Preface

In recent years, a considerable number of well-designed intervention trials have been completed in many parts of the world—including both lower-income and industrialized countries—to assess the impact of zinc supplementation in populations thought to have an elevated risk of zinc deficiency. These studies have confirmed the critical importance of adequate zinc nutriture to support child growth, reduce the risk of common infections, prevent adverse outcomes of pregnancy, and improve other aspects of human health and function. Because of the likely widespread occurrence of zinc deficiency, especially in low-income groups, and the important health consequences of this condition, efforts are needed to define more precisely the risk of zinc deficiency in vulnerable populations and to develop programs to control this condition where necessary.

The present document was prepared by the Steering Committee (SC) of the newly established International Zinc Nutrition Consultative Group (IZiNCG) and several other experts in zinc nutrition invited by IZiNCG to assist in its preparation. The SC was appointed by the United Nations University's Food and Nutrition Program for Human and Social Development (UNU/FNP) and the International Union of Nutritional Sciences (IUNS). The document was reviewed by 10 independent experts selected by the UNU/FNP and the IUNS. The IZiNCG's response to the reviews was assessed by two additional reviewers appointed by the UNU/FNP and IUNS. Therefore, the present publication reflects the input from experts both within and outside the IZiNCG SC.

This document's primary objective is to provide a summary of current knowledge on zinc as it pertains to public health issues, primarily in low-income countries. It presents a comprehensive background review of information on zinc metabolism, zinc requirements, risk factors for zinc deficiency, methods of assessing population zinc status, and available options for developing intervention programs to control zinc deficiency. The document is not intended to replace current reference values set by other international or national agencies with normative and/or policy roles, but to assess the scientific support of current reference values and to make recommendations for their reevaluation as appropriate. The implication of these considerations to available options for developing intervention programs to control zinc deficiency is also a key focus of this report.

Because this information has not been summarized previously in a single text, we have intentionally presented the material in some detail. An abbreviated companion document will be made available subsequently to facilitate access to the key points that need to be considered prior to designing programmatic interventions. The present document should be useful to nutrition researchers concerned with health-related aspects of zinc nutrition and to other health professionals who are planning nutrition and/or health surveys and public health intervention programs.

Introduction

During the first half of the 20th century, researchers discovered that zinc is essential for the normal growth and survival of higher plants, poultry, rodents, and swine [1]. Despite these observations, many nutritionists doubted that zinc deficiency occurred in humans because of the element's ubiquitous distribution in the environment and the lack of obvious clinical signs of deficiency in presumably high-risk human populations. Nevertheless, evidence of human zinc deficiency began to emerge during the 1960s, when cases of zinc-responsive dwarfism and delayed sexual maturation were first reported among Egyptian adolescents [1]. Since then, clinical studies of children with acrodermatitis enteropathica—an inborn error of zinc metabolism that results in poor zinc absorption and, consequently, in severe, secondary zinc deficiency—have ascertained the critical role of zinc in physical growth of humans and normal functioning of the gastrointestinal tract and immune system [2].

Since these early observations in people with

acrodermatitis enteropathica, a number of well-designed intervention trials have been completed in a broad range of populations throughout the world. Results of these trials have confirmed that zinc supplementation increases growth among stunted children [3] and reduces the prevalence of common childhood infections, such as diarrhea and pneumonia, in populations at risk [4]. Moreover, data from a recent study in northern India indicated that daily zinc supplementation among full-term, small-for-gestational-age infants significantly reduced mortality by 68% [5]. Data are also accumulating to suggest that zinc deficiency may be related to adverse outcomes of pregnancy [6] and compromised neurobehavioral function in children [7]. These findings argue strongly for the need to define further the extent of human zinc deficiency worldwide and to initiate public health intervention programs to control this problem in at-risk populations.

Regrettably, there are no simple, quantitative, biochemical or functional markers of zinc status currently available that are sufficiently sensitive to identify mild to moderate zinc deficiency in individuals. The absence of such sensitive biomarkers of individual zinc status has, to some extent, undermined efforts to quantify the global prevalence of zinc deficiency, and the resulting lack of information has hampered the development of relevant intervention programs. Nevertheless, experts in zinc nutrition have presented several cogent arguments to suggest that zinc deficiency may, in fact, be very common in many lower-income countries [8–10]. For example, foods that are particularly rich sources of absorbable zinc are inaccessible to many of the world's poorer populations. Animal products, such as shellfish and red meat, which contain substantial amounts of zinc in readily absorbable form, are not consumed extensively due to their high cost, limited supply, and, in some cases, religious or cultural practices. Whole-grain cereals and legumes, which are more widely available than animal-source foods, also contain reasonably high amounts of zinc, but the zinc contained in these grains is absorbed less efficiently because uptake by the intestine is inhibited by other components of these foods. Thus, many people—particularly those in lower-income settings—have limited access to diets that meet their theoretical requirements for zinc.

The notion that zinc deficiency may be widespread in lower-income populations is further supported by the results of zinc supplementation trials completed in a broad range of countries. Provision of supplemental zinc during these intervention trials has led to improved growth among underweight or stunted children, thus demonstrating that their habitual zinc intakes were inadequate to meet physiologic requirements [3]. Nearly one-third of preschool children in lower-income countries have stunted growth [11], and the foregoing results indicate that a considerable proportion of this growth failure is likely attributable to zinc deficiency.

It is well established that iron deficiency is extremely common; anemia, due largely to iron deficiency, affects between one-third and one-half of the preschool children and women of reproductive age in lower income countries [12]. Because absorbable forms of iron and zinc are found in many of the same foods, these high rates of iron deficiency provide further suggestive evidence of the probable widespread occurrence of zinc deficiency.

Considering the likely common occurrence of zinc deficiency and the critical roles of adequate zinc nutriture in supporting normal growth and development, preventing morbidity from common infections, and possibly reducing child mortality, health planners are strongly advised to implement appropriate measures to evaluate the zinc status of their target populations and to use this information in considering whether programmatic interventions are indicated. To assist with the development of these activities, the present document provides the following: (1) background information on zinc metabolism and new estimates of the physiologic and dietary requirements for zinc; (2) recommendations for approaches that can be used to assess a population's risk of zinc deficiency; and (3) a review of the range of programmatic options that are available to enhance zinc nutriture in populations at risk of zinc deficiency.

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