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Folic acid intake of the German population

Final report on the research project

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Contents

1 Introduction/Problem

Normally the neural tube closes at the end of the fourth embryonal week. If this procedure is disrupted, neural tube defects occur that differ in terms of location and severity depending on the clinical phenotype:

If the defect occurs in the spine, it is called *Spina bifida* (Latin “cleft spine”). The most common form (55%) is *Spina bifida aperta*, where the spinal cord membranes (meninges) and often parts of the myelon protrude through a fissure in the vertebral arches. Depending on whether only the meninges or the myelon have moved into a fissure, this condition is described as *meningocele* or *meningomyelocele*. The opening is almost always dorsal. Depending on the location of the defect, (thorax, lower back or sacrum) patients have an incomplete paraplegia with emptying disorders of the bladder and rectum. Supply of the lower extremities with sensitive and motory nerves is also impaired. Despite increased chances of survival as a consequence of progress in surgery techniques and antibiotic treatment only 60% of those affected survive up to two years of age. Most patients are later wheelchair bound. In the brain the most frequent form is *anencephaly* (35-45 % of all neural tube disorders) in which the cranial vault and major parts of the forebrain are missing. Affected children die before or shortly after birth. One rare cranial NTD form is *encephalocele* (brain prolapse), a ruptured protrusion of brain tissue covered by a membrane caused by a defect of the osseous skull. It may be frontal, lateral or dorsal.

Very little is known at present about the causes of NTDs. They do seem to be caused by several factors, i.e. both environmental and genetic factors are involved. Genes of the enzymes involved in folic acid metabolism like methylenetetrahydrofolate reductase (MTHFR) and genes of folate receptors and carriers have been examined for some years for their involvement in the occurrence of NTDs. In particular the polymorphism 677C-T of MTHFR is under discussion as a genetic risk factor for NTDs. Up to now there have not, however, been any clear signs of an association between polymorphisms in the genes examined and the onset of NTDs (Kalter, 2003).

Incidence of neural tube defects (NTDs)

NTDs are the most frequent congenital malformations in humans after heart defects and cleft lip and palates. The incidence of NTD at birth varies considerably around the world. Overall, in the last five decades the NTD rate has fallen in many parts of the world (Kalter, 2000). The trend towards a general decline in incidence was observed after a temporary increase in the NTD rate during and after World War Two, and since then in Germany too (Koch & Fuhrmann, 1984). Within the framework of EUROCAT (Epidemiology of the Congenital Anomalies in Europe 1980-99) a downward trend for NTD was also visible in Europe between 1980 and 1999 (EUROCAT, 2002). The exact causes are not known. It is suspected that women, even if they have not undergone any targeted folic acid prophylaxis, profit from today’s customary rich diet. Furthermore, the drop in NTDs in babies born alive can certainly be attributed to improved prenatal diagnosis techniques which make it possible for women to terminate their pregnancy when deformities are identified early on (Rankin *et al.,* 2000).

As there is no national malformation register in Germany, which also records prematurely terminated pregnancies, there is no exact information about the number of neural tube defects in this country. Regional surveys of malformations, which are regularly conducted in Mainz on the basis of the birth register and since 1980 in the federal state Saxony-Anhalt in conjunction with malformation monitoring, indicate incidences of 1.84 (CI 95 %: 1.44 - 2.33) and 1.17 (CI 95 %: 0.86 - 1.1) per 1000 births for the period 1980-99 (EUROCAT, 2002). In 2002 the incidence of NTD in the federal state Saxony-Anhalt was 0.84 per 1000 live births. It was slightly lower than the previous year (Malformation Monitoring Saxony-Anhalt, 2003).

Measures to prevent neural tube defects

Various studies have shown that an elevated periconceptional intake of folic acid, either combined with multi-vitamin supplements or on its own, can reduce the risk of NTDs (Czeizel 1995; 2000; Czeizel and Dudas 1992; Moore *et al.,* 2003; Tönz *et al.,* 1996). Up to now it has not been possible to identify by means of which mechanism folic acid is involved in the closure of the neural tube (Fleming, 2001).

A large part of the population in Germany does not reach the recommended folate intake. Because of the observed association between sufficient folic acid intake and the prevention of NTDs, it has been recommended in Germany since 1995 that women who wish or could become pregnant, take 400 µg folic acid per day as a supplement in addition to the recommended intake for the general population. They should start taking this at the latest four weeks before becoming pregnant and continue up to the end of the first trimester of pregnancy because the neural tube normally closes four weeks after conception (between day 22 and day 28 of pregnancy) or around six weeks after the first day of the last menstruation. If a woman already has a child with NTD, then the additional intake of 4 mg synthetic folic acid per day is recommended (Koletzko & von Kries, 1995). Studies show that in Germany only very few women follow the recommendation for periconceptional folic acid supplementation. What makes the situation even more difficult is that many of the pregnancies are not planned (approximately 40-50%). At the time when the neural tube closes and folic acid supplementation is recommended, many women do not yet realise they are pregnant.

Against this backdrop folic acid experts met at the then Federal Institute for Consumer Health Protection (BgVV) in 2000 in order to look at fortifying staple foods with folic acid. In order to assess the risks and benefits of a programme of this kind, BgVV/ BfR – in co-operation with the Robert Koch Institute (RKI) and the Research Institute of Child Nutrition (FKE) – conducted a project with the following objectives:

1. Drawing up of a market overview of folic acid fortified foods already on the market.

2. Review of the The German Food Code and Nutrient Data Base (BLS): integration of data from the market overview and preparation of various BLS versions in which flour fortification amounting to 100, 150 and 200 µg per 100 g flour (wheat and rye – all types) and its impact on the folic acid content of all the products made from these flours is simulated.

3. Calculations using the results of the 1998 German Nutrition Survey.

   3.1 Model calculations concerning folic acid and folate intake taking into account fortified foods.

   3.2 Model calculations including the additional assumption that flour is fortified with folic acid to varying degrees.

4. Calculations using the data from the Dortmund Nutritional and Anthropometric Longitudinally Designed Study (DONALD Study).

   4.1 Re-evaluation taking into account folic acid intake from fortified foods.

   4.2 Model calculations with the additional assumption that flour is fortified with folic acid to varying degrees.

In Chapter 2 of this report the results of the above sub-projects are presented and discussed. This is followed by an overview of the metabolism, function, requirements and hazard characterisation of folic acid (Chapter 3). Finally in Chapter 4 recommendations are made for improving folate supply for the prevention of NTDs in Germany.

The project was conducted on behalf of the Federal Ministry for Food, Consumer Protection, and Agriculture and financed from funds of the Federal Institute for Consumer Health Protection and Veterinary Medicine (BgVV) and today's Federal Institute for Risk Assessment (BfR).

2 Project Report

2.1 Market overview of foods fortified with folic acid

2.1.1 Methods

The market research institute GfK was commissioned to carry out a market analysis in order to identify foods fortified with folic acid which are currently on the market. For cost reasons the survey was restricted to the group of products *Dairy products, cereals* (not including bars) and s*oft drinks* which are frequently used for fortification with nutrients. The survey is based on data from 25 national outlets. The folic acid content of the products was identified on the basis of the list of ingredients or nutritional information. Since, however, it was not always possible to distinguish between folic acid containing and folic acid fortified products by the wording of the labels, some manufacturers were asked whether the labelled folic acid contents referred to naturally occurring or added folic acid. The folic acid containing products recorded were compared with the purchasing numbers identified for German homes from the GfK household panel “ConsumerScan”. This meant that market shares could be calculated on the basis of the products actually bought in Germany. The reference period chosen was April 2001 to March 2002.

2.1.2 Results

An overview of the products identified, their folic acid levels and their market shares can be found in the Annex (Tables A1-A6, Figures A1-A3).

According to this 45.5% of the *cereal products* purchased in Germany during the above period contained levels of folic acid between 30 and 340 µg per 100 g. Products with 167-200 µg folic acid per 100 g had the highest market shares. 1.5% of the *dairy products* purchased during the period under review had been fortified with folic acids on levels between 20 and 80 µg per 100 g whereby products with 40 µg folic acid per 100 g were the most frequently consumed ones. Out of the *soft drinks* purchased during the above period, 11% contained folic acid at levels between 7 and 200 µg per 100 ml; in the case of the lower levels, (7, 12, 15, 25 µg folic acid) this involved naturally contained folate. Soft drinks with 30, 50 and 100 µg folic acid per 100 ml were by far the most frequently purchased products.

2.2 Review of the The German Food Code and Nutrient Data Base (BLS)

In the version of the The German Food Code and Nutrient Data Base BLS II.3 currently available from 1999 (referred to below also as BLS 0), the following formula was used to calculate "free folate equivalents":

"free folate equivalents” (according to the former definition)	=	monoglutamate + 0.2 * polyglutamate
VB9	=	VB9F + 0.2 * (VB9G - VB9F)

The values for total folate (VB9G) and free folic acid or monoglutamate (VB9F) were determined analytically and from them the so-called “free folate equivalents" (VB9) were calculated. The values given in the BLS for “free folate equivalents” are not the same as the folate equivalents based on the new DGE definition (D-A-CH 2000):

1 µg Folate equivalent = 1 µg Dietary folate = 0.5 µg Folic acid

Based on the precondition that foods are not fortified, the assumption in the BLS up to now, the terms “total folate” (VB9G) from BLS 0 and “Dietary folate” or “Folate equivalent” (based on the new definition) can be equated:

Total folate (VB9G) = Dietary folate = Folate equivalent (based on the new definition)

2.2.1 Extension of the BLS to include fortified foods from the market analysis

The product categories covered by the market analysis were broken down into product groups and products (cf. Table A7 in the Annex) and the data sets were listed according to declining amounts of folic acid. Since no brand names are contained in the BLS, the results from the market survey could not be directly assigned to the food codes given in BLS[1]. That is why only food codes were used which had also been used to assess the food consumption within the framework of the 1998 Nutrition Survey. Taking into account the amounts and frequencies of consumption (“frequency list” of RKI) as well as market shares of products, and bearing in mind the formula given in section 2.2, folic acid contents of the products listed in Table A7 were added to amounts of free folic acid (VB9F) given in the BLS.

In the case of cereals and soft drinks, products with both low and high levels of fortification have relatively high market shares (cf. Fig A1 and Fig A3 in the Annex). Hence a folic acid value was introduced for these two categories of products for low and high fortification in the BLS which led to two different BLS versions:

- BLS 1: low fortification of the three product groups *Dairy products, Cereals* and *Soft drinks*
- BLS 2: high fortification of the three groups of products *Dairy products, Cereals* and *Soft drinks*

2.2.2 Extension of BLS based on the assumption that flour is fortified with folic acid

In order to be able to estimate the influence of flour fortification on folate/ folic acid intake in the model calculations, the folic acid levels chosen in the BLS for simulation (100/150/200 µg folic acid per 100 g flour) were added to the data for “free folic acid” or monoglutamate for wheat and rye (wholemeal) flours. This also automatically increased the folic acid levels in all foods manufactured from these flours. Processing losses were not taken into account.

After this extension a further six BLS versions were available for the model calculations:

- BLS 3: low fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 100 µg folic acid per 100 g
- BLS 4: high fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 100 µg folic acid per 100 g
- BLS 5: low fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 150 µg folic acid per 100 g
- BLS 6: high fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 150 µg folic acid per 100 g
- BLS 7: low fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 200 µg folic acid per 100 g
- BLS 8: high fortification of the three product categories *Dairy products, Cereals* and *Soft drinks* + fortification of flour with 200 µg folic acid per 100 g

[1] eg There are only three general codes for the various mueslis in the BLS: "Muesli", "Fruit Muesli" and "Chocolate Muesli".

2.3 Calculations based on the data from the 1998 German Nutrition Survey

The Nutrition Survey was conducted in conjunction with the German National Health Survey 1998 in order to describe the nutritional situation of the adult German population. The data collection and calculation of nutrient intake were done with the help of computer-backed interviews (DISHES). This meant it was possible to record comparable, individual consumption data (food and nutrient intake). Based on the consumption data, daily nutrient intake was calculated with the help of the BLS, Version II.3 (May 1999). 4,030 persons aged between 18 and 79 took part in the survey.

According to the results of this survey only 16% of men and 10% of women reach the intake recommended by DGE of 400 µg folate equivalents per day assuming a consumption situation with no fortified foods. In the case of men it was mainly people aged 51 and above who are below the recommendations, in the case of women it was both young women under 19 as well as older women above the age of 65 (Table 1).

Table 1: Folate intake of men and women when consuming conventional non-fortified foods [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	316	147	772	241	135	492
19 - < 25	312	142	595	235	128	546
25 - < 51	291	180	525	246	145	489
51 - < 65	281	169	463	243	146	538
> 65	260	156	477	217	140	447

2.3.1 Model calculations concerning folic acid or folate intake from fortified foods

2.3.1.1 Methods

Men and women were divided into the age groups <19 years of age, 19-<25 years of age, 25-<51 years of age, 51-<65 years of age, ≥ 65 years. The model calculations were done using the BLS versions II.3 or 0 as well as specially prepared BLS versions 1-8. Furthermore, folic acid intake from food supplements was taken into account. For each age group, the proportion of men and women reaching the recommended intake of 400 µg folate equivalents per day or exceeding the tolerable upper intake level (UL) defined by SCF for synthetic folic acid of 1 mg per day was identified.

The data in the BLS versions BLS 1 (products with a low level of fortification) and BLS 2 (products with a high level of fortification) were combined with consumption data from the 1998 Nutrition Survey. To calculate the intake of folate equivalents from fortified foods, the folic acid amounts of the fortified foods were multiplied by factor[2] 1.7 and this value was added to the amounts of dietary folate contained in the respective food (= VB9G in BLS 0[3]).

$$\text{Folate equivalent} = VB9G_{(BLS\ 0)} + 1.7 * \text{Folic acid content in fortified foods}$$

It was assumed that all individuals who eat products from the three categories, *Dairy products, Cereals* and *Soft Drinks*, *only* consume them *in fortified form.* All the results were

[2] The bioavailabilty of synthetic folic acid is roughly twice as high as that of dietary folate. In the formula used here to calculate folate equivalents, a conversion factor 1.7 is used instead of the conversion factor 2 becuase it is common knowledge that synthetic folic acid ingested in a meal compared with folic acid ingested in the form of supplements on an empty stomach, is only available to approximately 85% (Food and Nutrition Board, Institute of Medicine, 1999).

[3] As no analytical redetermination of total folate content (VB9G) was undertaken, the value from the original BLS was used.

calculated using a weighting factor which increases the representativeness of the data for the German population in 1998.

2.3.1.2 Results

Assuming that the study population only consumes slightly fortified foods (BLS 1), 46% of men and 37% of women would reach the recommended intake. In particular men aged between 25 -<51 years could improve their folate intake in this way; intake was lowest in the age group of men over 65. Young women would profit most from consuming fortified foods (more than 50% increase in intake) whereas women aged 65 and over would derive the least benefit from consuming slightly fortified foods (Table 2).

Table 2: Folate intake by men and women assuming that slightly fortified foods are consumed [µg folate equivalents/ day]

Age [year]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	441	158	899	488	206	868
19 - < 25	471	195	1009	412	177	942
25 - < 51	402	203	840	355	175	819
51 - < 65	357	187	739	339	164	747
> 65	310	166	696	275	159	586

If the study participants were to consume highly fortified foods from the same product categories (BLS 2), then 57% of men and 49% of women would reach the recommended intake. Apart from the age group >65, the median intake for men in all age groups would meet the reference value. Around 30-40 % of women of childbearing age would not reach the reference value for folate equivalents; the margin to the intake especially recommended for these women would be particularly high (Table 3).

Table 3: Folate intake by men and women assuming that highly fortified foods are consumed [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	531	158	1450	881	231	1944
19 - < 25	592	195	1862	628	197	1852
25 - < 51	487	210	1411	430	179	1336
51 - < 65	390	187	1219	391	167	1082
> 65	339	169	1154	311	161	805

2.3.2 Model calculations based on the additional assumption that flour is fortified with folic acid

2.3.2.1 Methods

The data from the BLS versions 3-8 were combined with consumption data from the Nutrition Survey. In addition to the assumption that products from the three product categories *Dairy products, Cereals* and *Soft drinks* are only consumed in fortified form, it was further assumed that foods made from wheat or rye flour are *only consumed in fortified form*. Thus, folic acid fortification of *all* wheat and rye flour types, including wholemeal flour, was simulated. Flours from other cereal grains as well as flakes and semolina (pasta products) were not included. Furthermore, it was assumed that foods enriched with low or high levels of folic acid are also consumed (on the same levels as assumed in 2.3.1).

2.3.2.2 Results

If, in addition to low product fortification, a flour fortification of 100 µg folic acid per 100 g flour is simulated (BLS 3), 91% of men and 80% of women would reach the recommended intakes. In the age group ≥ 65 years, 15% of men and 28% of women would still be below the recommended intakes under these conditions (Table 4).

Table 4: Folate intake by men and women assuming that slightly fortified foods and flour fortified with folic acid (100 µg/100 g) are consumed [µg folate equivalent/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
<19	769	395	1464	673	329	1221
19 - <25	742	359	1532	640	318	1088
25 - <51	677	375	1147	560	313	1026
51 - <65	611	352	1062	539	281	966
> 65	549	309	988	465	302	750

Assuming a high product fortification and additional flour fortification with 100 µg folic acid per 100 g (BLS 4), 92% of men and 84% of women would achieve the reference values. Particularly amongst young women <19 years, folate intake would increase considerably; in this age group the 5th percentile of intake would already correspond to recommended intake; the 95th percentile of intake would be 560% of the recommendations (Table 5).

Table 5: Folate intake by men and women assuming that highly fortified foods and flour fortified with folic acid (100 µg/100 g) are consumed [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	797	395	2011	933	414	2265
19 - < 25	942	380	2161	819	343	2047
25 - < 51	762	387	1696	629	328	1589
51 - < 65	664	359	1507	587	291	1270
> 65	588	321	1459	509	302	934

If flour was to be fortified with 150 µg folic acid per 100 g and, furthermore, slightly fortified foods were consumed from the three product categories (BLS 5), 96% of men and 91% of women would reach the recommended intakes (Table 6).

Table 6: Folate intake by men and women assuming that slightly fortified foods and flour fortified with folic acid (150 µg/100 g) are consumed [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	870	523	1733	727	388	1322
19 - < 25	901	423	1608	724	367	1207
25 - < 51	808	442	1343	648	356	1131
51 - < 65	729	405	1213	631	322	1085
> 65	663	364	1114	557	367	859

The additional consumption of highly fortified foods from the three product categories (BLS 6) would mean that 97% of men and 92 % of women would achieve the recommended intakes. The median intake would be up to 200% and the 95th percentile would be up to 600% of recommended intakes. The 5th percentile of intake for almost all men and, more particularly, young women would already correspond to the recommended intake (Table 7).

Table 7: Folate intake by men and women assuming that highly fortified foods and flour fortified with folic acid (150 µg/100 g) are consumed[µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	954	523	2290	957	473	2420
19-< 25	1074	454	2329	923	407	2141
25-< 51	895	456	1844	726	383	1696
51-< 65	787	437	1617	681	325	1357
> 65	683	381	1563	591	367	1047

Assuming fortification of flour with 200 µg folic acid per 100 g and additional consumption of other slightly fortified foods, 98% of men and 95.5% of women would reach the recommended intakes (Table 8).

Table 8: Folate intake of men and women assuming that slightly fortified foods and flour fortified with folic acid (200 µg/100 g) are consumed [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	976	578	1999	818	445	1471
19 - < 25	1030	471	1802	816	423	1350
25 - < 51	921	504	1529	740	402	1256
51 - < 65	842	454	1360	718	364	1209
> 65	764	435	1286	643	427	961

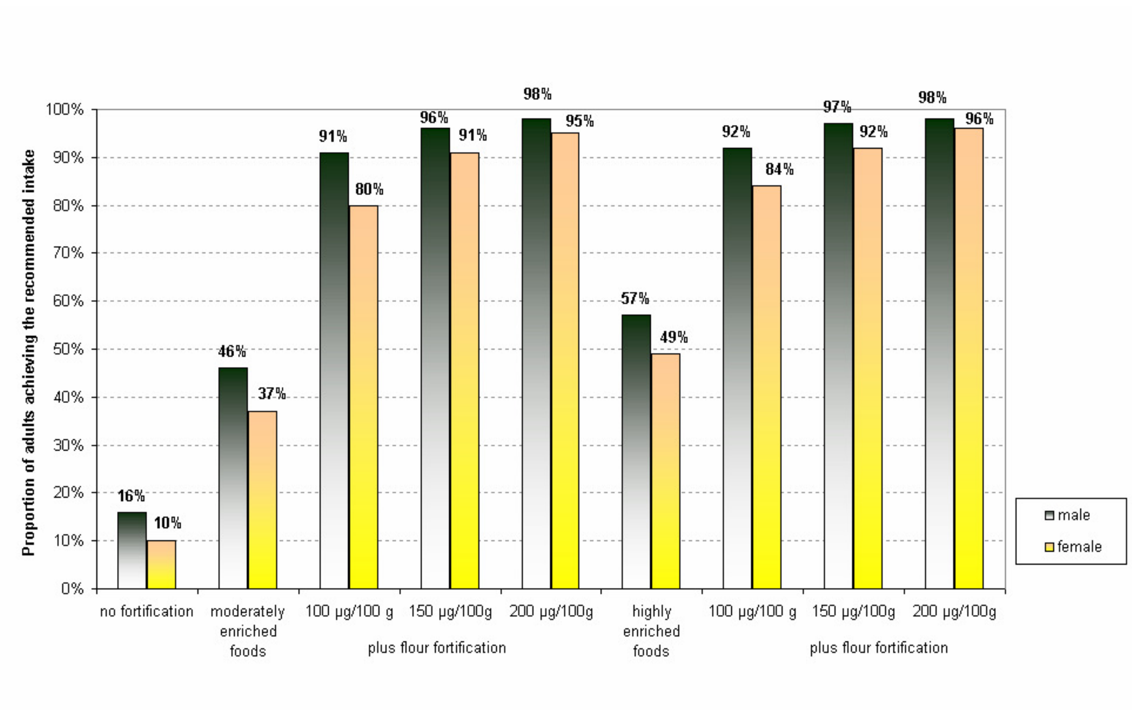
Particularly if highly fortified foods were to be consumed in addition to flour fortified with 200 µg folic acid per 100 g, the median intake for young women and men (<19-25 years of age) would be more than 1000 µg folate equivalents per day. The 95th percentile of intake would amount to more than 2000 µg folate equivalents per day in these age groups (Table 9).

