Growth and Malnutrition (Failure to Thrive)

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[Editor: The following chapter is divided into three parts. 'Part 1: Malnutrition in Aboriginal children' and 'Part 2: Growth monitoring for action' are authored by Dr David Brewster. 'Part 3: Measurement of head circumference: Discussion' is authored by Dr Andrew White.]

Summary

1. Growth failure is the principal manifestation of malnutrition in children.
2. Normal growth variations and errors in charting must be recognised and not labelled as malnutrition.
3. Anthropometric assessment can differentiate wasting and stunting.
4. A detailed history, physical exam and assessment for psychosocial deprivation are important.
5. The most common dietary problem in Aboriginal children is insufficient weaning foods.
6. In the primary care setting, major organic disease is uncommon (<5%) and can usually be suspected on clinical assessment.
7. Routine hospitalisation with an expensive laboratory work-up to exclude rare causes is considered inappropriate medical practice in the absence of other manifestations of illness.
8. Dietary improvement with home visits can improve growth in some community children.
9. Micronutrient supplements (zinc and vitamin A) have improved growth in children living in poor circumstances.

Part 1: Malnutrition in Aboriginal children

Key features

Malnutrition principally affects young children during the weaning period (4–24 months), i.e. those who are not yet able to feed themselves. The great majority of malnourished children in any community suffer from mild or moderate energy deficiency, and will not be recognised as undernourished by the casual observer because the only clinical manifestation will be growth retardation. Stunting will not be recognised unless the child's growth is charted and compared with normal standards. These children look like healthy children of a younger age, so mothers are usually not concerned about the child's health.

Parental ignorance of the importance of adequate feeding in the weaning period, in maintaining health, and lack of knowledge of hygiene are

important contributing factors. Malnutrition and infection are synergistic in the hospital context, so a child who is malnourished is more prone to infections. These further impair his nutritional state by depressing his appetite and increasing the demand on his reserves of protein and energy. In the community context, promoting catch-up growth after diarrhoeal disease will break the cycle of malnutrition-infection.

Many Aboriginal community children have 'tropical enteropathy syndrome' due to intestinal mucosal damage from living in a contaminated environment with poor hygiene circumstances. Consequently, they may not demonstrate the expected catch-up growth between episodes of diarrhoea unless a special effort is made to increase their intake of weaning foods during convalescence.

The important deficiencies are usually energy, protein and iron. Specific deficiencies may complicate the clinical picture, though these are not often clinically florid (e.g. vitamin A, zinc, folate). If malnutrition is present from early infancy, particularly if it follows intrauterine growth retardation, it may permanently affect brain growth and mental function, leading to individuals who do not reach their potential. Prolonged periods of iron deficiency and poor head growth (microcephaly) make this more likely.

Prevalence

It is well recognised that Aboriginal children in the Northern Territory have a higher burden of disease, with higher admission rates and longer lengths of hospital stay than other children in the Territory. Ruben and Walker estimated a minimum prevalence of malnutrition of 20% (weight/height or height/age >2 standard deviations below the NCHS standard) in children 0–2 years of age living in the Darwin rural region, with microcephaly very commonly accompanying malnutrition.[1,2] According to WHO/FAO criteria for developing countries a community nutritional intervention is warranted when the prevalence of acute malnutrition in children under five years is >10%, or 5–9% with aggravating factors.[3]

Tropical enteropathy

The GI tract is extremely susceptible to effects of malnutrition, enteric infections and bacterial contamination.[4] Abnormal permeability ratios due to tropical enteropathy have functional significance in that they explained a major part (40%) of the growth faltering in Gambian children.[5,6] Thus, mucosal damage measured by permeability ratios is clearly an important contributor to ill health in children on borderline diets in contaminated environments.[7] In children in developing countries permeability testing has been used to assess the impact of various nutritional, infectious, environmental and dietary factors on gut integrity. For example, studies in Malawi, Central Africa, showed the superiority of a milk-based diet over local cereals in rehabilitating children with kwashiorkor[8,9], and that tube-feeding resulted in more rapid weight gain than oral feeds.[10] Studies on Aboriginal children at Royal Darwin Hospital have shown that the severe complications of diarrhoeal disease (acidosis, hypokalaemia, lactose intolerance) are associated with high permeability ratios and high nitric oxide excretion from gut damage.

