Scientific Advisory Committee on Nutrition

# Paper for information: Bread and flour regulations

## Agenda item: 2

Please see attached paper for discussion.

It is envisaged that this paper will be redrafted and finalised by correspondence following the SACN meeting on 10 February 2012

# NUTRITIONAL IMPLICATIONS OF REPEALING THE UK BREAD AND FLOUR REGULATIONS

## Background

1. Under the UK Bread and Flour Regulations 1998 (FLR) industry is required to add certain nutrients (ie iron, calcium, thiamin and niacin) to all wheat flour (except wholemeal flour) at the milling stage. This legislative requirement was introduced in the 1950's in order to restore the iron, thiamin and niacin lost in the milling process to the levels present in unrefined flour. The addition of calcium was introduced the 1940s as a means of providing more calcium in the diet at a time when dairy products were scarce and the phytate content of high extraction flour used in the wartime loaf inhibited absorption of calcium. Details of the nutrients and levels added are summarised in table A, Appendix A.

2. As part of the Red Tape Challenge initiative to reduce regulation in all sectors, Department for Environment Food and Rural Affairs (Defra) are reviewing the need for these regulations and will be going out to public consultation on their removal later this year.

3. This paper seeks the Committee's view on the nutritional implications of removing this legislation and this will form part of the Impact Assessment associated with the consultation. To support this, a modelling exercise has been carried out using the most recent NDNS dataset to estimate the impact of removal of these nutrients from flour on nutrient intakes in all age groups. This paper presents the results of this modelling exercise and provides evidence in relation to other considerations for specific nutrients and vulnerable groups.

4. This issue was last considered by COMA[i] in its 1981 report on the nutritional aspects of bread and flour[ii]. This report recommended that the addition of calcium carbonate and the restitution of iron, thiamin and nicotinic acid to flour should no longer be mandatory, on the basis that dietary survey evidence available at the time suggested that intakes of these nutrients were adequate, and, in the case of iron, the fortificant was poorly absorbed. However, this recommendation was never implemented. More recently COMA, in its 1998 report on Nutrition and Bone Health recommended that calcium fortification of bread should be retained[iii].

## Method

5. The most recent data from the National Diet and Nutrition Survey (NDNS) Rolling Programme for years 1 and 2 combined[iv] was used to model the impact of removing the mandatory fortificants from flour on intakes of those nutrients, in adults, older adults and children. The NDNS dataset was interrogated to provide a distribution of estimated flour consumption by

age/sex, based on estimates of the percentage of flour in each NDNS food group (see table B Appendix A)[v]. These estimates of flour consumption were used to model the impact of removing mandatory fortification of flour on mean intakes of each fortificant nutrient and on the distribution of intakes in relation to Dietary Reference Values (DRVs).

6. For the purposes of modelling intakes it was assumed that all flour consumed was plain, white flour, and that this flour was all sourced from the UK (and hence fortified). A full list of the assumptions made in the model is given at Appendix A. Details of the nutrient composition data used for 'fortified' and 'unfortified' flour and DRVs applied[vi] are also provided in Appendix A (tables C and D).

**Results**

7. Table 1 shows the distribution of flour consumption (grams per day) by age and sex based on estimated flour content of NDNS food groups. Mean consumption ranged from 33g per day in children aged 1½ to 3 years to 79g per day in boys aged 11-18 years. Histograms presenting the distribution of flour consumption by sex are provided in figure 1.

8. Tables 2-5 show intakes of thiamin, niacin equivalents, calcium and iron and with and without fortification of wheat flour. For each age/sex group the proportion with intakes below the LRNI, EAR and RNI are provided.

9. The following summarises the key findings following the modelling to remove added thiamin, niacin, calcium and iron from flour:

***a) Thiamin and Niacin equivalents***

➢ *Children and adults (aged 1½-65+ years)*

- Mean intakes of thiamin and niacin equivalents remain above the Reference Nutrient Intake for each age/sex group. In addition, the proportion with intakes below the LRNI remains around 0-3% and no more than 4% in any group

***b) Calcium***

➢ *Younger children (all 1½-3 years, boys and girls aged 4-10 years)*

- Mean intakes remain above the RNI for each age/sex group
- No more than 2% of children aged 1½-3 years, and boys or girls aged 4-10 years have *current* intakes below the LRNI. This would remain unchanged should calcium fortification of flour cease

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➢ *Older children (boys and girls aged 11-18 years)*

- *Current* mean intakes of calcium for boys and girls aged 11-18 years are 87% of the RNI. Removing calcium fortification of flour reduces mean intakes further to 80% of the RNI for boys and 81% for girls of this age
- A substantial proportion of this age group currently have intakes below the LRNI (15% of girls and 8% of boys) and this would increase further (to around a fifth of girls and a tenth of boys) should calcium fortification of flour cease

➢ *Adults (aged 19-64 years)*

- Current mean intakes of calcium in adults aged 19-64 years remain above the RNI for men and at the RNI for women. There is a small increase in the proportion of men with intakes less than the LRNI (from 3 to 4%) and an increase from 6% to 9% for women

➢ *Adults (aged 65+ years)*

- Current mean intakes of calcium in adults aged 65+ years remain above the RNI and there is a small increase in the proportion of men with intakes less than the LRNI (from 1 to 3%) and an increase from 2% to 5% for women

***c) Iron***

➢ *Younger children (all 1½-3 years)*

- Current mean intakes are 92% of the RNI and 8% currently have intakes below the LRNI. The removal of added iron from flour would have little impact on this

➢ *Younger children (boys and girls aged 4-10 years)*

- Mean intakes remain above the RNI for boys and girls aged 4-10 years
- No more than 1% of boys and girls aged 4-10 years have *current* intakes below the LRNI. This would remain unchanged should iron fortification of flour cease

➢ *Older children (boys and girls aged 11-18 years)*

- *Current* mean intakes for boys aged 11-18 years are 95% the RNI and removal of added iron from flour would reduce this further to 92%. 5% have intakes below the LRNI and this would increase to 7%
- *Current* mean intakes for girls aged 11-18 years are substantially below the RNI (58%) and would decrease further to 56% of the RNI without fortification of flour
- Forty four percent of girls aged 11-18 years currently have iron intakes below the LRNI. Without fortification of flour this proportion would increase to 50%

➢ *Adults (aged 19-64 years)*

- Males: Mean intakes of iron remain above the RNI for men and the proportion with intakes less than the LRNI is minimal and remains unchanged
- Females: Current mean iron intakes are below the RNI (80%) and 22% of this age group have intakes below the LRNI. However, the impact of ceasing fortification on the proportion with low iron intakes is fairly small**.** Removing flour fortification would reduce mean intakes to 79% of the RNI and increase the proportion of with intakes below the LRNI to 24%

➢ *Adults (aged 65+ years)*

- Current mean intakes of iron in adults aged 65+ years remain above the RNI. The proportion of men and women with current intakes less than the LRNI is small and removal of iron fortification from flour would have minimal impact

**Discussion**

10. The impact of removing the four mandatory fortificants from flour on overall intakes of these nutrients has been assessed by modelling intakes on the basis of all wheat flour being unfortified and comparing these with the RNI, EAR and LRNI for each micronutrient in each age/sex group. Results show the distribution of intakes after the removal of fortificants, average intakes as a % of RNI and the percentage of the sample with intakes below the RNI, EAR and LRNI (including estimated numbers based on UK population estimates).