Table 9: Folate intake of men and women assuming that highly fortified foods and flour fortified with folic acid (200 µg/100 g) are consumed [µg folate equivalents/ day]

Age [years]	Men			Women		
	Median	P 5	P 95	Median	P 5	P 95
< 19	1139	650	2425	1020	546	2569
19 - < 25	1195	522	2509	1037	468	2283
25 - < 51	1014	523	1981	822	427	1803
51 - < 65	895	493	1723	778	364	1502
> 65	790	443	1695	677	427	1128

The following diagram shows the percentages of the population that reaches the recommended intakes in the various fortification scenarios (cf. also Annex, Tables A8-A16).

Fig. 1: Proportion of the study population in the Nutrition Survey with folate intakes in line with the DGE reference value, assuming that slightly or highly fortified foods are consumed in addition to flour fortified with levels of 100, 150 and 200 µg folic acid per 100 g



The proportion of individuals reaching the recommended folate intake would increase by 30 percentage points for men and 27 percentage points for women if slightly fortified foods were consumed instead of unfortified foods. It would increase by a further 11 and 12 percentage points respectively if highly fortified foods from the three product categories were consumed instead of slightly fortified foods.

Assuming that folic acid fortified flour (100 µg/100 g) were used, besides the consumption of other slightly fortified foods, the proportion of individuals reaching the recommended intakes would increase for men from 46 to 91% and for women from 37 to 80%. If highly fortified foods were consumed besides the use of folic acid fortified flour (100 µg/100 g), 92% of men and 84% of women would reach the recommended intake (increase by 35 percentage points).

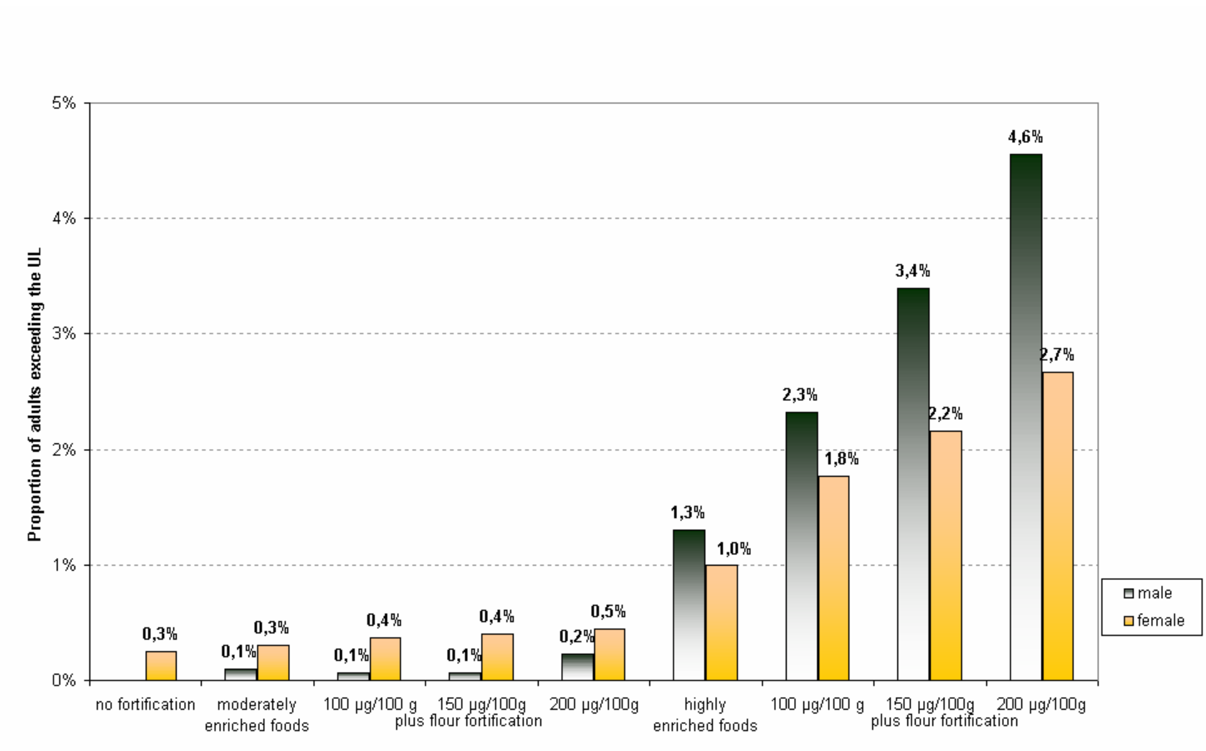
Exceeding the tolerable upper intake level (UL)
When considering the possible adverse effects of high intakes of folic acid, it should be borne in mind that the EU Scientific Committee on Food (SCF) derived a tolerable upper intake level for folic acid of 1 mg per day for adults (SCF, 2000) based on a LOAEL of 5 mg/ day and an uncertainty factor of 5 (because no NOAEL could be determined). The UL also applies to pregnant and breastfeeding women.

Assuming that no fortified foods are consumed, no men and 0.3% of women (5 people in the random sample aged between 25 and 65) exceed the UL. The exceedance in these cases is attributable to the ingestion of folic acid-containing food supplements.

If only slightly fortified products from the three product categories are consumed, only 0.1% of men and 0.3% of women (age group 25-<51 years of age) would be above the UL for folic acid. The share of the population with a folic acid intake > 1 mg per day would increase slightly if folic acid fortified flour were used, too.

If one assumes that only highly fortified products from the three product categories are consumed, then 1.3% of men (particularly aged between 25-<51 years) and 1% of women (particularly in the age group up to 25) would ingest more than 1 mg folic acid per day. Assuming that folic acid fortified flour is used in addition, the proportion of the population exceeding the UL for folic acid would increase by up to 4.6% depending on the fortification level of the flour. The following diagram shows the percentage of the population that would exceed the UL for folic acid taking into account the various fortification scenarios.

Fig 2: Proportion of the study population in the Nutrition Survey achieving folic acid intakes above the UL assuming that fortified foods are consumed and that flour is fortified, too



The figure clearly shows that the use of fortified flour plus the consumption of slightly fortified other foods would scarcely lead to the UL being exceeded. The proportion exceeding the UL would be below 0.5% even in the case of the higher flour fortification levels. If, however, in addition to fortified flour, highly fortified foods were consumed, the percentage of those exceeding the UL would increase by up to 2.7% (women) and 4.6% (men) depending on the fortification level of the flour.

Figures 3 and 4 give the proportion of the study population with folic acid intakes above the UL broken down by age group (cf. also Tables A8-A16 in the Annex).

Fig 3: Proportion of men in the various age groups with folic acid intakes above the UL assuming that fortified foods are consumed in addition to the fortification of flour

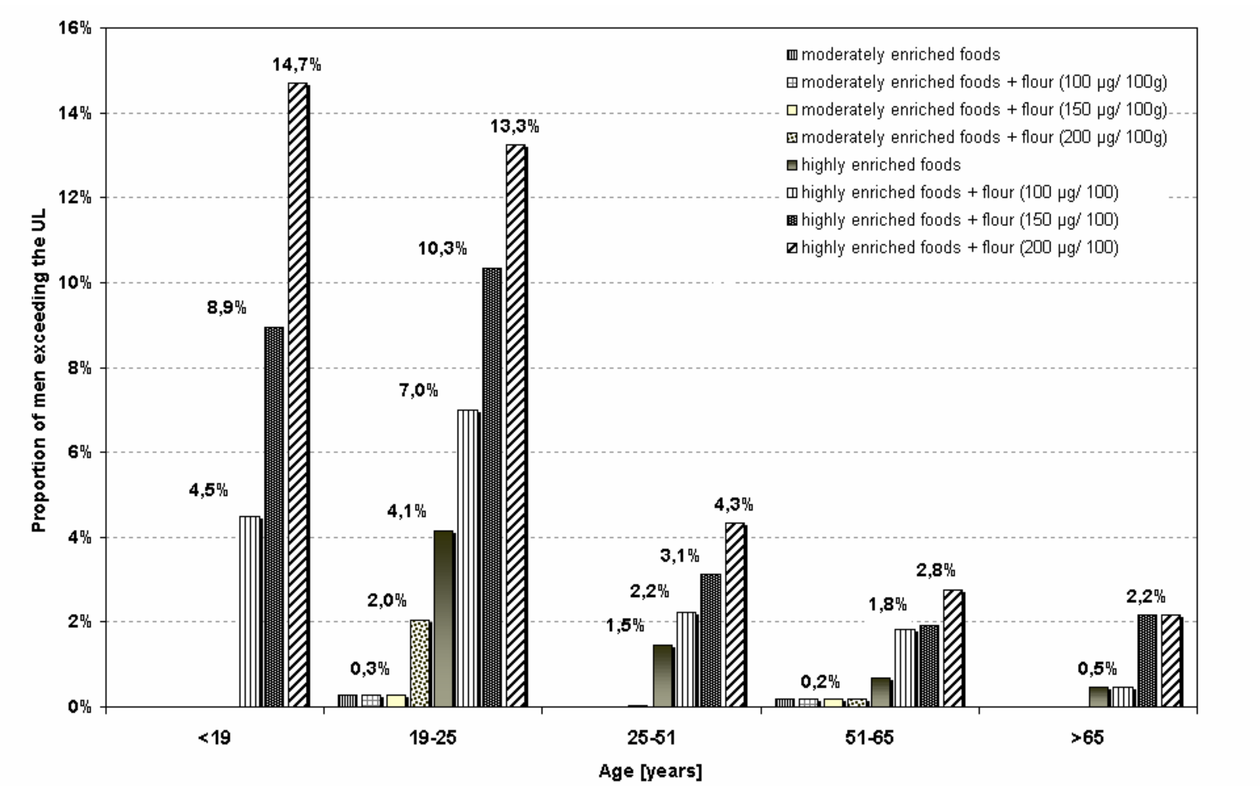
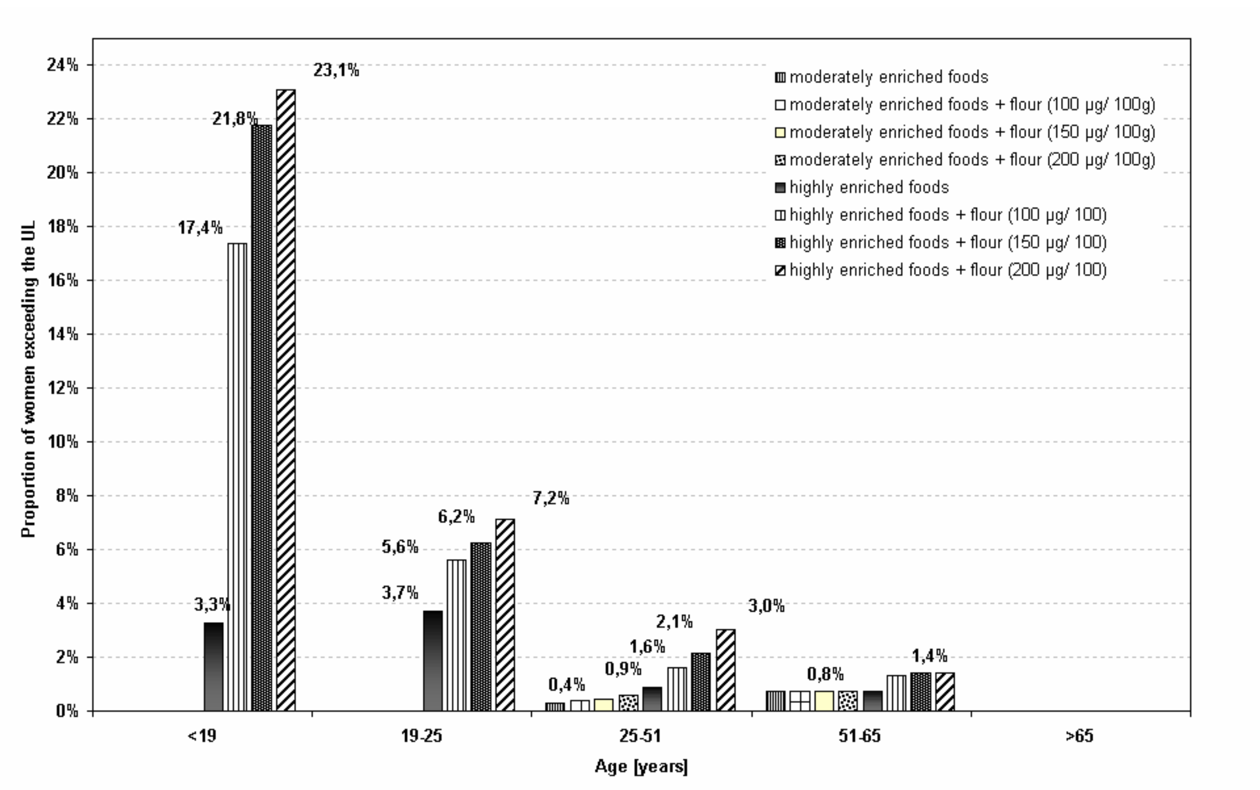


Fig 4: Proportion of women in the various age groups with folic acid intakes above the UL assuming that fortified foods are consumed in addition to the fortification of flour



People aged between 19 and 25 would most frequently exceed the UL for folic acid. Since Vitamin B_{12} malabsorption (and pernicious anaemia), whose symptoms could be masked through the intake of high levels of folic acid, normally occurs in older age groups, special attention was paid in these groups to a possible exceeding of the UL.

Based on the calculations maximum 0.8% of people aged 50 upwards would achieve folic acid intakes above the UL if, in addition to fortified flour, only slightly fortified other foods were consumed. If it is assumed that highly fortified foods are consumed in addition to flour fortified with folic acid, then in the age groups 50 upwards up to 2.8% would exceed the UL for folic acid. Women >65 would not ingest folic acid levels above the UL in any of the fortification scenarios.

2.3.3 Summary of the results

The following table gives an overview of the proportion of the adult population not reaching the reference values for folate equivalents or exceeding the UL for folic acid through their normal diet (not taking into account foods fortified with folic acid) and under the assumption of various fortification scenarios. The proportion of people aged 51 and over, who exceed the UL for folic acid, is presented separately.

Table 10: Proportion of the adult population who do not achieve the median recommended intakes, taking into account the various fortification scenarios, as well as the proportion of adults whose folic acid intake would exceed the UL for folic acid under the given conditions

Fortification scenarios	Men			Women		
	Median folate equivalent intake [µg/d]	< 400 µg Folate equivalent intake/ day [%]	> 1000 µg Folic acid/ day [%]	Median folate equivalent intake [µg/d]	< 400 µg Folate equivalent/ day [%]	> 1000 µg Folic acid/ day [%]
No fortification (BLS 0)	260-316	84	0	217-246	90	0.3
Low fortification (BLS 1)	310-470	54	0.1 (> 51 y.: 0.2%)	275-488	63	0.3 (> 51 y.: 0.8%)
High fortification (BLS 2)	339-592	43	1.3 (> 51 y.: 0.7%)	311-881	51	1.0 (> 51 y.: 0.8%)
Low fortification + fortified flour (100 µg/100 g) (BLS 3)	549-769	9	0.1 (> 51 y.: 0.2%)	465-673	20	0.4 (> 51 y.: 0.8%)
High fortification + fortified flour (100 µg/100 g) (BLS 4)	588-942	8	2.3 (> 51 y.: 1.8%)	509-933	16	1.8 (> 51 y.: 1.3%)
Low fortification + fortified flour (150 µg/100 g) (BLS 5)	663-901	4	0.1 (> 51 y.: 0.2%)	557-727	9	0.4 (> 51 y.: 0.8%)
High fortification + fortified flour (150 µg/100 g) (BLS 6)	683-1074	3	3.4 (> 51 y.: 2.2%)	591-957	8	2.2 (> 51 y.: 1.4%)
Low fortification + fortified flour (200 µg/100 g) (BLS 7)	764-1030	2	0.2 (> 51 y.: 0.2%)	643-818	5	0.5 (> 51 y.: 0.8%)
High fortification + fortified flour (200 µg/100 g) (BLS 8)	790-1195	2	4.6 (> 51 y.: 2.8%)	677-1037	4	2.7 (> 51 y.: 1.4%)

The data indicate that the fortification of flour with 150 µg folic acid per 100 g in addition to the consumption of fortified foods from the three product categories *Cereals, Dairy products* and *Soft drinks* would lead to more than 90% of the adult study population achieving the reference value of 400 µg folate equivalents per day. Under these conditions maximum 3.4% of the study group would exceed the UL for folic acid. In none of the scenarios discussed here would the median intake of folate equivalents for women achieve the special reference values for early pregnancy (1200-1400 µg folate equivalents[4] per day).

2.4 Calculations based on the data from the DONALD Study

2.4.1 Fortified foods and food supplements in the LEBTAB database of the Research Institute of Child Nutrition, Dortmund

In the DONALD Study (Dortmund Nutritional and Anthropometric Longitudinally Designed Study) which was launched in 1985 at the Research Institute of Child Nutrition (FKE), diet, metabolism, growth and development are examined in healthy infants, children and adolescents aged between 3 months and 18 years in a longitudinal manner (Kroke *et al.,* 2004).

For the evaluation of the diet logs of the participants in the DONALD Study, the FKE set up its own food and nutrient database LEBTAB which encompasses information on the energy and nutrient levels of around 5,000 foods, dishes and recipes as well as food supplements (2003). The database also contains information on fortified foods. It is continuously updated with products mentioned in the logs from the participants of the food consumption survey (approximately one product per 3-day-record). The folic acid levels in the products are taken from nutrition labelling which means that no distinction could be made between natural folate contents and added folic acid. The native folate contents are however generally so low that the errors caused by this are probably negligible.

In the Annex (Tables A17-A25) all the foods containing or fortified with folic acid are listed in declining frequency of mentions in the records together with the respective folic acid levels [µg per 100 g product or per serving size] and the food code from LEBTAB. In total 644 different products were identified which could be classed in the following eight product groups: (1) soft drinks, (2) dairy products, (3) cereals, (4) infant formula (= milk for infants and young children and complementary food), (5) juices, (6) beverage powder, (7) sweets, and (8) food supplements.

In the logs infant formula fortified with folic acid was mentioned the most frequently (44%) followed by cereals (20%), and soft drinks (11%). In 75% of the soft drinks, dairy products and infant formula, the folic acid levels were below 100 µg/100 g. The majority of cereals, juices and food supplements contained less than 200 µg folic acid per 100 g or daily dose whereas beverage powder and sweets were found to have higher folic acid levels (150-650 µg and 200-1300 µg per 100 g).

2.4.2 Reassessment taking into account folic acid intake from fortified foods

The calculation of folate/ folic acid intake taking into account fortified foods was conducted for the DONALD study group on the basis of consumption data from 3-day weighed records. 1990 - 2001 was selected as the evaluation period for the purposes of these model calculations. In total 6,135 food logs from 861 individuals (47% boys, 53% girls) were available for evaluation, i.e. on average each person supplied seven logs.

[4] This recomended intake results from the DGE reference value for adult women (400 µg/day) and for pregnant women (600 µg/day) and the recomendation of periconceptional supplementation of an additional 400 µg folic acid per day (= 800 µg folate equivalents).

2.4.3 Methods

As already outlined above, the nutrient levels of the (fortified) foods were taken from the labels on the products. Folate equivalents were calculated using the following formula[5]:

Folate equivalents = 1.7 * indicated folic acid amount [µg]

The intake amounts were broken down into 1) dietary folate from normal diet, 2) folic acid from fortified foods and 3) folic acid from food supplements. A separate evaluation was done for consumers and non-consumers of fortified foods or supplements. For the DONALD population the amounts of fortified foods consumed are known from the survey logs.

2.4.4 Results

Depending on age the use of foods fortified with folic acid shifts from infant formula in infants (6-12 months) and children under the age of 2, to cereals which are consumed two to three times more frequently by the younger age groups than the older children and adolescents. Fortified soft drinks and juices make the largest contribution in terms of volume of all fortified foods to the folic acid supply of children and adolescents. The number of consumers of fortified foods is relatively small in the individual age groups and the amounts consumed (with the exception of infant formula) are also relatively low in the overall group. Only in the case of soft drinks do they exceed a mean value of 30 ml per day amongst 15-18 year old boys.

Tables of summarised results are presented below for the individual sub-sections. A comprehensive presentation of the results is given in Tables A26-A33 in the Annex.

a) Non-consumers
The mean value of folate intake increases amongst those who do not eat any fortified foods or food supplements from 70 µg/day (66 µg/day) in the case of male (female) infants to 187 µg/day (155 µg/day) amongst 15-18 year old boys (girls). The recommended intakes are not achieved by any of the age groups aside from infants, not even at the 90th percentile. In all age groups folate intake is around 50% lower than amongst those who consume fortified products. The following table gives the median values and the 5th and 95th percentiles of folate intake for the various age groups compared with recommended intakes.

Table 11: Folate intake by children and adolescents who do not eat any fortified foods and/or food supplements [µg/day]

Age [Years]	Male			Female			Recommended intake
	Median	P 5	P 95	Median	P 5	P 95	
< 1	65	35	121	62	40	110	80
1	85	50	160	82	49	131	200
2 - 3	87	52	145	84	53	122	200
4 - 6	103	57	169	97	57	152	300
7 - 9	126	76	201	118	71	195	300
10 - 12	142	90	251	129	73	192	400
13 - 14	159	93	267	139	81	260	400
15 - 18	184	103	291	143	72	268	400

b) Consumers
The folate intake of children and adolescents who eat fortified foods is two times higher than that of those who do not eat these foods. The mean value of folate intake increases from 123 µg/day (120 µg/day) in male (female) infants to 429 µg/day (350 µg/day) amongst 15-18

[5] By way of comparison: in the case of the calculations using data from the Nutrition Survey, the following formula was applied: *folate equivalents =* dietary folate *+ 1.7 * folic acid.*

year old boys (girls). Irrespective of age and gender foods fortified with folic acid account for 50% and food supplements for 8% (in 15-18 year olds) of folate intake from all sources. The following table gives an overview of folate intakes amongst consumers of fortified foods and food supplements compared to the recommended intakes for this vitamin.