Although breastfeeding rates are high and continue into the second year of life, there is insufficient intake of complementary foods in the first 2–3 years of life. Once children lose weight with diarrhoeal disease or

other infections it is difficult for them to regain it on the usual weaning diet of low energy density, particularly in view of the underlying enteropathy. Frequent or recurrent infections increase energy needs and cause anorexia, making catch-up growth even more difficult. This is compounded by high rates of bacterial colonisation and small bowel bacterial overgrowth, as well as environmental enteropathy with disaccharide intolerance. The vicious cycle of malnutrition-infection increases the severity of infections and the need for hospitalisation. Recent evidence indicates that malnutrition in utero and early childhood may increase the risk of heart and kidney diseases.[11,12]

Health and nutrition promotion

Child nutrition faces a number of problems before its key health promotional messages can reach a receptive audience. The first is that malnutrition is largely silent and does not present in obvious ways like diarrhoea, pneumonia, or renal failure. The only obvious manifestations may be growth retardation — particularly stunting and microcephaly, which do not make the child ill — and so the mother may not recognise its importance in increasing morbidity. However, there is some evidence that stunting, microcephaly, iron deficiency and borderline zinc and vitamin A status during the vulnerable brain growth spurt (0–2 years) have serious detrimental consequences for immune, intestinal and cognitive functions,[13–20] although the evidence is interpreted differently by different reviewers.[21,22]

Just as anti-smoking campaigns that preached cancer risks had little impact, we believe that isolated nutrition educational approaches will not reach a receptive audience in communities until the potential benefits are demonstrated to carers and communities. This has been the experience of nutritional rehabilitation programs and other health programs, i.e. that promotional activities need to be integrated with nutritional interventions and are ineffective in isolation.[23] In addition communities must also recognise malnutrition as a problem and then be assisted and supported to address the issue, including appropriate development of community education resources (which can take a variety of forms). The community also needs to build capacity to address these issues by appropriate training, increasing knowledge and skills in this area and the availability of appropriate food sources.

The ‘Improving Growth Promotion in the NT’ project is using a community development approach in child growth promotion, funded by the CRC for Aboriginal and Tropical Health. Preliminary findings suggest that there are important differences in perceptions between health providers and parents of the causes of poor child growth, including the role of illness and caring, appropriate weaning times, and ways of knowing whether a child is growing well. For example, health service providers generally focus on reducing the prevalence of illness and improving nutrition, whereas Aboriginal community members see caring for children as being central to improving child growth. This project argues that the process of supporting community members through a community development process, although time-consuming, is likely to lead to the implementation of appropriate community growth promotion strategies. Whether this can be demonstrated by convincing outcomes remains to be seen.

There is little good evidence about sustainability of programs in Aboriginal communities. The Minjilang study[24] does indicate the importance of community participation. The NT Department of Health and Community Services (DHCS, formerly Territory Health Services) are committed to

growth, assessment and action (GAA) and the Strong Women, Strong Babies, Strong Culture programs. The latter was alleged to have positive health outcomes in relation to low birth weight, although there are methodological weaknesses to the study.[25] The key to sustainability is the demonstration of an effective implementation and improved outcomes that are obvious to the community, so that continuing community participation will be assured:

> The immediate expense of nutrition programs and broader interventions should be considered a critical investment in the future . . . Steps taken today to combat malnutrition and its intellectual effects can go a long way towards improving quality of life — and productivity — of large segments of a population and thus of society as a whole. [26]

When the adverse socioeconomic circumstances of a child's environment cannot be easily changed, providing adequate nutrition during the weaning period of early childhood will lessen the disadvantages and deficits engendered by poverty. There is a window of opportunity at this age for an effective intervention because it corresponds to the most vulnerable period of rapid somatic growth and also the brain growth spurt.[27–31] Follow-up studies of community nutrition programs have demonstrated long-term benefits on intellectual and physical function.[32–37] There can be little doubt that a community nutrition project targeted at the vulnerable weaning diet is a more effective health services model for improving malnutrition during the vulnerable weaning period (4–18 months) than hospital admission.

