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Assessing dietary habits through nitrogen and carbon stable isotope composition of human scalp hair and fingernails

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Poor dietary habits are linked to a wide range of health problems, some of which can be severe and even life-threatening. A precise assessment of dietary patterns is essential for treating individuals and detecting potential health risks. However, relying on dietary evaluations conducted via self-reported questionnaires often leads to inaccuracies and inherent biases. Further, nutritionists generally recommend plant-based protein sources over animal meat and advocate for obtaining sugars from fruits rather than sugar-sweetened beverages. The nitrogen and carbon stable isotope composition of human tissues, which has emerged as a reliable biomarker for nutritional evaluation, boasts of its ability to differentiate between these dietary sources. This method not only reveals individual dietary habits but also aids in identifying diet-related disorders. Since nitrogen and carbon in the human body come from dietary sources, the stable isotope composition of an individual's tissues correlate with the isotope composition of their diet. However, physiological factors affect the metabolic processes that transfer dietary elements to tissues, potentially skewing isotope values. For example, during nitrogenous waste formation, heavier nitrogen isotopes are discriminated against, resulting in higher $\delta^{15}N$ values in tissues. Disruptions in these metabolic processes can impact tissue isotope ratios and thus, providing us with an indication of dietary disorder. The stable isotope composition of human tissues has also been linked to certain diseases and used as an indicator of nutritional stress, particularly in cases of starvation and undernourishment. For instance, liver cirrhosis lowers only $\delta^{15}N$ value, eating disorders lead to an isolated increase in $\delta^{15}N$ value and nutritional stress typically raises $\delta^{15}N$ value and lowers $\delta^{13}C$ value.

The use of stable isotope composition in health research depends on fully understanding its relationship with diet. In this study, we collected scalp hair and fingernail samples from healthy participants over a 15-day period in 2021. The COVID-19 restrictions provided a controlled environment, limiting participants' travel and food options on a residential campus. This eliminated potential influences from dietary disorders and environmental factors on the nitrogen and carbon isotope composition of tissues. We observed that the type and amount of protein consumed affects the $\delta^{15}N$ and $\delta^{13}C$ values of human tissues. The study also measured the magnitude of enrichment in $\delta^{15}N$ and $\delta^{13}C$ values from diet to tissue and compared them to shifts associated with dietary disorders in $\delta^{15}N$ and $\delta^{13}C$ values of human scalp hair. These results will help understand whether fluctuations in tissue isotope values are due to higher animal protein intake or are markers of dietary disorders.