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Measurement issues raised by the realist review

Measuring disadvantage

Many authors reflected on the appropriateness (or not) of different measures of 'disadvantage' in the particular population studied. Whilst most included studies opted for generic, population-level measures (such as the proportion of children in the school who were officially underweight) to delineate the target group, some also used locally developed indicators of poverty or disadvantage that could be applied to individual children – such as the quality of the shoes, the number of school books found in the satchel, the amount of money in the pockets, whether the child owned a pencil, or whether the family owned a refrigerator.^{20;24} Overall, many authors were not confident that their measure of disadvantage had accurately identified children who stood to benefit from supplementary feeding.

Measuring food consumption

There was a high degree of heterogeneity amongst studies in relation to how consumption (or lack of consumption) of food was measured. Most trials measured the overall volume of waste rather than relating the amount rejected by a particular child to the outcome in that child, though the latter is clearly statistically preferable.

Measuring growth

In most studies, growth was measured by increase in weight and/or height. Some studies also included extensive biochemical and anthropometric assessments (summarised and discussed elsewhere¹). One study in Peru, in which many children were severely undernourished at baseline, cast doubt on the validity of weight gain as a measure of growth.²⁰ In this study, whereas in the intervention group, improved cognitive test scores were *positively* associated with the amount of weight gained, the *reverse* was true of the control group (i.e. the greater the weight gain the lower the improvement in test scores). This was probably, suggested the authors, due to the confounding impact of fluid retention in frank Kwashiorkor (the more malnourished the child, the more fluid is retained), hence weight gain can indicate worse, not better, nutritional status. Bailey et al, who studied the impact of different supplements on growth in Indonesian children, found (to their surprise) that calorie-rich diets produced more weight gain than protein- and calorie-rich ones.¹³ They speculated from physiological principles that in the absence of adequate protein, calorie supplementation leads not to true growth but to more fluid retention. They also suggested that the children may have been "too far along the track of undernutrition" to respond to the supplement. These studies suggest that weight gain is an unreliable indicator of improved nutritional status when the child is metabolically decompensated.

It is worth noting that 'growth' is a complex phenomenon. A study from Beijing China, undertaken in an area where a high proportion of children were known to have poor calcium intake and subclinical vitamin D deficiency, randomised 757 10-year-old girls to receiving 330 ml milk, 330 ml milk fortified with vitamin D, or no intervention for two years.¹⁷ Percentage increase in sitting height and standing height were significantly improved in the milk supplemented groups compared to the controls at one year follow-up, though absolute differences in growth outcomes did not reach

statistical significance; those given milk fortified with vitamin D had significant gains in bone mineral density compared to those given unfortified milk. At the outset of the study, the authors considered two possible hypotheses: the supplement led directly to a specific effect on bone growth via improved calcium metabolism, or the milk provided an energy-protein supplement which indirectly led to bone growth. Further statistical analyses of the same dataset lent support to the former hypothesis, and also identified physical exercise as an important mediator of the link between calcium intake and accumulation of bone mass.^{18;29;30}

Measuring cognitive function, educational attainment or behaviour in school

The studies used a wide range of psychometric and other instruments to measure performance. Few studies justified (on theoretical grounds) the particular test used. In two studies, when performance was evaluated using a mechanical, stimulus-response format (for example, "put a ring round all the letter As on this page"), short-term supplementation had little impact on performance, whereas if the test involved a greater degree of creativity and motivation (for example, "name as many animals as you can in time limit Y"), supplementation had a significant impact.^{14;20} However, other trials failed to demonstrate this pattern,²⁴ and since the studies probably differed in the level of confounding due to benevolent attention (see text), no firm conclusions can be drawn.

Appendix 1 [web]: The historical context of school feeding programmes and associated research trials

Almost all the studies reviewed in this paper were undertaken in the context of emerging or established government-led policies to provide food supplementation to disadvantaged groups. Two early British studies, published in 1926 and 1928, underpinned a national programme to provide every UK child with daily school milk (which ran from 1944 to 1971).^{5:7} Whereas the introduction of free school milk in the UK occurred under a Labour government and was part of a growing Welfare State founded on socialist principles, its withdrawal occurred under a Conservative government bent on withdrawing state involvement in private life (the campaign was, incidentally, led by the then Education Minister, Mrs Thatcher, who subsequently became Prime Minister; she never lost the nickname “Maggie Thatcher, kiddie-milk snatcher”). Though her decision was unpopular (and lacked an evidence base at the time), her declaration that the UK population was now sufficiently well nourished to make universal food handouts unnecessary was supported by the findings of a trial, begun in the early 1970s, that had been set up to challenge this policy.² The Canadian Red Cross School Meals Study in the late 1940s was another somewhat paternalistic public health intervention designed around a ‘cradle to grave welfare’ ideal, though led by a charity rather than government.¹¹ Again, by the time the ideal was implemented, the population was too well-nourished to need it.