The experience with large scale integrated nutrition projects has shown that integrated, well-managed and targeted programs of nutrition education, food supplements and health services were most effective.[3,38–42] The lessons for us from extensive international experience with therapeutic nutrition programs are the need to:

- Enter into partnership with communities to respect their cultural values, while ensuring close supervision and good management of the project
- Target children with faltering growth during the weaning period
- Include an educational component to promote appropriate diets for children at home and
- Use a commercial high energy therapeutic supplement initially, containing a range of nutrients.

The most common reasons for unsuccessful programs are:

- Ration sharing ('leakage')
- Not reaching the most vulnerable families
- Use of a low energy or unacceptable supplement
- Lack of micronutrients and
- Poor management of the project.

It is well known that a low energy weaning diet (e.g. Weetbix, potato) alone will not be sufficient for rapid catch-up growth during convalescence from an enteric infection. In the past, children have been sent to hospital for a high energy milk diet by nasogastric tube. It makes more sense to provide high energy nutritional therapy to children with significant failure to thrive within the community rather than at the hospital. The nutritional weaning therapy Fortisip is already being used in some communities. Each 200 mL of Fortisip has 1270 kJ of energy (1.5 kcal/mL), and contains: protein 10 g (13% of energy as protein), vegetable oil 13 g

(39% of energy), carbohydrates 35.8 g (mainly as maltodextrin and sucrose, 48% of energy), vitamins A (666 iu), B, C, D, E and K, niacin and folic acid, with a sodium content of 160 mg, potassium of 300 mg, and an osmolarity of 390 mOsmol/L.

Finally, it is the strong clinical impression of paediatricians in the NT that nutritional growth retardation in Aboriginal children occurs predominantly in the weaning period between 4–24 months and is due to an inadequate weaning diet (other than breast milk). This is also the major contributor to iron deficiency anaemia, since breast milk alone is insufficient to satisfy energy and iron requirements over most of that period. It is therefore important to focus on the weaning period and an improved weaning diet in any effort to address nutritional problems of Aboriginal community children in the Top End. Similarly, the strong correlation of female literacy or educational levels with child health and mortality[43] is clearly relevant to Aboriginal children.

Terminology

A confusing array of terms and classifications are used to describe malnutrition. In this discussion, we focus on undernutrition, excluding both obesity and specific nutrient deficiencies. In the developed world malnutrition is usually described as 'failure to thrive' (FTT), which means growth retardation or low weight-for-age. Although FTT usually refers to a child below the third percentile for weight-for-age. This cut-off tends, on one hand, to identify genetically small children with transient growth deceleration due to an infection and, on the other hand, to miss significant weight loss in a bigger child. Consequently, FTT should be seen as growth deceleration or crossing growth percentiles, particularly falling through two percentile spaces (e.g. from 50–75th percentile to 10–25th percentile) on the growth chart.

Children who are underweight may also be classified as 'wasted' or 'stunted'. Stunting, or short stature, is defined as a height-for-age below two standard deviations below the mean (Z-scores), but it needs to be appreciated that about 3% of normal children will grow on or below this cut-off. If a stunted child has had two height measurements at least a year apart then the height velocity can also be charted. For example, the third percentile for height velocity in boys of 7 to 12 years of age is about 4 cm/year. Where stunting is due to undernutrition, it represents chronic malnutrition. Wasting, on the other hand, represents more acute malnutrition and is measured as a low weight-for-height. Wasting means a child is thin, and severe wasting is called 'marasmus'. The other form of severe malnutrition is 'kwashiorkor' (which is rarely seen in Australia) and is characterised by oedema, hypo-albuminaemia, dermatitis and fatty infiltration of the liver. Although some underweight children will be both wasted and stunted, many do not satisfy criteria for either wasting or stunting and are merely underweight for age.

Anthropometric indices

Growth measurements and charting are essential in investigating a child with possible malnutrition. Key measurements are weight (kg), length or height (cm) and head circumference (cm). For growth charting, length is measured in children <24 months and height thereafter, because there is a mean difference of about 1.5cm between height and length, and growth charts change from length to height at 24 months. Anthropometric assessment alone is not a good indicator of nutritional status in children with oedema and

hypo-albuminaemia (kwashiorkor). Accuracy of measurements is essential, particularly for length/height. Errors in measurement are very common and one always needs to consider this as the explanation for anthropometric indices that do not fit the clinical appearance of the child.

