When and how to use fibre in paediatrics?

Help them develop by helping their little gut to work

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Dietary fibre is a familiar concept in health promotion and nutrition advice. Fibre is used as a preventative and treatment strategy for digestive health and a range of chronic diseases, including obesity, diabetes and cancer.[1] The public perceive fibre as natural and healthy; dietary guidelines throughout the world include recommendations to improve dietary fibre intakes.[1, 2] Research on dietary fibre has mostly been conducted on adults, and the results extrapolated for children and infants.[3] This article reviews the latest evidence for dietary fibre in infants and children, including its place in paediatric enteral feeds and supplements. The results from a fibre survey on UK paediatric dietitians are included and provide a valuable insight into the current practice in the UK.[4]

Definitions of dietary fibre

A universally accepted definition of dietary fibre does not exist. Historically, 'fibre' was used loosely to describe the edible part of a plant cell wall that is indigestible.[5] Recent definitions have taken into account the complexity and heterogeneity of different types of fibre and their biological, chemical and physiological characteristics.[6] Furthermore, synthetically made fibres (functional fibre), such as glucose polymers and modified starches, are now included in most definitions.[2, 6]

Dietary fibre includes carbohydrates or parts of a plant that are resistant to digestion and absorption in the small intestine and are partially or completely fermented in the large intestine.[2, 7] Types of dietary fibre can include cellulose, hemicellulose, oligosaccharides, pectins, inulin, resistant starch and non-carbohydrate components of plant cell walls, such as lignins, phytate and saponins.[6, 8, 9] Some definitions of fibre also include sugars that are incompletely absorbed, such as lactose and fructose.[3] **The box below** contains the SACN (2015) definition of dietary fibre. **Figure 1** summarises the groups of fibres present in the diet, found both naturally in food and as additives.[8]

A simple classification of fibre that is often used clinically divides fibres into their solubility. Fibres that are classified as soluble will dissolve in water and form a gel. Soluble fibres are readily fermentable by colonic bacteria. Some soluble fibres will have a 'prebiotic' effect. Insoluble fibre should not dissolve in water and, therefore, contributes more to faecal bulk. There are some exceptions to this – for example, insoluble soy polysaccharides may be well fermented, and some soluble fibres such as oat bran and psyllium can increase stool mass.[10, 11]

Did you know? In nature, most fibre-containing foods contain around one-third soluble and two-thirds insoluble fibre.[12]