**Thiamin and Niacin**

11. No adverse effects on intakes of thiamin and niacin have been identified from modelling the removal of added thiamin and niacin from wheat flour. Mean intakes remain well above the RNI and less than 5% have intakes below the LRNI in any age/sex group. There is currently no evidence of low intakes in the population and these nutrients are widespread in the diet. Non-wheat flour sources of thiamin and niacin include meat and meat products, vegetables and potatoes, breakfast cereals, and milk and milk products. Clinical deficiency of thiamin and niacin is rare in the general UK population.

12. Thiamin and niacin requirements may be higher in some special groups. In particular athletes may have a higher thiamin requirement due to their high carbohydrate intakes. High alcohol consumers have increased requirements for thiamin. Alcohol inhibits absorption of thiamin which is required during the metabolism of carbohydrate, fat and alcohol. The Wernicke-Korsakov syndrome is characteristic of thiamin deficiency associated with alcoholism[vii]. Lactating women have a higher requirement for niacin. However, given that thiamin and niacin intakes are well above the DRVs and the contribution from wheat flour is relatively small, it seems unlikely that any of these groups would be put at risk by the removal of fortification.

**Calcium**

13. The modelling identified that the removal of added calcium from wheat flour would adversely affect intakes for young people aged 11-18 years and females aged 19-64 years. Calcium intakes are currently below the RNI for the 11-18 age group and a substantial proportion of girls (15%), and to a lesser extent boys (8%) have intakes below the LRNI. This is partly due to lower dairy consumption in this age group[viii]. Removal of added calcium from flour would increase the proportion of girls below the LRNI to 21%. This group is at a potentially key stage in bone development as 90-95% of Peak Bone Mass is contributed during growth[7]. There is evidence that intakes below the LRNI might not be compatible with good bone health[3]. There is no biomarker available to assess calcium status so intake is the only guide available to dietary adequacy. UK DRVs for calcium are set lower than in some other countries. Lactating women have a higher requirement for calcium so removal of fortificant calcium from flour may put this vulnerable group at risk of low intakes.

14. Bread and other products made with fortified flour are an important source of calcium in the diet. The 1998 COMA report on Nutrition and Bone Health[3] recommended that calcium fortification of bread should be retained to ensure that intakes did not fall below then current levels. The latest NDNS data shows that cereals and cereal products provide around 30% of calcium intakes, the majority from bread and flour containing products[8]. Fortified flour may be a particularly important source of calcium for those who do not consume dairy products. The calcium added to wheat flour is known to be bioavailable.

**Iron**

15. The modelling of the removal of added iron from wheat flour did not identify any substantial impact on intakes for younger children, males aged 19-64 years and adults aged 65+ years. The greatest impact would be for older girls and women, who have higher iron requirements. However, it has been acknowledged that Dietary Reference Values for iron are insecure and may be too high[9]. Current intakes of iron by girls aged 11-18 years and women of childbearing age are of particular concern and a high proportion have intakes below the LRNI. The removal of iron from flour would increase the proportion of girls below the LRNI from 44% to 50% and women 19-64 years from 22% to 24%. This relatively small impact is due to the difference between the iron content of fortified and unfortified flour being small. Unfortified white flour contains 1.5mg iron per 100g, only 0.4mg less than fortified flour.

16. Bread and other flour-containing products are major contributors to iron intake in the UK diet. The latest NDNS data shows that cereals and cereal products provide nearly 40% of iron intake in adults and 50% in older children, over half of which comes from bread and other flour-containing products[8]. However, the bioavailability of iron in the form that it is added to flour is doubtful. The SACN report on Iron and Health[ix] notes that although iron-fortified foods (especially cereals) make a substantial contribution to intake, the evidence from efficacy trials and from countries running national fortification programmes suggests that foods (such as flour) fortified with elemental iron make little practical contribution to increasing iron status, due to the low solubility and low intestinal uptake of the fortificant. However it is theoretically possible that the bioavailability of fortificant iron may be higher in people with low iron status, although there is no evidence available to support this.

**Trends in bread and flour consumption**

17. Comparison of current NDNS data with previous surveys shows that consumption of total bread, including white bread, has declined in all age groups[4]. There is some evidence of a switch from white to brown, granary and wheatgerm breads (including bread made from a mixture of white and wholegrain flour). The Family Food Survey of household food purchases[x] also shows a long-term decline in bread purchases. This suggests that bread is declining over time as a contributor to nutrient intake although it is likely to remain an important source of many nutrients.

18. NDNS shows that consumption of other flour-based products (eg buns, pastries, pastries, fruit pies and puddings have also declined in all age groups except 65+ years[4].

**Imported bread and flour**

19. A proportion of bread and flour products consumed in the UK are imported and therefore not fortified. However, the proportion of bread and flour products currently imported into the UK is minimal[xi]. Previous data shows that an amount equal to ~1% of domestic flour is imported[xii]. For the purposes of estimating current intakes and modelling intakes the assumption has been made that all flour is sourced from the UK and therefore subject to fortification. As a proportion of flour is imported this will reduce the impact of removing the nutrients although it is not possible to say to what extent.

**Other sources of the fortificant nutrients**

20. All the nutrients added to wheat flour on a mandatory basis are also added to many breakfast cereals and some other products on a voluntary basis. The Family Food Survey[10] records breakfast cereal purchases as stable for the last ten years. Data from the 2008/10 NDNS compared with previous NDNS surveys[4] suggests that breakfast cereal consumption has decreased in some age groups - older children, adults and adults aged 65+ years.

21. Thiamin and niacin have been widely added to breakfast cereals for many years and they provide up to a quarter of intake for thiamin and up to fifth of intake for niacin[xiii].

22. There have been large increases in the levels of calcium added to some major brands of breakfast cereals since the last NDNS of young people (1997)[13] which has contributed to the higher calcium intakes seen in children in the current compared with previous NDNS, in spite of a drop in milk consumption. Today some branded breakfast cereals commonly consumed by children are typically fortified at levels of 400-500mg/100g. Increased voluntary fortification of other products with calcium such as processed cheese, fruit juice and powdered beverages, has also contributed to the increase in intakes, especially in children.

23. Iron has also been added to a wide range of breakfast cereals on a voluntary basis for many years. There has been little change overall in levels of iron fortification in breakfast cereals as this is constrained by technological and palatability limitations. Overall mean iron intakes have not increased for adults and older children in the current NDNS compared with previous surveys and may have decreased slightly[4]. The proportion of women and girls with iron intakes below the LRNI has fallen slightly from previous NDNS but remains very high. The relative contribution that cereals and cereal products make to iron intakes has decreased in children and adults (due to higher meat consumption and lower breakfast cereal consumption).