What growth standard should be used? Until recently, the conventional answer was the National Centre for Health Statistics (NCHS) growth curves, which are the basis of growth charts used in Australia. However, these are based on North American children, most of whom were bottle fed, so they may not be appropriate for breastfed children. New international growth curves are being developed which should also be used in Australia, and will probably be introduced soon. Revised American (www.cdc.gov/growthcharts) and European growth curves (www.eurogrowth.org) have been published recently which are more appropriate for breastfed children. Aboriginal children have the same growth potential as non-Aboriginal children, so it would be wrong to conclude that growth faltering was 'normal' for them. Correction of age must be made for prematurity until 18 months with head circumference, until two years for weight and until 40 months for height.44

Routine growth monitoring is a key component of infant and child health services. It has come under scrutiny in recent years in both the developing and developed world, and criticised as a waste of valuable time and causing unnecessary parental anxiety. A systematic review found no reliable evidence of a benefit.[45] [Editor: This is discussed further in Part 2 below.] A UK consensus meeting recommended that infants need only be weighed at birth and with immunisations and surveillance checks, with only those causing clinical concern weighed and measured thereafter.[46] In settings where only mild malnutrition is seen, weight-for-age alone may be the most appropriate anthropometric index.[47] These issues are best decided at a regional level on the basis of the existing evidence and local circumstances.

Clinical assessment

All children being investigated for malnutrition should have a complete history and physical examination. The history will establish whether the child was pre-term or low birth weight due to intrauterine growth retardation. Clinical assessment also needs to establish whether there are signs or symptoms of organic disease. A dietary history, developmental assessment, observations of parent/child interaction and assessment of family stress dysfunction or neglect are also important. It is always worth ensuring that the infant formula is being correctly prepared and not diluted as a cost saving device, that excessive fruit juice is not replacing milk, that low energy 'diet' foods are not being given because of erroneous health beliefs or food fads, and that restricted diets for alleged food allergies are not causing inadequate energy or micronutrient intake. If there are problems in any of these areas, more detailed assessment with the assistance of a dietician or other allied health professional should be considered.

Normal growth variants

In investigating a child with possible malnutrition it is important not to cause undue parental anxiety by incorrectly labelling a child with normal nutritional status. Errors in measurement or charting are one pitfall as mentioned previously. Infants show considerable variability in the early weeks, with 5% shifting up or down in percentiles as part of normal growth.[46] This is often referred to as 'catch-up' growth, with intrauterine

growth retardation or ‘catch-down’ adjustments in early infancy. In the latter case, breastfeeding problems need to be considered without causing unnecessary anxiety to a breastfeeding mother.

Familial short stature is a common normal variant and unnecessary parental anxiety can be avoided by adjusting for mid-parental height, although it can be misleading unless allowance is made for regression to the mean.[48] Constitutional growth delay occurs in a sub-group of mostly boys whose height falters between three and 36 months with delayed bone age, so ultimately they attain normal adult height. Studies have found that ‘constitutional growth delay’ tends to be used for middle class families whereas ‘failure to thrive’ is more likely to be used for poor families with the same degree of growth retardation.[46] Children commonly have weight loss and anorexia accompanying infections, particularly diarrhoea, but this is followed by catch-up growth provided the child receives a diet of adequate protein and energy density.

Organic vs non-organic causes

Historically, FTT was divided into organic and psychosocial aetiologies. Major organic disease is found in <5% of community cases of FTT, and can mostly be diagnosed from signs and symptoms accompanying the growth failure. Furthermore, even with organic disease, FTT may be due to poor nutrition in addition to the disease process. Non-organic causes imply poor emotional or physical nurturing, which is often classified as reactive attachment disorder, but infant temperament and difficult feeders may also be factors in poor growth. Abuse, neglect or deprivation is likely to result in malnutrition, but these only account for 5–10% of FTT cases in developed countries. Many consider this organic/ psychosocial dichotomy obsolete since most cases are of mixed aetiology.

