Abstract

This study aimed to assess the whole grain (WG) content of foods consumed in the UK which include ingredients that retain all three structural components of the grain, and contained ≥10% WG. Dietary data from seven studies with 10,474 UK subjects were examined for foods containing WG. The WG content was then determined from ingredient lists, manufacturers' information and recipes. 372 food descriptors from nine food groups (4.4% of all food codes) contained ≥10% WG. Of these 372 foods, 31.5% contained ≥51%, 30.6% 25-50%, and 37.9% 10-24% WG dry matter as eaten. The relatively small number of WG foods identified in the total number of foods consumed confirms the low contribution of WG foods to the overall pattern of foods consumed in the UK. Since foods containing <51% WG accounted for the majority of WG food codes identified, recognising the importance of these foods to WG intake is essential.

1. **Introduction**

There is now extensive observational evidence demonstrating an inverse association between higher whole grain intake and numerous health outcomes (Huang, Xu, Lee, Cho & Qi, 2015; Ye, Chacko, Chou, Kugizaki & Liu, 2012). Given the strength of the evidence, whole grain related dietary guidance and health claims have been established in several countries. These highlight the importance of whole grains as a dietary constituent and encourage consumers to incorporate whole-grain foods into the diet on a regular basis (HEALTHGRAIN, 2006; Health Canada, 2007; National Health and Medical Research Council, 2005; NHS Choices, 2010; USDA & USDHHS, 2010).

The Danish Whole Grain campaign has had a positive impact on whole grain intake in Denmark, with the lowest whole grain consumers doubling their intake (Danish Whole Grain Partnership, 2014). However, positive efforts from both governmental agencies and the food industry elsewhere, such as in the UK and US, have had limited success with data indicating that whole grain intake and patterns of consumption at the population level are extremely low (Bachman, Reedy, Subar & Krebs-Smith, 2008; Mann, Pearce, McKevith, Thielecke & Seal, 2015; Thane, Jones, Stephen, Seal & Jebb, 2005; Thane, Jones, Stephen, Seal & Jebb, 2007; USDA, 2005). In addition, intake data suggest that foods containing between 10% and 51% whole grain content (i.e. less than the 51% cut-off point used for the purposes of health claims and food labelling in the US) have become an increasingly more important contributor to whole grain consumption (Mann et al., 2015; Thane et al., 2007; USDA, 2005). Making comparisons between populations, establishing how whole grains exert their protective effect, the quantities required for maintaining good health and evaluating the success of health

promotion strategies is problematic due to the lack of consistency in the approaches used to quantify intakes. The following definition of 'whole grain' was created and approved by the American Association of Cereal Chemists (AACC) in order to aid consumers and food manufacturers: "Whole grains shall 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" (AACC, 1999). As described by Seal, Jones and Whitney (2006), however, there are no universally accepted methods for quantifying whole grain intake at the grain, ingredient and food levels, and differences in nomenclature have been used. Given the variation in the approaches used it is clear that a consolidated database based on clear definitions of whole grain and whole-grain ingredients is needed which can be used to quantify whole grain intake more accurately.

1.1 Aims of study

The purpose of the present study was to use pooled information from a number of population-based studies to identify foods that included whole-grain ingredients which retained all three structural components of the grain. The aim was to identify and catalogue foods consumed in the UK which contained at least 10% whole grain content by weight in order to facilitate quantification of whole grain intake.

2. Methods

Dietary data from the seven studies described in Table 1 were amalgamated and examined for foods containing whole-grain ingredients, and the 'food codes' used in the dietary analysis identified. Whole-grain ingredients were classified as the components of a recipe derived from whole grains. The majority of whole-grain ingredients were flours or processed cereals

prepared from the intact grain and contained all three components of the grain (endosperm, germ and bran) as defined by the AACC (1999) and described by Seal et al. (2006). A food was described as a 'whole-grain food' when ≥10% of the food as eaten was whole grain. Foods containing high amounts of bran and/or germ but not containing all three components of the grain were not included in the list. In the large UK population-based surveys used in this analysis, sweetcorn (maize) was classified as a vegetable and therefore not included as a cereal grain. Values for sweetcorn (as eaten) have been included in our list of whole-grain foods (Supplementary Table 1), for informative purposes. Foods where sweetcorn is a minor ingredient such as quiches and soups have not been included since they would not exceed the 10% threshold for calculation.

In order to identify foods containing at least 10% dry matter whole grain, the water content (%) and the dry matter whole grain content (%) of whole-grain ingredients were established (Table 2). Using the data in Table 2 and recipe information from Holland, Unwin and Buss (1988), Holland, Welch and Buss (1992), the Food Standards Agency (2002), a specialist recipe book for cakes and baked cereal products (Hobson, 2002) or manufacturers (including official website information), the whole grain delivery on a dry matter basis as a percentage of the fresh weight of food was calculated using the equation shown in Figure 1. Weight losses of food from cooking were taken into account when estimating the percentage whole grain content. For some foods such as breakfast cereals where food codes used in dietary analysis do not generally include milk or fluid consumed with the cereal, the data are for the cereal in the food packets only. For others, such as porridge, and cooked foods such as breads and desserts where the liquid is integral to the food as described and codes for the food as eaten are used, the percentage whole grain on a dry matter basis is given for the food as eaten since this will be the information required to calculate whole grain intake from food

descriptors and portion sizes described in these terms. Using recipe and weight loss information from Holland et al. (1988) for porridge (made up with whole milk), an example of how the equation in Figure 1 was implemented can be described as follows: Porridge contains oatmeal (60g), salt (7g) and milk (500g). Oatmeal, the only whole grain ingredient, is 91.1% dry matter whole grain (Table 2). The dry matter whole grain delivery is therefore 60 x 0.911 = 54.7g. During cooking porridge loses 79.4 g in weight (14% weight loss as specified by Holland et al. (1988)), therefore the final cooked weight of porridge is 487.6g. The dry matter whole grain content as a percentage of the fresh weight of porridge is therefore (54.7/487.6) x 100 = 11.2%. This is the value for the food as eaten, and can be used to calculate whole grain intake (in grams of whole grain dry matter) if the portion size of the porridge consumed is known.

The foods identified as containing 10% or more whole grain content using this method were grouped by food type into nine groups (breads; breakfast cereals (including porridge); pasta; rice; biscuits and sweet snacks; savoury snacks; cakes, pastries and desserts, egg dishes and 'others'). The whole grain containing foods were classified into three categories of whole grain content as follows: 1) Foods containing 51% or more whole grain dry matter as eaten (in line with the cut-off point used for health claims and food labelling in the US) ; 2) Foods containing between 25 and 50% whole grain dry matter as eaten (since foods have also been defined as whole grain if they contain at least 25% whole grain by weight (Jacobs, Pereira, Slavin & Marquart, 2000)); 3) Foods containing between 10 and 24% whole grain as eaten (since foods containing 10-24% whole grain are important contributors to whole grain intake in the UK (Thane et al., 2005; Thane et al., 2007)) .