Table 12: Folate intake of children and adolescents who eat fortified foods and/ or food supplements [µg folate equivalents/ day]

Age [Years]	Male			Female			Recommended intake
	Median	P 5	P 95	Median	P 5	P 95	
< 1	109	60	248	100	58	266	80
1	119	67	363	111	67	236	200
2 - 3	144	68	461	143	73	385	200
4 - 6	191	95	562	168	92	461	300
7 - 9	224	125	539	200	105	623	300
10 - 12	274	155	800	249	119	823	400
13 - 14	294	149	843	286	127	575	400
15 - 18	370	156	948	276	141	753	400

The majority of children aged between 1 and 12 (P 75), who eat fortified foods, reach intake values close to the recommendations. For some of the group aged 13-18 years (boys more frequently than girls) the intakes are higher than the recommendation. For infants the 25th percentile of folate intake is already above the recommended intakes (Figures 5 and 6).

Fig 5: Folate intake not taking into account food supplements for *boys* aged between 6 months and 18 years, broken down by consumers and non-consumers of foods fortified with folic acid

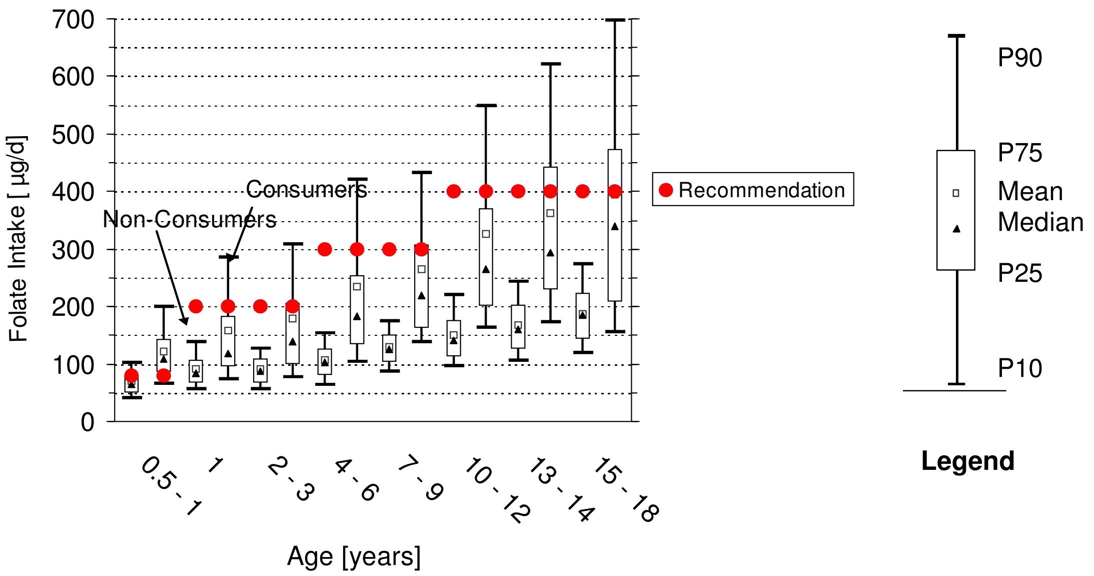
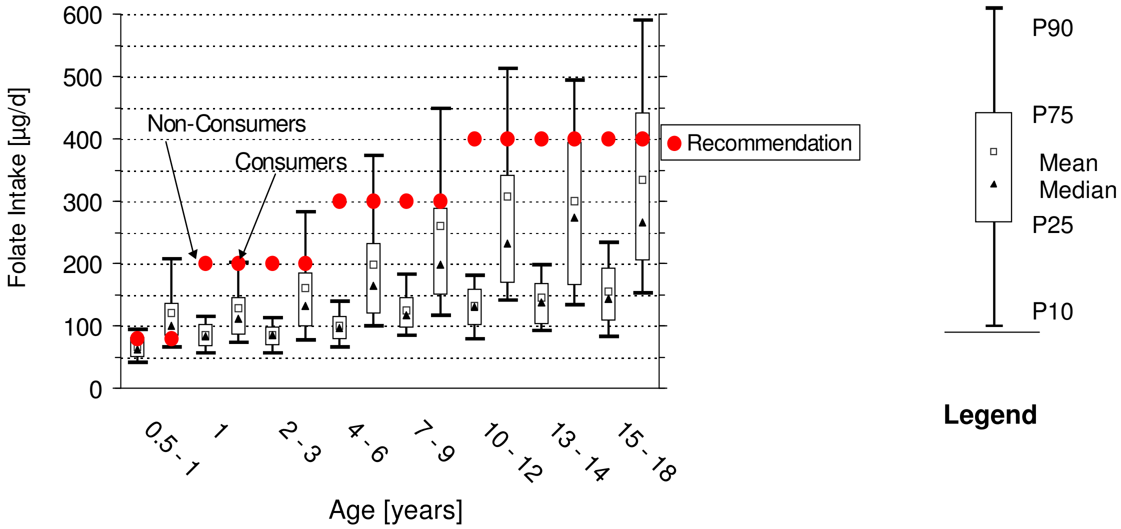


Fig 6: Folate intake not taking into account food supplements for *girls* aged between 6 months and 18 years, broken down by consumers and non-consumers of foods fortified with folic acid



Examination for longer-term trends revealed a significant but albeit low increase in the contribution of foods fortified with folic acid to total intake of this vitamin of around 0.3% per year ($p < 0.0207$) taking into account the ingestion of food supplements or by 0.25% per year ($p < 0.0493$) when ignoring folic acid intake from food supplements. The contributory factors age and gender examined at the same time in the model are not statistically significant [$p < 0.1791$ resp. $p < 0.2151$] if one also takes into account the ingestion of food supplements. If one ignores the taking of food supplements then the influence of age ($p < 0.0371$) is statistically significant, i.e. with growing age the contribution of fortified foods to folate intake falls; gender ($p < 0.2011$) has no significant effect.

2.4.5 Evaluation based on the assumption that flour is fortified with a high level of folic acid

2.4.5.1 Methods

For the age groups 1 to 18 years of age, too, the contribution was estimated that folic acid fortification of wheat and rye (wholemeal) flours at various fortification levels (100/150/200 µg folic acid per 100 g flour) could make to folate intake. Again, flours from other cereal grains as well as flakes and semolina (pasta products) were not taken into account. The amounts of flour consumed were taken from the food logs; the flour proportions in processed foods (e.g. bread, biscuits, ready to eat dishes) were calculated. As flour was mentioned in 96% of the logs, no distinction was made in the calculations between consumers and non-consumers. In order to estimate the folic acid amount per day which could potentially be achieved through fortified flour, the daily portion of flour was multiplied by the respective fortification level (100/150/200 µg folic acid per 100 g). Processing losses were not taken into account. The possible folate equivalent intake from fortified flour was added to the dietary folate intake per day from a normal diet.

2.4.5.2 Results

Only around 10-15% of the flour consumed was clearly indicated in the food logs of the study participants as wheat or rye (wholemeal) flour. Most came from products manufactured with these flours as an ingredient (e.g. bakery goods). Overall, far more wheat (approximately 90%) was used than rye flour (approximately 10%) and flour with a low degree of fineness (approximately 95-90%) was preferred over wholemeal flour (approximately 5-10 %). In all age groups boys eat more flour than girls. Hence the total amount of flour consumed increased on average from 12 g (9 g) amongst the male (female) infants to 105 g (71 g) amongst the 15-18 year old boys (girls) per day. Whereas the consumption of flour steadily increased amongst the boys as they grow older, the girls plateau at age 10 (approximately 70 g/day). Referred to the protein level 65 g flour corresponds to around 100 g mixed wheat-rye bread.

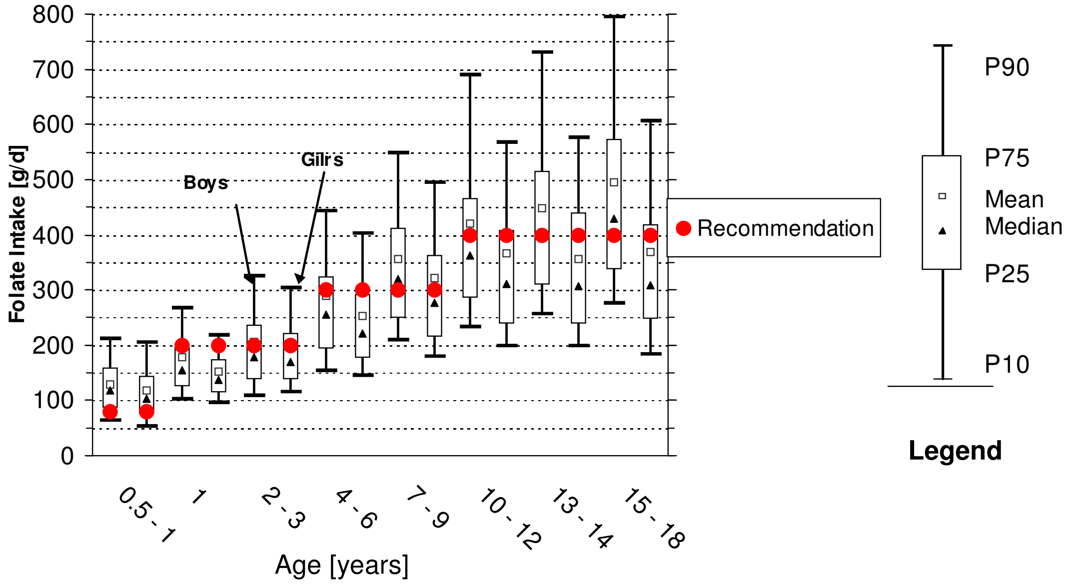
a) Folate intake

If wheat and rye (wholemeal) flour was generally fortified with 100 µg/100 folic acid, the folate intake of infants would increase by around 15%. For 1 year olds it would increase by around 40% and for older children and adolescents irrespective of gender by around 50-55% compared to a conventional diet. 75% of infants would exceed the recommended folate intake. The majority of 1-6 year old girls and boys and 7-18 year old girls would still not achieve the recommended intakes. The median intake for 7-18 year old boys would be close to the recommended intake; in the case of 15-18 year olds it would already be above it. The 90th percentile of folate intake would be above the recommendations in all age groups (amongst infants by around 150%, in the case of 2-3 year old boys and girls and 10-18 year old girls by around 50% and for 10-18 year old boys by around 90-100%) (Table 13 and Figure 7).

Table 13: Folate intake of children and adolescents assuming that flour is fortified with 100 µg folic acid per 100 g [µg folate equivalent/ day]

Age [Years]	Male			Female			Recommended intake
	Median	P 5	P 95	Median	P 5	P 95	
< 1	119	51	252	104	46	245	80
1	154	90	329	138	87	257	200
2 - 3	178	99	416	169	103	377	200
4 - 6	254	133	577	221	127	483	300
7 - 9	320	188	636	276	161	634	300
10 - 12	361	205	831	310	173	731	400
13 - 14	396	224	853	307	180	656	400
15 - 18	429	224	1027	309	161	781	400

Fig 7: Folate intake of children and adolescents taking into account flour fortified with folic acid (100 µg/100 g)

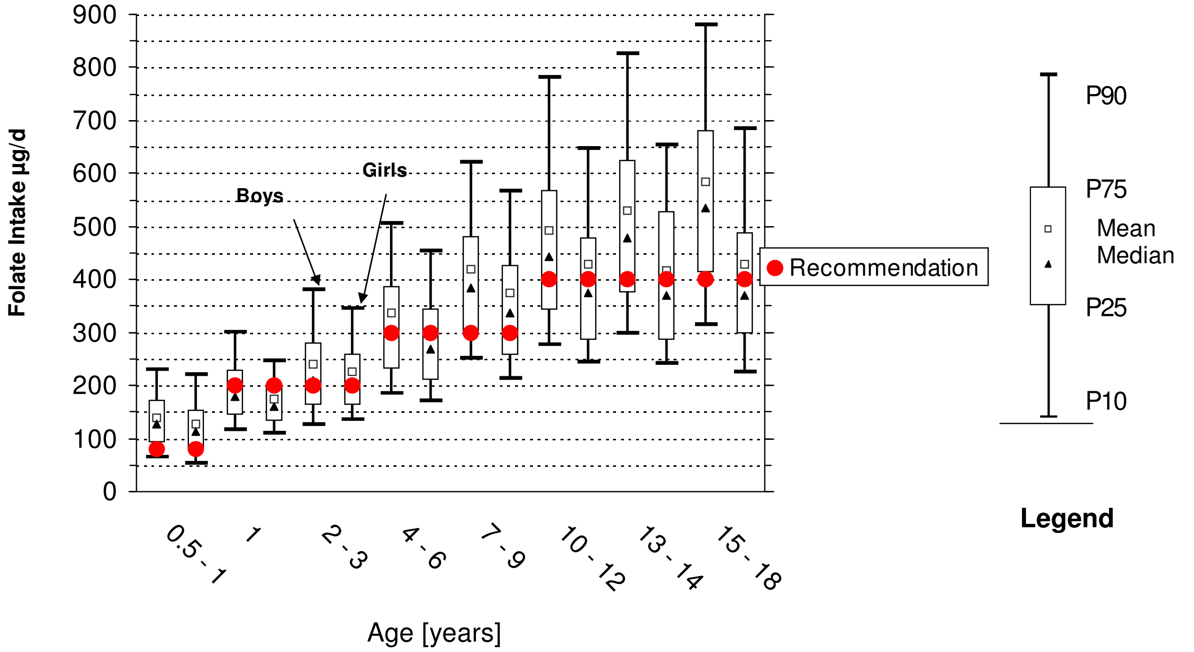


Assuming a folic acid fortification of rye and wheat flour with 150 µg/100 g flour, the average folate intake would increase steadily from 139 (127) µg/day amongst male (female) infants to 585 (429) µg/day amongst 15-18 year old boys (girls). The mean intake of infants would then increase by around 25%, of 1 year olds by around 60% and of older children and adolescents irrespective of gender by around 70-80 % compared with folate intake from a conventional diet with no fortification. The median folate intake for girls in all groups would be below the recommendations except for infants and 2-6 year olds. For boys the median would be above the recommendations in all age groups except for 1 year olds (Table 14 and Figure 8).

Table 14: Folate intake of children and adolescents assuming that flour is fortified with 150 µg folic acid per 100 g [µg folate equivalent/ day]

Age [Years]	Male			Female			Recommended intake
	Median	P 5	P 95	Median	P 5	P 95	
< 1	128	52	258	113	46	262	80
1	178	101	356	159	89	279	200
2 - 3	211	115	456	203	119	410	200
4 - 6	303	156	625	269	146	543	300
7 - 9	385	227	717	336	189	684	300
10 - 12	444	244	931	375	210	811	400
13 - 14	478	264	986	370	216	729	400
15 - 18	534	272	1092	369	188	861	400

Fig 8: Folate intake of children and adolescents taking into account flour fortified with folic acid (150 µg/100 g)

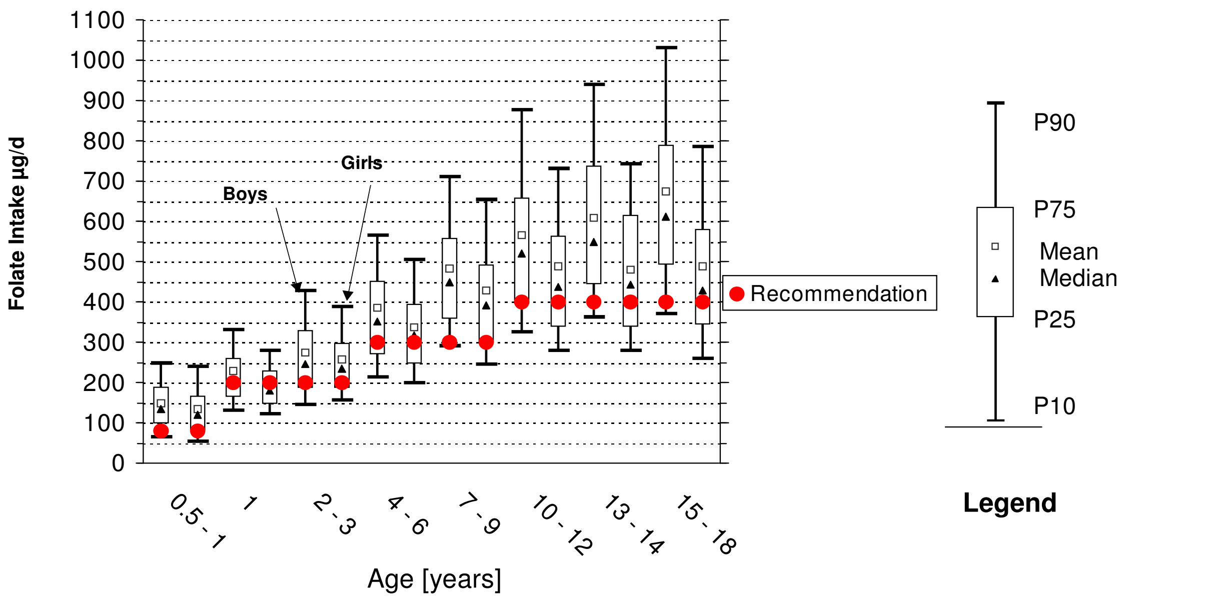


Assuming a folic acid fortification of rye and wheat flours with 200 µg/100 g flour, folate intake would increase on average from 149 µg/day (134 µg/day) amongst male (female) infants to 674 µg/day (490 µg/day) amongst 15-18 year old boys (girls). Compared with normal food consumption the folate intake of infants would increase by around 30%, amongst 1 year olds by around 80% and amongst older children and adolescents irrespective of gender by around 90-110%. The mean folate intake of 1 year olds and 4-6 year old children and of 10-18 year old girls would correspond to the recommended intakes. Amongst infants and boys aged 2-3 and 7-18, 75% of the participants would be above the recommendations. 10% of the various age groups would exceed the recommended intakes by around 210% (infants), 100% (2-3 year olds), 90% (10-18 year old girls) and 150% (15-18 year old boys) (Table 15 and Figure 9).

Table 15: Folate intake of children and adolescents assuming that flour is fortified with 200 µg folic acid per 100g [µg Folate equivalent/ day]

Age [years]	Male			Female			Recommended intake
	Median	P 5	P 95	Median	P 5	P 95	
< 1	135	53	276	120	46	280	80
1	203	113	388	179	108	316	200
2 - 3	245	127	515	236	136	449	200
4 - 6	352	179	685	318	166	596	300
7 - 9	449	256	811	391	215	762	300
10 - 12	519	279	1043	437	244	882	400
13 - 14	550	295	1083	442	249	789	400
15 - 18	612	320	1240	427	223	930	400

Fig 9: Folate intake of children and adolescents taking into account flour fortified with folic acid (200 µg/100 g)



b) Folic acid intake

The following table gives an overview of the median folic acid intake in the various age and gender groups assuming that wheat and rye (wholemeal) flour is fortified at various concentrations (100/150/200 µg folic acid per 100 g flour).

Table 16: Fold acid intake [µg/day] of children and adolescents assuming that flour is fortified with 100/150/200 µg folic acid per 100 g (medians)

Age [years]	Male			Female			Tolerable upper intake level (UL)
	100 µg	150 µg	200 µg	100 µg	150 µg	200 µg	
	per 100 g			per 100 g			
< 1	8	12	17	5	8	11	-
1	27	41	54	25	37	50	200
2 - 3	36	54	72	35	22	69	200
4 - 6	54	80	107	47	71	95	300
7 - 9	71	107	143	60	89	119	400
10 - 12	82	123	164	68	103	137	600
13 - 14	90	135	180	71	107	142	600
15 - 18	100	151	201	65	98	131	800

The median values of folic acid intake from fortified flour depending on age are between 5 and 100 µg per day for a fortification level of 100 µg folic acid per 100 g. If flour were fortified with 150 µg folic acid per 100 g, there would be a median intake of between 12 and 150 µg and in the case of the highest simulated fortification level (200 µg/100 g) of between 17 and 201 µg folic acid per day.

Exceeding the tolerable upper intake level (UL)

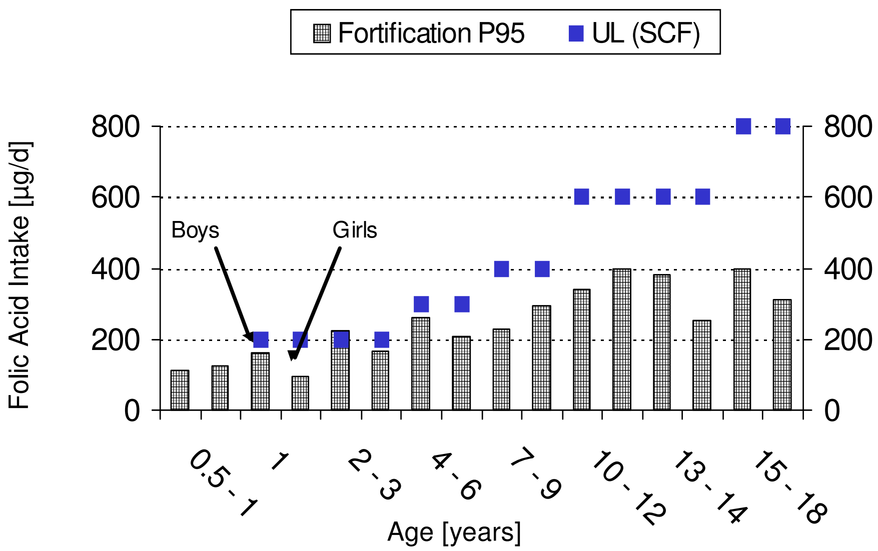
No data are available on the long-term effects of highly dosed folic acid administration to infants. Hence SCF recommended that this group's folate intake should be solely from conventional food. The ULs for children and adolescents, which are lower than for adults, have been derived by extrapolation from the UL for adults on the basis of relative body weight (SCF, 2000):

Age [years]	UL [µg/d]
1 - 3	200
4 - 6	300
7 - 10	400
11 - 14	600
15 - 17	800

Folic acid intake from flour, even in the event of high consumption of flour-containing foods (P 95), would not lead in any of the age groups of children and adolescents to the respective UL for folic acid being exceeded even when a fortification level of 200 µg folic acid per 100 g flour is simulated.

