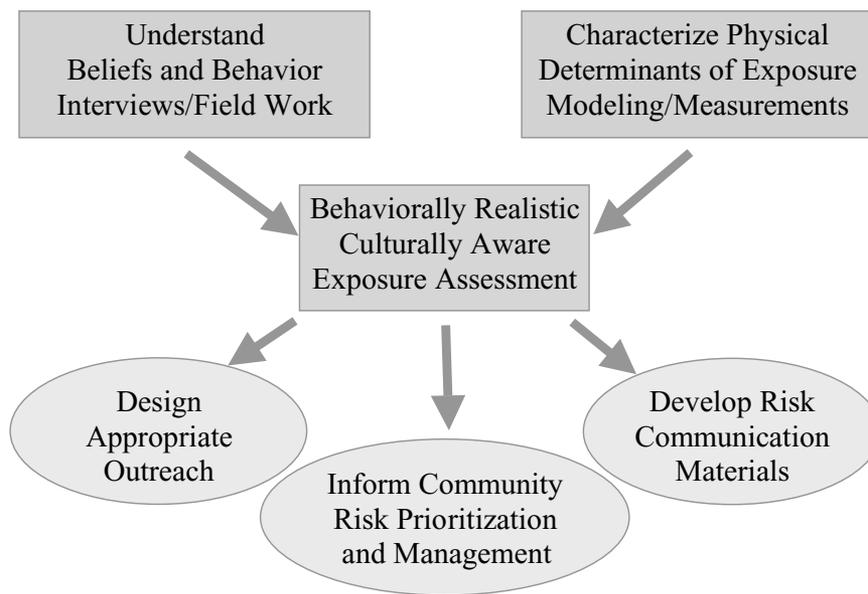
**3. METHODOLOGICAL CONSIDERATIONS: AN INTEGRATED, MULTIDISCIPLINARY APPROACH**

Because much of the previous work on this topic pointed to Santeria practices as a source of mercury contamination, we focused our work on mercury use in religious practice in northern New Jersey's Latino and Caribbean communities. Specifically, we sought to answer the following questions: (1) What do people believe about mercury, its purpose in religious or secular cultural practice, and its perceived risks? (2)

Specifically how is mercury used? (3) What are the indoor concentration levels that result from these uses? (4) What are the implications for risk communication and public policy?

In some ways, the risks of mercury exposure from cultural and religious uses can be approached in a similar way to risks from other consumer chemical products; for example, the mental models methodology<sup>(45)</sup> has been adapted to integrate what is known about a person's risk beliefs and behavior regarding a product with quantitative modeling of those risks.<sup>(46)</sup> However, risks inherent in cultural practice require some new approaches to properly address cultural context. We developed an approach that infuses an ethnographic consideration of culture into comparisons of expert and lay beliefs, collection of behavioral data, and quantitative risk modeling (Fig. 1). Qualitative methods provide information on cultural context and specific data about beliefs and behavior. Qualitative data are used as inputs for a suite of quantitative tools—indoor air quality modeling, mass transfer modeling, field measurements, and laboratory experiments—that complete a quantitative assessment of exposure. Together these pieces create behaviorally realistic and culturally aware exposure assessments.

It is essential in this work to integrate the qualitative and the quantitative; the quantitative allows one to understand the concrete consequences of the qualitative findings in terms of exposure, while the qualitative provides inputs to the model that take into consideration the realities of cultural context and human behavior. We found the use of multiple methods helped us obtain a more complete understanding of both quantitative and qualitative questions.



**Fig. 1.** Integrated methodology for culturally distinctive risk assessment.

Because mercury's behavior is not well understood in indoor air, we incorporated modeling, laboratory experiments, and field measurements to understand the chemical's fate and transport. Similarly, a variety of qualitative methods were used to gather a broad spectrum of data. Ethnographic methods were selected in particular because of two key issues identified in our previous work: insider/outsider dynamics, which raise fundamental issues of trust, and researchers' cultural biases, which can result in incorrect assumptions or misinterpretation of findings.

Insider-outsider dynamics refer to the tendency for a closed community to use a number of cultural cues to identify group members and nonmembers. In the Latino and Caribbean communities we studied, there is a distinct mistrust of outsiders that stems in part from experiences of anti-immigrant sentiment. Insider-outsider dynamics intensify in the Afro-Caribbean religious community because of the history of suppression and misrepresentation of these religions in the United States and in many other countries in which they are practiced.<sup>(47)</sup> Because of the repressive climates in which the religion has evolved, secrecy and information control is of utmost importance and restricted to initiates; thus outsiders can be defined with respect to religion as well as culture. Insider-outsider dynamics play out over mercury: there is a commonly held belief that mercury is an illegal substance (it is not<sup>(48)</sup>) and community members are extremely wary of discussing the ways in which it may

be used, out of fear of a "crackdown" by the authorities. In previous work, Riley *et al.*<sup>(23)</sup> found that members of the research team obtained different responses depending on whether they were seen as insiders or outsiders; many respondents denied knowing about mercury use in the community when speaking with Anglo members of the research team, but discussed it openly with the Afro-Cuban Santero researcher.

Cultural biases can take many forms; two common pitfalls that concern us with this work are: (1) viewing all Latinos as similar without recognizing key cultural differences based on country of origin and other identities recognized in a non-U.S. context;<sup>(49,50)</sup> and (2) failing to distinguish religious from general cultural practice in mercury use. In many reports on this topic, practices that are quite different from each other have been placed under one Santeria label or under one Latino/Caribbean label. Uses are ascribed to religion without any link to belief or tradition. For example, Wendroff<sup>(37)</sup> discusses botánica sales to "adherents of syncretistic Afro-Caribbean/Latin American religions, such as Santeria and Voodoo" without connecting belief and practice or distinguishing between the two religions. The Chicago Department of Health<sup>(39)</sup> states: "In the religious community of 'Santeria,' mercury is believed to be a source of power and luck. Believers buy the mercury and either burn it in candles or sprinkle it around the house." However, loose generalities about belief in mercury's powers for luck are not sufficient to identify a practice as part

of Santeria, as many nonadherents believe in luck, and in mercury.

By incorporating ethnographic methods, including participant observation and a knowledge of anthropological constructs (e.g., distinguishing religious vs. secular practice in a culture; understanding the role of race and ethnicity in the context of culture) we can reduce cultural bias by looking closely at ethnicity and cultural variation, distinguishing key factors in risk generation (e.g., between religious and general cultural practices). We can reduce insider-outsider issues by meaningfully involving insiders and their perspectives in the work.