**Socio-economic differences in impact**

24. The impact of removing mandatory fortification of flour may be greater in low income groups as they tend to have higher consumption of bread. Household purchase data from the Family Food module of the Living Costs and Food Survey[10] shows that the lowest quintile for gross household income purchased 26% more total bread and 78% more white bread than the highest income quintile. For white bread the lowest income quintile purchased 170g/week more than the highest quintile, approximately equivalent to an additional small slice of bread per day (24g). Removing fortification of white bread alone would reduce the iron and calcium content of the diet for the lowest income quintile by 0.14mg iron and 28mg calcium per day (2% of the EAR for calcium and 5% for iron). There were no income differences in purchases of sandwiches.

25. Purchases of cakes and biscuits were also highest in the lowest income quintile but the difference was smaller – about 70g/week and this was partially offset by lower purchases of pizza in the lowest income quintile. There was no income difference in purchases of flour.

26. Analysis of purchases by net equivalised income[xiv] shows a similar pattern except that the highest bread purchases are found in the second lowest decile rather than the lowest.

27. Analysis of Scottish data from the Family Food Survey[xv], using the Scottish Index of Multiple Deprivation (SIMD)[xvi] also showed that households in the most deprived quintile purchased about 20g/day more non-wholemeal bread than did households in the least deprived quintile. Analysis of the 2006 Scottish children's survey dataset[xvii] by SIMD found that consumers of non-wholemeal (i.e. fortified) bread in the most deprived quintile ate about 5g per day more than those in the least deprived quintile. Preliminary results from the 2010 survey are very similar.

28. Data from the 2000/01 NDNS adults 19-64 years[xviii], analysed by household receipt of benefits, showed that adult men, but not women, in benefit households ate about 100g more white bread per week (14g per day) than those in non-benefit households. However the same analysis on the 1997 NDNS young people 4-18 years[13] dataset showed the difference in the opposite direction with slightly lower white bread consumption in benefit households. Analysis of NDNS data by social class, where available, shows higher white bread consumption in the manual social class group[13,xix,xx]. Analysis by income, where available, showed no differences[13,19]. Consumption of biscuits, buns, cakes and pastries tended to be lower in benefit and manual social class households[13,18,19,20]. Adults in benefit households consumed less breakfast cereals (especially high fibre) compared with non-benefit households[18] but there was no difference for children analysed by receipt of benefits, social class or income[13].

29. Analysis of micronutrient intakes in adults in benefit compared with non-benefit households showed that the proportion of women with intakes below

the LRNI for iron and calcium was higher in the benefit group than in the non-benefit group (53% below LRNI for iron and 12% for calcium in the benefit group compared with 29% for iron and 4% for calcium in the non-benefit group. The Low Income Diet and Nutrition Survey[xxi] found that 38% of women in the same age group had iron intakes below the LRNI and 13% had calcium intakes below the LRNI.

**Regional differences in impact**

30. There may also be regional differences in impact due to differences in consumption of bread and flour products. Household purchase data from the Family Food survey[10] shows that there are differences in bread purchases by UK country and by regions of England. Households in Northern Ireland and Scotland purchased more bread than did England or Wales households. Northern Ireland households purchased 176g more total bread per week, of which 126g more white bread than did households in England. For Scotland the difference was smaller, 80g total bread per week of which 26g white bread. Within England, total and white bread purchases were highest in the West Midlands and lowest in London, with a difference of 162g/week for white bread and 170g/week for total bread. Household purchases of flour were three times as high in England as in Northern Ireland. There was no clear pattern in country or regional differences in purchases of other flour-containing products.

31. NDNS data from 2000/01[18] showed that white bread consumption for men was higher in Northern England and Central and South West England and Wales than in Scotland and London and the South East. There were no differences for women and no clear pattern for other age groups. There were no regional differences in consumption of biscuits, cakes, buns and pastries.

32. There was some evidence of lower mean intakes of some minerals, including iron and calcium in Scotland compared with other regions. However this was not seen consistently.

33. It should be noted that apparent regional differences may be partly due to socio-economic factors.

**Summary of the evidence**

34. Modelling of NDSN data suggests that there is no evidence that removal of added thiamin and niacin from white and brown wheat flour would have any adverse effects, even on groups with increased requirements, as these nutrients are widespread in the diet, intakes are well above DRVs and clinical deficiency is rare.

35. Low calcium intakes are already seen in a proportion of older children young women. Removal of added calcium from flour would increase the proportion of these groups below the LRNI and this may have adverse effects on bone health.

36. A high proportion of girls and women have low iron intakes. Removal of iron from wheat flour would increase the proportions below the LRNI although the impact is limited as the majority of iron in flour is naturally present. Evidence suggests that the form of iron added to flour is not generally bioavailable although its availability in people with low iron status is unknown.

37. There has been a long term decline in bread consumption but it remains an important source of the fortificant nutrients, particularly calcium. Survey data shows that low income groups consume more bread than other groups so may be more affected by removal of fortificants.

**Conclusions**

38. Conclusions will be drafted following discussions at the February 2012 meeting and circulated for comment.

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**Table 1: Distribution of flour consumption (grams per day) by age and sex)**

| | Age (Years) | N | Mean | Std Deviation | Min | Percentiles | | | | | | | | | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2.5% | 5% | 10% | 25% | 50% | 75% | 90% | 95% | 97.5% | |
| Males | 4-10 | 212 | 61.6 | 27.4 | 0 | 12.0 | 20.0 | 26.2 | 41.7 | 60.7 | 80.9 | 99.2 | 106.9 | 120.6 | 141.4 |
| | 11-18 | 267 | 78.8 | 38.9 | 0 | 16.0 | 19.5 | 32.8 | 48.4 | 75.0 | 107.8 | 129.4 | 140.6 | 172.2 | 222.0 |
| | 19-64 | 405 | 70.8 | 39.4 | 0 | 6.9 | 16.1 | 23.0 | 44.7 | 66.8 | 94.4 | 123.4 | 140.4 | 155.7 | 234.6 |
| | 65+ | 95 | 69.3 | 39.5 | 0 | 0 | 4.7 | 16.4 | 36.4 | 70.9 | 97.7 | 119.2 | 140.2 | 153.4 | 219.9 |
| Females | 4-10 | 202 | 57.0 | 27.7 | 2.3 | 11.3 | 13.1 | 23.1 | 39.7 | 54.5 | 70.1 | 93.7 | 114.4 | 132.6 | 145.4 |
| | 11-18 | 253 | 60.1 | 29.9 | 0 | 7.7 | 13.6 | 22.2 | 38.9 | 59.1 | 77.1 | 101.7 | 114.4 | 127.7 | 169.0 |
| | 19-64 | 408 | 52.0 | 32.8 | 0 | 2.3 | 7.6 | 12.2 | 27.0 | 46.8 | 72.5 | 100.4 | 109.1 | 122.1 | 172.0 |
| | 65+ | 122 | 49.9 | 27.2 | 1.8 | 4.5 | 6.3 | 13.8 | 31.1 | 46.8 | 68.5 | 85.5 | 97.3 | 119.4 | 128.3 |
| Overall | 1½-3 | 162 | 32.8 | 19.8 | 0 | 2.8 | 4.5 | 10.1 | 19.0 | 29.8 | 43.7 | 57.3 | 70.8 | 84.4 | 119.7 |
| | 4-10 | 414 | 59.3 | 27.6 | 0 | 11.9 | 18.1 | 25.0 | 39.8 | 56.7 | 76.5 | 97.0 | 106.9 | 120.7 | 145.4 |
| | 11-18 | 519 | 69.7 | 36.0 | 0 | 12.7 | 16.4 | 25.2 | 43.9 | 65.2 | 93.5 | 118.4 | 132.8 | 142.9 | 222.0 |
| | 19-64 | 813 | 61.4 | 37.4 | 0 | 4.6 | 9.5 | 16.3 | 33.8 | 56.1 | 83.5 | 112.8 | 128.0 | 142.6 | 234.6 |
| | 65+ | 218 | 58.4 | 34.4 | 0 | 4.0 | 5.4 | 14.5 | 34.1 | 57.0 | 79.3 | 103.9 | 120.1 | 136.2 | 219.9 |

