

Invited commentary

Food-based nutrition education and hygiene can improve the growth of stunted children

The paper by Salehi *et al.* (2004) in the current issue of the *British Journal of Nutrition* is a welcome and rather rare example of an evaluation of a successful nutrition-education trial targeting poorly nourished children. There are few community-based effectiveness trials that have succeeded in improving growth, and almost all such trials have been reported in technical reports and proceedings of meetings that are not widely available and seldom peer-reviewed (Griffiths *et al.* 1996; Allen & Gillespie, 2001). The approach and results in this study of Qashqa'i tribal people in Iran provide an outline and context for addressing several issues related to nutritional interventions to improve growth.

The authors chose to start with the beliefs, attitudes, subjective norms and enabling factors (BASNEF) approach of Hubley (1988), which they modified to include a 'knowledge' component. In their intervention, the authors relied heavily on the support of tribal elders and teachers, who served as the 'influential people' specified in Hubley's model, as keys to addressing social pressures and providing 'enabling factors' such as tribal cooperation and literate helpers. The authors relied heavily upon literate daughters, who delivered much of the intervention. The BASNEF approach has not been widely applied elsewhere, but it does contain many of the practical components seen in other approaches (Allen & Gillespie, 2001). Key educational messages included information on: water, waste, and food sanitation; growth monitoring; appropriate complementary foods and feeding; child requirements for specific foods; food preparation; increased access to fruits and vegetables; increased uses for fruits, vegetables and pulses, especially lentils; referral to health centres. Notably absent from the intervention components was provision of food supplements directly to mothers or children. Consequently, the impacts of the intervention resulted from behavioural responses of the mothers and caregivers to the intervention messages and adoption of the health-related practices as the new group norms during the study period.

Using the mean weight-for-age Z-score (WAZ) and the mean age, the mean weight of the children at baseline was approximately 11.5 kg. Accordingly, the mean dietary energy intake (exclusive of breast milk) was approximately 490 J (117 kcal)/kg per d and probably adequate for most of the children (Butte, 1996; Torun *et al.* 1996). The initial average protein intake (exclusive of breast milk) was approximately 34.7 g/d (with 28% from animal sources), so the total protein intake was approximately 3 g/kg per d. Consequently, it seems unlikely that the Qashqa'i children as a group were protein-deficient at baseline

(Dewey *et al.* 1996). Even so, because the exact age, body weight and intake distributions were not presented, there may have been some children who had less energy and/or protein than the estimated requirements.

Upon inspection of Tables 6 and 7, one sees that the intervention resulted in net mean daily increases of 20 g lentil flour, 20 g beans, 10 g milk, 29 g egg, 30 g fresh vegetables, 10 g dried vegetables and 100 g seasonal fruit. In addition, after 1 year of the intervention there were net decreases in estimated mean daily intakes of wheat flour (30 g) and sugar (15 g), presumably due to food substitutions. The corresponding intervention-related net increases in macronutrients reported were 4.4 g animal protein (from 9.7 g at baseline) and 5.9 g vegetable protein (from 25.0 g at baseline). The intervention did not change the estimated mean daily intake of total dietary energy (5 583 J (1 335 kcal)). Thus, the intervention added new plant foods to the diet (lentils, beans, vegetables, fruits) and increased intakes of milk and eggs, without altering average energy intake.

It seems most likely that the chief nutritional benefits of the intervention were due to multiple micronutrients. The additional foods would have enhanced intakes of a wide range of micronutrients, including Fe, Zn, Mg, retinol, folate, carotenoids, riboflavin, and vitamins C and B₁₂. Moreover, the added vitamin C from the fruits would have increased the availability of Fe (Allen, 1998), and the combination of foods may have had other synergistic effects (Jacobs & Steffen, 2003).

At baseline the mean height-for-age Z-score (HAZ) for the intervention or 'test' group in the study of Salehi *et al.* (2004) was -2.1 . This corresponds to a prevalence of stunting ($HAZ < -2$) of approximately 54%, which is considered very high compared with other developing countries (World Health Organization, 1995). Mean WAZ at baseline was -1.4 , corresponding to a prevalence of approximately 27% underweight children ($WAZ < -2$), a level considered high (World Health Organization, 1995). The starting points are important because higher prevalences of stunting and underweight are associated with larger responses to nutrition interventions (Caulfield *et al.* 1999). The net intervention-related gain in length or height (intervention mean minus control mean) was 0.0163 m or HAZ 0.41 for the Qashqa'i children, and that for weight was 0.74 kg or WAZ 0.45. Because the children ranged from 0–59 months old at baseline, the Z-scores (adjusted for gender and age) are more easily interpreted than the absolute metric gains. The net reductions in the prevalences of stunting and underweight

(intervention minus control) after 1 year of the intervention were 17.5 and 12.2 % respectively. The magnitude of these effects has significant public health implications for subsequent morbidity and mortality of the children (World Health Organization, 1995).

