Nutrition and Child Disability

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Malnutrition and Child Disability

Major global public health problems: one billion people worldwide are malnourished, and around one billion people worldwide live with a disability.

Both are related to key human rights: the right of all children to adequate nutrition.

Currently both are prominent within the global health agenda:
2010 Scaling up Nutrition (SUN)
2011 World report on disability (WHO and World Bank)
2013 Lancet Nutritional Series (Cost effective interventions for tackling malnutrition)
Golden 1000 days

The right nutrition in the 1,000 days between a woman’s pregnancy and her child’s second birthday builds the foundation for a child’s ability to grow, learn and thrive.

**Pregnancy:** Pre-pregnancy to birth

Babies developing in the womb draw all of their nutrients from their mother. If mom lacks key nutrients, so will her baby, putting the child’s future health and development at risk.

**Infancy:** Birth to 6 months

Breast milk is superfood for babies. Not only is it the best nutrition an infant can get, but it also serves as the first immunization against illness and disease.

**Toddlerhood:** 6 months to 2 years

Nutrients from a variety of healthy foods are an essential complement to breast milk to ensure healthy growth and brain development.

The impact of good nutrition early in life can reach far into the future. Children who get the right nutrition in their first 1,000 days:

- Are 10x more likely to overcome the most life-threatening childhood diseases.
- Complete 4.6 more grades of school.
- Go on to earn 21% more in wages as adults.
- Are more likely as adults to have healthier families.

**Sources**

3. Ibid.
4. Ibid.
Importance of early child development
Critical periods of brain development
Malnutrition and neurodisability are both major public health problems in Africa. This review highlights key areas where they interact. This happens throughout life and starts with maternal malnutrition affecting fetal neurodevelopment with both immediate (e.g., folate deficiency causing neural tube defects) and lifelong implications (e.g., impaired cognitive function). Maternal malnutrition can also increase the risk of perinatal problems, including birth asphyxia, a major cause of neurologic damage and cerebral palsy. Macronutrient malnutrition can both cause and be caused by neurodisability. Mechanisms include decreased food intake, increased nutrient losses, and increased nutrient requirement. Specific micronutrient deficiencies can also lead to neurodisability, for example, blindness (vitamin A), intractable epilepsy (vitamin B6), and cognitive impairment (iodine and iron). Toxin ingestion (e.g., from poorly processed cassava) can cause neurodisability including a peripheral polyneuropathy and a spastic paraparesis. We conclude that there is an urgent need for nutrition and disability programs to work more closely together.

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Interaction between neurodisability and malnutrition

Diagram showing the interaction between decreased nutrient intake, increased nutrient loss, increased nutrient need/utilization, micronutrients, macronutrient, and anti-nutrients in the context of lifecycle vulnerabilities such as pregnancy, infancy, childhood, adolescence, adult, and old age.
Neurologically impaired children

Malnutrition often overlooked and inadequately managed.
Prevalence 46-90% in cerebral palsy
Etiology multifactorial
Nutritional and non-nutritional factors
Nutritional factors

Dietary intake

Nutritional deficiencies: Marked deficits can often observed in essential fatty acids and long chain polyunsaturated fatty acids, which are known to play key roles in brain development. Deficits in micronutrients such as iron, zinc, vitamin D and folate are common.

Altered energy requirements
Gastrointestinal disorders affecting nutrient intake
Dysphagia.
Gastrointestinal reflux
Constipation
Zinc supplementation for mental/motor development

Zn is essential for the formation and migration of neurons
Essential for the formation of neuronal synapses
Zn deficiency $\rightarrow$ neurotransmitter imbalances

There is no convincing evidence that zinc supplementation to infants or children results in improved motor or mental development.

Gogia S Cochrane review 2012
Iron therapy for improvement of psychomotor development and cognition in iron deficiency

There is no convincing evidence that iron treatment of young children with IDA has an effect on psychomotor development or cognitive function within 30 days after commencement of therapy. The effect of longer-term treatment remains unclear.

There is an urgent need for further large randomised controlled trials with long-term follow-up.

Wang B et al. Cochrane review 2013
Non-Nutritional factors

Intellectual disability
Anti-epileptic therapy: Gastrointestinal disturbances and Bone disease
Altered Energy Requirements (ER)

Resting energy expenditure (REE) significantly lower in most children with CP
Accurate estimate of ER is important for nutritional intervention
Often difficult to obtain in neurologically impaired children
Equations specific for cerebral palsy children are available
Best predictors of ER are fat-free mass and ambulatory status
Serum leptin levels (possible nutritional biomarker in children with CP)
Cerebral Palsy growth charts based on GMFCS

http://www.LifeExpectancy.org/Articles/NewGrowthCharts.shtml
ADHD ASD: Food for thought
Factors that influence gut microbiota in childhood

Maternal diet and obesity → Maternal infections and stress → Gestational age → Delivery mode → Early life infections and stress → Milk-feeding patterns → Complementary feeding/diet

Maternal gut microbiota → Placenta → Fetal exposure to microbes → Brain development

Antibiotics/Drugs → Altered gut microbiota (dysbiosis) → Brain function and behaviour → Optimal brain function and behavior

ADHD → Normal gut microbiota (eubiosis) → Genetically pre-disposed subject → Development of infant’s gut microbiota
Antibiotics in the first year of life and subsequent neurocognitive outcomes

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Keywords
Antibiotics, Attention deficit hyperactivity disorder, Cognition, Depression, Gut microbiota

ABSTRACT

Aim: There may be a link between disruption to the gut microbiota in early life and later neurocognitive outcomes. We hypothesised that antibiotic use in early life is associated with a detrimental effect on later neurocognitive outcomes.

