National risk of zinc deficiency as estimated by national surveys

Hess SY, Food and Nutrition Bulletin 2017: 38, 3-17.

Available at: http://journals.sagepub.com/doi/pdf/10.1177/0379572116689000

Introduction

In recent years, recognition of the importance of zinc deficiency worldwide has expanded dramatically. Zinc deficiency impairs immune function and increases the susceptibility to infection, restricts physical growth and affects pregnancy outcome. The number of child deaths attributable to zinc deficiency in 2011 was estimated at 116,000 (1).

To assess zinc status of a population, the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the International Atomic Energy Agency (IAEA) and the International Zinc Nutrition Consultative Group (IZiNCG) recommend measuring plasma or serum zinc concentration or dietary zinc intake by 24 hour recalls or weighed food records (2). In addition, the stunting prevalence of children under 5 years of age can be used as a proxy to estimate the risk of zinc deficiency. Another proxy used to estimate the risk of zinc deficiency is the use of inadequate zinc intake based on the estimated absorbable zinc content of the national food supplies derived from the Food and Agriculture Organization of the United Nations' (FAO) food balance sheets (FBS). These analyses suggest that at least 17% of the world's population is at risk of inadequate zinc intake (3), with the highest risk occurring in Sub-Saharan Africa and South Asia.

Although plasma zinc concentration is under strong homeostatic control, which makes assessing individual zinc status very challenging, several expert committees have recently also endorsed using plasma or serum zinc concentration as an appropriate biomarker of population zinc status (4, 5). In recent years, more nationally representative surveys have included the assessment of plasma or serum zinc concentration. The current issue of NNA summarizes a review paper published in *Food and Nutrition Bulletin* which summarized information on the prevalence of zinc deficiency from national surveys (6).

Methods

To obtain information on national surveys with available zinc results, internet searches (PubMed, Google) were completed and experts known to be involved in conducting national nutrition surveys were contacted. Surveys were eligible for inclusion in the present review if a nationally representative sampling scheme was used, plasma or serum zinc concentrations were analyzed, and the survey was implemented in low or middle income country.

A total of 20 surveys were eligible. These reports included 5 surveys from Africa (7-12), 4 surveys from the Americas (13-18), 3 surveys from the Eastern Mediterranean and

European regions (19-22), 3 surveys from South-East Asia (23-25) and 5 surveys from the Western Pacific region (26-30). Of these surveys, 17 collected venous blood from preschool children, one obtained specimens from 1-11 year olds (Mexico) and one from 6-12 year olds (the Philippines). Thirteen surveys also collected blood samples from adult women. In addition, Fiji collected blood only from women. Various recommended analytical methods were used to assess plasma or serum zinc concentrations in these surveys (6) and most surveys used the cut-offs recommended by IZiNCG to determine zinc deficiency (31), except for Afghanistan, Pakistan and the Republic of Maldives (<60 µg/dL), Guatemala and China (<70 µg/dL) and Nigeria (<80 µg/dL), respectively. Another methodological difference between the surveys was that some, but not all, adjusted plasma zinc concentration for the presence of inflammation using C-reactive protein and/or alpha-1-acid glycoprotein.

The present review also compared the prevalence of low plasma zinc concentration from the above-mentioned surveys with the estimated proportion of population with inadequate dietary zinc intake, which was retrieved from the online supplementary table provided by Wessells & Brown (3), and with the national stunting prevalence retrieved from the UNICEF State of the World's Children report or the WHO's global database on child growth and malnutrition (32, 33). A prevalence of >20% low plasma zinc concentrations, >20% stunting and >25% inadequate dietary zinc intake implies that zinc deficiency may be a public health concern (2).

Results and Conclusions

Thirteen of the 19 surveys found a prevalence of low plasma zinc concentrations in children >20%, which implies that zinc deficiency is a public health problem in these countries. Among the African countries, Cameroon found the highest rates of zinc deficiency with 83% of children and 82% of women of reproductive age having low plasma zinc concentrations. Half of the children (51%) and women (52%) in Kenya had low plasma zinc concentrations. Similar results were found in Senegal with 50% of children and 59% of women having low plasma zinc concentrations. Only Afghanistan, Azerbaijan, Nigeria, the Republic of Maldives, Sri Lanka and China found a low prevalence of inadequate plasma zinc concentrations among children, which in some cases may be due to the different cut-off used. Of the studies with information from women of reproductive age, 13 of 14 surveys found a prevalence of low plasma zinc concentration in women >20%.

Estimates of percent population with inadequate dietary zinc intake based on FBS underestimated the risk of zinc deficiency as defined by plasma zinc concentration. Only five of the above mentioned countries were identified with a prevalence of inadequate dietary zinc intake >25%. In contrast, the prevalence of stunting among children under 5 years of age may be a useful proxy to identify countries with potential risk of zinc deficiency. With some exceptions, the prevalence of both low plasma zinc concentrations and stunting categorized countries similarly into high and low risk of zinc deficiency.

Policy Implications

In the past 20 years, 20 low and middle income countries have included the assessment of plasma zinc concentration in their national nutrition surveys. In the majority of these countries, zinc deficiency was found to be of public health concern among women of reproductive age and young children, and in these settings interventions are recommended to prevent zinc deficiency (34). The stunting prevalence and to a lesser extent the estimated proportion of population with inadequate dietary zinc intakes can be useful proxies to identify countries at potential risk of zinc deficiency. If such a risk is identified, the extent of the zinc deficiency should be further evaluated by assessing plasma zinc concentration in a representative sample of the population.

NNA Editor's Comments

The inclusion of plasma or serum zinc concentration in numerous national nutrition surveys in low and middle income countries indicates that blood collection and processing is feasible, even in challenging field settings. Because contamination with zinc is a concern, implementers of future surveys may find the practical tips by IZiNCG on blood collection and processing techniques useful (35). To date, most survey reports only state the percent of the population with zinc deficiency. It would also be useful to report the mean plasma zinc concentration along with the standard deviation, standard error or 95% confidence interval or the full distribution of the concentration. This would allow readers to gain a better understanding of the distribution of zinc deficiency.

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