REFERENCES

1. Zong G, Gao A, Hu FB & Sun Q. Whole Grain Intake and Mortality From All Causes, Cardiovascular Disease, and Cancer: A Meta-Analysis of Prospective Cohort Studies. Circulation 2016, 133:2370-80.

2. McRae MP. Health Benefits of Dietary Whole Grains: An Umbrella Review of Meta-analyses. J Chiropr Med 2017, 16:10-18.

3. World Cancer Research Fund/American Institute for Cancer Research. Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. Continuous Update Project Expert Report 2018. Available at dietandcancerreport.org.

4. GBD 2017 Diet Collaborators. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Published Online April 3, 2019. Available at: http://dx.doi.org/10.1016/S0140-6736(19)30041-8.

5. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S et al. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 2019, 6736(10170):3-49. https://doi.org/10.1016/S0140-6736(18)31788-4.

6. EU Science Hub. Food-based dietary guidelines in Europe. Available at: https://ec.europa.eu/jrc/en/health-knowledge-gateway/promotion-prevention/nutrition/food-based-dietary-guidelines.

7. Lassen A, Christensen LM & Trolle E. Development of a Danish Adapted Healthy Plant-Based Diet Based on the EAT-Lancet Reference Diet. Nutrients 2020, 12:738. doi:10.3390/nu12030738.

8. US Department of Health and Human Services and US Department of Agriculture. Dietary Guidelines for Americans 2005. Available at: https://health.gov/sites/default/files/2020-01/DGA2005.pdf [cited July 9, 2020].

9. Mejborn H, Biltoft-Jensen A, Trolle E & Tetens I (Eds.) 2008. Fuldkorn – Definition og vidensgrundlag for anbefaling af fuldkornsindtag i Danmark. Report (in Danish) from the National Food Institute: Søborg.

10. Alt om kost. Spis mad med fuldkorn. (in Danish). Available at: https://altomkost.dk/raad-og-anbefalinger/de-officielle-kostraad-godt-for-sundhed-og-klima/spis-mad-med-fuldkorn/ [cited July 9, 2020].

11. Shea BJ, Reeves BC, Wells G, Thuku M, Hamel C, Moran J et al. AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. BMJ 2017, 358:j4008, doi:10.1136/bmj.j4008.

12. Schwingshackl L, Knüppel S, Schwedhelm C, Hoffmann G, Missbach B, Stelmach-Mardas M et al. Perspective: NutriGrade: a scoring system to assess and judge the meta-evidence of randomized controlled trials and cohort studies in nutrition research. Adv Nutr 2016, 7:994-1004.

13. Ovesen L. 2008. Indtag af fuldkorn og sygdomsrisiko – en systematisk gennemgang. In: Mejborn H, Biltoft-Jensen A, Trolle E, Tetens, I (Eds.) Fuldkorn – Definition og vidensgrundlag for anbefaling af fuldkornsindtag i Danmark. Report (in Danish). National Food Institute: Søborg.

14. Pietinen P, Rimm EB, Korhonen P, Hartman AM, Willett WC, Albanes D & Virtamo J. Intake of dietary fiber and risk of coronary heart disease in a cohort of Finnish men. The Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study. Circulation 1996, 94:2720-7.

15. Pietinen P, Malila N, Virtanen M, Hartman TJ, Tangrea JA, Albanes D & Virtamo J. Diet and risk of colorectal cancer in a cohort of Finnish men. Cancer Causes Contr 1999, 10:387-96.

16. Jacobs DR, Meyer HE & Solvoll K. Reduced mortality among whole grain based eaters in men and women in the Norwegian County Study. Eur J Clin Nutr 2001, 55:137-43.

17. Montonen J, Knekt P, Järvinen R, Aromaa A & Reunanen A. Whole-grain and fiber intake and the incidence of type 2 diabetes. Am J Clin Nutr 2003, 77:622-9.

18. Larsson SC, Giovannucci E, Bergkvist L & Wolk A. Whole grain consumption and risk of colorectal cancer: a population-based cohort of 60,000 women. Br J Cancer 2005, 92:1803-7.

19. Pedersen AN, Christensen T, Matthiessen J, Knudsen VK, Sørensen MR, Biltoft-Jensen A et al. 2015. Danskernes kostvaner 2011-2013. Report (In Danish) from National Food Institute: Søborg. Available at: www.food.dtu.dk.

20. EFSA 2007. Development of Food-Based Dietary Guidelines. EFSA Scientific colloquium summary report. 21-22 March 2006, Parma, Italy.

21. USDA 2014. Whole Grain Resource for the National School Lunch and School Breakfast Programs A Guide to Meeting the Whole Grain-Rich Criteria. Available at: https://fns-prod.azureedge.net/sites/default/files/WholeGrainResource.pdf [cited May 14, 2020].

22. Andersen JLM, Halkjær J, Rostgaard-Hansen AL, Martinussen N, Lund ASQ, Kyrø C et al. Intake of whole grain and associations with lifestyle and demographics: a cross-sectional study based on the Danish Diet, Cancer and Health—Next Generations cohort. Eur J Nutr 2021, 60:883-895. https://doi.org/10.1007/s00394-020-02289-y.

23. Nordic Council of Ministers. 2014. Nordic Nutrition Recommendations 2012 – Integrating nutrition and physical activity. Nordic Council of Ministers, Nord 2014:002.

APPENDIX A
Whole-grain definitions in different countries and organisations

Several countries have defined whole grain and whole-grain food products, either in national legislation or as a code of conduct. To explore which of the European Union Member States have national whole-grain definitions, an enquiry was sent to all EU countries through the EFSA Focal Point Network[a], and the answers received are included below. Definitions reported through the EFSA Focal Point Network are labelled with *.

This overview also includes definitions used in non-EU countries and some private organisations.

Austria*

Austria does not have a legislated whole-grain definition but uses a guideline called “Codex Alimentarius Austriacus“ (Österreichisches Lebensmittelbuch) [1]. The guideline is mainly made for producers and not for consumers.

Whole meal (wholemeal) is the term used to refer to ground grains that are identical to or have approximately the same composition as the unprocessed grains.
Whole-grain bread is made from whole grains, whole meal or wholemeal flour. Addition of other types of flour for up to 10% of the total weight of the grain products is allowed.
The three pseudo-cereals are considered as grains, and can thus be classified as whole grain.

Belgium*

No legal definition of whole grains exists in Belgium. However, the definitions suggested by the Healthgrain Forum for whole grains "Whole grains shall consist of the intact, ground, cracked or flaked kernel after the removal of inedible parts such as the hull and husk. The principal anatomical components - the starchy endosperm, germ and bran - are present in the same relative proportions as they exist in the intact kernel”, and for whole-grain food products “A whole-grain food is one for which the product is made with ≥30 % whole-grain ingredients on a dry-weight basis and more whole-grain ingredients than refined-grain ingredients", are used [2,3].

Bulgaria*

There is no commonly accepted definition of whole grains in Bulgaria but since April 2011, national standards were approved by the Bulgarian Food Safety Agency for the production of flour and bread, including whole-grain versions. The standards are available in Bulgarian language only.

[a] EFSA (European Food Safety Authority) is a European agency funded by the European Union that operates independently of the European legislative and executive institutions (Commission, Council, Parliament) and EU Member States. EFSA provides independent scientific advice to the decision makers who regulate food safety in Europe.
The Focal Point Network comprises representatives of the national food safety authorities of the EU Member States, Iceland and Norway. Observers from Switzerland and the EU Candidate Countries also attend Advisory Forum meetings. Through the Forum, EFSA and the Member States can join forces in addressing European risk assessment and risk communication issues.

Croatia*

Croatian legislation (in Croatian language only) defines whole grains as “whole grains containing husks”, and whole grain cereals as “cereals consisting of pericarp (bran), endosperm and/or germ”, i.e. the husk has been removed. Buckwheat is included as a cereal plant species [4].

The definitions are followed by special provisions where cereal products are defined considering, quality standards, the purpose, composition, properties, and types of technological process (for mill products from wheat, rye, corn, buckwheat; special purpose flour and semolina; finished cereal products; mixtures for bakery products; bakery products, pasta, dough and dough products). Whole-grain wheat bread must contain at least 80% of whole-grain wheat-mill products calculated on the total quantity of mill products. Whole-grain rye bread must contain at least 70% of rye flour or other whole-grain rye-mill products calculated on the total quantity of mill products. Whole-grain corn bread must contain at least 60% of whole-grain corn-mill products calculated on the total quantity of mill products. Mixed wholemeal bread must contain more than 50% of flour or other whole-grain mill products of different types calculated on the total quantity of mill product.

Cyprus*

Cyprus has no official definition for whole grains but the definition in Regulation (EU) No 1308/2013 is followed, i.e. “*grains from which only part of the end has been removed, irrespective of characteristics produced at each stage of milling*.” [5].

The regulation concerns market standards of agricultural products, including shape and quality of rice for which this definition applies. It is therefore not related to the concept “whole grains” as it is discussed in this chapter.

Czech Republic*

A definition is set by the Czech Decree No. 18/2020 Coll., on requirements on mill products, pasta, bakery products, confectionary products and doughs: “Whole-grain bread is a bakery product which is made of at least 80%† whole-grain flours or the equivalent volume of mill grain products so that all parts of a grain are included.” (†of total weight of mill products used) .

Denmark

In 2008, a Danish expert group suggested a definition of whole grains and whole-grain products [6]. The definition was strictly botanical, including only few genera from the grass family leaving out wild rice and teff. Subsequently, the whole-grain definition was used as basic criterion for the Danish Whole-Grain Logo administered by the Danish Whole-Grain Partnership, and later as one of the criteria for the Nordic Keyhole label. Since 2009, the definition has been part of the Danish legislation.

Whole grains are defined as complete cereal grains (endosperm, germ and bran). The grains may be cut, cracket, flaked or milled but the three fractions must be present in the same proportions as in the intact grain of the individual cereals. The species wheat, spelt, rye, oat, barley, maize, rice, millet, durra and other sorghum species are considered whole grains [7].

In a guidance document for use of the Nordic Keyhole label it is specified that endosperm, germ and bran may be separated during milling but in the final flour they must be present in the same

proportions as in the intact grains of the individual cereals. A loss of up to 2% of the grain or 10% of the bran during cleaning of the grains is accepted, when the cleaning is performed for safety and quality reasons [8].

