What Pediatricians Can Do to Address Malnutrition Globally and at Home

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Malnutrition is directly or indirectly responsible for approximately one-half of all childhood deaths globally.[1] Malnutrition is also a major cause of morbidity; in fact, iron-deficiency anemia was the leading cause of years lived with disability among children and adolescents in 2013.[2] Malnutrition has 3 principal constituents: protein-energy malnutrition (PEM), micronutrient deficiencies, and overweight/obesity. As we transition from the Millennium Development Goals to the Sustainable Development Goals, tackling malnutrition holds even more importance. Good nutrition is an essential driver of sustainable development because it plays a critical role in child brain development, generates broad-based economic growth, and signals the fulfillment of people's rights to food and good health.

Malnutrition, however, remains widespread globally, and its recognition and prioritization are often neglected by clinicians, practitioners, and policy makers. Of the $10.3 billion budgeted in 2017 for funding US global health programs, the majority is focused on diseases such as HIV, malaria, and tuberculosis, and only $109 million or 1% is directly allocated for nutrition.[3] Because the etiologies of malnutrition are multifactorial and interrelated (Fig 1), no single magic bullet exists to eradicate it.

With the increasing emphasis on early life experiences that take place during the first "1000 days" from conception to 2 years, pediatricians have a unique and important role in addressing childhood malnutrition. The goal of the present article was to describe the role of pediatricians in identifying, treating, and preventing malnutrition and advocating for increased attention to this important public health issue.

HOW IS MALNUTRITION ASSESSED?

Nutritional status can be measured at the individual or population level. Reliable assessment tools of malnutrition are essential to reflect individual status, measure biological function, and predict health outcomes in both clinical and programmatic settings.

In children, PEM or poor growth is defined according to anthropometric measurements that fall below 2 SDs of the normal sex-specific weight-for-age (underweight), height-for-age (stunting), and weight-for-height (wasting). In children aged ≥2 years, BMI-for-age can be used to classify children as overweight or obese. Severe PEM, categorized as marasmus (severe wasting) and kwashiorkor (malnutrition with edema), may have distinctive clinical manifestations such as extended abdomen, rectal prolapse, and

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hair and skin color changes. Mid-upper arm circumference is often used in community settings to identify children with severe acute malnutrition who are in need of treatment. However, physical examination and laboratory features of PEM are generally not reliable. Instead, accurate anthropometric measurements by trained personnel should be emphasized for the identification of malnutrition. Anthropometric data can be plotted and analyzed by using software available from the World Health Organization (WHO; www.who.int/childgrowth/software) or the Centers for Disease Control and Prevention (CDC; www.cdc.gov/epiinfo). In the past, a US growth reference from the CDC/National Center for Health Statistics was used, but now the WHO Growth Standards, based on growth patterns of breastfed children living in favorable conditions in 6 countries, are most often used. "Abnormal growth" is statistically defined by using percentiles or *z* scores (SDs from the reference median) with a *z* score less than –2 to identify children with malnutrition and less than –3 to identify severe PEM.

The choice of the anthropometric indicator depends on the purpose of the assessment. For example, wasting indicates recent loss of weight, usually as a consequence of famine or severe disease, and has the greatest potential for causing mortality. In contrast, stunting or chronic malnutrition reflects a failure to reach one's linear growth potential due to inadequate dietary intake, recurrent illness, or contaminated environments. Despite reductions in undernutrition globally, 165 million children (or 1 in 4) are stunted, increasing the risk for poor development, reduced educational attainment and adult economic productivity, and noncommunicable diseases.[1,6] Overweight and obesity are increasing substantially and affect ~1 in 5 children in all world regions, not just high-income countries.[7] An obesogenic environment characterized by unhealthy diet and low physical activity, as well as biological factors (including undernutrition in early childhood), are largely responsible for the increased risk of obesity in children.[8]

