Zinc Requirements: Assessment and Population Needs

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Many factors affect zinc requirements of individuals, both physiological and pathophysiological, all of which require further research. For example, there is evidence, still requiring adequate confirmation, that there is upregulation of zinc absorption during pregnancy and downregulation of intestinal excretion of endogenous zinc in lactation. Inflammation, diarrhea, and nematode infestation are all important examples of pathological circumstances in which quantitative effects on zinc homeostasis and requirements are needed. However, the essential cornerstone is reliable assessment of population requirements in healthy children and women neither pregnant nor lactating.

Despite optimism for many years, new approaches for determining/validating zinc requirements have yet to be established. However, there have been refinements in the factorial approach which will be considered today. The factorial approach depends on estimation of physiological requirements, followed by determining the quantity of ingested zinc required to achieve the quantity of absorbed zinc level of absorption necessary to balance physiological requirements. The latter, in turn, depends on bioavailability, which is determined largely by dietary phytate. Of three widely recognized estimates of dietary zinc requirements, two, for very different reasons, have underestimated physiological zinc requirements to what are potentially dangerously low levels. One resulted from estimates prior to the recognition of the necessity of taking account of the positive correlation between the quantity of intestinal excretion of endogenous zinc and the quantity zinc absorbed each day [1]; the other has resulted primarily from errors in the estimation of this relationship [2]. As the latter is currently widely accepted internationally, it has been necessary to review the explanation for the extraordinary differences between these estimates and those of the Institute of Medicine (IOM) reported 3 years earlier [3]. Minor errors were also identified in the IOM estimates together with reason for concern about the low levels set for upper limits in young children.
A key recent advance in the estimation of the average zinc requirements of populations has been the belated recognition of the importance of saturation response modeling based on the knowledge that absorption of zinc by the enterocyte is a saturable process [4]. Up- or downregulation of zinc proteins involved in the process of zinc absorption appears to be directed towards assisting in the optimization of this kinetic model. As an aside, the evolutionary effort that appears to have been devoted to minimizing excess absorption suggests that excess of this nutrient may not be as safe as often assumed. This basic saturation response modeling has also contributed to the quite recent development of a well-tested model to predict the quantitative inhibitory effect of phytate on zinc absorption over a wide range of dietary zinc [5]. This development is of special importance in assessing the zinc needs of low-resource populations and others dependent on plant-based diets.

The estimation of zinc requirements in children older than 6 months is far from perfect, being based largely on extrapolation from adult data. An allowance to meet the needs of mean growth rates is added. As for adults, there are adequate infant data and limited data on preschool children to confirm that saturation response modeling provides a better fit than any other regression analysis (and provides additional data of biological relevance). The models, of course have a lower absorption curve, corresponding closely to corresponding differences in zinc requirements. Perhaps surprisingly, the modeling for infants, even premature infants, fits the adult modeling if adjusted for differences in length of the small intestine [6]. Lacking at this time are quantitative data on the effect of phytate on zinc absorption in young children, data which are now slowly being obtained. Once available, zinc requirements for young children relying on high-phytate plant diets will be able to be predicted with the same level of confidence that we now have for adults. Coupled with reliable dietary survey data for the population, this will allow more reliable estimates of zinc requirements of targeted populations. With the evidence now documented for the global public health importance of zinc deficiency, at least in young children, this has to be a priority research goal.

References