To avoid misleading consumers, whole-grain products must contain a minimum amount of whole grain. To carry the Danish Whole-Grain Logo, criteria are set for whole-grain content in ten different food groups. Foods must contain at least 50-100% whole grains on dry matter basis depending on food group [9]. Besides, it is a prerequisite that the products meet nutrient profiles on fat, fibres, salt and sugars, that are equal to the criteria for the Nordic Keyhole label.

Another set of slightly less strict criteria exists for the Nordic Keyhole label [10]. Food groups containing a cereal part such as cereal foods (e.g. bread and breakfast cereals) and ready-made meals (e.g. sandwiches and pizzas) must have a specified minimum whole-grain content that varies from food group to food group. Foods must contain at least 30-100% whole grains on dry matter basis depending on food group. In addition, the products must meet nutrient profiles on fat, dietary fibre, salt and sugars.

Estonia*

Estonian legislation does not have a grain/whole-grain product definition. However, there is a voluntary agreement (in Estonian) between the Ministry of Rural Affairs, the Veterinary and Food Board, the National Health Development Institute and different Estonian food industry organisations. The agreement also contains a definition of the grain/wholegrain [11].

France

France has no legal definition of whole grains or whole-grain food products.

To allow for communication about whole-grain content to consumers, the French biscuit industry has introduced guidance for its members [12]. To label foods “source of whole grain”, they must contain 15-39% of the recipe by weight as whole grains. If products are being labelled “rich in whole grain” they must contain more than 40% of the recipe by weight as whole grains.
For moist bread, 10% of the final weight must contain whole grains to use the claim “contains whole grains,” and 30% of the final weight must be whole grains to be “rich in whole grains.” For rusks, 15% of the final weight must be whole grains to claim “contain whole grain”, and 40% of the final weight must be whole grains to claim “rich in whole grain”. In whole-grain biscuits, at least 15% of the ingredients should be whole grains.
Besides this, the “biscuits et gateaux”-association has proposed that the products should contain at least 40% cereals, less than 35% energy from fat, less than 35% saturated fat, no trans fatty acids and less than 40% total sugars if they are labelled as whole grain.

Germany

In Germany, the law establishes different criteria for different types of whole-grain products but contains no definition of whole grains [13-15]. According to German law, use of the term whole-grain requires that at least 90% of the flour in bread and pastries must be whole grains. If oat is part of the whole-grain fraction, at least 20 of the 90% grains must be oat. In fine baked goods, at least 90% of the grains and starch ingredients must be whole grain flour.

For pasta, 100% of the grain component must be whole grains in order to use the designation whole grain.

German authorities do not allow the use of a whole-grain label on biscuits, because they are considered to contain too much sugar and fat.

Greece*

According to the Ministry of Health and the European Federation of Energy Traders, paragraph 12 of Article 106 of the National Food and Drink Code (in Greek) sets out the definition and specifications of 100% whole-grain flour from pure wheat for the manufacture of corresponding bread as well as the production of whole-wheat pasta flour. The specifications concern moisture, gluten, acidity in sulphuric acid and the residue in carbon tetrachloride [16].

Hungary*

In Hungary, the legislative definition of whole-grain based foods is: “cereal-based foods produced by using all parts of the cereal or pseudo-cereal grain kernel (containing germ and bran), and food made from at least 50% of such ingredients” [17]. Furthermore, whole-grain food products have to comply with other relevant regulations such as Decree No. 152 of 2009 (XI. 12.) on the binding provisions of the Codex Alimentarius Hungaricus [18,19].

In Codex Alimentarius Hungaricus, the following whole-grain food products are defined:

- Whole-wheat flour: contains all parts of the wheat kernel, including germ and bran, and therefore it is almost a fully wholemeal grist with wheat-like colour.
- Wholemeal rye flour: is a grist produced by all parts of the rye kernel (Secale cereale L.).
- Wholemeal spelt flour: grist made from the grains of spelt wheat for human consumption. It is almost a wholemeal product with the colour of spelt wheat. It contains wholemeal spelt flour in a wide range of particle sizes and bran with larger particle size.
- Wholemeal triticale flour: grist produced by all parts of triticale (x Triticosecale Wittm.).
- Wholemeal wheat bread: is usually a leaven based dough made of at least 60% of wholemeal flour (wheat, rye or spelt) and a maximum of 40% of other grists (mostly flour) such as wheat, rye or spelt. It is produced by preparing, shaping, leavening and baking the dough.

Iceland

The Nordic Keyhole label can be used on foods on a voluntary basis. Thus, the same legal definitions apply for whole grains and whole-grain food products as mentioned for Denmark.

Ireland*

There is no legal definition of a grain or whole grain, and there is no real distinction made between cereal grains and pseudo-cereals.

Italy

In Italy, the term “integrale” refers to whole-grain flour. The grains are milled, and the amount of bran in the flour is adjusted until the ash content is between 1.30 and 1.70 g/100 g dry matter. Protein must be at least 12.00 g/100 g dry matter [20]. It is not specified that the germ fraction must be present in the flour.

Pasta made entirely from “integrale” flour can be labelled “pasta de semola integrale di grano duro” [20].

Latvia*

There is no legislative definition of whole grain and/or whole-grain food products in Latvia.

Lithuania*

According to the national legal act (in Lithuanian language only) “Wholegrain products” refers to products made by processing (grinding, crushing, or thermally treating) whole cleaned grains. These products contain all the components characteristic of grain (endosperm, germ and bran) in proportions typically found in whole grains [21].

Since 2013 it has been possible to use the Nordic Keyhole label on foods in Lithuania. Thus, definitions of whole grains and whole-grain products similar to the one mentioned for Denmark also apply.

Malta*

There is no legally endorsed definition of whole grain or whole-grain food products in Malta.

Norway

The Nordic Keyhole label can be used on foods on a voluntary basis. Thus, the same legal definitions apply for whole grains and whole-grain food products as mentioned for Denmark.

Poland*

Whole grains and whole-grain food products have not been legally defined in Poland. However, some products that are either on the Polish market or found in marketing information bear a whole-grain description in accordance with a common understanding of this term, e.g. whole-grain flour means fully milled flour, i.e. produced from all the edible parts of the grain (endosperm, germ and bran) in the same proportion as they occur in the natural grain [22].

Portugal*

In Portugal, a national legislation (in Portuguese language only), Ordinance n.º 52/2015, of 26th February, sets the characteristics to which different types of bread and related products must comply. This legislation includes a definition of “whole-grain bread”, according to the type of wheat or rye flours that can be used in bread making [23].

Romania*

There is no definition of whole grain/whole-grain products in the national legislation.
There are private organisations in Romania using the definition: “Whole grains shall consist of the intact, ground, cracked or flaked kernel after the removal of inedible parts such as the hull and husk. The principal anatomical components - the starchy endosperm, germ and bran - are present in the same relative proportions as they exist in the intact kernel. Small losses of components - i.e. less than 2% of the grain/10% of the bran – that occur through processing methods consistent with safety and quality are allowed.”.

Slovak Republic*

National regulations define whole-grain food products and the requirements for them: “Wholemeal flour means a mill product with a higher proportion of packaging particles obtained by multi-stage milling of cereal grains after removal of the germ” [24]; and: “wholemeal pasta is pasta made from wholemeal flour” [25].

Slovenia*

In the rules on the quality of cereal and bakery products, whole grains are defined as: “Wheat wholemeal products (wheat wholemeal flour and wheat wholemeal groats) are made by grinding cleaned whole grains”, and “unpolished rice (brown rice, cargo rice, natural rice, wholemeal rice) if only the outer husk has been removed” [25]. Wheat wholemeal bread shall be made from at least 80% wheat wholemeal flour or wholemeal wheat groats. Wholemeal mixed bread must contain at least 51% of different types of wholemeal flour or crumb, calculated on the total amount of flour [26].

Spain*

In Spanish legislation (in Spanish language only), there are quality standards for flours, meal and other cereal products plus bread that mention whole grain and whole-grain products [27].

Sweden*

The Nordic Keyhole label can be used on foods on a voluntary basis. Thus, the same legal definitions apply for whole grains and whole-grain food products as mentioned for Denmark.

Switzerland*

In Switzerland, whole-grain flour of wheat (“Vollkornmehl”) is obtained from the whole grain of wheat, with or without outermost husk parts; the total yield must be at least 98 % by mass of the whole grain [28]. Whole-grain flour of cereals other than wheat (“Spezialvollkornmehl”) is obtained from the whole-grain of cereals other than wheat or whole starchy cereals.

The Netherlands*

According to Dutch law, the term “whole grain” means the starch rich endosperm, germ and bran present in the natural proportion, also after processing [29].

Bread can only be labelled “100% whole grain” if all the flour in the recipe is 100% whole grain.
For biscuits, there is an old (1989) but still valid permission by the Food Inspection Agency for biscuits to be labelled as “whole grain” if at least 50% of the flour is whole grain .
In practice, the requirement of 100% whole grain flour is applicable for all types of bread, pasta and breakfast cereals, whereas biscuits and related bakery products apply the “at least 50%-option”.

A new national legislation from July 2020 on whole grains is defined in the “Commodities Act Decree on Flour and Bread”. The word whole grain (wholemeal) may be used in the designation of a product referred to in the Decree provided that the naturally occurring starchy kernel, germ and bran of the cereal in question are present in their natural proportions, whether or not after having undergone processing (Article 16); and the designation brown bread or wheat bread may be used only for bread in which (wholemeal) wheat flour, whether or not mixed with broken wheat and wheat flakes, is the main component and in which bran is visible to the naked eye (Article 9) [30].

Turkey*

In Turkey, there are legal definitions and technical features (in Turkish language only) for the definitions of whole-wheat flour. The flour obtained by grinding the wheat cleaned from foreign substances to include all the anatomical parts of the wheat grain [31] and for wholemeal bread, whole-wheat bread (bread type produced from whole-wheat flour), and whole-wheat flour bread (at least 60% of whole-wheat flour is added to wheat flour) [32].

United Kingdom

There is no legal definition of whole grain or whole-grain food products in the UK. However, the term "wholemeal" can be used about flour derived from wheat. The word wholemeal may only be used on bread products if all the flour used as an ingredient in the preparation of the bread is wholemeal [33].

