

# Consumption of whole-grain foods by British adults: findings from further analysis of two national dietary surveys

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## Abstract

*Objective:* To assess the consumption of whole-grain foods in different age and sociodemographic groups in Great Britain, using data from two national surveys.

*Design:* Cross-sectional analysis of the consumption of whole-grain foods.

*Setting:* The 1986–87 Dietary and Nutritional Survey of British Adults and the 1994–95 National Diet and Nutrition Survey of people aged 65 years and over.

*Subjects:* In 1986–87, 2086 British adults aged 16–64 years; 1189 British adults aged 65 years and over in 1994–95.

*Results:* In the 1986–87 survey population, consumption of whole-grain foods increased with age. Median consumption of whole-grain foods was 1 serving per week in 16–24-year-olds and 3 servings per week in the 35–64-year-olds ( $P < 0.0001$ ). In 1994–95, median consumption was 5 servings per week in adults aged 65 years and over. Overall, one-third of British adults ate no whole-grain foods on a daily basis, and less than 5% ate 3 or more servings per day. Manual occupation and smoking were consistently associated with a higher proportion of non-consumers and fewer servings per week of whole-grain foods, independent of age, sex, region and season (each  $P < 0.001$ ). The main sources of whole-grain foods were wholemeal bread and breakfast cereals, which accounted for more than three-quarters of all servings.

*Conclusions:* Consumption of whole-grain foods in the adult UK populations is more prevalent in the non-smoking, higher socio-economic groups. Amongst consumers of whole-grain foods, the frequency is similar to that reported in the USA and Norway.

**Keywords**  
Whole-grain foods  
Great Britain  
Adults  
Elderly

Epidemiological evidence suggests an inverse relationship between the consumption of whole-grain foods and the risk of a variety of chronic diseases. Studies have found that habitual consumption of whole-grain foods is associated with reduced total mortality<sup>1,2</sup>, cancer mortality at certain sites<sup>1,3</sup>, risk of coronary heart disease (CHD)<sup>4</sup>, ischaemic stroke<sup>5</sup> and type 2 diabetes<sup>6,7</sup>. However, in these studies quantification of the consumption of whole grains varies and is often based on questionnaires such as the semi-quantitative food-frequency questionnaire employed by Liu *et al.*<sup>4</sup>. Consumption has therefore been limited to numbers of servings of whole-grain foods rather than absolute or quantified amounts. Despite this imprecision, which might be expected to reduce the likelihood of identifying associations with health outcomes, a protective effect of whole grains has been observed. However, consumption of whole-grain foods is strongly associated with other dietary and lifestyle habits linked to good health, including regular fruit and vegetable consumption, participation in physical activity

and not smoking, and it is arguable that some of the health benefits observed are the result of residual confounding. Nonetheless, whole grains provided by wheat, rice, pasta, barley, rye and oats provide a number of important nutrients and bioactive compounds. These include protein, soluble and insoluble non-starch polysaccharides, essential fatty acids, a variety of micronutrients (e.g. vitamin B complex, vitamin E, folate, zinc, magnesium, potassium, selenium and copper) and phytochemicals (e.g. flavonoids and lignans) which may contribute to the observed health benefits<sup>8</sup>.

The US Food and Drug Administration now permits food products that contain at least 51% whole grains (including the milled products of whole grains) to carry the following health claim: 'Diets rich in whole grains and other plant foods and low in total fat, saturated fats and cholesterol may reduce the risk of heart disease and some cancers' (<http://www.cfsan.fda.gov/~dms/flgrains.html>). A claim specifically in relation to heart health has been approved by the Joint Health Claims Initiative in the UK:

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'People with a healthy heart tend to consume more wholegrain foods as part of a healthy lifestyle (<http://www.jhci.org.uk/wholegrainheart.htm>).

In the USA, in spite of the encouragement to consume 3 portions of whole-grain foods, surveys show that consumption levels are low, estimated at between half<sup>9</sup> and one<sup>10</sup> serving per adult per day. Information on the consumption of whole-grain foods has not been available in the UK.

The aim of the present study was to assess the consumption and principal sources of whole-grain foods in Great Britain, using two nationally representative dietary surveys, according to a number of sociodemographic and lifestyle factors.