#### 4. PARTICIPANT OBSERVATION AND INTERVIEWS

Our qualitative work was undertaken to elicit the meaning of this community's experience with mercury, to characterize uses that might result in elevated exposures to individuals, and to understand underlying cultural practices and beliefs. Our work explores uses specific to Santeria in order to differentiate between cultural and religious use. Complete details of the ethnographic field work are presented in Newby *et al.*;<sup>(51)</sup> here we present key findings that relate specifically to the exposure assessment. The research area (Union City and West New York, NJ) was chosen based on the high concentration of Hispanic population (over 70%). Previous work in the area had identified a number of botánicas that sell mercury.<sup>(23)</sup> For this study we focused our work in the Afro-Cuban religious community,<sup>4</sup> especially among Santeros and Babalaos (roughly, priests and high priests), but also including botánica owners and clients. Santeros and Babalaos have the greatest knowledge of Santeria, having spent considerable time and money to learn complex ritual practices, and thus earn the qualification to offer services to clients (including performance of rituals involving mercury). Initial contact was established through botánicas and by participating in festivities honoring Santa Barbara (Changó).<sup>5</sup>

Careful attention was given to minimize cultural and other biases in study group definition. A common erroneous assumption is that mercury use is restricted to a specific group, easily identified on the

basis of religion and/or ethnicity. The reality is that either criterion could leave out individuals who should be included; not all Santeria practitioners are Latino; not all mercury users are Santeria practitioners; and future residents of a contaminated dwelling (of any demographic) could be exposed to mercury even if they don't use it. Geography is potentially the most inclusive criterion for defining a study community, although it too is imperfect, including many who are not exposed to mercury and excluding previous residents who have left the area. By using botánicas as the point of initial contact, which serve both religious and nonreligious mercury users, we worked primarily geographically, and then focused in on Santeria adherents.

In participant observation, the researcher immerses him- or herself in the cultural context, observing activities and relationships in the community first-hand. By observing people's actions as well as their words, the researcher may gain a broader understanding than might be obtained through other methods. This approach is well suited to studying culturally distinctive risk in closed communities because of the direct access to first-hand information, the simplicity of the approach, and the relative inaccessibility of information through other means. Although we did not engage in rituals involving mercury due to ethical concerns about human subjects, we were active participants in the ritual community, allowing us to establish a good rapport with community members. This was evidenced by respondents' sharing of confidences and willingness to engage in mercury sales.

Field work was conducted over a period of months beginning with establishing initial contacts with botánicas and religious practitioners in the spring of 2000 and ending with interviews conducted in November and December of 2001. The interdisciplinary field research team was culturally and methodologically diverse, which allowed for an innovative approach in project design. All team members were familiar with the structure of Afro-Cuban religious practice, with one being a Cuban-born Santero (initiated priest) with over 20 years of religious practice in Cuba and the United States. Other members included an American engineer and risk analyst and a bilingual American sociologist with experience with Latin American immigrant populations.

Some of our contacts from participant observation agreed to participate in open-ended, structured interviews (based on the mental models methodology<sup>(45,46)</sup>) about mercury use. The interviews consisted of five sections, although not all questions

<sup>4</sup> Although the majority of the respondents were themselves Afro-Cuban, there were also other practitioners of the religion who were from different backgrounds.

<sup>5</sup> These ceremonies did not involve mercury. We felt it would be a violation of human-subjects ethics to observe rituals involving mercury.

applied to all respondents. First we obtained basic demographic and socioeconomic information, including age, place of birth, household information, and occupation. The second section focused on respondents' religious background and level of participation in Afro-Caribbean practices. The third section focused on the details of mercury use, including where and how rituals are conducted as well as people's beliefs about the ritual power of mercury. The fourth section asked about the business aspects of mercury use, including where and how mercury is obtained as well as the cost of mercury and those rituals that use mercury. The final component asked specifically about respondents' knowledge of the exposure pathways and health effects of mercury. The interview questions are discussed further in Newby *et al.*<sup>(51)</sup>

Some argue that participant observation increases the likelihood of subjective influence and observer effects compared with more structured methods such as interviews. However, in this case we believe that an insider participant observer reduces such influence by establishing trust and open communication with community members before conducting interviews. Where insider-outsider dynamics are strong, participant observation makes it possible to understand observations from the subjects' point of view, rather than imposing an outsider's interpretations, which carry their own biases.<sup>(52)</sup> We sought to minimize observer effects by keeping a group diary among the entire research team. We checked in daily to discuss not only our day's work, but also our evolving relationships with community members. The Santero researcher regularly reflected on his own role in religious practice, as well as his relationship to other Santeros as both a researcher and as a fellow practitioner.

Participants responded more openly to the Afro-Cuban Santero member of the research team. Respondents appeared to trust that the interviewer, as a group member himself, would treat secret issues with respect and be sensitive about the portrayal of religious practice. Additionally, his knowledge of the Lukumi<sup>6</sup> language was important as respondents used it to discuss many aspects of religious practice. Trust was established in the face of cynicism about the value and purpose of mercury research. Several asked: "Why the interest in mercury? Who are you working for?" or expressed the view that "[m]ercury use is private, but it is not dangerous." The non-Santero researchers were unable to gain the same

level of information from the same individuals in many cases.

#### 4.1. Uses Identified in Field Work

Table II provides a summary of the 22 interview respondents, along with their mercury use (all names are pseudonyms to protect anonymity). Seventeen of the Santeros(as), Babalaos, and practitioners interviewed perform rituals that include mercury, but do not prescribe it for the individual use of their clients. Three of the remaining respondents do not use mercury but have sold it in their places of employment.

Mercury is used in specific ways within Santeria. In some rituals mercury is considered indispensable; the ritual will have no validity without mercury. In other rituals mercury is considered a positive addition to what is being done, but is not essential. Out of respect for the secrecy of the religion, we will not reveal ingredients other than mercury and the medium in which it is contained; many other items are typically included. Media used in Santeria are used for a variety of purposes and treatments, many of which do not contain mercury.

