NUTRITIONAL APPROACHES TO GROWTH FALTERING

Growth is central to later health and wellbeing, with the first two years of life being a particularly important window of growth. While validated screening tools are available to identify growth faltering, it is less clear what nutritional strategies could be put into place once identified. This article discusses the main causes behind growth faltering alongside key studies looking at the nutritional approaches to this problem.

Dr Emma Derbyshire PhD, RNutr (Public Health) Independent Consultant, Director of Nutritional Insight Ltd

For article references please email info@networkhealthgroup.co.uk

Growth faltering can be concerning for both families and health professionals. Healthy growth, particularly during the first two years of life is needed to support immune function and physical health, along with neurological and cognitive development.[1] For example, growth faltering in early life, as well as during the pubertal years has been associated with poorer cognitive and schooling outcomes.[2]

With regard to human growth itself, this occurs in different stages. For example, prenatal growth is the most rapid period of growth followed by infancy.[3] On average, an infant gains around 20cm a year during the early months of life. This is usually followed by another 10-20cm by the age of one year.[3]

Following on from this, pubertal growth is the next period of rapid growth when nutritional needs are again high.[4] Subsequently, for these reasons, the first two years of life and puberty are often referred to as the 'rendezvous' of growth; a period of growth that should not be missed.[3]

DETERMINING GROWTH

As shown in Table 1, the causes of growth faltering are multifaceted, which can be divided into general reasons, or medical causes. Amongst low income countries, poverty, food insecurity, highly infectious environments and poor understanding of nutrition and hygiene, are some of the main factors contributing to growth faltering.[5]

Prematurity is another risk factor for reduced infant growth, with postnatal growth failure being inversely associated with gestational age, i.e. longer pregnancies tend to lower the risk of this.[6] Other work has shown that medical conditions, such as coeliac disease, may contribute to growth faltering amongst children identified as having this.[7]

Table 1: Causes of growth faltering

General:
Inadequate intake of energy and protein
Inadequate intake of micronutrients
Poor appetite regulation
Delayed introduction of solid foods
Fear of new foods (neophobia)
Oral-motor dysfunction
Medical/disease-related:
Prematurity
Reduced gestational age
Reduced dietary intakes
Increased nutritional requirements
Increased nutritional losses

Sources: Sullivan & Goulet (2010)[4]; Poindexter (2014)[6]

It is important to monitor growth from birth, whatever the clinical situation or country, to make sure this is on track. The World Health Organisation (WHO) has developed a set of growth standards using data collected from the WHO Multicentre Growth Reference Study. These are based on how children should grow in all settings, i.e. derived from a worldwide sample of children, rather than being limited to a specific setting and time.[8] These Standards were published in 2006 and are based on infants and children from Africa, Asia, Europe, Latin and North America who were fed according to international

Dr Emma Derbyshire is a nutrition consultant who writes regularly for academic and media publications. Her specialist areas are maternal nutrition, public health nutrition and functional foods. www.nutritional-insight.co.uk

nutritional standards and whose mothers were adequately nourished.[9]

A series of validated charts have since been developed by the WHO for measuring the growth of children from birth to five years and are available through their website (www.who.int/nutrition/media_page/en/). As growth is one of the most sensitive indicators of health and wellbeing it is important that health professionals use validated growth charts, like these, to give better interpretations of children's growth patterns. This, in turn, then enables suitable intervention strategies to be put into place.[10]

NUTRITIONAL APPROACHES

A PubMed search was undertaken to identify studies published over the last 10 years investigating links between nutrition and growth faltering. Main findings from randomised controlled trials and key epidemiological studies are shown in Table 2.

Based on the studies identified, three looked at the effects of different protein supplementation programmes. One found that providing extremely low birthweight babies (<1000g) with higher protein intakes had significantly improved growth velocity over the first 30 days after regaining birth weight.[11] Other work which involved randomising 92 preterm infants to receive fortified breast milk (with 1.4 or 1.0g protein per 100ml) from birth until their due or discharge date, showed that higher levels of protein led to significant improvements in infants' body weight.[12] In an Ethiopian study, growth faltering lessened amongst children eating quality maize protein (maize biofortified with higher lysine and tryptophan).[13]

Other randomised trials have investigated whether lipid-based supplements could reduce growth faltering, although no improvements were seen.[14,15] One study looked at the potential effects of glutamine supplementation (0.25mg/kg body weight, taken twice daily) although findings were insignificant when tested over a period of five months amongst a sample of Gambian infants.[16]

Several studies have researched the effects of multi-micronutrient supplements, with somewhat mixed findings. Vietnamese research has shown that growth faltering was partly reduced when infants were provided with complementary foods fortified with micronutrients over a six-month period[17], with daily multiple micronutrient supplements also being found to reduce growth faltering in a similar population and study time-period.[18] Other studies, however, have found that zinc and iron supplementation[19] and multi-micronutrient interventions have not prevented, or reduced growth faltering.[20,21]

