Nutrition and hearing loss: a neglected cause and global health burden

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Hearing loss is a neglected public health problem that affects an estimated 360 (1) to 554 (2) million adults and children in the world. Although the difference in magnitude depends in part on the hearing threshold adopted, available estimates ignore milder, yet consequential, hearing loss. The estimates, however, reveal a disability that appears early in life, increases several-fold over the life span, and affects all societies. The prevalence of hearing loss is disproportionately high in low-resource settings, especially in South Asia and sub-Saharan Africa (2), the reasons for which remain uncertain.

Hearing loss has profound health, social, and economic consequences (3). Affected children are likely to experience speech, language, and cognitive delays and poor school performance (4), whereas adults face higher risks of unemployment or low earnings (3), cognitive decline, and dementia (5). Social isolation accompanies daily life of the hearing impaired (6). Major causes of this burden vary across the life stages and include congenital disorders; otitis media; vaccine-preventable infections such as measles, mumps, and rubella; noise exposure; ototoxic drugs; and age (1). Surprisingly, only severe prenatal iodine deficiency (7) is listed by the WHO as a nutritional cause of hearing loss (1), leaving the broad roles of diet and nutrition within its complex set of etiologies yet to be defined.

In high-income countries, large-population studies in adults have reported protective risk ratios against hearing loss with higher dietary intakes of fish, long-chain PUFAs, folate, and vitamins A, E, and C (8). Although findings across studies are inconsistent, animal evidence exists to support roles for each of these studied nutrients in regulating redox stress, protecting cochlear function, and enabling hearing. Interestingly, dietary exposure to potentially ototoxic heavy metals (e.g., cadmium, lead), a high BMI and waist circumference (i.e., obesity), and reduced physical activity have also been linked to hearing loss (8), which implies that systemic stress from a chronically unhealthy diet, lifestyle, and environment may carry consequences for ear health and hearing.

In low-income countries, where undernutrition remains widespread, limited research has identified micronutrient deficiencies (e.g., of vitamin A and zinc) as risk factors for otitis media (9), which reveals a formidable research gap to define roles for malnutrition in the etiology of this global disability.

In this issue of the Journal, studies by Curhan et al. (13) and Choudhury et al. (14) reinforce the likely importance of micronutrient imbalance or deficiency as determinants of hearing loss for 2 very different life stages, populations, environments, and causal pathways: the Nurses’ Health Study cohort in the United States (13) and a study in infants born at ≥4 wk of gestation in New Delhi, India (14). Curhan et al. prospectively assessed diets of 65,521 nurses by a validated food-frequency questionnaire every 4 y from 1991 to 2009, at the end of which the occurrence and year of onset of a hearing problem, inferred as hearing loss, was obtained by self-report. Although no effect of vitamin A was observed, perhaps reflecting its homeostatic control in a well-nourished population, the authors reported higher intakes of β-carotene, β-cryptoxanthin, and folate to be protective against incident hearing loss. Oxidative stress and impaired homocysteine metabolism appear to contribute to inner-ear dysfunction, effects that adequate carotenoid and folate nutriture may attenuate by postulated scavenging of free radicals (13) and maintenance of antioxidant enzyme homeostasis (15), respectively, although other mechanisms likely exist. Paradoxically, the risk of hearing loss was increased in subjects who reported an increased intake of vitamin C, also an established antioxidant, at amounts that exceeded the Recommended Dietary Allowance (i.e., >75-90 mg/d) but that fell well below the Tolerable Upper Intake Level (<2000 mg/d) of the Dietary Reference Intakes, suggesting that poorly understood, organ-specific nutrient interactions may exist.

A limitation of the Nurses’ Health Study was its reliance on self-report of incident hearing loss, because audiometric testing is necessary to quantify severity and extent of hearing loss and to differentiate sensorineural, or inner-ear, from conductive or middle-ear pathologies. Conventional audiometry has required permanent equipment in a sound-proof room. In the United States, NHANES overcame this limitation by using audiometric booths fit onto
mobile units. However, accurate, reliable, and far less costly portable devices will soon enable quantitative audiometry in field settings to facilitate population-based hearing assessment.

The nutritional origins of hearing loss likely differ substantially in chronically undernourished settings where etiologies of premature dysfunction may start in utero. In India, Choudhury et al. (14) screened newborn hearing via the auditory brainstem response, a well-accepted measure of auditory maturation. Delayed interpeak latencies and wave V latency, as observed in newborns with latent iron deficiency (i.e., cord plasma serum ferritin \( \leq 75\) ng/mL), is highly suggestive of abnormal myelination of the auditory pathway. Multiple facets of intracellular iron metabolism support oligodendrocyte signaling pathways, proliferation, energetics, and formation of myelin, which are critical for auditory neurotransmission (16). In one small study, disturbed myelination in infancy, approximated by auditory brainstem response, was associated with auditory abnormalities later in childhood (17). As the roles and timing of iron in myelin growth and maturation become better understood, it will be essential to explore the efficacy of iron supplementation to iron-deficient mothers during gestation or their infants in normalizing auditory function.

Although these 2 provocative studies raise many questions, they add to a developing story that adequate and balanced nutrition during pregnancy, infancy, and adulthood may reduce hearing loss globally and across the life span. Needed, and on the horizon, is an accurate, faster, and less costly field methods for measuring diet, status for some micronutrients, and hearing to expand investigations of the roles of nutrition on hearing loss. Both under- and overnutrition are likely to be essential aspects of this story. As the UN General Assembly in September 2015 calls for disability-inclusive sustainable development goals, it is time for hearing loss to exit the ranks of neglected public health problems and move toward centrality in the global nutrition community.

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REFERENCES


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