Two of the principal religious uses of mercury have to do with the physical representation of specific santos,<sup>7</sup> or deities within Santeria. Despite their superficial association with Catholic saints, all orishas are represented by various natural objects, including stones, coins, bits of metal, and shells. The santo Elegua will contain less than one capsule of mercury, placed inside a concrete representation of Elegua, shaped like a head with cowrie shells representing the facial features. Elegua is said to control people's destinies and is considered the Lord of the Crossroads;<sup>(53)</sup> traditionally, anyone who has been initiated into Santeria should have an Elegua. The santo Osain is prepared in a gourd, which is resealed with candle wax. At least one capsule would be used (depending on how you were taught) along with a number of other items. The gourd is hung in front of the door (inside the house). Osain represents nature's force and the plants that are the source of all medicine. It would be common for someone with health problems to receive this santo; it would not be found in most initiates' homes.

In Santeria there are various ways in which mercury may be used to address what, in this belief system, would be considered spiritual problems. Most of these problems would have to do with a perceived lack of

<sup>6</sup> A derivative of the Yoruba language.

<sup>7</sup> All deities or *orishas* are referred to as *santos*.

Table II. Interview Summary

Respondent	Sex	Race/Ethnic Background	Status in Religion*	Botánica Owner**	Azogue Use
1	Female	Brazilian	Espiritista	Own shop	Yes
2	Female	Mexican	None	Employee	No***
3	Female	Cuban	Santera	Yes	Yes
4	Male	Afro-Cuban	Babalao	No	Yes
5	Female	Afro-Cuban	Santera	Yes	Yes
6	Male	Afro-Cuban	Babalao	No	Yes
7	Male	Peruvian	Babalao	No	Yes
8	Female	Afro-Cuban	Santera	No	Yes
9	Female	Dominican	Santera	Yes	Yes
10	Male	Mexican	Santero	Yes	Yes
11	Male	Ecuadorian	Practitioner	No	No***
12	Male	Dominican	Practitioner	No	No***
13	Male	Peruvian	Practitioner	No	No
14	Female	Colombian	Santera	Yes	Yes
15	Female	Cuban	Practitioner	No	Don't know
16	Female	Dominican	Santera	Yes	Yes
17	Female	Cuban	Santera	Yes	Yes
18	Female	Afro-Cuban	Santera	No	Yes
19	Male	Cuban-American	Santero	Yes	Yes
20	Male	Colombian	Palero	No	Yes
21	Male	Afro-Cuban	Santero	Yes	Yes
22	Female	Afro-Puerto Rican	Espirista	Yes	Yes

\*Babalao, Santero, and Practitioner designate Santeria adherents with different levels of knowledge within the religion. Espiritista denotes a practitioner of Espiritismo, and Palero denotes a priest in the religion of Palo Mayombe.

\*\*If a botánica is run by a husband and wife and both were interviewed, both will be designated as botánica owners in this category. Respondent 1 owns her own spiritual consulting shop, but this is not a botánica.

\*\*\*Respondent does not use azogue (mercury) but has sold it in his/her place of employment.

balance surrounding the client, which can manifest itself in health problems, negative life experiences, or a general spiritual or psychological malaise. In order to attract ashé<sup>8</sup> or positive order and balance, rituals involving mercury could be used. A Santero or Babalao would prepare these treatments, which other individuals would not have the knowledge to replicate. The Santero or Babalao would have a number of possible treatments that he or she could select. Thus mercury is not seen as essential for any particular problem, but it is viewed as a powerful resource that can be brought to bear for those individuals in need. These treatments are not given to all adherents, and are not given on a regular basis to any individual, but only to certain individuals who seek help for particular problems in their lives.

Table III provides examples of common treatments in Santeria that may use mercury, as related by interview participants. It should be noted that the

list is not exhaustive, and there may be variation in the preparation of the treatments. These are prepared by Santeros and are not self-administered (unless an initiated Santero/a is doing a treatment for him- or herself). However, clients typically purchase ingredients and bring them to the Santero/a, who performs the ritual. This transportation of materials introduces the possibility of mercury spills and subsequent exposure. Note that several preparations (the gourd and the glass bottle) are only used outside. In indoor preparations, mercury is placed in liquid or solid media. While the degree of enclosure varies, mercury is typically not exposed to open air.

**4.2. Uses of Mercury Not Affirmed by Our Respondents**

The practice reported in the literature that has the greatest potential to generate high concentrations of mercury vapors indoors is sprinkling. However, Santeros and Babalao in our study did not report sprinkling mercury droplets or recommending this

<sup>8</sup> Ashé has come to mean luck in Cuban popular culture, although in the religious context it is seen as being the spiritual force behind all things.

**Table III.** Mercury Uses in Santeria Reported by Interview Participants

Container	Duration	Amount Used	Location	Enclosure Description
Concrete (Eleggua)	Indefinite	1 capsule	Behind front door	Lodged inside concrete
Gourd (Osain)	Indefinite	1 or more capsules	On front door	Sealed with wax
Gourd	21 days	$\frac{1}{2}$ capsule	Outside	Sealed with wax and dirt
Glass with water	7 days	$\frac{1}{2}$ capsule	Inside	Under water
In ice	7 days	$\frac{1}{2}$ capsule	Inside, in freezer	In paper, in ice, inside a can, in freezer
Apple	4–7 days	$\frac{1}{2}$ capsule	Inside	Inside apple
Glass bottle	Indefinite	1 capsule	Outside, buried	Glass bottle corked and buried

practice; most were unfamiliar with it, and several were surprised to hear it was being attributed to religious practice. Several Cuban Babalaos and Santeros stated that because mercury is so powerful, using too much or sprinkling it in one's home or workplace could actually backfire. According to one Babalao: "You want to be careful. It's not to be used lightly. If you use it too much you might have bad luck instead."

Sprinkling is generally discussed in the literature as being self-administered, which further suggests that it is not likely a part of traditional Santeria. Respondents reported prescribing rituals involving mercury to be performed by a Santero or Babalao on behalf of a client—but not prescribing mercury by itself or for a client's individual use. Santeros and Babalaos have been specially trained and do not share secret information with clients. Many rituals are quite complex and those who perform them are well compensated for their time and specialized knowledge. Teaching the noninitiated to perform their own rituals would not be good business practice. Because Santeria is not a centralized religion and has a syncretic history that is adapted to new realities, practices do change with location and over time.<sup>(54)</sup> The possibility of change in religious practice came up in a conversation with Orlando, an Afro-Cuban Santero.

