

# Review of whole grain and dietary fiber recommendations and intake levels in different countries

Kevin Burke Miller

*This review of whole grain and dietary fiber recommendations and intake levels was presented at the symposium on whole grains, dietary fiber, and public health, convened in Beijing, China, on May 11, 2018. The review reflects on inconsistencies among the definitions of whole grains and fiber as well as recommended intake levels in different countries. The lack of consistent dietary recommendations from authoritative sources may delay the regional implementation and consumer adoption of diets that include whole grains and fiber. Currently, few countries include specific intake recommendations for whole grain, and even among those countries with guidance the recommendations can be vague and qualitative. As a result of the well-documented associations between increasing whole grain intake and reduced disease risk, there is compelling evidence to create clear, actionable dietary recommendations for both whole grains and fiber. Furthermore, work is ongoing to develop uniform standards for whole grain and whole-grain food to ensure recommendations are being met. Health and regulatory authorities are encouraged to acknowledge the public health benefits that could be derived from strong, clear whole-grain and dietary fiber recommendations; examine existing definitions (whole grain as an ingredient, whole-grain food, and dietary fiber); and adopt the most appropriate approach to best serve public health needs for their respective populations.*

## INTRODUCTION

This article presents a summary of a presentation delivered at the symposium on whole grains, dietary fiber, and public health, convened in Beijing, China on May 11, 2018. The objective of the presentation was to increase awareness of the differences in recommendations for whole grain and fiber intake in various countries and highlight the gaps between actual and recommended intake levels. The public is in need of clear, consistent, and actionable dietary recommendations to help them achieve optimal intakes of food groups and nutrients. Increased intakes of fiber, and the substitution of whole grain for refined grain, is expected to

translate to reduced risk of noncommunicable diseases, and regional health authorities are encouraged to recognize the public health benefit of optimizing fiber and whole grain intakes by developing or including whole grain and dietary fiber recommendations in dietary guidance. The present examination of existing whole grain and fiber intake recommendations is intended to highlight those approaches that are clear and actionable.

## GLOBAL WHOLE GRAIN RECOMMENDATIONS AND INTAKE LEVELS

The association between whole grain intake and disease risk reduction has been well established in observational

Affiliation: *K.B. Miller* is with the Scientific and Regulatory Affairs, General Mills, Minneapolis, Minnesota, USA.

Correspondence: *K.B. Miller*, 9000 Plymouth Ave N, Golden Valley, MN 55427, USA. Email: Kevin.miller2@genmills.com.

*Key words:* dietary guidance, fiber, intake, recommendations, whole grain.

©The Author(s) 2020. Published by Oxford University Press on behalf of the International Life Sciences Institute. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com.

studies,<sup>1-5</sup> where greater intakes are linked to reductions in the prevalence and risk of diseases including cardiovascular disease (CVD), gastrointestinal (GI) cancer, and diabetes. Underconsumption of whole grains has been listed as a factor contributing to the risk for disability-adjusted life years globally.<sup>6</sup> In addition, an analysis published in 2018 concluded that consumption of whole grains, nuts, and seeds can have the greatest positive impact on health of all dietary factors investigated, including the consumption of fruits and vegetables.<sup>7</sup> Therefore, populations consuming higher proportions of their grains as whole grains may derive a direct health benefit as well as reducing the burden on already overburdened healthcare systems.

As a result of the strong association between higher whole grain intake and reduced risk of disease, it is not surprising that recommendations to increase whole grain consumption exist in many countries. Despite the strength and amount of evidence supporting higher intakes of whole grain, there is still no global consensus on *how much* whole grain should be consumed or the amount of whole grain that should be in foods marketed as “whole grain.” There is a need for clear and meaningful dietary guidance that is regionally and culturally relevant, to encourage people to consume whole-grain foods.

