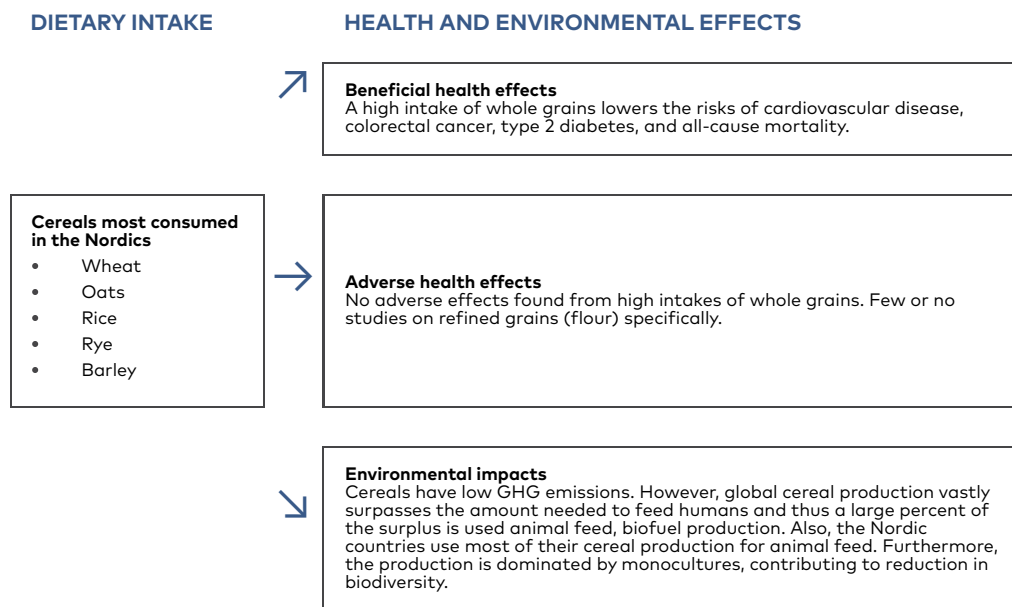


Cereals



Science advice: It is recommended to have an intake of at least 90 g/day of whole grains (including whole grains in products), with likely further benefits of higher intakes. Whole grain cereals other than rice should preferentially be used.

For more information about the health effects, please refer to the background paper by Guri Skeie and Lars T. Fadnes (Skeie & Fadnes, 2023). For more information about the environmental impacts, please refer to the following background papers (Benton et al., 2024; Harwatt et al., 2024; Meltzer et al., 2024; Trolle et al., 2024).

The definition of cereals (grains) comprises commonly eaten seeds from species from the grass family, i.e., wheat, rye, oat, barley, maize, rice, millet, sorghum/durra, teff and wild rice (Christensen & Biltoft-Jensen, 2022). In addition, the global consensus definition includes 'pseudo-cereals' (amaranth, buckwheat and quinoa) (van der Kamp et al., 2021). Whole grains are defined as intact grains or processed grains (e.g., ground, cracked or flaked) where the three fractions endosperm, germ and bran are present in the same relative

proportion as in the intact grains (van der Kamp et al., 2021). A consensus statement suggests that whole grain should be the main ingredient in whole grain food products, i.e., whole grain should constitute more than 50 % of the dry matter (WholeGrain, 2021). The term "cereals" also encompasses refined grains, where the refining process involves removing the bran and germ, which are nutrient rich components, leaving the starchy endosperm, containing varying amounts of protein (e.g., gluten). Many whole grain breads also contain refined grains for taste and baking properties.

Dietary sources and intake. Cereals are important sources of energy, carbohydrate and protein, and a source of thiamine, folate, vitamin E, iron, and zinc. If cereals have been grown in selenium-rich soils (i.e., U.S. and Canada), they are also an important source of this element. The average intakes of cereal products range from approximately 110 g/day in Finnish females to 270 g/day in Norwegian males (Lemming & Pitsi, 2022).

Health effects. Seven qSRs are available on the role of cereals (grains) and health outcomes (Fogelholm et al., 2012; Hauner et al., 2012; Reynolds et al., 2019; SACN, 2015; WCRF/AICR, 2018b, j; Åkesson et al., 2013). There is a convincing dose-response association between whole grain consumption and lower risk of all-cause mortality, coronary heart disease, colorectal cancer and type 2 diabetes incidence (Reynolds et al., 2019; Skeie & Fadnes, 2023; WCRF/AICR, 2018j). Higher intake of whole grains is also associated with lower body weight, total cholesterol and systolic blood pressure (Reynolds et al., 2019).

Dose-response curves show that risk reduction for all-cause mortality is observed for intakes up to 50-60 g/day of whole grains. Higher intakes (i.e. 90 g/day) confer even greater risk reduction for coronary heart disease, type 2 diabetes and colorectal and breast cancer (Reynolds et al., 2019).

According to the discussion in Skeie and Fadnes (2023), there is less evidence for refined grains, but available evidence does not indicate similar beneficial associations compared with whole grains.

As described in the collaboration between the Global Burden of Disease project and the NNR2023 project, a diet low in whole grains is the highest-ranked dietary risk factor in the Nordic and Baltic countries. Across all countries, low whole grains diets are responsible for one fifth of the total burden of disease attributed to dietary factors and it is the greatest overall contributor to ischemic heart disease and colon and rectum cancer (Knudsen et al., 2025).

Environmental impacts. Most modern grain varieties have relatively high yields, and except for large methane emissions from traditional rice paddies and nitrous oxide from excess nitrogen fertilizer, GHG emissions from grain production are low (Harwatt et al., 2024; Meltzer et al., 2024; Trolle et al., 2024). Fertilizer utilization is variable but can be high. Thus, grain-based foods can be produced with a relatively modest environmental impacts. However, the production is dominated by intensive, large-scale cropping systems with low diversity, contributing to reduced biodiversity and where long-term sustainability is difficult to ensure. Global cereal production vastly surpasses the amount needed to feed humans (Bahadur KC et al., 2018). The surplus is used for animal feed and biofuel production. The large demand generated by such uses may contribute to adverse environmental effects of grain production.

Main data gaps. There is more information available for the health effects of whole grain than for that of refined grains. Papers analysing how substitution of refined grains with whole grains influences health outcomes are sparse. There are few studies on specific cereals. There is a lack of data on differences in environmental impacts among domestically, regionally and internationally sourced cereals, especially when considering the potential changes in environmental conditions and increasing occurrence of environmental shocks.

Risk groups. People with coeliac disease and other gluten-related disorders are at risk of low cereal intakes, but can instead consume other cereals such as millet, rice, maize, quinoa, buckwheat, amaranth, teff and sorghum products to cover energy, fibre, and nutrient needs. Gluten-free oats are also an option.

Science advice:

- **Based on health outcomes:** It is recommended to consume at least 90 g/day (dry weight) of whole grains (including whole grains in products), with likely further benefits of higher intakes. Such further intakes have no adverse effects and may contribute to a healthy, plant-based diet. At high energy requirements refined grains also have a role. This justifies allowing some refined cereals in the diet.
- **Based on environmental impacts:** Due to the low climate impact of cereals and cereal-based foods, rice being an exception, they are key foods in the transition to a lower climate impact diet.
- **Overall science advice:** It is recommended to have an intake of at least 90 g/day of whole grains (including whole grains in products), with likely further benefits of higher intakes. Whole grain cereals other than rice should preferentially be used.