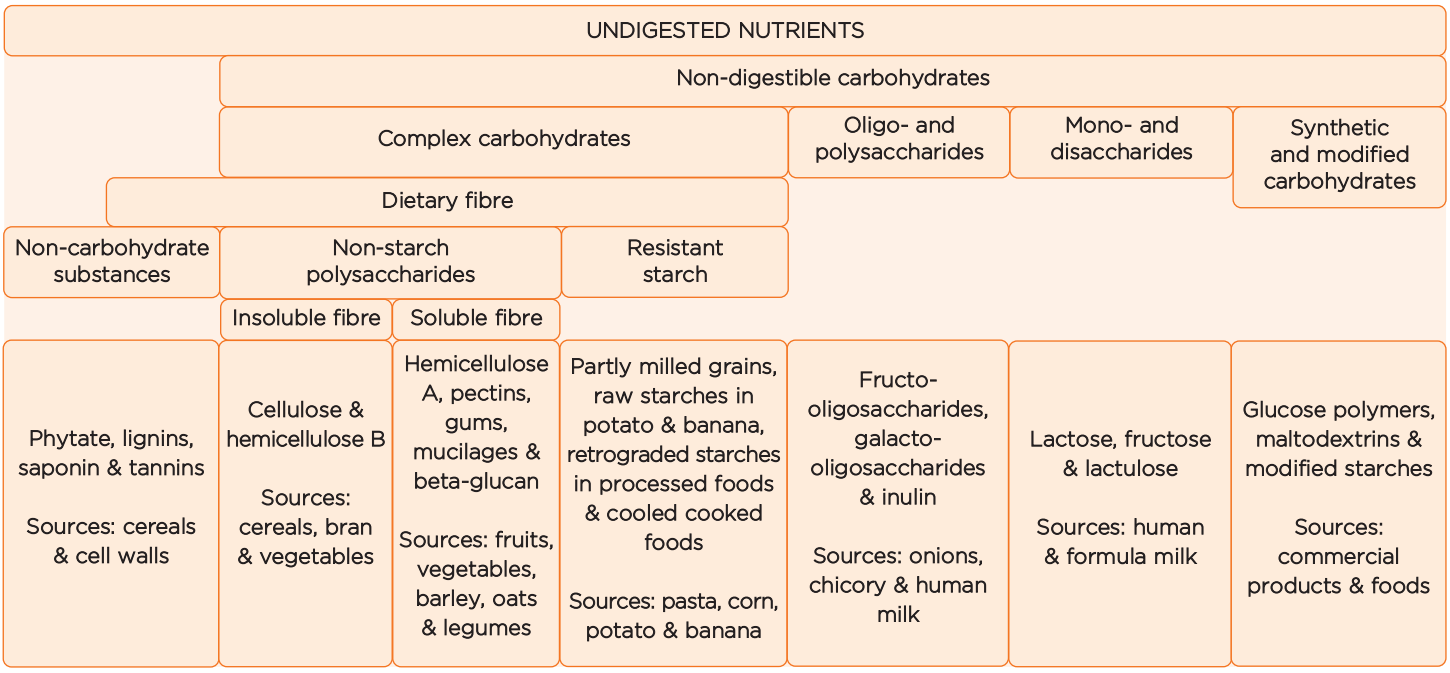
Limitations of the evidence

The lack of a clear definition of fibre has led to difficulties in establishing the health effects and recommendations for fibre intakes across all age groups. Studies using older definitions or different dietary collection and assessment methodologies have made it difficult to pool study data.[1] This applies to interpreting data from the National Diet and Nutrition Survey.[13] Another issue is that the type of fibre has different effects on gut physiology and health; one gram of fibre as a concept does not necessarily equate to particular levels of impact on health. Many studies test only isolated fibres as a supplement, making general dietary recommendations difficult.[14] A final caveat in interpreting the research on fibre is in extrapolating data from adult studies and applying them to children. 'Children are not little adults' and due to the developing gastrointestinal systems, fibre may have different actions on the gut and on health in children compared to adults.[3]

Definition of Dietary Fibre

Dietary fibre should be defined as all carbohydrates that are neither digested nor absorbed in the small intestine and have a degree of polymerisation of three or more monomeric units, plus lignin.' (SCAN, 2015).[2]

Figure 1: Classification of Fibre



Source: Adapted from Aggett *et al.* (2003)[8]

Fibre recommendations for infants and children

In the UK, the Scientific Advisory Committee on Nutrition (SACN) advises the government on dietary guidelines and heath. The 2015 SACN guidance on Carbohydrates and Health provides the most up-to-date UK recommendations on fibre.[2] This guidance is based on their new definition of fibre which covers a range of fibres – not just non-starch polysaccharides (NSP). **Table one** outlines the new SACN guidance.

Table One: Recommended Fibre Intakes[2]

Age group	Recommended fibre intake per day (g)
2-5 years	15
5-11 years	20
11-16 years	25
17 years +	30

For infants under the age of two, no quantitative recommendations exist. However, the guidance encourages a gradual introduction of a diverse range of fibre-containing foods from six months onwards.[2]

Previous guidance has been expressed either as a function of energy intake (e.g. 8.2-14 g/kcal/day) or age + 5-10 g fibre/day.[15] The American Academy of Pediatrics suggests 0.5 g fibre/kg/day for children over the age of two, with a maximum of 35 g/day.[14] Varying recommendations throughout the world highlight the lack of sufficient evidence to support a single 'gold standard' fibre recommendation.

Actions of dietary fibre

The actions of fibre can be summarised into four basic groups:

1. Gel-forming effects

Soluble fibres swell with water in the stomach and small intestine. This is thought to increase the viscosity of the gastrointestinal contents and slow gastric emptying and the absorption of nutrients like glucose. Soluble fibres, therefore, have a significant impact on the glycaemic index (GI) of foods. Some soluble fibres (such as oat fibre) can reduce the absorption of cholesterol and fat in the small intestine and bind bile acids to increase faecal excretion of cholesterol.[6]

2. Fermentation by colonic bacteria

Soluble fibres, including inulin, fructo-oligosaccharides and resistant starch, reach the large intestine largely unaltered, and are fermented by the colonic bacteria to produce hydrogen, methane, carbon dioxide, short-chain fatty acids (SCFA) – mainly acetate, propionate and butyrate, and lactate.[11] Prebiotics are defined as those fermentable fibres that stimulate the growth of indigenous bacteria – mostly bifidobacteria and lactobacilli, which are considered beneficial to health. Benefits include improvements in gut barrier function, the immune system, reduction of pathogenic bacteria (e.g. clostridia and *E.coli)* and enhanced SCFA production. Differences in the colonic microflora of atopic and normal infants have been reported, with suggestions that modulation of the colonic microbiome might benefit allergic children.[16]

Fermentable fibres that do not meet the definition of a prebiotic still provide benefits via production of SCFA. SCFA regulate sodium and water absorption, intestinal motility and epithelial growth.[8] Fibre has been found to reduce the incidence of diarrhoea and the mechanism for this is thought to be from SCFA-stimulated absorption of colonic water and electrolytes.[10] SCFA also lower the colonic pH, making the more acidic environment less favourable to pathogenic pH-sensitive bacteria.[11]

Fermentation sites can vary throughout the lumen of the colon. Some fibres, such as oat bran, guar gum and resistant starch, are fermented predominately in the proximal colon so the benefits may not be observed in the distal colon. However, combining fibres from different sources allows the benefits of fermentation to occur throughout the colon.[9]

3. Bulking effects

Fibre (particularly insoluble fibres such as wheat bran) is known to increase faecal weight. This is partly due to the physical presence of the fibre, and also because insoluble fibres have water-holding properties in the distal colon and bulk the stool this way. Fermentation furthermore increases bacterial mass. Breast-fed infants are known to pass a greater number of softer and larger stools in comparison to formula-fed infants, and the oligosaccharides in human milk could partly explain this.[8] Larger, softer stools can ease defecation and reduce gastrointestinal transit time which may help to prevent or relieve constipation.