Undernutrition

Undernutrition is a factor in up to two-thirds of cases of growth retardation in childhood, and the degree of wasting and poor dietary intake may often not be recognised. Caregivers may often not appreciate the high energy needs of infants and toddlers, which are considerably higher than adults on a body weight basis. They may also not appreciate the need for catch-up growth after illness, and if the child’s intake does not increase after illness he may not demonstrate any catch-up growth but continue to grow along the percentile to which he has have fallen during the illness.

Laboratory tests

The tendency to order many tests to exclude an underlying organic disease needs to be avoided as it has a very low yield. Abnormal test results aided the diagnosis in only 16% of inpatients with FTT and only 0.8% (39/4880) of tests were helpful.[49] Vomiting was often associated with organic disease. Wright[46] suggests doing the following screening tests: full blood count; thyroid function tests; urea and electrolytes; anti-endomysial antibodies; mid-stream urine; chromosomes in girls (to exclude Turner syndrome); and chest X-ray, sweat test, HIV serology and Mantoux test if appropriate. These screening tests are only done to exclude pathology, most of which is evident clinically. There are no early reliable laboratory tests of nutritional status, since serum albumin, cholesterol, triglycerides and ß-carotene are unreliable or late signs of nutritional deficiency. Similarly, levels of zinc or vitamin A may be unreliable because serum levels do not always change in parallel with body stores. The general experience with

investigating children with malnutrition is that laboratory studies not suggested on the basis of the initial clinical examination are rarely helpful.

Trial of therapy

Children with growth retardation in the primary health care setting rarely need hospital admission or dietary supplement, but can be managed in the primary care setting in the first instance. For example, a recent randomised control trial in the UK found a significant benefit for a health-visitor led intervention, with a fifth of children showing improvement after dietary advice[50], although two other randomised trials failed to document a growth benefit of home visits.[51,52] With more severe degrees of malnutrition the most important investigation in the hospital context is a trial of feeding and close observation of the parent/child interactions and feeding pattern. Hospitalisation is much less effective in finding an underlying cause of malnutrition than in providing an environment to assess dietary intake, feeding techniques and parent-child interactions.

Conclusion

Managing the child with malnutrition relies heavily on growth charts but must remain aware of normal variations in growth, as well as the all too common errors in measurement. All children investigated for malnutrition should have a full history and physical examination — with particular emphasis on signs and symptoms of organic disease, a dietary history, developmental assessment and assessment of the parent-child interaction — looking for family dysfunction, stress or neglect. The tendency to do an extensive battery of laboratory investigations to exclude the long list of differential diagnoses associated with malnutrition is not appropriate but there may be a need for selective tests to exclude organic disease suggested in the clinical assessment.

Hospitalisation should be largely reserved for wasting and infection-associated malnutrition. For milder cases, follow-up after dietary advice with home visits (if feasible) can be done in the primary health care setting, with a need for paediatric referral only for cases who are more severely affected or who are not responding to therapy.

Supplements of vitamin A and zinc have been found in overseas studies to benefit children with malnutrition and persistent diarrhoea. Finally, the main focus in Aboriginal children should be on improving the intake of weaning foods and better hygiene and environmental living conditions in communities. The high prevalence of malnutrition in the weaning period in Aboriginal communities demands a preventive nutritional intervention program that would focus on the weaning diet, micronutrients (including iron) and hygiene.

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Part 2: Growth monitoring for action

Routine growth monitoring is a key component of infant and child health services. It has come under scrutiny in recent years in both the developing and industrialised world, and criticised as a waste of valuable time and causing unnecessary parental anxiety. The Nyeri Declaration on Growth Promotion for Child Development[1] expressed concern that weighing and charting of millions of children in the developing world had not been followed by appropriate action. It recommended that growth monitoring be accompanied by assessment, analysis and action.

However, a systematic review found no reliable evidence of a benefit from growth monitoring.[2,3] A UK consensus meeting recommended that infants need only be weighed at birth and with immunisations and surveillance checks, with only those causing clinical concern weighed and measured thereafter. In settings where only mild malnutrition is seen, weight-for-age alone may be the most appropriate anthropometric index.[4]

For school age children, screening for short stature with a single precise measurement using standard techniques and a reliable stadiometer has been recommended, taking the 0.4th percentile as the cut-off, which is particularly oriented to detecting Turner's Syndrome and growth hormone deficiency.[5] American recommendations are that children should have routine supervisory health visits with weight, height and head circumference measured at one, two, four, six, nine, 12 and 15 months, and weight and height at 18 months, and annually from two to five years. These issues are best decided at a regional level on the basis of the existing evidence and local circumstances.