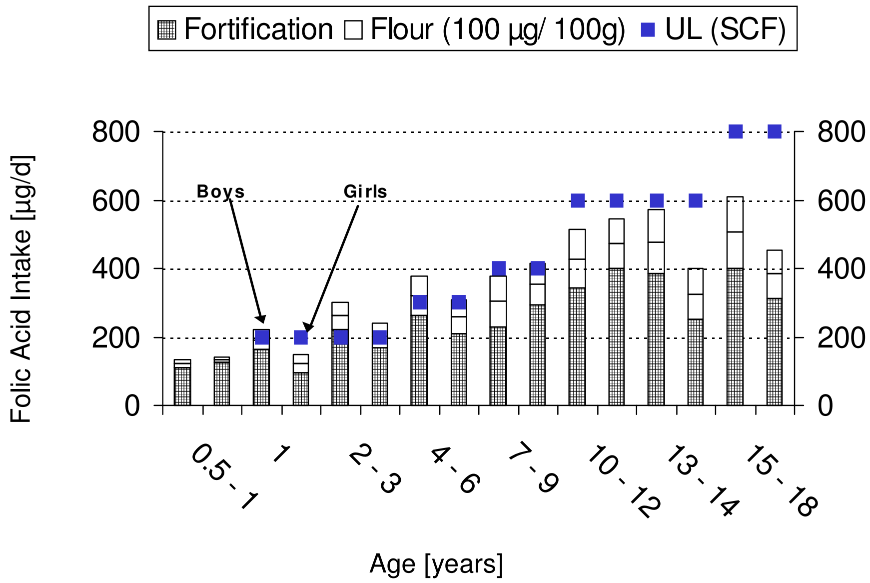
By contrast, the high consumption of fortified foods (P 95) even without additional fortification of flour, would lead to some 2-3 year old boys ingesting amounts of folic acid above the UL (Figure 10). The 1 year old boys, the 2-3 year old girls and 4-6 year old boys would come closer to the UL under these conditions. In the case of older children and adolescents the margin to the UL is still relatively high (approximately 200-400 µg folic acid). It is, therefore, unlikely that they would exceed the UL.

Fig 10: Margin to the UL in the various age groups in conjunction with high consumption of foods fortified with folic acid (P 95)



If large amounts of fortified foods for general consumption (P 95) and moderate amounts of foods produced from highly fortified flour (200 µg/100 g) were to be consumed, then according to the calculations the UL is likely to be exceeded particularly by younger children up to age 9 (Figure 11). Amongst 10-12 year old girls and 13-14 year old boys the amount of folic acid ingested would be close to the UL whereas in the other groups the margin to the UL would still be between 200 and 400 µg.

Fig 11: Margin to the UL in the various age groups in conjunction with the high consumption of foods fortified with folic acid (P 95) and the additional assumption that moderate amounts of highly fortified flour (200 µg/100 g) are consumed



The results show that foods for general consumption voluntarily fortified with folic acid would tend to lead more to the UL being exceeded by children and adolescents than the fortification of flour and the consumption of foods made from it.

2.5 Discussion

In Germany up to now no authorisation was required for the fortification of foods for general consumption with folic acid. As many manufacturers have used this option in recent years, there is now a wide range of foods enriched with folic acid on the market. The model calculations undertaken here were used to estimate for the first time in Germany, both for the adult population and for children and adolescents, the contribution which foods fortified with folic acid could make to meeting folate requirements. They were also used to estimate the impact of nationwide flour fortification on the folate intake of the population.

2.5.1 Results of the model calculations based on the 1998 German Nutrition Survey

Against the backdrop of the wide offering of foods fortified with folic acid, which could not be taken into account in the 1998 Nutrition Survey, it is possible that folate intake was under-estimated at that time for part of the population (those people who eat fortified foods).

The results of the model calculations show that the consumption of foods fortified with folic acid, particularly amongst young age groups in the adult population (<19 and 19-25 years), would lead to an increase in folate intake. This is due to the frequent consumption of foods from the three product categories *Dairy products, Soft drinks* and *Cereals.* Although we do not know what proportion of the adult population consumes foods fortified with folic acid, and at what levels adults eat these products, the model calculations do show that even in the case of the consumption of highly fortified foods as part of a normal diet, it would not be possible to achieve a predictable increase of folate intake sufficient to meet the reference value in the total population. On the other hand, it cannot be ruled out that parts of the population would exceed the UL for folic acid when they eat these foods.

By contrast, the additional use of fortified flour already at the lowest flour fortification level (100 µg/100 g) would lead to the 5^{th} percentile of intake roughly reaching the recommendation of 400 µg folate equivalents per day. However, no model calculations were undertaken which would permit any comments about folate/ folic acid intake if, aside from flour, no other fortified foods were to be consumed.

The model calculations involved various assumptions. This means that the potentially possible folate/ folic acid intake presented in the results was probably partly underestimated and partly over-estimated. Here are the reasons:

As already mentioned, no consumption data on fortified foods are available for the German adult population. One of the reasons for this is that the offering of products of this kind was still relatively small when the food consumption studies were carried out. Hence, both low and high fortification levels for all potentially fortified foods were included in the BLS and it was assumed that all individuals who consume *Dairy products, Soft drinks* and *Cereals* according to the Nutrition Survey only do this in fortified form. This certainly led to an over-estimation of folate/ folic acid intake in the calculations. On the other hand, the possible folate/ folic acid intake from fortified foods could be underestimated in the calculations since other foods fortified with folic acid like sweets (see LEBTAB database), tea as well as instant soups, ready to eat meals and margarine with between 40 and 400 µg folic acid per portion as well as salt (100 µg folic acid per g) were not taken into account either because their market importance was not known or – as in the case of salt – no data about the use of salt at household level had been recorded in the Nutrition Survey. Furthermore, account was not taken of the fact that fortified foods may also be ingredients in processed foods or added during the preparation of meals (e.g. white cabbage salad with a yogurt sauce (4) – BLS Code X138641; cold cucumber-yogurt soup (4) – BLS Code X476540). This could have led to an underestimation of folate/ folic acid intake. Since, however, *fortified Dairy products, Soft drinks* and *Cereals* are only relatively rarely part of processed foods, the inaccuracy this has generated in the results is probably limited.

In contrast to fortified foods, for which the consumption habits of the adult population are not known, the calculations of folic-acid fortified flour are based on representative consumption data on flour-containing foods. The flour fortification scenarios, therefore, permit a good estimation of folate/ folic acid intake to be expected under these conditions. For the calculations it was assumed that the bioavailability of folic acid corresponds to the availability of folic acid in bakery products containing folic acid fortified flour, which had been confirmed in more recent studies (Pfeiffer *et al.,* 1997; Vahteristo *et al.,* 2002).

Based on data from the British Department of Health Committee on Medical Aspects of Food and Nutrition Policy (COMA), Wright *et al.* (2002) calculated that fortification with 140 µg folic acid per 100 g flour would lead to 0.1% of the over 50s ingesting more than 1 mg folic acid per day, with 240 µg/ 100 g already to 0.6% and with 280 µg/ 100 g to 1.5% of this group. The model calculations presented here also show that between 0.1 up to a maximum of 0.5% of the population would be likely to have folic acid intakes above the UL if they consumed slightly fortified foods in addition to fortified flour. If the population consumed highly fortified food as well as folic-acid fortified flour, then the UL for folic acid would probably be exceeded by up to 2.7% (female) and 4.6% (male) of the study population.

Evaluations of the Nutrition Survey excluding possible "underreporters" showed a 6-9% higher folate intake that was reflected in higher median and mean values. However, the proportion of individuals above the UL did not increase.

2.5.2 Results of the reassessment and model calculations based on the DONALD Study

Given that the consumption of fortified foods by children and adolescents was continuously recorded over a period of many years in the DONALD Study, the contribution of these foods to folate intake could be determined on the basis of realistic consumption data. Folate intakes from fortified foods, which were obtained in the DONALD Study, are therefore closer to reality than the model calculations drawing on the Nutrition Survey. The random sample of the DONALD Study was, however, less representative than that of the Nutrition Survey although it is recognised from various studies that the data collected in the study are a good reflection of the eating habits of children and adolescents in Germany (Alexy *et al.,* 2001; 2002; Kersting *et al.,* 1998).

In the evaluation of the study the intake levels of folic acid from fortified foods were probably over-estimated in some cases because no distinction was made in terms of the information on the labels of the foods between added folic acid and endogenous folate levels.

In contrast to the model calculations using the data from the Nutrition Survey, the new evaluation of the DONALD data did not take account of folate levels occurring naturally in cereals which will have led amongst consumers of wholemeal products to an underestimation of folate equivalent intake from flour-containing products. All the same, the proportion of wholemeal flour in total flour consumption was low. Calculations of folate/ folic acid intake from folic acid fortified table salt were not possible using the DONALD data because no quantitative information was available in the nutrition logs about salt consumption.

In the group of children and adolescents, it was rather the consumption of fortified food products that led to approximations or an exceeding of the UL for folic acid than the consumption of fortified flour. As, however, the masking of symptoms of an undiagnosed vitamin B_{12} deficiency (basis for the derivation of the UL for adults) is less relevant for children and adolescents than for adults, the ULs, derived by extrapolating the UL of adults, are less suitable for assessing the risk of adverse effects in these age groups. However, it should not be forgotten that scarcely any study data are available for the group of children which would permit an estimation of the long-term effects of synthetic folic acid intake (Molly, 2003).

2.5.3 General aspects

When assessing folate intakes from normally unfortified food, it must be borne in mind that the folate levels indicated in the current food databases are disputed. Some authors assume that the contents are underestimated by around 20-30% because of unreliable determination methods (Tamura, 1998). However, a Dutch study did show that folate levels in foods which were analysed using HPLC and not using conventional microbiological methods were on average 25% below the values listed in the nutrient tables (Konings *et al.,* 2001).

A study in the USA showed that very high levels of folic acid (and also iron) are often present in fortified cereals. Analyses of different cereal products revealed that the level of folic acid detected in the products was up to 320% of the declared amounts (Whittaker *et al.,* 2001). In Germany a deviation of ± 30 % is accepted from the labelled folic acid amounts (Gesellschaft Deutscher Chemiker, 2000). In Germany therefore, far lower deviations from the actually indicated folic acid levels in fortified foods are to be expected; the results of the calculations presented here were not influenced by this to any significant degree.

In Germany bread and bakery goods with a median consumption of 112 (4-6 years) up to 238 (15-18 years) g per day by children and adolescents and of ~230 and 180 g per day for men and women are seen as the most important staple food (Kübler *et al.,* 1995a). They are eaten by almost everyone. To that extent, the fortification of flour – if it were done on a nationwide basis – could be seen as a measure capable of achieving a significant improvement in folate/ folic acid intake. When simulating flour fortification it was assumed that all wheat and rye flours, including wholemeal flour, are fortified with folic acid. In practice this measure would also reach those individuals who already (more or less) cover their folate intake needs from their healthy diet (wholemeal products etc). The calculations, however, show that even if **all** types of wheat and rye flour were fortified, any exceeding of the UL for folic acid can be attributed more to the consumption of (highly) fortified foods for general consumption and/ or to the use of food supplements rather than to flour fortification.

As no processing losses of folic acid were taken into account in the model calculations, it would have to be borne in mind when implementing flour fortification in practice that given the expected losses, higher amounts of folic acid would have to be added in order to achieve the fortification levels examined here in **ready-to-eat** foods.

2.5.4 Ways of improving folate/ folic acid intake

2.5.4.1 Experiences with periconceptional folic acid supplementation

In Germany scarcely any studies have been conducted up to now to assess the intensity, quality and consistency of previous awareness-raising campaigns for young women. Egen and Hasford established for Munich that the provision of targeted information by registered gynaecologists, chemists and midwives could increase the proportion of women who take folic acid supplements at the recommended time from 28 % to 42 % ($p < 0.05$). When women did not follow the recommendations this was because the pregnancy was unplanned or they were not convinced of the efficacy of supplementation for instance. Another impact of intervention was that the proportion of gynaecologists and chemists who informed women of childbearing age about the importance of folic acid prophylaxis also rose from 38% to 74% ($p < 0.05$) and 43 % (n.s.) (Egen & Hasford, 2003). This study shows that folic acid supplementation of women of childbearing age can be increased through targeted information campaigns although, at the same time, it is known that young women from lower social and educational echelons in particular are often difficult to reach (Egen & Hasford, 2003; Geisel, 2003).

Extensive campaigns were conducted in the Netherlands and the United Kingdom in order to raise awareness amongst women about taking folic acid supplements at the right time. At least for some of the women they were successful. In the Netherlands the number of women who had been informed about and followed the recommendation of taking folic acid rose from 10% in 1995 to 49% in 1996. The campaign in the United Kingdom recorded a similar increase to 50% (Raats *et al.,* 1998 cit. in: Oakley Jr., 2002).

A current survey by de Jong-Van den Berg *et al*. (2005), which examined awareness between 1988 and 2002 of the importance of periconceptional folic acid supplementation in a group of 16,555 pregnant women in conjunction with social demographic and other factors, showed that in 1988 there was almost no awareness of the association between folic acid and pregnancy risks whereas in 1996 and thereafter, 50% of women were aware of the advantages of timely folic acid supplementation. Periconceptional folic acid supplementation was practised by 15% of women in 1988. In the years after 1996 it was 40%. As other studies have also shown, increased awareness as well as actual folic acid intake depended to a large degree on factors like level of education, ethnic origin, wanted pregnancy, income, and counselling prior to pregnancy. The survey shows that there is an increased need for PR work about the use of folic acid to reduce NTDs in weak social groups and that it can indeed be successful (de Jong-Van den Berg *et al.,* 2005).

2.5.4.2 Improving folate intake through a conscious choice of foods

It should also be borne in mind that a change in diet can improve folate intake and that preventive effects regarding the NTD rate could be achieved: Study results show for instance that the intake of 560 µg folate equivalents from food per day over 4 weeks by a group of 23 people (18-45 years of age) led to comparable changes in the folate concentrations in the plasma and erythrocytes and in the total homocysteine concentrations in the plasma as did the intake of 210 µg dietary folate plus 250 µg folic acid (corresponding to 710 µg folate equivalents) by another group of 22 people with comparable initial values (Brouwer *et al.,* 1999). Similar results were obtained by a study in which the intake of an additional 500 µg folate equivalents per day from normal food led to a >70 % reduction of NTD incidence (Moore *et al.,* 2003). A change in diet would be very desirable overall when it comes to improving nutrient intake although it would be difficult to achieve, given today's eating and lifestyle habits for the total population and more particularly, for risk groups (young people with limited and lower social and educational level). Table 17 indicates how folate requirements could be met by means of a healthy diet. Wholemeal bread, fruit and vegetables (at least five portions a day) are of special importance. However, it is scarcely possible to meet the additional requirements of folic acid, as recommended by DGE for women of childbearing age and for pregnant and breastfeeding women, from a normal diet.

Table 17: Example of an adequate folate intake from the consumption of normal, non-fortified foods

	Food	Amount	Energy content		Folate equivalents	
		[g]	kcal/100 g	kcal/Portion	µg/100 g	µg/portion
Morning	Wholemeal rolls	45	222	99.90	23	10.35
	Butter	10	741	74.10	3	0.30
	Jam	20	279	55.80	1	0.20
	Tilsiter, medium-fat	30	211	63.30	18	5.40
	Coffee	200	2	4.00	1	2.00
	Condensed milk, 75% fat	12	133	15.96	6	0.72
	Orange	100	47	47.00	24	24.00
Lunchtime	Rice, polished boiled	200	93	186.00	7	14.00
	Chicken breast fillet, fried	150	464	696.00	12	18.00
	Tomato sauce	75	126	94.50	29	21.75
	Broccoli	200	23	46.00	48	96.00
	Sugared strawberries	150	94	141.00	13	19.50
	Yogurt, medium-fat	100	46	46.00	10	10.00
	Apple juice	200	49	98.00	4	8.00
Afternoon	Milk (semi-skimmed)	150	48	72.00	5	7.50
	Pear	100	52	52.00	14	14.00
	Muesli	45	351	157.95	44	19.80
	Coffee	200	2	4.00	1	2.00
	Condensed milk, 75% fat	12	133	15.96	6	0.72
Evening	Wholemeal bread	90	188	169.20	36	32.40
	Margarine, medium-fat	10	362	36.20	2	0.20
	Leberwurst	30	328	98.40	53	15.90
	Cheese slices, 75% fat	30	256	76.60	40	12.00
	Asparagus salad	150	62	76.80	40	12.00
	Herbal tea	200	1	2.00	1	2.00
	Peanuts	20	561	112.20	169	33.80
	Grapes	100	71	71.00	5	5.00
Nutrient intake per day:			2628 kcal		440 µg folate equivalent	

2.5.4.3 Fortification of flour with folic acid – experiences from other countries

In order to ensure that women of childbearing age have an adequate folic acid intake and reduce the incidence of NTD, some countries undertake mandatory fortification of flour; for instance in the USA and in Canada, 140 µg and 150 µg folic acid are added per 100 g flour, in Chile 220 µg folic acid per 100 g wheat flour are added and in Hungary 160 µg folic acid, 0.8 µg vitamin B_{12} and 880 µg vitamin B_6 are added per 100 g of the flour used to manufacture bread. Experiences from the USA, Canada and Chile have already been reported and are described below:

In the USA the fortification measure was expected to bring about additional intake of on average 100 µg folic acid. In fact, on average an additional intake of even more than 200 µg folic acid was achieved, which is reflected in the serum folate values of the population (Choumenkovitch *et al.,* 2002). The unexpectedly high folic acid intake is probably due to the higher dosing of this vitamin undertaken by manufacturers which is customary in order to ensure that the amount of an added nutrient indicated on the label is still present in fortified products after storage. Since the introduction of folic acid fortification a 19% reduction of the NTD rate has been observed (Honein *et al.,* 2001). Although folic acid intake was two times higher than expected, the incidence of NTD was not reduced on the scale originally expected (Honein *et al.,* 2001).

Since the introduction of mandatory flour fortification the median of the homocysteine concentration in the serum has fallen in the USA from 13.8 to 12.3 µmol/L and the proportion of individuals with high homocysteine concentrations (>15 µmol/L) has fallen from 41% to 28% ($P < 0.001$). However the effect on the mortality rate was low and, according to Anderson *et al.* probably due to other factors (Anderson *et al.,* 2004). The relatively short observation period could explain the fact that the mortality rate had still not been reduced significantly.

After the introduction of flour fortification in Ontario province, Canada, a 64 % increase in the mean serum folate concentration was observed from 14.8 nmol/l to 24.2 nmol/l. The folate concentration in the erythrocytes rose from 527 nmol/l to 741 nmol/l. The share of women for whom a folate deficiency was diagnosed fell from 6.3 % to 0.9 % (Ray, 2004). Similar changes were observed in men (Ray *et al.,* 2002). The incidence of open NTD has fallen since fortification from 1.13 to 0.58 cases per 1,000 births ($p < 0.0001$), i.e. by 52% (Ray *et al.,* 2002b). In Nova Scotia province in Canada a drop in open NTDs of 54% has been observed since the commencement of mandatory folic acid fortification whereby the incidence prior to fortification was 2.58 per 1,000 (between 1991 and 1997) and afterwards it was 1.17 per 1,000 births (between 1998 and 2000) (Persad *et al.,* 2002). In Chile where no other fortified foods or supplements are on sale aside from folic acid fortified flour, folic acid intakes of 427 µg/ d (95% CI 409-445) were achieved after the introduction of the fortification programme. The mean serum concentrations increased in women of childbearing age from around 10 nmol/ l to 37 nmol/ l (Hertrampf *et al.,* 2003). The NTD rate fell by 42% from 1.72 to 1 per 1,000 (LASPR, 2004).

The following table gives an overview of some of the current fortification programmes and their impact on reducing NTDs:

Table 18: A comparison of folic acid fortification programmes

Country	Folic acid fortification [µg/100 g]	Folic acid intake through fortification [µg/d]	NTDs [per 1000]				Reduction of NTDs [%]
			Prior to fortification		After fortification		
Canada							
• Ontario	150	220	1.13	('96-'97)	0.58	('98-'00)	52
• Nova Scotia	150	220	2.58	('91-'97)	1.17	('98-'00)	55
• Quebec	150	no data	1.89	('92-'97)	1.28	('98-'00)	32
• Newfoundland	150	70-74	4.37	('94-'97)	0.96	('98-'01)	78
Costa Rica	180	190	9.70	(1996)	6.30	(2000)	35
Chile	220	~440	1.70	('99-'00)	1.00	('01-'02)	42
USA	140	220	0.38	(1990)	0.30	(1999)	19
USA	140	220	0.52 *	('95-'96)	0.35	('98-'99)	31
USA	140	220	0.24**	('95-'96)	0.21	('98-'99)	16

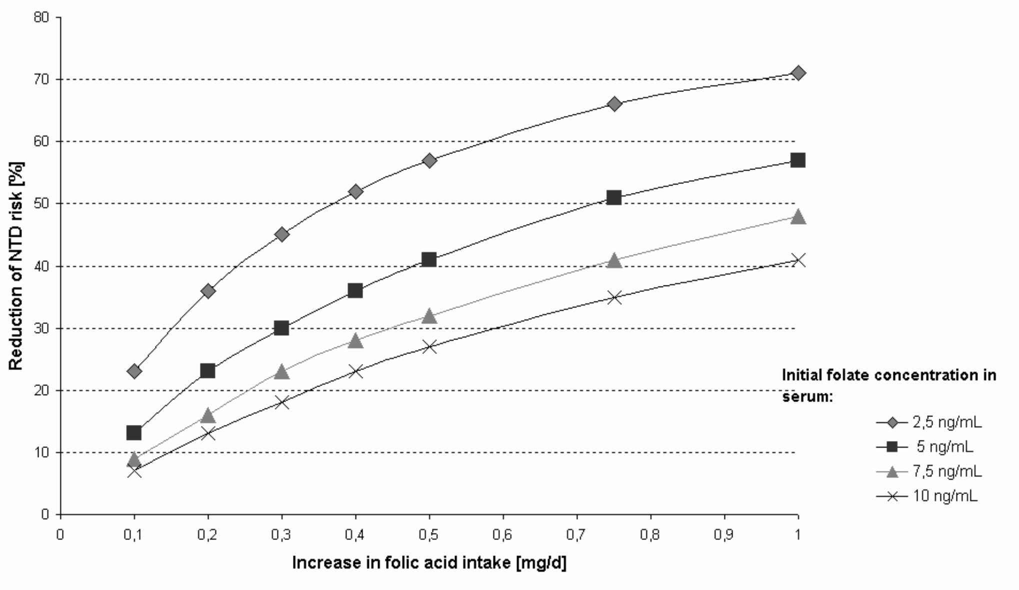
* *Spina bifida*
** *Anencephaly*

The data reveal that different NTD reduction rates were achieved with the same flour fortification level. They confirm the experiences from China with folic acid supplements: the higher the initial incidence, the greater the effect on NTD reduction (Berry *et al.,* 1999; Liu *et al.,* 2004).