The studies from the USA similarly illustrate the interplay of history, economics, politics and policymaking. In the USA in the 1940s and 50s, fears of a national food shortage had made it a political priority to modernise remote farming communities and improve the nation’s crop yields (for example, through introducing intensive farming and new chemical fertilisers).³⁹ Laboratory experiments had demonstrated that experimental subjects performed better when fed than when unfed.⁴⁰ Multiple public health programmes were introduced, designed to provide the population (either universally or targeted at the poor) with scientifically-developed nutritional supplements which would correct deficiencies and “raise the average IQ”. The US Congress passed a School Breakfast Programme Bill in 1966,⁴¹ and two of the studies reported in this review^{6:8} were designed to evaluate local implementations of this policy.

Post 1980, developments in US food policy were driven by two important changes: the main agricultural problem became overproduction, and many health problems were related to over-nutrition.³⁹ Studies on school feeding disappeared for 20 years. The two US studies from the 1990s,^{3:4} and the recent trial of school breakfast programmes in the UK,^{9:10} were set up to address a more contemporary social trend: the growing numbers of disaffected children from poor backgrounds who, even when ‘in class’ (and they often weren’t), were rarely ‘on task’. This new research tradition was partly based on surveys that had shown a

link between disruptive or off-task behaviour and skipping breakfast; the (somewhat naïve) assumption underpinning government-led school breakfast programmes was that providing the missing breakfast would eradicate the behaviour problems.¹⁰

The policy contexts of studies from low and middle income countries suggest that school nutrition programmes were often introduced in underdeveloped regions after mass education has failed to produce the expected increase in either academic performance or economic productivity.^{14;16;20;25;27;42} Attendance at school by pupils from low socioeconomic backgrounds in these studies was often erratic, and their performance on formal tests considerably lower than that of their more affluent compatriots. Something, apparently, was stopping these pupils from learning, and it was hypothesised that nutritional status might be the rate-limiting factor.²⁴ Many low and middle income countries therefore introduced supplementary feeding programmes in the second half of the 20th century, usually based in schools for convenience of administration. Such programmes were often funded by the local municipality and provided a substantial drain on budgets, hence there was a keen interest in either demonstrating benefit or justifying withdrawal of the programme so that money could be invested elsewhere. Early evaluation studies were generally undertaken by the same teams that conducted the trials; they were often of poor quality and published (if at all) in local 'grey literature'.⁴³ More recently, there has been a tendency towards more systematic, independent and robust evaluation of the programmes, and publication in less parochial journals.

The study from Peru,^{20;21} for example, was set up to evaluate a regional school food supplementation programme set up by the national government in 1993, which in turn had been established to help offset the social costs of the economic adjustment policies implemented by the Peruvian government since late in 1990. The food supplements were provided by Kelloggs, but the trials themselves were funded by government and undertaken by a local, private non-profit organisation devoted to research in nutrition; the evaluation was done independently by a team of American researchers. The authors refer to a number of previous studies in this region of Peru that were less rigorously conducted and which produced indeterminate findings.²¹ They comment that the later programme (included in our review) "*constitutes a clear departure from previous school feeding programmes, which were heavily politicized and poorly documented. From the programme's inception, nutritionists, managers, and social scientists have collaborated to produce a sound nutritional design, efficient distribution mechanisms, and effective evaluation methods*".²¹

The studies from India both appear to be the result of regional, rather than national, government initiatives.^{12;16} Both were conducted in the poor southern state of Tamil Nadu, at a time when malnutrition was common and a high proportion of children had secondary illnesses such as chronic diarrhoea, scabies, and skin inflammation. Both these studies used cheap, local ingredients

available in the marketplace, and the papers have an implicit ideological emphasis on developing local solutions that were not dependent on handouts from commercial or philanthropic sources.

