FOOD FOR THOUGHT

Fibre intake for optimal health: how can healthcare professionals support people to reach dietary recommendations?

Nicola M McKeown and colleagues advocate for the importance of translating the health impact of high fibre diets to patients and clients, with emphasis placed on incorporating a variety of plant based foods to achieve dietary fibre recommendations.

Historically, fibre was defined simply as plant “roughage,” and healthcare professionals might still be under the impression that fibre is a single entity. But, like most other nutrients, fibre is much more complex than it first seems, and most people today fall short of meeting dietary recommendations for this nutrient. Modern day diets are very different from those of our ancestors, which contained substantially more fibre because they consumed a variety of plant based foods. Ancestral humans might have consumed as much as 100 g of fibre daily. Today, adults in North America consume an average of 17 g of dietary fibre daily; intakes are slightly higher in European countries (18 g to 24 g a day). The definition of dietary fibre has evolved from “remnants of plant cells that are resistant to digestion by human enzymes” in the 1970s to the more complex global definition outlined in 2009 by the Codex Alimentarius Commission (box 1). Although there has been considerable debate over the past few decades about the terminology and analytical methodology used to define dietary fibre, most definitions now include carbohydrates with three or more monomeric units. This includes some well known prebiotic fibres, such as fructans and inulins. Despite scientific advances in the field, consumer confusion persists, and current intakes of dietary fibre fall short in many populations worldwide.

Box 1: Codex Alimentarius definition of dietary fibre

Carbohydrate polymers with 10 or more monomeric units* that are not hydrolysed by endogenous enzymes in the human small intestine, categorised as:

- Edible carbohydrate polymers naturally occurring in the food as consumed.

Not all dietary fibres are created equally

Consumers and healthcare professionals might not understand the complexity of dietary fibre, thinking that it is a single nutrient found in plant foods. Daily recommended fibre intakes and food labels refer to dietary fibre without considering the source, type, quality, or physiological effects. Additional complexity relates to the fact that isolated or synthetic fibres can be added to foods and beverages as ingredients, and the same fibres might have multiple names. Importantly, there are several distinct classes of fibre that deliver different health benefits. One key message for consumers and health professionals to understand is that, although all added fibres in foods contribute towards the recommended daily intake, different isolated fibres deliver different health benefits based on their physiochemical properties (solubility, viscosity) and physiological effects (fermentability).
Soluble, viscous fibres such as oat β-glucan, for example, reduce serum cholesterol and improve glycaemic control, whereas insoluble fibres such as coarse wheat and rye brans have a faecal bulking effect and might promote regular laxation. Dietary fibres are fermentable to some extent, but the degree to which they are fermented varies from low (cellulose, hemicelluloses, wheat bran) to moderate (β-glucans, gums, pectins, resistant starch) and high (prebiotic fibres such as inulin and oligofructose). A common misconception is that all insoluble fibres are entirely non-fermentable, but evidence indicates that the majority of fibres will result in changes in the composition of the microbiota, owing to competitive interactions.

Various authorities have recently evaluated the evidence linking isolated and synthesised fibre intake to physiological benefits for health (box 2).

### Box 2: Physiological health benefits attributed to isolated or synthetic fibres
- Lower blood glucose levels
- Reduce postprandial blood glucose or insulin levels, or both
- Lower total or LDL cholesterol levels, or both
- Lower blood pressure
- Improve laxation
- Decrease transit time
- Increase gastrointestinal mineral absorption

Natural fibres containing foods such as fruits, vegetables, legumes, and whole grains have long been known to deliver health benefits that can be attributable to dietary fibre, the diverse array of nutrients and phytochemicals found in these foods, and synergistic interplay between the two. Strong evidence from observational studies shows that populations with a large proportion of plant based, fibre rich diets (vegans, vegetarians) or those whose dietary patterns are characterised as being high in plant foods have greater protection against developing chronic disease.

### Current recommendations and dietary intakes

Recommendations around adequate intakes of dietary fibre differ around the world and by age group, but 25-30 g or more daily is widely recommended for adults. Recommended intakes were established as those required for maintaining normal laxation and cardiovascular health, although emerging evidence points to benefits extending well beyond these through modulation of the gut microbiota. In Europe and North America, grain based foods are the predominant contributors to dietary fibre, followed by vegetables, potatoes, and fruits, with little contribution from legumes, nuts, and seeds.