The Institute of Grocery Distribution (IGD), a private industry organisation in the UK, defines whole grain as "the edible entire grain after removal of inedible parts such as the hull and glume. It must include the entire germ, endosperm and bran". Examples of whole grains are: amaranth, barley, buckwheat, maize, millet, oats, quinoa, rye, sorghum, teff, triticale, rice (including brown and wild rice), and wheat (including club, common wheat, durum wheat, einkorn, emmer, faro, Kamut®, spelt) (list is not exhaustive) [34].

The Institute of Grocery Distribution further states: "Whole grain also includes grains that have been subjected to processing (e.g. milling, cracking, crushing, rolling, flaking, extrusion, malting) but only if after processing the proportions of the germ, endosperm and bran are present in the same or virtually the same proportions as the original grain. Temporary separation of whole grain constituents during processing for later recombination is acceptable provided the proportions of the germ, endosperm and bran are the same or virtually the same as in the original grain. Simply adding together these three whole grain constituents as separate ingredients does not constitute a whole grain and making a claim that it does could be misleading to consumers. Different varieties of the same grain may be combined during processing and be called whole grain (e.g. different varieties of wheat) as long as the final product contains the component parts of the grain in line with their pre-processed proportions.". Malted grains may be included if the amount of whole grains stated for the product is computed on the dry weight, if the sprout does not exceed kernel length, and if the nutrient values have not diminished [34].

Australia and New Zealand

The authorities in Australia and New Zealand define whole-grain food products as any food which uses every part of the grain including the outer layers, bran and germ [35]. This definition applies even if these parts are separated during processing and regardless of whether the grain is in one piece or milled into smaller pieces.

The term wholegrain refers to:

- 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
- ground grains such as whole-wheat flour used to make wholemeal bread.

The term wholemeal applies to foods in which the whole grains have been refined into finer particles. This gives manufacturers the option of describing their foods as either wholegrain or wholemeal to avoid misleading the customer.

Canada

On the Government of Canada's home page it is stated: "There are many types of grains, including cereal grains such as wheat, rice, oats, barley, corn, wild rice, and rye, as well as pseudo-cereals such as quinoa and buckwheat. These grains can be either whole or refined. (…) Whole grains contain all three parts of the kernel (the bran, the endosperm and the germ)" [36].
No Canadian regulation or guidance related to whole-grain content in whole-grain food products was found.

In Canada, when wheat is milled, parts of the kernel are separated and then recombined to make whole-wheat flour. Under the Food and Drug Regulations, up to 5% of the kernel can be removed to help reduce rancidity and prolong the shelf life of whole-wheat flour. The portion of the kernel that is removed for this purpose contains much of the germ and some of the bran. Thus, whole-wheat flour is not whole grain. Whole-wheat bread is made from whole-wheat flour. Therefore, 100% whole-wheat bread may not be whole grain. To be certain that they are getting whole grain, consumers in Canada must therefore look for the words "whole grain whole wheat" [36].

United States of America

In the US, there is no official definition of what is a whole grain or a whole-grain food product. However, the Food and Drug Administration has issued a draft guidance about what the agency considers "whole grain" to industry and to assist manufacturers in labelling their products. The American Food and Drug Administration (FDA) states: "Cereal grains that consist of the intact, ground, cracked or flaked caryopsis, whose principal anatomical components – the starchy endosperm, germ and bran – are present in the same relative proportions as they exist in the intact caryopsis – should be considered a whole grain food." The FDA further states: "Cereal grains may include amaranth, barley, buckwheat, bulgur, corn (including popcorn), millet, quinoa, rice, rye, oats, sorghum, teff, triticale, wheat, and wild rice." [37].

A whole-grain food can be a complete food such as brown rice or it can be a food ingredient such as whole-wheat flour in bread. However, there is no criterion for minimum whole-grain content of a whole-grain food product in the US, but if a food producer wants to make an authorized health claim referring to whole grains the food must contain at least 51% whole grains (% of total weight) and meet other requirements, e.g. for dietary fibre content [38].

In 2012, the Food and Nutrition Services division of the U.S. Department of Agriculture defined "whole grain-rich" foods for use in national school-meals programs. A whole grain-rich food must have at least 50% of its grain as whole grain and meet one of three requirements: 1) Contain at least 8 g of whole grain per serving, or 2) Include a FDA-approved whole-grain health claim on its packaging, or 3) For non-mixed dishes (e.g. breads, cereals) whole grain must be the primary ingredient by weight; for mixed dishes (e.g. pizza, corn dogs) whole grain must be the primary *grain* ingredient by weight [39].

The Whole Grains Council, a US based non-profit consumer advocacy group of millers, manufacturers, scientists and chefs, has approved the definition "Whole grains or foods made from them contain all the essential parts and naturally-occurring nutrients of the entire grain seed in their original proportions. If the grain has been processed (e.g., cracked, crushed, rolled, extruded and/or cooked), the food product should deliver the same rich balance of nutrients that are found in the original grain seed." [40]. This means that 100% of the original kernel – all of the bran, germ, and endosperm – must be present to qualify as a whole grain. The Whole Grains Council lists grains most familiar to consumers as whole grains but mention that "other cereal grasses from the *Poaceae* family, such as canary seed, Job's tears, Montina, Timothy, fonio, etc. are also whole grains, when consumed with all of their bran, germ and endosperm. (…) Amaranth, quinoa, and buckwheat are not in the *Poaceae* botanical family, but these "pseudo-grains" are normally included with true cereal grains because their nutritional profile, preparation, and use are so similar. (…) Oilseeds and legumes (such as flax, chia, sunflower seeds, soy, chickpeas, etc.) are not considered whole grains by the WGC." [40].

The Whole Grains Council has issued a series of three Whole-grain Stamps that can help consumers identify foods with whole grains. In products with the 100%-Stamp, all grain ingredients are whole grain, in the 50%-Stamp, 50% of all grain ingredients are whole, and products with the Basic Stamp provide at least 8 grams of whole grains but may contain more refined grains than whole grains. Besides, each Stamp also shows how many grams of whole grains are in a serving of the product [41].

REFERENCES

1. Österreichisches Lebensmittelbuch http://www.lebensmittelbuch.at/ [cited July 2, 2020].

2. van der Kamp JW, Poutanen K, Seal CJ, Richardson DP. The HEALTHGRAIN definition of 'whole grain'. Food Nutr Res 2014;58: http://dx.doi.org/10.3402/fnr.v58.22100.

3. Ross AB, van der Kamp J-W, King R, Lê K-A, Mejborn H, Seal CJ, Thielecke F. Perspective: A definition for whole-grain food products – recommendations from the Healthgrain Forum. Adv Nutr 2017;8:525-31.

4. Croatian Ministry of Agriculture. Regulation of cereals and cereal products (OG 81/2016). https://narodne-novine.nn.hr/clanci/sluzbeni/2016_09_81_1823.html. [cited July 2, 2020].

5. EU Regulation 1308/2013. Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organisation of the markets in agricultural products and repealing Counsel Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007.

6. Mejborn H, Tetens I. Definition af fuldkorn og forslag til betingelser for brug af betegnelsen 'Fuldkorn'. I: Mejborn H, Biltoft-Jensen A, Trolle E, Tetens, I (eds.) Fuldkorn – Definition og vidensgrundlag for anbefaling af fuldkornsindtag i Danmark. Rapport fra DTU Fødevareinstituttet, Søborg, 2008.

7. Miljø- og Fødevareministeriet (Ministry of Environment and Food), Danmark. Bekendtgørelse om anvendelse af Nøglehulsmærket på fødevarer m.v. Bekendtgørelse nr. 238 af 22/03/2018.

8. Fødevarestyrelsen (Danish Veterinary and Food Administration), Danmark. Vejledning om anvendelse af Nøglehulsmærket på fødevarer m.v. 2019. Available from:

https://prodstoragehoeringspo.blob.core.windows.net/1938090e-c4d3-4514-8c3b-5d3ad4d8c510/N%C3%B8glehulsvejledningen.pdf [cited May 11, 2020].

9. Fuldkornspartnerskabet. Fuldkornslogomanual, valid from 1. January 2020 to 31. December 2022. Available from: https://fuldkorn.dk/wp-content/uploads/2019/07/Fuldkornslogomanual-g%C3%A6ldende-fra-1.-marts-2015-31.-marts-2020.pdf [cited Feb 24, 2020].

10. Miljø- og Fødevareministeriet (Ministry of Environment and Food), Danmark. Bekendtgørelse om anvendelse af Nøglehulsmærket på fødevarer m.v. Bekendtgørelse nr. 238 af 22/03/2018.

11. Estonian Food Industry Association. https://toiduliit.ee/taistera-hea-tava.

12. Les Fabricants de Biscuits et Gâteaux de France. Charte Professionnelle des Fabricants de Biscuits et Gâteaux de France, April 2018 [Charter of ethics for French biscuit and cake manufacturers]. Available from: http://www.biscuitsgateaux.com/wp-content/uploads/2018/05/Charte-Professionnelle-BG-27-04-2018.pdf [cited May 11, 2020].

13. Bundesministerium für Ernährung und Landwirtschaft 1991. Leitsätze für Feine Backwaren (Guidelines for fine bakery products) 2010. Available from: https://www.bmel.de/SharedDocs/Downloads/Ernaehrung/Lebensmittelbuch/LeitsaetzeFeineBackwaren.pdf?__blob=publicationFile [cited Feb 24, 2020].

14. Bundesministerium für Ernährung und Landwirtschaft 1993. Leitsätze für Brot und Kleingebäck (Guidelines for bread and small bread-related products) 2005. Available from: https://www.bmel.de/SharedDocs/Downloads/Ernaehrung/Lebensmittelbuch/LeitsaetzeBrot.pdf;jsessionid=C3B0B9EC1EA9D2E90614E99AFF284E24.2_cid385?__blob=publicationFile [cited Feb 24, 2020].

15. Bundesministerium für Ernährung und Landwirtschaft 1998. Leitsätze für Teigwaren (Guidelines for dough based products) 1999. Available from: https://www.bmel.de/SharedDocs/Downloads/Ernaehrung/Lebensmittelbuch/LeitsaetzeTeigwaren.pdf?__blob=publicationFile [cited Feb 24, 2020].