To illustrate the whole grain delivery to the consumer portion size information for a selection of commonly consumed whole grain-containing foods, as identified in the UK National Diet and Nutrition Survey (NDNS), were collated. Grams of whole grain delivered per portion was

calculated using the appropriate whole grain content percentage as described above. The whole grain delivery was also examined as a proportion of the US minimum whole grain intake recommendation (3 servings a day, 48g/d; USDA & USDHHS (2010)). Food portion sizes were sourced from the NDNS adults 19-64 Foodbase (Food Standards Agency, 2006), Ministry of Agriculture Fisheries and Food (MAFF) food portion size atlas photograph 5 (Nelson, Atkinson & Meyer, 1997) and manufacturers package recommendation.

3. **Results**

Dietary data from a total of 10,474 subjects from seven different studies were used with the method described above for assessing the whole grain content of foods and to identify the foods consumed in the UK which contained at least 10% whole grain content. Table 1 shows the total number of individual foods with different food codes identified within each study and likewise the total number of individual whole-grain food codes (foods containing at least 10% whole grain as eaten). The total number of food codes for whole-grain foods represented 4.4% of all the food codes identified.

Overall, 372 different foods with whole grain as an ingredient were described in food records and identified as containing ≥10% whole grain dry matter as eaten (supplementary Table 1). A summary of the 372 whole grain containing foods is presented in Table 3. The table shows the list of foods as they were described in the different studies used to collect data. As with all diet records there were variations in the description provided within and between studies, but the description refers to the same food, for example, ‘muesli’, ‘muesli without sugar’ and ‘homemade muesli’ or ‘Flapjack’ bought and homemade. Thus the calculated whole grain content for these foods is the same, but the individual food descriptions have been retained in

the supplementary table for comparison between studies. Some foods, for example porridge, were prepared using different liquids (such as milk, water, etc.) but the same recipe was used for each. Thus the whole grain content of these foods was the same, although the choice of liquid would affect the overall nutrient composition of the food and as such only one food descriptor is named with unspecified liquid. Of the 372 foods identified, 31.5% contained at least 51% whole grain, 30.6% contained between 25 and 50% whole grain and 37.9% contained between 10 and 24% whole grain as eaten. Foods containing less than 51% whole grain as eaten contributed collectively 68.5% of all whole-grain food codes identified.

Since our analysis of British whole grain intake reported by Thane et al. (2005, 2007) further information regarding the whole grain content of granary products and bulgur wheat has been obtained. These foods were found to be not 10% or more whole grain as eaten and should not be included in future analyses but have been included here for information (Supplementary Table 1).

Table 4 presents a selection of commonly consumed whole grain containing foods and their portion sizes from a range of sources to illustrate how the data can be used to estimate whole grain intake from diet records. The delivery of whole grain for each portion size expressed as a gram weight and as a proportion of the minimum US recommendation is also presented. For example, should an individual consume a small slice of wholemeal bread (25g) this would deliver 13.7g of whole grain to the consumer or 29% of the minimum US recommendation.

4. **Discussion and conclusions**

This paper presents the whole grain content of foods which contain ingredients that retain all three structural components of the grain. These data can be applied to UK records of food

intake, and other countries where similar foods are consumed, to calculate whole grain consumption. Initial analyses of whole grain intake in nationally representative UK populations investigated eating occasions of whole-grain foods and did not take into account the variation in food portion size and whole grain content (Lang, Thane, Bolton-Smith & Jebb, 2003). Such an approach may have underestimated actual whole grain intake and also failed to acknowledge the importance of the varying proportions of whole-grain ingredients within food products. Using the combination of portion sizes of foods consumed (g) and their corresponding whole grain content (%) shown in Table 3, whole grain intake in terms of absolute amounts (g/d) can be calculated, for examples see Table 4. This method was successfully employed by Thane et al. (2005, 2007) to assess whole grain intake in British young people and secular trends in whole grain intake of British adults. Mann et al. (2015) have also completed the most recent estimation of whole grain intake in the UK population using this method. Results from these analyses of NDNS data, and the data from population-based studies carried out in the North East of England used in this study clearly support the observations that whole-grain foods fail to make a significant contribution to the UK diet (Thane et al., 2005, 2007; Mann et al., 2015; Jones, 2007).

Methods for quantifying whole grain intake in absolute amounts have been previously proposed by groups in the US and Sweden (Jensen et al., 2004; Koh-Banerjee et al., 2004; Menzel, Kamal-Eldin, Marklund, Andersson, Aman & Landberg, 2012). However, there are important differences between these methods and that described in the present study. Koh-Banerjee et al. (2004) and Jensen et al. (2004) calculated the different proportions of whole-grain ingredients within a product when calculating whole grain intake. However, the studies did not take into account the whole grain delivery of each individual ingredient. For example, Jensen et al. (2004) indicated that brown rice was 100% whole grain on a dry weight basis.

Brown rice is 100% whole grain but contains 13.9% water on a raw weight basis and is therefore 86.1% dry matter whole grain (Table 2). The number of foods containing whole grain presented was also much lower (20 foods) than the 372 in the present study and so their use in examining the whole grain intake amongst other populations is limited to these small number of foods. Similarly, Menzel et al. (2012) present the whole grain content of 144 foods on a fresh weight basis, and limited detail is given on how whole grain content values were calculated. Furthermore the foods assessed were products typically consumed in Sweden and so may limit the generalisability of the data presented to other populations. More recent studies have also recognised the importance of quantifying whole grain intake in absolute amounts and have described the development of databases of the whole grain content of foods (Franz & Sampson, 2006; Maras, Newby, Bakun, Ferrucci & Tucker, 2009). However, their use in making cross comparisons of populations is again limited due to the lack of data presented in the published paper.

Our study also demonstrates the importance of identifying grains from non-grains and the impact processing can have on the whole grain status of the ingredient used. The comprehensive list of whole grains, non-whole grains, whole grain ingredients and non-whole grain ingredients described by Seal et al. (2006) formed the basis from which the method for quantifying whole grain content in the present study was developed. The method proposed in this study used the AACC definition of whole grains (AACC, 1999). This definition has been updated following an AACC International Task Force (Jones, 2010), and has been further modified taking into account inevitable losses during cleaning and processing of the grain, and proposed for use in Europe (van der Kamp, Poutanen, Seal & Richardson, 2014). However, previous studies have also included non-whole-grain ingredients such as wheat germ and bran in analyses of whole grain intake (Jacobs, Meyer,

Kushi & Folsom, 1998; Liu et al., 1999; Liu et al., 2000; Steffen, Jacobs, Stevens, Shahar, Carithers & Folsom, 2003). Importantly, the method described in this study can be adapted so that using relevant information from Holland et al. (1998, 1992), the Food Standards Agency (2002), and Hobson (2002) intakes of ingredients such as wheat germ and bran can be calculated should this be required. For example, bran muffins were not included in the present analysis but the bran content could replace the 'whole grain in food recipe' in Figure 1 and the resulting value would correspond to the equivalent 'whole grain' content if wheat bran were classified as 'whole grain' as described in the studies above. The data presented in this study were derived from dietary intake records collected between 1986 and 2011. The list therefore contains foods which may no longer be available, but also includes foods where recipes may have changed as a result of reformulation. When calculating whole grain intake it is important to use compositional data which reflect the time of data collection. In some instances we have reported more than one value where foods appeared in more recent records and reformulation was known (Supplementary Table 1).