Earlier work found that increasing the energy content of infant formula led to reductions in length z-scores.[22] Subsequently, authors of this work advised that the energy content of infant formulas should not be increased without also increasing the protein and micronutrient levels for infants with growth faltering.[22] In line with this epidemiological evidence from Willows and colleagues (2011) showed that diets higher in protein, fat, iron and vitamin appeared to improve the growth of Chinese children.[23] More recently, emerging work suggests that certain gut microflora, particularly an abundance of *Acidaminococcus* could also be associated with growth deficits.[24]

DISCUSSION

Growth in early life is central to the development of a healthy immune system, neurological and cognitive function, organ formation and overall physical wellbeing.[1] Clearly, the underlying causes of growth faltering are multifactorial, although gestational age is one determining factor.[6] Unfortunately, once growth faltering tends to be recognised, nutritional deficits tend to have already occurred and can be difficult to recover.[6] Subsequently, improved screening programmes are needed to identify expectant mothers whose infants may be at risk of growth faltering, so suitable strategies can be put into place early on.

In terms of nutritional approaches, protein supplementation programmes look most promising at present.[11,12,13] Now, further research is needed to determine 'how much' in relation to different levels of growth faltering. Unfortunately, findings from other nutritional interventions which have included energy supplements, multi-micronutrients, fatty acids and glutamine, have been less consistent, although the emerging role of gut microflora warrants further investigation. Other factors, such as aflatoxin exposure should also be considered, as strong effects on growth have been observed amongst Gambian women exposed to this in pregnancy.[25]

Table 2: Nutrition and growth faltering: key studies

Author	Area of interest	Methods	Main Findings
Gough et al (2015)[24]	Microflora	Secondary analysis of twin cohorts	Reduced microbiota diversity was associated with stunting and increased Acidaminococcus sp. was associated with growth deficits
Maleta et al (2015)[14]	Lipid-based supplements	Randomised single-blind trial	No benefits were seen in relation to length gain or reduced stunting between 6 and 18 months of age
Cormack & Bloomfield (2013)[11]	Protein	Prospective cohort study	Babies fed higher protein intakes in the first month of life had a significantly greater growth velocity ($p<0.0001$)
Van der Merwe (2013)[15]	Long-chain PUFA supplements	Randomised double-blind trial	No improvements in linear growth were seen
Miller et al (2012)[12]	Protein content of a milk fortified	Randomised controlled trial	Infants in the higher-protein group achieved a greater weight at study end (mean difference: 220g; $p= 0.03$)
Pham VP et al (2012)[17]	Micronutrient-fortified comple-mentary food	Village randomised controlled trial	Growth faltering stopped partly in Vietnamese infant but it is possible that benefits may only be short-term
Willows et al (2011)[23]	Dietary adequacy	Observation study of 172 children aged 1 to 5 years in rural China	Consuming more protein-, fat-, zinc-, iron- and vitamin A-rich foods may improve growth and reduce anaemia
Akalu et al (2010)[13]	Quality protein maize (QPM)	Two randomised controlled studies	Children eating conventional maize faltered in their growth, whereas children consuming QPM did not change significantly in height-for-age and had marginal increases in weight-for-age
Dijkhuizen et al (2008)[19]	Iron and zinc supplementation	Four randomised double-blind trials	Neither iron nor zinc supplementation prevented growth faltering during infancy
Williams et al (2007)[16]	Glutamine supplementation	Double-blind placebo-controlled trial	Glutamine supplementation failed to improve the growth of malnourished Gambian infants
Clarke et al (2007)[22]	Energy-supplemented formula	Open, parallel randomised study	Increasing the energy content of normal infant formula without increasing protein and micronutrients should not be practiced in infants with faltering growth
Hop et al (2005)[18]	Multiple micronutrient supplementation	Double-blind placebo-controlled randomised trial	The length-for-age Z-score decreased significantly amongst the daily multi micronutrient group compared with the placebo or weekly multi micronutrient group
Lopez de Romana et al (2005)[20]	Multiple micronutrient supplementation	Double-blind masked controlled trial	No effects on growth faltering during infancy were observed
Untoro et al (2005)[21]	Multiple micronutrient supplementation	Four double-blind placebo-controlled randomised trials	Growth faltering was not prevented

Equally, on the other side of the coin, whilst growth faltering is clearly an important issue, further study is needed to look into interventions for rapid early weight and fat gain. Interestingly, it has been found that attenuation of protein supply in these cases can help to normalise the risk of this.[26] Thus, it seems that protein has a key role to play in both growth faltering and rapid weight gain. It now seems to be a question of what balance of protein is needed to support 'healthy' growth.

CONCLUSIONS

Healthy growth, particularly during the first two years of life is central to a child's later health and wellbeing. With regard to nutritional approaches protein interventions look to be most promising at present. That said, roles of multi-interventions that include protein warrant further investigation, as does the role of gut microflora. There is also potential to look at infant feeding and weaning practices in relation to infant growth.