

## Guidance on Fibre, Wholegrain Cereals and Cancer Risk

### **Key Messages**

Consumption of fibre and wholegrain cereal foods are associated with a lower risk of common lifestyle diseases such as obesity, type 2 diabetes and cardiovascular disease. Evidence is now building for the importance of including wholegrain foods regularly in a diet that reduces cancer risk.

Dietary fibre *probably* decreases the risk of colorectal cancer, and there is *limited suggestive* evidence it may also be associated with a lower risk of oesophageal cancer. There is insufficient evidence on dietary fibre to make a conclusion regarding other cancers, such as breast, prostate and ovarian.

Dietary fibre occurs naturally in foods such as wholegrain cereals, fruit, vegetables, seeds, nuts and legumes. Fibre is the edible part of plants resistant to digestion and absorption in the small bowel of humans.

Wholegrain and wholemeal cereal foods are those that include the outer layers of the grain, including the bran and germ. Products made from whole grains, such as wheat, brown rice, corn, oats, rye, barley, millet and sorghum are an important part of a healthy diet as they are excellent sources of vitamins, minerals, protein, dietary fibre and protective phytochemicals.

Dietary fibre is encouraged as part of a varied and nutritious diet. Current recommendations are for women to eat 25g of dietary fibre per day and men to eat 30g per day.

The Cancer Society recommends people aim to ensure that **half** their daily serves of breads and cereals are either wholegrain or wholemeal varieties (in general this means eating **at least two serves** per day) and to eat **at least two serves** of fruit per day and **five serves** of vegetables per day including legumes. This advice is consistent with national recommendations including the Food and Nutrition Guidelines for Healthy Adults and the Recommended Dietary Intakes included in the Nutrient Reference Values for Australia and New Zealand .<sup>53, 55</sup>

As the benefits of fibre may be from the combination of nutrients working together, it is recommended that whole foods be consumed rather than a dietary fibre supplement.

## Background

Dietary fibre is found in foods such as wholegrain cereals, fruit, vegetables, seeds, nuts and legumes such as peas, beans and lentils (Table 1).<sup>1</sup>

Table 1. Average fibre content of different foods

Food	Fibre (g) per 100g
Wheat bran	45.4
Oat bran	15.9
Sunflower seeds, raw	10.8
Date, dried	9.7
Rolled oats	9.5
Almond, raw	8.8
Apricot, dried	7.7
Dark rye bread	7.1
Red kidney bean, canned	6.5
Cashew, raw	5.9
Wholemeal pasta, boiled	5.3
Wholemeal bread	5.0
Wholegrain bread	4.8
Sultanas	4.4
Lentil, boiled	3.7
Broccoli	3.6
White bread	2.8
White pasta, boiled	2.7
Pear, unpeeled	2.4
Apple	2.3
Pumpkin, peeled	1.8
Brown rice, boiled	1.5
White rice, boiled	0.4

The Australia New Zealand Food Standards Code defines fibre as the fraction of the edible parts of plants or their extracts, or synthetic analogues, that are resistant to digestion and absorption in the small bowel, usually with complete or partial fermentation in the large bowel.<sup>2</sup>

Dietary fibre includes polysaccharides, oligosaccharides and lignins, and promotes one or more of the following beneficial physiological effects: laxation; reduction in blood cholesterol; and modulation of blood glucose.<sup>2</sup> Dietary fibre can be added to foods, such as white bread to increase fibre content.