The data presented in this study shows the large number, and hence the importance of foods containing less than 51% whole grain content in the UK diet. Exclusion of these foods when quantifying whole grain intake would underestimate total whole grain intake. As shown by Thane et al. (2005) foods containing less than 51% whole grain content contributed 28% to overall whole grain intake in British young people and a higher percentage in older adolescents. In the analysis of the secular trend in whole grain intake in British adults Thane et al. (2007) again showed that foods with less than 51% whole grain content are important contributors to whole grain intake representing 18% of overall whole grain intake in the 1986-7 survey and significantly more (27%) in 2000-1. More recently a standardised definition of a whole-grain food has been proposed by a review from a multidisciplinary

expert round table (Ferruzzi et al., 2014). Ferruzzi et al. (2014) suggest that a whole-grain food should provide 8g or more of whole grain per 30g of product. However, this equates to a minimum whole grain content of 27% and would again exclude a number of foods that contribute to whole grain intake. The present study calculated whole grain content values for foods containing at least 10% whole grain content to provide data which can be used to give the most accurate estimation of whole grain intake. This method highlights the importance of foods failing to meet the US Food and Drug Administration (FDA) and Joint Health Claims Initiative (JHCI) definition of a whole-grain food to overall whole grain intake (HEALTHGRAIN, 2006), and the need for agreement on the minimum whole grain content required, for a food to be described as 'whole-grain'.

Food consumption data from over 10,000 subjects were used in this study revealing over 300 foods containing more than 10% whole grain content. Including different food descriptions this identified 372 food items. Of these 117 (31.5%) were more than 51% whole grain. However, it is important to be aware of the ways in which foods are described in nutritional surveys and the other nutritional characteristics of foods with an apparently lower whole grain content. Table 3 shows that the majority of foods with a higher whole grain content were breads, breakfast cereals and more 'healthful' snacks. For most dietary analysis databases, breakfast cereal portions are entered as the dry weight of cereal (or estimated from a description of a 'small bowl') with milk added as a separate food item. Thus these foods mostly have a higher whole grain content. For others, such as porridge where the cereal is whole grain, the portion size used is that for the made-up food. Thus, as eaten, porridge has a lower whole grain content value. This should not be confused with the total whole grain delivery from the bowl of cereal which would make a significant overall contribution to total whole grain consumption. The majority of other foods with a lower whole grain content

included foods high in sugar and or fat such as cakes, pies and desserts which may contribute to whole grain intake but in the context of a healthy diet should be eaten in moderation (NHS Choices, 2010).

In summary, an increasing amount of data show that consuming whole-grain foods may reduce the risk of a number of chronic diseases. However, the inconsistencies in approaches used to calculate whole grain intake not only impede cross-comparisons of study populations but also the quantification of amounts of whole grain required to prevent disease development. This also makes it difficult to incorporate this information into meaningful public health messages. This study provides information on the whole grain content of 372 foods described in a number of UK dietary surveys, from nine different foods groups, to add to earlier data on much smaller numbers of foods. These whole-grain foods represented, on average, 4.4% of all food codes used, thus reflecting the poor variety and representation of whole-grain foods in total food intake. Since foods containing less than 51% whole grain content accounted for more than 60% of all whole-grain foods it is essential that these foods are included in estimates of whole grain intake. However, other nutritional characteristics of foods with a lower whole grain content also require careful consideration when promoting whole-grain food consumption, and manufacturers should be encouraged to develop high whole grain, healthful products if whole grain consumption is to be increased. The data presented here could be incorporated into existing dietary databases to calculate whole grain intake alongside other foods and nutrients. This facility would be beneficial when quantifying the amounts of whole grain required each day to promote a health benefit and translating quantities required into consumer friendly information. In the future the data will be useful when tracking temporal changes in whole grain intake and evaluating the success of public health initiatives aimed at increasing whole grain consumption.

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Conflict of interest

CJS and KDM have received unrestricted research funding from Cereal Partners UK, Cereal Partners Worldwide and Nestlé. There are no conflicts to declare.

Authorship

ARJ carried out the fieldwork and wrote the first draft of the paper; KDM carried out additional fieldwork and contributed to the writing of the paper; CJS, SAK and DPR supervised the research and contributed to the writing of the paper.

References

AACC. Definition of Whole Grain. (1999)
http://www.aaccnet.org/initiatives/definitions/Pages/WholeGrain.aspx Accessed 01.11.15.

Bachman, J.L., Reedy, J., Subar, A.F., & Krebs-Smith, S.M. (2008). Sources of food group intakes among the US population, 2001-2002. *Journal of the American Dietetic Association, 108*(5), 804-14.

Department of Health and the Food Standards Agency. National Diet and Nutrition Survey: Headline results from years 1, 2 and 3 (combined) of the rolling programme (2008/2009 – 2010/11). (2012).
http://webarchive.nationalarchives.gov.uk/20130402145952/http://media.dh.gov.uk/network/261/files/2012/07/ndns-y3-report_all-text-docs-combined.pdf Accessed 01.11.15.

Ferruzzi, M. G., Jonnalagadda, S. S., Liu, S. Marquart, L., McKeown, N., Reicks, M., Riccardi, G., Seal, C., Slavin, J., Thielecke, F., van der Kamp, J. W., & Webb, D.(2014). Developing a standard definition of Whole-Grain foods for dietary recommendations: Summary report of multidisciplinary expert roundtable discussion. *Advances in Nutrition 5*(2), 164-176.

Finch, S., Doyle, W., Lowe, C., Bates, C. J., Prentice, A. Smithers, G., & Clarke, P. C. (1998) National Diet and Nutrition Survey: people aged 65 years and over. vol. 1: *Report of the diet and nutrition survey.* London: The Stationary Office.

Food Standards Agency. (2002). *McCance and Widdowson's The Composition of Foods, Sixth summary edition*. Cambridge: Royal Society of Chemistry.

Food Standards Agency. Calculation and collation of typical food portion sizes for adults aged 19-64 and older people age 65 and over. (2006). http://www.foodbase.org.uk/results.php?f_report_id=82 Accessed 01.11.15.

Franz, M., & Sampson, L. (2006). Challenges in developing a whole grain database: Definitions, methods and quantification. *Journal of Food Composition and Analysis 19,* S38-S44.

Gregory, J., Foster, K., Tyler, H., & Wiseman, H. (1990). The Dietary and Nutritional Survey of British Adults. London: HMSO.

Gregory, J., Lowe, S., Bates, C.J., Prentice, A., Jackson, L. V., Smithers, G., Wenlock, R., & Farron, M. (2000). National Diet and Nutrition Survey: young people aged 4 to 18 years. vol. 1: *Report of the diet and nutrition survey*. London: The Stationery Office.

HEALTHGRAIN. Health claims. (2006) http://www.healthgrain.eu/pub/chapter-seven.php#UK Accessed 02.09.10.

Health Canada. Eating Well with Canada's Food Guide. (2007) http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang-eng.pdf Accessed 01.11.15.

Henderson, L., Gregory, J., & Swan, G. (2002). The National Diet and Nutrition Survey: adults aged 19 to 64 years. vol. 1: *Types and quantities of food consumed*. London: The Stationary Office.

Hobson, W. (2002). *The Classic 1000 Cake and Bake Recipes*. London: Foulsham.

Holland, B., Unwin, I.D., & Buss, D.H. (1988). *Cereals and Cereal Products: The third supplement to McCance & Widdowson's The Composition of Foods.* (4th ed). Nottingham: The Royal Society of Chemistry & Ministry of Agriculture, Fisheries and Food.

