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Investigating the impact of diet on the stable isotope composition of human scalp hair and fingernails

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Diet-related diseases such as nutritional stress, malnutrition and eating disorders resulting from an unhealthy diet contribute to various health issues, which in some cases may be life-threatening. An accurate diet reconstruction is thus crucial for individuals at risk due to dietary concerns. The principle of diet reconstruction is rooted in the proverb 'you are what you eat', and an individual's diet is the sole source of nitrogen and carbon in their body. The stable isotope composition of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) can serve as a tool to recognise dietary patterns and identify health conditions. However, the variations in the values of $\delta^{15}N$ and $\delta^{13}C$ isotopes can imply either dietary changes or disorders associated with diet, making it challenging to ascertain the precise cause of such variations. This study aimed to establish the relationship between the isotopic composition of human tissues, specifically scalp hair and fingernails, and diet. Samples of human tissues were collected from 100 healthy participants within a 15-day period, with 74 of them providing comprehensive diet records. The participants resided in a controlled environment, a remote residential campus with limited food options and restricted access to external food sources. This controlled setting ensured that the isotopic composition of the collected samples solely reflected the impact of diet, eliminating the influence of environmental factors and dietary disorders on the isotopic composition. All the dietary sources and sixty-six food items available to the participants were considered and analysed, respectively, to determine the percentage of animal protein in their diet. This was correlated with the $\delta^{15}N$ and $\delta^{13}C$ values of human tissues to quantify the proportion of animal protein in diet using linear equations. The variations in the $\delta^{15}N$ and $\delta^{13}C$ values of human tissues resulting from dietary changes were calculated and distinguished from those caused by dietary disorders. The study results demonstrated that the amount and type of food consumed impact the $\delta^{15}N$ and $\delta^{13}C$ values of human tissues. An increase in animal protein intake was associated with an increase in the dual isotopic composition. Notably, the nitrogen isotope values of human tissues differed by 0.9‰ between lacto-vegetarians and omnivores. The study further revealed that a 5% dietary change resulted in fluctuation of 0.4 - 0.5‰ in both $\delta^{15}N$ and $\delta^{13}C$ isotope ratios. This was compared to changes caused by dietary disorders in $\delta^{15}N$ and $\delta^{13}C$ values of human scalp hair. These findings help in determining whether the variations in $\delta^{15}N$ and $\delta^{13}C$ values of human tissues result from increased animal protein intake or serve as indicators of dietary disorders.