**AN EVALUATION OF POTENTIAL EXPOSURE TO MERCURY IN A COMMUNITY [Union City & West New York, NJ] WHERE MERCURY IS USED FOR CULTURAL PURPOSES**

Doctoral Dissertation, School of Public Health, University of Medicine and Dentistry of New Jersey

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## ABSTRACT OF THE DISSERTATION

Elemental mercury is used in a variety of superstitious and cultural practices. These practices involve **intentional dispersal of mercury within residential buildings** by individuals who believe this will provide some benefit or ward off harm but may represent **an insidious source of mercury exposure.**

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**We determined that cultural mercury use is a likely source of exposure for a small but noteworthy percentage of individuals in communities where there is such use.**

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## Chapter 1

### Comparison of Outdoor Mercury Vapor Levels to Levels in Common Areas of Residential Buildings in a Community where Mercury is used for Cultural Purposes

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We hypothesize that elevated levels of mercury vapor are present in residential buildings in communities that engage in cultural use of mercury compared with outdoors. We further hypothesize that elevated levels can serve as a signal of significant cultural use in addition to unintentional breakage and spillage from other sources.

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Windows and doors to residential apartments primarily influenced ventilation within the hallways. **12 of 34 (35%) buildings had open hallway windows during the time of the visit.**

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**Mercury concentration within the botanicas was significantly higher than that within the residential buildings** ($P<0.01$).

In the remaining five buildings, mercury vapor concentration increased as certain individual or groups of apartment entrances were approached. No visible contamination was noted in any of the cases and the actual source of vapor remained unknown.

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Although our data are not intended as estimates of residential exposure to mercury vapor they do indicate that, compared with outdoor levels, such exposures are likely in a significant proportion of multifamily residential buildings in an area with known cultural uses of mercury.

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Though the exact source was not identified, **the potential source of mercury vapor seemed to be residential apartments** in five of the buildings with elevated mercury vapor concentration. … Our… findings are consistent with the hypothesis of cultural uses of mercury, but not definitive. The **elevated mercury vapor concentration found in botanicas is also consistent with its availability for cultural use.**

These measurements were not made in areas that directly reflect exposure, nor, for the most part, do they measure concentration at the emission source. Therefore, **these measurements could underestimate mercury concentration at the point of long-term exposure.** … In most buildings surveyed, including those with the highest mercury vapor concentration, windows were open.

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Whether exposure to elevated mercury vapor arises from intentional cultural uses or from unintentional breakage and spillage of mercury-containing equipment, **these exposures pose the potential for adverse health effects and should be addressed.**

Based on reports on the manner in which mercury may be used for cultural purposes, and our present findings, **we also recommend expanded screenings in areas where mercury may be used for cultural purposes** with the inclusion of suitable control locations.

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**Chapter 2**

**Comparison of Mercury Vapor in Residential Communities that use Mercury for Cultural Purposes with a Reference Community**

After controlling for a number of factors that might influence $Hg^0$ vapor levels, **the most plausible explanation for greater $Hg^0$ vapor levels in the study area is cultural use of mercury.**

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Extensive detail exists elsewhere on the prevalence, manner of use and availability of $Hg^0$ for cultural purposes (Johnson 1999; Johnson 2004; Ozuah et al. 2003; Riley et al. 2001; Stern et al. 2003; Wendroff 1990; Zayas and Ozuah 1996). Though mercury is available in communities where it is culturally, due to apprehension, a distrust of authorities and those outside the culture, it's sale or distribution to these "outsiders" is limited (Riley et al. 2001; Stern et al. 2003). This is not the case outside the U.S. where we readily purchased several grams of $Hg^0$ and other select liquids and received verbal instructions on the most auspicious days to spread them on the floor in the home with the recommendation to do so twice-weekly (see figure 1).

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Although the magnitude of exposure to $Hg^0$ vapor from cultural use is unknown, **the hazard of $Hg^0$ vapor is well established and it is detectable years after small spills** from objects such as a fever thermometer (Carpi and Chen 2001; von Muhlendahl 1990). With larger spills, significant concentrations of $Hg^0$ vapor may persist for decades (Sasso et al. 1996). **This presents the specter of exposure to $Hg^0$ in residences from either unintentional or intentional $Hg^0$ releases without knowledge of such**

**exposure. Wendroff (2005) contends cultural mercury use has created such a problem. Based on the described manner and frequency of mercury use by some individuals this contention is not without basis.**

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We cannot attribute the greater prevalence of elevated mercury vapor levels in this area or in the primary study community to cultural use with absolute certainty, but **we have no alternate explanation.**

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Our method relies upon sensitive instrumentation to detect a signal of mercury release though the source may be distant. Thus, $Hg^0$ vapor exposure near the source in apartments is likely to be significantly greater than we detected in common areas, unless as we noted on occasion, the source was in the common area.