For routine screening in a high-risk setting (like NT Aboriginal children) the GAA program recommends approximately monthly weights in the first three years and then six-monthly to school entry, length/height measurements about six-monthly to school entry, and head circumference three times in the first six months of age.[6] A retrospective review of health centre records from 11 remote Aboriginal communities in the Top End recommended against annual growth screening of school children since it did not pick up new cases of growth failure.[7] Twenty-one per cent of the four to 10-year-old children measured were malnourished (weight/age below -2 Z-scores), with 51.4% stunted, 40.7% wasted and 7.9% both wasted and stunted.

It is important to detect poor growth prior to school age. The mean age (range) of onset of growth faltering is 6.6 (3.5–12) months for stunting and 8.9 (7.5–18) months for wasting. Hence, the critical period for linear

growth is the first two years of life, so growth monitoring needs to focus on this age group and follow up ‘at risk’ children closely.

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Part 3: Measurement of head circumference: discussion

Published recommendations

Hall[1] recommends to measure after birth, then at 6–8 weeks. Further measurements are indicated if:

1. The head circumference (HC) line is crossing percentiles upwards, and there are no symptoms of hydrocephalus, but only for four weeks after which immediate referral for evaluation should be made if abnormal$_1$; or
2. The child is being evaluated for concerns about growth or development.

   NHMRC guidelines 1993: Measure at birth, seven days (or at discharge from hospital) and then at 6-8 weeks.2. NHMRC guidelines on child health surveillance are being revised at present and any details will not be provided in advance 3.

Published evidence about head growth

• Large head can be caused by hydrocephalus, subdural effusion, subdural empyaema and various syndromes (Soto’s, Alexanders etc.). Microcephally can be caused by chromesomal or genetic abnormalities, congenital infections, congenital toxins (alcohol etc.), craniosynostosis.

• Head circumference below the third percentile is perfectly compatible with normal intelligence, but with lower measures abnormal development becomes more common.4 Small-for-gestational age babies at birth remain shorter and lighter and have smaller head circumferences than normal for gestational age babies.5

• Early malnutrition was shown to be associated with poor head growth in three studies.6,7,8

• There is also evidence that poor early nutrition affects cognitive function. However, other factors (including poverty) may be involved, and the relationship may be due to specific micronutrient deficiency rather than protein/calorie malnutrition.9,10,11
• A relationship between wasting (but not stunting) and microcephally independent of interuterine growth retardation (IUGR) was shown in a study of Aboriginal children at RDH; there was no relationship between microcephally and stunting. This study does not prove a causal relationship between nutrition and head growth.12

Issues

1. What is the purpose of measuring head circumference?
   - In the first few months of life as a screen — which will lead to investigation for causes of small or large head.
   - To allow identification of particular children with nutritional problems where intervention will make a difference to the individual. (Microcephaly will be a late and insensitive feature of undernutrition)
   - In older children as an indicator of nutritional status of a population (i.e. prevalence of microcephally). However, weight-for-age, height-for-age and weight-for-height are better measures.[13]

2. What could be the positive outcomes of HC monitoring?
   - Indicating that poor nutrition in early life has implications for brain growth, psychomotor development and intellectual function.

3. What could be the negative outcomes of HC monitoring?
   - Head circumference is an insensitive indicator of intellectual function and many individuals with lower HC have normal IQ. Families could be made unnecessarily concerned about their child's developmental potential based on HC.
   - Aboriginal health researchers in history have been caricatured as 'skull measurers', and head circumference reporting can be offensive and provoke sensationalist and racist publicity.[14,15]

Recommendations

- Measure HC at birth and then at 1–2 months of age. Any abnormalities detected should be referred immediately for assessment and investigation.
- Consider further measurements at six and 12 months, although the evidence for benefit is not very strong.
- Measurement of HC should be part of the medical review of children who are identified and referred because of poor growth or development
- Further measurements (on a population level) are not indicated and may be harmful.

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