Fibre can be categorised into soluble and insoluble fibre. Insoluble fibre, mostly from wheat and wheat products, acts to increase faecal bulk thereby aiding laxation.<sup>3</sup> Soluble fibre, which is found in oats, fruit and vegetables, slows down the release of nutrients thereby helping to modulate glucose absorption.<sup>4</sup> Soluble fibre also stimulates bile acid excretion which can lower cholesterol levels.<sup>5</sup>

Dietary fibre, especially soluble and resistant starch, also promotes anaerobic fermentation in the large bowel resulting in the production of short chain fatty acids and gases, such as carbon dioxide, hydrogen and methane.<sup>6</sup> Short chain fatty acids are believed to enhance colonic function and protect against chronic disease. In addition, fibre decreases intracolonic pH, which influences the growth of bacterial populations and this may reduce absorption of carcinogens.<sup>7</sup>

Resistant starch, a component of dietary fibre, is the fraction of ingested starch which survives digestion in the human small bowel and passes to the large bowel

where it is fermented by the resident microorganisms.<sup>7</sup> Resistant starch is found in certain foods, such as beans, cold cooked potatoes, brown rice, green bananas and food ingredients such as wholegrains and high amylose starches.<sup>7</sup>

### **Wholegrain cereals**

Wholegrain and wholemeal cereal foods are high in dietary fibre. These are foods that include all fractions (including the bran, germ and endosperm) of grains, such as wheat, rice, corn, oats, rye, barley and millet.<sup>8</sup>

Wholegrains are defined by the Australia New Zealand Food Standards Code as:<sup>2</sup>

- whole and intact grains as found in some bread and crisp breads
- puffed or flaked grains in some breakfast cereals
- coarsely milled or kibbled wheat found in breads such as pumpernickel or
- ground grains, such whole wheat flour used to make whole meal bread.

Wholemeal foods are made from wholegrains which have been milled to a finer texture rather than leaving them whole in the final product. Nutritionally, wholegrain and wholemeal foods are similar, but wholegrain foods are generally higher in resistant starch.

Wholegrain products contain more fibre, vitamins and minerals, and protective phytochemicals than refined cereal grain foods because many of the potentially beneficial nutrients and phytochemicals occur in the outer layers of grains.

### **Rationale**

There is good evidence that the consumption of fibre and wholegrain cereal foods is associated with a lower risk of common lifestyle diseases, such as obesity, type 2 diabetes and cardiovascular disease.<sup>9</sup>

Cancer risk can be influenced by lifestyle factors such as body weight, physical activity and diet. Evidence is building for the importance of eating a diet high in dietary fibre, including resistant starch and wholegrain foods in order to help lower the risk of certain cancers.

There has been some confusion regarding the role of fibre in reducing the risk of cancer, particularly fibre's role in colorectal cancer. Descriptive studies about the role of wholegrain foods in reducing the risk of cancer date back to the 1930s when a protective association was found between a range of foods, including wholemeal bread, and cancer risk in a UK population.<sup>10</sup>

In the 1970s it was hypothesised that dietary fibre protected against colorectal cancer, when low rates of the disease were observed in Africa, where fibre intakes were believed to be very high and refined carbohydrate intakes very low.<sup>11</sup> However, subsequent analyses of the diets of African populations at low risk suggest that their intakes of total dietary fibre are not high by international standards, but consumption of resistant starch was high.<sup>12</sup> Since then some large observational studies and randomised controlled trials (RCTs) have supported the dietary fibre hypothesis, but others have not. Ecological and animal studies have also shown support for a role of dietary fibre in cancer, specifically colorectal cancer risk reduction.

Methods for measuring cereal food intake have improved over the last decade, and this has provided more reliable epidemiological evidence.

Therefore, it is important for the Cancer Society to evaluate the current evidence regarding dietary fibre and wholegrains, and make clear recommendations based on the available scientific evidence. The evidence for the beneficial role of fibre in cancer reduction mostly relates to colorectal cancer, and there have been some suggestive benefit links made for breast, prostate, ovarian and oesophageal cancer reduction.

Fruit and vegetables are another good source of dietary fibre. There is evidence that some types of vegetables and fruits, in general, probably protect against a number of cancers; however that evidence relates to micronutrients in the fruit and vegetables rather than the fibre content.<sup>14</sup>

### **Evidence from Major Reviews of the Epidemiological Literature**

In 1998 the United Kingdom Department of Health's Committee on the Medical Aspects of Food & Nutrition Policy (COMA) concluded that:<sup>13</sup>

- moderately consistent evidence exists to suggest that higher intakes of dietary fibre are associated with lower risk of colorectal cancer
- epidemiological studies examining the relationship between dietary fibre and the risk of breast cancer have reported conflicting findings.