## Materials and methods

### Surveys

Dietary data from two nationally representative samples were analysed to provide an assessment of the consumption of whole-grain foods by adults in mainland Britain.

The Dietary and Nutritional Survey of British Adults<sup>11</sup> was conducted between October 1986 and August 1987. It collected dietary, biochemical, socio-economic and lifestyle data from randomly selected participants aged 16–64 years from England, Scotland and Wales. In total, 2197 individuals completed 7-day weighed dietary records. Data from those individuals who did not provide full information on selected sociodemographic and lifestyle factors (outlined below) were excluded from this analysis. Food diaries from 2086 participants (1041 men, 1045 women) were analysed for whole-grain food consumption.

The National Diet and Nutrition Survey of people aged 65 years and over<sup>12</sup> was conducted from October 1994 to September 1995. Food consumption data were collected using 4-day weighed dietary records from a random sample of 2626 adults aged 65 years and over living in either private dwellings or institutions. For the present analyses, only data from participants living in private dwellings who provided full details of selected sociodemographic and lifestyle factors (outlined below) were considered, giving a total of 1189 individuals (616 men, 573 women).

Whole-grain food consumption was analysed according to the following sociodemographic and lifestyle factors: sex (men, women); age group (16–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, 65–74 years, 75–84 years, 85+ years); region (North, Midlands, East Anglia, South-West, London & South-East, Wales, Scotland); smoking status (non-smokers, smokers); occupational social class (non-manual, i.e. professional, managerial, technical and skilled; manual, i.e. skilled manual, partly skilled and unskilled); and season (spring, April–June; summer, July–September; autumn, October–December; winter, January–March). In addition,

those who did not consume any whole-grain foods during the recording period were identified as non-consumers, with mean (standard deviation) and median (interquartile range) whole-grain food consumption assessed in consumers alone.

### Definition and sources of whole-grain foods

Whole-grain foods were defined as those that contained at least 51% whole-grain ingredient(s) by weight<sup>13</sup>. From over 3800 food codes in the 1986–87 dataset, 164 were identified as whole-grain foods. From over 4300 food codes in the 1994–95 dataset, 80 were identified as whole-grain foods. This discrepancy occurs because the codes listed in the 1994–95 dataset were categorised more discretely while a number of repeats were identified within the 1986–87 dataset. In addition, the older participants in the 1994–95 survey consumed a reduced variety of foods. A serving of whole-grain food was identified on each occasion any of these identified codes appeared in a dietary record for each individual, regardless of portion size. Percentage contributions of food groups to whole-grain food consumption were also determined in men and women separately in each survey according to the five sociodemographic and lifestyle factors.

### Statistical analysis

Food consumption data, provided by The Data Archive (University of Essex, UK), were collated and analysed using Excel (Microsoft Corp., USA) and SPSS (SPSS Inc., USA) software programs. Consumption of whole-grain foods (average number of weekly servings and distributions, and percentages of participants consuming certain numbers of daily portions) were assessed according to the five sociodemographic and lifestyle factors described previously, in men and women separately.

Since the number of whole-grain foods consumed per week was not normally distributed, non-parametric statistical tests were performed, and the median and interquartile range (first quartile–third quartile, representing the central 50% of the distribution) are reported.

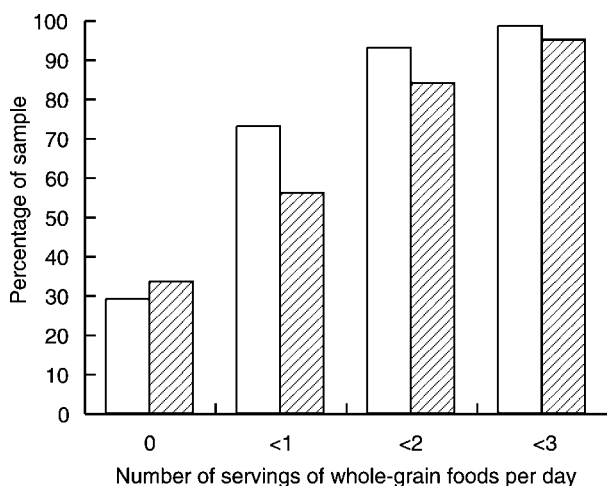
Associations between sociodemographic and lifestyle factors and the percentages of participants consuming zero, <1, <2 or <3 daily portions of whole-grain foods were first examined separately using the chi-squared test. For each factor, differences in the median number of portions consumed per week were determined using the Mann–Whitney *U* and Kruskal–Wallis tests for two- and multi-level factors, respectively. Age, occupational social class, smoking status, region and season were included as independent predictors of the consumption of whole grains using multiple logistic regression. Odds ratios adjusted for the other sociodemographic and lifestyle factors ( $OR_{adj}$ ) and 95% confidence intervals (CI) were also calculated as an alternative way of expressing the magnitude of the differences between consumers and non-consumers within the factors that were found to

