The Journal of Nutrition
Commentary

See corresponding article on page 1579.

Protein Quality and its Food Source in the Diets of Young Indian Children

Anura V Kurpad[1] and Tinku Thomas[2]

[1]Department of Physiology, St John's Medical College, Bengaluru, India; and [2]Department of Biostatistics, St John's Medical College, Bengaluru, India

In this issue, Headey and Palloni (1) report that an increased consumption of dairy in children belonging to households with lacto-vegetarian mothers was associated with a moderately reduced risk of stunting in comparison with households with nonvegetarian mothers. The increase in dairy consumption was complemented by a decreased consumption of starches, presumably sourced from cereals. The replacement of cereals with dairy in increasing wealth deciles has also been observed in other national surveys (2). A critique might be that the model examining maternal vegetarian status did not consider the child's dietary intake; some intake of nonvegetarian foods, particularly egg, was recorded in children of vegetarian mothers, although the average quantity was lower than that in the nonvegetarian category. The authors correctly point out that in India, the qualification of "nonvegetarian" (equated with meat consumption) should not be conflated with the assumption of an adequate consumption of animal source foods (ASF). The frequency of flesh food consumption in India is often very low (3) and consequently, the average daily amount eaten is low as well. According to a dashboard of Indian food intakes based on monthly household purchases (4), the average national daily consumption of flesh foods was 27 g/capita/d, and ranged from 3 to 86 g/capita/d across Indian states. The recent Indian Comprehensive National Nutrition Survey (CNNS; 112,000 children) reported that ~55% of children and adolescents consumed (lacto-)vegetarian diets, whereas ~40% were nonvegetarian; the remaining were ovo-lacto-vegetarian (5). Milk and milk products are the most common ASF consumed in India with its per-capita daily availability increasing over the last 3 decades, although the intake quantity varies considerably. A corresponding, though lower, increase in availability and consumption of eggs has also been noted (2). A note of caution here is the general underreporting in surveys, on topics such as "eating meat" that are sensitive to cultural and political pressures. A recent analysis of several Indian national surveys suggests that at best, the proportion of the Indian vegetarian population was even lower than reported elsewhere, at 31%, and more realistically, perhaps <20% (6). This reduces confidence in risk estimates based on reportage of vegetarian and nonvegetarian households.

Although the crude protein intake of Indian children appears to be adequate when simply compared with their requirement, proteins should also be judged by their quality, which includes measurement of the limiting indispensable amino acid (IAA) content of the proteins eaten, as well as their digestibility. Lysine is the limiting IAA in Indian cereal-based diets and its requirement in infants and children ranges from 35 to 45 mg/kg/d, but can increase substantially in poor socioeconomic environments due to concurrent energy deficits or persistent subclinical infections and intestinal parasites (7). Therefore, when accounting for these demand factors, measurements of the risk of a low-quality protein intake will be higher (8). This can be addressed by complementing the dominating dietary cereals with quality protein foods that contain high amounts of lysine, such as legumes, milk, eggs, and flesh foods. However, an additional consideration is the suboptimal intestinal digestive and absorptive function (9) that also occurs in poor environments, and could limit the effectiveness of these foods in complementing the lysine (and other IAA) intake to prevent stunting.

The digestible indispensable amino acid score (DIAAS) is a metric of protein quality that is based on the product of the true ileal digestibility and absorption of the limiting IAA and its content in the protein under consideration. Dietary evaluations made with this metric can throw light on the adequacy of high-quality protein foods in complementing cereals to improve the limiting IAA intake. Dual-isotope measurements of the true ileal digestibility of different food proteins in humans have shown that legume protein IAA digestibility is lower than ASF digestibility (10, 11), although the processing of legumes, for example by extrusion, can improve their digestibility significantly (12). However, with an average intake of 30 g/capita/d (4) and mean IAA digestibility ranging from 63 to 75%, legumes are eaten in inadequate quantities in habitual Indian diets to be effective as complementing foods. On the other hand, ASF are better digested, with IAA digestibility values ranging from 90% for egg (12) to 94% for milk (unpublished preliminary data). These figures give some indication that dairy products, and ASF in general, are easily digested foods that will be useful in feeding children appropriately and by extension, in the prevention of stunting.

With regard to the prevention of stunting, it is important to consider at which age the intake of dairy, or any other quality protein food, may be most influential. Analyses of recent

AVK is a Margdarshi fellow of the Wellcome Trust/DBT India Alliance.
Author disclosures: The authors report no conflicts of interest.
Disclaimer: AVK is a member of the Journal's Editorial Board.
Address correspondence to AVK (e-mail: a.kurpad@sjri.res.in).
Abbreviations used: ASF, animal source foods; DIAAS, digestible indispensable amino acid score; IAA, indispensable amino acid.

Manuscript received March 10, 2020. Initial review completed March 21, 2020. Revision accepted March 23, 2020.
First published online May 2, 2020; doi: https://doi.org/10.1093/jn/nxaa100.

