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Jamaican studies in nutrition and child development, and their implications for national development

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Protein–energy malnutrition (PEM) is diagnosed by comparing children's anthropometric measurements with reference values for their age and sex. It is estimated that 177 million children under 5 years of age in developing countries have weights-for-age below two standard deviations of their expected value. Low weight-for-height (wasting) is less common but low height-for-age (stunting) is estimated to affect 35% of children between 24 and 59 months of age (Grant, 1991). If PEM has a detrimental effect on children's mental development the implications are obviously enormous.

In the present paper, studies which have addressed this problem in Jamaica over the last 15 years will be discussed. No attempt is made to review the international literature which has been reviewed recently (Simeon & Grantham-McGregor, 1990). First those studies concerning severe and mild to moderate PEM in young children will be discussed, then studies conducted in school-aged children.

SEVERE PEM

The Wellcome classification for severe PEM will be used here (*Lancet* editorial, 1970). Many studies have shown that children who suffered from severe PEM in early childhood and subsequently return to poor environments usually have poorer mental development, school achievement and more behaviour problems than their peers or siblings (Grantham-McGregor, 1989). However, in spite of reasonably consistent findings, a causal relationship cannot be inferred unequivocally, because of study design problems. These include: the lack of adequate control for the confounding variable of poor social background, siblings have usually been undernourished themselves and there is generally no evidence of normal development before the episode of PEM. In addition the malnourished children have usually had long hospital stays which may have contributed to their poor development.

Acute stage of severe PEM. In an early study, in order to control for the effects of hospitalization, the developmental levels of eighteen severely malnourished children

were compared with those of fifteen adequately nourished children who were also in hospital and were suffering from other diseases (Grantham-McGregor *et al.* 1978).

The children had developmental assessments on the Griffiths' test (1967), during recovery in hospital. Both groups had low scores on admission, but the malnourished group was markedly lower. Also both groups had particularly low scores in the hearing and speech sub-scale. Both groups improved on recovery approximately the same amount so that the malnourished group maintained their deficit. No previous study had a control group of adequately nourished children in hospital and the low language scores had been attributed to PEM. Also the improvement in development quotients (DQ) had been attributed to the children's improving nutritional status (Cravioto & Robles, 1965). It is more likely, that both these manifestations had similar aetiologies in each group, such as being in hospital and generally feeling unwell.

Rehabilitation of severely malnourished children. Few studies aimed at improving the mental development of survivors of severe malnutrition have been reported. The only two with control groups comprised short-term stimulation while the children were in hospital, and these produced only transient benefits (McLaren *et al.* 1973; Cravioto & Arrieta, 1979).

We conducted a long-term programme of psychosocial stimulation with severely malnourished children (Grantham-McGregor *et al.* 1987). The intervention comprised play in hospital, followed by home visiting for 3 years. The visitors were community health aides, who demonstrated the use of home-made toys to the mothers and encouraged them to play with their children between the visits.

The intervened malnourished group (n 21) was compared with two other groups who were patients in the same hospital 1 year previously, and had received standard medical care only. These comprised a second severely malnourished group (n 18) and an adequately nourished one (n 21) suffering from diseases other than malnutrition. All children were tested throughout the study on the Griffiths' (1967) mental development scales and the Stanford Binet.

On admission to hospital both malnourished groups had similar developmental levels (DQ) and were seriously behind the adequately nourished group. All groups improved in hospital, the intervened group improving the most. Over the following 9 years the non-intervened malnourished group's DQ or intelligence quotients followed a trajectory below that of the adequately nourished children, and they showed little sign of catching up. This concurs with findings from retrospective case-control studies conducted elsewhere. The intervened malnourished children showed gradual improvement and caught up to the adequately nourished group in the first 2 years, after that they declined slightly. At 6 years after intervention stopped, they had significantly higher school achievement grades in spelling and reading but not in arithmetic than the non-intervened malnourished children. They were significantly lower than the adequately nourished group only in arithmetic (Fig. 1). The locomotor sub-scale was the only Griffiths' (1967) sub-scale in which the intervened children did not catch up with that of the adequately nourished group at any stage. Also they failed to catch up in height-for-age and head circumference-for-age. It is possible that if the children had been provided with nutritional supplementation after leaving hospital, locomotor development may have improved. The study, therefore, demonstrated that a low-cost modest intervention could benefit these children's development and that benefits lasted at least 6 years.