Holland, B., Welch, A.A., & Buss, D.H. (1992). *Vegetable Dishes: The second supplement to McCance & Widdowson's The Composition of Foods.* (5th ed). Cambridge: The Royal Society of Chemistry & Ministry of Agriculture, Fisheries and Food.

Huang, T., Xu, M., Lee, A., Cho, S. & Qi, L. (2015). Consumption of whole grains and cereal fibre and total and cause-specific mortality: prospective analysis of 367,442 individuals. *BMC Medicine, 13*, 59.

Jacobs, D. R. Jr., Meyer, K. A., Kushi, L. H. & Folsom, A. R. (1998). Whole-grain intake may reduce the risk of ischemic heart disease death in postmenopausal women: the Iowa Women's Health study. *American Journal of Clinical Nutrition 68*(2), 248-57.

Jacobs, D., Pereira, M., Slavin, J. & Marquart, L. (2000). Defining the impact of wholegrain intake on chronic disease. *Cereal Foods World 45*, 51-53.

Jensen, M.K., Koh-Banerjee, P., Hu, F.B., Franz, M., Sampson, L., Grønbaek, M., & Rimm, E.B. (2004). Intakes of whole grains, bran, and germ and the risk of coronary heart disease in men. *American Journal of Clinical Nutrition, 80*(6), 1492-9.

Jones, A.R.D. (2007). *Attitudinal and physiological responses to the consumption of wholegrain foods.* (PhD Thesis). Newcastle upon Tyne: Newcastle University.

Jones, J. M. (2010). Regulatory aspects of whole grain and wholegrain foods: definitions and labelling. *Cereal Chemistry 87*(2), 150-4.

Koh-Banerjee, P., Franz, M., Sampson, L., Liu, S., Jacobs, D.R. Jr., Spiegelman, D., Willett, W., & Rimm, E. (2004). Changes in whole-grain, bran, and cereal fiber consumption in relation to 8-y weight gain among men. *American Journal of Clinical Nutrition, 80*(5), 1237-45.

Lang, R., Thane, C.W., Bolton-Smith, C., & Jebb, S.A. (2003). Consumption of whole-grain foods by British adults: findings from further analysis of two national dietary surveys. *Public Health Nutrition, 6*(5), 479-84.

Liu, S., Manson, J. E., Stampfer, M. J., Hu, F. B., Giovannucci, E., Colditz, G. A., Hennekens, C. H., & Willett, W. C. (1999). Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study. *American Journal of Clinical Nutrition 70*(3), 412-9.

406 Liu, S., Manson, J. E., Stampfer, M. J., Rexrode, K. M., Hu, F. B., Rimm, E. B., & Willett,
407 W. C. (2000). Whole Grain Consumption and Risk of Ischemic Stroke in Women A
408 Prospective Study. The *Journal of the American Medical Association 284*(12), 1534-40.

409

410 Mann, K.D., Pearce, M.S., McKevith, B., Thielecke, F., & Seal, C.J. (2015). Low whole
411 grain intake in the UK: results from the National Diet and Nutrition Survey rolling
412 programme 2008–11. *British Journal of Nutrition, 113*(10), 1643-1651.

413

414 Maras, J. E., Newby, P. K., Bakun, P. J., Ferrucci, L., & Tucker, K. L. (2009). Whole grain
415 intake: The Baltimore Longitudinal Study of Aging. *Journal of Food Composition and*
416 *Analysis 22*(1), 53-8.

417

418 Menzel, C., Kamal-Eldin, A., Marklund, M., Andersson, A., Aman, P., & Landberg, R.
419 (2012). Alkylresorcinols in Swedish cereal food products. *Journal of Food Composition and*
420 *Analysis, 28*, 119-125.

421

422 National Health and Medical Research Council. Dietary Guidelines for Australians. A guide
423 to healthy eating. (2005)
424 http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/n31.pdf Accessed
425 01.11.14.

426

427 Nelson, M., Atkinson, M., & Meyer, J. (1997). *Food Portion Sizes A Photographic Atlas.*
428 London: MAFF Publications.

429

NHS choices. Eight tips for healthy eating. (2010). http://www.nhs.uk/Livewell/Goodfood/Pages/eight-tips-healthy-eating.aspx Accessed 04.03.16.

Seal, C.J., Jones, A.R., & Whitney, A.D. (2006). Whole grains uncovered. *Nutrition Bulletin, 31*(2), 129-37.

Steffen, L. M., Jacobs, D. R. Jr., Stevens, J., Shahar, E., Carithers, T., & Folsom, A. R. (2003) Associations of whole-grain, refined-grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: the Atherosclerosis Risk in Communities (ARIC) Study. *American Journal of Clinical Nutrition 78*(3), 383-90.

Thane, C.W., Jones, A.R., Stephen, A.M., Seal, C.J., & Jebb, S.A. (2005). Whole grain intake in British young people aged 4-18 years. *British Journal of Nutrition, 94*(5), 825-31.

Thane, C.W., Jones, A.R., Stephen, A.M., Seal, C.J., & Jebb, S.A. (2007). Comparative whole-grain intake of British adults in 1986-7 and 2000-1. *British Journal of Nutrition, 97*(5), 987-92.

The Danish Whole Grain Partnership. Whole grain intake sets new record. (2014) http://www.fuldkorn.dk/media/162235/PRM-Whole-grain-intake-sets-new-record.pdf Accessed 04.03.16.

United States Department of Agriculture. Grain Consumption by Americans, Nutrition Insight 32. (2005) http://www.cnpp.usda.gov/sites/default/files/nutrition_insights_uploads/Insight32.pdf Accessed 01.11.2015.

U.S. Department of Agriculture & U.S. Department of Health and Human Services. Dietary Guidelines for Americans 2010. (2010) http://www.cnpp.usda.gov/sites/default/files/dietary_guidelines_for_americans/PolicyDoc.pdf Accessed 04.03.16.

van der Kamp, J. W., Poutanen, K., Seal, C. J., & Richardson, D. P. (2014). The HEALTHGRAIN definition of "whole grain" *Food Nutrition Research 58*, 22100 - http://dx.doi.org/10.3402/fnr.v58.22100.

Ye, E.Q., Chacko, S.A., Chou, E.L., Kugizaki, M., & Liu, S. (2012). Greater whole-grain intake is associated with lower risk of Type 2 diabetes, cardiovascular disease, and weight gain. *Journal of Nutrition, 142*(7), 1304-1313.