Flour fortification with 100 µg folic acid per 100 g would lead to adults in Germany ingesting between an additional 117 (women) and 150 (men) µg folic acid per day simply by eating bread and bakery goods. A fortification of 150 µg folic acid per 100 g flour would lead to women ingesting an additional 176 µg and men an additional 225 µg folic acid per day.

Wald *et al.* (1998) estimated that an additional folic acid intake of 100, 200 and 400 µg/ day could reduce the incidence of NTDs by 18, 35 and 53%. Figure 12 shows that it is not only the folic acid dose, but also the initial concentration of folate in the serum, that has a decisive effect on risk reduction.

Fig 12: Association between increased folic acid intake and the resulting reduction of the NTD risk (composed from data by Wald *et al.,* 2001)



At an initial concentration of 2.5 ng/ml in serum, increasing folic acid intake would lead, depending on dose, to a far greater risk reduction than the initial concentration of 10 ng/ml. This means that the additional intake of 200 µg folic acid per day could lead to a reduction in the NTD risk by between 13% (with an initial serum value of 10 ng/ml) and 36% (at an initial serum value of 2.5 ng/ml). If an additional 400 µg folic acid per day were ingested, the risk reduction - depending on the initial folate concentration in the serum - would be between 23 and 52%.

Although it is not known whether the association described here also applies to Germany, particularly as the onset of NTD is influenced by several factors, and not all NTDs can be prevented by folic acid administration, the risk reduction of NTD generally seems to rise with increasing folic acid intake. Wald *et al.* (2001) conclude from their calculations that (flour) fortification cannot replace supplementation with folic acid in tablet form (dose ≥ 400 µg) but should rather be seen as an – albeit inadequate – "safety precaution" for women who become pregnant unexpectedly but have not had any folic acid prophylaxis.

2.5.4.4 Use of folic acid fortified salt (100 µg folic acid per g)

When considering management options to improve folic acid intake, it should not be forgotten that in Germany salt fortified with 100 µg folic acid per g salt is already available. This is important with respect to the possible folate supply of the target group, i.e. women of childbearing age, but also from the angle of food safety for the general population.

As already mentioned, the calculations conducted could not take into account the influence of the consumption of salt. The only study in which data about the use of salt at household level were recorded (only these amounts are of interest since folic acid fortified salt up to now is only offered for use at household level) is the National Food Consumption Study (NVS) which was conducted in the 1980s. One restriction which should be mentioned here is that data of this kind are not generally reliable because the consumers are not able to reliably estimate the amount of salt used. Furthermore, it is not clear from the NVS whether these are solely data about using salt in the home. Generally speaking, it is assumed that on average about 1-2 g of salt is used per person per day in addition to the amount of salt contained in processed foods (Manz, 1991). This means that the amounts of salt recorded in the NVS (on average: 2 g/ person/ day) seem realistic. A special evaluation of these data show that daily use of salt fortified with folic acid at household level could lead to a median folic acid intake of 118-154 µg (women) and 148-154 µg (men) (see Table 19). This corresponds to around 50% of the DGE reference values for folate equivalents. Processing losses through cooking, baking etc. were not taken into account.

Table 19: Folic acid intake from fortified salt (based on NVS calculations)

	Women				Men			
Consumers (n)	1502	5287	1698	2099	1182	4969	1698	930
Age (years)	19-24	25-50	51-64	>65	19-24	25-50	51-64	>65
Mean	137	154	188	164	172	174	188	188
Minimum	0	1	3	4	4	3	3	6
Maximum	1589	1251	1289	1944	832	1542	1289	2056
Percentile								
5	38	43	59	47	52	57	59	55
10	52	59	75	62	66	74	75	70
25	80	88	107	91	99	105	107	98
50	118	130	154	131	149	150	154	148
75	168	191	224	199	210	210	224	227
90	227	272	338	301	292	292	338	336
95	488	550	652	592	373	361	452	444

	Children and Adolescents			
Consumers (n)	917	1063	1027	1322
Age (years)	4-6	7-10	11-14	15-18
Mean	98	117	138	148
Minimum	4	3	11	5
Maximum	709	685	1252	1084
Percentile				
5	28	35	45	46
10	36	46	55	57
25	56	69	78	85
50	81	101	115	124
75	119	146	165	178
90	175	206	244	257
95	218	255	314	341

The amount of folic acid which could be ingested per day by adding salt corresponds roughly to the intake which would be possible from flour-containing products if one assumes an average flour consumption by the adult population of 180-230 g per day and flour were fortified with 100-150 µg folic acid per 100 g. Thus, fortified salt could also make a significant contribution to improving folate supply. Furthermore, salt has the advantage that because of iodisation (and fluoridation) it already has a certain track record in Germany as a carrier food for nutrient fortification. It will, therefore, possibly be more readily accepted by the population than a food like flour which has not previously been used for the purposes of fortification.

According to information from the company Südsalz folic acid fortified salt in Germany was used by around 10% of the Südsalz consumers one year after its market introduction (personal information, 2003). Since then another company has put a folic acid fortified salt on the market which is sold in discounter outlets and will probably therefore be used widely – even by socially weak groups. Nevertheless, even with extensive campaigns and a wide offering of this salt it will not be possible to reach all women of childbearing age (this would only be possible with nationwide salt fortification). Furthermore, women, who go out to work and for instance eat in canteens, use less salt at home.

Although the calculations of folic acid intake from fortified salt are not based on the data from the Nutrition Survey or the DONALD Study, but on those of the National Food Consumption Study, they are a good foundation for estimating mean folic acid intake from fortified salt based on the assumption that this salt is only used at household level. To improve the comparability of the estimated folic acid intakes from fortified salt, model calculations based on current consumption data would be necessary for the use of salt similar to those conducted for flour.

3 Risk Assessment of Folate/ Folic Acid

3.1 Nutrient characterisation

Folate is the generic term for a water soluble vitamin. The name comes from the Latin term 'folium' – the leaf – since the vitamin was first detected in leafy green vegetables. A distinction must be made between **folates** which occur naturally in foods and synthetic **folic acid** (CAS No. 59-30-3) used for therapeutic purposes and for supplementation. Folates consist of a pteridine and a para-aminobenzoic acid ring, at whose carboxy end up to 8 glutaminic acid residues are bound (pteroyl polyglutamates). Folic acid, by contract, is a fully oxidised pteroyl polyglutamate with only one glutaminic acid residue.

Up to now, the addition of folic acid to foods for general consumption has not been explicitly regulated in Germany. The vitamin could be added to foods without requiring authorisation. In the Annex to the European Directive 2002/46/EC folic acid is envisaged in the form of pteroyl-monoglutamic acid for use in food supplements. Furthermore, the compound is listed in the Annex to the Proposal for a *Regulation on the Addition of Vitamins and Minerals and of Certain Other Substances to Foods* (COM (2003) 671 final of 10 November 2003). Accordingly, it may, in future, be added to foods for general consumption. So far maximum levels, the setting of which is envisaged in Directive 2002/46/EC as well as in the Draft Regulation COM (2003) 671, have not been established.

3.1.1 Sources, incidence

Good sources of **folate** are leafy vegetables like spinach and lettuce but also tomatoes, potatoes, some types of cabbage and fruit as well as cereals, bread, cake and pastries made of wholemeal flour. Wheat germ and soybeans are especially rich in folate. Amongst the foods of animal origin, liver contains the highest concentrations whereas other types of meat and fish have relatively low levels of folates (D-A-CH, 2000).

As folates are water soluble, light sensitive and heat sensitive, their content in processed foods depends on the type of preparation. Losses of between 50 and 90% can occur during cooking (McKillop *et al.,* 2002). Since more than 60% of ingested folates come from foods consumed without any further preparation, the mean value of preparation losses is approximately 35% (D-A-CH, 2000).

Very different amounts of **folic acid** are used in *food supplements*[6] and *foods for general consumption* (cf. Chapter 2 and the tables in the Annex to this report).

3.2 Metabolism

Dietary folates are mainly present as pteroyl polyglutamates. They are mainly absorbed in the proximal part of the small intestine by an active absorption mechanism which is supported at higher folate doses by a passive transport mechanism. Absorption is stimulated by glucose and sodium; 6.0 is the optimum pH (Bässler *et al.,* 2002). Pteroyl polyglutamates must be hydrolysed with the help of a zinc-dependant carboxy peptidase to monoglutamates prior to absorption in the brush border of the mucosa cells whereas the vitamin ingested as folic acid will be reduced prior to resorption to tetrahydrofolate (THF) and partially methylated or formylated (Selhub *et al.,* 1983 in: Brouwer *et al.,* 2001). After transport to the liver full methylation takes place there and the resulting 5-methyl tetrahydrofolic acid is then bound to albumen and macroglobulin and transported to the cells where it is demethylated and

[6] Up to now, BgVV had recommended a maximum level of 900 µg per daily dose for the addition of folic acid to food supplements (BgVV, 2001)

converted into polyglutamate derivatives. The polyglutamate form is the storage form of the vitamin. Folic acid and its derivatives are distributed to all tissues; the distribution pattern of the various forms of folate shows dependency on the cell proliferation rate of the tissue. The total body store of human beings is estimated at 5-10 mg of which the liver contains around half. The biological half-life of this amount is approximately 100 days (IOM, 2000).

The amounts of 10-90 µg folic acid excreted daily with bile are regulated by enterohepatic circulation and almost fully reabsorbed. In the case of normal folic acid intake around 1-12 µg are excreted by the kidneys daily as folate compounds like 5-methyl-THF and 10-methyl-THF, as well as inactive metabolites like pteridine. It is not possible to assess the importance of faecal excretion since endogenously formed folates from microbial folate biosynthesis which takes place in the intestines are always excreted with the faeces. Folic acid migrates to human milk where it reaches concentrations of around 50 µg/l (Bässler *et al.,* 2002; IOM, 2000).

3.2.1 Nutrient interactions

Folate and Vitamin B_{12}

The function of the folates is closely linked to that of vitamin B_{12}. Both vitamins are involved in the conversion of homocysteine to methionine, an irreversible metabolism route, through which 5-methyl-THF is transferred to a methyl group on homocysteine. The reaction is catalysed by methionine synthase whereby the co-factor vitamin B_{12} is required. The reaction is blocked in the case of a vitamin B_{12} deficiency which means that the amount of reactive THF is reduced and is not sufficiently available for the formation of 5,10 methylene-THF or for DNA synthesis (so-called methyl trap).

Folate and Vitamin B_6

Homocysteine can either be remethylated to methionine or converted via cystathionine to cysteine. The reactions are catalysed through a B_6 dependent cystathionine- β -synthase and cystathionase (Bailey *et al.,* 2001; Bässler *et al.,* 2002). This shows that there is also a close relationship between the metabolism routes of folate and vitamin B_6.

3.2.2 Bioavailability

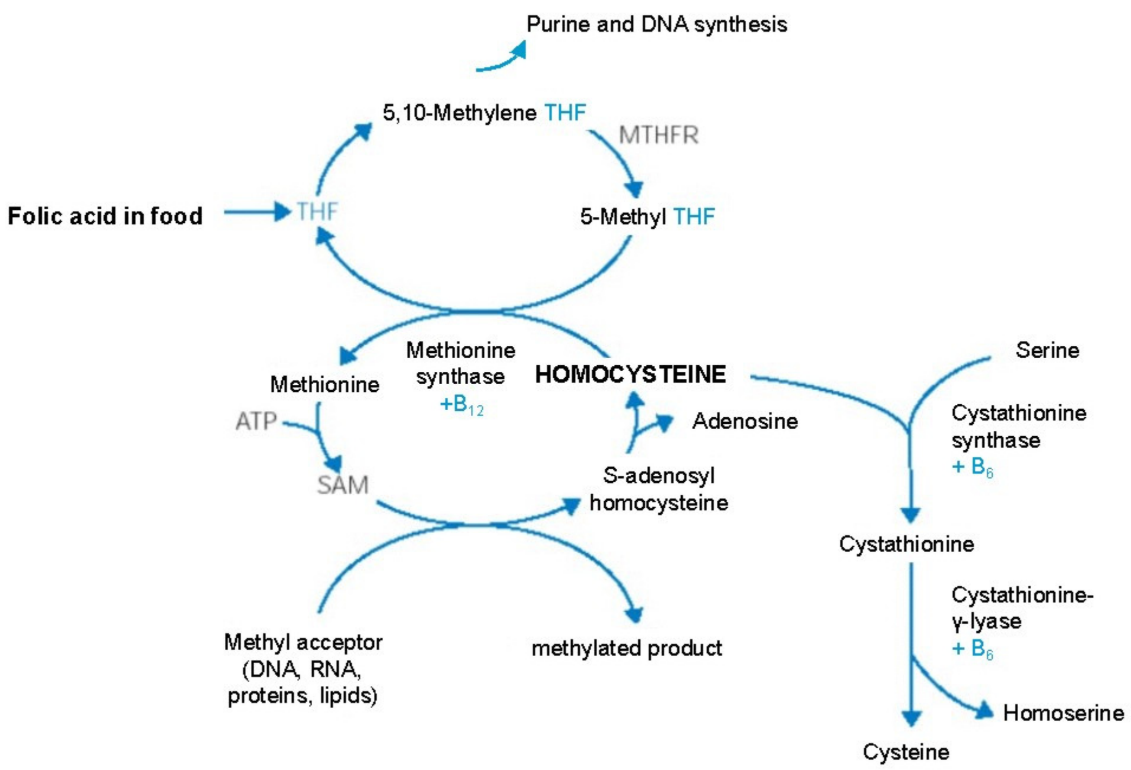
The bioavailability of dietary folates can be influenced by the relationship between monoglutamates and polyglutamates which occur in food, the release of folates from the cell structure, the type of food matrix and the presence of other nutrient components like organic acids, folate-binding proteins and reducing substances (Bässler *et al.,* 2002; Brouwer *et al.,* 2001; Molloy, 2002; Sanderson *et al.,* 2003). Dietary folates (polyglutamates) must be hydrolysed prior to absorption whereas synthetic folic acids (monoglutamates) can be absorbed without prior hydrolysis (Krishnaswamy & Nair, 2001; Sanderson *et al.,* 2003). Overall a 1.7 to 2-fold better bioavailability of folic acid compared to food folate is assumed (D-A-CH, 2000; IOM, 2000; Molloy, 2002).

The availability of folic acid from bread, which was baked using fortified flour, seems to differ considerably between manufacturing processes. The data fluctuate between 18 and 68% (Colman, 1982 cit. in: de Bree *et al.,* 1997). Pfeiffer *et al.* (1997) did not find any difference in the availability of folic acid from fortified white bread, wholemeal wheat bread, rice, pasta or water. Vahteristo *et al.* (2002) also showed that the intake of the same folate amounts from ordinary foods (rye products, orange juice) compared with that from bread fortified with folic acid, can lead to similar increases in plasma and erythrocyte folate concentrations.

3.3 Function

The main task of folates in the human organism is the transfer of 1-carbon units. In this context folate/ folic acid is not efficacious as such but in reduced form as 5,6,7,8-Tetrahydrofolate (THF), which can be bound to at least six different C1 groups like hydroxymethyl and formyl groups. The conversion of serine to glycine is the main source of the organism for the metabolism of 1-carbon units (Bässler *et al.,* 2002). The C1 residues are needed for purine synthesis (C8 and C2 of the purine ring) and for the methylation of homocysteine to methionine whereby vitamin B_{12} is necessary as a co-factor. S-adenosyl methionine, which is created through the reaction between methionine and ATP, supplies a methyl group for further methylations like, for instance ethanolamine to choline, noradrenaline to adrenaline or phosphatidyl ethanolamine to lecithin. In the case of SAM-dependent methylations homocysteine is created as an intermediate product. The following figure gives an overview of the metabolic pathways of the vitamin and the close relationship between folic acid and homocysteine in the metabolism.

Fig 13: Folate metabolism[7] (nach Koch *et al.,* 1998)



Given its role in DNA, RNA and protein metabolism, folate/ folic acid is of primary importance for adequate cell growth, normal cell proliferation and optimum cell differentiation.

[7] THF = Tetrahydrofolate
SAM = S-adenosyl methionine
MTHFR = Methylene tetrahydrofolate reductase

3.4 Requirements

The level of the homocysteine concentration in blood serves as an early indicator of inadequate folate supply. Several studies have shown that through the daily intake of 50-100 µg folic acid (as a supplement) haematological deficiency symptoms can be prevented. All the same, a maximum reduction of the homocysteine concentration is only achieved following regular daily intake of 400 µg folate equivalents (Holmes & Gates, 2003; Riddell *et al.,* 2000; Ubbink *et al.,* 1994; van Oort *et al.,* 2003). Any folate/ folic acid intake beyond that only influences the homocysteine level to a minor degree. On this basis recommended intakes were established for adolescents and adults, while RDA for infants and children are extrapolated from adult values based on their lower body weight (D-A-CH, 2000):

Table 20: Overview of recommended intakes

Age [years]	Recommendation[8] [µg folate equivalents* per day]
Infants**	
0 - < 4 months	60
4 - < 12 months	80
Children	
1 - 3 years	200
4 - 6 years	300
7 - 9 years	300
10 - 12 years	400
13 - 14 years	400
Adolescents and adults	
15 - 18 years	400
> 19 years	400
Pregnant women	600
Lactating women	600

* Calculated according to the sum of active folate compounds in conventional food
→ 1 µg folate equivalent = 1 µg dietary folate = 0.5 µg folic acid
** Estimated values

Women who wish to or could become pregnant are advised to take 400 µg/ day folic acid in the form of supplements in addition to recommended intake in order to prevent NTDs. This additional intake should begin at the latest 4 weeks after the commencement of pregnancy and continue up to the end of the first trimester of pregnancy because the neural tube normally closes 4 weeks after conception (between the 22nd and 28th day of pregnancy) or around 6 weeks after the first day of the last menstruation. If a woman already has a child with NTD, an additional intake of 4 mg synthetic folic acid is recommended per day (Koletzkc and von Kries, 1995).

Due to genetic polymorphisms, which go hand in hand with altered properties of 5,10-methylenetetrahydrofolate reductase (MTHFR), the need for folate/ folic acid increases (Pirelli *et al.,* 2003; Guinotte *et al.,* 2003; Molloy, 2002). Inadequate intake of the vitamin can have negative health consequences for individuals who are homozygotic for these polymorphisms. Around 10% of the population show a thermolabile variant of methylene-tetrahydrofolate reductase for instance because of a homozygosity for the C677T mutation which leads to elevated homocysteine concentrations in conjunction with inadequate folate and/ or vitamin B_{12} supply. These individuals need higher levels of folate to normalise the metabolism disorder triggered by the polymorphism (Bailey *et al.,* 2001).

[8] By way of definition the recommendations for nutrient intake meet the needs of almost 98 % of a defined group in the healthy population (DGE 2000). In terms of individuals an average nutrient intake of the recommended level is very unlikely to lead to inadequate intake. Intake below the recommended intake does not, therefore, point to a deficiency but does increase the probability of inadequate intake.

3.5 Nutritional status in Germany

3.5.1 Intake

The nutrition surveys carried out in Germany, in which the consumption of fortified foods or food supplements was not taken into account, indicate that the recommended intakes for this vitamin are not generally reached through a normal diet (Gonzalez-Gross *et al.,* 2003). For the first time the possible contribution of folic acid from fortified foods and food supplements to the folate intake of the population was taken into account in the model calculations presented in Chapter 2 of this report.

3.5.2 Biomarkers

Conclusions about the **current intake situation** can be drawn from the determination of serum folate concentrations. A serum folate level below 7 nmol/l (3 µg/l) is deemed as inadequate (IOM, 2000). To determine intake status **over a longer period** (2-3 months retrospectively), the folate concentration in the erythrocyte is considered to be a good indicator and a reliable source of information on tissue store. A fall in this concentration below 317 nmol/l (140 µg/l) points to a folate deficiency (Pietrzik & Prinz-Langenohl, 1998).

In pregnant women Daly *et al.* (1995) showed for Ireland that an erythrocyte folate concentration < 150 µg/l compared with > 400 µg/l correlated with an eight-fold risk of NTDs). At concentrations between 150 and 200 µg/l the risk was still four times, between 200 and 300 µg/l three and between 300 and 400 µg/l two times higher.

Within the framework of the Nutrition Survey folic acid concentrations in the serum and in erythrocytes were determined in addition to consumption data specifically amongst women of childbearing age in Germany (n=1266). The median serum folate concentration was 7.6 µg/l (P 5 = 4.2 µg/l; P 95 = 12.9 µg/l). In the erythrocytes the median was 266 µg/l (P 5 = 161.5 µg/l; P 95 = 498 µg/l) (Thamm, 2001). Assuming, however, that the relationship between marginal folate status and the risk of NTD noted by Daly *et al.* (1995) was applicable to Germany, the risk of NTD would be eight-fold amongst around 3% of the women examined (erythrocyte folate concentration < 150 µg/l), four-fold however for around 14% (folate concentration in erythrocytes between 150 and 200 µg/l), three-fold for 48% (erythrocyte folate concentration between 200 and 300 µg/l) and double for almost 22% (erythrocyte folate concentration between 300 and 400 µg/l) compared with women with folate concentrations in the erythrocytes > 400 µg/l (Thamm, 2001).