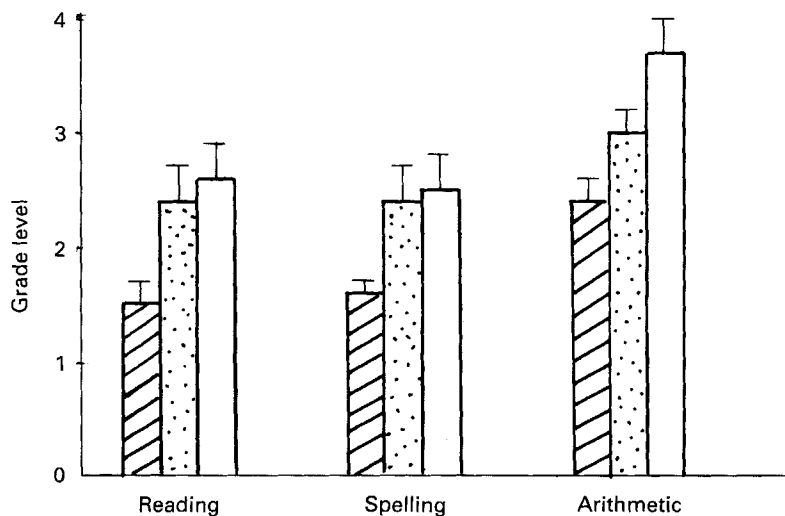


Fig. 1. School grades, 6 years after intervention (long-term psychosocial stimulation programme), in three groups of children. (▨), non-intervened malnourished (n 16); (▩), intervened malnourished (n 17); (□), adequately nourished (n 20). Values are means with their standard errors represented by vertical bars.

One child in the non-intervened malnourished group was adopted by a middle class family. He showed remarkable improvement in development, which suggests that with a vastly enriched environment marked improvements can occur (Grantham-McGregor & Buchanan, 1982). This is also suggested in other adoption studies of severely malnourished children (Winick *et al.* 1975; Monckeberg, 1990).

Association between development and nutritional status. On admission to hospital, the height-for-age, but not weight-for-height or presence of oedema, of the malnourished children described previously, predicted their level of development 1 month after returning home (Grantham-McGregor, 1982).

In a small study, children who had recently recovered from severe PEM were compared with children, matched for age and sex, who had a similar degree of stunting but had not suffered from a severe episode (Grantham-McGregor *et al.* 1989). Both groups were given developmental assessments on the Griffiths' (1967) test, and their DQs were only slightly but not significantly different. Both groups' DQs were significantly lower than a third group of fifteen non-stunted children of the same age and from similar areas of residence (Fig. 2). It was concluded that in this population, the poor developmental levels usually found in severely malnourished children may be largely explained by factors associated with stunting, rather than the acute episode.

STUDIES WITH MILD TO MODERATE UNDERNUTRITION

A survey of the nutritional status and developmental levels of 168 young children was carried out in two poor Kingston neighbourhoods. Their DQs on the Griffiths' (1967) test were significantly related to their heights-for-age but not weights-for-height, when several social background factors were controlled (Powell & Grantham-McGregor, 1985). The relationship between stunting and poor development is usually, but not

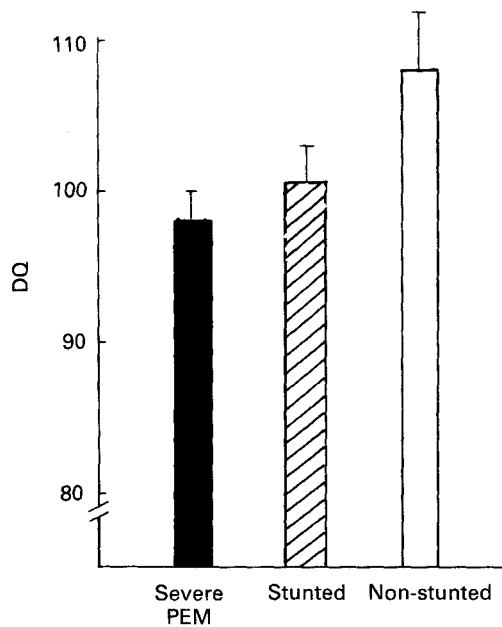


Fig. 2. Developmental quotients (DQ) of three groups of children: (■), recovered severely malnourished (n 29); (▨), group matched for age, sex and height (n 29); (□), non-stunted controls (n 15). Values are means with their standard errors represented by vertical bars. (From Grantham-McGregor *et al.* 1989.)

invariably, stronger than that with wasting (Grantham-McGregor *et al.* 1990). The mechanism is not clear. It may just reflect the duration of undernutrition as wasting tends to be more transient than stunting.

The effects of nutritional supplementation and psychosocial stimulation in growth-retarded children. Stunting is usually associated with poor development. However, stunting is also associated with poor environments (Martorell, 1988) and it is difficult to separate nutritional effects from those of poverty in purely observational studies.

To determine whether stunting was linked to poor development through nutritional deficiencies we conducted a 2-year trial of nutritional supplementation (Grantham-McGregor *et al.* 1991a). We also examined the role of stimulation. Stunted children (129) aged between 9 and 24 months, were randomly assigned to four groups: control, stimulated, supplemented, and combined supplementation and stimulation. Non-stunted children (32) matched for age, sex and neighbourhood to each control child were also examined.