Table 1 A summary of investigations used to develop a method for quantifying whole grain intake

Investigation	Aim	Dietary methodology	n[a]	Total number of foods	Total number of WG[b] foods n (%)
The Dietary and Nutritional Survey of British Adults Gregory et al. (1990)[c]	To provide comprehensive information on the dietary habits and nutritional status of the British population aged between 16-64 years in 1986/7	7-day weighed dietary record	2086	3848	196 (5.1)
National Diet and Nutrition Survey: people aged 65 years and over Finch et al. (1998)[c]	To provide comprehensive information on the dietary habits and nutritional status of British people aged 65 years and over in 1994/5	4-day weighed dietary record	1189	2667	126 (4.7)
National Diet and Nutrition Survey: young people aged 4 to 18 years Gregory et al. (2000)[c]	To provide comprehensive information on the dietary habits and nutritional status of young British people aged 4 to 18 years in 1997	7-day weighed dietary record	1583	4238	151 (3.6)
The National Diet and Nutrition Survey: adults aged 19-64 years Henderson et al. (2002)[c]	To provide comprehensive information on the dietary habits and nutritional status of the British population aged between 19-64 years in 2000/1	7-day weighed dietary record	1692	4612	153 (3.3)
The National Diet and Nutrition Survey rolling programme years 1, 2 and 3 Department of Health & Food Standards Agency (2012)	To provide comprehensive information on the dietary habits and nutritional status of the general UK population aged 1.5 years+ from 2008-2011	4-day estimated food diary	3073	3659	213 (5.8)
Portion Size Estimation Study Jones (2007)	To estimate the portion sizes of whole grain foods consumed by people aged 16 years and older in 5 studies in Newcastle upon Tyne (1997-2002)	3 and 7-day food diaries and FFQ[d]	825	2029	65 (3.2)
The CHEW-IT Study Jones (2007)	To investigate the acceptability of and barriers to consumption of whole-grain foods and the effects of increased consumption on heart disease risk factors in people aged 18 years and older in Newcastle upon Tyne (2007)	4-day food diary[d]	26	914	71 (7.8)

WG, Whole grain; FFQ, Food Frequency Questionnaire; [a]Number of participants for the purposes of this study; [b]Foods containing at least 10% whole grain content; [c]Data provided by C.W. Thane; [d]Portion sizes estimated using the Atlas of Food Portion Sizes (Nelson et al., 1997)

Table 2 Percent water and dry matter contents of whole grain ingredients (adapted from Holland et al. (1988) and Food Standards Agency (2002))

Ingredient	% Water content	% Dry matter
Barley, pearl, boiled[a,b]	69.6	30.4
Barley, whole grain, raw[a]	11.7	88.3
Brown rice (boiled)	66.0	34.0
Brown rice (raw)	13.9	86.1
Oatmeal (quick cook raw)	8.2	91.8
Oatmeal (raw)[a]	8.9	91.1
Rye flour (whole)	15.0	85.0
Spaghetti, wholemeal, boiled	69.1	30.9
Spaghetti, wholemeal, raw	10.5	89.5
Whole/whole-grain cornmeal[a]	12.2	87.8
Wholemeal flour	14.0	86.0

[a]Data derived from Holland et al.(1988); [b]The authors acknowledge that pearl barley is not whole grain (Seal et al., 2006) however Holland et al. (1988) only present data regarding boiled Barley in the pearled form.

Table 3 Whole grain content of foods recorded by participants of UK nutrition research studies with ≥10% whole grain as eaten.

Food	%WG as eaten
Food group: Breads	
Bread	11.8 - 58.5
Bread, toasted	13.9 - 68.5
Bread, fried	42.5
Rolls and muffins	24.9 - 64.1
Rolls and muffins, toasted	57.4 - 68.3
Other breads (Chapatti, Paratha, Pitta, Puri, Tortilla Wrap)	24.9 - 66.1
Other breads (Pitta), toasted	76.5
Food group: Breakfast cereals	
Flaked cereals	14.9 - 62.3
Cluster type cereals	14.9 - 55.9
Shredded wheat type cereals	48.2 - 86.0
Shaped cereals	17.2 - 68.7
Puffed wheat cereal	86.0
Wheat biscuit type cereals	66.7 - 88.4
Porridge type cereals	10.0 - 90.1
Food group: Pasta	
Pasta and pasta dishes	13.0 - 89.5
Food group: Rice	
Rice and rice dishes	12.6 - 86.1
Food group: Sweet snacks	
Biscuits and cookies	11.2 - 82.6
Cereal bars	11.8 - 55.3
Flap-jacks	14.4 - 53.9
Other sweet snacks (Oatcakes, Popcorn, Shortbread)	16.9 - 78.4
Food group: Savoury snacks	
All savoury snacks	20.8 - 85.2
Food group: Cakes, pastries and deserts	
Cakes and puddings	12.2 - 52.3
Pies and tarts	14.8 - 25.9
Fruit crumble	14.3 - 16.4
Other deserts (Doughnuts, Pancakes, Tea cakes)	21.5 - 70.0
Food group: Egg dishes	
Quiches	15.7
Food group: Others	
Miscellaneous grains (Barley, Bulgur wheat, Millet, Oats, Oatmeal, Quinoa, Wholemeal)	28.4 - 91.8
Other foods containing cereals (Dumplings, Pasties, Pizza, Stuffing)	11.6 - 29.9

WG, Whole grain; Values reported take into account water content of the grain, weight losses during cooking and liquid ingredients.

Table 4 Illustration of whole grain gram intake to the consumer of a selection of whole grain foods for a range of portion sizes.

Food	Portion size (g)	Source	Whole grain content per 100g	Whole grain delivery to consumer	
				grams	% of US minimum daily recommendation[d]
Bread					
Wholemeal bread, per slice	24	Warburtons (400g)[a]	54.8	13.2	27%
	25	MAFF Food Portion Size[b]	54.8	13.7	29%
	33	Hovis (400g)[a]	54.8	18.1	38%
	36	MAFF Food Portion Sizes[b]	54.8	19.7	41%
Wholemeal bread, full serving	58	NDNS Foodbase[c]	54.8	31.8	66%
Breakfast Cereals					
Cheerios	30	CPUK website[a]	64.3	19.3	40%
Fruit 'n' Fibre	40	Kelloggs website[a]	59.3	23.7	49%
Muesli	50	NDNS Foodbase[c]	65.4	32.7	68%
	87	MAFF Food Portion Sizes[b]	65.4	56.9	119%
Shredded wheat	45	CPUK website[a]	86	38.7	81%
Special K	30	Kelloggs website[a]	12	3.6	8%
Weetabix	37.5	Weetabix website[a]	80.8	30.3	63%
Porridge as eaten with unspecified liquid	197	NDNS Foodbase[c]	11.2	22.1	46%
	207	Oat so simple 27g packet[a]	13.7	28.4	59%
	228	MAFF Food Portion Sizes[b]	11.2	25.5	53%
	240	Readybrek - 40g packet[a]	10.2	24.5	51%
Pasta					
Wholemeal pasta boiled	172	NDNS Foodbase[c]	30.9	53.1	111%
Wholemeal pasta shells, boiled	266	MAFF Food Portion Sizes[b]	30.9	82.2	171%
Wholemeal spaghetti, boiled	266	MAFF Food Portion Sizes[b]	30.9	82.2	171%
Rice					
Brown rice, boiled	224	MAFF Food Portion Sizes[b]	34	76.2	159%
	180	NDNS Foodbase[c]	34	61.2	128%
Snacks					
Digestive Biscuit, full serving	26	NDNS Foodbase[c]	13.8	3.6	7%
Digestive Biscuit, per biscuit	8	McVities Digestive biscuit	13.8	1.1	2%
Nutri-Grain bar, fruit filled	37	NDNS Foodbase[c] and Kellogg's website[a]	22.4	8.3	17%
Popcorn, sweet	50	NDNS Foodbase[c]	16.9	8.5	18%
Ryvita crispbread	10	Ryvita website[a]	84.2	8.4	18%

MAFF, Ministry of Agriculture, Fisheries and Food; NDNS, National Diet and Nutrition Survey; CPUK, Cereal Partners UK