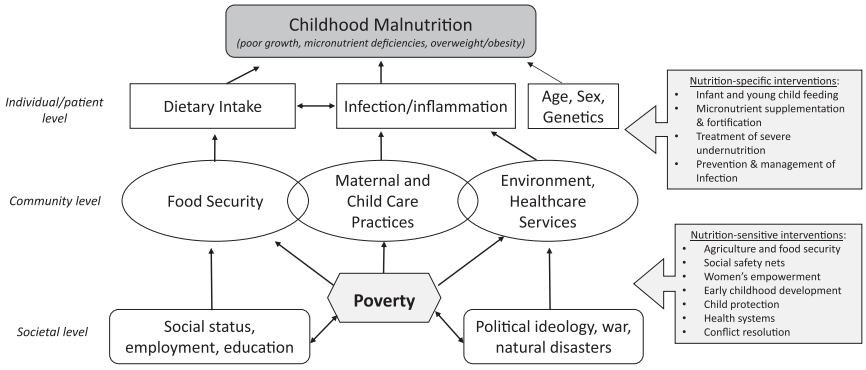

FIGURE 1
Major causes of childhood malnutrition and how pediatricians can act. (Adapted from the UNICEF framework and the *Lancet* Series on Maternal and Child Nutrition.[4,5])

Assessment of micronutrient deficiencies is more challenging than identification of PEM because the clinical signs are late to manifest. Vitamin and mineral deficiencies or "hidden hunger" affect 2 billion people, mainly women and young children.[9] The most widespread and recognized micronutrient deficiencies are of iron, zinc, vitamin A, iodine, vitamin D, and folate, often occurring concurrently in the sample population. Although the burden of micronutrient deficiencies is highest in resource-limited settings, populations in resource-rich settings can also be affected. For example, 14% of toddlers in the United States are iron deficient, with Hispanic children and those who are obese at highest risk; furthermore, iron deficiency is responsible for nearly 50% of childhood anemia.[10] Although the American Academy of Pediatrics (AAP) and the CDC recommend universal screening for iron deficiency in US children, recent US Preventive Services Task Force recommendations suggest otherwise.[11]

Given the high cost and challenge of collecting biomarkers, especially in resource-limited settings, there is an urgent need to develop cost-effective nutrient biomarkers. Multiple organizations have compiled tables of reference values for nutrient biomarkers according to age. Physiologic factors, such as fasting, inflammation, and renal function, are associated with many nutrient biomarkers and need to be taken into account in interpreting data. For example, inflammation (from infection, injury, stress, or environmental insults) can directly affect concentrations of nutrients because some nutrition biomarkers are themselves acute-phase proteins (eg, serum ferritin, retinol). The confounding effects of inflammation can result in incorrect diagnosis of malnutrition in individuals, as well as overestimation or underestimation of the prevalence of deficiency in a population. Accounting for the role of inflammation on micronutrient biomarkers has been identified as a critical research gap by the National Institutes of Health, the CDC, and other agencies.[12,13]

EVIDENCE-BASED INTERVENTIONS FOR MALNUTRITION EXIST

Evidence-based interventions for malnutrition have been well studied and can be categorized as nutrition-specific (address immediate causes,

often at the individual level) or nutrition-sensitive (address underlying causes, often at the community or societal level) (Fig 1). Ample effective nutrition-specific interventions exist and should be familiar to clinicians, including management of severe PEM by using the WHO 10-step approach and ready-to-use therapeutic foods[14]; promotion of breastfeeding and complementary feeding practices; and micronutrient supplementation and food fortification. The impact of such interventions is massive. Maternal multiple micronutrient supplementation delivered as part of antenatal care packages could save 102 000 lives per year; another 145 000 lives could be saved through vitamin A and zinc supplementation for children.[9] Despite ample evidence supporting nutrition-specific interventions, they are often not implemented. For example, adherence to the AAP recommendations for vitamin D supplementation for US infants may be as low as 10%.[15]

Nutrition-sensitive interventions, such as conditional cash transfers, promoting the education of girls and the social status of women, tobacco control measures, and improving the health care system and environment, require a multisectoral approach. Involvement of agriculture, education, social welfare, and public health are essential to address the underlying determinants of childhood nutrition.

OPPORTUNITIES FOR ADVOCACY AND ACTION

Pediatricians can play an important role for advocating for proper identification of childhood malnutrition and effective implementation and delivery of nutrition interventions. Nutrition interventions are not only efficacious but extremely cost-effective. For example, every dollar invested in nutrition generates as much as $48 in better health and increased productivity.[16] Part of the challenge has been recognizing malnutrition (eg, poor growth and micronutrient deficiencies), especially in the context of routine care of children in the United States. Recent efforts by the American Society for Parenteral and Enteral Nutrition to define pediatric malnutrition are helpful,[17] but more advocacy is needed to raise awareness that nutritional status in children is an essential "vital sign." Efforts to introduce new technologies to more efficiently measure malnutrition, such as digital body scans and noninvasive micronutrient testing systems, have incredible promise. Pediatricians should adhere to current recommendations for nutrition-specific interventions and should ensure that children at high risk are reached. Efforts to integrate nutrition with other health sectors and efforts to promote nutrition-sensitive interventions and social determinants of health, including the AAP's policy to reduce and ultimately eliminate child poverty,[18] will ultimately have the greatest impact. Increased commitment to nutrition by pediatricians will enable us to achieve our shared mission of ensuring optimal physical, mental, and social health and well-being for all children everywhere.