**Figure 1: Distributions of flour consumption by sex (as modelled)**

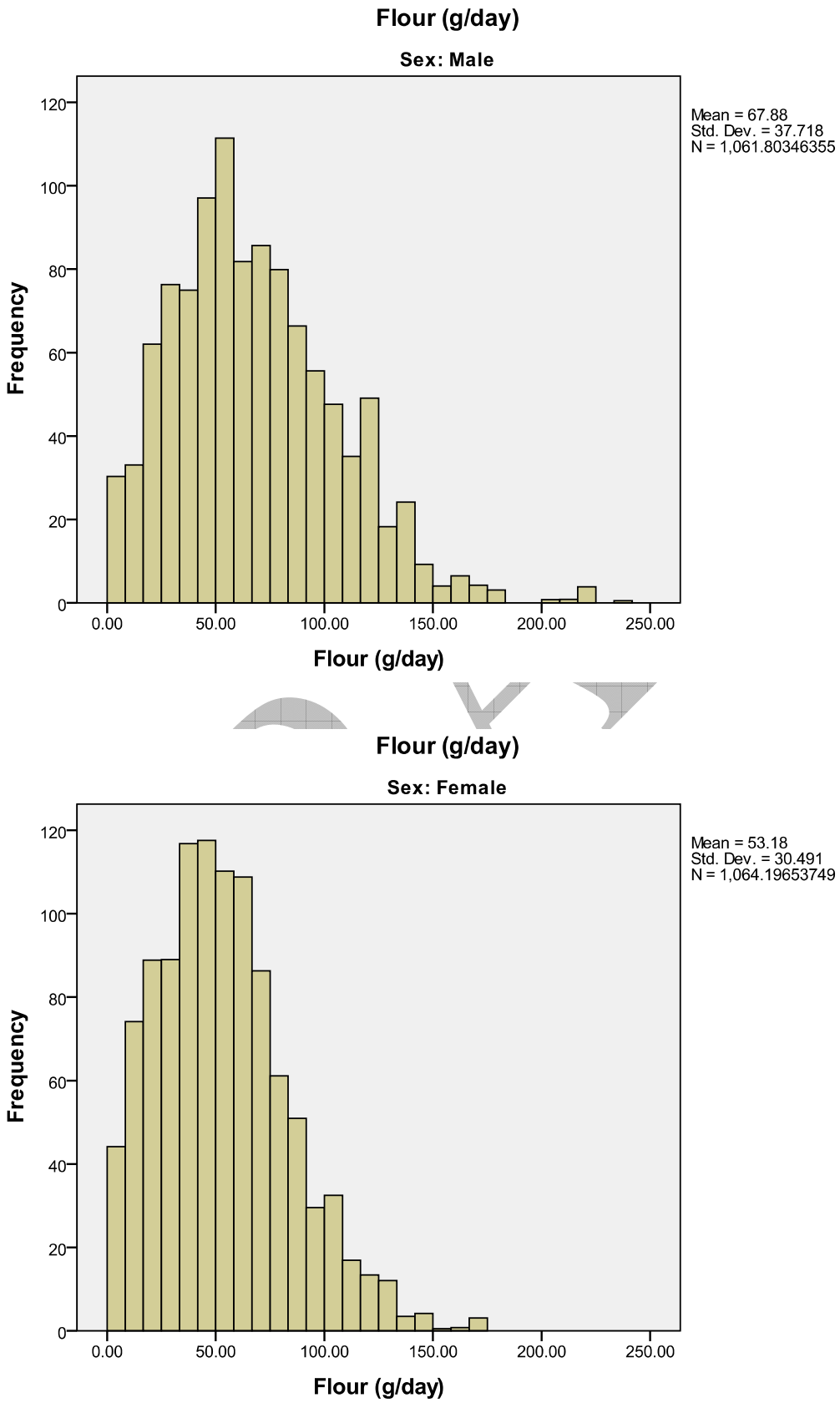

**Table 2 Intake of thiamin[3] with and without fortification of flour, by age and sex**

| | Intake with fortification of flour[1] | | | | | Intake without fortification of flour[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Males aged (years)** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** |
| 4-10 | 1.33 | 202 | 12,000 (<0.5%) | - (0%) | - (0%) | 1.22 | 185 | 59,000 (2%) | 12,000 (<0.5%) | - (0%) |
| 11-18 | 1.60 | 155 | 460,000 (15%) | 127,000 (4%) | 57,000 (2%) | 1.46 | 141 | 773,000 (25%) | 242,000 (8%) | 127,000 (4%) |
| 19-64 | 1.65 | 156 | 3,133,000 (17%) | 842,000 (4%) | 187,000 (1%) | 1.53 | 144 | 4,255,000 (22%) | 1,169,000 (6%) | 327,000 (2%) |
| 65+ | 1.56 | 173 | 334,000 (7%) | 239,000 (5%) | 48,000 (1%) | 1.44 | 160 | 525,000 (12%) | 334,000 (7%) | 142,000 (3%) |
| Total | 1.51 | 174 | 3,277,000 (11%) | 985,000 (3%) | 279,000 (1%) | 1.39 | 160 | 4,987,000 (16%) | 1,532,000 (5%) | 593,000 (2%) |
| **Females aged (years)** | | | | | | | | | | |
| 4-10 | 1.26 | 193 | 48,000 (2%) | - (0%) | - (0%) | 1.16 | 177 | 83,000 (3%) | - (0%) | - (0%) |
| 11-18 | 1.25 | 131 | 576,000 (20%) | 116,000 (4%) | 58,000 (2%) | 1.14 | 120 | 921,000 (32%) | 196,000 (7%) | 69,000 (2%) |
| 19-64 | 1.29 | 156 | 2,191,000 (12%) | 886,000 (5%) | 373,000 (2%) | 1.20 | 145 | 3,357,000 (18%) | 1,352,000 (7%) | 373,000 (2%) |
| 65+ | 1.31 | 174 | 189,000 (3%) | 142,000 (2%) | - (0%) | 1.22 | 162 | 378,000 (7%) | 142,000 (2%) | 94,000 (2%) |
| Total | 1.25 | 164 | 3,134,000 (10%) | 1,001,000 (3%) | 413,000 (1%) | 1.15 | 152 | 4,975,000 (16%) | 1,471,000 (5%) | 507,000 (2%) |
| **All aged (years)** | | | | | | | | | | |
| 1½ -3 | 0.94 | 236 | 28,000 (1%) | 28,000 (1%) | 28,000 (1%) | 0.88 | 221 | 29,000 (1%) | 28,000 (1%) | 28,000 (1%) |
| 4–10 | 1.30 | 198 | 59,000 (1%) | - (0%) | - (0%) | 1.19 | 181 | 154,000 (3%) | 12,000 (<0.5%) | - (0%) |
| 11-18 | 1.43 | 143 | 1,038,000 (17%) | 242,000 (4%) | 104,000 (2%) | 1.30 | 131 | 1,695,000 (28%) | 438,000 (7%) | 196,000 (3%) |
| 19–64 | 1.47 | 156 | 5,322,000 (14%) | 1,727,000 (5%) | 514,000 (1%) | 1.36 | 145 | 7,610,000 (20%) | 2,518,000 (7%) | 699,000 (2%) |
| 65+ | 1.42 | 174 | 520,000 (5%) | 378,000 (4%) | 47,000 (<0.5%) | 1.31 | 161 | 898,000 (9%) | 473,000 (5%) | 189,000 (2%) |
| Total | 1.38 | 169 | 6,414,000 (10%) | 1,986,000 (3%) | 691,000 (1%) | 1.27 | 156 | 9,965,000 (16%) | 3,004,000 (5%) | 1,101,000 (2%) |

