A121 Using Semimechanistic Modeling for the Prediction of Oxygen and Hydrogen Drinking Water Isotopes From Human Hair in Mexican Populations

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Learning Overview: The goals of this study are to: (1) explore the relationship between oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$) in tap water samples and human hair samples of known Mexican origin; and (2) explore the utility of semimechanistic modeling of $\delta^{18}O$ and $\delta^{2}H$ of drinking water from hair samples of Mexican origin.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting data on the relationship between Mexican tap waters and human hair and the utility of this relationship to act as a predictor of region of origin.

The use of oxygen and hydrogen isotopes in human drinking water, hair, bone, fingernails, and teeth has demonstrated the ability to successfully track movement and identify the region of origin for modern populations in the United States, Europe, and Asia.[1,2] Bowen et al. published a mass balanced semimechanistic model with adjustable parameters to estimate the value of $\delta^{18}O$ and $\delta^{2}H$ in drinking water based on $\delta^{18}O$ and $\delta^{2}H$ in human hair. This study tests the ability of this model to predict region of origin by estimating the oxygen and hydrogen isotopes associated with drinking waters for Modern Mexican populations

A subset of samples was used for this study, including $\delta^{18}O$ and $\delta^{2}H$ for *N*=38 hair samples and $\delta^{18}O$ and $\delta^{2}H$ for *N*=80 water samples from six states and overlapping locations in Central and Southern Mexico. Hydrogen and oxygen isotopes were measured for all samples for all locations using laser absorption spectroscopy at the University of Utah Stable Isotope Ratio Facility for Environmental Research (SIRFER) laboratory. The results are reported here using delta notation and the Vienna Standard Mean Ocean Water (VSMOW) scale. MATLAB® 9.2 was used to generate a semimechanistic mass balanced model based on the work of Bowen et al. (2009) using known $\delta^{18}O$ and $\delta^{2}H$ from hair values. General statistics were analyzed using SPSS version 25.0.

Results: Tap water values spanned a range from +0.4‰ to -12.7‰ and -4.2‰ to -91.7‰ for $\delta^{18}O$ and $\delta^{2}H$, respectively. Oxygen values for human hair ranged from 15.5‰ to 9.5‰. Hydrogen values for human hair ranged from -54.4‰ to -90.8‰. Linear regressions of hair and water samples revealed medium to weak correlations, which were lower than those previously published for other regions ($\delta^{2}H_h$=-51.678 + 0.347 * $\delta^{2}H_w$, R^2=0.65; $\delta^{18}O_h$=16.256 + 0.342 * $\delta^{18}O_w$, R^2=0.32).[2] For the model, the following parameters were adjusted to maximize fit, Fs=0.18601; l=0.00022849; g1=0.64281; ahw=1.196; aow=1.0125. Despite these adjustments, the medium and weak correlations between hair and estimated drinking water values remain.

The inconsistent results between this study and those on other regions suggests shifting water usage over time and the presence of multiple inputs in the diet of Mexican populations across states. Mexico suffers from water stress and, as a result, has the highest consumption of bottled water per capita in the world. This study clearly demonstrates that in order to use water isotopes in Mexican hair to determine region of origin, these cultural contexts must be taken into consideration.

Reference(s):

1. Ehleringer J.R., Bowen G.J., Chesson L.A., West A.G., Podlesak D.W., Cerling T.E. (2008). Hydrogen and Oxygen Isotope Ratios in Human Hair Are Related To Geography. *PNAS.* 105(8)2788-2793.
2. Thompson A.H., Chesson L.A., Podlesak D.W., Bowen G.J., Cerling T.E., Ehleringer J.R. 2010 Stable Isotope Analysis of Modern Human Hair Collected From Asia (China, India, Mongolia and Pakistan). *American Journal of Physical Anthropology.* 141:440-451.

Geolocation, Isotopes, Hair