In 2003, an expert report by the World Health Organization (WHO) and Food and Agriculture Organization concluded that fibre *possibly* decreased the risk of colorectal cancer.<sup>9</sup>

In 2007 the World Cancer Research Fund (WCRF) reported on food and the prevention of cancer.<sup>14</sup> This report found that fibre *probably* decreased the risk of colorectal cancer (Figure 1 and 2), and there was *limited suggestive* evidence that fibre decreased the risk of oesophageal cancer.<sup>14</sup> Meta-analysis was possible on eight cohort studies investigating colorectal cancer (Figure 2), and a dose-response relationship was apparent from cohort data.<sup>14</sup>

### **Evidence from Epidemiological Studies**

#### ***Colorectal cancer***

Results from RCTs and observational studies have been mixed for dietary fibre and colorectal cancer.

Most cohort studies show that dietary fibre decreases the risk of colorectal cancer,<sup>15-20</sup> while an RCT found a weak protective association between dietary fibre intake and adenomas, the precursors of colon cancer.<sup>21</sup>

The European Prospective Investigation into Cancer (EPIC) study found a significant dose dependent inverse association between colorectal cancer risk and population specific measures of dietary fibre intake.<sup>22</sup> A pooled analysis of 13 other cohort studies found a weak inverse association between dietary fibre and colorectal cancer risk.<sup>23</sup> Female based cohort studies have found a weak inverse association between colorectal cancer and dietary fibre<sup>24</sup> and an inverse association for colon cancer and wholegrain consumption.<sup>25</sup>

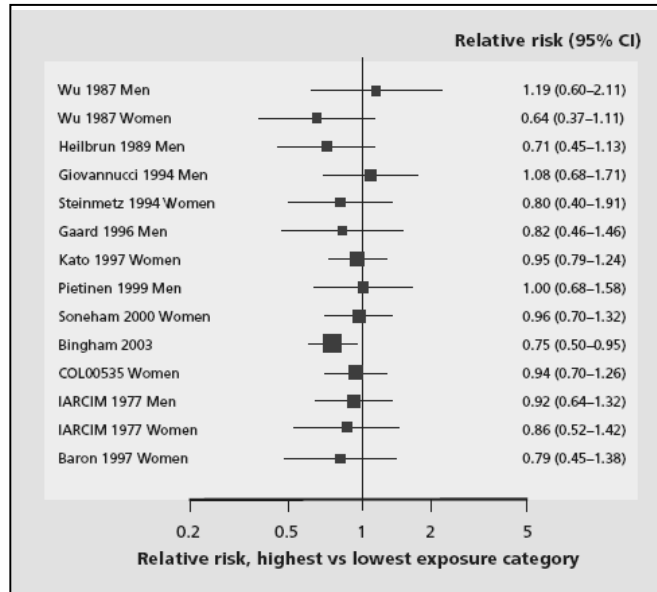


Figure 1. Results from cohort studies on dietary fibre, for highest versus lowest exposure category, and colorectal cancer as reported by the World Cancer Research Fund.<sup>14</sup>