Currently, dietary recommendations for whole grain intake from around the world may be based on qualitative or quantitative research, or a combination of both. For example, qualitative general recommendations that promote whole grain consumption with statements such as “eat more whole grains” or “eat more whole grains, like whole grain bread” may encourage intake but are vague, and therefore, difficult for consumers to make actionable decisions on how much to consume. The most useful recommendations quantify a specific intake goal for whole grain intake and identify specific, culturally appropriate foods to achieve the quantitative goal. Currently, qualitative research-based recommendations represent the most common approach to the development of global dietary guidance (Table 1).<sup>8-18</sup> However, efforts continue through tripartite collaborations of academics, industry, and governments to create a whole grain intake recommendation that can be adopted globally.

Since its first publication in 1980, the United States’ Dietary Guidelines for Americans (DGA) index has encouraged the consumption of adequate amounts of both whole grains and fiber.<sup>19</sup> It is important to separate whole grain and fiber intake recommendations because of the varying fiber content of whole grains. Whole grains are a source of more than just fiber in the diet. The 2005 DGA index was the first to include whole grains as one of the “key recommendations,” with a

specific recommendation to consume at least 3 ounce-equivalent servings each day.<sup>20</sup> Today, the dietary guidance of many countries advocates the replacement of refined grains with whole grains as part of a healthful diet (Table 1). Despite various dietary guidances recognizing the importance of whole grains, there is still no global standard for recommended whole grain intake. One reason for this lack of a standard recommendation is the fact that no single definition of whole grain exists, and that whole grain sources vary from region to region, thus creating complexity around creating a global whole-grain intake recommendation. However, efforts are underway to reach a consensus on the *minimum* amount of whole grains required to achieve meaningful health benefits.

Comparing reported intakes of whole grains between countries that may have different whole grain definitions, as well as different survey methods for assessing nutritional intake, can only provide rough estimates of actual whole grain intake.

Whole grain consumption varies widely across the globe. At present, whole grain intakes are more likely driven by consumption of traditional foods available in a given country, rather than by whole grain dietary recommendations or consumers seeking health benefits from whole grains. In some countries, grain foods that are traditionally consumed, such as pasta and breads, are made with refined grains. As a result, the mean intake of whole grains in these countries is lower than that in countries where traditional foods are often rich in whole grains. For example, the Scandinavian countries (Sweden, Norway, Denmark, and Finland) have a long tradition of consuming crisp and dark breads made of whole grain rye and wheat, as well as muesli cereals with whole grain oats. The differences are apparent when the mean whole grain intakes from Scandinavian countries are compared with intakes from elsewhere around the globe (Figure 1).<sup>21-29</sup>

Reporting of whole grain intakes is not standard in nutritional surveillance surveys. The few exceptions where whole grain consumption is tracked are shown in Figure 1. The data reported are derived from peer-reviewed publications and indicate mean daily whole grain intakes by adults around the globe range from 15 g to nearly 60 g. As noted previously, accurately reporting and comparing whole grain intakes around the world is challenging because of different definitions of whole grain and dissimilar nutritional surveillance methodology. Some publications assessing “whole grain” intakes are not represented in the chart because those data measured intake of “whole grain foods” (ie, as prepared) and not whole grain as an ingredient in whole grain-containing foods. It is clear there is a need

