DIAGNOSTICS

The multiplexed immunoassay:

A new tool to improve surveillance of vitamin and mineral deficiencies

Challenges to surveillance

Vitamins and minerals, collectively known as micronutrients, are essential for healthy growth and development. Micronutrient deficiencies affect an estimated 2 billion people worldwide, the majority of whom live in low- and middle-income countries. Micronutrient deficiencies significantly contribute to morbidity, mortality, and a variety of disabling conditions, with the burden falling especially hard on young children and expectant mothers.

Accurate population surveillance of micronutrient status can provide a clear picture of the health of a country, region, or community. While targeted nutrition-based interventions are commonly used to address micronutrient deficiencies in a population (e.g., supplementation or fortification of common foods), there is a need to determine if these interventions have a marked impact on at-risk groups, such as young children and women of childbearing age.

However, it can be difficult and expensive to conduct the wide-scale population surveillance needed to guide these interventions. Existing tests for micronutrient deficiencies require collecting samples from an individual and testing each with several diagnostic tools—multiplied across a population. Often, in low-resource and remote settings, these samples also need to be kept under cold chain and shipped internationally for analyses, a costly prospect. These challenges mean nutrition programs have very limited data from which to make decisions on how to most effectively implement nutrition programs and track their impact.

A multiplexed solution

As a solution to improve population surveillance for micronutrient status, PATH and our partners identified a multiplexed assay approach that simultaneously measures multiple micronutrient biomarkers using a single sample and unified test method. A multiplexed panel for micronutrient measurements can be used to determine the prevalence of nutritional deficiencies and offer a more accurate method by which to measure and track the effects of targeted nutrition interventions.

Using an existing technology called Q-Plex™, developed by private-sector partner Quansys Biosciences, Inc. (Logan, UT, USA), PATH and the University of Washington have worked to identify, combine, and validate additional micronutrient biomarkers to improve upon the previously developed micronutrient panel for vitamin A and iron deficiency.[1]

In January 2017, the Q-Plex™ Human Micronutrient Array (7-plex) became commercially available. A single sample enables assessment of multiple micronutrient biomarkers in one test, permitting rapid throughput. This assessment tool quantifies iron, vitamin A, and iodine deficiency biomarkers in addition to biomarkers for inflammation and *Plasmodium falciparum* malaria, which can affect iron levels. Because it requires only a small sample volume (8 µL), the micronutrient array can use serum collected via finger-stick or dried blood spots (DBS), greatly simplifying sample collection, preparation, and shipping.

These improvements address key logistical challenges to large-scale population surveillance by minimizing the complexity and cost of specimen collection, sample preparation, and testing. Initial verification on a cohort of pregnant women in Niger indicated the new assay is comparable to existing panels of tests.[2]

As population surveillance becomes simpler and more cost-effective with new tools such as the micronutrient array, nutrition programs can make data-driven decisions for public health interventions, put limited resources to their most effective use, and build in-country testing capacity.

The Q-Plex™ Human Micronutrient Array (7-plex) is available from Quansys Biosciences at a uniform price of US$400 per test kit ($1.43 per analyte) to public health researchers working in low- and middle-income countries.

The Q-Plex™ Human Micronutrient Array (7-plex) enables simultaneous detection of several vitamin and mineral biomarkers, as well as biomarkers for inflammation and *P. falciparum* malaria. http://www.quansysbio.com/human-micronutrient/. Image: Quansys.

Current status

PATH is further evaluating the micronutrient array against traditional enzyme-linked immunosorbent assays and other analytic methods. PATH has ongoing collaborations with the University of California, Davis, and The Johns Hopkins University Bloomberg School of Public Health to validate the performance of the assays on key populations (e.g., young children) in high-risk settings. Independent evaluations of the micronutrient array are also being conducted by the United States Centers for Disease Control and Prevention, GroundWorks, and Eurofins Scientific.

The micronutrient array is currently being assessed in an inter-laboratory, multi-technician study to demonstrate uniformity of data regardless of location or user. Further, to address an important need of the micronutrient community, preliminary work has verified that DBS samples are highly compatible with wet plasma. The assay is now being validated for use with DBS and also evaluated with a new tool that creates dried plasma spots from a finger-stick sample. These simple and minimally invasive sampling methods permit sample processing in the field, limit biohazard, and enable shipping out of cold chain.

Development has also been completed on a prototype assay for vitamin D. PATH is expanding the Q-Plex™ array technology to include surveillance panels for environmental enteric dysfunction, asymptomatic pan malarial parasitemia, vaccine seroconversion, and disease-related test panels. These allow for combining programmatic micronutrient surveillance testing with other key population risk factors from the same single sample. The flexibility of this platform to collect various key population surveillance data from one sample will be of significant value to national programs and researchers.

To order the Q-Plex™ Human Micronutrient Array (7-plex), visit http://www.quansysbio.com/multiplex/multiplex-assays/human_micronutrient/ or contact Meghan Young (myoung@quansysbio.com).

To learn more about PATH's work with multiplexed diagnostic and assessment tools, please contact David Boyle at dxinfo@path.org.

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Further reading

1 Brindle E, Stevens D, Crudder C, et al. A multiplex immunoassay method for simultaneous quantification of iron, vitamin A and inflammation status markers. *PLOS ONE.* 2014;9(12):e115164. https://doi.org/10.1371/journal.pone.0115164.

2 Brindle E, Lillis L, Barney R, et al. Simultaneous assessment of iodine, iron, vitamin A, malarial antigenemia, and inflammation status biomarkers via a multiplex immunoassay method on a population of pregnant women from Niger. *PLOS ONE.* 2017;12(10):e0185868. https://doi.org/10.1371/journal.pone.0185868.

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PATH is a global organization that works to accelerate health equity by bringing together public institutions, businesses, social enterprises, and investors to solve the world's most pressing health challenges. With expertise in science, health, economics, technology, advocacy, and dozens of other specialties, PATH develops and scales solutions—including vaccines, drugs, devices, diagnostics, and innovative approaches to strengthening health systems worldwide.

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