Someone may tell you about something that worked for them, to resolve their problems. If you try it and it works for you, you'll keep using it. You see the results. If something works, of course you will use it. Different people have different customs and ideas and different things work for them. I've never heard of sprinkling azogue in my religion, but if someone does it and gets results they'll keep doing it. They'll also recommend it to their friends.

Thus it is certainly possible that sprinkling could be a practice among certain practitioners and not commonly known to participants in our study. However, this practice seems particularly removed from belief and tradition, and we find it more likely that

the literature—which has not paid attention to differences in ethnicity and religion among Latino and Caribbean mercury users—has misattributed sprinkling to Santeria (and possibly to religious practice in general).

Interviewees raised the issue of cultural diversity within the religion as a source of variation in practice, although they would not consider those variations to be part of the religion. The Babalaos said that they thought Dominicans, Puerto Ricans, Mexicans, Brazilians, or Nigerians could be the source of the sprinkling practice. While members of the non-Hispanic population may see one large ethnic group with many commonalities, community members themselves see important cultural differences between groups. Respondents emphasized that many religious newcomers had very different cultural backgrounds from the traditional Afro-Cuban background. Rufino, an Afro-Cuban Babalao who also owns a botánica affirmed:

People think that we're all [Latinos] the same. It's not true. We're all very different. I have a difficult time working with people who come to see me for a consultation, but they don't understand anything about the religion. They try to understand what we do on their terms and it doesn't work. They don't understand that there's a specific way of doing things that must be followed.

There was also a perception among Babalaos that there are people, principally some white Cubans, who get into Santeria just to make money, without knowledge of African custom. Thus, they might alter traditions to suit economic interests. Underscoring insider-outsider dynamics, one participant theorized that outsiders "are envious of the religion and trying to give it a bad name so it won't spread. Since people are worried about mercury and think it's bad, the people that are against the religion say that we use it and tell others to use it."

### 4.3. Beliefs Identified in Field Work

In general, participants were unaware of the dangers of mercury vapors or the possible effects of long-term exposure. However, dermal absorption came up as nine respondents mentioned that it was bad to touch or play with it. “There’s nothing wrong with mercury, but you should be careful not to touch it too much. They say it’s bad.” Several interviewees dismissed the idea of health hazards outright, with one Santero commenting: “Americans say that everything is dangerous. They exaggerate. That’s just how they are, they worry about everything.” Strikingly, the mercury “hazard” mentioned most frequently was legal trouble related to possession or sale of mercury.

Of the 22 respondents interviewed, 12 brought up concerns about mercury sales being illegal and fear of health inspectors (mercury is legal in New Jersey, although several other states have initiated consumer product bans<sup>(48)</sup>). Several botánicas that had previously kept mercury on the premises were now much more secretive. R.C., an Afro-Cuban who owns a botánica with his wife, no longer sells mercury in the botánica, but obtains mercury from thermometers when he needs it. He said he stopped selling mercury because “it’s too much of a hassle. It’s illegal and you can get in trouble.” A Cuban botánica employee said that she has sold elemental mercury in the past but her boss received “a letter from Public Health” saying that it was illegal. (According to officials with the Hudson County Regional Health Commission, no such letter was ever sent.) A Dominican botánica owner said that she no longer sells elemental mercury because of the crackdowns by the “inspectors,” but that she may perform rituals containing mercury for someone in a spiritual consultation. Carlos Antonio, a white, Cuban-American Santero (33 years old), forcefully stated that he doesn’t sell mercury and doesn’t want to know anything about it because of the inspectors. “It’s illegal. That’s all there is to it. You can get into big trouble and it’s not worth it. It is really just a small part of business anyway.” He said he uses mercury in his own personal rituals, but does not recommend its use to others.

Several respondents also stated that mercury use had become more scrutinized by the government in the post-9/11 environment. One respondent said that you could end up in jail if you were caught with mercury. Another stated that getting caught with mercury could be just as bad as being caught with an explosive device or a bomb: “Ever since September 11, the government has been looking for people who may have

mercury. You don’t want to get caught with it. You can go to jail.”

Perceptions of illegality affect individuals’ behavior, and may not necessarily reduce the risk of mercury exposure. The responses discussed above indicate that personal use persists even when botánicas curtail sales. A Colombian Santera and botánica owner who no longer sells mercury in capsules in the botánica now keeps it in her house and prefers to sell larger quantities, relocating and potentially increasing the risk. A woman who is both a Cuban Santera and the wife of a Puerto Rican botánica owner reported that they sell mercury capsules to people with whom they feel comfortable, for the low price of \$1.50. Their logic is that people would not report them if they get a bargain, but one possible consequence is increasing sales at the bargain price.

## 5. EXPOSURE ASSESSMENT

Using quantitative modeling and field measurements, we sought to estimate the resultant risk from reported practices. Exposure assessment included quantitative modeling of mercury’s fate and transport in indoor air, experimental measurements to validate models and their assumptions, and field measurements of mercury concentrations in buildings.

### 5.1. Box Models

In previous work we demonstrated the use of box models to estimate potential mercury vapor concentrations in indoor air:<sup>(23)</sup>

$$C(t) = \frac{S}{Q} \left(1 - e^{-Qt/V}\right) \quad V \frac{dC}{dt} = S - QC.$$

Solving analytically and assuming an initial concentration of 0, we were able to estimate indoor air concentrations from various activities, including sprinkling. A typical sprinkling scenario estimate assumed a 9 g mercury capsule was sprinkled in a 40 m<sup>3</sup> living room with an air exchange rate of 1 per hour, resulting in an equilibrium concentration of 1.4 μg/m<sup>3</sup>. This value is below the American Council of Governmental Industrial Hygienists’ (ACGIH) 8-hour time weighted average of 25 μg/m<sup>3</sup>,<sup>(55)</sup> but above the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL) of 0.2 μg/m<sup>3</sup>.<sup>(56)</sup> These two levels are presented as points of comparison, but should be interpreted carefully. The threshold limit value (TLV) is a worker’s

standard, applicable to adults working an assumed 8-hour workday; residents can occupy their spaces as much as 24 hours a day, and often include members of more vulnerable populations, in this case pregnant women and children. The MRL is not a regulatory standard or action level, but rather represents the ATSDR's best estimate of a level it believes presents minimal risk to the population (compare with the EPA's reference concentration RfC,<sup>(57)</sup> set similarly at  $0.3 \mu\text{g}/\text{m}^3$ ). Target cleanup levels for dwellings are more typically between  $1$  and  $10 \mu\text{g}/\text{m}^3$ , but vary from case to case.