**Table 1 Examples of dietary recommendations for whole grain intake**

Country	Source	Recommendation [Translated to English]
<b>Quantitative recommendations</b>		
Netherlands <sup>8</sup>	Health Council of the Netherlands. Dutch dietary guidelines 2015.	Replace refined cereal products with whole-grain products. Eat at least 90 g of brown bread, wholemeal bread, or other whole grain products daily.
Denmark <sup>9</sup>	Ministeriet for Fødevarer Landbrug og Fiskeri Fødevarstyrelsen	Four portions per day, equivalent to minimum <b>75 g</b> whole grains for energy requirements of 10 MJ/d. Whole grains are found in food made from cereal products, where the entire grain is used.
Sweden <sup>10</sup>	Livsmiddelsverket Swedish dietary guidelines risk and benefit management report (Rapport 5; 2015)	Consume <b>75g</b> of whole grains per 2400 calories. An intake corresponding to 75 g of whole grains per 10 MJ energy is considered an appropriate amount. This equates to about 70 g of whole grains a day for women and about 90 g a day for men. One Danish report also suggested 75 g/10 MJ, based on the highest intakes in Nordic populations.
United States of America <sup>11</sup>	US Department of Health and Human Services and US Department of Agriculture. Dietary guidelines for Americans 2015–2020. 8th ed. Published December 2015.	Make one-half of your total daily grains whole grains. This recommendation is based on 6 total grain servings, with one-half being 3 servings of whole grains (which is calculated to be equal to <b>48g</b> based on 16g whole grains per serving of 100% whole-grain wheat bread)
<b>Qualitative recommendations</b>		
Australia <sup>12</sup>	Eat For Health – Australian dietary guidelines. National Health and Medical Research Council. Published 2013.	“Enjoy grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties.” Note: The Australian dietary guidelines outline the recommended average daily number of servings from each of the 5 food groups, with the grain (cereal) foods recommendation “mostly wholegrain.”
Canada <sup>13</sup>	Canada’s dietary guidelines for health professionals and policy makers. Published 2019.	Guideline 1. Vegetables, fruit, whole grains, and protein foods should be consumed regularly.
Mexico <sup>14</sup>	Guías Alimentarias-y de-Actividad Física. En Contexto de Sobrepeso Y Obesidad en la Poblacion Mexicana. Documento de Postura. Published 2015.	These guidelines recommend the consumption of cereals and whole grains because they provide fiber, which can help prevent constipation and colon cancer, and promote heart health.
Germany <sup>15</sup>	German Society for Nutrition. 10 Regeln der Deutschen Gesellschaft für Ernährung (DGE).	Favors whole-grain foods. The whole grain varieties of cereal products such as bread, pasta, rice, and flour are the best choices for your health.
Saudi Arabia <sup>16</sup>	The healthy food palm. In: Dietary guidelines for Saudis.	Choose whole grains. Select foods prepared from whole grain or cereal grain.
United Kingdom <sup>17</sup>	UK NHS Choices. The eatwell guide.	Try to choose whole grain varieties whenever you can.
China <sup>18</sup>	The Chinese Nutrition Society (CNS). Food-based dietary guidelines. (FBDGs).	Consume at least 50g of “coarse” grain per day* *Although a quantitative amount is listed, “coarse grains” include both cereal grains and pulses / legumes. Therefore, the recommendation for “coarse grains” should not be directly compared to recommendations for “whole grains.”