16. Greek Ministry of Health. https://www.aade.gr/sites/default/files/2020-03/106-iss1.pdf. [cited July 2, 2020]

17. Ministry of Human Capacities, Hungary. Decree of the Minister of Human Capacities No. 37/2014 (IV. 30.) on nutritional health prescriptions relating to public catering (available only in Hungarian). http://njt.hu/cgi_bin/njt_doc.cgi?docid=169011.332366.

18. Ministry of Agriculture and Rural Development, Hungary. Decree No. 152 of 2009 (XI. 12.) FVM of the Ministry of Agriculture and Rural Development on the binding provisions of the Codex Alimentarius Hungaricus (available only in Hungarian). http://njt.hu/cgi_bin/njt_doc.cgi?docid=126175.381015.

19. Codex Alimentarius Hungaricus – Directive 2-201 on Milling products (available only in Hungarian). https://elelmiszerlanc.kormany.hu/download/c/f2/92000/%C3%BAj%20M%C3%89%202-201-Malomipari%20term%C3%A9kek%20ir%C3%A1nyelv-2020.pdf.

20. Ministero delle Politche Agricole Alimentari e Forestali. Regolamento per la revisione della normativa sulla produzione e commercializzazione di sfarinati e paste alimentari, a norma dell'articolo 50 della legge 22 febbraio 1994, n. 146. [Regulations for the revision of the production and sales norms for flour and pasta, an update of article 50, n. 146 dated 22 February 1994] 2001. Available from: https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2772 [cited Feb 25, 2020].

21. The Republic of Lithuania, Ministry of Agriculture. The Technical Regulation on the definition, production and commercial presentation of bread and sweet bread products defines and classifies bread and sweet bread products and regulates the main ingredients and substances used in these baked goods. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/0cff68d05eee11e4b240c0fa7489cd0e?jfwid=fhhu5mnuf.

22. National Institute of Public Health – National Institute of Hygiene (NIZP-PZH) and the Polish Federation of Food Industry; no reference available.

23. Ordinance n.º 52/2015, of 26th February. https://dre.pt/home/-/dre/66603017/details/maximized?serie=I&dreId=66603010. [cited July 6, 2020].

24. DECREE of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 2/2014 on edible cereals and grain mill products. Available from: https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2014/2/20140201.

25. DECREE of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 24/2014 on bakery products, confectionery products and pasta. Available from: https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2014/24/20180901.

26. The Republic of Slovenia. Definition of whole grain: Rules on the quality of cereal products (Official Gazette of the Republic of Slovenia, No. 1/14 and 52/19), Article 17(5): http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV11465; and Definition of whole grain products: Rules on the quality of bakery products (Official Gazette of the Republic of Slovenia, No. 11/15 and 22/19), Art. 10 for wheat bread, Art. 13 for whole grain mixed bread: http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV11665. [cited July 2, 2020].

27. Ministerio de la Presidencia, Relaciones con las Cortes y Memoria Democratica. Royal Decree 308/2019, of 26 April, Article 4.3, and Royal Decree 677/2016, Article 2.7.

28. Swiss Government. Ordinance on foodstuffs of vegetable origin, mushrooms and salt (OFVO; SR 817.022.17), art. 63 and 64.

29. De Staatssecretaris van Volksgezondheit, Welzijn en Sport, The Netherlands. Warenwetbesluit meel en brood (decision of June 4, 1998, amending the commodities act decree on flour and bread). Available from: https://wetten.overheid.nl/BWBR0009669/2017-10-01 [cited Feb 25, 2020].

30. Ministry for Medical Care. Decree amending the Commodities Act Decree on flour and bread and the Commodities Act Decree on administrative penalties for addition of certain reserved and mandatory designations and applying certain technical amendments. Draft available from: https://ec.europa.eu/growth/tools-databases/tris/en/search/?trisaction=search.detail&year=2019&num=497. [cited July 2, 2020].

31. Turkish Food Codex Wheat Flour Communiqué. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=17255&MevzuatTur=9&MevzuatTertip=5 [cited July 2, 2020].

32. Turkish Food Codex Bread and Bread Types Communiqué. https://www.mevzuat.gov.tr/mevzuat?MevzuatNo=15746&MevzuatTur=9&MevzuatTertip=5 [cited July 2, 2020].

33. UK Government. The Bread and Flour Regulations 1998, No. 141.

34. IGD 2007. UK Whole Grain Guidance Note. Available at: https://www.igd.com/Portals/0/Downloads/Charitable%20Impact/UK%20Whole%20Grain%20Guidance%203433.pdf [cited Feb 26, 2020].

35. Food Standards Australia New Zealand. Wholegrain food, 2016. Available at: https://www.foodstandards.gov.au/consumer/nutrition/wholegrain/Pages/default.aspx [cited Feb 25, 2020].

36. Government of Canada 2019. Available from: https://www.canada.ca/en/health-canada/services/canada-food-guide/resources/healthy-eating-recommendations/eat-a-variety/whole-grain/get-facts.html [cited May 11, 2020].

37. FDA 2006. Draft Guidance for Industry and FDA Staff: Whole Grain Label Statements. Docket Number FDA-2006-D-0298. Available at: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/draft-guidance-industry-and-fda-staff-whole-grain-label-statements [cited May 14, 2020].

38. FDA 1999. Health Claim Notification for Whole Grain Foods. Available at: https://www.fda.gov/food/food-labeling-nutrition/health-claim-notification-whole-grain-foods [cited May 14, 2020].

39. USDA 2014. Whole Grain Resource for the National School Lunch and School Breakfast Programs A Guide to Meeting the Whole Grain-Rich Criteria. Available at: https://fns-prod.azureedge.net/sites/default/files/WholeGrainResource.pdf [cited May 14, 2020].

40. Whole Grains Council 2004. Definition of a whole grain. Available at: https://wholegrainscouncil.org/definition-whole-grain [cited May 13, 2020].

41. Whole Grains Council 2020. Whole Grain Stamp. Available at: https://wholegrainscouncil.org/whole-grain-stamp [cited May 14, 2020].

APPENDIX B
WholEUGrain umbrella review: search protocol, search terms, inclusion and exclusion criteria

SEARCH STRATEGY

The structured literature search was restricted to searches in PubMed and the Cochrane Library, and both authors performed all searches independently. Both authors also searched the Cochrane Library for additional references, as well as through the reference lists of included studies/reports for additional references not found through the systematic searches.

SEARCH TERMS

We performed our search in the PubMed database using MeSH terms. The use of MeSH terms ensures that the searches conducted included all synonyms, spelling forms, singular and plural forms, etc. for the search terms of interest. Since MeSH terms are usually added to new articles 2-3 months after entry on the PubMed database, we also conducted classical searches (including all search words included under each MeSH term-category) for a limited time period of 4 months up to the final search date.

- Cardiovascular Diseases [MeSH] AND Whole grains [MeSH]
- Diabetes Mellitus, Type 2 [MeSH] AND Whole grains [MeSH]
- Cancer: Neoplasms [MeSH] AND Whole grains [MeSH]
- Mortality [MeSH] AND Whole grains [MeSH]
- Body Weight [MeSH] AND Whole grains [MeSH]

INCLUSION CRITERIA

Language

Studies/reports in English were included.

Time range

We included studies published between different restricted timespans, depending on the date for the latest systematic literature review (SLR) and/or meta-analysis of the disease or observation of interest conducted by an expert panel (see below for the specific timespans for each section). These SLRs and meta-analyses were also included in the summaries of results presented in Chapter 3.

Cardiovascular diseases (CVDs)

A SLR and dose-response meta-analyses of prospective studies by Aune et al. (2016) [1] conducted a search that ended on April 3rd 2016. Thus, the search period for the WholEUGrain umbrella review was April 4th 2016 – February 20th 2020.

Type-2 diabetes

The Cochrane Collaboration published a SLR in 2010 [2], and the literature search ended on May 2006. Thus, the search period for the WholEUGrain project review was May 1st 2006 – February 20th 2020.

Cancer

The latest SLR by WCRF [3] (with focus on colorectal cancer) conducted a search that ended on April 30th 2015. Thus, the search period for the WholEUGrain project review was May 1st 2015 – February 20th 2020.

Mortality

A systematic literature review and dose-response meta-analyses of prospective studies by Aune et al. (2016) [1] conducted a search that ended on April 3rd 2016. Thus, the search period for the WholEUGrain project review was April 4th 2016 – February 20th 2020.

Overweight

The latest WCRF CUP project literature review [4] reports on the latest evidence gathered on the subject, with a search that ended on August 21st 2016. Thus, the search period for the WholEUGrain project review was August 21st 2016 – December 31st 2020.

Types of studies

Systematic literature reviews and meta-analyses of prospective cohort studies were included for the sections on CVDs, cancer, type 2 diabetes, and mortality. Systematic literature reviews and meta-analyses of both prospective cohort studies and randomized controlled studies were included in the section on overweight.

Population

The literature searches were restricted to studies on adults, with the exception of the section on overweight, where both adults and children were included in the search. No exclusion criteria in relation to demographic or socioeconomic factors were applied.

Observations of interest

Studies researching the association between whole-grain intake and disease outcomes for cancer, type 2 diabetes, CVDs, overall mortality, and risk of overweight were included. Results reported as either relative risk (RR), hazard risk (HR) or odds ratio (OR) were accepted. For the section on overweight, the observations of interest also included changes in body weight, BMI, and other adiposity measures, like waist circumference, body fat percentage, fat mass, and fat-free mass.

Studies were eligible for inclusion if they reported a quantity of whole-grain intake expressed in either grams/ounces or number of portions, or an assessment of either low vs. high whole-grain intake (e.g. based on quartile/quintile distributions). Studies were eligible if they reported estimates of intake of whole grains or estimates of intake of whole-grain food products.

Outcome measures

Eligible studies had to include one or more of the following outcome diseases/conditions: cancer, type 2 diabetes, cardiovascular diseases (coronary heart disease, ischemic heart disease, coronary artery disease, ischemic stroke or heart failure), overall mortality, and overweight-relevant indicators (weight changes, BMI, waist circumference, body fat percentage, fat mass, fat-free mass).

EXCLUSION CRITERIA

Any studies whose data collection or data interpretation was funded by agencies with commercial interests in the results were excluded.

REFERENCES

1. Aune D, Keum N, Giovannucci E, Fadnes LT, Boffetta P, Greenwood DC, et al. Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: Systematic review and dose-response meta-analysis of prospective studies. BMJ 2016;353:i2716.