ABBREVIATIONS

AAP: American Academy of Pediatrics
CDC: Centers for Disease Control and Prevention
PEM: protein-energy malnutrition
WHO: World Health Organization

REFERENCES

1. Black RE, Victora CG, Walker SP, et al; Maternal and Child Nutrition Study Group. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382(9890):427–451
2. Kyu HH, Pinho C, Wagner JA, et al; Global Burden of Disease Pediatrics Collaboration. Global and national burden of diseases and injuries among children and adolescents between 1990 and 2013: findings from the Global Burden of Disease 2013 Study. *JAMA Pediatr*. 2016;170(3):267–287
3. Valentine A, Wexler A, Kates J; Kaiser Family Foundation. The US Global Health Budget: Analysis of the Fiscal Year 2017 Budget Request. Available at: http://kff.org/global-health-policy/issue-brief/the-u-s-global-health-budgetanalysis-of-the-fiscal-year-2017-budget-request/
4. UNICEF. *The State of the World's Children*. New York, NY: UNICEF; 1998
5. Bhutta ZA, Das JK, Rizvi A, et al; Lancet Nutrition Interventions Review Group; Maternal and Child Nutrition Study Group. Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet*. 2013;382(9890):452–477
6. Adair LS, Fall CH, Osmond C, et al; COHORTS group. Associations of linear growth and relative weight gain during early life with adult health and human capital in countries of low and middle income: findings from five birth cohort studies. *Lancet*. 2013;382(9891):525–534
7. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2014;384(9945):766–781
8. World Health Organization. *Report of the Commission on Ending Childhood Obesity*. Geneva, Switzerland: World Health Organization; 2016
9. Muthayya S, Rah JH, Sugimoto JD, Roos FF, Kraemer K, Black RE. The global hidden hunger indices and maps: an advocacy tool for action. *PLoS One*. 2013;8(6):e67860
10. Brotanek JM, Gosz J, Weitzman M, Flores G. Iron deficiency in early childhood in the United States: risk

factors and racial/ethnic disparities. *Pediatrics*. 2007;120(3):568–575

11. Siu AL; US Preventive Services Task Force. Screening for iron deficiency anemia in young children: USPSTF recommendation statement. *Pediatrics*. 2015;136(4):746–752
12. Raiten DJ, Sakr Ashour FA, Ross AC, et al; INSPIRE Consultative Group. Inflammation and Nutritional Science for Programs/Policies and Interpretation of Research Evidence (INSPIRE). *J Nutr*. 2015;145(5):1039S–1108S
13. Suchdev PS, Namaste SM, Aaron GJ, Raiten DJ, Brown KH, Flores-Ayala R; BRINDA Working Group. Overview of the biomarkers reflecting inflammation and nutritional determinants of anemia (BRINDA) Project. *Adv Nutr*. 2016;7(2):349–356
14. World Health Organization Guideline. *Updates on the Management of Severe Acute Malnutrition in Infants and Children*. Geneva, Switzerland: World Health Organization; 2013
15. Perrine CG, Sharma AJ, Jefferds ME, Serdula MK, Scanlon KS. Adherence to vitamin D recommendations among US infants. *Pediatrics*. 2010;125(4):627–632
16. Hoddinott J, Alderman H, Behrman JR, Haddad L, Horton S. The economic rationale for investing in stunting reduction. *Matern Child Nutr*. 2013;9(suppl 2):69–82
17. Mehta NM, Corkins MR, Lyman B, et al; American Society for Parenteral and Enteral Nutrition Board of Directors. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *JPEN J Parenter Enteral Nutr*. 2013;37(4):460–481
18. Council on Community Pediatrics. Poverty and child health in the United States. *Pediatrics*. 2016;137(4):e20160339

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