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Invited Commentary

Dietary interventions in school settings: can they change children's diets and metabolic outcomes?

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The burden of non-communicable diseases (NCD) caused by poor nutrition is one of the greatest public health challenges of contemporary times[1]. Poor diets and poor cardiovascular health have their origins in early childhood. The types of foods that children consume and their diet-related risk factors for NCD (such as obesity, high blood pressure and hyperlipidaemia) track from childhood into adulthood[2–5]. If we can develop interventions that improve the diets of children, we expect that children will have better health over the longer term, perhaps through shifting children to healthier diets before poor habits become entrenched, or by reducing the time or developmental period in which children are exposed to unhealthy diets. There are multiple time points for possible interventions beginning with maternal diet periconceptually, so programmes that promote healthy eating in school settings present one important opportunity to influence children's current diets, future diets and future health.

In this issue, Damsgaard *et al.*[6] report the findings of a randomised controlled cross-over trial in which the provision of food during school to Danish children aged 8–11 years was compared with children's usual school lunch, which is typically a packed lunch brought from home. The intervention was both comprehensive and targeted; it included two snacks and lunch consumed daily at school over a 3-month period, with the food modelled on the New Nordic Diet (a health promoting diet using local seasonal ingredients). The primary outcome of the trial was a metabolic score (MetS), which is a summary score of measures of arterial pressure, HDL-cholesterol, TAG, homeostasis model assessment of insulin resistance (HOMA-IR) and waist circumference; in addition, the trial included secondary outcomes such as BMI *z*-scores and fat mass. The researchers reported no overall effect of the intervention on the MetS because the intervention had differential effects on the individual components of the score. In other words, small reductions in arterial pressure, TAG and HOMA-IR were offset by undesirable changes to waist circumference (increased by 0·5 cm) and HDL-cholesterol (slight decrease of 0·02 mmol/l), resulting in no overall change in the MetS. Despite this, the breadth of the outcomes that were measured in this trial is helpful for understanding which markers of cardiovascular health may be responsive to this type of intervention. Moreover, this underscores the importance of examining multiple outcomes for broad-based dietary interventions.

Looking more closely at the dietary data, we see that the effect of the intervention on children's diets was negligible: only 14 g/d increase in vegetable intake (equivalent to approximately one tablespoon of peas or two florets broccoli), 10 g/d fish intake (approximately two teaspoons), <1 g/d fibre take and <1% change in the percentage of energy intake from fat and protein[6]. These small changes in diet reflect the fact that the intervention only altered school meals (not meals provided at home or on weekends), and therefore it is not surprising that there were small effects on cardiovascular outcomes. Given that the intervention was only 3 months long, we could be hopeful that a longer intervention (or indeed a permanent change to improve the food supplied at school) might result in more pronounced effects, although this would require confirmation. Others may argue that small incremental changes to diet, such as this, are more likely to be adopted and maintained than larger, more extreme changes. It is heartening to read that fewer than 2% of children (*n* 13/834) withdrew from the study because they did not enjoy the meals provided. Nonetheless, the small effects observed in this trial are similar to other studies of dietary interventions in school settings[7,8].

Some of the trials that test school-based programmes to improve the diets of children have only reported measures of adiposity, yet there is a strong case for including more metabolic health outcomes as Damsgaard *et al.* have done, because this will capture a wider range of risk factors for NCD than obesity alone. Recent debates highlight that healthy-weight UK children have unhealthy metabolic profiles[9–11], hence interventions that attend to metabolic outcomes rather than just obesity provide more information about what 'works' to improve other markers of poor health. Taken as a whole, the literature regarding the efficacy of school-based interventions to improve children's adiposity outcomes through dietary interventions is mixed. A systematic review of interventions based on the WHO's 'Health Promoting Schools' framework reported low-quality evidence and small effects on increasing children's fruit and vegetable intake, and moderate-quality evidence on influencing measures of adiposity, although this appears largely due to combined physical activity + nutrition interventions, than

to nutrition interventions[7]. In contrast, a systematic review of obesity prevention programmes in childhood found that dietary interventions in schools show promise for obesity outcomes, although the heterogeneity between studies mean that more evidence is needed[8]. What is even more difficult to judge is whether an intervention in one country (such as the effect of the New Nordic Diet in Danish children) will be transferable to another country. These types of interventions may be very specific to the local context and culture. The acceptability of dietary interventions probably contributes to the heterogeneity observed in many school-based trials, and limits our ability to draw inference to another setting. What is clear is that school-based interventions require a great deal of local development and testing.

The trial by Damsgaard *et al.* combined with the wider body of evidence about school-based interventions raises interesting questions about our expectations of dietary interventions to improve the metabolic health of children. This is not about intervening at younger ages in order to obtain larger effects – trials that involve parents of newborn babies have also had negligible effects on toddler's diets or their BMI[12–14]. For example, Wen *et al.*[13] reported that BMI of 2-year-olds were significantly lower by 0·29 kg/m^2 after an intensive intervention that involved eight home visits by specially trained community nurses, but the absolute difference in weight is approximately 200 g. Damsgaard *et al.*'s ambitious and rigorous trial offers us a best-case scenario to show what might be possible if we were able to shift children from their typical diet to school meals that supply nutritious, health-promoting, culturally acceptable foods. As public health nutritionists, we need to reflect on this and consider whether school-based programmes will achieve the biggest 'bang for our buck'. Where can the biggest improvements to metabolic health of children be made?[15] Do school-based programmes offer value for money compared with other interventions, when they work on only one-third of the typical three meals per day? Would governments have the will, capacity and resources to implement and maintain this type of programme? It is hard to see how dietary intervention in schools will solve our metabolic problems. To make greater progress on improving the metabolic health of our children, it is likely that brave new efforts by governments that impose bigger and broader changes to our food environment will be required.

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