be associated significantly with whole-grain food consumption.

Identical statistical analyses were performed after excluding participants who reported being unwell with eating habits affected during the periods of dietary assessment (7% and 10% of participants, respectively, from the 1986–87 and 1994–95 surveys). The effect of likely underreporting of food consumption was also considered, by additional exclusion of participants whose ratio of recorded energy intake to estimated basal metabolic rate<sup>14</sup> was below a cut-off point of 1.2<sup>15</sup>. This additional exclusion resulted in further removal of 35% and 53% of participants from statistical analyses of the respective survey samples. Statistical significance was accepted throughout at  $P < 0.05$ .

## Results

The overall distribution of whole-grain food servings per day from both surveys is shown in Fig. 1. Around one-third of adults from both surveys did not consume whole-grain foods on a daily basis and most (over 95%) consumed less than 3 servings per day.



**Fig. 1** Distribution of whole-grain food consumption. Open boxes represent data for 2086 men and women aged 16–64 years studied in 1986–87; hatched boxes represent data for 1189 men and women aged 65 years and over studied in 1994–95

The median consumption of whole-grain foods by age and sex is shown in Table 1. In the 1986–87 survey, median consumption was only 2.5 servings per week in adults aged 16–64 years, and 5 servings per week in older adults aged 65 years and over from the 1994–95 survey. In the 1986–87 population there was a significant trend for the proportion of non-consumers to increase with age ( $P < 0.001$ ) and for the median consumption to increase with age ( $P < 0.001$ ). This difference remained significant even after adjusting for participants who were unwell with eating habits affected and likely underreporters. In the 1994–95 survey, although the proportion of non-consumers was similar to the younger adults, the median consumption of whole-grain foods was higher. There were no significant differences in whole-grain food consumption between men and women in either survey.

When the analyses were confined to consumers of whole grains only, the differences between groups were smaller but still significant. In the 1986–87 survey population, consumption increased with age from a median of 4 servings per week in men aged 16–24 years to 6 servings per week in those aged 55–64 years ( $P < 0.01$ ). This was similar in women, with a median of 3 servings per week in 16–24-year-olds increasing to 6 servings per week in those aged 55–64 years ( $P < 0.0001$ ). In the 1994–95 survey men and women in all age groups consumed a median of 7 servings per week.

There were no significant differences in whole-grain food consumption by season in any group.

There were no significant regional differences in median whole-grain food consumption in adults aged 65 years and over, in either sex. In the 1986–87 survey of younger adults, whole-grain food consumption varied significantly between regions as shown in Table 2 (men,  $P = 0.013$ ; women,  $P = 0.004$ ). Scotland and Wales had the lowest median number of servings per week for each sex. Excluding those who were unwell with eating habits affected did not significantly alter the regional differences within each sex; however, after additional exclusion of likely underreporters, there were no significant differences between regions ( $P = 0.12$  and  $P = 0.13$  for men and women, respectively).

**Table 1** Consumption of whole-grain foods by age and sex

		Dietary and Nutritional Survey of British Adults, 1986–87					National Diet and Nutrition Survey, 1994–95
		16–24 years	25–34 years	35–44 years	45–54 years	55–64 years	65 years and over
Men	<i>n</i>	172	252	254	183	180	616
	Median (IQR) (servings per week)	1 (0–4)	2 (0–6)	3 (0–9)	3 (0–8)	3* (1–8)	5 (0–10)
	% NC	49	31	28	31	24†	34
Women	<i>n</i>	154	245	244	218	184	573
	Median (IQR) (servings per week)	1 (0–3)	2 (0–6)	3 (1–7)	4 (0–7)	4* (1–8)	5 (0–9)
	% NC	40	28	21	27	24†	33

IQR – interquartile range (first quartile–third quartile); NC – non-consumers of whole-grain foods.