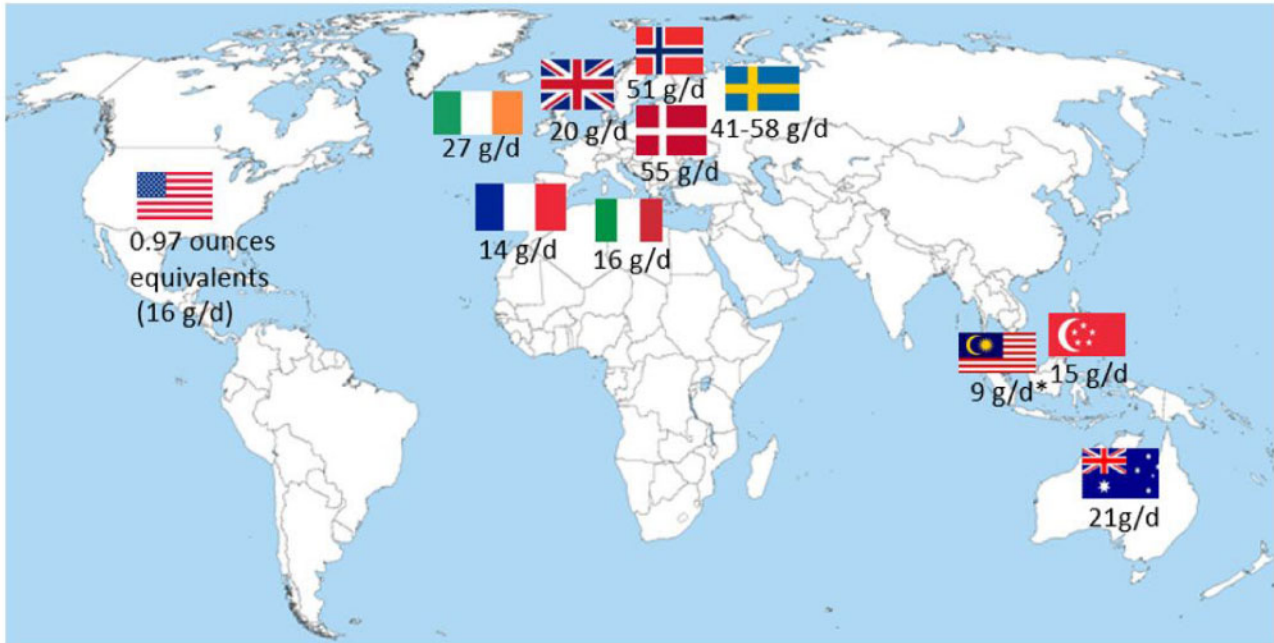
for globally consistent definitions, where “whole grain” is defined as an ingredient and “whole grain food” as food containing the minimum amount of whole grain required for it to be labeled “whole grain.” Definitions enable accurate assessment of intakes that improve scientists’ ability to correlate consumption to health outcomes and develop meaningful dietary guidance.

Consistent definitions are also important to consumers seeking whole-grain foods for their purported health benefits, and provide confidence that the foods consumed do contain whole grain, as compared to refined grains, seeds, or legumes. Some foods are assumed to contain whole grains even when the grain does not

meet the accepted definition of “whole grain.” For example, Health Canada refers to this potential confusion in their communication “Whole Grains – Get the Facts”:

*“As sold in Canada, whole wheat flour may have much of the germ removed. Therefore, 100% whole wheat bread may not be whole grain.”<sup>30</sup>*

Developing a clear, globally consistent definition of whole grain and the minimum quantity of whole grains required in a food for it to be marketed as “whole grain” should remain a priority to improve diet quality, build consumer confidence, and improve accuracy of nutritional surveillance research to promote public health.



**Figure 1** Examples of reported mean intakes of whole grains by adults, highlighting differences among countries that often reflect whether or not traditional foods consumed by the population emphasize whole grains (eg, Scandinavia) or refined grains (eg, Italy, France).

### GLOBAL DIETARY FIBER RECOMMENDATIONS

Dietary recommendations and reported fiber intake levels vary widely among countries (Table 2).<sup>31–36</sup> Unfortunately, the reported intakes typically do not even approach the intake levels recommended by different countries. For example, in Australia the mean fiber intake by adults was reported to be 18.2 g as compared to the recommended intakes of 25 g and 40 g for women and men, respectively.<sup>37</sup> The importance of achieving the recommended intakes is underscored by research showing that not only does risk of cardiovascular disease and type 2 diabetes decrease when such recommendations are followed, the economic value through reduced healthcare expenditures could also be significant.<sup>38</sup> Dietary fibers comprise a wide assortment of nondigestible carbohydrates with an equally broad set of health benefits that depend on the fiber type. In order to develop meaningful dietary recommendations, it is necessary to assess the health effect(s) being sought for the population, the intake amounts necessary to deliver the effect(s), and the availability of appropriate foods. The goal of the following section is to compare and contrast some of the global fiber definitions, dietary recommendations, and reported fiber intakes.