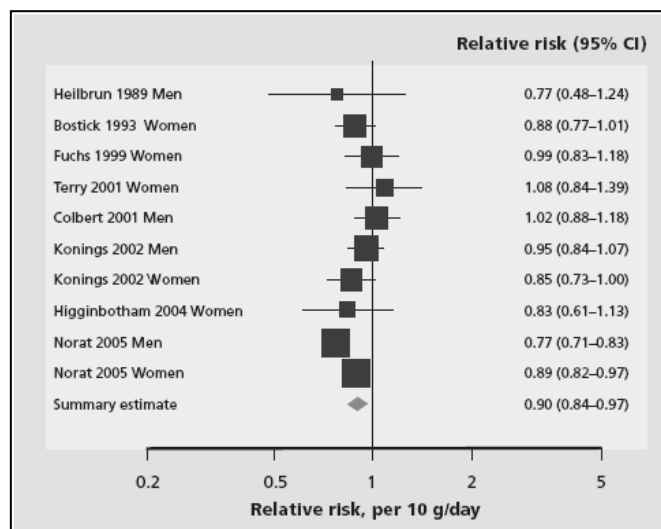


Figure 2. Results from cohort studies on dietary fibre, per 10g/day, and colorectal cancer as reported by the World Cancer Research Fund.<sup>14</sup>

A meta-analysis of 40 case-control studies on 20 cancers found an inverse association in 9 out of 10 studies for wholegrain intake and risk of colorectal cancer or polyps.<sup>26</sup>

However, a Cochrane review of RCTs<sup>27</sup> and a cohort study in male smokers<sup>28</sup> found no association between dietary fibre intake and the risk of colorectal cancer. A pooled analysis of two RCTs shows there is no association between dietary fibre and the risk of adenomas.<sup>29</sup>

One RCT found a weak positive association between colorectal cancer recurrence and a high fibre diet.<sup>30</sup>

There have been a few other studies that have not supported the dietary fibre hypothesis.<sup>10</sup> However, in these studies there have been a number of difficulties with the results including subject compliance with a high fibre diet, failure to separate cereal fibre from legume fibre, and difficulties in drawing relevant conclusions relating to cereal fibre due to differences in fibre content of supplements versus wholefoods.

Some studies have shown that fibre supplements do not protect against recurrent colorectal adenomas, and the reason for this is unclear. The Australian Polyp Prevention Trial suggested wheat-bran supplementation was associated with an increased risk of recurrence for adenomas of any size.<sup>31</sup> In addition, a multicentre study that tested the effect of diet supplementation with ispaghula (psyllium) husk found that it significantly increased the risk of adenoma recurrence.<sup>32</sup> Another trial found that wheat-bran supplementation had no significant protective effect against recurrent colorectal adenomas.<sup>33</sup>

However, a protective effect of fibre supplementation on the later stages of carcinogenesis cannot be ruled out. In addition, these studies may be showing a differential role for different components of dietary fibre in anti-carcinogenesis that may be worthy of further investigation. Hence further studies are required to address these issues.

Therefore, in summary, it is reasonable to conclude from the current epidemiological evidence that dietary fibre from food sources *probably* decreases the risk of colorectal cancer.

### ***Oesophageal cancer***

Results from a single cohort study<sup>34</sup> and several case-control studies<sup>35-38</sup> indicate that dietary fibre decreases the risk of oesophageal cancer. Another two case-control studies show wholegrain cereal consumption is linked to a lower risk of oesophageal cancer.<sup>39, 40</sup>

Overall, the limited number of studies on oesophageal cancer have determined that there is a *suggestive* link between fibre intake and decreased oesophageal cancer risk.

### ***Breast cancer***

The epidemiological evidence for fibre offering protection against breast cancer is not strong. The results from four cohort studies indicate that there is no relationship between the consumption of dietary fibre and the risk of breast cancer.<sup>41-44</sup> One cohort study found no association between wholegrain intake and ER negative post-menopausal breast cancer.<sup>45</sup>

One cohort study found a significant inverse association between the consumption of dietary fibre and risk of breast cancer,<sup>46</sup> while a case-control study found a significant negative association between wholegrain cereal consumption and breast cancer risk.<sup>47</sup>

Therefore, more research is required to establish if a relationship exists between dietary fibre and breast cancer before a conclusion can be made.