\*  $P < 0.001$  for trend aged 16–64 years (Kruskal–Wallis test).

†  $P < 0.001$  for trend aged 16–64 years (chi-squared test).

**Table 2** Regional differences in consumption of whole-grain foods in adults aged 16–64 years (1986–87 survey)

		North	Midlands	East Anglia	South-West	London & South-East	Scotland	Wales
Men	<i>n</i>	262	191	37	75	345	86	45
	Median (IQR) (servings per week)	2 (0–7)	4 (0–10)	2 (0–6)	2 (0–8)	2 (0–6)	1 (0–5)	1 (0–5)
	% NC	34	29	38	28	29	45	33
Women	<i>n</i>	270	168	29	93	343	89	53
	Median (IQR) (servings per week)	3 (0–7)	4 (0–7)	6 (3–8)	5 (1–8)	3 (0–6)	1 (0–6)	2 (0–6)
	% NC	30	26	10	18	27	34	34

IQR – interquartile range (first quartile–third quartile); NC – non-consumers of whole-grain foods.

The percentage of non-consumers of whole-grain foods within each region was not significantly different and averaged about 30% in both sexes.

The median consumption of whole-grain foods for men and women was significantly greater in non-manual vs. manual groups as shown in Table 3 ( $P < 0.001$  for all groups, except  $P = 0.01$  for women aged 65 years and over (not shown)). After exclusion of both participants who were unwell with eating habits affected and likely underreporters, the difference persisted in the 1986–87 survey (men: manual 1, non-manual 5 servings per week,  $P < 0.0001$ ; women: manual 3, non-manual 5 servings per week,  $P = 0.007$ ), but not in those aged 65 years and over (men: manual 5, non-manual 7 servings per week,  $P = 0.012$ ; women: manual 5, non-manual 5 servings per week,  $P = 0.11$ ). The number of non-consumers was also higher in the manual group in both surveys, independent of the other sociodemographic and lifestyle factors included in the multiple logistic regression analyses, although in older women this did not reach significance (1986–87 men: 41% vs. 21%,  $P < 0.0001$ ,  $OR_{adj}$  1.47, 95% CI 1.32–1.62; women: 37% vs. 22%,  $P < 0.001$ ,  $OR_{adj}$  1.33, 95% CI 1.19–1.48. 1994–95 men: 41% vs. 24%,  $P < 0.001$ ,  $OR_{adj}$  1.45, 95% CI 1.27–1.63; women: 36% vs. 30%,  $P = 0.17$ ,  $OR_{adj}$  1.14, 95% CI 0.95–1.32).

When the analyses were confined to consumers of whole grains only, the difference between groups was smaller but still significant in the survey of younger British adults (1986–87 men: manual 5, non-manual 6 servings per week,  $P = 0.004$ ; women: manual 4, non-manual 5 servings per week,  $P = 0.02$ ), but remained significant

only in the women in the 1994–95 survey (men: manual 7, non-manual 9 servings per week,  $P = 0.11$ ; women: manual 7, non-manual 9 servings per week,  $P = 0.03$ ).

Smokers consistently ate fewer servings of whole-grain foods per week than non-smokers in both survey populations ( $P < 0.0001$ ) (Table 3). After exclusion of those unwell with eating habits affected and likely underreporters, the magnitude of the difference was reduced but remained significant in all cases. The number of non-consumers was also significantly higher among smokers in both surveys, independent of the other sociodemographic and lifestyle factors included in the multiple logistic regression analyses (1986–87 men: 47% vs. 25%,  $P < 0.0001$ ,  $OR_{adj}$  1.55, 95% CI 1.40–1.69; women: 39% vs. 21%,  $P < 0.0001$ ,  $OR_{adj}$  1.46, 95% CI 1.31–1.61. 1994–95 men: 51% vs. 30%,  $P < 0.001$ ,  $OR_{adj}$  1.49, 95% CI 1.27–1.72; women: 45% vs. 31%,  $P < 0.01$ ,  $OR_{adj}$  1.42, 95% CI 1.16–1.67).