Modelled data from the National Diet and Nutrition Survey Rolling Programme (Years 1 and 2 combined: 2008/9–2009/10) to show the effect on intakes of removing fortificants. Mid-2010 UK population estimates. Source: http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/population-estimates-timeseries-1971-to-current-year/rft---table-2-quinary-age-groups-constituent-countries.zip [NB: the estimated total numbers affected in the population do not equate to individual totals exactly due to the way in which the age splits have been estimated]

[1] Based on fortified flour – nutrient databank values

[2] Based on levels in unfortified flour. Modelling based on estimated flour consumption

[3] Excludes intake from dietary supplements

'-' = zero

**Table 3 Intake of niacin equivalents[3] with and without fortification of flour, by age and sex**

| | Intake with fortification of flour[1] | | | | | Intake without fortification of flour[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Males aged (years)** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** |
| 4-10 | 27.7 | 251 | - (0%) | - (0%) | - (0%) | 27.1 | 246 | - (0%) | - (0%) | - (0%) |
| 11-18 | 36.9 | 208 | 92,000 (3%) | 11,000 (<0.5%) | - (0%) | 36.2 | 204 | 139,000 (5%) | 35,000 (1%) | - (0%) |
| 19-64 | 44.6 | 255 | 47,000 (<0.5%) | 47,000 (<0.5%) | 47,000 (<0.5%) | 43.9 | 251 | 47,000 (<0.5%) | 47,000 (<0.5%) | 47,000 (<0.5%) |
| 65+ | 37.5 | 244 | 48,000 (1%) | 47,000 (1%) | 47,000 (1%) | 36.8 | 239 | 48,000 (1%) | 48,000 (1%) | 47,000 (<0.5%) |
| Total | 36.7 | 245 | 282,000 (1%) | 74,000 (<0.5%) | 48,000 (<0.5%) | 36.0 | 241 | 421,000 (1%) | 160,000 (1%) | 48,000 (<0.5%) |
| **Females aged (years)** | | | | | | | | | | |
| 4-10 | 26.3 | 256 | 12,000 (<0.5%) | - (0%) | - (0%) | 25.8 | 251 | 12,000 (<0.5%) | - (0%) | - (0%) |
| 11-18 | 30.1 | 198 | 150,000 (5%) | 104,000 (4%) | 23,000 (1%) | 29.5 | 194 | 161,000 (6%) | 104,000 (4%) | 23,000 (1%) |
| 19-64 | 32.2 | 230 | 559,000 (3%) | 233,000 (1%) | 93,000 (<0.5%) | 31.7 | 226 | 559,000 (3%) | 233,000 (1%) | 93,000 (<0.5%) |
| 65+ | 29.8 | 241 | - (0%) | - (0%) | - (0%) | 29.3 | 237 | - (0%) | - (0%) | - (0%) |
| Total | 29.3 | 235 | 791,000 (3%) | 452,000 (1%) | 191,000 (1%) | 28.8 | 231 | 831,000 (3%) | 452,000 (1%) | 191,000 (1%) |
| **All aged (years)** | | | | | | | | | | |
| 1½ -3 | 19.4 | 310 | 28,000 (1%) | 28,000 (1%) | 28,000 (1%) | 19.0 | 305 | 28,000 (1%) | 28,000 (1%) | 28,000 (1%) |
| 4–10 | 27.0 | 254 | 12,000 (<0.5%) | - (0%) | - (0%) | 26.4 | 248 | 12,000 (<0.5%) | - (0%) | - (0%) |
| 11-18 | 33.6 | 203 | 242,000 (4%) | 115,000 (2%) | 23,000 (<0.5%) | 32.9 | 199 | 300,000 (5%) | 138,000 (2%) | 23,000 (<0.5%) |
| 19–64 | 38.4 | 242 | 606,000 (2%) | 280,000 (1%) | 140,000 (<0.5%) | 37.8 | 238 | 607,000 (2%) | 280,000 (1%) | 140,000 (<0.5%) |
| 65+ | 33.2 | 242 | 47,000 (<0.5%) | 47,000 (<0.5%) | 47,000 (<0.5%) | 32.6 | 238 | 47,000 (<0.5%) | 47,000 (<0.5%) | 47,000 (<0.5%) |
| Total | 33.0 | 240 | 1,066,000 (2%) | 520,000 (1%) | 237,000 (0%) | 32.4 | 236 | 1,246,000 (2%) | 608,000 (1%) | 237,000 (0%) |

Modelled data from the National Diet and Nutrition Survey Rolling Programme (Years 1 and 2 combined: 2008/9–2009/10) to show the effect on intakes of removing fortificants. Mid-2010 UK population estimates. Source: http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/population-estimates-timeseries-1971-to-current-year/rft---table-2-quinary-age-groups-constituent-countries.zip [NB: the estimated total numbers affected in the population do not equate to individual totals exactly due to the way in which the age splits have been estimated]

[1] Based on fortified flour – nutrient databank values

[2] Based on levels in unfortified flour. Modelling based on estimated flour consumption