3.6 Hazard characterisation

3.6.1 Deficiency

Megablastic anaemia may occur as a consequence of chronic clinical **folate** deficiency. Furthermore, because of the importance of folates for DNA synthesis, there may be disruptions in cell proliferation that have a particularly negative impact on the rapidly proliferating cells in bone marrow and in the intestinal tract and go hand in hand with a reduction in the number of white cells (neutrophiles, lymphocytes, monocytes, eosinophiles and basophiles) and thrombocytes (Bailey *et al.,* 2001; Molloy, 2002). Inadequate folate supply during pregnancy is linked with a higher risk of premature births, low birth weight and foetal growth retardation (Scholl & Johnson, 2000). Furthermore, various studies have shown that an elevated periconceptional intake of folic acid, in combination with multi-vitamin products or on its own, reduces the risk of NTDs and other congenital malformations (Czeizel and Dudas 1992; Czeizel 1995; 2000; Moore *et al.,* 2003; Tönz *et al.,* 1996). The genesis of NTDs is, however, conditioned by various factors. Up to now it was not possible to determine by means of which mechanism folic acid is involved in the closure of the neural tube (Fleming, 2001).

Furthermore, a link between sub-optimum folate supply and the onset of cardiovascular diseases is also under discussion. This is attributed to the fact that in the case of inadequate folate supply, homocysteine cannot be methylated to methionine and accumulates in the organism or reacts with another homocysteine molecule to homocystine. This damages the endothelium and may lead to vascular occlusion (Ubbink *et al.,* 1996). The results from large intervention studies will provide information on whether these observations constitute a causal relationship.

3.6.2 Excessive intake

In conjunction with high **folate** intake from foods for general consumption, no adverse effects have been observed so far which means that neither an NOAEL nor a LOAEL for natural folate could be determined either by SCF or another scientific body (EVM, 2003; IOM, 2000; SCF, 2000). As the population in Germany on average only reaches 50-70% of the reference values, there is no risk of an excessive intake of the vitamin from normal food.

Systematic toxicological studies have not been conducted either for synthetic folic acid (PGA) or for synthetically produced folate compounds. There are indications from animal experiments that 60-90 mg/kg synthetic folic acid can have a neurotoxic or epileptogenic effect when administered intravenously. However, the studies are contradictory and, in the opinion of SCF, cannot be used to derive an NOAEL or a LOAEL. There are no signs of neurotoxicity through folic acid intakes from human studies (SCF, 2000).

Folic acid administration of more than 1 mg can have a convulsant effect in epileptics because folic acid induces an elevated hepatic metabolism of individual anti-epileptics (barbiturates, phenytoin) and therefore weakens their action. In some cases higher doses of these medicines are needed. On the other hand anti-epileptic agents inhibit the intake of folic acid (Staub & Gallmann, 1996). There may be interactions between folate absorption in conjunction with the parallel taking of medicinal products to treat cancer or rheumatism. However, at the present time, there are no clear signs that elevated folate or folic acid intake can have a negative impact on the efficacy of these medicinal products. The intake of 1 mg folic acid per day does not seem to impair the therapeutic action of low-dosed methotrexates. At higher doses, folic acid may possibly even contribute to reducing the side effects of this medicinal product (Campbell, 1996).

From an intake of 5 mg folic acid onwards, a parallel vitamin B_{12} deficiency may be “masked”, i.e. the haematological symptoms that are identical in the case of vitamin B_{12} and folic deficiency are improved through folic acid intake whereas the neurological symptoms which go hand in hand with a vitamin B_{12} deficiency are not prevented and may even be exacerbated (Drazkowski *et al.,* 2002; IOM, 2000; SCF, 2000). Because of this association FNB has identified a LOAEL of 5 mg. An NOAEL cannot be determined as no data are available about the occurrence of masking when taking levels of folic acid between 1 and 5 mg (IOM, 2000). SCF backed the FNB assessment (SCF, 2000). Risk groups for the masking of a vitamin B_{12} deficiency include older people (> 60 years) for whom a vitamin B_{12} deficiency but also a folate deficiency occurs far more frequently than for the average population (Clarke *et al.,* 2003).

It can be assumed that the most frequent cause of vitamin B_{12} deficiency is an absorption disorder for dietary vitamin B_{12}. No data are available for the Federal Republic of Germany about the incidence of vitamin B_{12} malabsorption. Despite adequate intake by all age groups, there are reports in the VERA Study of a higher prevalence of low vitamin plasma levels in men aged 65 and above, whereby only 4.3% of the total random sample were found to have

plasma concentrations below the reference value (Kübler *et al.,* 1995b). From other studies it is known that between 10 and 15% of all people above the age of 60 suffer from a vitamin B_{12} deficiency whereas pernicious anaemia, the final stage of an autoimmune disorder with a loss of intrinsic factor forming intestinal mucosa skin cells, only occurs in around 2% of all people above the age of 60. In the Framingham Study a 15% prevalence of non-diagnosed cobalamin deficiency was observed in the over 60s which is probably attributable to malabsorption (Lindenbaum *et al.,* 1994 cit. in: Andrès *et al.,* 2002). Baik and Russell (1999) also believe that 10-15 % of this age group suffers from a vitamin B_{12} deficiency.
Sleep disorders, agitation, hyperactivity, nausea, flatulence, disturbed sense of taste and allergic reactions like erythema, pruritus and urticaria have been observed in conjunction with the intake of higher folic acid amounts (~15 mg) (Bässler *et al.,* 2002).

Furthermore, various authors have observed that intake levels above 250 µg folic acid (as a single dose) can no longer be completely converted to 5-methyl tetrahydrofolate. Consequently, some of non-metabolised folic acid appears in the plasma. Up to now it is not known what impact the vitamin in this form can have on the organism (Bailey *et al.,* 2001 cit. in: Quinlivian & Gregory III, 2003; IOM, 2000; Kelly, 1997; Yetley & Rader, 2004).

In animal studies it was shown that, in the presence of existing pre-malignant lesions or neoplastic clusters, folic acid can increase the risk of cancer and accelerate the development of tumours if high amounts far in excess of actual requirements are ingested (Kim, 2003; Kim *et al.,* 2004). Even if no concrete conclusions can be drawn from these observations about the use of folic acid in humans, folic acid supplementation in individuals already presenting pre-malignant lesions or other precursor stages to cancer, could lead to a more rapid progression of the disease whereas supplementation in healthy humans may have a preventive effect on the occurrence of colon cancer (Kim, 2004). From the angle of a possible threat to health from the excessive intake of folic acid and the relatively high prevalence of colon rectal adenomas in the western population[9] these findings should be taken seriously and further elucidated in the interests of public health.

Furthermore, it is being discussed whether supplementation with folic acid or dietary folate intake beyond requirements could possibly be linked for some genotypes to a risk of adverse effects. Ulrich *et al.* (2002) observed that humans with a polymorphism of thymidylate synthase (TSER 2rpt/2rpt) at a folate intake of more than 440 µg per day ran a 1.5-fold higher risk of developing colon cancer than those whose folate intake was below 440 µg per day.

3.7 Gaps in knowledge

- It is not known by means of which mechanism folic acid has a preventive effect on the onset of NTDs.

- The folic acid fortification programmes in other countries have not been up and running for long enough or not enough findings are available about changes in folate intake or the reduction in NTDs since 2000 in order to be able to assess the impact of chronic folic acid intake from fortified foods over a long period on the overall population.

- In Germany there is no national register of congenital malformations.

- There are no studies about the effect chronic folic acid supplementation has in children if amounts are ingested which are far higher than the recommendations (Yetley & Rader, 2004).

[9] In the USA ~25 % of the population > 50 years of age have adenomas in the colon (Winawer, 1997 cit. in: Kim, 2004).

- It is unclear whether the results from other countries can be transferred to the German situation. Given the multifactorial aetiology of NTDs it is not possible to estimate the percentage by which the incidence of this anomaly in Germany could be reduced by improving folate intake.

- Nor is enough known at the present time about the effect which the administration of folic acid in humans has on the onset of cancer of the colon when neoplastic lesions and adenomas are already present (Kim *et al.,* 2004).
- It is still to be clarified which (positive or negative) effects the vitamin can have on certain groups amongst the population taking into account the gene polymorphisms relevant for the folate metabolism.

- There are no representative figures about the prevalence of vitamin B_{12} deficiency and pernicious anaemia in Germany.

- So far it has not been proven unequivocally whether the link between high homocysteine levels and the onset of cardiovascular disease is a causal relationship and whether the long-term administration of folic acid can reduce not only the homocysteine level but also the risk of the onset of these diseases.

4 Ways of Improving Folate Intake with a View to Preventing Neural Tube Defects in Germany

Previous nutrition surveys have shown that the German population does not reach adequate folate intake from normal non-fortified food. Since an optimum supply with this vitamin is of major importance, particularly for women of childbearing age when it comes to preventing NTDs, efforts must be made to improve the overall folate/ folic acid intake of this group in the population.

There are various ways of improving folate intake which are discussed below along with their advantages and disadvantages:

1. Improving folate intake through a conscious change in diet, i.e. consumption of foods that have a naturally high folate level

Advantages: Improving folate intake by eating foods with a naturally high folate content generally leads to a healthier diet as more wholemeal products, fruit and vegetables would have to be consumed in order to reach the higher folate intake. At the same time, this would also improve the intake of other nutrients without having to expect nutrient imbalances or overdoses.

Disadvantages: Given the existing eating and lifestyle habits in Germany, this measure is difficult to implement. It requires extensive nutritional awareness and counselling of the population. Positive effects could only be achieved slowly and certainly not for the entire population as shown by the DGE “5 a day” campaign. A folate/ folic acid intake, as recommended for women in early pregnancy, could not be achieved or only through extreme dietary habits.

2. Improving the folate intake of women of childbearing age by taking food supplements (400 µg folic acid per daily dose)

Advantages: By means of the regular use of a food supplement with 400 µg folic acid per daily dose, women of childbearing age could ingest the amount of folic acid recommended for this group of the population to cover their elevated needs for the prevention of NTDs.

Disadvantages: Intensive campaigns are necessary in order to inform women of childbearing age about the positive effects of periconceptional folic acid intake. Therefore, successes can be achieved only in the long term and almost certainly only for some of these women. From other countries it is known that the success rate (accessability of women and compliance with the recommendation) of campaigns of this kind is maximum 50%, one of the reasons being that around 40-50% of pregnancies are not planned. An additional obstacle – particularly for women from low income groups in the population – is that the prescription of folic acid preparations for NTD prophylaxis imposing a burden on statutory health insurance in Germany would not be possible.

3. Improving folate intake by consuming foods for general consumption fortified with folic acid

Up to now no authorisation was required for the addition of folic acid to foods for general consumption in Germany. In recent years many food manufacturers have made use of this option which means that a wide range of foods in various product categories enriched with folic acid are on sale on the market.

Advantages: The reassessments of the 1998 Nutrition Survey and the DONALD Study have shown that simply by consuming fortified foods of the product categories *Dairy products*, *Cereals* and *Soft drinks* part (around 50%) of the population could reach the recommended intake. As the age groups 18 to 25 in particular consume foods from these three product categories, the folic acid intake of some women of childbearing age could also be improved in this way.

Disadvantages: Although young women could increase their folic acid intake according to the study results, it is to be expected that given the variable consumption amounts and frequencies, there will be very unevenly distributed intakes of folic acid amongst consumers of optionally fortified foods. Only very few women would reach the recommended intakes for early pregnancy of 1,200-1,400 µg folate equivalents per day by consuming fortified foods (coupled with an otherwise unchanged diet.)

On the other hand, it cannot be ruled out that parts of the population could exceed the tolerable upper intake level for folic acid of 1 mg per day by consuming several products or larger amounts of one product fortified with folic acid. Particularly through the consumption of folic acid fortified, low energy foods like soft drinks, very high intakes of folic acid may be reached under certain circumstances because the consumption of these foods is not regulated by satiation.

4. Improving folate intake through folic acid fortification of basic foods supported by health policy

a) Fortification of wheat and rye flour with folic acid - nationwide

Advantages: If flour fortification were to be done nationwide (as assumed in the model calculations), the folic acid intake of the overall population, including socially disadvantaged groups, would increase more evenly and in a more predictable manner than in the case of other measures. In the overall population and with a view to the target group, a dose of 150 µg folic acid per 100 g flour would be able to make a significant contribution to folate intake. To the extent that no other folic acid fortified foods are consumed, there need be no expectation of folic acid intakes above the UL amongst adults or children. The target group of women of childbearing age would definitely be reached through this fortification measure, which means that those individuals who do not follow the recommendations of periconceptional folic acid supplementation and/ or have become pregnant by chance, would ingest at least part of the recommended additional folic acid amount for this group.

Disadvantages: Intensive PR work would be necessary in order to bring about understanding in the population for the fortification of flour and create transparency about the risks and benefits.

Since a number of foods for general consumption enriched with folic acid are already on the market, folic acid intakes above the UL cannot be ruled out in the consumers of these foods.

In any case women of childbearing age would have to be informed about the advantages of periconceptional intake of folic acid since it cannot be guaranteed through the ingestion of fortified flour alone that the recommended amount of 400 µg folic acid per day is ingested in addition to a conventional diet.

b) Fortifying wheat and rye flour with folic acid (partially) – not nationwide

Advantages: At a dose of 100-150 µg folic acid per 100 g flour, groups in the population, who use the fortified flour, could considerably improve their folic acid intake.

Disadvantages: Partial fortification of flour would only lead to an improvement in the folic acid intake of the target group if the population or the target group of women purchased and consumed the fortified flour and products made from it. The advantages of adequate folic acid intake must be communicated in a convincing manner in information campaigns.

By means of partial flour fortification, to be conducted in parallel to the current offering of other folic acid fortified foods, it cannot be ruled out that some people in the population would regularly ingest high levels of folic acid (above the UL).

c) Fortification of table salt with folic acid (partially) – not nationwide

Advantages: Because of its widespread use by the population, salt is capable of contributing to raising folic acid intake in all groups in the population (> 1 year). Groups in the population who use salt can cover around 50% of their daily folate needs by an average use of salt at household level of 2 g per day. Furthermore, in Germany salt is a recognised carrier food for the nutrient fortification of iodine and fluoride. It might therefore be more readily accepted by the population than the fortification of another staple food like flour.

Disadvantages: As this salt is currently on sale alongside non-fortified types of salt for private households only, intensive information campaigns would be necessary in order to reach the target group of women of childbearing age. Hence there is no guarantee of an increase in the folic acid intake of the target group. Furthermore, similarly to flour fortification, it would have to be recommended to women of childbearing age in future, too, that they take periconceptional folic acid in the form of food supplements.

Given the growing spread of folic acid fortified salt and the existing or growing offering of folic acid fortified foods for general consumption, it is to be expected that parts of the population will exceed the UL for folic acid.

5 Summary

The goal of the project was to examine which measures are best suited to improving the folate/ folic acid intake of the population in order to make an effective contribution to preventing NTDs in Germany. Bearing in mind the advantages and disadvantages of the individual measures presented here, their suitability for the prevention of NTDs is estimated as follows:

1. The taking of **food supplements with 400 µg folic acid per daily dose** would, in principle, be most suited to preventing NTDs because
   - the folic acid amount recommended for early pregnancy would in fact be ingested and
   - the target group can be accessed directly.

   However, in the past only a small proportion of women followed the recommendation of supplementing folic acid periconceptionally. Hence, in future comprehensive awareness-raising campaigns are needed in order to inform the target group of women of childbearing age about the importance of taking folic acid prior to and during pregnancy. Given the high rate of unplanned pregnancies (40-50%) it must, however, be expected that even if this measure is successfully implemented, only maximum 50% of the target group can be reached.

2. **By means of partial flour fortification** – **similar to the use of folic acid fortified salt –** an improvement in the folic acid intake of the target group could only be achieved if the flour or salt is indeed consumed/ used by the target group women. An improvement to the folate status of women of childbearing age is not, therefore, guaranteed. The advantages of sufficient folic acid intake must be convincingly communicated by means of information campaigns.

3. If **nationwide flour fortification** were to be introduced in Germany (as assumed in the model calculations), the folic acid intake of the entire population, including socially disadvantaged groups, could be increased in an even and predictable manner. The target group women would definitely be reached through this fortification measure. Fortification with 150 µg folic acid per 100 g would best be suited to making a significant contribution to folic acid status without, on the other hand, a high proportion of the population reaching folic acid intake above the UL.

   A nationwide flour fortification measure should, in the opinion of BfR, only be introduced if it can be ensured that
   - other folic acid fortified foods on the market contain a maximum 100 µg folic acid per portion,
   - soft drinks or foods, whose consumption is not limited through satiation, are no longer fortified with folic acid,
   - no folic acid fortified salt is sold in parallel to fortified flour.

   These constraints would be necessary in the opinion of BfR in order to avoid an overly high proportion of the population exceeding the UL for folic acid. Furthermore, it makes sense to limit a fortification measure to <u>one</u> staple food in order to better monitor its success and to adapt the conditions if necessary.

With a view to the **effectiveness** of measures 2 and 3 it must be said that neither the folic acid concentration currently used in salt (and its use in the home) nor the flour fortification levels discussed here (and their processing in all flour containing products) would be suitable to increasing folic acid intake to such an extent that women of childbearing age would reach the additional intake of 400 µg per day recommended for NTD prevention. In order to achieve this dose, the regular taking of food supplements would be the most effective path. This means that in future the recommendation must be maintained at all events to women of childbearing age that they supplement their normal diet with 400 µg folic acid per day. However, it should be stated here that the recommended dose of 400 µg folic acid per day is not based on systematic dose-finding studies. A positive effect is, therefore, also conceivable with an additional folic acid intake of less than 400 µg per day.

To the extent that the offering of folic acid fortified foods for general consumption on the market cannot be systematically restrained or restrained in a targeted manner, increased attention should be given to information campaigns about the advantages of adequate folic acid intake for women of childbearing age. In this context the taking of folic acid containing supplements and the use of folic acid fortified salt should be recommended.

6 Annexes

6.1 Results of the market analysis of folic acid fortified foods

Table A1: Product category Cereals, Manufacturers total (April 2001 to March 2002)

Manufacturers	Amount in tonnes
Kenatura	0.5
Maizena	7.4
Zonnatura	15.7
Dailycer	21.2
Dr. Doerr	25.6
Dr. Ritter	41.0
Modersohns Muehlen U. Backbetr	44.3
Knorr	50.5
Bioquelle	137.9
Hipp	186.9
Weetabix Ltd.	216.9
Dr. Kousa	257.4
Wurzener	411.2
Schneekoppe	1006.3
Seitenbacher	1858.1
Vitalkost	2624.9
Brueggen	4278.5
Nestle	4374.0
Hahne	4634.1
Walkmuehle	5399.9
Koelln	6599.5
Dr. Oetker	7989.2
Kellogg's	20466.6
Handelsmarken	25864.0
Others	36761.6
Total	**123273.0**

Table A2: Product category Cereals. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] total
Ms Koelln Fruechte Vollkorn	Koelln	30	592.8	177839440
Ms Koelln Kn.Flakesm.Selection	Koelln	30	171.3	51375885
Ms Koelln Joghurt M.Erdbeere	Koelln	31	522.7	162034498
Ms Koelln Kn.Flakes Mues.Honig	Koelln	33	167.7	55352513
Tr Koelln Knusprige Haferfleks	Koelln	33	721.4	238044622
Ms Koelln Knusp.Schoko Krokant	Koelln	35	536.5	187787830
Ms Koelln Knusper M.Rosinen	Koelln	35	64.2	22451853
Ms Koelln Schoko	Koelln	35	2439.4	853804136
Other Muesli	Others	62	73.1	45336289
Tr Hipp Crispy Croco	Hipp	150	61.4	92041463
Ms Schneekoppe 10Frue./10Vit.	Schneekoppe	165	299.4	494001981
Ms Schneekoppe Vollfr.Hochwert	Schneekoppe	165	156.3	257921796
Tr Kellogg's Choco Smacks	Kellogg's	167	334.8	559142224
Tr Kellogg's Chocos	Kellogg's	167	1678.2	2802586794
Tr Kellogg's Chombos	Kellogg's	167	487.4	813881655
Tr Kellogg's Coco Krispies	Kellogg's	167	1351.0	2256122437
Tr Kellogg's Cornflakes	Kellogg's	167	3230.8	5395501496
Tr Kellogg's Froot Loops	Kellogg's	167	685.9	1145392795
Tr Kellogg's Frosties	Kellogg's	167	3397.1	5673076145
Tr Kellogg's Frosties Caramel	Kellogg's	167	143.1	238978944
Tr Kellogg's Frosties Choco	Kellogg's	167	182.3	304389988
Tr Kellogg's Frosties Spice	Kellogg's	167	370.0	617938673
Tr Kellogg's Honey Loops	Kellogg's	167	448.4	748776447
Tr Kellogg's Pops	Kellogg's	167	242.2	404493722

