Food-based proteins discovered as key to child malnutrition in developing countries

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Former Washington University medical student Lacey LaGrone -- now a resident physician -- measures a child's height in Malawi. A team of researchers led by the School of Medicine's Mark J. Manary, MD, has found that inadequate dietary intake of essential amino acids and the nutrient choline is linked to stunted growth and development, a debilitating condition that affects millions of children worldwide. Credit: Indi Trehan/Washington University

Contrary to popular belief among world relief workers, children in developing countries may not be eating enough protein, which could contribute to stunted growth, a Johns Hopkins-directed study suggests.

Analyzing blood samples from more than 300 African children—more than 60 percent of whom had stunted growth—researchers found that children who were stunted had 15 to 20 percent lower levels of essential amino acids, the building blocks of proteins, than children who were growing normally. They also had lower levels of other protein markers. These results were published in the Feb. 19 edition of the journal *EBioMedicine*.

"This challenges the widespread assumption that children are getting enough protein in developing countries," says lead study author Richard Semba, M.D., M.P.H., the W. Richard Green Professor of Ophthalmology at the Johns Hopkins Wilmer Eye Institute. "This could cause a huge shift in the aid community. We have to really think about trying to improve the diet. Children are not getting quality food."

Essential amino acids are considered essential because they cannot be synthesized by the body and must be obtained from diet, Semba says. The best food sources of essential amino acids are animal-derived foods, such as milk, eggs and meat; soybeans also are a good source. Insufficient intake of essential amino acids can not only impact growth but could also adversely affect multiple metabolic pathways in the body since they play diverse roles in human health.

"We are delighted that the resources and expertise at the National Institute on Aging could help facilitate this important work," says Luigi Ferrucci, scientific director of the National Institute on Aging.

In the 1950s and 1960s, Semba says, international organizations were focused on protein malnutrition in children in developing countries. But

in the 1970s, the emphasis shifted to micronutrient dietary supplements because the assumption was that most children received adequate protein. This study suggests that micronutrient supplements sprinkled on a typical diet of grain-based porridge are insufficient, he says. About 160 million children under age 5 suffer from chronic malnutrition worldwide, according to his study; nearly all children who are stunted live in poor areas of Africa, Asia and Latin America.

Semba and colleagues used an analytical chemistry technique called liquid chromatography-tandem mass spectrometry to measure blood levels of amino acids, as well as other essential compounds called glycerophospholipids, sphingolipids and other metabolites in blood samples from 313 children ages 1 to 5 from six villages in rural southern Malawi. Participants' height and weight were recorded by trained field workers.

Sixty-two percent of study participants were stunted. Children who were stunted had lower concentrations of all nine essential amino acids, including tryptophan (27 percent lower), isoleucine (15 percent lower), leucine (17 percent lower), valine (15 percent lower), methionine (13 percent lower), threonine (21 percent lower), histidine (15 percent lower), phenylalanine (6 percent lower) and lysine (22 percent lower), compared with nonstunted children. In addition, stunted children had 10 to 40 percent lower concentrations of other nutritional markers, such as conditionally essential amino acids (arginine, glycine, glutamine), nonessential amino acids (asparagine, glutamate, serine) and six different sphingolipids. Sphingolipids are fundamental components for development of the brain. In addition, stunting was associated with alterations in concentrations of glycerophospholipids, which are needed to make the membranes of all cells.

Semba, who also holds an appointment in the Johns Hopkins Bloomberg School of Public Health's departments of Molecular Microbiology and

Immunology and of International Health, says the findings cannot necessarily be extrapolated to other children at risk of stunting, since there may be dietary, cultural and environmental factors that differ from the setting in rural Malawi. Semba and colleagues have plans for additional study in this population, including looking at younger children and following children over time.

Semba and his colleagues hope that this research will prompt a broader discussion on how to address child malnutrition.

"Providing high-quality protein with sufficient levels of essential amino acids in developing countries will be a major challenge and will require substantial investment in the agricultural sector," says Semba.

"No child should be stunted by the age of 2. The brain damage is nearly irreversible, and the child faces a lifetime of disadvantage," says Martin Bloem, senior nutrition advisor at the United Nations World Food Programme. "To provide high-quality food to fix this problem, it will cost $125 to $150 per child."

More information: Richard D. Semba et al, Child Stunting Is Associated with Low Circulating Essential Amino Acids, *EBioMedicine* (2016). DOI: 10.1016/j.ebiom.2016.02.030

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