[a]Manufacturers packaging/website information; [b]Food Portion Size photograph 5 (Nelson et al., 1997); [c]NDNS Foodbase adults 19-64 median portion size (Food Standards Agency, 2006); [d]Minimum dietary recommendation of 48g/d as per the US dietary guidelines for Americans (USDA & USDHHS, 2010)

Supplementary table

Table 1 Whole grain content of foods recorded by participants of UK nutrition research studies with ≥10% whole grain on an as-eaten basis taking into account water content of the grain, weight losses during cooking and liquid ingredients

Food as described in diet record	% Whole grain as eaten
Breads	
Bread, granary (if wholemeal flour used)	49.0
Bread, granary, toasted (if wholemeal flour used)	57.4
Bread, multigrain, supermarket own brand	54.8
Bread, multigrain, supermarket own brand, toasted	64.1
Bread, oatmeal	11.8
Bread, oatmeal, toasted	13.9
Bread, rye	54.1
Bread, rye, toasted	63.4
Bread, white and wholemeal with added wheatgerm	24.9
Bread, wholemeal	54.8
Bread, wholemeal, fortified, supermarket own brand	54.8
Bread, wholemeal, fried in any fat/oil	42.5
Bread, wholemeal, toasted	64.1
Chapatti, wholemeal, made with any fat/oil	58.8
Chapatti, wholemeal, no fat/oil	59.9
Chapatti, wholemeal, stuffed	24.9
English muffins, wholemeal or bran	61.4
Granary French stick (if wholemeal flour used)	49.0
Homemade bread, untoasted, mixed grain	49.0
Hovis best of both, white and wholemeal bread	24.9
Hovis countrygrain, wholemeal bread	49.0
Hovis countrygrain, wholemeal bread, toasted	57.4
Muffin, wholemeal, toasted	68.3
Paratha, wholemeal	27.2
Pitta bread, wholemeal	65.3
Pitta bread, wholemeal, toasted	76.5
Premier Foods Nimble, wholemeal ‘slimmers’ bread	54.8
Premier Foods Nimble, wholemeal ‘slimmers’ bread, toasted	64.1
Puri, wholemeal, with any fat/oil	25.3
Reduced-calorie wholemeal toast	64.1
Rolls, brown/granary/wheatgerm (if wholemeal flour used), crusty	49.0
Rolls, brown/granary/wheatgerm (if wholemeal flour used), soft	49.0
Rolls, brown/granary/wheatgerm (if wholemeal flour used), toasted	57.4

Rolls, white and wholemeal blend	24.9
Rolls, wholemeal	54.8
Rolls, wholemeal, toasted	64.1
Tortilla wrap, wholemeal	66.1
Wheaten bread/Irish soda bread	36.5
Whole-grain crisp rolls	64.1
Wholemeal bread, sesame and sunflower seeds	49.0
Wholemeal soda bread	58.5
Wholemeal soda bread, toasted	68.5
Wholewheat and rye bread, toasted, no yeast	63.8
Breakfast cereals	
Apricot Crunchies, supermarket own brand	56.8
Boulders breakfast cereal, supermarket own brand	18.9
Bran flakes, with sultanas, supermarket own brand	40.4
Bran flakes, without sultanas, supermarket own brand	54.2
Cow and Gate, Sun, Moon and Stars cereal 1 year+	56.0
Cranks muesli	65.4
Crunchy Clusters-type cereal without nuts	55.9
Crunchy/crispy muesli-type cereal	55.9
Dorset cereal with fruit and nuts	46.7
Flakes and grains cereal with tropical fruit, supermarket own brand	46.7
Fruit ‘n’ Fibre, supermarket own brand	59.3
Heinz Stage 3/4 breakfast cereal for babies	72.9
Hipp-a-bisc Toddler cereal	80.8
Homemade muesli	65.4
Honey and nut bran flakes, supermarket own brand	49.0
Honey Monster Honey Waffle breakfast cereal	21.3
Jordans natural muesli	65.4
Kellogg’s Bran flakes	54.2 / 57.6[a]
Kellogg’s Common Sense oat bran flakes	54.2
Kellogg’s Common Sense, and raisins and apple	40.4
Kellogg’s Crunchy nut clusters	40.1
Kellogg’s Frosted Wheats	71.4
Kellogg’s Fruit ‘n’ Fibre	59.3
Kellogg’s Honey Nut Loops	54.9
Kellogg’s Just Right, half fat muesli	28.7
Kellogg’s Multigrain Start	41.9
Kellogg’s Raisin Wheats	62.8 / 64.5[a]
Kellogg’s Special K	12.0 / 27.5[a]
Kellogg’s Special K with red berries	10.3 / 22.4[a]
Kellogg’s Strike	28.7
Kellogg’s Sustain	24.9 / 57.7[a]

Kellogg's Choc 'n' Roll	39.0
Kellogg's Optivia Berry	55.3
Kellogg's Rice Krispies, multi-grain shapes	23.7
Kellogg's Special K, fruit and nut clusters	14.9
Kellogg's Special K, medley cereal	14.9
Kellogg's Special K, Oats and honey	40.0
Kellogg's Special K, Sustain cereal	55.1
Muesli	65.4
Muesli, 55% fruit, supermarket own brand	46.7
Muesli, luxury fruit and nut, supermarket own brand	46.7
Multi Grain Hoops breakfast cereal, supermarket own brand	47.4
Nabisco Team	28.7
Nestlé Clusters	55.9/ 43.0[a]
Nestlé Coco Shreddies	48.2 / 64.6[a]
Nestlé Cookie Crisp	29.8
Nestlé Curiously Cinnamon, formerly Cinnamon Grahams	27.9
Nestlé Frosted Shreddies	48.4 / 80.4[a]
Nestlé Golden Grahams (corn and wheat squares)	17.2
Nestlé Golden Nuggets	27.6
Nestlé Honey Cheerios	65.1
Nestlé Honey Nut Cheerios	52.8
Nestlé Honey Nut Shredded Wheat	67.1 / 72.4[a]
Nestlé Multi Cheerios	64.3 / 68.7[a]
Nestlé Nesquik chocolate cereal	0 / 38.4[a]
Nestlé Oats and More, Almond	58.7
Nestlé Oats and More, Honey	62.3
Nestlé Oats and More, Raisin	54.1
Nestlé Shredded Wheat Fruitful, mini fruit	57.6
Nestlé Shredded Wheat	86.0
Nestlé Shreddies	80.0 / 80.4[a]
Oat and bran flakes, no additions, supermarket own brand	54.2
Oat bran flakes, with raisins & almonds	40.4
Oat Granola	48.8
Perfect choice breakfast cereal, supermarket own brand	55.9
Post Grape-nuts	43.9
Puffed wheat, not frosted/sugar coated	86.0
Shreddies, supermarket brand, not frosted	80.0
Special Flakes breakfast cereal, supermarket own brand	18.9
Strawberry crisp clusters, supermarket own brand	48.9
Sultana Bran, bran flakes with sultanas	40.4
Tradecraft muesli, luxury fruit and nut	46.7
Unsweetened fruit and bran muesli, whole wheat flakes and fruit, supermarket own brand	46.7