Strikingly, a comprehensive overview of dietary fibre recommendations versus actual intakes found that only a small

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proportion of the global population meets the recommendations for dietary fibre intake. Why is this? In most countries, dietary guidelines emphasise foods rather than nutrients, and most people are not meeting the food based recommendations for fruits, vegetables, legumes, and whole grains, thereby falling short of their dietary fibre intake. People are unlikely to understand the type or quantity of individual foods or food combinations needed to achieve recommended dietary fibre intakes. Coupled with this, some consumers do not recognise the contribution of whole grains to fibre intake, and others do not know how to identify wholegrain, compared with refined grain, products. Despite the purported health benefits of dietary fibre, many consumers are eating highly processed, refined grains and too few fruits and vegetables, and some consumers might actively avoid carbohydrate rich foods for the health benefits purportedly associated with low carbohydrate diets. People in both situations are likely to fall short of meeting fibre recommendations. Examples of food sources of dietary fibre can help health professionals guide patients on selecting nutritious, carbohydrate based foods with a diversity of dietary fibre types. Advice should emphasise consuming adequate amounts of dietary fibre from various plant foods that are naturally high in fibre (box 3).

Box 3: Reaching fibre recommendations: eat a variety of plant based foods

- Global recommendations are to increase fruit and vegetable intake, specifically:
  - World Health Organization: at least 400 g (five portions) of fruit and vegetables a day
  - USA: two cups of fruit and 2.5 cups of vegetables for adults on diets aiming for 2000 kcal a day
  - UK: five a day programme (two fruit and three vegetables of 80 g each a day)
- Meal plans with a target of 2000 kcal daily show that adults need to eat a variety of whole grains, legumes, nuts and seeds, and fruits and vegetables at meal and snack times to reach a target of 30 g or more fibre a day
- Refined grain products—now widely consumed but containing low fibre levels—should be replaced with high fibre wholegrain products

- Legumes (pulses) are recognised as a protein source but are often overlooked as a source of fibre, with half a cup of cooked legumes (85 g) containing, at a minimum, 4.5 g of dietary fibre
- Adding one tablespoon of flax or chia seeds to salads or oatmeal will provide an estimated extra 3 g or 5 g of fibre, respectively.
- Check nutrition labels to identify fortified high fibre cereals—some wheat or bran based products might have up to 11 g of dietary fibre per serving
- Isolated fibres might be added to food products, most often for technological reasons (such as adding pectin to jam to make it firmer)
- Foods with ≥3 g of fibre per 100 g, ≥1.5 g per 100 kcal, or ≥10% of daily reference value per serving can be named a “good source of fibre.” If twice as much fibre is present, they can be called “high fibre.”
- Further information on reaching fibre goals: https://www.bda.uk.com/resource/fibre.html

**Health benefits of fibre**

Observational studies show that higher fibre intake has a strong protective association against risk of developing several chronic diseases, including cardiovascular disease, stroke, type 2 diabetes, colorectal cancer (fig 2a) and diverticular disease. In addition, a higher intake of fibre is linked to lower rates of cardiovascular disease and disease specific and all cause mortality (fig 2b). Consistent with this, based on two meta-analyses of data from prospective cohort studies, a 15-16% reduced risk of all cause mortality was found among people who consume high levels of fibre compared with those who consume lower levels. These analyses indicate that daily fibre intakes of 25-29 g are adequate, and intakes greater than 30 g a day would be even more beneficial. A growing number of people are following elimination diets that exclude fibre rich whole grains, such as “paleo,” “keto,” and gluten-free diets, and it is important to recognise that these people will lose the protective mechanisms linked to these foods, such as the cholesterol lowering and improved glycaemic control. Observational evidence indicates that higher intakes of fibre from cereal sources (that is, primarily whole grains) seem to provide a greater degree of protection against the development of type 2 diabetes (fig 2c). The observed protective associations are unlikely to be caused solely by the fibre subtypes, but rather arise from the interaction with the gut microbiota or the insulin sensitising nutrients found in whole grains.
Fibre and gut health

The relation between gut microbiota and health has been extensively researched over the past decade. Many aspects of diet have been correlated with changes in microbiota composition, but dietary fibres have been identified as a critical determinant of gut microbiota composition and function. Fermentable fibres have been shown to result in distinct differences in gut microbiome composition and the production of healthy metabolites. More recently, research has shown that differences in gut microbiota composition between people lead to variability in how different fibres are fermented. Short chain fatty acids (butyrate, propionate, and acetate) derived from fermentation are crucial to health. These metabolites not only provide food for the colonic epithelium but can also be absorbed through the epithelium and potentially deliver a wide array of other physiological health benefits throughout the body.