2. Priebe MG, van Binsbergen JJ, de Vos R & Vonk RJ. Whole grain foods for the prevention of type 2 diabetes mellitus. Cochrane Database of Systematic Reviews, 2010. doi:10.1002/14651858.CD006061.pub2.

3. Norat T, Vieira AR, Abar L, Aune D, Polemiti E, Chan D, et al. Systematic Literature Review: The Associations between Food, Nutrition and Physical Activity and the Risk of Colorectal Cancer. Continuous Update Project. World Cancer Research Fund International, 2017.

4. World Cancer Research Fund International. Literature review: Diet, nutrition and physical activity: Energy balance and body fatness. Continuous Update Project. World Cancer Research Fund International, 2017.

APPENDIX C
WholEUGrain umbrella review: quality-assessment tools

As a part of the review process, two tools for evaluating the quality of the included studies were developed (see tables 4B1 and 4B2). Every study was evaluated independently by each author, and rated on the basis of several parameters regarding design and method-quality.

The tool used for quality-assessment of studies included in the sections on CVD, type 2 diabetes, cancer and mortality was developed by adapting the guidelines of the USA's National Institutes of Health [1]. With this tool, studies can score from 0 to a maximum of 18 points (see table 4B1).

Similarly, a tool for evaluating the quality of studies included in the overweight section was developed (see table 4B2). This tool was developed separately, since we included reviews and meta-analyses of both RCTs and cohort studies in the overweight section. Therefore, we adapted an approach similar to the one described by the World Cancer Research Fund International's Continuous Update Project review on the subject [2]. This tool was developed by adapting and adjusting the guidelines from the systematic review checklists of the National Institute for Health and Care Excellence (NICE) and the Critical Appraisal Skills Programme (CASP). With this tool, studies can score from [-] to a maximum of [++] points (see table 4B2).

Each study was graded according to its overall score, which reflects the quality of the study as well as the risk of potential bias arising from its design and execution:

- 0-6 points or [-] Poor: Few or no checklist criteria have achieved the highest or the middle scores. The quality of the study is low and there is considerable risk of bias due to the study's design and execution.

- 7-16 points or [+] Fair: Some of the checklist criteria have achieved the highest or middle scores. The criteria that have not been fulfilled or not adequately described are unlikely to alter the conclusions of the study. There is a low risk of bias due to the study's design and execution.

- 17-18 points or [++] Good: All or most of the checklist criteria have been fulfilled with the highest scores. Where they did not meet the highest score, the conclusions are very unlikely to be altered. There is low to no risk of bias due to the study's design and execution.

Table 4B1 – Quality-assessment tool for the sections on CVD, type 2 diabetes, cancer and mortality.

Quality parameters			Points
Study information	Research question for the review	Clearly defined (e.g. with PICO – population, intervention, comparator, outcome)	1
		Not clearly defined	0
	Study type	SLR & meta-analysis	2
		SLR alone	1
		Non-systematic review	0
	Design	Prospective cohort studies	2
		Retrospective cohort studies	1
		Both cohort studies and case-control studies	1
		Case-control studies	0
	No. of studies included	Over 10	2
		5 - 9	1
		Under 5	0
Review methodology	Literature search & resources	Systematic & broad approach (e.g. databases & other resources e.g. grey literature AND manual search of reference lists), clearly described	2
		Systematic approach with only databases	1
		Non-systematic approach (e.g. no predefined eligibility / exclusion criteria)	0
	Screening and review of studies	Dual review (two independent authors)	1
		Non-dual review or not well described method for screening and review	0
	Quality assessment	Assess quality with quality tool(s)	1
		Does not assess quality of included studies	0
	Review presentation	Presentation of key characteristics for included studies (either narrative or table format)	1
		Non-systematic presentation of study characteristics	0
	Risk of publication bias assessment	Funnel plot or calculation	2
		Narrative description of risk bias	1
		No assessment	0
	Heterogeneity	Calculated/described	1
		Not calculated/described	0
Measurement types	Whole-grain intake	Both types	2
		Quantity (in grams or portions)	2
		Qualitative categories (e.g. high vs. low)	1
		Use of dietary fibre as proxy for whole-grain intake	0
	Outcome definition	Hard endpoints (no. of cases)	1
		Proxys (symptoms)	0

Table 4B2 – Quality-assessment tool for the overweight section.

Study identification (author, year, ref.ID)	
Factor:	Score
1. Does the review address an appropriate and clearly-focused question that is relevant to one or more of the guidance topic's key questions? Answer "yes" if: › the review aimed to look at intake of whole grain and its effect on anthropometric measures of body weigh/composition; › and if there are clearly stated inclusion/exclusion criteria (e.g. by using the PICO checklist).	
2. Does the review include the types of studies relevant to the key research question? Answer "yes" if: › it includes RCTs, or only cohorts/longitudinal observational studies, or both types › Answer "no" if other study types are included (e.g. cross-sectional or case-controls)	
3. Is the literature search sufficiently rigorous to identify all the relevant studies? Must meet following criteria for a "yes": › At least 2 electronic sources were searched (databases and/or grey literature) › Must include years and names of databases searched › Search terms must be available/traceable (either in text or suppl. materials) › Screening of studies for inclusion was performed by min. two independent authors	
4. Is the quality of included studies appropriately assessed and reported? Must meet following criteria for a "yes": › Methods of assessment provided › Quality of included studies reported or traceable in supp. materials › Quality of included studies considered in discussion/conclusions	
5. Is an adequate description of the analytical methodology used included, and are the methods used appropriate to the question? Must meet following criteria for a "yes": › E.g. if meta-analysis is used, is it appropriate and is heterogeneity assessed and taken into consideration if it exists? › Was publication bias assessed? › If mixed study types are included, are these analysed separately in the results section?	
6. Were the characteristics of the included studies provided? Must meet following criteria for a "yes": › Overall study characteristics presented in an aggregated form such as a table › data should be provided on the participants (age, sex, country of origin, health status) › interventions/exposures and outcomes › effect size of intervention/cohort	
7. Were potential conflicts of interest reported? Potential sources of support should be clearly acknowledged for the systematic review and considered for the included studies.	
8. Can the results be applied to a general population? Answer "yes" if majority of reviews include data for healthy populations, or representative of populations, where results can be generalised.	

REFERENCES

1. National Heart, Lung, and Blood Institute. Study Quality Assessment Tools – NHLBI, NIH. Available at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools [cited April 6, 2020].

2. World Cancer Research Fund International. Literature review: Diet, nutrition and physical activity: Energy balance and body fatness. Continuous Update Project. World Cancer Research Fund International, 2017.

APPENDIX D
WholEUGrain umbrella review: Judging the evidence

Below is a summary of the adapted criteria for judging the evidence, as they are applied by the World Cancer Research Fund in their Continuous Update Project, as described in the Third Expert Report from 2018 [1].

STRONG – CONVINCING

Evidence strong enough to support a judgement of a convincing causal (or protective) relationship, which justifies making recommendations designed to reduce the risk of NCDs. The evidence is robust enough to be unlikely to be modified in the foreseeable future as new evidence accumulates.

Requirements:

- Evidence from more than one study type.
- Evidence from at least two independent cohort studies.
- No substantial unexplained heterogeneity within or between study types or in different populations relating to the presence or absence of an association, or direction of effect.
- Good-quality studies to exclude with confidence the possibility that the observed association results from random or systematic error, including confounding, measurement error and selection bias.
- Presence of a plausible biological gradient (dose-response) in the association. Such a gradient need not be linear or even in the same direction across the different levels of exposure, so long as this can be explained plausible.
- Strong and plausible experimental evidence, either from human studies or relevant animal models, that typical human exposures can lead to relevant outcomes.

STRONG – PROBABLE

Evidence strong enough to support a judgement of a probable causal (or protective) relationship, which justifies making recommendations designed to reduce the risk of NCDs.

Requirements:

- Evidence from at least two independent cohort studies or at least five case-control studies.
- No substantial unexplained heterogeneity within or between study types in the presence or absence of an association, or direction of effect.
- Good-quality studies to exclude with confidence the possibility that the observed association results from random or systematic error, including confounding, measurement error and selection bias.
- Evidence for biological plausibility.

LIMITED – SUGGESTIVE

Evidence that is too limited to permit a probable or convincing causal judgement but is suggestive of a direction of effect. The evidence may be limited in amount or by methodological flaws, but shows a generally consistent direction of effect. This judgement is broad and includes associations where the evidence is only

marginally strong enough to identify a direction of effect. This judgement is very rarely sufficient to justify recommendations designed to reduce the risk of NCDs; any exceptions require special, explicit justification.

Requirements:

- Evidence from at least two independent cohort studies or at least five case-control studies.
- The direction of effect is generally consistent though some unexplained heterogeneity may be present.
- Evidence for biological plausibility.

LIMITED – NO CONCLUSION

Evidence is so limited that no firm conclusion can be made. This judgement represents an entry levels and is intended to allow any exposure for which there are sufficient data to warrant consideration, but where insufficient evidence exists to permit a more definitive grading. This does not necessarily mean a limited quantity of evidence. A body of evidence for a particular exposure might be graded "limited – no conclusion" for a number of reasons. The evidence may be limited by the amount of evidence in terms of the number of studies available, by inconsistency of direction of effect, by methodological flaws (e.g. lack of adjustment for known confounders) or by any combination of these factors.
With further good-quality research, any exposure graded in this way might in the future be shown to increase or decrease the risk of NCDs.

SPECIAL UPGRADING FACTORS

When present, such factors can upgrade the judgement reached. An exposure deemed a "limited – suggestive" causal factor in the absence, for example, of a biological gradient, might be upgraded to "probable" if one were present. The application of these factors requires judgement, and the way in which such judgements affect the final conclusion must be stated.

Factors to consider:

- Presence of a plausible biological gradient (dose-response) in the association. Such a gradient need not be linear or even in the same direction across the different levels of exposure, so long as this can be explained plausibly.
- A particularly large summary effect size (OR or RR of 2.0 or more, depending on the unit of exposure) after appropriate control for confounders.
- Evidence from randomized trials in humans.
- Evidence from appropriately controlled experiments demonstrating one or more plausible and specific mechanisms actually operating in humans.
- Robust and reproducible evidence from experimental studies in appropriate animal models showing that typical human exposures can lead to relevant outcomes.