Weetabix Ltd., Alpen muesli with added sugar	59.3 / 63.7[a]
Weetabix Ltd., Alpen muesli without sugar	65.4 / 68.9[a]
Weetabix Ltd., Alpen muesli with extra fruit	46.7
Weetabix Ltd., Crunchy bran	27.5
Weetabix Ltd., Disney breakfast cereals	56
Weetabix Ltd., Oatabix	88.4
Weetabix Ltd., Weetabix	80.8 / 81.7[a]
Weetabix Ltd., Weetabix crispy minis, chocolate	76.5
Weetabix Ltd., Weetabix crunchy bran	24.1
Weetabix Ltd., Weetabix Fruitibix	66.7
Weetabix Ltd., Weetabix Oat and wheat bran	54.2
Weetabix Ltd., Weetabix Top Bran	24.1
Weetabix Ltd., Weetos	23.2 / 37.8
Wheat flakes with sultanas or raisins	55.0
Whole Earth perfect balance cereal	43.9
Wholewheat, corn and rice cereal with raisins and sultanas, supermarket own brand	46.7
Porridge	
Hipp organic creamed porridge, dry weight	25.5
Hot oat cereal with bran, supermarket own brand	10.2
Instant oat cereal any flavour, Oat so simple, as served	13.1 / 13.4[a]
Instant oat cereal any flavour, Oat so simple, dry weight	69.2 – 73.8
Instant oat cereal plain, Oat so simple, as served	13.7
Instant oat cereal plain, Oat so simple, dry weight	90.1
Plum Baby Four Grain porridge with plum and banana	35.2
Porridge, as served (made up with unspecified liquid)	11.2
Porridge with 10% bran, as served (made up with unspecified liquid)	10.2
Weetabix Ltd., Ready Brek original, as served	10.2 / 17.3[a]
Weetabix Ltd., Ready Brek original, dry weight	52.8
Weetabix Ltd., Ready Brek original, dry weight updated	89.3
Weetabix Ltd., Ready Brek, flavoured, as served	10.0 / 12.4[a]
Weetabix Ltd., Ready Brek, flavoured, dry weight	37.4 / 63.8[a]
Weetabix Ltd., Ready Brek, with added fruit and nuts, dry weight	26.4
Pasta	
Lasagne, white/wholemeal, boiled	19.4
Lasagne, wholewheat with minced beef, semi-skimmed milk, no fat	13.0
Pasta spaghetti, wholemeal boiled	30.9
Pasta, spaghetti, wholemeal, dried	89.5
Spaghetti wholemeal, canned in tomato sauce, reduced sugar	15.2
Spaghetti, wholemeal, canned in tomato sauce	15.2
Wholemeal pasta salad	15.1
Rice	
Brown easy cook Italian/American rice, cooked	34.0

Brown easy cook Italian/American rice, raw	86.1
Brown rice and moin-moin, with red palm oil	26.0
Brown rice risotto	12.6
Brown rice salad	18.1
Brown rice stir-fry	26.0
Brown rice, vegetables and egg	17.5
Rice, brown, boiled	34.0
Rice, brown, fried in any fat/oil	26.0
Rice, brown, raw	86.1
Rice, red, boiled	21.2
Rice, wild, boiled	26.1
Biscuits, cereal bars and sweet snacks	
Almond biscuits, made with wholemeal flour, olive spread	34.7
Banana and raisin flapjacks	37.3
Belvita breakfast biscuits	28.8
Cadburys Raisin Brunch Bar	20.4
Cereal bars made with oats only	40.1
Cereal crunchy bars	19.3
Chewy cereal snack bar	21.0
Country oat crunch biscuit	12.8
Digestive biscuit, plain	13.8
Digestive biscuit, plain, reduced fat	11.2
Digestive biscuit, with oats and chocolate/fruit, half coated	38.3
Doubly chocolate biscuit	12.8
FABS Snack Inc., Fab Snack	45.1
Flapjack with nuts and fruit	32.7
Flapjack with wholemeal flour	32.7
Flapjack with wholemeal flour and any fat or oil	34.7
Flapjack, all butter, supermarket own brand	14.4
Flapjack, made any fat or oil	34.7
Flapjack, with oats and flour, dipped in chocolate	34.7
Flapjacks with blackberries, apple, olive spread	35.3
Flapjacks, fruit	35.3
Flapjacks, homemade	34.7
Flapjacks, made with sunflower margarine and cornflakes	34.7
Flapjacks, purchased	34.7
Flapjacks, with any fat or oil, high in oats	53.9
Fox's officially low fat cookie bar, toffee apple flavour	12.8
Fruit Break bar	21.0
Healthy living maple syrup cereal bar, supermarket own brand	21.0
Homemade biscuits, wholemeal	77.9
Kellogg's cereal bar, fruit-filled (Nutri-Grain soft)	12.8 / 22.4[a]

Kellogg’s Elevenses snack bar	14.6
Kellogg’s oat and rice cereal muesli bar, fortified	17.6
Kellogg's Fibre Plus Cereal Bars	18.2
Kellogg's Nutri-Grain Elevenses Bars, any, not carrot	16.4
Kellogg's Nutri-Grain Elevenses Carrot Cake Bar	15.9
Kellogg's Nutri-Grain Oat Baked Bars	55.3
Kellogg's Nutri-Grain Soft Oaties Cookies	12.8
Kellogg's Optivia Cereal Bar	33.3
Kellogg's Special K Mini Breaks	28.1
McVities Hobnobs, digestives, with oats, plain	51.1 / 54.4[a]
McVities Hobnobs Slice	30.7
McVities Hobnobs, digestives, with oats, chocolate half coated	38.3 / 41.1[a]
Nestlé Oats and More Cereal Bars	29.6
Oat and coconut biscuits, with olive spread	13.8
Oat and date slice, made with wholemeal flour, lemon juice	40.5
Oat slices	54.7
Oatcakes made with any fat/oil	78.4
Oatcakes, grilled	78.4
Oatmeal cookies	82.6
Oatmeal cookies, supermarket own brand	29.1
Organix Carrot Cake Cereal Bar	41.9
Organix Cookie Bites	31.8
Organix Flavoured Baby Rice Cakes	71
Organix Fruit Cereal Bars, not carrot/chocolate	42.5
Organix Goodies Biscuit, 12 Month+, whole-grain flour only	25.8
Popcorn, sweet (coated in a sugar/butter glaze)	16.9
Ryvita Goodness Bars	22.1
Shortbread, half wholemeal, any fat/oil	27.3
Shortbread, wholemeal, any fat/oil	54.6
Staffordshire oatcakes	78.4
Sultana cookies with oats	20.4
Tracker Bar, Chocolate Chip or Peanut	11.8
Weetabix Ltd., Weetabix Oaty Bars	28.4
Wholemeal almond shortbread	53.8
Wholemeal and oat biscuits	51.1
Wholemeal biscuit, fruit or nut	36.8
Wholemeal biscuit, plain or flavoured	77.9
Wholemeal flapjack	34.7
Wholemeal shortbread, supermarket own brand	54.6
Wholemeal, cream-filled biscuits	36.8
Savoury snacks	
Crispbread, multigrain	74.0