Table A2 contd.: Product category Cereals. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] total
Tr Kellogg's Rice Krispies	Kellogg's	167	124.4	207696114
Tr Kellogg's Smacks	Kellogg's	167	2852.2	4763145286
Tr Little Man Cornflakes	Lidl	167	1239.5	2070021094
Tr Little Man Flakers Honey	Lidl	167	832.4	1390103637
Tr Little Man Flakers Sugar	Lidl	167	482.0	804853347
Tr Little Man Golden Puffs	Lidl	167	788.9	1317433607
Ms Schneekoppe Erdb. U.Joghurt	Schneekoppe	170	88.8	150965261
Tr Apti Corn Flakes	Markant	170	41.1	69861788
Tr Apti Frosted Flakes	Markant	170	23.6	40107900
Tr Apti Golden Pearl	Markant	170	60.9	103490447
Tr Apti Honey Nut Flakes	Markant	170	54.3	92239891
Tr Apti Magic Zimt	Markant	170	30.0	51036741
Tr Apti Nuts_N Flakes	Markant	170	3.2	5428937
Tr Apti Schoko Corn Flakes	Markant	170	5.1	8745438
Tr Little Man Little Pack	Lidl	170	212.0	360447251
Tr Nestle Aepple Minis	Nestle	170	210.9	358568295
Tr Nestle Bananen Nuss Cluster	Nestle	170	211.1	358782022
Tr Nestle Chocapic	Nestle	170	19.8	33733926
Tr Nestle Cini-Minis	Nestle	170	1261.9	2145138999
Tr Nestle Clusters	Nestle	170	764.1	1298938734
Tr Nestle Nesquik	Nestle	170	1017.1	1729026888
Tr Nestle Trio	Nestle	170	337.5	573702057
Tr Weetabix Trad.Cer.	Weetabix Ltd.	170	209.2	355587938
Tr Euro Shopper Cornflakes	Edeka	200	165.5	331023935
Tr Euro Shopper Honey Wheat	Edeka	200	132.4	264760705
Tr Euro Shopper Nut Flakes	Edeka	200	70.0	140018296
Tr Euro Shopper Schoko Chips	Edeka	200	138.2	276376947
Tr Euro Shopper Schoko Cornfl.	Edeka	200	33.3	66513700
Tr Fit&Aktiv Honey Wheat	Vitalkost	200	281.0	561986497
Tr Fit&Aktiv Mini Zimtos	Vitalkost	200	217.6	435241719
Tr Fit&Aktiv Nougat Bits	Vitalkost	200	114.5	228892010
Tr Fit&Aktiv Schoko Chips	Vitalkost	200	344.4	688852335
Tr Fit&Aktiv Wheat+Nut	Vitalkost	200	239.6	479193638
Tr G .Breakfast Mini Zimtos	Norma	200	195.5	390921053
Tr G.Breakfast Fruit Cereals	Norma	200	142.0	284028806
Tr G.Breakfast Honey Wheat	Norma	200	298.7	597437742
Tr G.Breakfast Schoko Chips	Norma	200	244.9	489731468
Tr G.Breakfast Schoko Cornfl	Norma	200	66.9	133721759
Tr G.Breakfast Wheat & Nut	Norma	200	153.1	306212099
Tr G.Breakfast White Flakes	Norma	200	116.9	233730255
Tr Genialty Cricachoc	Spar	200	2.2	4487588
Tr Genialty Form & Vitality	Spar	200	14.2	28342768
Tr Gletscherkr. Honey Balls	Others	200	2034.5	4069043781
Tr Gletscherkr. Schoko Chips	Others	200	1007.5	2014997754
Tr Gletscherkr. White Flakes	Others	200	1144.1	2288185383
Tr Gletscherkrone Zimt Chips	Others	200	1203.0	2405935505
Tr Granola Choc-Blop	Penny	200	852.4	1704882498
Tr Granola Cornflakes	Penny	200	529.9	1059724655
Tr Granola Nougat Bits	Penny	200	471.3	942618798
Tr Granola Peanut Flakes	Penny	200	451.9	903827953
Tr Granola Snow Flakes	Penny	200	524.8	1049673851
Tr Granola Zimtis	Penny	200	613.4	1226756141
Tr Great Value Cinna Cubes	Wal Mart	200	23.4	46851805
Tr Gut Und Billig Honey Wheat	Edeka	200	207.2	414480539
Tr Gut Und Billig Mini Zimtos	Edeka	200	181.0	362025164
Tr Gut Und Billig Nut Flakes	Edeka	200	38.9	77716667
Tr Gut Und Billig Schoko Chips	Edeka	200	216.5	433083503
Tr Gut Und Billig Schokocornfl	Edeka	200	16.7	33404349
Tr Gut Und Billig Schoko-Reis	Edeka	200	65.6	131233757
Tr Gut Und Billig Wheat & Nut	Edeka	200	92.8	185585747

Table A2 contd.: Product category Cereals. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] total
Tr Gut Und Billig White Flakes	Edeka	200	90.6	181248441
Tr Knusperone Honey Wheat	Others	200	2522.7	5045471855
Tr Knusperone Nut Crisp	Others	200	1672.6	3345206354
Tr Knusperone Schoko Chips	Others	200	976.6	1953227678
Tr Knusperone White Flakes	Others	200	971.3	1942566005
Tr Leckermatz Honey Wheat	Granett F. Tengelmann	200	751.6	1503249974
Tr Leckermatz Mini Zimtos	Granett F. Tengelmann	200	564.3	1128567726
Tr Leckermatz Nougat Bits	Granett F. Tengelmann	200	193.2	386340235
Tr Leckermatz Schoko Chips	Granett F. Tengelmann	200	569.3	1138586526
Tr Leckermatz Wheat&Nut	Granett F. Tengelmann	200	11.4	22763549
Tr Little Man Flakers Schoko	Lidl	200	800.5	1601037636
Tr Schneekoppe Cf/Vita-Flakes	Schneekoppe	200	68.4	136710701
Tr Kellogg's Fruit_N Fibre	Kellogg's	250	134.5	336159440
Tr Kellogg's Just Right	Kellogg's	250	201.1	502844616
Tr Kellogg's Nut Feast	Kellogg's	250	38.4	95969146
Tr Kellogg's Toppas	Kellogg's	250	816.1	2040308791
Tr Kellogg's Toppas Choco	Kellogg's	250	319.1	797620845
Tr Kellogg's Toppas Traube	Kellogg's	250	192.1	480122290
Tr Nestle Fitness&Fruit	Nestle	260	92.0	239109182
Tr Kellogg's Bran Flakes	Kellogg's	333	199.4	663995751
Tr Kellogg's Choco Cornflakes	Kellogg's	333	179.2	596577805
Tr Kellogg's Crunchy Nut	Kellogg's	333	1592.7	5303509050
Tr Kellogg's Special K.	Kellogg's	333	798.3	2658200226
Tr Nestle Fitness	Nestle	340	426.6	1450586012
Total			**56054.5**	**100.728.810.216**

Fig A1: Folic acid contents and respective proportion of fortified cereal products in total sales

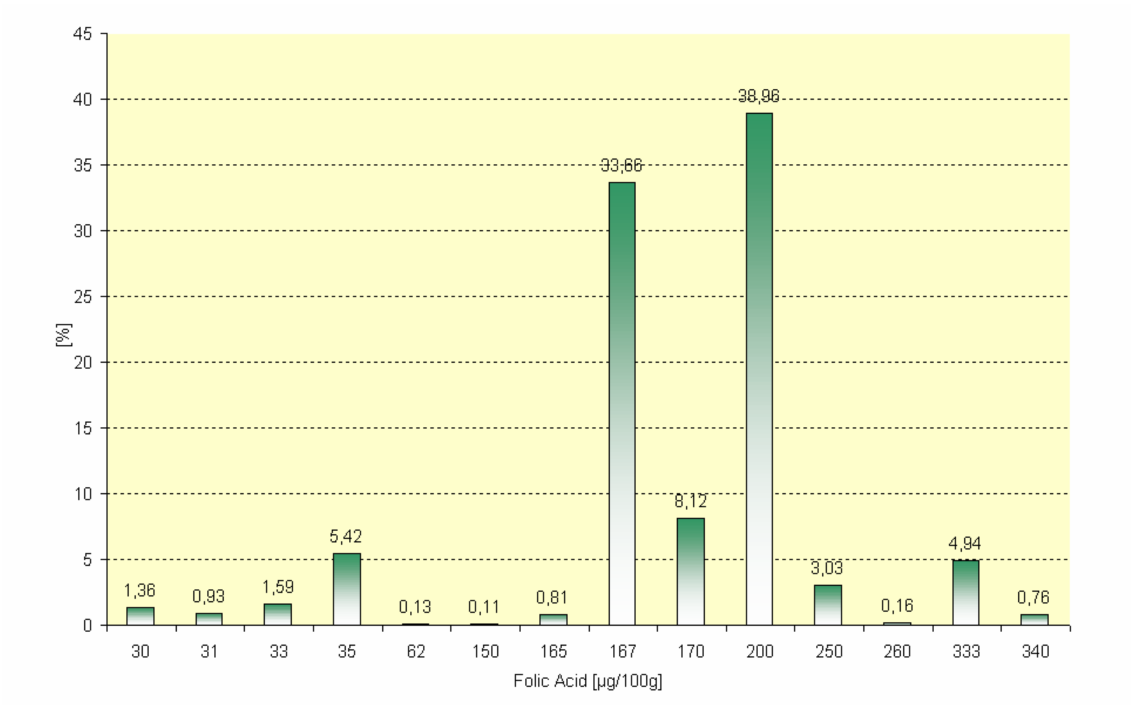


Table A3: Product category Dairy Products. Manufacturers total (April 2001 to March 2002)

Manufacturer	Volume in tonnes
Sodima	0.74
Sachsenland	1.70
Sendenhorst Mk	2.17
Berglandmilch	2.30
Saarland Milch	4.16
Kaerntnermilch	8.93
Ostbayrische Mw	9.82
Uelzena Mw	10.96
Ingolstadt-Thalmaessing Mw	13.65
Goldsteig Kaesereien	13.97
Emmi Deutschland	17.54
Bruckmann	23.56
Neuburger Mw	23.70
Donau Alb Mw	25.96
Schweriner Mk	32.66
Fit+Aktiv Vitalkost	36.24
Baeko	37.74
Naarmann Mw	51.03
No-We-Mo	64.80
Tiffany	68.62
Lindenberg Mk	88.56
Alpamare Vertrieb	89.57
Nadler Feinkost Gmbh	91.76
Gabler-Saliter	92.06
Apostel	97.11
Rogge Mk	100.74
Hellweg Mk	112.22
Am Burgwald Mw	112.61
Bodensee Albmilch	114.32
Trittauer Meierei	121.96
Osterhusumer Meierei	137.92
Rottaler Mw	148.75
Heider Gmbh	162.35
Fage Dairy Industry S.A.	177.70
Melkland Hg	190.53
Woehrmann Mw	193.81
Mueritz Milch	259.67
Mevgal S.A.	316.82
Heirler Gmbh	319.04
Naturella Getraenke Gmbh	333.05
Wiehengebirgs Mk	431.99
Borken Mk	443.03
May Werke	448.02
Coberco Dairies	463.07
Kurhessen Mz	505.45
Alnatura	512.26
Fulda Lauterbach Mw	520.73
Bad Woerishofen Mw	530.71
Central-Molkerei	549.54
Fauser Vitaquellwerk	568.82
Iset Lebensmittel	579.19
Lippische Mv	740.19
Igemo Mw	746.29
Emmi International	791.97
Lactalis Deutschland	831.92
Allgaeuland Kaeserei	904.92
De-Vau-Ge	1009.34
Suedthuer. Frischdienst	1034.15
Coesfeld Mk	1043.82
Mopro Gmbh	1242.74
Bayerische Mu	1249.04

Table A3 contd.: Product category Dairy Products. Manufacturers total (April 2001 to March 2002)

Manufacturer	Volume in tonnes
Raiffeisen-Mg	1281.87
Milupa	1356.31
Andechser Mk	1908.75
Friesland Deutschland	1924.01
Yakult Deutschland	2255.67
Magdeburg Mh	2479.23
Bremerland/Nordheide	2562.35
Hansa Milch	2668.31
Rhoengold Mk	2808.31
Omira Oberland-Milch	3374.35
Borgmann	3552.54
Dr. Gatzweiler	3643.23
Bubi E.G.	3799.30
Hocheifel Mu	3803.10
Regensburger Mw	3838.69
Thueringer Mw	3938.56
Oldenburger Mz	4144.40
Campina Melkunie	5692.12
Zoma Milch + Molke	5788.92
Alpro N.V.	5843.82
Muensterland Mw	6029.38
Elsdorfer Mk	6611.29
Noem	6635.48
Berchtesgadener Land Mw	6977.86
Hansano Mh	7078.95
Schwaelbchen Mk	7440.46
Mainfranken Mw	7640.60
Breisgaumilch	7689.08
Frischli Mw	8032.68
Hochwald	80480
Sachsenmilch	8113.90
Hohenlohe-Franken	9142.41
Gropper Mk	9192.49
Fraenkische Rhoen Mw	9330.74
Gruene Aue Mk	9542.22
Schwaben Mw	10346.33
Schwarza Mk	10884.05
Karwendel-Werke	11984.18
Humana Mu	12000.44
Vogtlandmilch	13790.20
Brio Friesland	13828.63
Elbe Weser Hg	15037.37
Weihenstephan Mk	17333.78
Emzett Berlin	17723.33
Strothmann	19437.04
Nestle	22530.56
Naabtaler Mw	24857.31
Onken	25667.77
Immergut	28027.96
Tuffi Campina	28617.39
Zott	30336.75
Nordmilch	34436.95
Suedmilch Campina	47246.79
Bauer	68639.27
Danone	69518.35
Ehrmann	93872.21
Mueller Mk	129894.66
Others	146140.37
Handelsmarke	302627.44
Total	**1.397.806.52**

Table A4: Product category Dairy Products. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] total
Fruchtzwerge Uess 300 g	Danone	20.0	1014.9	202970702
Biofit Vitame Pfirs.0,1% 150 g	Gropper Mk	24.0	1275.7	306166012
Biofit Vitamine Ananas 0,1%	Gropper Mk	24.0	776.7	186405986
Biofit Vitamine Pflaume 0,1%	Gropper Mk	24.0	593.2	142371556
Gropper Biofit Pflaum./Ananas	Gropper Mk	24.0	8.1	1940341
Strothm Molke Drink Multi 0,5L	Strothmann	30.0	3986.3	1195878616
Milram Buttermilch Multiv.0,5L	Nordmilch	40.0	893.7	357476350
Milram Vitality Mult 500Ml	Nordmilch	40.0	1722.0	688784151
Mue Drink Multivit. 500Ml Be	Mueller Mk	40.0	1973.6	789442478
Mueller Fruchtbuttermulti 500	Mueller Mk	40.0	434.4	173748813
Mueller Multivitbutterm 1%500 g	Mueller Mk	40.0	1712.2	684870696
Weih.Fr.Buttermilch Mult1%500 g	Weihenstephan Mk	44.6	998.5	445334124
Vollfit Prob. Trinkjoghurt 4X1	Noem	80.0	1053.2	842528760
Vollfit Tj Probiot. 4X125G	Noem	80.0	3973.8	3179042051
Total			**20416.1**	**9,196,960,636**

Fig A2: Folic acid levels and respective proportion of fortified dairy products in total sales

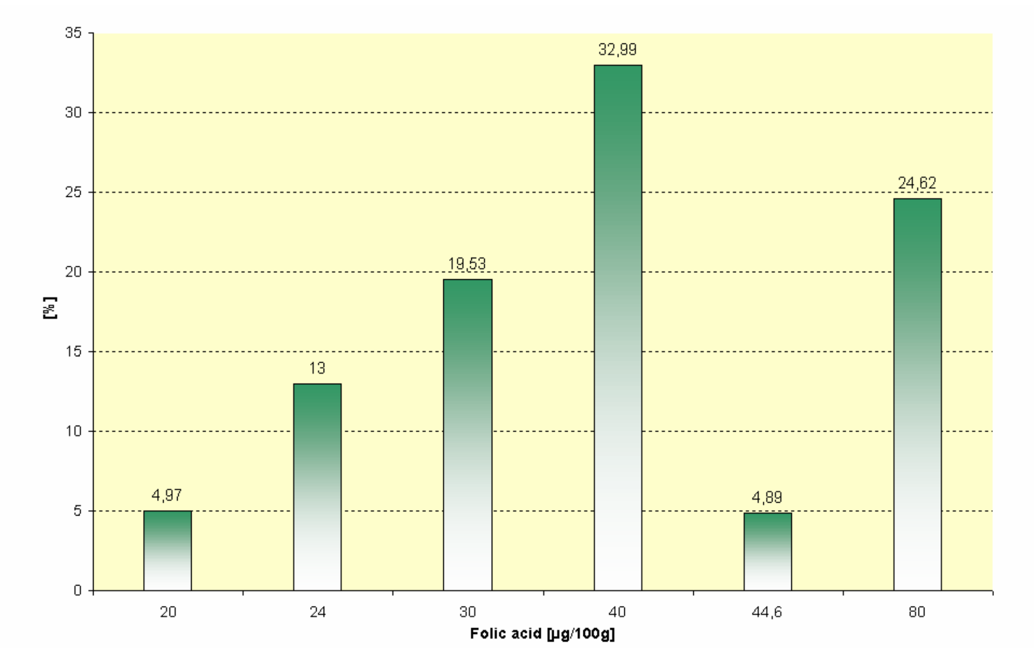


Table A5: Product category Juices. Manufacturers total (April 2001 to March 2002)

Manfuacturer	Volume in tonnes
Demeter	1.92
Skipper	2.22
Moevenpick	4.00
Designerfood	5.63
Emig Ag	7.61
Steinberger	10.87
Hohenloher Fruchtsaefte	12.79
Peterstaler Mineralquellen	17.04
Kelterei Heil	19.9
Lindauer Fruchtsaefte Gmbh	21.68
Ackermanns Haus	26.94
Siegsdorfer Petrusquelle	32.75
Bad Harzburger	32.77
Urbacher Mineralquellen	37.53
Harzer Mineralquellen	44.09
Rhodius Mineralquellen	44.66
Pepsi Cola Gmbh	49.76
Kraemer	56.98
Donath	64.14
Eden	82.53
Vmh Mineral & Heilquellen	84.06
Toenissteiner -Sprudel	92.67
Mk Mueller	106.39
Bad Duerrheimer	115.35
Alnatura	116.78
May Werke	125.70
Chiquita	167.63
Euco	167.86
Peterstaler & Rippoldsauer	179.13
Wander	184.11
Mineralbrunnen Ag	209.10
Apollinaris & Schweppes	227.72
Rickertsen	254.46
Vruthen	269.33
Schoenbornquelle	281.54
Kinella	353.78
Schloer	354.60
Coca Cola	378.48
Fsp Frischsaft-Prod. Gmbh	400.77
Asinto Getraenke Gmbh	406.35
Brauerei Alsfeld Ag	420.77
Karl Schuetz Gmbh	432.40
Milupa	437.65
Gedima Erfrischungsgetr. Gmbh	467.57
Sdi Softdrink International	508.41
Klindworth Fruchtsaefte	518.33
Oettinger Brauhaus Gmbh	526.34
Lockwitzgrund	536.70
Blaue Quelle	549.45
Kajo	646.02
Bad Driburg Heil-Und Mineralqu	747.15
Klosterquell Hofer Gmbh	779.98
Bad Vilbeler	798.15
Rapp	817.70
Soneta	901.95
Stock Vital	904.68
Waldecker Mineralbrunnen	934.91
Rabenhorst	1029.51
Rhoensprudel	1060.17
Toenissteiner	1083.39

Table A5 contd.: Product category Juices. Manufacturers total (April 2001 to March 2002)

Manfuacturer	Volume in tonnes
Odenwaldquelle	1129.14
Auricher Suessmosterei	1184.18
Quaker + Partner	1302.91
Vilsa Brunnen	1436.68
Wild	1593.64
Hans Doehle Gmbh	1707.03
Paul Bauer Fruchtsaftkelterei	1713.48
Poelz	1725.46
Tropicana	1741.14
Burkhardt	1860.39
Emsland	1869.27
Red Bull	1931.42
Spreequell Mineralbr. Gmbh	1970.02
Fruewe	2121.33
Quellenhof Br.Bochum	2146.80
Humana	2368.21
Possmann	2456.33
Winkels	2520.65
Schwartau	2561.43
Christinen Brunnen Teuteb.Min.	2882.86
Bayla Kelterei Franz G. Brendl	2966.65
Wolfra	3278.45
Frispa	3738.72
Foerstina Sprudel	3826.96
Goldquell	3967.57
Lindavia	4179.21
Mineralquellen Niederlichtenau	4220.46
Niederrhein-Gold	4602.38
Sportfit	5437.04
Neu's	5596.33
Deutsche Sisi-Werke	5609.54
Pfanner	5862.01
Adelholzener	6463.66
Elmenhorster Fsg Gmbh	6847.11
Hardthof	6936.45
Nestle	7311.41
Glockengold	7617.19
Frankenbrunnen	8892.18
Amecke	9304.66
Libehna Gmbh	9323.75
Neuhoefer	9753.20
Dietz	9789.24
Ernst Kumpf Gmbh & Co Kg	10329.74
Hipp	11548.12
Merziger	11840.50
Rottaler	13367.51
Niehoff's Vaihinger Gmbh	18159.49
Jacoby Scherbening	19329.93
Wesergarten Getraenke	19400.93
Grosskelterei Roetha	24897.90
Krings	27554.24
Becker	30557.17
Dt. Sisi Werke	40632.52
Nordgetraenke Hansa Mb	61817.47
Kirberg	63250.88
Albi	82125.07
Riha Wesergold	93337.75
Dittmeyer	142174.73
Eckes & Granini	170541.81

Table A5 contd.: Product category Juices. Manufacturers total (April 2001 to March 2002)

Manfuacturer	Volume in tonnes
Others	381923.07
Private label	820830.95
Total	**2,236,519,16**