4. Changes in other aspects of the diet

A fibre-rich diet typically ensues a nutrient-dense diet; high intakes of fruits, vegetables, legumes and wholegrains. The benefits of these for the prevention of obesity in adults are well known and improved glucose tolerance, decreased cholesterol and triglycerides have all been linked to fibre intake.[11] Fibre-rich diets may reduce the availability, digestion and absorption of fat and carbohydrates. Whilst this may be beneficial for weight control, concerns that fibre may impair growth and nutrient absorption have been raised when promoting fibre in the diets of infants and children.[8] Consuming very large amounts of fibre is likely to be harmful.[9] High quantities of fruit juices (containing non-digestible carbohydrates – fructose, sugar alcohols and pectins) are likely to cause diarrhoea in children, and reports of vegan children consuming large amounts of muesli have resulted in poor growth and mineral status.[8] However, national nutrition surveys of industrialised countries, including the UK, frequently show that children have poor fibre intakes and fail to achieve recommended intakes.[1, 13] Children with chronic illness are particularly at risk for poor fibre intakes.[17] Fears of the adverse effects of over-consumption of fibre, such as poor growth or iron-deficiency, are not well supported, except in cases of extreme intakes.[8]

The role of fibre in paediatric clinical practice

Digestive health

Fibre can be seen as having a moderating effect on bowel function – especially at either end of the spectrum – that is, in constipation or diarrhoea.[10]

Low fibre intakes have been implicated in the aetiology of functional constipation, difficulty with defecation (dyschezia) and in appendicitis in children.[3, 8] Increasing fibre intake to recommended intakes should be one of the first treatment options for functional constipation in healthy children.[18] Studies using isolated fibres – such as glucomannan, wheat bran, partially hydrolysed guar gum and cocoa husks – along with fibre blends in the treatment of childhood constipation have shown significant improvement and reduced need for laxatives, with less side-effects than lactulose.[6, 19, 20]

Tube and sip feeding

In a double-blind randomised crossover study, Evans *et al.* (2009) studied the effects of a fibre-containing enteral formula on 25 tube-fed children with a range of medical conditions (including cystic fibrosis, neurological conditions, liver transplant and bone marrow transplant).[21] Although the trial was relatively small, they found evidence of reduced constipation, less reliance on laxatives and decreased abdominal pain on the fibre-containing formula compared to the fibre-free formula.[21] The authors recommend that fibre-containing formula should be standard practice for the majority of children on tube-feeds.[21]

Similarly, the efficacy, safety and tolerance of fibre supplementation in paediatric sip feeds was studied in 60 children with chronic illness.[17] Laxative usage decreased in the fibre-containing sip feed group and, in addition, no abdominal symptoms such as flatulence, bloating or abdominal distention was reported.[17] The tolerance, anthropometry, nutritional biochemistry or haematology was not different between the two groups.[17]

Results from the fibre survey showed that 88% of UK paediatric dietitians reported that fibre is important for children with faltering growth.[4] The top three conditions listed by UK paediatric dietitians where a fibre containing feed or supplement is used are as follows: constipation, faltering growth and children with neurodisability (e.g. cerebral palsy).[4]

Chronic disease

In adults, higher intakes of dietary fibre have been linked to a reduced risk of chronic disease including: cardiovascular disease, Type 2 diabetes, some cancers and an association with lower body weight.[22] Improved glucose tolerance, reduced insulin requirements, decreased serum cholesterol and triglycerides and better weight control have all been reported in adults with diabetes who increase their fibre intake.[22] Whilst the evidence is lacking to confirm these benefits in childhood, it seems reasonable to recommend fibre in childhood for the foundation of adult health.[8]

Allergy

Emerging research on the health benefits of the gut microbiota link the probiotic benefits of fibre to the immune system, and the regulation of gene expression involved in carbohydrate and lipid metabolism.[23] Links between early health of the gut microbiota and the onset of allergy and obesity have been reported.[24, 25] More studies are needed to establish the direct effect of fibre on immune and metabolic programming, but it is an area of increasing research.

Conclusions

Fibre plays an important role in paediatric nutrition: promoting normal laxation and in the development of healthy colonic microbiota for long-term health. Whilst the clinical evidence for the use of fibre as a treatment for digestive conditions or chronic disease in children is not well known, fibre should be seen as an essential component of a child's diet and a priority for health promotion. It has been recommended that fibre-containing enteral formulas are used as standard practice for the majority of children with normal gut function requiring nutrition support.[21] This preference was reflected in a recent fibre survey on UK paediatric dietitians' practice.[4] Fibre intakes should be encouraged to reach the new SACN (2015) guidelines, which include fibre from a variety of sources.[2]

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