REFERENCES

1. [1] World Cancer Research Fund International/American Institute for Cancer Research. Continuous Update Project Expert Report 2018. Judging the evidence. Available at: dietandcancerreport.org [cited April 15, 2021].

Appendix E
WholEUGrain umbrella review: overview of included studies and data overlap

Table E.1 – Overview and characteristics of the included studies in the CVD section.

Reference & Type		Studies	Exposure	Outcome	Analyses	Total no. cases	Quality
WholEUGrain umbrella review	Reynolds et al. 2019 [1] SLR & MA	N = 11 prospective cohorts USA (6), Finland (1), Sweden (2), Denmark (1), Spain (1)	Whole grains n=11	Risk of CVD, CHD & stroke	High vs. low; dose-response (linear & non-linear); sensitivity analyses when $I^2 > 50\%$ or $P_{het} < 0.10$; influence analyses for the effect of each individual study; analyses for high quality data	CVD: 4,357 CHD: up to 7,697 Stroke: 1,247	Good
	Bechthold et al. 2019 [2] SLR & MA	N = 16 prospective cohorts USA (8), China (1), Denmark (2), Sweden (4), Finland (1)	Whole grains n=12 WG products n=4	Risk of HF, stroke or CHD	High vs. low; dose-response (linear & non-linear); subgroup analyses with sex, length of follow-up, geographic location, no. of cases, dietary assessment validation; sensitivity analyses for studies with low risk of bias.	HF: up to 6,455 Stroke: up to 11,116 CHD: up to 8,652	Good
	Barret et al. 2019 [3] SLR	N = 3 prospective cohorts USA (3)	Whole grains n=1 WG products n=2	Risk of CHD and stroke	NAp	NAp	Fair
	Deng et al. 2017 [4] SLR	N = 1 meta-analysis (incl. 4 prospective cohorts)	Whole grains	Risk of stroke	High vs. low.	NA	Fair
	Aune et al. 2016 [5] SLR & MA	N = 16 prospective cohorts USA (9), Sweden (2), Norway, Sweden & Denmark (1), Finland (1), China (1), Spain (1), unknown (1)	Whole grains n=13 Both whole grains & WG products n=3	Risk of CVD, CHD & stroke	High vs. low; dose-response (linear & non-linear); subgroup and meta-analyses stratified by study characteristics (duration of follow-up, sex, geographical location, number of cases, validated dietary assessment, study quality, and adjustment for confounding factors); influence analyses for the effect of each individual study	CVD: up to 26,243 CHD: up to 7,068 Stroke: up to 2,337	Good

SLR: systematic literature review; MA: meta-analysis; CVD: cardiovascular diseases; CHD: coronary heart disease; HF: heart failure; WG: whole grain; I^2: heterogeneity; P_{het}: significance value for heterogeneity; NA: not available; NAp: not applicable.

Table E.2 – Overview and characteristics of the included studies in the type 2 diabetes section.

Reference & Type		Studies	Exposure	Outcome	Analyses	Total no. cases	Quality
WholEUGrain umbrella review	Reynolds et al. 2019 [1] SLR & MA	N = 8 prospective cohorts USA (6), Finland (1), Sweden (1)	Whole grains n=8	Risk of type 2 diabetes	High vs. low, dose-response (linear and non-linear); sensitivity analyses when $I^2 > 50\%$ or $P_{het} < 0.10$; influence analyses for the effect of each individual study; analyses for high quality data.	14,686	Good
	Schwingshackl et al. 2017 [6] SLR & MA	N = 13 prospective cohorts USA (7), Finland (1), Sweden (2), Australia (1), Denmark (1), Germany (1)	Whole grains n=8 WG products n=5	Risk of type 2 diabetes	High vs. low, dose-response (linear and non-linear); stratified dose-response analyses by subgroup (sex, age, length of follow-up, geographic location, no. of cases, outcome assessment, and dietary assessment methods); sensitivity analysis for studies with low risk of bias.	29,633	Good
	Aune et al. 2013 [7] SLR & MA	N = 12 prospective cohorts USA (8), Finland (1), Sweden (2), Germany (1)	Whole grains n=8 WG products n=1 Both n=3	Risk of type 2 diabetes	High vs. low; dose-response (linear & non-linear); sensitivity analyses excluding one study at a time (for a min. of 5 studies in analysis); subgroup analyses for gender, duration of follow-up, geography, no. of cases, and adjustment for confounders.	19,829	Fair
	Cho et al. 2013 [8] SLR	N = 6 prospective cohorts USA (5), Finland (1)	WG products n=6	Risk of type 2 diabetes	NAp	NAp	Fair
	Ye et al. 2012 [9] SLR & MA	N = 6 prospective cohorts USA (5), Finland (1)	WG products n=6	Risk of type 2 diabetes	High vs. low; subgroup analyses (sex, study quality, health status, study duration, level of dietary intake, and method of outcome measurement).	NA	Fair
	de Munter et al. 2007 [10] SLR & MA	N = 5 prospective cohorts USA (4, Finland (1)	WG products n=5	Risk of type 2 diabetes	Dose-response (linear); sensitivity analyses for the effect of each individual study.	10,944	Fair
	Priebe et al. 2008 [11] Cochrane SLR	N = 5 prospective cohorts USA (4), Finland (1)	WG products n=5	Risk of type 2 diabetes	NAp	NAp	--

SLR: systematic literature review; MA: meta-analysis; WG: whole grain; I^2: heterogeneity; P_{het} value: significance value for heterogeneity; NA: not available; NAp: not applicable.

Table E.3 – Overlap of datasets from prospective cohort studies included in the systematic literature reviews and meta-analyses of whole grains and diabetes reviewed.

Prospective cohorts	Priebe et al. 2008 (Cochrane)	WholEUGrain umbrella review					
		de Munter et al. 2007	Ye et al. 2012	Cho et al. 2013	Aune et al. 2013	Schwingshackl et al. 2017	Reynolds et al. 2019
Liu et al. 2000 – NHS (USA)	√		√	√			
Meyer et al. 2000 – IWHS (USA)	√	√	√	√	√	√	√
Fung et al. 2002 – HPFS (USA)	√	√	√	√	√		√
Montonen et al. 2003 – FMCHES (FIN)	√	√	√	√	√	√	√
van Dam et al. 2006 – BWHS (USA)	√	√	√	√	√	√	√
de Munter et al. 2007 – NHS I & NHS II (USA)		√	√		√		√
Kochar et al. 2007 – PHS (USA)				√		√	
Ericson et al. 2013 – MDC (SWE)					√	√	
Hodge et al. 2004 – MCCS (AUS)						√	
Lacoppidan et al. 2015 – DCH (DNK)						√	
Parker et al. 2013 – WHI (USA)					√	√	√
von Ruesten et al. 2013 – EPIC-Postdam (GER)						√	
Sun et al. 2010 – HPFS (USA)					√	√	
Sun et al. 2010 – NHS I (USA)					√	√	
Sun et al. 2010 – NHS II (USA)					√	√	
Wirström et al. 2013 – NA (SWE)					√	√	√
Fisher et al. 2009 - EPIC-Postdam (GER)					√		

IWHS: Iowa Women's Health Study; HPFS: Health Professionals Follow-up Study; FMCHES: Finnish Mobile Clinic Health Examination Survey; BWHS: Black Women's Health Study; NHS: Nurse's Health Study; PHS: Physicians Health Study; MDC: Malmö Diet Cancer study; MCCS: The Melbourne Collaborative Cohort Study; DCH: Diet, Cancer and Health cohort; WHI: Women's Health Initiative; EPIC: European Prospective Investigation into Cancer and Nutrition; NA: non-available. Country codes: AUS: Australia, DNK: Denmark, FIN: Finland, GER: Germany, SWE: Sweden, USA: United States of America.

Table E.4 – Overview and characteristics of the studies retrieved through the WholEUGrain umbrella review and included in the cancer section.

Reference & Type	Studies	Exposure	Outcome	Analyses	Total no. cases	Quality
Reynolds et al. 2019 [1] SLR & MA	N = 7 prospective cohorts USA (3), Finland (1), Sweden (1), Denmark (1), Scandinavian countries (1; Norway, Sweden & Denmark)	Whole grains n=6 WG products n=1	Risk of colorectal cancer Risk of prostate cancer	High vs. low; dose-response (linear & non-linear); sensitivity analyses when $I^2 > 50\%$ or $p_{het} < 0.10$; influence analyses for the effect of each individual study; analyses for high quality data	8,803 colorectal cancer 7,010 prostate cancer	Good
Xiao et al. 2018 [12] SLR & MA	N = 4 prospective cohorts + 7 case-control studies USA (2), Italy (2), Greece (1), Switzerland (1), Denmark (1), Sweden (1), Germany (1), Iran (1), Korea (1)	Whole grains n=1 WG products n=11	Risk of breast cancer	High vs. low; dose-response (linear); influence analyses for the effect of each individual study; sensitivity & stratified analyses for sources of heterogeneity; subgroup analyses by study design, sample size, publication year, numbers of adjusted variables, and quality scores of studies.	11,589	Fair
Schwingshackl et al. 2017 [13] SLR & MA	N = 7 prospective cohorts + 2 case-control studies USA (5), Sweden (1), Netherlands (1), Iran (1), China (1)	Whole grains n=8 WG products n=1	Risk of total cancer	High vs. low.	NA	Fair
Lei et al. 2016 [14] SLR & MA	N = 1 prospective cohort + 7 case-control studies (only 5 studies incl. in MA) USA (5), Netherlands (1), Italy (1), Finland (1)	Whole grains n=2 WG products n=6	Risk of pancreatic cancer	High vs. low; subgroup analyses by study design, geographic area, type of whole grains, gender, control type, study quality, and adjustments factors; sensitivity analyses, omitting 1 study at a time.	2,548	Fair
Makarem et al. 2016 [15] SLR	N = 20 longitudinal studies USA (14), Denmark (4), Sweden (2)	Whole grains n=16 WG products n=3 Both n=1	Risk of breast cancer; endometrial cancer; kidney cancer; prostate cancer; oesophagus and stomach cancer; small intestine cancer; colorectal cancer; head and neck cancers; non-Hodgkin's lymphoma	NAp	NAp	Fair

SLR: systematic literature review; MA: meta-analysis; NA: not available; NAp: not applicable.

Table E.5 – Overview and characteristics of the included studies in the mortality section.