Crispbread, rye	84.2 / 82.5[a]
Crispbread, rye, with sesame seeds	81.6
Crispbread, whole-grain and seeded	81.6
Jacobs Twiglets	60.2 / 66.2[a]
Popcorn, salted	54.9
Rice cakes	85.2
Ryvita Breaks/currant crunch	68.0
Ryvita minis, crispbread snacks flavoured	73.1
Ryvita multigrain	68.9
Ryvita, crackerbread, wholemeal	83.4
Ryvita, dark rye	84.2
Ryvita, high fibre	84.2
Tortilla chips	63.4
Walkers Sunbites	59.2
Wholemeal or farmhouse crackers	20.8
Cakes, pastries and desserts	
All Bran loaf with wholemeal flour, no milk	12.2
Apple and blackberry pie, wholemeal, all-butter pastry	24.8
Apple charlotte with wholemeal bread	14.3
Apple crumble, made with porridge oats	15.1
Apple crumble, made with wholemeal flour and any fat/oil	14.3
Apple crumble, wholemeal with pie filling and Weetabix	16.4
Apple crumble, wholemeal, fat spread and Weetabix	16.4
Apple pie with butter and wholemeal flour	24.8
Apple pie, wholemeal and shortcrust pastry made with any fat/oil	24.7
Apricot and prune crumble, with wholemeal flour, olive	14.3
Apricot wholemeal crumble	14.3
Blackcurrant pie, two crusts, wholemeal pastry	24.8
Carrot cake, wholemeal, purchased, no icing	21.8
Chocolate cake, wholemeal flour and chocolate butter icing	17.1
Crumble, wholemeal, any fruit	14.3
Diabetic fruit cake, made with Flora, wholemeal flour, fructose, banana	17.1
Doughnut, wholemeal	41.0
Fatless sponge with jam, made with wholemeal flour	17.3
Fruit and seed cake with wholemeal flour, soya milk and malt extract	14.1
Fruit cake with wholemeal flour, orange concentrate, no fat	17.1
Fruit cake, wholemeal flour and PUFA margarine	14.4
Fruit cake, with wholemeal flour and butter	14.4
Fruit pie, wholemeal pastry, one crust, half lard, half margarine	14.8
Fruit pie, wholemeal pastry, two crusts made with any fat/oil	24.8
Hot cross buns, wholemeal	40.8
Individual jam tart, wholemeal	25.9

Jam/treacle tart, wholemeal	25.9
Oatcakes, fried in dripping	60.9
Oatcakes, pancake-type, not biscuit	70.0
Parkin, home made, subjects own recipe	20.8
Parkin, made with wholemeal flour	40.3
Pear crumble with oats	14.3
Pineapple upside down cake, wholemeal flour	14.3
Raspberry crumble, with PUFA and whole-grain feast	14.3
Rhubarb crumble with oats and PUFA margarine	14.3
Rhubarb crumble with wholemeal flour and oats	14.3
Rhubarb crumble, wholemeal and butter	14.3
Rock bun, wholemeal	31.7
Steamed ginger pudding, wholemeal flour and PUFA	14.3
Summer pudding, made with wholemeal bread	13.0
Swiss roll/sponge, no fat, wholemeal, jam filling	17.3
Teacakes, wholemeal, toasted	57.5
Treacle pudding, made with wholemeal flour	27.4
Waitrose wholemeal apricot cake	17.1
Weetabix and almond bake	16.4
Wholemeal almond slice	31.6
Wholemeal and PUFA crumble	14.3
Wholemeal apple cake, with PUFA margarine	17.1
Wholemeal bread and butter pudding	19.0
Wholemeal bread pudding with suet	15.0
Wholemeal cheese scone	45.0
Wholemeal cherry crumble	14.3
Wholemeal chocolate cake with butter	23.2
Wholemeal chocolate cake with fudge icing	17.1
Wholemeal chocolate chip cake	14.4
Wholemeal coconut and fruit cake	14.4
Wholemeal crumble with apricot	14.3
Wholemeal date and walnut loaf	14.4
Wholemeal drop scone	35.2
Wholemeal fatless sponge	17.3
Wholemeal fruit bun	52.3
Wholemeal fruit cake, no sugar	17.1
Wholemeal fruit cake, purchased	14.4
Wholemeal fruit loaf	29.2
Wholemeal fruit scones made with any fat/oil and liquid	44.4
Wholemeal fruit teacake, toasted	44.4
Wholemeal ginger and sultana cake with Flora	24.5
Wholemeal ginger cake	14.4

Wholemeal individual fruit pie, commercial	24.7
Wholemeal jam sponge with Flora	17.3
Wholemeal malt loaf	29.2
Wholemeal malt loaf, toasted	34.2
Wholemeal mincemeat tart, flaky pastry	24.8
Wholemeal pancakes, fried in PUFA oil	21.5
Wholemeal pancakes, made with skimmed milk	21.5
Wholemeal pastry, any fat/oil	60.0
Wholemeal scone, made with any fat/oil	50.0
Wholemeal sponge pudding with PUFA, almonds and plums	14.0
Wholemeal sponge, buttercream filling, made with any fat/oil	17.2
Wholemeal sponge, made with PUFA margarine, no filling/icing	24.5
Wholemeal sponge, with butter and apricot jam	17.3
Wholemeal steam sponge fruit pudding, with hard margarine	25.7
Wholemeal steamed sponge pudding, with treacle syrup	25.7
Wholemeal strawberry sponge	17.3
Wholemeal sultana sponge cake	24.5
Wholemeal teacake, no fat/oil	53.9
Wholemeal teacakes with Flora	49.1
Egg dishes	
Blue cheese quiche, made with wholemeal flour	15.7
Cheese and onion flan, with wholemeal pastry	15.7
Cheese and spinach quiche, wholemeal shortcrust pastry	15.7
Cheese and tomato quiche, made with wholemeal pastry	15.7
Eggy bread, wholemeal, milk, blended oil	10.0
Quiche, made with wholemeal flour and fromage frais	15.7
Ratatouille quiche, with wholemeal pastry	15.7
Wholemeal cauliflower and cheese flan, supermarket own brand	15.7
Wholemeal cheese tart	15.7
Wholemeal quiche Lorraine	15.7
Others	
Barley, whole grain, boiled in water	30.4
Bulgur wheat, cooked	30.9
Carrot and onion pie, wholemeal pastry, with Flora and margarine	15.1
Cheese and tomato pizza with wholemeal base	25.8
Dumpling, half wholemeal	12.2
Dumplings, made with wholemeal flour and cornmeal, no fat	18.9
Ebly wheat grains, cooked	30.9
Flour, wholemeal (100%)	86.0
Millet, boiled	30.4
Oatmeal stuffing	17.0
Oatmeal, raw	91.1

Oatmeal, with cooking losses	91.1
Oats, rolled, quick cook	91.8
Pizza, homemade, half wholemeal base, low-fat cheese & peppers	11.6
Pizza, wholemeal, homemade, vegetarian	25.5
Quinoa, cooked	28.4
Stuffing, with oatmeal	28.2
Welsh rarebit, made with wholemeal toast	22.3
Wholemeal dumplings	24.9
Wholemeal stuffing	17.0
Wholemeal stuffing, no fat	19.4
Wholemeal vegetable pastie	29.9
Wholemeal Yorkshire pudding, any liquid, cooked in any oil/fat	24.1
Maize	
Sweetcorn kernels, canned, reheated, drained[b]	27.7

PUFA, Polyunsaturated fat; [a]% Whole grain as eaten updated in 2014 (these products may have been reformulated); [b]Data derived from Food Standards Agency (2002)[j]