The supplement comprised 1 kg milk-based formula/week, and the stimulation was weekly home-visiting similar to a programme used previously (Grantham-McGregor *et al.* 1987). The controls were visited every week in the same way as the supplemented children in an attempt to control for any increased attention the supplemented children may have received. However, this was not a true placebo, as it was considered unethical to provide low-energy supplements to stunted children. Children were evaluated every 6 months on four sub-scales of the Griffiths' (1967) mental development scales (locomotor, hand and eye coordination, performance, hearing and speech) by testers blind to the treatment of the children. The stunted children initially had significantly lower scores in

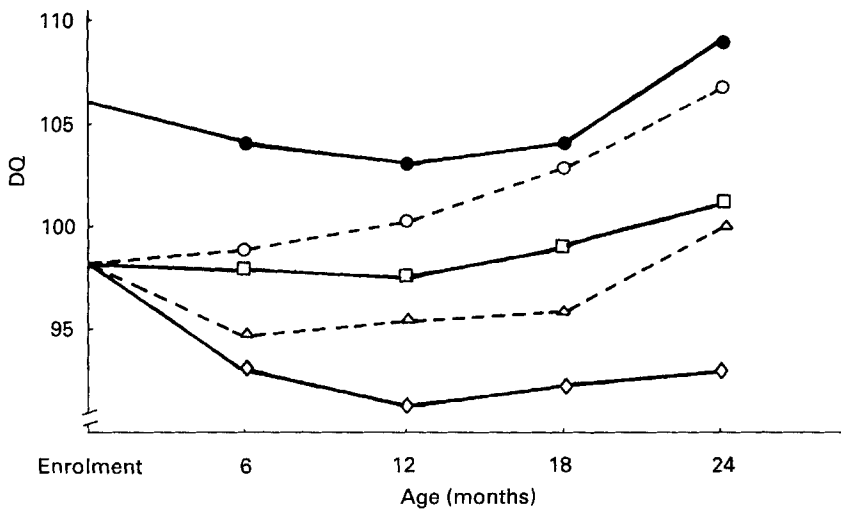


Fig. 3. Developmental quotients (DQ) of stunted groups adjusted for initial age and score, compared with non-stunted group adjusted for age only (Grantham-McGregor *et al.* 1991). (○- - -○), Both; (□—□), stimulated; (△- - -△), supplemented; (◇—◇), control; (●—●), non-stunted.

all sub-scales than the non-stunted ones. The control group declined over the 2 years and ended 14 DQ points below the non-stunted group. Stimulation benefited all sub-scale scores, whereas supplementation benefited scores in the locomotor and performance sub-scales, and the effect on the hearing and speech sub-scales approached significance ($P < 0.08$). The combined effects of supplementation and stimulation were additive and this was the only group to catch up to the non-stunted groups. The mean DQ of the groups are shown in Fig. 3.

This study fulfilled most of the requirements of a clinical trial and provides evidence that stunted children's development improves with supplementation. The implications are that at least part of their deficit in development is directly attributed to poor nutrition.

Studies in schoolchildren. Several studies have been conducted in schoolchildren. In a small study, breakfast was given to one class of remedial children for one term. They improved in arithmetic and school attendance, but not height or weight compared with two other matched classes (Powell *et al.* 1983). We hypothesized that the mechanism was the relief of short-term food deprivation. A much larger study was carried out in grade 5 children in five randomly chosen government primary schools in Kingston (Clarke *et al.* 1991). An association was found between the children's height-for-age, haemoglobin level, breakfast history and days without food in the home (N. W. Clarke, personal communication) on the one hand and poor school achievement on the other. After allowing for extensive social background variables in multivariate analyses, the nutrition variables still contributed to the variance in the children's school achievement levels.

In an experimental trial of missing breakfast (Simeon & Grantham-McGregor, 1989), stunted and non-stunted, 9.5-11-year-old children were compared. Stunted children's cognitive functions were detrimentally affected when they missed breakfast, but non-stunted children's were not. These findings have implications for school feeding programmes in developing countries. They have generally been poorly evaluated

(Levinger, 1986), but may be more effective than evaluations in developed countries have suggested. These findings are also important because they demonstrate an interaction between the children's underlying nutritional status and short-term food deprivation. Other nutrient deficiencies such as iodine and iron could also interact with PEM.

MECHANISM

The mechanism linking PEM to poor mental development is not established; however, there are several hypotheses. A frequently cited one is that the children's activity and exploration levels are reduced as a result of PEM and they subsequently acquire skills slower than the normal rate (Levitsky, 1979).

