



Invited commentary to the paper 'Zinc status and its association with the health of adolescents: a review of studies in India'

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We are pleased to view the article based on Dr. Rama Kawade's thesis illustrating the importance of micronutrient adequacy, especially zinc, and associated health implications in Indian adolescent girls. This brief commentary addresses three major aspects in which Kawade's work has made a significant contribution; nutrition and health issues of adolescents, rising importance of zinc in terms of deficiency problems being addressed, and development of dietary interventions to alleviate micronutrient deficiencies.

There are an estimated 1.2 billion adolescents – one in every five people – in the world today and of these about 243 million are Indians comprising the future working force of the nation (1). Adolescence and the reproductive years are periods of particular nutritional stress. Adequate nutrition contributes to adequate development and health of adolescents. In particular, along with energy and protein needs, micronutrient sufficiency has attained great importance in adolescent health since role of micronutrients in prevention of disease has been identified (2). Micronutrient deficiencies may also lead to impaired work capacity and learning disabilities. Considering the increasing indulgence of the younger generation in fast foods it is essential to examine their diet patterns for possible micronutrient inadequacies. Moreover, poor eating and exercise habits during adolescence lead to impaired growth and development and also illness in later life.

Like many developing countries, India is in nutrition transition and although overall calorie intakes have improved, studies focusing on micronutrient intakes are still scarce. Adolescent girls, more so in India, are a vulnerable group (3). Their physiological demands are high and information on nutritional deficiencies and interventional studies in this group are limited. Available evidence suggests that as a result of unhealthy eating

habits, with meagre intakes of milk, fruit and vegetables, children and adolescents are at risk of micronutrient deficiencies including iron, vitamin A, zinc and calcium (4–8). Further, mineral deficiencies are believed to be high in vegetarian populations (such as in Indians) because of high phytate and fibre contents of plant foods (9, 10).

Of the mineral deficiencies, zinc has attained importance as many body functions are linked to zinc-containing enzymes. Zinc being a cofactor of over 300 enzymes, it is vital for several body functions such as growth, cell reproduction, adult fertility, vision, insulin function, taste perception, cognitive function, thymulin activity and anti-inflammatory activity. In addition, it regulates the release of vitamin A from the liver. Thus, zinc is an essential micronutrient for healthy functioning of the human body and moderate to severe deficiency of zinc may alter multiple physiological and metabolic functions. Kawade's work describes the prevalence of zinc deficiency in an Indian lacto-vegetarian adolescent population (11). The study has also highlighted the role of zinc in cognitive performance and taste acuity and this part of her work is a novel and interesting piece of research. The association of plasma and erythrocyte zinc concentrations with four types of tastes (12) has been shown in older Europeans; however, the present study establishes a closer relationship of erythrocyte zinc with salt taste

detection threshold in adolescent girls. Associations between iron and cognition have been reported by several studies (13–16). However, Kawade's study provides evidence that blood zinc status is correlated with cognitive performance even in presence of normal iron status.

Studies reporting diet patterns of adolescents are also limited. Due to changing lifestyle and modernization, there is an increase in fat intakes of Indians and decrease in intakes of vegetables and fruit. Considering the population-specific dietary habits of adolescents, it is necessary to develop guidelines for diet diversification in order to increase micronutrient intakes (10). Kawade's approach of developing micronutrient-rich recipes similar to the identified diet patterns will go a long way to improving the health of the girls.

Further, it was interesting to note that 10 weeks of zinc supplementation through a food-based strategy resulted in significant improvement in functional indices of zinc. Kawade has thus demonstrated that the use of these zinc-rich recipes may be a sustainable strategy for improving zinc status of adolescent girls.

Another interesting contribution of the study is the diet quality index for assessing micronutrient sufficiency. It is well documented that adolescents all over the world are in the habit of consuming fast foods and aerated drinks (17). Assessment of the dietary adequacy of micronutrients is therefore crucial in adolescents. Majority of available dietary measures focus on adequacy of macronutrients, food variety and overall balance (18–20). However, some recent diet quality indices for youth (21) and adults (22) have incorporated eating behaviour in terms of snack foods and soft drinks. Even so, micronutrient quality of diets of adolescents remains an unexplored area. Kawade's study offers a simple tool in the form of an Adolescent Micronutrient Quality Index (AMQI) to assess dietary adequacy of nutrients in adolescent girls. The significant correlations of AMQI with biomarkers of zinc, vitamin C and β -carotene exhibit its efficacy in diet assessment studies.

Thus, Kawade's study, as well as shedding light on the zinc and micronutrient status of urban adolescent Indian girls, also demonstrates the use of zinc-rich recipes in improving zinc and other micronutrient status at the household level. The new AMQI suggested by her is likely to be a useful clinical tool for rapid diet quality assessment of adolescent girls. Hence the results of her thesis have practical applications.

There is ample scope for further studies in this area. The micronutrient quality index, AMQI developed in Kawade's study has the potential for suitable modifications for different age-sex groups, considering their specific needs for assessing micronutrient status. It will be a useful measure for dietetics practitioners all over the world for assessing micronutrient deficiency risk among vegetarians by focusing on the importance of

micronutrient-dense foods and food processes that increase bioavailability of minerals.

Zinc, as a multifaceted element, suggests that the effects of zinc supplementation on other aspects of health such as bone development, infections and obesity may need to be studied in adolescents. Thus the study offers new pointers for further enhancing adolescent health.

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