**Box 4: Health promoting functions of short chain fatty acids**

**Acetate**
- Appetite regulation
- Enhances mucosal production and secretion

**Propionate**
- Promotes goblet cell differentiation and expression of mucin related genes
In terms of “gut health,” short chain fatty acids support the immune system and help provide mucosal protection through enhancement of mucosal secretion and anti-microbial peptides. Decreased diversity in the gut microbiota, in the context of low fibre diets, not only leads to reduced short chain fatty acid production but also an increase in the amount of mucin degrading bacteria. This might lead to inflammation and make the gut susceptible to pathogenic microbe exposure or pro-inflammatory and carcinogenic metabolites, potentially leading to an increased risk of colorectal cancer (fig 3).
Fibre and inflammatory bowel disease

The implications of all sources and types of dietary fibre in the development of inflammatory bowel disease (comprising Crohn’s disease and ulcerative colitis) remain largely unknown. There is limited evidence to indicate that low fibre diets or eliminating fibre rich foods is therapeutically beneficial for the prevention or management of inflammatory bowel disease. Despite this, people with inflammatory bowel disease reportedly eat less total fibre than the general population, and this might in part be attributed to medical advice to reduce fibre intake. A recent meta-analysis of data from six cohort studies found no protective association between dietary fibre and risk of ulcerative colitis, but greater fruit and vegetable intake led to a 41% reduced risk in developing Crohn’s disease. Thus, in terms of prevention, consuming a high fibre diet that includes vegetables, fruits, whole grains, and beans is...
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Another strategy is to also target an increase in legume intake,
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consumers to choose recommended foods including fruits,
There is little research focused on strategies specifically designed
phytochemicals that might work synergistically with fibre.
with the properties and physiological health benefits described
above, as well as many other important nutrients and
phycotoxins that might work synergistically with fibre.

Policy suggestions to fill the fibre gap
There is little research focused on strategies specifically designed
target increasing dietary fibre intake in the population. Fibre is
generally listed on processed foods, giving consumers that ability
to choose foods rich in fibre. Closing the fibre gap will require
consumers to choose recommended foods including fruits,
vegetables, whole grains, and legumes. Many public health
campaigns have promoted increasing these food groups with limited
success. Continued recommendations to focus on increasing intakes
of these fibre rich food groups are appealing to consumers and
should result in increased fibre intakes.

Another strategy is to also target an increase in legume intake,
which remains low with typical intakes of less than one serving a
day. Recommendations to make half your grains whole and choose
one pulse serving a day are more actionable for consumers. Policy
changes that could improve fibre intake in the population include
providing incentives to manufacturers to increase the availability
of wholegrain and legume products, improving labelling (for
example, on the front of packets), and increasing consumer outreach
and education on the health benefits of fibre. Recent data from the
United States indicate that consumers are still purchasing food
products that contain substantially more refined grain than whole
grain products, particularly those in lower income households or
households with children. Consumer preference towards refined
grain products is largely sensory based; thus, production of wheat
varieties high in fibre, such as high amylose wheat, that retain the
characteristics of white flour offer one strategy to increase fibre
intake.42

Conclusion
The evidence is strong that healthy diets, in which fibre content is
aligned with dietary recommendations, are protective against the
development of cardiovascular disease, diabetes, cancer, cancer
mortality, and all cause mortality.43
There is universal agreement among health professionals that fibre is
an important component of the diet, and the health benefits of
high dietary fibre containing diets have been recognised for some
time.44 Many potential mechanisms are recognised to mediate the
effects of high dietary fibre on health, either independently or
synergistically with phytochemicals and nutrients in the food
matrices. Continued research is needed to examine the mechanisms
by which microbial diversity and changes in gut microbiota activity
and bacterial enzymes influence health. In the future, experts might
consider personalised dietary recommendations based on an
individual’s gut microbiota composition.45 Increasing intake of
dietary fibre is a highly promising nutritional target that might
reduce risk of non-communicable diseases worldwide. But there is
continued need for healthcare professionals and researchers to
emphasise that fibre is a dietary component of public health
concern, and there is an urgent need for policy efforts to target
increasing dietary fibre intake in the population.

Key messages
• Higher intake of dietary fibre is associated with lower risk of several non-communicable diseases
• Globally, dietary fibre intake is low, and there is a continued need for dietary advice to focus on incorporating a variety of fibre rich foods into one’s diet
• Isolated and synthetic dietary fibres have different physiological health effects
• Different types of fibre influence the gut microbiota composition, and changes in composition potentially deliver a diverse array of health benefits

Contributors and sources: The author group spans a wide range of expertise from nutritional epidemiology and public health to food technology, microbiology, and regulatory affairs. All authors have published in the area of dietary fibre and health, and JS, GCF Jr, and JvdWK are renowned experts in the fibre field. GCF Jr has expertise in fibre analysis and digestive physiology; JS has expertise in the role of fibre and whole grains (among other aspects of diet) in health and disease; JvdWK has expertise in food technology, microbiology, and regulatory affairs. NMM has expertise in diet and cardiometabolic disease risk. Sources of information for this article included systematic reviews and primary research articles based on randomised clinical trials, or prospective observational study designs as well as dietary guidelines. All authors contributed to drafting this manuscript, with NMM taking the lead role in writing the manuscript, and all authors providing intellectual input to improve the manuscript, as well as reading and approving the final version. NMM is the guarantor of the manuscript.

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