



Associations of Heavy Metals and Hearing Loss in Hispanic Children

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Background

It is estimated that hearing loss affects more than 11% of children and adolescents in the United States alone (1). Heavy metals, such as lead and cadmium, have been identified as environmental risk factors for hearing loss via a variety of mechanisms (2). Research has shown that certain groups, such as Hispanic populations in the U.S., have higher amounts of certain heavy metals, such as cadmium (3).

The National Health and Nutrition Examination Survey (NHANES) provides a large, nationally representative sample and has been used in hearing loss research. However, research that investigates the relationships between heavy metals and hearing loss has been limited with the latest NHANES dataset, and specific subpopulation analysis has been sparse.

Aim

To build on earlier research with a deeper look into U.S. subpopulations, a greater range of metals, and utilization of more recent data, with the goal of identifying groups that may be at-risk for hearing loss.

Methods

Dataset: NHANES 2017-March 2020 Pre-Pandemic cycle

Population: Of the 4785 participants, 1066 were excluded for partial testing, hearing loss before age 1, flat tympanograms, and non-detected values. There were 2673 final participants aged 6-19.

Hearing loss:

- Classifications of pure-tone averages were as follows: low-frequency pure-tone average (LPTA) with the average of thresholds at 0.5, 1, and 2 kHz; high-frequency pure-tone average (HPTA) with the average of thresholds at 3, 4, 6, and 8 kHz; and speech-frequency pure-tone average (SPTA) with the average of thresholds at 0.5, 1, 2, and 4 kHz.
- Low-frequency hearing loss (LFHL), high-frequency hearing loss (HFHL), and speech-frequency hearing loss (SFHL) were defined as an LPTA, HPTA, or SPTA greater than 15 dB in either ear, respectively. Any hearing loss (AHL) was defined as an LPTA, HPTA, or SPTA greater than 15 dB in either ear.

Analysis: In R, demographic characteristics were explored using Pearson's chi-squared tests. A broad analysis identified mercury as a metal of interest. Multivariate logistic regressions were performed with hearing loss as the outcome, followed by subgroup and population analyses. Covariates were age, gender, poverty-income ratio (PIR), history of three or more ear infections, health insurance, and health access.

Results

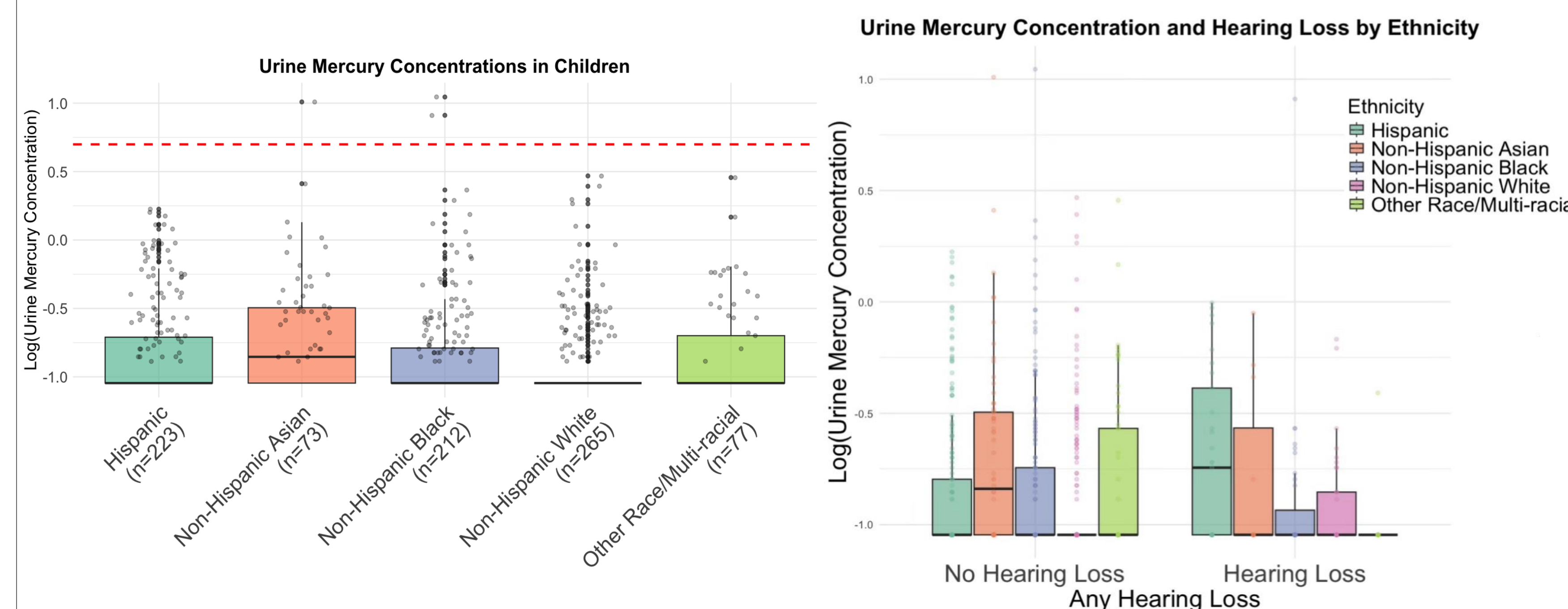
Participants (6-19 years old)