[3] Excludes intake from dietary supplements

'-' = zero

**Table 4: Intake of calcium[3] with and without fortification of flour by age and sex**

| | Intake with fortification of flour[1] | | | | | Intake without fortification of flour[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Males aged (years)** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** |
| 4-10 | 838 | 167 | 250,000 (10%) | 48,000 (2%) | 12,000 (<0.5%) | 788 | 157 | 309,000 (12%) | 83,000 (3%) | 36,000 (1%) |
| 11-18 | 868 | 87 | 2,170,000 (71%) | 1,357,000 (44%) | 241,000 (8%) | 804 | 80 | 2,380,000 (78%) | 1,518,000 (49%) | 345,000 (11%) |
| 19-64 | 921 | 132 | 5,704,000 (30%) | 2,332,000 (12%) | 514,000 (3%) | 864 | 123 | 6,920,000 (37%) | 3,078,000 (16%) | 795,000 (4%) |
| 65+ | 964 | 138 | 992,000 (22%) | 425,000 (9%) | 48,000 (1%) | 908 | 130 | 1,193,000 (26%) | 573,000 (13%) | 143,000 (3%) |
| Total | 887 | 136 | 10,097,000 (33%) | 5,142,000 (17%) | 974,000 (3%) | 832 | 128 | 11,641,000 (39%) | 6,191,000 (20%) | 1,536,000 (5%) |
| **Females aged (years)** | | | | | | | | | | |
| 4-10 | 767 | 153 | 393,000 (16%) | 107,000 (4%) | 47,000 (2%) | 721 | 144 | 500,000 (21%) | 131,000 (5%) | 47,000 (2%) |
| 11-18 | 696 | 87 | 2,092,000 (72%) | 1,255,000 (43%) | 437,000 (15%) | 647 | 81 | 2,291,000 (79%) | 1,595,000 (55%) | 599,000 (21%) |
| 19-64 | 738 | 105 | 9,091,000 (48%) | 4,149,000 (22%) | 1,072,000 (6%) | 696 | 99 | 10,350,000 (54%) | 5,175,000 (27%) | 1,678,000 (9%) |
| 65+ | 799 | 114 | 2,065,000 (36%) | 610,000 (11%) | 142,000 (2%) | 758 | 108 | 2,628,000 (46%) | 993,000 (17%) | 282,000 (5%) |
| Total | 740 | 119 | 13,412,000 (43%) | 6,519,000 (21%) | 2,043,000 (7%) | 697 | 112 | 15,328,000 (49%) | 8,360,000 (27%) | 2,881,000 (9%) |
| **All aged (years)** | | | | | | | | | | |
| 1½ -3 | 773 | 221 | 86,000 (4%) | 29,000 (1%) | 28,000 (1%) | 747 | 213 | 86,000 (4%) | 57,000 (2%) | 28,000 (1%) |
| 4–10 | 804 | 160 | 642,000 (13%) | 155,000 (3%) | 48,000 (1%) | 756 | 151 | 809,000 (16%) | 214,000 (4%) | 83,000 (2%) |
| 11-18 | 784 | 87 | 4,254,000 (71%) | 2,617,000 (44%) | 680,000 (11%) | 728 | 81 | 4,671,000 (78%) | 3,113,000 (52%) | 943,000 (16%) |
| 19–64 | 829 | 118 | 14,800,000 (39%) | 6,482,000 (17%) | 1,632,000 (4%) | 780 | 111 | 17,274,000 (46%) | 8,217,000 (22%) | 2,474,000 (7%) |
| 65+ | 871 | 124 | 3,039,000 (29%) | 1,040,000 (10%) | 190,000 (2%) | 824 | 118 | 3,829,000 (37%) | 1,607,000 (16%) | 425,000 (4%) |
| Total | 813 | 127 | 23,465,000 (38%) | 11,643,000 (19%) | 3,002,000 (5%) | 764 | 120 | 26,920,000 (44%) | 14,522,000 (24%) | 4,397,000 (7%) |

Modelled data from the National Diet and Nutrition Survey Rolling Programme (Years 1 and 2 combined: 2008/9–2009/10) to show the effect on intakes of removing fortificants. Mid-2010 UK population estimates. Source: http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/population-estimates-timeseries-1971-to-current-year/rft---table-2-quinary-age-groups-constituent-countries.zip [NB: the estimated total numbers affected in the population do not equate to individual totals exactly due to the way in which the age splits have been estimated]

[1] Based on fortified flour – nutrient databank values

[2] Based on levels in unfortified flour. Modelling based on estimated flour consumption

[3] Excludes intake from dietary supplements

**Table 5 Intake of iron[3] with and without fortification of flour by age and sex**

| | Intake with fortification of flour[1] | | | | | Intake without fortification of flour[2] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Males aged (years)** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** | **Mean (mg)** | **Mean intakes as a % of RNI** | **Estimated number (%) below RNI** | **Estimated number (%) below EAR** | **Estimated number (%) below LRNI** |
| 4-10 | 9.1 | 122 | 725,000 (29%) | 119,000 (5%) | 12,000 (<0.5%) | 8.8 | 118 | 808,000 (32%) | 154,000 (6%) | 12,000 (<0.5%) |
| 11-18 | 10.8 | 95 | 1,909,000 (62%) | 770,000 (25%) | 162,000 (5%) | 10.4 | 92 | 2,024,000 (66%) | 885,000 (29%) | 219,000 (7%) |
| 19-64 | 12.0 | 138 | 4,021,000 (21%) | 1,777,000 (9%) | 234,000 (1%) | 11.7 | 135 | 4,161,000 (22%) | 1,917,000 (10%) | 234,000 (1%) |
| 65+ | 11.3 | 130 | 1,050,000 (23%) | 382,000 (8%) | 143,000 (3%) | 11.0 | 127 | 1,241,000(27%) | 382,000 (8%) | 143,000 (3%) |
| Total | 10.6 | 120 | 10,991,000 (36%) | 4,246,000 (14%) | 825,000 (3%) | 10.4 | 117 | 11,743,000 (39%) | 4,751,000 (16%) | 988,000 (3%) |
| **Females aged (years)** | | | | | | | | | | |
| 4-10 | 8.4 | 113 | 917,000 (38%) | 226,000 (9%) | 24,000 (1%) | 8.2 | 110 | 1,025,000 (43%) | 285,000 (12%) | 24,000 (1%) |
| 11-18 | 8.6 | 58 | 2,855,000 (98%) | 2,463,000 (85%) | 1,278,000 (44%) | 8.3 | 56 | 2,855,000 (98%) | 2,519,000 (87%) | 1,468,000 (50%) |
| 19-64 | 9.8 | 80 | 14,592,000 (77%) | 10,350,000 (54%) | 4,196,000 (22%) | 9.6 | 79 | 14,825,000 (78%) | 10,629,000 (56%) | 4,522,000 (24%) |
| 65+ | 9.5 | 109 | 2,507,000(43%) | 757,000 (13%) | 47,000 (1%) | 9.3 | 107 | 2,815 (49%) | 993,000 (17%) | 94,000 (2%) |
| Total | 8.9 | 85 | 21,905,000 (70%) | 14,586,000 (47%) | 6,213,000 (20%) | 8.7 | 83 | 22,544,000 (72%) | 15,237,000 (49%) | 6,935,000 (22%) |
| **All aged (years)** | | | | | | | | | | |
| 1½ -3 | 6.3 | 92 | 1,517,000 (66%) | 742,000 (32%) | 184,000 (8%) | 6.2 | 90 | 1,560,000 (68%) | 808,000 (35%) | 199,000 (9%) |
| 4–10 | 8.7 | 118 | 1,642,000 (33%) | 345,000 (7%) | 36,000 (1%) | 8.5 | 115 | 1,832,000 (37%) | 428,000 (9%) | 36,000 (1%) |
| 11-18 | 9.7 | 77 | 4,761,000 (80%) | 3,228,000 (54%) | 1,441,000 (24%) | 9.4 | 75 | 4,876,000 (82%) | 3,401,000 (57%) | 1,691,000 (28%) |
| 19–64 | 10.9 | 109 | 18,605,000 (49%) | 12,139,000 (32%) | 4,476,000 (12%) | 10.6 | 107 | 19,002,000 (50%) | 12,512,000 (33%) | 4,803,000 (13%) |
| 65+ | 10.3 | 118 | 3,592,000 (35%) | 1,140,000 (11%) | 189,000 (2%) | 10.1 | 116 | 4,065,000 (39%) | 1,371,000 (13%) | 236,000 (2%) |
| Total | 9.8 | 103 | 32,739,000 (53%) | 18,680,000 (30%) | 6,959,000 (11%) | 9.5 | 100 | 34,132,000 (56%) | 19,834,000 (32%) | 7,835,000 (13%) |