When the analyses were confined to consumers of whole grains only, there were no differences between the groups in the survey of British adults in 1986–87. In the 1994–95 survey the differences were smaller but remained significant (men: smoker 7, non-smoker 7 servings per week,  $P = 0.03$ ; women: smoker 7, non-smoker 7 servings per week,  $P = 0.05$ ).

Wholemeal bread comprised almost one-half (48%) of the total consumption of whole-grain foods, with whole-grain cereals providing about one-third (29%) in adults aged under 65 years. The remaining contributions to whole-grain food consumption were obtained from a variety of minor sources, as shown in Table 4. In adults

**Table 3** Consumption of whole-grain foods according to occupational social class and smoking status (1986–87 survey)

		Occupational social class			Smoking status		
		Non-manual	Manual	<i>P</i> -value*	Non-smoker	Smoker	<i>P</i> -value*
Men	<i>n</i>	474	567		691	350	
	Median (IQR) (servings per week)	4 (1–9)	1 (0–5)	$< 0.0001$	4 (0–5)	1 (0–4)	$< 0.0001$
	% NC	41	21	$< 0.0001$	47	25	$< 0.0001$
Women	<i>n</i>	659	386		675	370	
	Median (IQR) (servings per week)	4 (1–7)	2 (0–6)	$< 0.0001$	4 (1–8)	1 (0–4)	$< 0.0001$
	% NC	37	22	0.0001	39	21	$< 0.0001$

IQR – interquartile range (first quartile–third quartile); NC – non-consumers of whole-grain foods.

\* Values from both univariate *P*-value (unadjusted) (Mann–Whitney *U*-test) and multivariate *P*-value (adjusted for age, region, season, occupational social class and smoking status) (multiple logistic regression) analyses were identical.

**Table 4** Percentage contributions of food groups to consumption of whole-grain foods in the 1986–87 and 1994–95 surveys

Food group	1986–87 survey (16–64 years)		1994–95 survey (65 years and over)	
	Men (n = 707)	Women (n = 761)	Men (n = 409)	Women (n = 383)
Wholemeal bread	48	48	42	43
Whole-grain breakfast cereals	29	26	46	44
Biscuits	10	10	7	9
Other breads	3	8	<0.5	0
Pasta, rice and other miscellaneous cereals	4	4	2	1
Buns, cakes and pastries	3	3	3	2
Other breakfast cereals	1	<0.5	<0.5	<0.5
Puddings and ice cream	1	<0.5	<0.5	<0.5
Non-cereal foods	1	<0.5	<0.5	<0.5

aged 65 years and over, wholemeal bread (42%) and breakfast cereals (46%) remained the predominant types of whole-grain foods, although they made a much larger contribution, and there was a smaller variety of other sources within this age group compared with younger adults (Table 4). In each case these percentage contributions to whole-grain food consumption were not consistently affected by age, region, season, occupational social class or smoking behaviour.

## Discussion

Epidemiological evidence suggests that consumption of at least one serving of whole-grain foods per day is associated with a reduced risk of death from chronic degenerative diseases such as cardiovascular disease (CVD)<sup>1,2,5</sup>, CHD<sup>2,4</sup> and some cancers<sup>2</sup>. Based on semi-quantitative questionnaires of either bread consumption<sup>2</sup> or whole-grain product use<sup>1,4,5</sup>, data from Norwegian men and women<sup>2</sup> and US women<sup>1,4,5</sup> have found that consumption of whole grains was consistently inversely related to CVD mortality, with a weaker, although still significant relationship with cancer mortality<sup>2</sup>. In the majority of studies the association was attenuated but remained significant after adjustment for other positive health behaviours such as not smoking, physical activity and other lifestyle factors. However, in the Norwegian study, there was no significant benefit of whole-grain product consumption after adjustment for these confounders on cancer mortality<sup>2</sup>. Although the findings of these studies are broadly similar, there are important methodological differences in the quantification of intake of whole grains. For example, in the Norwegian study it was found that both the number of slices of bread eaten daily and the proportion of whole-grain flour used contributed to the inverse trends found between consumption of whole grains and disease-associated mortality<sup>2</sup>. At present the data do not allow any more detailed quantitative recommendations for the consumption of whole-grain foods.