We examined this later hypothesis in two studies. The behaviour of severely malnourished children was observed while they were in hospital in the acute stage. They were compared with adequately nourished children who were ill with other diseases (Grantham-McGregor *et al.* 1991*b*). Time-scheduled observations were used. The malnourished children were initially significantly less active, explored toys less, touched fewer toys and used fewer types of exploratory behaviours. They were also more apathetic, whereas the controls were more distressed. All differences disappeared on recovery, except that the malnourished children still handled fewer toys. This latter difference also disappeared when the children's DQ were controlled. Initial behaviours did not predict DQ levels on recovery within the malnourished group. The rapid return to normal in behaviour, contrasted with the children's persistently poor DQ.

In the supplementation study of stunted children described above (Grantham-McGregor *et al.* 1991*a*), the children's activity levels were observed on enrolment, using time-scheduled observations in the homes (Meeks Gardner *et al.* 1990). The stunted children were less active than the non-stunted children. Activity levels were significantly related to the locomotor sub-scale scores of the Griffiths' (1967) test but not to other sub-scales (Grantham-McGregor *et al.* 1990). Further, activity levels did not predict future change in development (J. M. Meeks Gardner, personal communication). Although it is established that severely malnourished and young stunted children have reduced activity levels, the studies failed to confirm a causal link between reduced activity and poor development. The role of activity in poor development, therefore, remains questionable.

IMPLICATIONS FOR INDIVIDUAL AND NATIONAL DEVELOPMENT

Though the interpretation of the Jamaican studies is limited by their relatively small scale (reflecting the limited research resources available), they confirm that meaningful nutritional intervention is possible in the Jamaican context, and in particular that nutritional status is associated with individual developmental improvement and educational success or failure. This is important from a policy point of view because of the demonstrated or suggested associations between education and individual or national development (Fig. 4).

Published studies have demonstrated, or at least plausibly proposed, that education influences the level of economic productivity in some occupations, and promotes modern attitudes and values (Lewin *et al.* 1982; Schiefelbein, 1983). Education also improves the development of cognitive skills in children (Wagner, 1974; Stevenson *et al.* 1978).

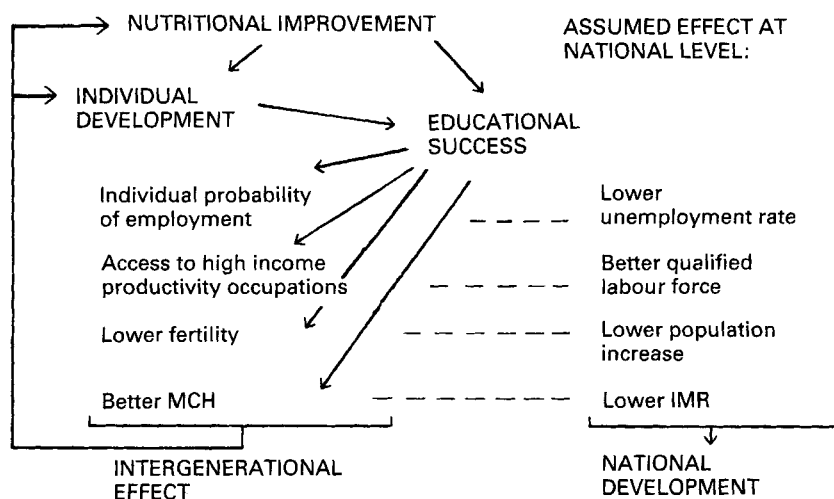


Fig. 4. Assumed or demonstrated associations between nutritional improvement, individual and national development. IMR, infant mortality rate; MCH, maternal and child health.

Education for women is especially important as it is associated with reduced fertility, later age of marriage and better child care (Levine, 1980). Educated mothers make better use of health services and their children have better health care and nutrition and lower infant mortality rates (Wagner, 1974; Caldwell, 1979). Also better educated mothers make more effective teachers of their children (Laosa, 1978; Levine, 1980), and there is some suggestion that their children's development is also better than children of less-educated mothers (Levine, 1980). These may be regarded as specific cases supporting the argument put forward by Schultz (1959) for education as an activity economically justifiable on the grounds that it creates 'human capital', with high rates of return compared with other forms of investment where scarce skills are concerned (Carnoy *et al.* 1982).

Almost no studies have been done on the rate of return to the creation of human capital in Jamaica. In 1980 it was estimated that returns on training in the health care professions were 20–30% per annum (Cumper, 1982). The general economic conditions for high rates of return are present in Jamaica; large income differentials between occupations, occupations linked to educational levels, and a shortage of many skills.

However, limiting the economic importance at national level of nutritional interventions aimed at supporting education are first, the apparently limited extent of moderate or severe malnutrition (Samuels, 1987), and second, the small scale of local high-technology industries. This would not prejudice the importance of such interventions as a way of increasing equity and improving individual life chances. Also in countries where malnutrition is more prevalent the effect at a national level would be expected to be greater.

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