Modelled data from the National Diet and Nutrition Survey Rolling Programme (Years 1 and 2 combined: 2008/9–2009/10) to show the effect on intakes of removing fortificants. Mid-2010 UK population estimates. Source: http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/population-estimates-timeseries-1971-to-current-year/rft---table-2-quinary-age-groups-constituent-countries.zip [NB: the estimated total numbers affected in the population do not equate to individual totals exactly due to the way in which the age splits have been estimated]

[1] Based on fortified flour – nutrient databank values

[2] Based on levels in unfortified flour. Modelling based on estimated flour consumption

[3] Excludes intake from dietary supplements

# Appendix A

**Table A: Nutrients and levels added to wheat flour (except wholemeal flour)**

| Nutrient | Amount per 100g flour | Form |
|---|---|---|
| Calcium** | 235-390mg | Calcium carbonate |
| Iron | ≥1.65mg | Any or a combination of:<br>- ferric ammonium citrate<br>- green ferric ammonium citrate<br>- ferrous sulphate<br>- dried ferrous sulphate<br>- iron powder |
| Thiamin | ≥ 1.24mg | Thiamine hydrochloride |
| Niacin | ≥ 1.60mg | Nicotinic acid or nicotinamide |

** except self-raising flour which contains ≤0.2% Ca

**List of assumptions in modelling**

- The percentage of flour in each of the main NDNS flour containing food groups was estimated using the same approach used to model the impact of fortification of flour with folic acid on folate intakes (for the SACN Folate Report)[22]

- The percentages of flour used in the analysis are shown in table B

- The flour content of products not covered in table B was assumed to be zero

- This approach excludes some products that would contain flour in the recipe such as savoury flans, pies, quiches and battered/breaded fish/meat. The contribution of these products to flour consumption was considered to be low and so they were omitted from the analysis

- Bread based on non-wheat flour is in a separate NDNS food group which is not included in the analysis

- All flour consumed is milled in the UK and subject to fortification. This is based on information that imported flour represents an insignificant proportion of flour consumed in the UK

- All flour consumed is plain, white flour. Wholemeal bread is the only significant source of wholemeal flour. All other flour-containing products are made with white flour. The composition of fortified and unfortified white flour is as shown in Table C

**Table B: Flour content of food products**

| NDNS Food Group | Estimated % Flour |
|---|---|
| White Bread | 63 |
| Brown, granary and wheatgerm bread | 63 |
| Pizzas | 25 |
| Other cereals, dumplings Yorkshire puddings etc | 25 |
| Biscuits | 50 |
| Fruit pies | 30 |
| Buns Cakes & Pastries | 45 |
| Sponge type puddings | 30 |
| Other cereal based puddings (crumbles, bread pudding, pancakes, cheesecake trifle etc) | 10 |

**Table C: Composition of fortified and unfortified white flour**

| Food | Composition of food mg per 100g | | | |
|---|---|---|---|---|
| | Calcium | Iron | Thiamin | Niacin |
| Wheat flour, white, plain, fortified[23] | 96 | 1.9 | 0.28 | 1.7 |
| Wheat flour, white, plain, unfortified[24] | 15 | 1.5 | 0.10 | 0.7 |
| ***Difference*** | ***81*** | ***0.4*** | ***0.18*** | ***1.0*** |

**Table D: Dietary Reference Values by age and sex[25]**

| Nutrient | Age/sex | LRNI | EAR | RNI |
|---|---|---|---|---|
| | | | | |
| Calcium (mg/day) | 1-3 yrs M&F | 200 | 275 | 350 |
| | 4-6 yrs M&F | 275 | 350 | 450 |
| | 7-10 yrs M&F | 325 | 425 | 550 |
| | 11-14 yrs M | 480 | 750 | 1000 |
| | 11-14 yrs F | 450 | 625 | 800 |
| | 15-18 yrs M | 480 | 750 | 1000 |
| | 15-18 yrs F | 450 | 625 | 800 |
| | 19-50 yrs M&F | 400 | 525 | 700 |
| | 50+ yrs M&F | 400 | 525 | 700 |
| | | | | |
| Iron (mg/day) | 1-3 yrs M&F | 3.7 | 5.3 | 6.9 |
| | 4-6 yrs M&F | 3.3 | 4.7 | 6.1 |
| | 7-10 yrs M&F | 4.7 | 6.7 | 8.7 |
| | 11-14 yrs M | 6.1 | 8.7 | 11.3 |
| | 11-14 yrs F | 8.0 | 11.4 | 14.8 |
| | 15-18 yrs M | 6.1 | 8.7 | 11.3 |
| | 15-18 yrs F | 8.0 | 11.4 | 14.8 |
| | 19-50 yrs M | 4.7 | 6.7 | 8.7 |
| | 19-50 yrs F | 8.0 | 11.4 | 14.8 |
| | 50+ yrs M&F | 4.7 | 6.7 | 8.7 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| Thiamin (mg/day) | 1-3 yrs M&F | 0.2 | 0.3 | 0.4 |
| | 4-6 yrs M&F | 0.3 | 0.4 | 0.6 |
| | 7-10 yrs M&F | 0.4 | 0.5 | 0.7 |
| | 11-14 yrs M &F | 0.5 | 0.7 | 0.9 |
| | 15-18 yrs M | 0.7 | 0.9 | 1.2 |
| | 15-18 yrs F | 0.6 | 0.7 | 1.0 |
| | 19-24 yrs M | 0.6 | 0.8 | 1.1 |
| | 19-24 yrs F | 0.5 | 0.7 | 0.9 |
| | 25-34 yrs M | 0.6 | 0.8 | 1.1 |
| | 25-34 yrs F | 0.5 | 0.7 | 0.9 |
| | 35-44 yrs M | 0.6 | 0.8 | 1.1 |
| | 35-44 yrs F | 0.5 | 0.6 | 0.8 |
| | 45-54 yrs M | 0.6 | 0.8 | 1.0 |
| | 45-54 yrs F | 0.5 | 0.6 | 0.8 |
| | 55-64 yrs M | 0.6 | 0.8 | 1.0 |
| | 55-64 yrs F | 0.5 | 0.6 | 0.8 |
| | 65-74 yrs M | 0.5 | 0.7 | 0.9 |
| | 65-74 yrs F | 0.4 | 0.6 | 0.8 |
| | 75+ yrs M | 0.5 | 0.7 | 0.9 |
| | 75+ yrs F | 0.4 | 0.6 | 0.7 |
| | | | | |
| Niacin equivalents (mg/day) | 1-3 yrs M | 4.3 | 5.4 | 6.5 |
| | 1-3 yrs F | 4.0 | 5.0 | 6.0 |
| | 4-6 yrs M | 6.5 | 8.1 | 9.8 |
| | 4-6 yrs F | 6.1 | 7.6 | 9.1 |
| | 7-10 yrs M | 8.0 | 10.0 | 12.0 |
| | 7-10 yrs F | 7.5 | 9.3 | 11.2 |
| | 11-14 yrs M | 10.4 | 13.0 | 15.6 |
| | 11-14 yrs F | 9.6 | 12.0 | 14.4 |
| | 15-18 yrs M | 13.3 | 16.6 | 19.9 |
| | 15-18 yrs F | 10.7 | 13.4 | 16.1 |
| | 19-24 yrs M | 12.2 | 15.2 | 18.3 |
| | 19-24 yrs F | 9.6 | 12.0 | 14.4 |
| | 25-34 yrs M | 12.1 | 15.1 | 18.1 |
| | 25-34 yrs F | 9.6 | 12.0 | 14.4 |
| | 35-44 yrs M | 11.6 | 14.5 | 17.4 |
| | 35-44 yrs F | 9.3 | 11.6 | 13.9 |
| | 45-54 yrs M | 11.4 | 14.2 | 17.0 |
| | 45-54 yrs F | 9.3 | 11.6 | 13.9 |
| | 55-64 yrs M | 11.4 | 14.2 | 17.0 |
| | 55-64 yrs F | 9.1 | 11.4 | 13.7 |
| | 65-74 yrs M | 10.3 | 12.9 | 15.5 |
| | 65-74 yrs F | 8.4 | 10.5 | 12.6 |
| | 75+ yrs M | 10.1 | 12.6 | 15.1 |
| | 75+ yrs F | 8.1 | 10.1 | 12.1 |