	Reference & Type	Studies	Exposure	Outcome	Analyses	No. cases	Quality
WholEUGrain umbrella review	Zong et al. 2016 [16] SLR & MA	N = 12 prospective cohorts USA (8), Scandinavia (NO, SE, DK) (1), Sweden (1), Norway (1), UK (1)	Whole grains n=6 WG products n=6	Risk of all-cause mortality	High vs. low; dose-response (linear & non-linear); subgroup analyses by study location, WG assessment (foods vs. ingredients), type of dietary questionnaire, WG as main exposure (yes/no), sample size, median follow-up duration, adjustments for dietary factors, Newcastle-Ottawa Scale score, means age at baseline.	97,867	Good
	Chen et al. 2016 [17] SLR & MA	N = 12 prospective cohorts USA (n=6), Scandinavia (NO, SE, DK) (n=1), Sweden (n=1), Norway (n=1), Netherlands (n=1), UK (n=1), Spain (n=1)	Whole grains n=3 WG products n=9	Risk of all-cause mortality	High vs. low; dose-response (linear & non-linear); sensitivity analyses for the effect of each individual study; stratified analyses by geographic region, sex, duration of follow-up, methods for exposure assessment, types of intake (WG or GW products), quality scores, exclusion of prevalent disorders at baseline, and adjustment for potential confounders.	100,653	Good
	Wei et al. 2016 [18] SLR & MA	N = 11 prospective cohorts USA (n=8), Norway (n=1), Scandinavian countries (n=1; Norway, Sweden & Denmark), Spain (n=1)	NA	Risk of all-cause mortality	High vs. low; dose-response (linear & non-linear); subgroup and meta-regression analyses were performed according to age, baseline mean age, duration of follow-up and methods of dietary assessment; adj. for confounding factors, including histories of hypertension, dyslipidaemia and type 2 DM; sensitivity analyses for the effect of each individual study.	94,638	Good
	Li et al. 2016 [19] SLR & MA	N = 10 prospective cohorts USA (n=8), Sapin (n=1), Scandinavian countries (n=1; Norway, Sweden & Denmark)	NA	Risk of all-cause mortality	High vs. low; dose-response (linear & non-linear); subgroup analyses (sex, continent, furation of follow-up, degree of adjustment for confounding incl. history of hypertension, dyslipidaemia, type 2 diabetes, and dietary fiber intake); sensitivity analyses for the effect of each individual study.	92,647	Good
	Ma et al. 2016 [20] SLR & MA	N = 11 prospective cohorts USA (n=7), Spain (n=1), Netherlands (n=1), Norway (n=1), Scandinavian countries (n=1; Norway, Sweden & Denmark)	Whole grains n=3 WG products n=8	Risk of all-cause mortality	High vs. low; dose-response (linear); sensitivity analyses for the effect of each individual study; subgroup analyses by gender, study location, follow-up period, cohort size, adjustment for confounders (total energy intake, BMI, smoking status, alcohol consumption, physical activity level) or intermediate variables (diabetes, blood pressure & serum cholesterol).	101,282	Good
	Benisi-Kohansal et al. 2016 [21] SLR & MA	N = 11 prospective cohorts USA (n=6), Spain (n=1), UK (1), Sweden (n=1), Denmark (n=1), Norway (n=1)	Whole grains n=6 WG products n=5	Risk of all-cause mortality	High vs. low, dose-response (linear and non-linear); sensitivity analyses for the effect of each individual study; subgroup analyses for type of WG (total or products), study quality, duration of follow-up, sex, dietary assessment tools, and location.	101,979	Good
	Schwingshackl et al. 2017 [22] SLR & MA	N = 19 prospective cohorts USA (9), Spain (1), UK (1), Netherlands (1), Switzerland (1), Norway (1), Sweden (3), Scandinavian countries (Norway, Sweden & Denmark) (1), China (1)	Whole grains n=14 WG products n=5	Risk of all-cause mortality	High vs. low, dose-response (linear and non-linear); subgroup analyses by sex, duration of follow-up, location, number of cases, validation of dietary assessment; sensitivity analyses for studies with low risk of bias.	121,217	Good

	Zhang et al. 2018 [23] SLR & MA	N = 9 prospective cohorts USA (7), Spain (1), Norway (1)	Whole grains n=4 WG products n=5	Risk of all-cause mortality	High vs. low, dose-response (linear and non-linear); sensitivity analyses for the effect of each individual study; subgroup analyses for publication year, study duration, area, sex, mean age, number of deaths.	84,464	Fair
	Reynolds et al. 2019 [1] SLR & MA	N = 10 prospective cohorts USA (n=7), Spain (n=1), Netherlands (n=1), Scandinavian countries (n=1; Norway, Sweden & Denmark)	Whole grains n=9 WG products n=1	Risk of all-cause mortality	High vs. low, dose-response (linear and non-linear); sensitivity analyses for the effect of each individual study; analyses for high quality data	99,224	Good
	Aune et al. 2016 [5] SLR & MA	N = 11 prospective cohorts USA (7), Scandinavia (NO, SE, DK) (1), China (1), Spain (1), Netherlands (1)	Whole grains n=10 Whole grains & WG products n=1	Risk of all-cause mortality	High vs. low; dose-response (linear & non-linear); subgroup analyses stratified by study characteristics (duration of follow-up, sex, geographical location, number of cases, validated dietary assessment, study quality, and adjustment for confounding factors); sensitivity analyses for the effect of each individual study.	100,726	Good

SLR: systematic literature review; MA: meta-analysis; WG: whole grain; NA: not available; NAp: not applicable.

Table E.6 – Overview of coincident prospective cohort studies included in meta-analyses of whole grains and overall mortality.

Prospective cohorts	Aune et al. 2016	WholEUGrain project review								
		Zong et al. 2016	Chen et al. 2016	Wei et al. 2016	Li et al. 2016	Ma et al. 2016	Benisi-Kohansal et al. 2016	Schwingschackl et al. 2017	Zhang et al. 2018	Reynolds et al. 2019
Wang et al. 2016 – LNITC (CHN)	√							√		
Zhong et al. 2016 – NHANES III (USA)		√								
Zhong et al. 2016 – NHANES 1999-2004 (USA)		√								
Boggs et al. 2015 – BWHS (USA)	√			√	√	√		√	√	√
Johnsen et al. 2015 – HELGA (NOR, SWE, DNK)	√	√	√	√	√	√		√		√
Huang et al. 2015 – NIH-AARP DHS (USA)	√	√	√	√	√	√	√	√	√	√
Roswall et al. 2015 – SWLHC (SWE)		√	√					√		
Vormund et al. 2015 – Swiss MONICA (CHE)								√		
Wu et al. 2015 – NHS-I (USA)	√	√	√	√	√	√	√	√	√	√
Wu et al. 2015 – HPFS (USA)	√	√	√	√	√	√	√	√	√	√
Yu et al. 2015 – SCCS (USA)								√		
Buil-Cosiales et al. 2014 - PREDIMED (ESP)	√		√	√	√	√	√	√	√	√
Tognon et al. 2012 – VIP (SWE)								√		
Olsen et al. 2011 – DCH (DNK)							√			
Tognon et al. 2011 – GGPSG (SWE)		√					√	√		
van den Brandt et al. 2011 – NldCS (NLD)			√			√		√		√
Jacobs et al. 2007 – IWHS (USA)	√	√	√	√	√	√	√	√		√
Sahyoun et al. 2006 – NA (USA)	√		√	√	√	√	√	√		√
Liu et al. 2003 – PHS (USA)			√	√	√		√	√	√	
Steffen et al. 2003 – ARCS (USA)	√	√	√	√	√	√	√	√	√	√
Appleby et al. 2002 – HFS (GBR)							√			
Jacobs et al. 2001 – NoCS (NOR)		√	√	√		√	√	√	√	
Jacobs et al. 1999 – IWHS (USA)									√	
Key et al. 1996 – CBVHC (GBR)		√	√					√		

ARCS: Atherosclerosis Risk in Communities Study; BWHS: Black Women's Health Study; CBVHC: Cohort of British vegetarians and health-conscious people; DCH: Diet, Cancer and Health cohort; GGPSG: Gerontological and Geriatric Population Studies in Gothenburg; HELGA: 3 sub-cohorts from Norway, Sweden, and Denmark; HFS: Health Food Shoppers Study; HPFS: Health Professionals Follow-up Study; IWHS: Iowa Women's Health Study; LNITC: Linxian Nutrition Intervention Trial Cohort; MONICA: Multinational MONItoring of trends and determinants in CArdiovascular disease; NHS-I: Nurse's Health Study I; NHANES: National Health and Nutrition Examination Survey; NIH-AARP DHS: NldCS: Netherlands Cohort Study; NoCS: Norwegian County Study; National Institute of Health-American Association of Retired Persons Diet and Health Study; PREDIMED: Primary Prevention of CVD with a Mediterranean Diet; PHS: Physicians Health Study; SCCS: Southern Community Cohort Study; SWLHC: Swedish Women's Lifestyle and Health cohort; VIP: Vasterbotten Intervention Program; NA: not available. Country codes: CHE: Switzerland, CHN: China, DNK: Denmark, ESP: Spain, GBR: United Kingdom, NLD: Netherlands, NOR: Norway, SWE: Sweden, USA: United States of America.

Table E.7 – Overview and characteristics of the included studies in the WholEUGrain umbrella review for the overweight section.