In the most basic form, dietary fiber can be categorized into soluble and insoluble fibers. The insoluble category of fibers can be further divided into cellulose, hemicellulose, and lignin fibers. The classification of

fibers according to four characteristics (soluble/insoluble, viscous/nonviscous, dietary/functional, and fermentable/non-fermentable) has been reviewed elsewhere.<sup>39</sup> Each of the fiber types functions through different mechanisms of action and may modify endpoints that are risk factors for disease and health (eg, by lowering cholesterol [for cardiovascular disease], acting as a fecal bulking agent [for laxative purposes], and inhibiting glucose absorption [for diabetes]). The evidence supporting the effect of soluble beta-glucans in reducing blood lipids and therefore reduce cardiovascular disease risk is well accepted. Likewise, wheat bran fiber has been referred to as the gold standard of fibers in terms of reducing the risk of colon cancer and increasing fecal bulking and laxation. Based on the variety of benefits from different fiber, it is clear that a healthful diet must include a diversity of fiber types available from different foods. Dietary guidance should encourage intake of many forms of dietary fiber and not just one or two food fiber sources.

Similar to the existing differences in definitions of “whole grain,” the definition of dietary fiber is inconsistent among countries. Previously, fiber was identified using one or more of the Codex Alimentarius–approved methods for chemical analysis.<sup>40</sup> Based on this approach, the Codex indicated that dietary fiber consists of either (1) edible, naturally occurring, nondigestible material composed of carbohydrate polymers that are at least 3 units long; (2) carbohydrate polymers (at least 3

**Table 2 Comparison of dietary fiber recommendations for select countries**

Country	Source	Fiber recommendation
United States <sup>11</sup>	Dietary Guidelines for Americans 14 g / 1000 kcal	28 g/d (per 2000 kcal)
Australia <sup>12</sup>	Eat for Health, Dietary Guidelines	Between 25–40 g/d for women and men, respectively
Canada <sup>13</sup>	Health Canada	25 and 38 g/d for women and men, respectively
Mexico <sup>14</sup>	Mexico Secretaria de Salud	25 g/d
United Kingdom <sup>17</sup>	Food Standards Agency, UK	18 g/d <sup>a</sup>
	British Nutrition Foundation	30 g/d
European Union <sup>31</sup>	European Food Safety Authority	25 g/d
India <sup>32</sup>	Indian Council for Medical Research, National Institute of Nutrition	40 g (per 2000 kcal)
Turkey <sup>33</sup>	Ministry of Health	25 and 29 g/d for women and men, respectively
Norway <sup>34</sup>	Helsedirektoratet kostråd	Intake of dietary fiber should be at least 25–35 g/d, or approximately 3 g per megajoule
Republic of South Korea <sup>35</sup>	General Dietary Guidelines for Koreans	12g / 1000 kcal; 20g and 25g for men and women, respectively
South Africa <sup>36</sup>	Department of Health, Republic of South Africa	Recommended range 18–38 g/d, in adults

<sup>a</sup>The UK's recommendation of 18 g/d does not include resistant starches or short oligomers.<sup>17</sup>

units long) obtained from foods by physical, enzymatic, or chemical means; or (3) synthesized carbohydrate polymers (at least 3 units long). What is lacking from this approach is whether or not a health benefit has been demonstrated for the specific fiber.

In the United States, the Food and Drug Administration (FDA) recently updated their criteria for labeling nondigestible carbohydrates as “dietary fiber” on the nutrition facts panel of a food package.<sup>41</sup> The FDA derived the new fiber definition from a report published by the Institute of Medicine (IOM, 2001),<sup>42</sup> which defined dietary fiber as nondigestible carbohydrates and lignin that occur naturally in plant-based foods (“intrinsic fibers”). However, some fibers in the diet may be isolated from foods such as cereal grains, fruits, and vegetables. Therefore, a category named “added fiber” was included to identify those fibers separated from their source matrix. The FDA defines dietary fiber as being either intrinsic (from the food) or isolated (separated from the food). However, the isolated and synthetic fibers then became subject to a new requirement: these fibers had to demonstrate a beneficial physiological effect in humans. The intention of this new requirement was to ensure that any dietary fibers in foods would contribute towards health and well-being, as demonstrated by evidence of health benefit.

