A149 Taphonomic Effects on Isotope Ratios of Human Hair

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After attending this presentation, attendees will understand how isotope ratios of human hair can change throughout decomposition and continued outdoor exposure over a one-year period.

This presentation will impact the forensic science community by providing information regarding the first study conducted on human hair samples to evaluate the effects of taphonomic processes on isotope ratios of postmortem hair. The forensics community uses isotope ratios of postmortem hair for predicting diet and geographic origins of unknown human remains, and this presentation will provide an assessment of geospatial modeling accuracy using isotope ratios from individuals with known residence histories.

Isotope analyses of human remains have been conducted with growing frequency in forensic anthropology. Isotope ratios of elements, such as carbon, nitrogen, hydrogen, oxygen, and strontium from hair have provided information regarding individual diet and geographic origin. The isotope ratios of hair can be projected across landscapes using geospatial models (i.e., isoscapes). As hair grows at a known rate, these data provide a serial recording of diet and travel history for the weeks and months prior to death; however, these isoscapes have been developed using clean modern samples from salons and do not reflect the typical condition of hair found in forensic contexts. A critical knowledge gap has been whether exposure to the outdoor environment and postmortem decompositional fluids have an effect upon isotope ratios in hair. If the isotope ratios of human hair are to be used reliably in forensic casework, it is essential to understand the effects of taphonomy on isotope signatures, and whether these signatures persist and reflect those seen during life.

This research was conducted at the Anthropology Research Facility in Knoxville, TN, an outdoor laboratory for the study of human decomposition. Body donors with known residence histories (n=8) plus two additional donors at the Forensic Anthropology Research Facility in San Marcos, TX, were enrolled in the study, and hair samples were collected over a one-year period of environmental exposure. Two facilities with different climatic and soil environments were used to understand the ways in which temperature, humidity, geographic location, and underlying lithology affect isotope ratios of hair. Donors were placed in both surface and burial conditions to determine the effects of placement condition on isotope ratios of hair. Carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), hydrogen ($\delta^{2}H$), oxygen ($\delta^{18}O$), and strontium ($^{87}Sr/^{86}Sr$) isotope ratios from the human hair samples were analyzed. Environmental samples of soil and precipitation were also collected and analyzed. Carbon and nitrogen isotope ratios in human hair underwent little change over time and were more consistent than hydrogen, oxygen, and strontium isotope ratios, all of which were impacted by the depositional environment.

Oxygen and strontium ratios were compared to isoscape models to create geographic predictions for last residence for each of the donors. Oxygen isotope ratios predicted regions within 250 kilometers of the last known residence of the donors 81% of the time, and strontium predicted regions within 250 kilometers of last known residence 100% of the time. Combined, oxygen and strontium predictions fell within 250 kilometers of last known residence 80% of the time. This study revealed that isotope ratios of human hair can change postmortem and are influenced by placement location (i.e., Tennessee or Texas facility), surface or burial placement, and duration of exposure. Isotope ratios of human hair, despite these postmortem changes, still provided valuable information regarding geographic travel history. As these postmortem changes become better understood, they could be incorporated into predictive models to improve model accuracy. Nonetheless, when the isotope ratios of human hair are analyzed postmortem, it is important to consider how taphonomic processes impact isotope ratios.

Isotope Analysis, Human Decomposition, Isotope Ratios of Human Hair

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