Methods: Eight hundred and seventy-one European mothers and their children enrolled in the Auckland Birthweight Collaborative Study at birth. Information on antibiotic use during the first year of life and between 12 months and three-and-a-half years of age was gathered via maternal interview. Intelligence test scores and measures of behavioural difficulties were obtained when children were three-and-a-half years, seven years and 11 years of age.

Results: Antibiotic use in the first year of life was reported in 70% of the 526 children with antibiotic data assessed at age three-and-a-half years. Those who had received antibiotics had more behavioural difficulties and more symptoms of depression at follow-up. Results were consistent across all standardised psychologist administered tests, as well as parent rated, teacher rated and self-report measures.

Conclusion: This study demonstrates an association between antibiotic use in the first year of life and subsequent neurocognitive outcomes in childhood. If confirmed by further research, these findings could have implications for the use of antibiotics for minor illnesses in infancy.
MAL-ED Study

A Multinational and multidisciplinary approach to understand the relationship between enteric pathogens, malnutrition, gut physiology, physical growth, cognitive development, and immune responses in infants and children up to the age of 2 years in resource-poor environments
Microbiota targeted dietary interventions

- Rural vs. Western Diet
- Mediterranean diet
- Vegetarian/Vegan diets
- High-fiber diets
- High-fat diets
- High-protein diets
- Elimination diets (gluten-free and/or casein-free, food additive exclusion
  Oligoantigenic diet)
- Prebiotics and probiotic supplementation
### Elimination diets in ADHD

<table>
<thead>
<tr>
<th>Diet</th>
<th>Exclude</th>
<th>Main target</th>
<th>Meta-analyses</th>
<th>Conclusion efficacy</th>
</tr>
</thead>
</table>
| Gluten-free casein-free     | Gluten and casein (e.g., products containing wheat, oats, barley, or rye; and milk and dairy products)                                 | ASD         | No meta-analyses available (recent extensive review by Elder et al. [19]) | Results are inconclusive  
                           |                                                                            |                           | Weak evidence for any positive effects                                                | A subset of individuals may respond positively (e.g., those with gastrointestinal abnormalities) |
| Food additives exclusion    | Artificial food coloring  
                           | Artificial flavors  
                           | Artificial fragrances  
                           | Preservatives  
                           | Artificial sweeteners  
                           | ADHD         | Two recent meta-analyses [51, 18]                                                      | Small effects  
                           |                                                                            | Effects may not be specific to ADHD                                                 | Effects may depend on food sensitivity                                                |
| Oligoantigenic             | Antigenic foods (basic diet may be restricted to a few hypoallergenic foods: turkey, pears, rice, lettuce, water)                  | ADHD         | Two recent meta-analyses [51, 18]                                                      | Large effects including studies using proximal assessment, but small effects based on probably blinded assessment studies  
                           |                                                                            |                           |                                                                            | No information on long-term effectiveness                                                 |

Role of nutritional supplements in ADHD

Zinc, iron, and magnesium supplementation may reduce ADHD symptoms in children with or at high risk of deficiencies in these minerals. However, convincing evidence in this regard is lacking.

Lange KW Current Psychiatry Rep 2017
Polyunsaturated fatty acids for ADHD

Children and adolescents with ADHD have been shown to have significantly lower plasma and blood concentrations of PUFA and, in particular, lower levels of omega-3.

Overall, there is little evidence that PUFA supplementation provides any benefit for the symptoms of ADHD in children and adolescents. The majority of data showed no benefit of PUFA supplementation, although there were some limited data that did show an improvement with combined omega-3 and omega-6 supplementation.

Gillies D Cochrane 2012
Role of nutritional supplements in ASD

Several studies have tried to establish an association between nutritional elements such as folic acid or vitamin D and risk for ASD.

Studies are fundamentally limited by the fact that they have assessed the deficiency and/or the efficacy of supplementing these nutrients after developing ASD.

Single double-blinded RCT showed the efficacy of 4 months of vitamin D3 in ASD patients.

Saad K et al. Journal of Child Psychology and Psychiatry (2016)

Conclusions

Further clinical and in vivo studies are needed to better understand the mechanisms underlying the link between nutrition and child disability.

We conclude that there is an urgent need for nutrition and disability programs to work more closely together.