Creation of the new “isolated and synthetic” category was important because some, but not all, fibers had been found to elicit health effects outside of their food or source matrix. For example, isolated beta-glucan fiber from oats or barley has been shown to lower cholesterol even without consumption of oats or barley. Isolated fibers are typically found in dietary

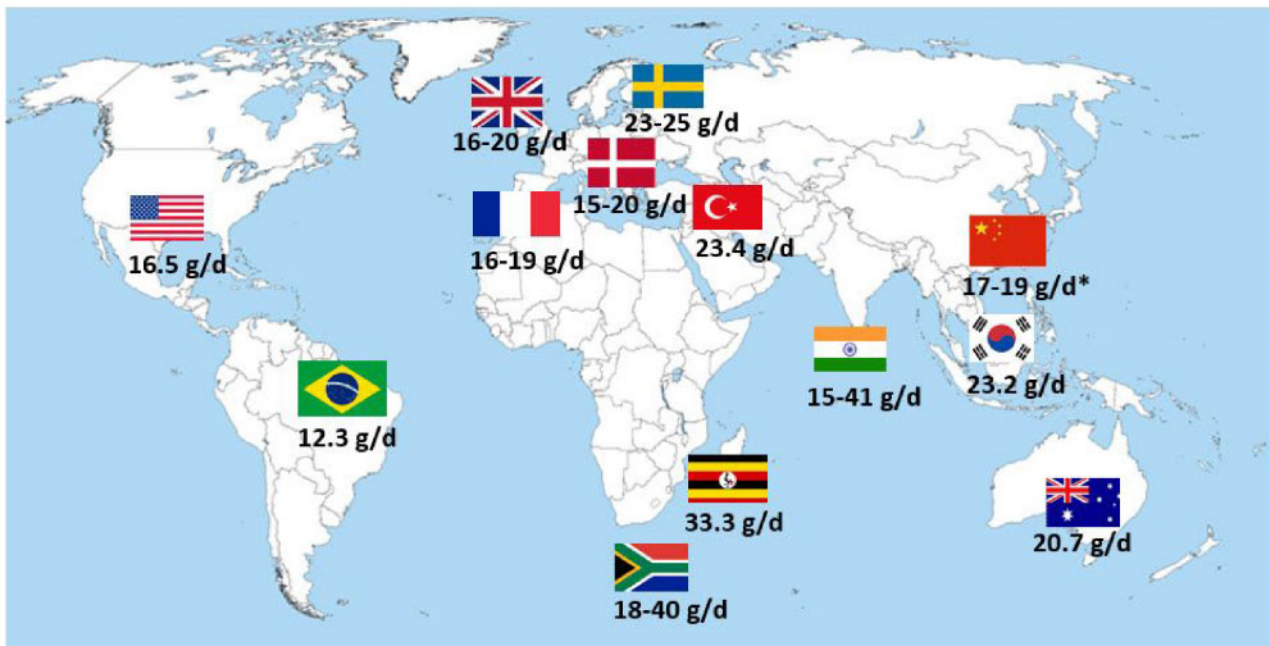
supplements or added back to foods to increase their fiber content. However, dietary fiber recommendations are based on intakes from food, not supplements. This is not to imply that isolated fibers do not deliver benefits, but rather to emphasize the importance of non-fiber nutrients delivered by grains, vegetables, and other foods. For example, oat beta-glucan has been demonstrated to help lower cholesterol, but choosing isolated beta-glucan over the whole oat reduces intake of vitamins, minerals, and phytonutrients, including avenanthramides, which may confer an anti-inflammatory effect that helps protect against heart disease and cancer.<sup>42</sup> The health benefits from consuming isolated fibers may be more limited than the benefits from fiber(s) consumed as part of the original food – for example, vegetables and whole grains.<sup>43</sup>