Uncertainty in the model stems from choices of model parameters and inputs (air exchange rate, room size, amounts, etc.). To the extent that these rely on individual estimates, they involve uncertainty related to truth and memory issues and the estimation abilities of subjects. Adsorption/desorption behavior is not accounted for in the model. The sensitivity analysis shows that the most sensitive assumption (other than amount) relates to the volatilization rate of mercury, which depends largely on the average droplet size (surface area). The volatilization rate of mercury is not well understood, and typical droplet size distributions are not well characterized. Thus refining this model would require additional data about droplet size distribution for typical use scenarios in which mercury is directly exposed to air, and empirical measurements of volatilization rates, which may also be affected by factors including temperature, oxidation, and settling of dust or other particles on mercury droplets. With such data, stochastic modeling could be used to better characterize potential exposures. Any model validation will have to first measure droplet size and mercury's volatilization rate to ultimately be useful.

In the absence of such data, a simple sensitivity analysis was used to provide a low, medium, and high exposure scenario, shown in Fig. 2. The high exposure scenario assumed a small ( $25 \text{ m}^3$ ) room, with a low air exchange rate (0.5 ACH), with the mercury shattered into more than 1,200 droplets of 1 mm diameter. The low exposure scenario assumed a drafty (1.5 ACH), large room ( $120 \text{ m}^3$ ), with a single globule of mercury (approximately 10 mm diameter). The middle case was as above, with 1.0 ACH in a  $40 \text{ m}^3$  room, with approximately 10 droplets of 5 mm diameter. Low exposure was around  $0.14 \mu\text{g}/\text{m}^3$ , below the ATSDR MRL, while high exposure was around  $22 \mu\text{g}/\text{m}^3$ , below the ACGIH occupational threshold limit value, but well above the MRL. These data suggest that a

### Concentration of Mercury Indoors After Sprinkling

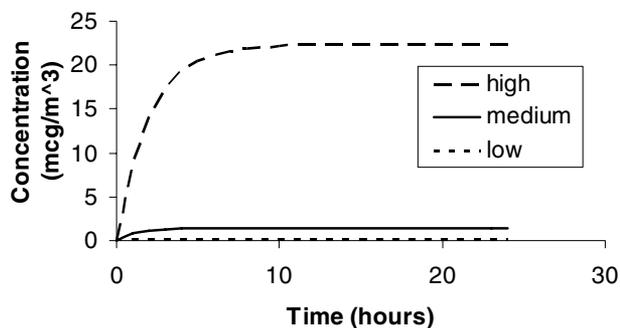


Fig. 2. Concentration of mercury indoors after sprinkling.

single sprinkling activity using a single capsule places exposure in a contested area, for the most part above the minimal risk area, but not always at levels considered actionable for remediation by those agencies. Of course, if sprinkling activities were repeated with some frequency or incorporated larger amounts of mercury, exposure could be much higher.

### 5.2. Mass Transfer Modeling

Cases like those reported in our interviews in which mercury is not directly exposed to air necessitate additional mass transfer modeling that is then coupled with the box model. An initial comparison of the diffusivities of mercury in different media suggested that exposure from enclosed or submerged uses indoors would be orders of magnitude less than open-air scenarios (e.g., sprinkling). We used Fick's law to model a scenario in which mercury is placed in a glass of water. Using the correlation developed by Wilke and Chang<sup>(58)</sup> for nonelectrolytes in an infinitely dilute solution and the association parameter for water given in Reid *et al.*,<sup>(59)</sup> the diffusivity of mercury was estimated to be  $3.17 \times 10^{-5} \text{ cm}^2/\text{s}$  at room temperature (298K).

We assumed that we have the situation in Fig. 3, where a thin layer of mercury (10 g, approximately one capsule, or twice the recommended amount) rests on the bottom of a glass of water. This is a conservative assumption, as mercury could form any number of droplets, from a single bead (about  $6 \text{ cm}^2$ ) to broad distribution ( $50 \text{ cm}^2$ ). We considered this as two separate mass transfer processes—one from mercury through water, and another from water through air.

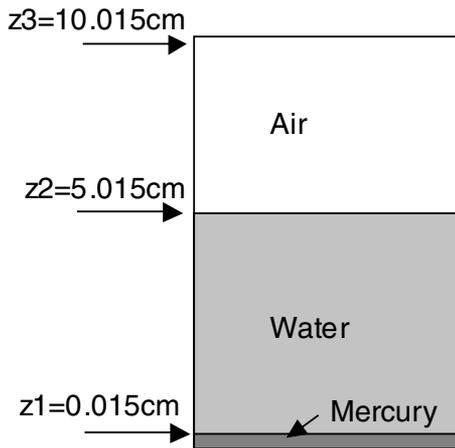


Fig. 3. Schematic of mercury diffusion in glass of water.

For the first process, Fick’s law gives an expression for steady state, one-dimensional mass transfer without chemical reaction or counterdiffusion as:

$$N_{AZ} = \frac{cD_{AB}}{z_2 - z_1} \ln \left( \frac{1 - x_{A2}}{1 - x_{A1}} \right),$$

where  $N_{AZ}$  (g/s/cm<sup>2</sup>) is the mass flux of A in the z direction, c is the molar density of the mixture (number of total moles divided by the total volume, mol/cm<sup>3</sup>),  $D_{AB}$  is the diffusion coefficient (cm<sup>2</sup>/s),  $z_2$  and  $z_1$  are the heights at which the water layer begins and ends (cm), designating the diffusion path, and  $x_{A2}$  and  $x_{A1}$  are the mole fractions of A in the solution at  $z_2$  and  $z_1$ .<sup>(60)</sup>

Boundary conditions are set so that  $x_{A2} = 0$  because any diffusion of mercury from water into air will be much more rapid compared with diffusion of mercury into water, and  $x_{A1} = 60$  ppb<sub>w</sub>, the saturation value of mercury in water.<sup>(61)</sup> The transition from the pure liquid to the aqueous phase is assumed to be instantaneous. The flux of mercury into the water is estimated to be approximately  $8.3 \times 10^{-15}$  g/s/cm<sup>2</sup>, or 1.5 ng/hour in a cylindrical glass with a diameter of 8 cm. The concentration of mercury in water over time was determined; data are shown in Fig. 4.

