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A115   Spatial Distributions of Isotope Ratios in Tap Water, Hair, and Teeth From Latin America for Region of Origin Predictions of Unidentified Border Crossers

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Learning Overview: The goal of this presentation is to introduce recent applications of stable isotopes and "isoscapes" for predicting region of origin of unidentified remains cases of Undocumented Border Crossers (UBCs) from the United States-Mexico border. This research provides an overview of the process and implications of building an isoscape from tap water and hair samples and discusses how these reference data provide a framework to predict region-of-origin of deceased migrants from Arizona and South Texas.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the use of reference baseline isotope data to refine predictions of region of origin of unidentified remains of UBCs and to highlight both the limitations and challenges of these approaches.

Each year, hundreds of UBCs are found deceased along the United States-Mexico border, with the highest volume of deaths occurring in Arizona and South Texas. UBCs are among the most difficult individuals to identify due to the lack of antemortem identification records and challenges in obtaining family reference DNA samples. Stable isotope analysis of human tissues represent another line of evidence to provide investigative leads for identification efforts of UBCs from Arizona and South Texas. Previous research on carbon isotopes identified significant dietary differences between the continental United States and Latin America, providing a useful screening tool. The addition of oxygen and strontium isotopes provides a more precise geospatial tool for narrowing region of origin since these isotopes reflect the sources of drinking water and food, respectively. To date, only crude isoscape maps exist for most regions within Latin America due to the lack of baseline reference data, which hinders efforts for predicting region of origin. This presentation adds to the growing baseline data for Latin America by presenting data on regional variation of isotopes in water and hair.

Tap water ($n=158$) and hair ($n=101$) samples were collected from 51 towns and 32 cities throughout Mexico to serve as a reference database for assigning deceased unidentified UBCs to potential regions of origin. Tap water samples were measured for oxygen and hydrogen isotopes, and hair samples were measured for oxygen isotopes. Water ($\delta^{18}O$ and $\delta^{2}H$) and hair ($\delta^{18}O$) isoscapes were generated using ArcGIS® based on the spatial distribution of the reference sample using Moran's I to quantify spatial autocorrelation (Spatial Statistics Toolbox, ArcGIS® 10.6). The tap water ratio data were defined by Moran's indices of 0.843 and 0.856 (z-scores of 7.5 and 7.6 and p <0.000001 for $\delta^{18}O$ and $\delta^{2}H$, respectively).

Carbon and oxygen isotopes were also measured in tooth enamel bioapatite from deceased UBCs from Pima County, AZ, ($n=30$) and Brooks County, TX ($n=41$). Permission to sample these remains was granted by the Pima County Office of Medical Examiner and Texas State University for the Arizona and Texas samples, respectively. Various lines of evidence indicate that the majority of UBCs found in Arizona derive from Mexico, whereas the majority of UBCs found in South Texas derive from Central America (primarily Guatemala, Honduras, and El Salvador). The mean enamel bioapatite $\delta^{13}C$ value is –6.4‰ (±2.3‰, 1 SD; range=10.2‰) for the Arizona samples versus –5.4‰ (±3.0‰, 1 SD; range=13.0‰) for the South Texas samples, demonstrating a non-significant difference ($t=1.594$, $df=69$, $p=0.115$). The mean enamel bioapatite $\delta^{18}O$ value is –4.4‰ (±3.2‰, 1 SD; range=0.9‰) for the Arizona samples versus –5.5‰ (±1.2‰, 1 SD; range=7.2‰) for the Texas samples, a statistically significant difference ($t=-3.949$, $df=68$, $p<0.001$). However, the differences in $\delta^{13}C$ and $\delta^{18}O$ between UBCs from Arizona and South Texas are small, and their source populations within Mexico and Central America cannot be determined using the isotope data currently available.

Three case studies from Arizona are used to highlight the application and limitations of the tap water and hair oxygen isotope isoscape based on individuals of known origin (i.e., UBCs who have recently been identified). The isoscape predictions for these cases are consistent with the known origin of these individuals, but include several possibilities within Mexico. The addition of strontium isotope baseline data will aid in refining these predictions in the future.

The ultimate goal is to incorporate the data into a larger network of tap water and human hair isoscapes in order to establish probability densities for the most probable regions of origins for the deceased undocumented migrants.

Isotope Analysis, Undocumented Border Crossers, Forensic Anthropology

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