Globally, dietary recommendations for fiber are more prevalent than guidance for whole grain intake despite the two being highly correlated. Fiber in the diet is most often derived from fruits, vegetables, grains, and beans. However, the role that cereal grains can play in delivering a variety of different fibers cannot be overlooked. For example, wheat is a source of several fibers, including cellulose and hemicellulose (eg, arabinoxylan) as well as a significant source of fructans, including inulin and oligofructose, in the American diet.<sup>44,45</sup>

### Global dietary fiber intake levels

Global fiber intakes vary widely from country to country. Typically, dietary fiber intakes are highest in those countries with a diet derived mostly from plant products, including grains, vegetables, beans, and legumes





Ranges in mean fiber intakes reported are gender differences between intakes by males and females (e.g., UK, Denmark) or urban and rural population differences (e.g., India)

**Figure 2** Examples of reported mean dietary fiber intakes illustrating the differences between, and even within, countries based on gender and whether the population surveyed is rural or urban.

(Figure 2).<sup>46–55</sup> Mean fiber intakes are also often higher in rural settings than urban settings. Moreover, some African countries and India are observed to have among some of the highest intakes of dietary fiber globally. The Food and Agriculture Organization (FAO) reports the diet of Uganda to consist of foods rich in fiber, including “plantain, starchy roots (cassava, sweet potatoes), and cereals (maize, millet, sorghum). Pulses, nuts, and green leafy vegetables complement the diet.”<sup>56</sup> Ranges in the fiber intakes reported (Figure 2) represent either the difference in dietary intakes between males and females (eg, UK and Denmark) or the differences in intake between urban and rural populations (eg, in South Africa and India).

Populations achieving recommended fiber intakes, as described in their respective dietary guidance reports, are more likely to have a reduced burden of diseases and potentially even a higher quality of life.<sup>57</sup> In addition, diets higher in fiber are more likely to be sustainable diets with more reliance on grains, vegetables, beans, and legumes that can be incorporated into efficient agricultural programs.<sup>58</sup>

## CONCLUSION

As countries develop or update existing guidance and recommendations for fiber and whole grains, it is important to understand current intakes by the populations involved in relation to not only the amount of fiber or whole grains,

but also the dietary fiber sources. To be of practical benefit, recommendations in the dietary guidance must reflect culturally appropriate sources of fiber. An additional consideration is the objective upon which the recommendations are based. Populations with a high prevalence of cardiovascular disease may benefit from increasing their intake of cereal grains, such as oats and barley, as a result of the healthful properties of their soluble fiber, beta-glucan. As dietary guidance is developed, it is important to acknowledge that recommendations must promote a variety of higher-fiber foods and specify substitution of refined grains with whole grains in order to deliver their unique properties and health benefits.

## Acknowledgments

This article stems from a presentation given at the symposium on whole grains, dietary fiber, and public health held in Beijing, China on May 11, 2018. The symposium was cohosted by ILSI Focal Point in China, the Chinese Institute of Food Science and Technology, the Institute of Nutrition and Health at the Chinese Center for Disease Control and Prevention, and the China Food Information Center.

Funding for the symposium and publication of the proceedings was provided by PepsiCo, Nestlé, Wilmar, Amway, McDonald’s, and Starbucks. All non-industry speakers were offered reimbursement for their travel