[i] Committee on Medical Aspects of Food Policy, predecessor to SACN

[ii] Department of Health and Social Security. Nutritional Aspects of Bread and Flour. Report on Health and Social Subjects No. 23. Report by the Committee on Medical Aspects of Food Policy. London: HMSO, 1981

[iii] Department of Health. Report on Health and Social Subjects 49. Nutrition and Bone Health. TSO (London, 1998)

[iv] Bates B, Lennox A, Bates C & Swan G. National Diet and Nutrition Survey: Headline results from years 1 and 2 (combined) of the Rolling Programme (2008/2009 – 2009/2010), Available at: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_128166 (accessed 17/1/12)

[v] This approach is the same as that used previously to model the impact of fortification of flour with folic acid on folate intakes as presented in Appendix 2, Annex 2 of the SACN report on Folate and Disease Prevention, 2006)

[vi] For calcium and iron, DRVs were taken directly from the 1991 DRV report. For thiamin and niacin equivalents, DRVs were calculated as %EAR using revised EARs from the SACN energy report

[vii] Department of Health. Report on Health and Social Subjects 41: Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. HMSO (London, 1991)

[viii] DH Internal analysis of data of results from the National Diet and Nutrition Survey: Headline results from years 1 and 2 (combined) of the Rolling Programme (2008/2009 – 2009/2010)
[ix] Scientific Advisory Committee on Nutrition. Iron and Health. TSO (London, 2010). Available at: http://www.sacn.gov.uk/reports_position_statements/reports/sacn_iron_and_health_report.html (accessed 23/1/12)
[x] Family Food datasets available at http://www.defra.gov.uk/statistics/foodfarm/food/familyfood/datasets/ (accessed 26/1/12)
[xi] Personal communication, British Retail Consortium, 2012
[xii] Food Standards Agency June 2007 Board Paper: Improving folate intakes of women of reproductive age and preventing neural tube defects: practical issues. Available at http://www.food.gov.uk/multimedia/pdfs/fsa070604.pdf (accessed 24/1/12)
[xiii] Bates B, Prentice A, Jackson LV, Smithers G, Wenlock R & Farron M. National Diet and Nutrition Survey: Young People Aged 4 to 18 Years. TSO (London, 2000)
[xiv] Net equivalised income adjusts household income for differences in household size and composition to take account of economies of scale for two or more adults living in a household, or children, who have lower living costs
[xv] Barton K et al. Estimation of Food and Nutrient Intakes from Food Survey data in Scotland 2001-2009. Report to Food Standards Agency Scotland 2012. Available at: http://www.foodbase.org.uk/results.php?f_report_id=418
[xvi] SIMD is based on indicators within seven individual domains of current income, employment, housing, health, education, skills and training, geographic access to services and telecommunications and crime. SIMD is calculated from data zone level information based on postcode and census geographies. There are 6505 data zones covering Scotland ranked from least to most deprived
[xvii] Sheehy C. et al. Survey of sugar intake among children in Scotland. Report to Food Standards Agency Scotland. March 2008. Available at: http://www.foodbase.org.uk//admintools/reportdocuments/607-1-1097_sugarintakescot2008rep.pdf
[xviii] Henderson L, Gregory J and Swan G. National Diet and Nutrition Survey: Adults Aged 19 to 64 Years. Volume 1: Types and Quantities of Foods Consumed. HMSO (London, 2002). Available at: http://tna.europarchive.org/20110116113217/http://www.food.gov.uk/science/dietarysurveys/ndnsdocuments/ndnspreviousurveyreports/printedreportpage (accessed 30/1/12)
[xix] Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G and Clarke PC. National Diet and Nutrition Survey: People Aged 65 Years and Over. Volume 1: Report of the Diet and Nutrition Survey. TSO (London, 1998)
[xx] Gregory JR, Collins DL, Davies PSW, Hughes JM and Clarke PC. National Diet and Nutrition Survey: Children Aged 1½ to 4½ Years. Volume 1: Report of the Diet and Nutrition Survey. HMSO (London, 1995)
[xxi] Nelson M, Erens B, Bates B, Church S, Boshier T. Low Income Diet and Nutrition Survey. TSO (London:2007)
[22] Scientific Advisory Committee on Nutrition. Folate and Disease Prevention. TSO (London, 2006)
[23] Laboratory of the Government Chemist. Nutrient Survey of Flours and Grains, 2005. (Available at http://www.foodbase.org.uk//admintools/reportdocuments/438-1-773_N10022_Flours_and_grains_report.pdf [Accessed: Dec 2011]
[24] Food Standards Agency. McCance and Widdowson's The Composition of Foods, Sixth summary edition. RSC (Cambridge: 2002)
[25] Department of Health. Report on Health and Social Subjects 41: Dietary Reference Values for Food Energy and Nutrients for the United Kingdom. Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy. HMSO (London: 1991). NB: thiamin and niacin DRVS calculated using SACN EARs for energy