Hispanic subgroup analysis

- 7 children had LFHL, 11 children had HFHL, 9 children had SFHL, and 14 children had AHL among the 111 Hispanic children who had urine mercury levels measured
 - Increased urine mercury exposure was significantly associated with increased hearing loss in all four categories:
 - LFHL ($\beta = 0.966$, $p = 0.032$)
 - HFHL ($\beta = 0.951$, $p = 0.010$)
 - SFHL ($\beta = 1.181$, $p = 0.009$)
 - AHL ($\beta = 0.924$, $p = 0.007$)
 - This significance was not seen with the non-Hispanic group, nor was it seen for blood mercury concentrations.

Population analysis

- Interaction term analysis, which looks at how the effect of mercury differs between Hispanic and non-Hispanic children, was significant for increased LFHL ($\beta = 1.133$, $p = 0.025$), SFHL ($\beta = 1.087$, $p = 0.027$), and AHL ($\beta = 0.994$, $p = 0.012$).
- Among all children, urine mercury was not significantly associated with hearing loss.
- The distribution of both urine mercury concentrations alone and by hearing loss were graphed by ethnicity using box-and-whisker plots.



Characteristic	Non-Hispanic, N = 1996 [†]	Hispanic, N = 677 [†]	p-value [‡]
Gender	996 (50%)	341 (50%)	0.8
Age	12.8 (3.7)	12.7 (3.8)	0.4
Low Frequency Hearing Loss	140 (7.0%)	34 (5.0%)	0.069
High Frequency Hearing Loss	203 (10%)	63 (9.3%)	0.5
Clinical Hearing Loss	129 (6.5%)	33 (4.9%)	0.13
Any Hearing Loss	265 (13%)	86 (13%)	0.7
Poverty Income Ratio	480 (27%)	194 (33%)	0.001
Access to Healthcare	1,823 (91%)	559 (83%)	<0.001
Health Insurance	1,880 (94%)	588 (87%)	<0.001
Ringling, Buzzing	56 (9.7%)	14 (7.2%)	0.3
Dizziness, Lightheadedness	165 (29%)	52 (27%)	0.6
Any Loud Noise Exposure	143 (27%)	48 (28%)	0.8
History of 3 or More Ear Infections	483 (47%)	176 (47%)	>0.9

[†] n (%); Mean (SD)
[‡] Pearson's Chi-squared test; Wilcoxon rank sum test

Discussion

- In Hispanic children, increased urine mercury exposure appears to be associated with increased hearing loss across all classifications. Mercury has historically been identified as an ototoxic substance, but previous NHANES research has not reported it to be associated with hearing loss.
- The increased hearing loss in the subgroup analysis of Hispanic children could be explained by another factor that amplifies hearing loss risk, such as socioeconomic status markers.
- The discrepancy in blood and urine findings may be explained in part by the fact that urine heavy metals tend to represent more chronic exposure.
- The distribution of urine mercury concentrations shows many outliers in each ethnicity group.

Future directions

- Analysis will be carried out for other subpopulations.
- Analyses that further explore the impact of factors which reflect socioeconomic status will be conducted to see if there is another factor, such as socioeconomic status that may be driving the discrepancy in hearing loss.
- Elastic net analysis will be performed to handle the multicollinearity present in the data and to highlight any other metals or risk factors that may be implicated.
- The adult cohort will be investigated as well.

Limitations

- Within NHANES, not every participant takes part in every component of the whole dataset. Thus, there are sample size limitations when it comes to the participants who have had audiometric testing, urine and blood metal analyses, and the various covariates. This is especially amplified with subgroup analyses.
- Analyzing metals individually can mask combined effects of metals, which has been previously reported.

References

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