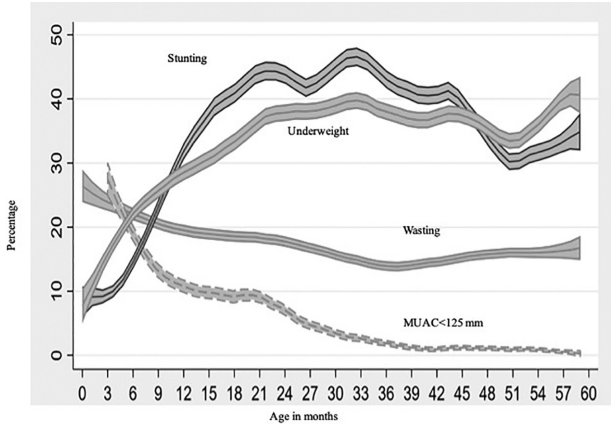

FIGURE 1 Percentage (with 95% CI) of stunting, wasting, underweight, and mid-upper arm circumference (MUAC) <125 mm among Indian children aged <5 y, from the CNNS 2016–2018 survey (5).

national data (5) have shown that growth faltering starts very early in India, in the first year of life (**Figure 1**), and stabilizes around the age of 2 y. After the period of exclusive breast feeding, the digestibility of high-quality complementary foods is important in the child's diet. When the protein intake of children aged <3 y reported in a large survey (National Nutrition Monitoring Bureau, NNMB, 13) were corrected for quality by the DIAAS, the risk of deficiency was 29% (14). Among quality protein foods, the digestibility of legume (mung bean) and egg protein in children aged 1–2 y was similar to what was observed in adults (13), and were 65 and 87%, respectively (14). For mung bean, this means adequate quantities are required, and it should be mixed with cereal in a 1:2 ratio for effective IAA delivery, a ratio that is not common in most household preparations as legumes are expensive, but still offers a path to better diets through plant foods. Headey and Palloni (1) also report the consumption of eggs among children of vegetarian mothers, which has not been examined in association with stunting, but indicates the potential for other ways to improve dietary protein quality. Nevertheless, dairy is an important part of the quality protein intake at this age, and the finding that this is lower in nonvegetarian households is relevant and important.

The report by Headey and Palloni (1) is an important addition to the literature around the relation of ASF intake, particularly dairy, to the growth of children. The authors acknowledge that the effect of ASF and dairy are not only about protein but also the content of micronutrients and growth-stimulating factors. The focus here has been on protein, which should be evaluated in the context of marginal protein intakes where protein quality and cost become important limiting factors and the intake of relatively small amounts of quality protein foods becomes relevant. Most effective among these is ASF, where the addition of 200 or 50 g milk or egg improves the DIAAS of the daily diet of children aged <3 y to 100% and can reduce the risk of quality protein inadequacy from 29 to <10% (14). However, this requires an adequate production and supply of such quality protein foods (15), which is not trivial in low- and middle-income countries, when due consideration to the environment is given.

Acknowledgments

The authors were responsible for all aspects of this manuscript.

References

1. Headey DD, Palloni G. Stunting and wasting among Indian preschoolers have moderate but significant associations with the vegetarian status of their mothers. J Nutr 2020.
2. Varadharajan KS, Thomas T, Kurpad AV. Poverty and the state of nutrition in India. Asia Pac J Clin Nutr 2013;22:326–39.
3. Sathyamala C. Meat-eating in India: whose food, whose politics, and whose rights? Policy Futures in Education 2019;17:878–91.
4. ICMR NIN-TATA Centre for Excellence in Public Health Nutrition. [Internet]. [cited 2020 Mar 6]. Available from https://www.dashboard.nintata.res.in.
5. Comprehensive National Nutrition Survey (CNNS) National Report. Ministry of Health and Family Welfare (MoHFW), Government of India, UNICEF and Population Council. 2019. New Delhi.
6. Natarajan B, Jacob S. 'Provincializing' vegetarianism. Putting Indian food habits in their place. Economic and Political Weekly 2018;53:54–64.
7. Pillai RR, Elango R, Ball RO, Kurpad AV, Pencharz PB. Lysine requirements of moderately undernourished school-aged Indian children are reduced by treatment for intestinal parasites as measured by the Indicator Amino Acid Oxidation technique. J Nutr 2015;145:954–9.
8. Minocha S, Thomas T, Kurpad AV. Dietary protein and the health-nutrition-agriculture connection in India. J Nutr 2017;147:1243–50.
9. Uauy R. Keynote: rethinking protein. Food Nutr Bull 2013;34:228–31.
10. Kashyap S, Varkey A, Shivakumar N, Devi S, Reddy BHR, Thomas T, Preston T, Sreeman S, Kurpad AV. True ileal digestibility of legumes determined by dual-isotope tracer method in Indian adults. Am J Clin Nutr 2019;110:873–82.
11. Kashyap S, Shivakumar N, Varkey A, Duraisamy R, Thomas T, Preston T, Devi S, Kurpad AV. Ileal digestibility of intrinsically labeled hen's egg and meat protein determined with the dual stable isotope tracer method in Indian adults. Am J Clin Nutr 2018;108:980–7.
12. Devi S, Varkey A, Dharmar M, Holt RR, Allen LH, Sheshshayee MS, Preston T, Keen CL, Kurpad AV. Amino acid digestibility of extruded chickpea and yellow pea protein is high and comparable in moderately stunted South Indian children with use of a dual stable isotope tracer method. J Nutr 2020;150(5):1178–85.
13. Diet and nutritional status of rural population, prevalence of hypertension and diabetes among adults and infant and young child feeding practices. Hyderabad (India): National Institute of Nutrition, Indian Council of Medical Research, National Nutrition Monitoring Bureau; 2012.
14. Shivakumar N, Kashyap S, Kishore S, Thomas T, Varkey A, Devi S, Preston T, Jahoor F, Sheshshayee MS, Kurpad AV. Protein-quality evaluation of complementary foods in Indian children. Am J Clin Nutr 2019;109:1319–27.
15. Minocha S, Makkar S, Swaminathan S, Thomas T, Webb P, Kurpad AV. Supply and demand of high quality protein foods in India: trends and opportunities. Global Food Security 2019;23:139–48.