Another insight from this realist review of school feeding programmes dating from 1928 to 2004 is the move from framing school feeding as a purely scientific solution (making good a biochemical deficiency in the children) to a very different framing of such programmes in the discourse of development, both at local community level and as part of the international response to the Millennium Development Goals (<http://www.un.org/millenniumgoals/>). Studies undertaken in the early and mid 20th century made very little mention of negotiation or engagement with the local community; they rarely piloted the supplement for palatability or acceptability, and in many cases children were (it would seem) treated almost as experimental animals and coerced into consuming whatever supplement had been supplied by the nutritional team.^{5-8;11;13;44} Many of these early studies describe children being repeatedly placed in queues in their underwear to be weighed and measured, and in some cases having repeated blood tests, to check the extent to which the 'deficiency' was being made good. Whilst some later studies have also taken a biochemical and physiological focus,¹⁷ in general the more recent the study the more emphasis has been placed on social and cultural themes including ensuring the palatability and cultural acceptability of the food, the social context in which it is eaten, the link between providing a school meal and educating children (and their parents) about healthy eating, and embedding the supplementary meal in the local economy (e.g. by using local ingredients and a local production chain). As part of this frame shift, there has been growing recognition that whilst nutritional deficiency and educational under-achievement in disadvantaged children are clearly related, they cannot be solved simply by shipping in a scientifically engineered supplement. The contemporary framing of school feeding trials is that poor school performance by disadvantaged, malnourished children has complex physiological, pathological, psychological and social causes, and a quality feeding programme engages with all these dimensions.

This shift in the framing of school feeding programmes is well illustrated by two trials from Jamaica, published in 1983 and 1998.^{23;24} The earlier trial was a small study funded by national government and undertaken in the context of national development priorities; at the time, its authors made bold claims for the potential benefits of food supplements in addressing wider economic problems in the country.²³ But the larger, most recent study was firmly situated by the same team of authors in a context of growing international concern for the persistent problem of child malnutrition.²⁴ This trial was funded by a US-based international development bank, and whilst its findings were similar to those of the earlier trial (the supplemented group improved in terms of nutritional status and on some but not all measures of cognitive performance), its conclusions are more measured: that inter-group differences, while statistically significant, are relatively unimpressive in clinical terms, and that "*the massive problem of poor*

*achievement levels requires integrated programmes including health and educational inputs as well as school meals”.*²⁴

The trend away from an overtly experimental approach (in which white-coated scientists from the West would ‘design’ a nutritional package for target groups in low and middle income countries) to a developmental one (in which scientists work with local people to produce an intervention that is workable, acceptable, and locally owned), is illustrated by the recent nutritional development programme in Kenya, funded by a US international development agency and undertaken as part of a wider programme to explore how best to provide food aid to low and middle income countries.²⁵ This trial, and another which was published too late to be included in the Cochrane review,⁴⁵ exemplify the new model of outside agencies (who provide resources and specialised skills) working in partnership with indigenous ones (who provide cultural know-how, historical experience and local staff) to implement and evaluate a complex intervention that combines scientific rigor and cultural congruence. Whilst Kenyan trial had impressive effects on all its major end-points (children consumed more nutrients, grew more, were better nourished, and performed better at school),²⁵ little information was given on its costs, and the sustainability of the programme beyond the period of American aid is of course unknown.

One important feature of many school feeding programmes is sponsorship from the food industry. The earliest study in this review (the Scottish study of school milk published in 1928⁷) was sponsored by the national Milk Marketing Board; many programmes in low and middle income countries were sponsored or supported by Nestlé, Kellogg, or their subsidiaries.^{14;20;24} Such sponsorship does not, of course, invalidate the studies, but it does highlight the strong commercial interest that food companies will understandably have in influencing government policy when large-scale mass supplementation programmes are being considered. It is important to note that even when studies of supplementation demonstrate clear benefit from the supplement, this does not necessarily indicate that the supplement tested was the most effective, cost effective or acceptable choice for the target population.

It would seem that, both in high income and low and middle income countries, scientific trials of school feeding programmes do not just ‘happen’, but emerge as part of an explicit or implicit research policy that is in turn a product of the prevailing social and political context, with commercial interests looming large. Many such programmes are politically charged and hard to implement on the ground, but with careful planning, productive partnerships may be struck between government, the commercial sector and academia.

For references see main paper.