

Measuring Ultra-Processed Foods in Diet

Scores based on metabolite levels in blood and urine could provide an objective measure that avoids shortcomings of self-reported dietary data.

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Ultra-processed foods (UPFs) are ready-to-eat or ready-to-heat manufactured products that often use ingredients not found in home cooking. The products are usually high in calories, salt, sugar, and fat. UPFs account for more than half of all calories consumed in the United States. Studies have linked their consumption to weight gain and obesity and to risk of heart disease and some cancers.

Measuring UPF consumption has been challenging. Determining what qualifies as UPF requires detailed information on food sources, processing methods, and ingredients. Dietary questionnaires don't always capture this information.

Metabolites are compounds that are produced by the body's conversion of food into energy. Their levels in the blood and urine reflect food intake. A research team led by Dr. Erikka Loftfield at the NIH's National Cancer Institute reasoned that metabolites might provide a less biased measure of ultra-processed food consumption.

To develop an objective measure of UPF intake, the team used self-reported dietary data and metabolite measurements in blood and urine samples from a 12-month study of diet and activity. The data included more than 700 people. The participants ranged from 50 to 74 years old, and 93% were white. Results of the analysis appeared in [PLOS Medicine](#) on May 20, 2025.

As part of the study, participants repeatedly provided detailed dietary data using an online dietary assessment tool. The team used these data to estimate the average percentage of calories that came from UPFs for each person during the 12-month study period. They then compared average UPF intake with average metabolite levels in blood and urine. Nearly 200 metabolites in blood and 300 in urine were correlated with UPF intake. These included a range of molecules, such as lipids, amino acids, carbohydrates, and vitamins.

To develop measures of UPF intake, the researchers used a machine learning algorithm to select metabolites for each specimen type to combine into "poly-metabolite scores." For blood, they used levels of 28 metabolites, and for urine 33. According to the algorithm, an amino acid found in

certain vegetables was one of those most negatively associated with UPF intake. In contrast, one of those most positively associated with UPF intake was a compound formed when sugars react with proteins, and which has been associated with risk of diabetes and other cardiometabolic diseases.

To test whether the poly-metabolite scores could distinguish diets high in UPFs from diets low in UPFs, the team applied them to data from an earlier study of 20 people who participated in a live-in feeding trial at the NIH Clinical Center. Participants ate either an ultra-processed or a minimally processed diet for two weeks and then switched to the other diet for two weeks. Blood and urine metabolite levels were measured at the end of each two-week period. This allowed poly-metabolite scores to be calculated for each diet in each participant. The team found that the scores differed significantly between diets, even within the same participant.

The results suggest that poly-metabolite scores could provide objective measures of UPF intake. Such measures would reduce dependence on self-reported dietary data and its associated shortcomings.

“Limitations of self-reported diet are well known,” Loftfield explains. “Metabolomics provides an exciting opportunity to not only improve our methods for objectively measuring complex exposures like diet and intake of ultra-processed foods, but also to understand the mechanisms by which diet might be impacting health.”

The researchers note that they developed their scores using data from a narrow population. Data from broader populations will be needed to refine the scores and improve their applicability.

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