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When we examine these data in context with the prior literature, previous and ongoing biomonitoring programs, **there is no choice other than to acknowledge some percentage of individuals are needlessly and possibly unknowingly exposed to $Hg^0$ vapor because of the cultural or folk use of mercury. This includes residents of apartments where mercury was used culturally by prior residents.**

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**Chapter 3**

**Evaluation of Urinary Mercury as a Biomarker of Exposure for Individuals Exposed to Mercury Vapor in a Non-occupational Setting**

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While noting sub-clinical neurological findings from low-level $Hg^0$ vapor exposure, Heyer et al. (2004) put forth the supposition, ***"It is possible that elemental mercury may follow the history of lead, eventually being considered a neurotoxin at extremely low levels."***

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We have demonstrated that the utilization of the value, 20μg/L, as the upper limit of normal urine mercury fails to identify significant exposure. All individuals in the lowest $Hg^0$ vapor exposure category were exposed to $Hg^0$ vapor at a level of magnitude above the U.S. EPA RfC (U.S. EPA 1995) and the ATSDR MRL (ATSDR 1999), yet two-thirds had urine Hg less than 20μg/L. If individuals in this group were the first to seek urine mercury screening, significant exposure might have been undetected. Thus, for this reason and those stated in the text, **we feel strongly that the value, 20μg/L, and the word "normal" should only appear together in a historical context.**

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**Chapter 4**

**Conclusions and Recommendations**

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**The detection of elevated $Hg^0$ vapor levels in residential buildings and botanicas supports the contention that mercury is available and released in residential buildings by cultural use.**

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However, the selection of reference buildings controlled factors likely to contribute to elevated $Hg^0$ vapor levels leaving **cultural mercury use as the plausible explanation** for the difference in $Hg^0$ vapor levels between the control and reference communities.

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In summary we conclude:

1. **$Hg^0$ vapor levels in the common areas of residential buildings in communities that use mercury for cultural purposes are significantly greater than those outdoors.**

2. **$Hg^0$ vapor levels are significantly greater in the common areas of residential buildings in communities that use mercury for cultural purposes compared to those in communities where the use of $Hg^0$ is unlikely.**

3. **$Hg^0$ vapor exposure from cultural mercury use is likely in a small but noteworthy percentage of households in the study area.**

4. Biomonitoring of urine mercury is [a] reasonable tool to assess intermediate and chronic duration non-occupational exposure to $Hg^0$ vapor, including that from cultural use, though at present, its sensitivity to detect exposure at less than $3\mu g/m^3$ $Hg^0$ is unclear.

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***Recommendations for Public Health Action***

The prevalence of cultural mercury use and the likelihood of exposure to $Hg^0$ vapor at levels of public health concern warrant specific actions to address this use in communities where this practice exists. Though the extent of public health action might vary based on the prevalence of cultural use and associated $Hg^0$ exposure, the following recommendations are relevant to the study communities surveyed in this research.

1. Culturally appropriate educational outreach activities, using written materials or other media that addresses sources of mercury, its health hazards, and resources for individuals who may be exposed are required. Educational materials must be accessible to individuals without deliberate action to seek information regarding mercury.

2. **Health care providers should be provided with educational materials and guidance regarding biomonitoring.**

3. **Public health clinics and appropriate community-based clinics should provide urine mercury screening to those individuals that reasonably believe they are exposed, regardless of their ability to pay for this analysis.**

4. **Local public health officials should have the capability, individually or regionally, to conduct mercury vapor monitoring with sensitive instruments. Monitoring in residences should be offered to all individuals with urine mercury above population norms. Public health officials should consider monitoring in all residences that request it.**

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5. Recommendations 1 through 4 should be designed and implemented in a manner that allows

evaluation of their efficacy and relevance to other communities.

6. **A strategy should be developed by state and local public health and environmental officials, in consultation with federal officials, to guide response actions if residences with mercury vapor at levels of concern are identified.**

***Recommendations for Additional Research***

Research needs in addition to those that might accompany the recommended public health actions are also present.

1. **In other communities where there is cultural mercury use, air-monitoring surveys similar to that in Chapter 2 may be useful where deliberate public health action is deferred due to a lack of information regarding the prevalence of these practices.**

2. Studies to establish baseline levels of mercury vapor in residential buildings are warranted both to evaluate the contribution of indoor mercury vapor to total mercury exposure and to provide a basis of comparison for public health investigations involving indoor mercury vapor exposure.

3. The existing literature should be evaluated with consideration of the contribution of dental amalgam to urine mercury, to better describe the "normal" ranges of urine mercury in non-occupationally exposed populations.

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4. The effect of adjustment on urine mercury should be further evaluated in an attempt to aid interpretation of results and to foster consistency in reporting so that inter-study and inter-individual comparisons may be more relevant.

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**Appendix A**

**Determination of the Number of Households in the Study Area that Might Contain Elemental Mercury in Sufficient Quantity to Generate a Signal of Mercury in Common Areas of the Residence**

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**By extrapolation, 1.74% of households** (95% CI: 1.05%, 2.43%) or 689 (CI: 416, 962) of the 39,591 **within the study area may contain mercury at a level sufficient to result in a $Hg^0$ vapor signal of greater than 25 ng/$m^3$ in building <u>common areas</u>.** On average, there are 2.8 persons per household in this community.

**Conclusion**

The majority of households in the study area are not likely to contain $Hg^0$ in sufficient quantity to generate $Hg^0$ vapor signals of greater than 25 ng/$m^3$ in common areas. Despite this, **the number of individuals in households where $Hg^0$ is present at this level is of concern.**

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**Curriculum Vita**

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