It is interesting to consider efficacy studies of multiple-micronutrient supplements (with little or no additional dietary energy) to improve growth of stunted children, because they provide estimates of the likely maximum nutritional effects obtainable from well-controlled trials. Unfortunately, there are few such studies in the literature. Thu *et al.* (1999) supplemented undernourished Vietnamese children (6–24 months old, mean HAZ about -1.65) with a multiple-micronutrient syrup (retinol, Fe, Zn, vitamin C) either daily or weekly for 12 weeks. Micronutrient status improved with the supplementation equally for both daily and weekly groups, but the net intervention-related gains in height and weight (HAZ 0.18, WAZ 0.10) 6 months after enrolment were not statistically significant. Considering only the children who were stunted at baseline (HAZ < -2), however, the net improvements in height were significant at HAZ 0.52 and 0.39 for groups receiving the supplement daily and weekly respectively.

Undernourished Mexican children (8–14 months old, mean HAZ about -1.3) were supplemented 6 d per week for approximately 12 months with a low-energy drink containing nineteen vitamins and minerals at $\geq 100\%$ of the US recommended dietary allowances (National Research Council, 1989). The overall intervention-related gains were approximately: HAZ 0.21, WAZ 0.08. Statistically significant intervention-related gains in height (HAZ 0.30) were observed for infants < 12 months of age at enrolment, but not for those in the older group (HAZ 0.10; Rivera *et al.* 2001).

Three efficacy studies of multiple-micronutrient supplementation have been conducted with school-aged children (6–11 years old). These studies demonstrated significantly improved growth in weight (Abrams *et al.* 2003; Ash *et al.* 2003), height (Ash *et al.* 2003) and knee height (Sandstead *et al.* 1998) after interventions from 8 weeks to 6 months. The results of these studies of older children are supportive of biological potential for growth responses to micronutrients, but they are difficult to interpret in relation to the results from Salehi *et al.* (2004) because of the considerable age differences in the children and the ways in which the results were presented. Similarly, several authors (Caulfield *et al.* 1999; Allen & Gillespie, 2001; Rivera *et al.* 2003) have summarized other efficacy studies of nutritional supplementation that improved growth of young stunted children, but the supplements included either single micronutrients or substantial protein and energy so the results are less relevant to those from the Qashqa'i.

Even though the results for multiple-micronutrient efficacy are few, the available studies indicate that the effects on growth appear to be largest for children in the first year of life and for those who are most stunted. When the findings of the nutrition-education effectiveness intervention among the Qashqa'i are compared with the efficacy results, the net responses of HAZ 0.41 and WAZ 0.45 over 1 year seem very large for children who were aged 0–59 months

at enrolment, even though about half of them were stunted. One must conclude then that a substantial portion of the improved growth for the Qashqa'i children probably resulted from aspects of the intervention beyond increases in intakes of micronutrients *per se*. The fact that rather large improvements in growth were observed supports the assumption that the baseline diets were probably adequate for dietary protein and energy. Large improvements in growth among these children, however, must be put into perspective: the 0.033 m per year gained by the Qashqa'i intervention children still falls below the 3rd centile for increments in height of well-nourished children in the USA (Roche & Himes, 1980).

Several components of the intervention described by Salehi *et al.* (2004) include aspects of hygiene and child health that probably contributed to the enhanced growth of the intervention children, but that are not formally analysed in their report: environmental health (inside and outside tents), sanitary waste disposal, personal hygiene, water supply and sanitation, proper use of vaccination charts, proper use of growth charts, hygienic food preparation, and prompt referral of mother and child to health centres. These factors are known to be related to infection and morbidity in young children (Lal *et al.* 1996; Curtis *et al.* 2000; Nishiura *et al.* 2002), which, in turn, have been linked to impaired growth (Esrey *et al.* 1992; Walker *et al.* 1992; Stephenson *et al.* 2000; Moffat, 2003). Importantly, educational interventions targeted at improving behaviours associated with some of these aspects of hygiene and child health have been sufficiently successful to decrease the incidence of infection and disease (Feacham, 1984; Griffiths *et al.* 1996; Hoare *et al.* 1999).

Identifying non-nutritional aspects of the intervention among the Qashqa'i that probably contributed to its successful and appreciable impacts on the growth of stunted children is in no way intended to diminish the authors' successful efforts in changing the participants' food choices and dietary intakes. On the contrary, the authors are to be congratulated for achieving success in what must have been a difficult setting with a nomadic population, and in making the results available to the scientific community. Because the intervention was behaviourally based, it may be more likely to be sustained after the research programme is completed than if it were based on supplementation. The findings are of particular interest because the authors were able to improve growth through enhancing intakes of local foods, largely plant foods, without increasing energy intake and with minimal increases in protein. Their results should provide encouragement to others that the application of nutrition and health interventions shown to be efficacious can be implemented successfully in an effective community-based programme.

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