Reference & Type	Studies	Exposure	Outcomes	Analyses	Total no. participants	Quality
Reynolds et al. 2020 [24] SLR	N = 2 cohort studies GBR (1), Netherlands (1)	NA	Body weight & weight gain	NAp	5,019	Good
Wang et al. 2020 [25] SLR & MA	N = 20 RCTs USA (5), DK (4), Finland (2), Sweden (1), UK (2), Iran (1), Australia (1), New Zealand (1), Netherlands (1), Germany (1), China (1)	WG products =20	Body weight, BMI & waist circumference	Average reduction in body weight or waist circumference; BMI collected but no results reported; subgroup analysis for positive vs. negative results.	App. 1,800 (incl. controls)	Fair
Sadeghi et al. 2020 [26] SLR & MA	N = 21 RCTs USA (8), UK (3), Denmark (3), Italy (2), Finland/Italy (1), Finland (1), Sweden (1), Australia (1), Switzerland (1)	WG products =21	Body weight BMI Fat mass Fat-free mass Waist circumference	Mean differences in changes; subgroup analyses based on sex, BMI, health status, duration of intervention, study design, use of hypo- vs. isocaloric diets, WG-diet vs. WG-products, anthropometric measures as primary vs. secondary outcomes; sensitivity analyses to assess influence of single studies.	1,798	Good
Maki et al. 2019 [27] SLR & MA	N = 6 prospective cohorts USA (4), Spain (1), Sweden (1) N = 8 RCTs USA (4), Denmark (2), GBR (1), TWN (1)	WG products =6	BMI Body weight	For RCTs Secondary and sensitivity analyses to assess the relationship of higher WG versus a control on: (1) change in waist circumference (cm), (2) change in body fat percentage, (3) weight change (kg) in a subset of studies that included subjects of both sexes, and (4) weight change (kg) in hypocaloric intervention studies.	Observational studies = 136,834 RCTs = 973	Fair
Schlesinger et al. 2019 [28] SLR & MA	N = 6 prospective cohorts USA (3), Spain (2), Australia (1)	Whole grains =2 WG products =4	Risk of overweight/obesity, abdominal obesity, and weight gain	High vs. low; dose-response (linear & non-linear); sensitivity analyses excluding studies not adjusting for energy intake	> 185,000	Good
Reynolds et al. 2019 [1] SLR & MA	N = 11 RCTs UK (2), Vietnam (1),Taiwan (1), USA (2), Italy/Finland (1), China (1) Finland (2), Canada (1),	Whole grains =1 WG products =10	Changes in body weight, BMI, waist circumference and fat mass	High vs. low, sensitivity analyses due to high heterogeneity	919	Good
McRae 2017 [29] Umbrella review of MAs	N = 2 MAs of RCTs Harland & Garton 2008 n=15 RCTs Pol et al. 2013, n=26 RCTs	Harland & Garton 2008 Whole grains =15 Pol et al. 2013 Whole grains =18 NA n=8	Changes in body weight, BMI, and waist circumference	High vs. low	121,889	Fair

SLR: systematic literature review; MA: meta-analysis; RCTs: randomised controlled trials; WG: whole grains; NA: not available; NAp: not applicable; GBR: Great Britain.

REFERENCES

[1] Reynolds A, Mann J, Cummings J, Winter N, Mete E, Te Morenga L. Carbohydrate quality and human health: a series of systematic reviews and meta-analyses. Lancet 2019;393:434–45. doi:10.1016/S0140-6736(18)31809-9.

[2] Bechthold A, Boeing H, Schwedhelm C, Hoffmann G, Knüppel S, Iqbal K, et al. Food groups and risk of coronary heart disease, stroke and heart failure: A systematic review and dose-response meta-analysis of prospective studies. Crit Rev Food Sci Nutr 2019;59:1071–90. doi:10.1080/10408398.2017.1392288.

[3] Barrett EM, Batterham MJ, Ray S, Beck EJ. Whole grain, bran and cereal fibre consumption and CVD: a systematic review 2019. doi:10.1017/S000711451900031X.

[4] Deng C, Lu Q, Gong B, Li L, Chang L, Fu L, et al. Review Article Stroke and food groups: an overview of systematic reviews and meta-analyses 2017. doi:10.1017/S1368980017003093.

[5] Aune D, Keum N, Giovannucci E, Fadnes LT, Boffetta P, Greenwood DC, et al. Whole grain consumption and risk of cardiovascular disease, cancer, and all cause and cause specific mortality: Systematic review and dose-response meta-analysis of prospective studies. BMJ 2016;353. doi:10.1136/bmj.i2716.

[6] Schwingshackl L, Hoffmann G, Lampousi AM, Knüppel S, Iqbal K, Schwedhelm C, et al. Food groups and risk of type 2 diabetes mellitus: a systematic review and meta-analysis of prospective studies. Eur J Epidemiol 2017;32:363–75. doi:10.1007/s10654-017-0246-y.

[7] Aune D, Norat T, Romundstad P, Vatten LJ. Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose-response meta-analysis of cohort studies. Eur J Epidemiol 2013;28:845–858. doi:10.1007/s10654-013-9852-5.

[8] Cho SS, Qi L, Fahey GC, Klurfeld DM. Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease. Am J Clin Nutr 2013;98:594–619. doi:10.3945/ajcn.113.067629.

[9] Ye EQ, Chacko SA, Chou EL, Kugizaki M, Liu S. Greater Whole-Grain Intake Is Associated with Lower Risk of Type 2 Diabetes, Cardiovascular Disease, and Weight Gain. J Nutr 2012;142:1304–13. doi:10.3945/jn.111.155325.

[10] de Munter JSL, Hu FB, Spiegelman D, Franz M, van Dam RM. Whole Grain, Bran, and Germ Intake and Risk of Type 2 Diabetes: A Prospective Cohort Study and Systematic Review. PLoS Med 2007;4:e261. doi:10.1371/journal.pmed.0040261.

[11] Priebe MG, Van Binsbergen JJ, De Vos R, Vonk RJ. Whole grain foods for the prevention of type 2 diabetes mellitus. John Wiley and Sons Ltd; 2010. doi:10.1002/14651858.CD006061.pub2.

[12] Xiao Y, Ke Y, Wu S, Huang S, Li S, Lv Z, et al. Association between whole grain intake and breast cancer risk: a systematic review and meta-analysis of observational studies. Nutr J 2018;17. doi:10.1186/s12937-018-0394-2.

[13] Schwingshackl L, Schwedhelm C, Galbete C, Hoffmann G. Adherence to mediterranean diet and risk of cancer: An updated systematic review and meta-analysis. Nutrients 2017;9. doi:10.3390/nu9101063.

[14] Lei Q, Zheng H, Bi J, Wang X, Jiang T, Gao X, et al. Whole grain intake reduces pancreatic cancer risk: A meta-analysis of observational studies. Med (United States) 2016;95. doi:10.1097/MD.0000000000002747.

[15] Makarem N, Nicholson JM, Bandera E V, Mckeown NM, Parekh N. Consumption of whole grains and cereal fiber in relation to cancer risk: a systematic review of longitudinal studies n.d. doi:10.1093/nutrit/nuw003.

[16] Zong G, Gao A, Hu FB, Sun Q. Whole Grain Intake and Mortality from All Causes, Cardiovascular Disease, and Cancer: A Meta-Analysis of Prospective Cohort Studies n.d. doi:10.1161/CIRCULATIONAHA.115.021101.

[17] Chen GC, Tong X, Xu JY, Han SF, Wan ZX, Qin JB, et al. Whole-grain intake and total, cardiovascular, and cancer mortality: A systematic review and meta-analysis of prospective studies. Am J Clin Nutr 2016;104:164–72. doi:10.3945/ajcn.115.122432.

[18] Wei H, Gao Z, Liang R, Li Z, Hao H, Liu X. Whole-grain consumption and the risk of all-cause, CVD and cancer mortality: a meta-analysis of prospective cohort studies. Br J Nutr 2016;116:514–25. doi:10.1017/S0007114516001975.

[19] Li B, Zhang G, Tan M, Zhao L, Jin L, Tang X, et al. Consumption of whole grains in relation to mortality from all causes, cardiovascular disease, and diabetes. Medicine (Baltimore) 2016;95:e4229. doi:10.1097/MD.0000000000004229.

[20] Ma X, Tang WG, Yang Y, Zhang QL, Zheng JL, Xiang YB. Association between whole grain intake and all-cause mortality: A meta-analysis of cohort studies. Oncotarget 2016;7:61996–2005. doi:10.18632/oncotarget.11491.

[21] Benisi-Kohansal S, Saneei P, Salehi-Marzijarani M, Larijani B, Esmaillzadeh A. Whole-Grain Intake and Mortality from All Causes, Cardiovascular Disease, and Cancer: A Systematic Review and Dose-Response Meta-Analysis of Prospective Cohort Studies. Adv Nutr An Int Rev J 2016;7:1052–65. doi:10.3945/an.115.011635.

[22] Schwingshackl L, Schwedhelm C, Hoffmann G, Lampousi A-M, Knu¨ppel S, Iqbal K, et al. Food groups and risk of all-cause mortality: a systematic review and meta-analysis of prospective studies 1,2. Am J Clin Nutr 2017;105:1462–73. doi:10.3945/ajcn.117.153148.

[23] Zhang B, Zhao Q, Guo W, Bao W, Wang X. Association of whole grain intake with all-cause, cardiovascular, and cancer mortality: A systematic review and dose-response meta-analysis from prospective cohort studies. Eur J Clin Nutr 2018;72:57–65. doi:10.1038/ejcn.2017.149.

[24] Reynolds AN, Huyen |, Pham TD, Montez J, Mann J. Dietary fibre intake in childhood or adolescence and subsequent health outcomes: A systematic review of prospective observational studies 2020. doi:10.1111/dom.14176.

[25] Wang W, Li J, Chen X, Yu M, Pan Q, Guo L. Whole grain food diet slightly reduces cardiovascular risks in obese/overweight adults: A systematic review and meta-Analysis. BMC Cardiovasc Disord 2020;20:82. doi:10.1186/s12872-020-01337-z.

[26] Sadeghi O, Sadeghian M, Rahmani S, Maleki V, Larijani B, Esmaillzadeh A. Whole-Grain Consumption Does Not Affect Obesity Measures: An Updated Systematic Review and Meta-analysis of Randomized Clinical Trials 2020. doi:10.1093/advances/nmz076.

[27] Maki KC, Palacios OM, Koecher K, Sawicki CM, Livingston KA, Bell M, et al. The Relationship between Whole Grain Intake and Body Weight: Results of Meta-Analyses of Observational Studies and Randomized Controlled Trials 2019. doi:10.3390/nu11061245.

[28] Schlesinger S, Neuenschwander M, Schwedhelm C, Hoffmann G, Bechthold A, Boeing H, et al. Food Groups and Risk of Overweight, Obesity, and Weight Gain: A Systematic Review and Dose-Response Meta-Analysis of Prospective Studies. Adv Nutr 2019;10:205–18. doi:10.1093/advances/nmy092.

[29] McRae MP. Health Benefits of Dietary Whole Grains: An Umbrella Review of Meta-analyses. J Chiropr Med 2017;16:10–8. doi:10.1016/j.jcm.2016.08.008.