Vitamin and Mineral Inadequacy Accelerates Aging-associated Disease

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Most of the world's population, even in developed countries, has inadequate intake of one or more of the ~30 essential vitamins and minerals (V/M), mostly used as cofactors by the proteins/enzymes of metabolism. A varied and balanced diet should provide enough V/M; an unbalanced diet with too much refined food provides calories, but not enough V/M. *Triage theory* (1,2) posits that, as a result of recurrent shortages of V/M during evolution, natural selection developed a strategic rationing response to moderate shortages so that the scarce V/M is preferentially retained by V/M-dependent proteins that are essential for short-term survival and reproduction. In contrast, proteins needed for long-term health, which I term "longevity proteins" because they defend against the diseases associated with aging, are starved for the V/M and thus are disabled. Moreover, since the damage from moderate deficiency is insidious, its importance for long-term health is not clinically apparent. Strong support for triage theory comes from our analyses of published data on proteins dependent on vitamin K (3) and on selenium (4). Both of these V/M have built into metabolism a triage-like trade-off between short-term survival and long-term health; each uses a different mechanism to accomplish this end. Mechanistic, genetic, and epidemiological evidence suggests that this metabolic trade-off accelerates aging-associated diseases, such as cancer, cardiovascular disease, immune dysfunction, and cognitive decline.

Importantly, by the official U.S. Institute of Medicine measure of inadequacy, the Estimated Average Requirement (EAR), most of the U.S. population is below the EAR for one or more V/M (5). The RDA is set at 2SD above the EAR. The percentages of the U.S. population that are currently below the EAR (including fortifications and supplements) are (5): vitamin D 70%, vitamin E 60%, magnesium 45%, calcium 38%, vitamin K 35%, vitamin A 34%, vitamin C 25%, zinc 8%, vitamin B6 8%, folic acid 8%, etc. These low intakes are especially true for children, adolescents, elders, and the obese. The U.S. population also has a very low intake of DHA/EPA omega-3 intake. These official estimates of population inadequacy are likely to be underestimates, as EARs do not take long-term triage effects into account, which is likely to lead to increased EAR estimates. An assay for a longevity protein concentration/activity in a finger prick of blood may be useful for early detection of a functional effect of a low intake of each V/M, and could be used for prevention. About half of the proteins we have studied are longevity proteins. This implies an undiscovered class of longevity V/Ms may exist, which we are exploring and discovering (6).

Most of the obese eat very poor diets, as judged by the calorie to V/M ratio (7-11). They are starving for V/M, which may overrule satiety signals or activate triage mechanisms. (10-13). The frequency of every age-associated disease that has been examined is increased in the obese. Our Choribar (V/M-dense, low-calorie, high-fiber, fruit-based) markedly improves metabolism in those with less than optimal diets (most subjects) in many human trials (14, 15).

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