### ***Prostate cancer***

Few studies have investigated dietary fibre intake and prostate cancer risk. A multi-centre case-control study in Italy found no association between total fibre

and prostate cancer risk.<sup>48</sup> Another case-control study showed that wholemeal bread was marginally protective against prostate cancer in men less than 70 years.<sup>49</sup> Rye bran has been shown to be protective in the rat prostate cancer model,<sup>50</sup> but no human intervention studies have been undertaken.<sup>10</sup>

Hence epidemiological evidence is currently insufficient to make a conclusion regarding prostate cancer risk and consumption of dietary fibre.

### ***Ovarian cancer***

The relationship between types of fibre and ovarian cancer risk was investigated in an Italian case-control study.<sup>51</sup> A significant protective effect on ovarian cancer incidence was observed in the highest quintile of total fibre intake.<sup>51</sup> An inverse relationship to ovarian cancer risk was found for vegetable fibre, while no effect of fruit fibre was observed and a positive relationship was found for grain fibre.<sup>51</sup> However, the presence of other components in these foods means these results are not a good indication of fibre and cancer risk alone.

Therefore, as not many epidemiological studies have examined the association, there is insufficient evidence to make a conclusion about ovarian cancer and dietary fibre.

### **Probable Metabolic Mechanisms**

It is likely that the various components of dietary fibre and their associated phytochemicals work in combination to protect against cancer. Possible mechanisms related to fibre and how it may be providing cancer protection include:<sup>10</sup>

- increasing stool bulk, which decreases transit time thereby reducing possible exposure of the colonic epithelium to potential carcinogens
- binding toxic or mutagenic metabolites, which may promote cell proliferation
- lowering faecal pH, which prevents the conversion of primary bile acids into secondary acids which are potential carcinogens
- altering bacterial fermentation and increasing short chain fatty acid production, such as butyrate, which promote a normal phenotype in colonocytes
- lowering insulin levels, thereby preventing insulin resistance, as elevated circulating plasma insulin has been associated with colon and breast cancers.

Other suggested mechanisms include:

- antioxidant properties of phytochemicals such as phytates and phenolics, which can prevent the production of active oxygen species and reduce the effects of free radical damage on DNA.<sup>10</sup>
- cancer inhibitory action of phytosterols, which can help boost immune recognition of cancer, influence hormonal dependent growth of endocrine tumours and alter sterol biosynthesis.<sup>52</sup> In addition, phytosterols can directly inhibit tumour growth by slowing down cell cycle progression, inducing apoptosis and inhibiting tumour metastasis.<sup>52</sup>
- effect of high fibre wholegrain foods on controlling energy intake and body weight, as they are low in fat and can help increase satiety.<sup>53</sup> Overweight and obesity have been linked to an increased risk of cancer of the endometrium, kidney, breast (only in post-menopausal women), colon, oesophagus and pancreas.<sup>14</sup> Other cancers also thought to be associated with body weight include cancer of the gallbladder and liver.<sup>14</sup>

### **Potential Adverse Effects of Wholegrain Consumption**

Potential adverse effects of wholegrain foods must be taken in context with the rest of the diet. In theory, wholegrains may reduce the availability of minerals due

to the binding of fibre and phytic acid to minerals. However the consumption of wholegrains within recommended fibre intakes has not shown adverse effects on nutrient mineral status.<sup>54</sup>

### **Recommendations**

Although the evidence is not strong for the protective role of dietary fibre and colorectal cancer risk, dietary fibre should be encouraged as part of a varied and nutritious diet. Current recommendations in the Nutrient Reference Values for Australia and New Zealand are for women to eat 25g of dietary fibre per day and men to eat 30g per day.

Recommended intakes for children range from 14g per day for 1 - 3 years, 18g for 4-8 years, 24g for 9 - 13 years boys, 20g for girls of the same age and 22g (girls) and 28g (boys) for 14 - 18 years.<sup>55</sup>

Substituting wholegrain and wholemeal cereal foods for refined cereal foods in at least half the daily bread and cereal serves could achieve the dietary fibre intake goal, increase intakes of protective phytochemicals found in the outer grain layers, and, therefore, contribute to colorectal cancer risk reduction. Increasing intake of fruit, vegetables and legumes could also help achieve the dietary fibre intake goal and provide additional important phytochemicals.