We then used these concentration data to model the water-air interface and predict mass flux into the air at different times. An analogous equation to the first case applies:

$$N_{AZ} = \frac{cD_{AB}}{z_3 - z_2} \ln \left( \frac{1 - y_{A3}}{1 - y_{A2}} \right),$$

where  $z_3 - z_2$  represents the new diffusion path through the air.  $y_{A2}$  is determined using Henry’s Law

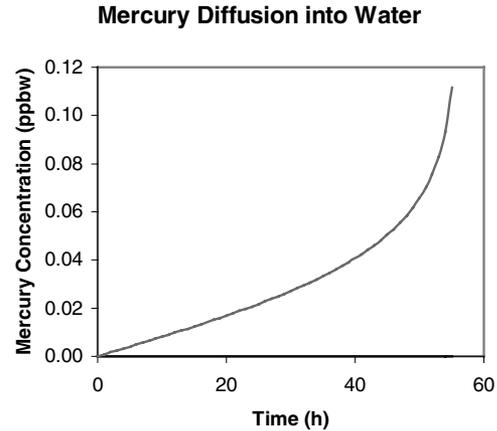


Fig. 4. Mercury concentrations in water over time.

to predict the equilibrium mercury vapor mole fraction at the water-air interface. We assumed that the concentration  $y_{A3}$  (top of the glass) is 0 due to air convection outside the glass, rapidly dispersing the mercury. The mass flux of mercury from the water into the air increases over time, but is very low as long as the mercury remains submerged in water. There is a discontinuity when the water completely evaporates, resulting in a significant rise in mass flux. From that point, the problem is treated as a mercury-air diffusion problem, with a saturation value of mercury in air of 2.4 ppm (20 mg/m<sup>3</sup>) at 25°C<sup>(62)</sup> as  $y_{A2}$  and a diffusivity of mercury in air  $D_{AB} = 0.143$  cm<sup>2</sup>/s at 25°C.<sup>(63)</sup> Results of this analysis are presented in Fig. 5. As the water evaporates, the diffusion path would become longer, reducing the mass flux; however, for simplicity, the path was considered constant throughout the simulated period.

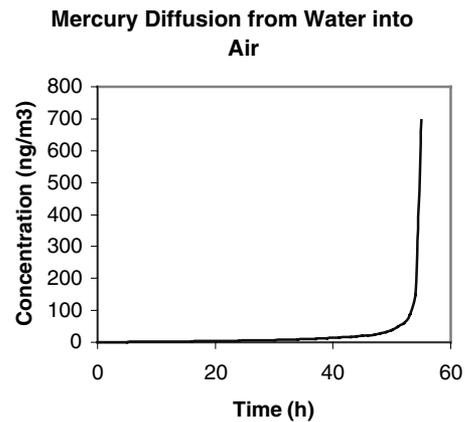


Fig. 5. Mercury concentrations in air, 0% humidity.

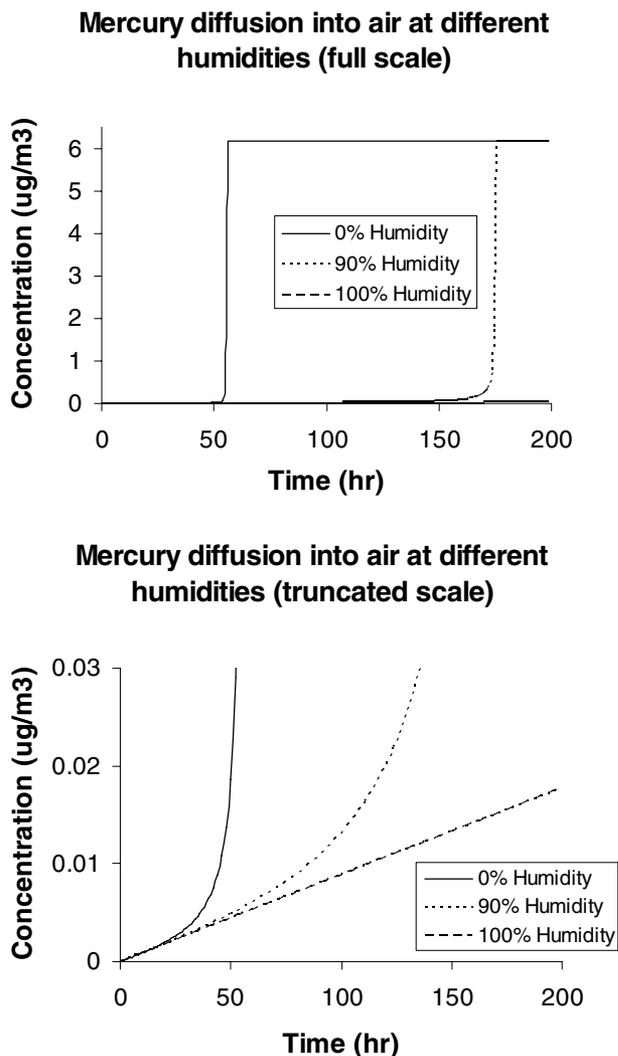


Fig. 6. Mercury concentrations in air at 0, 90, and 100% humidity (truncated and full scale).

If these mass fluxes can be considered source rates ( $S$ , g/hour) in a simple indoor air quality model with instantaneous mixing, the steady-state concentration of mercury vapor ( $S/Q$ , the source in g/hour divided by the air flow rate,  $Q$ , in  $\text{m}^3/\text{hour}$ ) in a  $20 \text{ m}^3$  room at 1 ACH ( $Q = 20 \text{ m}^3/\text{hour}$ ) is shown in Fig. 6, for cases of varying humidity (truncated and full scales are shown due to large variation in scale for different humidities). Concentrations are on the order of  $0.01\text{--}0.1 \mu\text{g}/\text{m}^3$  when mercury is submerged, but jump to around  $6 \mu\text{g}/\text{m}^3$  when the water has evaporated.

These models are offered as a first-order estimate of the magnitude of exposure. It would appear that the uses described result in exposures to mercury be-

low the ATSDR MRL. Diffusion of mercury through solids (e.g., a gourd or concrete Elegua) is likely to be even slower than through liquids; while liquid-liquid diffusion coefficients are on the order of  $10^{-4}\text{--}10^{-6} \text{ cm}^2/\text{s}$ , liquid-solid diffusion coefficients are on the order of  $10^{-4}\text{--}10^{-8} \text{ cm}^2/\text{s}$ .<sup>(64)</sup> Analytical measurements and/or more precise modeling are needed for cases where mercury is likely to be in contact with air, as opposed to submerged in a liquid or solid substance.