The two surveys analysed in the present study give the most comprehensive analysis of whole-grain food

consumption in the British adult population to date. Consumption of whole-grain foods in mainland Britain is extremely low, especially in the 1986–87 survey, with a median consumption of only 2.5 servings per week in adults aged 16–64 years, and 5.2 servings per week in older adults (aged 65 years and over) from the 1994–95 survey. Around one-third of individuals in each survey did not consume any whole-grain foods during their respective survey periods, with over 90% consuming less than the 3 servings per day recommended in the American dietary guidelines<sup>16</sup>. Even among regular consumers of whole-grain foods the median consumption was only 5 servings per week in younger adults, and 7 servings per week in the elderly.

Differences in whole-grain food consumption in the two surveys were very marked. Consumption of whole-grain foods was higher in the 1994–95 survey, but it is not possible to assess whether this was an effect of age or a secular trend, since the data for adults aged 16–64 years were obtained over 15 years ago. Further data will shortly be available from the National Diet and Nutrition Survey of adults aged 19–64 years (conducted during 2000–01, due for publication in 2002–03), which will enable an up-to-date appraisal of whole-grain food consumption in the adult population.

Further analysis of the subject characteristics associated with differences in whole-grain food consumption showed that those consuming the most whole-grain foods were likely to be non-smokers and from non-manual occupational social class in both surveys. These findings are broadly similar to those observed for the consumption of whole grains within the USA<sup>5,17</sup> and Norway<sup>2</sup>. In order to increase consumption of whole-grain foods at a population level it is necessary to both decrease the proportion of non-consumers and increase the median consumption in existing consumers, focusing in particular on those groups with particularly low consumption.

The major sources of whole-grain foods in the British diet are bread and breakfast cereals, with modest contributions from whole-grain biscuits, particularly in the younger age groups. However, the absolute

consumption of whole grains in a portion of bread or cereals is larger than that contained in a biscuit, which emphasises the importance of bread and cereals as the key foods to target in order to increase the consumption of whole-grain foods. This information implies that public health campaigns to encourage the population to substitute whole-grain forms of bread and cereals for non-whole-grain varieties may be a useful strategy to increase consumption of whole grains.

The present findings follow those observed in a similar population-based study in the USA<sup>10</sup>. A random sample of over 9000 American adults reported a mean consumption of 1 serving of whole grains per day, with 36% of adults averaging less than this each day. Only 8% met the recommended 3 servings per day, slightly higher than the 3% observed in the present study. Similarly, the major sources of whole-grain foods were breads and breakfast cereals. The differences are modest and may be explained by the different definition of whole-grain foods and servings used within the surveys and possible secular trends in consumption. Each survey provides an indication of consumption patterns within their relative country, which is useful for identifying groups that may benefit most from increasing intakes of whole grains. While the consumption patterns in the USA and UK are similar they are in sharp contrast to that observed in Finland, where rye bread is a staple of the Finnish diet and is not viewed necessarily as a 'healthy' food<sup>18</sup>. High consumption rates of rye bread are observed in people with a low socio-economic status, whereas refined varieties are preferred by the higher socio-economic groups. Rye consumption by the Finns is not associated with other health behaviours<sup>18</sup>.

There are no published data on the consumption of whole-grain foods in British children and young people. However, given the overall trend towards increased consumption of whole grains with age, it is unlikely that the consumption of whole-grain foods in young people is higher than reported here. A subsection of a national survey of Americans found that consumption of whole-grain foods between the ages of 2 and 9 years was similar to that in adulthood with average servings of 1 per day<sup>19</sup>, reflecting low consumption levels at all ages.

Given the epidemiological evidence that people who regularly consume whole-grain foods have a lower risk of non-communicable disease, these data suggest that public health strategies to increase consumption of whole grains should be considered as part of the overall recommendations for a healthy diet.

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