Therefore, the Cancer Society recommends people aim to:

- ensure that **half** their daily serves of breads and cereals are either wholegrain or wholemeal varieties. In general this means eating **at least two serves** per day
- eat at least **two serves** of fruit and **five serves** of vegetables, including legumes, daily.

This advice is consistent with national recommendations from the Food and Nutrition Guidelines for Healthy Adults, which recommends people "eat plenty of cereals, preferably wholegrain" and "eat plenty of vegetables and fruits".<sup>53</sup> The guidelines recommend **6 serves** per day of cereal foods for adults.

As the benefits of fibre may be from the combination of nutrients working together it is recommended that whole foods be consumed rather than a dietary fibre supplement.

### ***What is a serve of cereal food?***

A sample serve of cereal or bread is as follows:<sup>53, 60</sup>

- 1 slice of bread
- 1 medium slice rewena bread
- 1 medium bread roll
- 1 cup of cooked rice, pasta or noodles
- 1/2 cup of cooked porridge
- 1 cups of breakfast cereal (flakes)
- ½ cup of untoasted muesli
- 1 cup cassava or tapioca.

### **What is a serve of fruit and vegetables?** <sup>60</sup>

A serve of fruit equals:

- 1 medium fruit (apple, banana, orange, pear)
- 2 small pieces of fruit (apricots, kiwifruit, plums)
- 1/2 cup diced pieces or canned fruit
- 2 tablespoons sultanas, 4 dried apricot halves
- 1cup (250mL) fruit juice.

A serve of vegetables equals:

- 1 medium potato, kumara or other similar sized root vegetable, e.g. taro, yam
- ½ cup cooked vegetables
- ½ cup salad or mixed vegetables
- 1 tomato.

### **Current Consumption Levels in New Zealanders**

Dietary survey data shows that New Zealanders are consuming less than the current recommended level of dietary fibre. The National Nutrition Survey showed that in 1997, \* women were eating approximately 18g of fibre per day and men about 23g per day.<sup>56</sup>

Survey data from children the 2002 National Children's Nutrition Survey (5- 14 years) found mean intakes of 18.4g per day with intakes for the older children being below recommended levels.<sup>57</sup>

Studies have shown that people consuming higher quantities of wholegrain cereals tend to be older, have a higher socio-economic background, are less likely to smoke and more likely to exercise.<sup>19, 24, 59</sup>

Therefore, many New Zealanders need to increase their intake of dietary fibre, and health promotion programmes should continue to encourage the consumption of wholegrain foods.

### **Future Research**

Additional studies on fibre, wholegrain cereals and cancer risk are needed. In the future, there is a need for more:

- Well designed observational studies on diet and cancer
- Studies that explore the mechanisms of action of food bio-actives (i.e. investigate different components in wholegrain cereal foods, such as lignans, oligosaccharides, amylase and protease inhibitors) to help establish mechanisms of action and thereby supportive evidence of observational effects
- Research that helps link knowledge of causal pathways with pathology of cancer at various sites, in particular paying greater attention to the influence of wholegrain cereal intake on cancers at sites other than the colorectum
- Investigation into the effect of specific foods in the context of the whole diet and lifestyle factors such as physical activity and the environment<sup>1</sup>.

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\* At the time of developing this guidance statement, the last National Nutrition Survey in New Zealand was conducted in 1997

<sup>1</sup> Such as the effect of co-consumption of fat and fibre and the impact on cancer risk, whether high wholegrain intake can counteract other negative dietary factors, or if there are specific grains in particular that are more beneficial.

In addition, food databases need to be updated regularly with regard to the dietary fibre content of foods, and to accurately reflect the wide variety of cereal foods now available. Consumers also need greater assistance to identify wholegrain foods in the market place. Improvements in how these foods, which meet overall criteria for healthiness, are identified on labels would be one possibility.

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