### 5.3. Experimental Data

Two different experimental studies shed some light on the modeling results. The first involved a model validation study considering an EPA modeling scenario that assumed when mercury is placed in a candle that it all immediately volatilizes. Thus, if 4 g were placed in a candle in a  $27 \text{ m}^3$  room, the concentration would rapidly rise to  $2000 \mu\text{g}/\text{m}^3$ .<sup>(42)</sup> We conducted a simple experiment<sup>(23)</sup> in which varying amounts of mercury were weighed, placed in a candle, and burned. After the candles burned for 1 hour, the mercury was recovered from the wax and reweighed. While there was significant uncertainty in our data due to systematic error in retrieval, it was clear that most of the mercury did not volatilize at all but was trapped in the wax due to its greater density (losses averaged  $0.09 \text{ g}/\text{candle} \pm 0.1 \text{ g}$ ).

The second set of empirical data came from field measurements of the housing stock in Union City and West New York, NJ.<sup>(65,66)</sup> These data were not intended to validate the indoor air quality model, but to provide some measure of prevalence of elevated concentrations. Mercury vapor concentrations in indoor air were measured in 34 interior hallways and 67 vestibules of apartment buildings, using a Lumex RA-915 portable mercury vapor analyzer. A total of 260 readings were taken in 212 locations, with each reading representing an average of three 10-second measurements. Mercury concentrations were significantly greater than outdoor concentrations in 38% of the buildings, with two buildings giving readings above the ATSDR MRL of  $200 \text{ ng}/\text{m}^3$  (774 and  $2022 \text{ ng}/\text{m}^3$ , respectively). The hallways were well ventilated due to open windows and doors. Due to readings rising near the doors of certain apartments, the mercury sources appeared to be inside the apartments. Several botánicas were also monitored, with concentrations between  $40\text{--}500 \text{ ng}/\text{m}^3$ . A few buildings were visited in Montclair, NJ, as a control. No readings were above the MRL, but few buildings were visited.

## 6. DISCUSSION

Mercury continues to be used in the Latino communities in the study area of northern New Jersey. Mercury is used in certain Santeria practices that are explicitly religious, and in selected treatments to assist clients with problems. These uses do not involve sprinkling of mercury, and mercury is typically not exposed to open air, resulting in lower indoor air concentrations and exposure to mercury vapor. Instead, the greatest concerns related to Santeria involve accidental leaks and spills of mercury, followed by the potential for evaporation or other removal of the medium in which mercury is submerged or contained, exposing it to open air. The use of gelatin capsule containers may increase the risk of mercury spills over a bottle with a dropper lid. Religious uses appear to involve infrequent practices with small amounts, enclosed in other media, significantly reducing exposure and risk compared to uses like sprinkling.

Our findings show that there are different types of mercury use stemming from different cultural and religious traditions. Much of the mercury use that can result in the highest exposures to mercury vapors (e.g., sprinkling, mixing with soap and water for floor washing) may have its roots outside of Afro-Cuban religious tradition. This indicates that health professionals will need, in the future, to pay more attention to differences in ethnicity, religion, and culture if they are to reach those who are likely to experience the highest mercury exposures. A better understanding of the cultural uses within various Latino communities in Hudson County is important, but continuing to focus research and outreach programs on a specific religious community with a history of persecution will only exacerbate strained relations and make it increasingly difficult to obtain accurate information.

In general, our participants were unaware of specific hazards or routes of mercury exposure, with a few respondents mentioning dermal exposure routes. No one knew about the tendency of mercury to volatilize or the possible effects of inhalation exposure to mercury vapor. This represents a significant knowledge gap that needs to be closed through risk communication. This is not to say that this community is less informed than other communities in the United States; on the contrary, it is likely that similar knowledge gaps would be found across the country in equal need of risk communication. However, as discussed here, the cultural complexities require careful design of interventions tailored to this community; the need for generalized communications about mercury in indoor air

should not overshadow the need to reach this community effectively.

Our respondents did see mercury as “dangerous” in a different way, believing that selling, possessing, and using it can result in arrest and imprisonment. Recent educational outreach efforts, the events of September 11, and bans on mercury products in other states and communities may have encouraged this notion. This climate of fear has created a secretive and potentially hostile environment for conducting interviews or outreach programs. The subject has become taboo, especially in conversations with those perceived as outsiders. Further regulation, including banning sales of mercury, may effectively criminalize the practice without reducing sales or usage. As one respondent declared: “They tell us not to use it and say it’s bad. Of course, if they need to people will use it. They just won’t talk about it.”

### 6.1. Cultural Risk

In a multicultural society, it is often one culture’s traditional activities and observances that distinguish it from the dominant culture and help maintain group identity. When such cultural activities pose a risk, a series of critical questions arise for researchers and for policymakers. For example, a community may not view a particular activity as risky, or a particular substance as hazardous. A community may not wish to be studied. There are key ethical questions about the extent to which government or academe ought to intrude in a community that does not welcome study. At the same time, a failure to communicate about a risk to a particular community can also be viewed as an unacceptable bias that leads to unequal protection from harm.

An important research question in this area is how communities contextualize and define risk. Pioneering work by Douglas and Wildavsky<sup>(67)</sup> presented risk as a collective construct, subject to cultural and social contexts and processes. As Boholm<sup>(68)</sup> writes:

“risk” is extremely contextual and fluent, what is or what is not considered a “risk” depends to a large extent on other things. Social relationships, power relations and hierarchies, cultural beliefs, trust in institutions and science, knowledge, experience, discourses, practices and collective memories all shape notions about risk or safety.

What constitutes risk within minority immigrant communities may differ greatly from scientifically defined risk. Mercury is considered a risk and a concern

by experts using the risk paradigm. The ways in which mercury is seen as risky in the community we studied centered primarily around its perceived illegality, and on the notion that mercury is a powerful substance that could backfire and bring bad luck if used incorrectly. Immigrants' perceptions of themselves as disadvantaged within the power structure, and their experience of insecurity while becoming accustomed to ways of life in a new country, affect their definitions of risk. Consequently, the "risk" associated with mercury may be identified by academics as exposure to toxic vapors but by community members as the possibility of fines or imprisonment.