40. Joint FAO/WHO Food Standards Programme, Secretariat of the CODEX Alimentarius Commission: CODEX Alimentarius (CODEX) Guidelines on Nutrition Labeling CAC/GL 2–1985 as Last Amended 2010. Rome: FAO; 2010.
41. US Food and Drug Administration. Docket FDA-2016-D-3401. At the time of writing US FDA had not published the updated definition in the Federal Register (21 CFR 101). *Questions and Answers on Dietary Fiber*. Available at: [https://www.fda.gov/food/food-labeling-nutrition/questions-and-answers-dietary-fiber#define\\_dietary\\_fiber](https://www.fda.gov/food/food-labeling-nutrition/questions-and-answers-dietary-fiber#define_dietary_fiber). Accessed May 2019
42. Institute of Medicine (US) Panel on the Definition of Dietary Fiber and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. *Dietary Reference Intakes. Proposed Definition of Dietary Fiber*. Washington, DC: National Academies Press (US); 2001.
43. Sang S, Chu Y. Whole grain oats, more than just a fiber: role of unique phytochemicals. *Mol Nutr Food Res*. 2017;61(7):1600715.
44. Ross AB. Whole grains beyond fibre: what can metabolomics tell us about mechanisms? *Proc Nutr Soc*. 2015;74:320–327.
45. Stevenson L, Phillips F, O'Sullivan K, et al. Wheat bran: its composition and benefits to health, a European perspective. *Int J Food Sci Nutr*. 2012;63:1001–1013.
46. Sardinha AN, Canella DS, Martins AP, et al. Dietary sources of fiber intake in Brazil. *Appetite*. 2014;79:134–138.
47. Andreeva VA, Deschamps V, Salanave B, et al. Comparison of dietary intakes between a large online cohort study (Etude NutriNet-Santé) and a nationally representative cross-sectional study (Etude Nationale Nutrition Santé) in France: addressing the issue of generalizability in e-epidemiology. *Am J Epidemiol*. 2016;184:660–669.
48. Lockyer S, Spiro A, Stanner S. Dietary fibre and the prevention of chronic disease – should health professionals be doing more to raise awareness? *Nutr Bull*. 2016;41:214–231.
49. Fagt S, Matthiessen J, Thyregod C, et al. Breakfast in Denmark. Prevalence of consumption, intake of foods, nutrients and dietary quality. A study from the international breakfast research initiative. *Nutrients*. 2018;10:E1085.
50. Larsson SC, Wolk A. Dietary fiber intake is inversely associated with stroke incidence in healthy Swedish adults. *J Nutr*. 2014;144:1952–1955.
51. Singh A, Singh SN. Dietary fiber content of Indian diets. *Asian J Pharma Clin Res*. 2015;8:58–61.
52. Yeon S, Oh K, Kweon S, et al. Development of a dietary fiber composition table and intakes of dietary fiber in Korea National Health and Nutrition Examination Survey (KNHANES). *Korean J Community Nutr*. 2016;21:293–300.
53. Mchiza ZJ, Steyn NP, Hill J, et al. A review of dietary surveys in the adult South African population from 2000 to 2015. *Nutrients*. 2015;7:8227–8250.
54. Harvey P, Rambeloson Z, Dary O. *The 2008 Uganda Food Consumption Survey: Determining the Dietary Patterns of Ugandan Women and Children (A2Z: The USAID Micronutrient and Child Blindness Project)*. Washington, DC: Academy for Educational Development; 2010.
55. Wang HJ, Wang ZH, Zhang JG, et al. Trends in dietary fiber intake in Chinese aged 45 years and above, 1991–2011. *Eur J Clin Nutr*. 2014;68:619–622.
56. Food and Agriculture Organization of the United Nations. Agriculture and Consumer Protection Department. Uganda: Nutrition country profiles. Available at: [http://www.fao.org/ag/agn/nutrition/uga\\_en.stm](http://www.fao.org/ag/agn/nutrition/uga_en.stm)
57. Brauchla M, Reidenbach K, Baker S, et al. The effects of increased dietary fiber intake on the self-reported quality of life of school-age children. *Health*. 2014;6:115–122.
58. Chaudhary A, Marinangeli CPF, Tremorin D, et al. Nutritional combined greenhouse gas life cycle analysis for incorporating Canadian yellow pea into cereal-based food products. *Nutrients*. 2018;10:E490.