An understanding of the ways in which cultures manage uncertainty (an essential feature defining risk<sup>(68)</sup>) is another lens through which to view mercury use. People may be using mercury in ritual ways in order to *reduce* uncertainty in their lives. That is, mercury is attributed properties that are seen as helping to assure positive outcomes. So while mercury users see ritual use of the substance as potentially decreasing risk, the public health community will see mercury use as increasing it. Thus, any risk management effort will necessarily evoke the insider-toutsider issues discussed earlier.

The role of culture in the evolution of risks of mercury use in this community is nuanced and should not be oversimplified. It is easy for experts operating in a scientific risk paradigm to view specific cultural or religious behavior as inducing risk, and thus seek to control it. However, the practices themselves seem to introduce less risk than accidental leaks and spills. At the same time, the likelihood of owning a container of mercury that could leak or spill may be higher among community members because of religious or cultural practices, so that a general education campaign seeking to educate communities about mercury ought not to skip over this one.

Were the larger community of mercury users to set risk or environmental health priorities, our findings suggest that exposure to mercury vapors might not be considered a priority (perhaps even if these risks were better understood). However, potential exposure to mercury vapors could be a concern for other individuals living in the same geographic area, due to worries about previous contamination in dwellings. Thus, definition of the community at risk of exposure becomes a central issue. Since remediation may cause people to lose their homes, there are problems for anyone living in a potentially contaminated dwelling, whether they use mercury or not. This is further complicated by the lack of readily available, inexpensive

exposure measures that could allow the larger community to evaluate their risk.

Until there is holistic, community-based risk identification and assessment in this locale with significant participation from mercury users, any policy implementation will be problematic. This needs to be done using a comparative risk or risk-ranking framework that will allow risks to be placed in proper context with other risks faced by the community (e.g., Reference 69). While scientists may contribute to this process, lay community members should have the autonomy to define and rank risks, and balance these against community-defined benefits. Care must be taken not to alienate specific religious communities as well as Latino groups in general. Religious and cultural uses of mercury should be viewed in the context of larger health issues within these communities where many individuals may be marginalized economically as well as lack access to the health and mental health care system. A better understanding of Latino community health in general will help researchers to comprehend the role of mercury in religious practitioners' perceived mental and spiritual well-being.

In policy implementation, an overall approach to mercury management that emphasizes equitable treatment of sources (e.g., plumbing supply stores, public schools, abandoned waste sites, and botánicas) would be helpful in rebuilding trust as well as distributing attention where it is needed. At this point, there is no evidence of widespread mercury exposure that would require bold policy interventions such as outright bans or routine testing of children or buildings. The most appropriate policy intervention is outreach to educate individuals about mercury's risks, and particularly the vapor inhalation route of exposure. Such an intervention is needed both within the community we studied and across the country. One size does not fit all, so community context should be taken into account when designing outreach activities. Below we discuss outreach activities for the community of study, recognizing that other outreach activities might be employed to reach other segments of the population.

## 6.2. Outreach Activities

Central to public health practice and risk communication is the importance of knowing and involving the community.<sup>(70,71)</sup> In addition to implementing best practices identified in the risk communication literature,<sup>(72-74)</sup> we offer the following recommendations:

*Don't violate religious secrecy or make assumptions about what practices are religious.* Recent public health communications have been developed to specifically address mercury uses in Santeria. Most of these have taken the form of brochures that include references to sprinkling mercury and associate mercury use directly with religious practice (see Appendix of Reference 28). However, the process of making secret information public can damage an already tenuous relationship with a distrustful community. Literature developed by those outside the community may refer to practices that are not considered a true part of the religion. This type of public exposure breaches key taboos about secrecy and can be seen by practitioners as irrelevant and out of touch—or worse, as an attack on their beliefs. Things that look religious to an outsider may not be—for example, possession of a candle of the Seven African Powers does not automatically lead to the conclusion that the owner is an adherent of Santeria, or of any religion.

*Avoid an implicitly racialized view of Santeria and other Afro-Caribbean religions.* Despite Santeria's roots as an Afro-Cuban religion, many people without claim to African ancestry participate in the religion. Assuming a strong association between race and religion will continue to leave out individuals who use mercury and erroneously involve those who do not.

*Look past pan-ethnic labels.* The use of pan-ethnic labels and the nature of religious identity make it difficult to locate people who use mercury. Sprinkling emerges as a practice with high exposure potential, and more research is needed—with attention to variations in race, ethnicity, and cultural practice—to locate and understand sprinkling activities.

*Don't look the other way.* In paying closer attention to ethnicity and religion, we have learned that Santeria practitioners in our study area are using mercury in relatively contained ways that result in lower exposures than previously reported. They are using mercury, however, and it is important that practitioners receive information about hazards related to spills and vapor exposure. Appropriate communication about mercury for Santeria practitioners would not mention the religion but simply discuss mercury and its exposure pathways, accidental spills, and how to clean them up. The Santero network may be the best conduit for distributing such materials on mercury hazards, especially if Santeros participate in developing them. We believe Santeros might cooperate in such an effort if it reflects and respects the nature of mercury use in their profession, because it is consis-

tent with their role as experts, with specialized skills that should not be practiced by just anyone.

*Be inclusive.* There is a great need for mercury education across the general population to address the low public awareness of exposure pathways for elemental mercury as well as methylmercury, and the differences between the two. Locally sponsored collection days continue to bring in large quantities of elemental mercury,<sup>9</sup> reminding us that elemental mercury is still widely available, with wide-ranging histories of storage and use.<sup>(75)</sup> Latino and Caribbean communities should not be left out of such efforts, nor should they be singled out on the basis of misunderstood religious ritual. An educational program aimed at those who use mercury, sell it, or recommend its use is essential. Such a program should clarify the nature of the hazard, emphasize the need to minimize mercury's use, and demonstrate the necessity of keeping it in closed containers. Recommendations for disposal of mercury and cleanup of spills should be standardized across government agencies and included in communications about mercury.

## 7. CONCLUSION

To assess mercury exposure from cultural and religious practices, we demonstrated the use of ethnographic research methods in an integrated, multidisciplinary methodology that examines cultural context, beliefs, and behavior as well as chemical fate and transport. The ethnographic approach was essential in this case where reliable information can only be obtained by cultural and religious “insiders.” This approach can extend to any case of cross- or multi-cultural risk perception and communication.

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<sup>9</sup> For example, in 2001, 1,400 lbs. were collected from Massachusetts municipal waste collection centers, and 1,218 lbs. from Connecticut homes.<sup>(64)</sup>

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