Table A6: Product category Juices. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] total
Alete Fru.+Eis./Apf/Traub.500	Nestle	7	41.0	2867214
Alete Fru+Eisen Apf/Trau 0,5L	Nestle	7	313.0	21907164
Alete Fru+Eisen Trau/Apf Saft	Nestle	7	14.0	980829
Alete Fru/Multiv. 330Ml	Nestle	12	8.0	953730
Alete Multi Vit.Saft 500Ml	Nestle	12	300.0	35995712
Alete Multivit. Abc Pl	Nestle	12	15.8	1897561
Alete Multivitamin 750Ml	Nestle	12	243.8	29260156
Nestle Multivit. 4X033L	Nestle	12	53.5	6422852
Hipp Multiv.Saefte 2X0,5L	Hipp	15	131.7	19761248
Hipp Multivitam.Saftpl	Hipp	15	224.9	33737265
Kinella Multivitam. 0,5Ml	Deutsche Sisi-Werke	25	273.1	68263163
Becker Aktiv Banane-Vanille	Becker	30	580.2	174060787
Becker Aktiv Pfir./Mara./Jo 1L	Becker	30	1011.3	303396816
Becker Aktiv Traub-Kirsch-Holl	Becker	30	677.7	203303994
Belsina Diaet Multivitam.Nekt.	Plus	30	3619.0	1085705630
Belsina Multisaft 6X0,2 L	Plus	30	43.4	13027446
Bizzl Fruchtoran.Mw	Mineralquellen Niederlichtenau	30	764.8	229449556
Bizzl Multifrucht Mw	Mineralquellen Niederlichtenau	30	671.9	201556465
Capri Sonne Multi 0,2	Dt. Sisi Werke	30	265.2	79560293
Capri Sonne Multivit. 0,2	Dt. Sisi Werke	30	32.8	9831782
Capri Sonne Multiv. 10X0.2	Dt. Sisi Werke	30	6598.9	1979664452
Chris.Multivit.12Fruch.1,5L Mw	Christinen Brunnen Teuteb.Min.	30	10.0	3010649
Christ.Multivit. Ew 4X0,33L	Christinen Brunnen Teuteb.Min.	30	104.1	31224066
Christ.Multivita. Ew4X0,5L	Christinen Brunnen Teuteb.Min.	30	886.6	265973676
Christ.Multivitam.4Xew 0,5L	Christinen Brunnen Teuteb.Min.	30	256.3	76897212
Christ.Multivitamin 0,33L Ew	Christinen Brunnen Teuteb.Min.	30	103.1	30916865
Christ.Multivitamin Fsg 1Lew	Christinen Brunnen Teuteb.Min.	30	64.6	19371350
Christin.Multi.Fsg	Christinen Brunnen Teuteb.Min.	30	5.4	1620541
Dr.Kochs Apfel-Minze0,75L Ew	Eckes & Granini	30	272.3	81679519
Dr.Kochs Traube Holun.0,75L Ew	Eckes & Granini	30	600.5	180153052
Eurosh. Diaet Multinektar 1L	Edeka	30	2522.2	756648163
Fruewe Lucull Multinekt. 1L	Winkels	30	259.2	77761751
Gaensef.Apfel/Kiwi Jogh.Drink	Others	30	25.6	7672731
Hardth.Multi.D-Fn 1L	Hardthof	30	2937.8	881333798
Isab.Diaet-Multi-Dfn	Nordgetraenke Hansa Mb	30	129.2	38768582
Isab.Multi 12Fr.Nekt.1,5L	Nordgetraenke Hansa Mb	30	1015.4	304611595
Isabell Nek Orangen 50% 1Lbrik	Nordgetraenke Hansa Mb	30	11156.3	3346897026
Iso Classic Drink 330Ml Dose	Lidl	30	1337.7	401314205
Iso Fruit	Others	30	754.8	226431718
Iso Fruit 0,33L	Others	30	59.8	17934779
Iso Fruit Pet Orange6X0,5L Pet	Others	30	18050.6	5415174575
Lorini Multivitamin- Nektar L	Plus	30	561.2	168369274

Table A6 contd.: Product category Juices. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] totalt
May Multiv.Fsg 5X0,2	May Werke	30	85.2	25566308
Mini Big Isofit 6X0,5L	Others	30	427.8	128324547
Multivitamin 12Frucht 1,5L Ew	Christinen Brunnen Teuteb.Min.	30	683.9	205173753
Multivitamin Frucht Sg	Hardthof	30	1108.6	332592434
Multivitamin Nektar 5X0,2L	Rewe	30	816.8	245052668
Multivitamin Trimm	Norma	30	69.6	20887695
Natreen Break-Time 0,5L	Others	30	78.1	23423954
Roethaer Mulitvitamin Fsg 3X02	Grosskelterei Roetha	30	18.8	5632402
Roethaer Multi Fsg Kalarm 1.5L	Grosskelterei Roetha	30	3888.1	1166418752
Sachsenobst Fsg Multiv.0,33L	Others	30	7.3	2190911
Sachsenobst Multivitamin Ew 1L	Others	30	4.6	1380090
Sole Vita Multinekt.Diaet Brik	Lidl	30	15571.7	4671507204
Sole Vita Multivit.Nektar5X	Lidl	30	580.9	174256154
Solevita Multinek.10Er 12Fruch	Lidl	30	559.1	167741429
Trimm Diaet Multivitnektar 1 L	Norma	30	2634.3	790298807
Trimm Multivitaminmehrfruchtne	Norma	30	743.7	223120346
Trinkdas Multiv.Fsg	Grosskelterei Roetha	30	43.4	13024440
Tumador Fruchtbaer 1,5L	Hans Doehle Gmbh	30	255.5	76635054
Werder Multi Diaet Nektar 1Lmw	Others	30	10.1	3013989
Gran.Multivitamin 0,2Ltr Eck	Eckes & Granini	50	9.3	4645105
Gran.Multi-Vitaminnekt.12X0,2L	Eckes & Granini	50	5.5	2761849
Granini Fn Multivit.	Eckes & Granini	50	165.2	82585177
Granini M.Vitamin Ew6X0.75Ew	Eckes & Granini	50	510.2	255108913
Granini Multivitaminew	Eckes & Granini	50	3614.9	1807441614
Granini Tg Fn Multi 1,0L Mw	Eckes & Granini	50	5.7	2841443
Multi Nektar Light 1L	Others	50	8706.7	4353325840
Multivitamin Light 12 Frucht	Others	50	3778.4	1889209633
Multivitamin Nektar Suessli 1L	Aldi	50	22217.2	11108596362
Multivitamin Suessli	Aldi	50	298.2	149100617
Rio Gr.Mehrfruchtsaft Ew 1,5L	Edeka	50	1430.8	715407025
Dfn Multivitamin 1L	Grosskelterei Roetha	60	1094.4	656663878
Elmenho.D-Fn 10Fruch	Elmenhorster Fsg Gmbh	60	246.5	147894186
Rapp'S Multivit.Saft 1L Mw	Rapp	60	162.6	97544707
Roetha Exo.Wellness Drink Tetr	Others	60	390.9	234545117
Sitting Bull 0,25 L	Lidl	66,6	1789.1	1191566253
Becker Diaet Nektar Fruehst.	Becker	70	3543.4	2480355986
Eurosh. Multisaft 0,75L Ew	Edeka	75	269.1	201849077
Val.Mehrfruchtmul.4X0,75L	Dittmeyer	80	5.2	4127746
Valens Mehrfrucht 1L Mw	Dittmeyer	80	263.7	210946947
Valens.Mehrfr.Multivitam.0,75L	Dittmeyer	80	199.6	159657927
A&P Hm Multisaft 0,75L	Tengelmann	100	94.6	94617130
A&P Hm Multivitamins. 3X0,25L	Tengelmann	100	74.3	74320711
Albi Light D-Fn Multiv. 1,0Lmw	Albi	100	3106.4	3106440260
Albi Mu12 Goldfr Ew	Albi	100	822.3	822311795
Albi Mu12 Rote Fr Ew	Albi	100	431.3	431323951
Albi Mu12 Trop.Fr Ew	Albi	100	45.0	45013634
Amecke Sanfte Saefte Multivit.	Amecke	100	888.2	888241761
Ameckes M.Vitamin Mw	Amecke	100	448.3	448301642
Amscke Multi.Saft 0,75L Mw	Amecke	100	299.3	299336697
Belsina 12-Fru-Saft 5X0,2L	Plus	100	478.9	478912555
Belsina Multivitaminsaft 0,75L	Plus	100	1509.9	1509927086
Dr.Kochs Trink10 6X0.75Ew	Eckes & Granini	100	10.6	10607405
Dr.Kochs Trink10 Ew	Eckes & Granini	100	837.3	837298250
Frucht-Oase Multivitaminfrucht	Others	100	5148.3	5148319011
Goldquell Multivita.Nek. Mw 1L	Goldquell	100	79.8	79755214
Hardthof Multi Fsg 5X0,25L	Hardthof	100	193.0	193017748
Hohes C Fs Mult.6Xew	Eckes & Granini	100	2911.9	2911872381

Table A6 contd.: Product category Juices. Products with indications of folic acid content (April 2001 to March 2002)

Product name	Manufacturer	Folic acid [µg/100 g]	Volume in tonnes	Folic acid [µg] totalt
Hohes C Fs Multi.Ew	Eckes & Granini	100	17728.9	17728915735
Hohes C Multiv.Fs 3X0,2 Brik	Eckes & Granini	100	997.9	997942612
Hohes C Multivit.Fs	Eckes & Granini	100	2115.5	2115500929
Hohes C Multivit.Fs 1,5L Pkl	Eckes & Granini	100	3141.9	3141858110
Hohes C Multivit.Fs 1,5X8 Pkl	Eckes & Granini	100	27.4	27384720
Hohes C Multivitamin	Eckes & Granini	100	86.0	86032938
Ja Multivitaminsaft	Rewe	100	1034.6	1034591382
Jacobi Mehrfruchtsaft Tetra 0,	Jacoby Scherbening	100	2793.7	2793698548
Jacoby Bio 7 Mehrfr.Saft 1L	Jacoby Scherbening	100	3.9	3912898
Krin.Mult.V.S.0,2Lx3	Krings	100	2.6	2623256
Krings Multivit 3Er	Krings	100	17.4	17360911
Krings Multivitam Ew	Krings	100	130.9	130895622
Krings Multivitamin	Krings	100	17.3	17341040
Multi 12 Goldfruechte 1,0L Mw	Albi	100	1613.3	1613335713
Multi Vitamin Nektar @04	Sportfit	100	16.2	16146966
Multi12 Goldfr. 0,2Lew	Albi	100	58.1	58140766
Multivitamin 12 Fsg 6X0,5L	Riha Wesergold	100	11.8	11798529
Multivitamin Diaet Jacobi	Jacoby Scherbening	100	8620.7	8620729337
Multivitamin Diaet Wesergarten	Riha Wesergold	100	4644.7	4644665586
Multivitaminsaft 3X0,25L	Riha Wesergold	100	171.5	171514899
Multivitaminsaft Ew	Albi	100	286.6	286606559
Multivitaminsaft Fruchtoase	Others	100	10296.4	10296372802
Multivitaminsaft Rio D Oro 0,2	Aldi	100	2834.2	2834204417
Natreen Multivit.Dfn6X1L	Krings	100	32.3	32260536
Natreen Nek Multivit5864	Krings	100	1187.7	1187670297
Nv 10Frucht Multinektar Light	Niehoff_S Vaihinger Gmbh	100	29.5	29505366
Nv Multivit.10 Fruchtsaft 0,75	Niehoff_S Vaihinger Gmbh	100	154.6	154571299
Nv Multivit.10 Fruchtsaft 1,0L	Niehoff_S Vaihinger Gmbh	100	103.5	103458025
Nv Multivit.10 Fruchtsaft 1L M	Niehoff_S Vaihinger Gmbh	100	25.4	25361479
Rio Bravo Multivitaminsaft	Markant	100	345.7	345675734
Rio Grande Mehrfr.Saft 1L Mw	Edeka	100	1094.6	1094615126
Sole Vita Di T Mulitvit.1.5Lkt	Lidl	100	8243.5	8243531258
Solevita Multivitamin 5X0,25 L	Lidl	100	430.1	430137697
Solevita Multivitamins. 5X250	Lidl	100	1541.9	1541912801
Spar Multivi	Markant	100	16.8	16760618
Spar-Multivit-Saft3X	Markant	100	23.2	23227475
Sparsame Multi 12Fr.Di T Nekt.	Markant	100	387.2	387201573
Trimm Mulitvitaminsaft 0,75L	Norma	100	999.8	999834495
Trimm Multivitaminfruchtsaft 0	Norma	100	454.0	453972701
Vitafit Multivitaminfs Ew Glas	Lidl	100	12494.5	12494533145
Weserg. Multi 12 Fn 5X0.2L	Riha Wesergold	100	49.3	49311977
Weserg.Multi Fsg 2L Ew 20%Diat	Riha Wesergold	100	847.2	847223124
Wesergarten Multivitaminnektar/Kirsch	Riha Wesergold	100	123.0	123019732
Wesergold M.Vit Nekt	Riha Wesergold	100	2823.3	2823320104
Wesergold M.Vitam Ew	Riha Wesergold	100	2449.5	2449483889
Wesergold Multi 12 Fr.Nek. 5Er	Riha Wesergold	100	20.5	20488446
Wesergold Multi-Diaet-Fruchtne	Riha Wesergold	100	517.5	517529463
Wesergold Multivitamin Ew 100%	Riha Wesergold	100	141.8	141828638
Wesergold Multivitaminnekt.2L	Riha Wesergold	100	22.0	22007964
Es Multi.Fsg 6X0,5L Pet Ew	Edeka	200	779.6	1559256457
Es Multivitamin Fsg Pet 0,5 L	Edeka	200	76.0	151907272
Es Multivitaminsaft 5/0,25L	Edeka	200	71.0	142058235
Eurosh.Multifr.S.Getr.1.5Lpg	Edeka	200	995.4	1990785654
Weserg.Kind.Multisaft 5X0,25L	Riha Wesergold	200	236.5	472922148
Total			**244038.5**	**163774349804**

Fig A3: Folic acid contents and respective proportion of fortified soft drinks in total sales

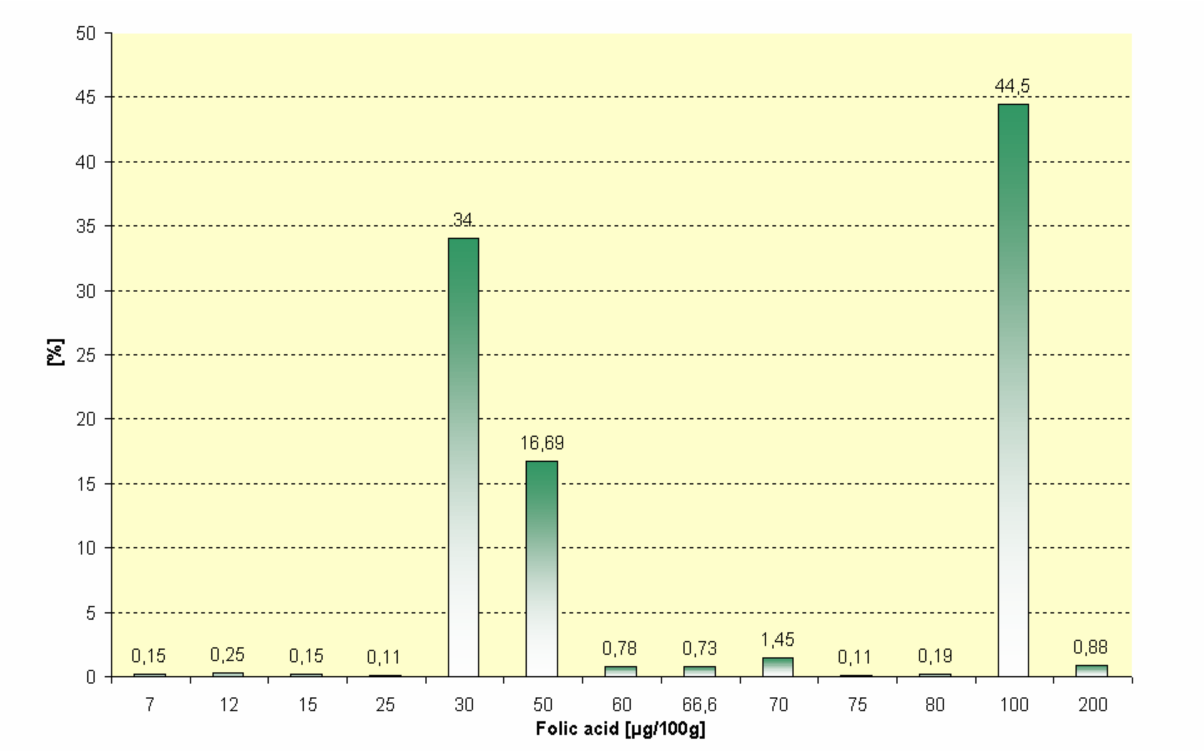


Table A7: Overview of products and fortification levels included in the BLS

Product categories	Product groups	Products	BLS Code	Moderate fortification level	High fortification level
				[µg/ 100 g or 100 ml]	
Dairy prducts	Yoghurt drink	Yogurt with fruit	M241000	80	80
		Fat free yogurt with fruit	M241100		
		Low fat yogurt with fruit	M241200		
		Yogurt 10% with fruit	M241500		
		Yogurt with fruit preparation	M242000		
		Low fat yogurt with fruit preparation	M242111		
		Low fat yogurt with fruit preparation	M242211		
		Full fat yogurt with fruit preparation	M242311		
	Whey	Whey	M160000	40	40
		Sweet whey	M161011		
		Sour whey	M262011		
	Buttermilk	Buttermilk	M150000	40	40
		Buttermilk with fruit	M251011		
Breakfast cereals	Cornflakes	Cornflakes	C515001	170	330
	Muesli	Muesli	C512011	62	62
		Muesli	C512111		
	Fruit muesli	Fruit muesli	C512301	170	170
Soft drinks	Juice	Apple fruit juice	F110600	30	100
		Orange fruit juice	F603600		
	Nectar[10]	-	-	-	-
	Fruit juice beverage	-	-	-	-

[10] As there are no datasets for nectar or fruit juice drinks in BLS II.3, only folic acid amounts in "juice" can be taken into account for soft drinks. Furthermore, according to the RKI frequency list apple juice and orange juice are by far the most frequently mentioned in the survey logs of the Nutrition Survey 1998. Therefore, in the BLS only the folic acid values of these two datasets were amended.

6.2 Results of model calculations using data from the German Nutrition Survey 1998

Table A8: BLS 0 (no fortification)

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Standard deviation)	Median	P 5	P 95	Minimum	Maximum
Men								
<19	39	340	(135)	316	147	772	123	772
19 - <25	166	341	(140)	312	142	595	97	1020
25 - <51	898	314	(130)	291	180	525	90	1536
51 - <65	447	295	(102)	281	169	463	88	834
≥ 65	213	276	(118)	260	156	477	84	1040
Women								
<19	57	268	(88)	241	135	492	91	836
19 - <25	196	264	(112)	235	128	546	84	1004
25 - <51	1225	280	(156)	246	145	489	42	3057
51 - <65	522	321	(575)	243	146	538	52	7323
≥ 65	267	239	(117)	217	140	447	65	886

Proportion of people below the refence values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	74.49	21.44	0	0
19 - <25	72.19	115.61	0	0
25 - <51	83.59	869.00	0	0
51 - <65	87.84	402.28	0	0
≥ 65	89.15	241.94	0	0
all	84.29	1650.27	0	0
Women				
<19	92.06	29.97	0	0
19 - <25	89.16	132.16	0	0
25 - <51	88.98	888.36	0.15	1.51
51 - <65	88.74	430.34	0.75	3.62
≥ 65	92.01	375.39	0	0
all	89.58	1856.22	0.25	5.13

Table A9: Simulation BSL1: Moderate fortification levels of the three product groups dairy products, Soft drinks and Cereals

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan. dev.)	Median	P 5	P 95	Minimum	Maximum
Men								
<19	39	508	(229)	441	158	899	123	1450
19 - <25	166	518	(276)	471	195	1009	106	2400
25 - <51	898	448	(226)	402	203	840	90	1682
51 - <65	447	400	(207)	357	187	739	88	2731
≥ 65	213	358	(200)	310	166	696	84	1310
Women								
<19	57	513	(176)	488	206	868	156	1126
19 - <25	196	467	(210)	412	177	942	96	1471
25 - <51	1225	410	(213)	355	175	819	61	3366
51 - <65	522	428	(582)	339	164	747	68	7323
≥ 65	267	306	(158)	275	159	586	65	986

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
[years]	%	N	%	N
Men				
<19	44.45	12.79	0	0
19 - <25	40.43	64.74	0.28	0.45
25 - <51	49.32	512.68	0	0
51 - <65	60.50	277.06	0.20	0.89
≥ 65	70.03	190.06	0	0
all	54.00	1057.33	0.07	1.35
Women				
<19	37.70	12.27	0	0
19 - <25	48.11	71.31	0	0
25 - <51	59.94	598.45	0.27	2.74
51 - <65	61.90	300.18	0.75	3.62
≥ 65	80.65	329.04	0	0
all	63.28	1311.26	0.31	6.37

Table A10: Simulation BLS 2: High fortification levels of the three product groups dairy products, soft drinks and cereals

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
< 19	39	715	(411)	531	158	1450	123	2008
19 - < 25	166	771	(600)	592	195	1862	122	5970
25 - < 51	898	607	(448)	487	210	1411	90	3711
51 - < 65	447	523	(476)	390	187	1219	88	7491
≥ 65	213	444	(377)	339	169	1154	84	2702
Women								
< 19	57	939	(495)	881	231	1944	185	2656
19 - < 25	196	760	(496)	628	197	1852	107	3697
25 - < 51	1225	548	(352)	430	179	1336	61	4080
51 - < 65	522	521	(621)	391	167	1082	68	7323
≥ 65	267	358	(240)	311	161	805	65	1275

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
[years]	%	N	%	N
Men				
< 19	32.17	9.26	0	0
19 - < 25	31.04	49.71	4.14	6.64
25 - < 51	37.72	392.16	1.46	15.13
51 - < 65	51.95	237.89	0.68	3.11
≥ 65	59.49	161.45	0.47	1.29
all	43.44	850.48	1.34	26.17
Women				
< 19	31.92	10.39	3.25	1.06
19 - < 25	28.99	42.97	3.69	5.46
25 - < 51	45.82	457.47	0.88	8.83
51 - < 65	51.70	250.73	0.75	3.62
≥ 65	71.93	293.44	0	0
all	**50.91**	**1055.00**	**0.92**	**18.98**

Table A11: Simulation BLS 3:Moderate fortification level of the three product groups and flour fortification with 100 µg folic acid per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
< 19	39	823	(275)	769	395	1464	342	1745
19 - < 25	166	817	(327)	742	359	1532	277	2729
25 - < 51	898	717	(270)	677	375	1147	175	1991
51 - < 65	447	645	(238)	611	352	1062	243	3036
≥ 65	213	588	(238)	549	309	988	224	1542
Women								
< 19	57	702	(190)	673	329	1221	247	1296
19 - < 25	196	666	(227)	640	318	1088	183	1689
25 - < 51	1225	601	(233)	560	313	1026	84	3566
51 - < 65	522	613	(590)	539	281	966	94	7564
≥ 65	267	490	(173)	465	302	750	141	1225

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	5.46	1.57	0	0
19 - <25	8.42	13.48	0.28	0.45
25 - <51	7.47	77.68	0	0
51 - <65	10.13	46.37	0.20	0.89
≥ 65	14.62	39.67	0	0
all	9.13	178.77	0.07	1.35
Women				
<19	7.49	2.44	0	0
19 - <25	14.67	21.75	0	0
25 - <51	18.47	184.43	0.41	4.06
51 - <65	20.90	101.34	0.75	3.62
≥ 65	27.48	112.12	0	0
all	20.37	422.08	0.37	7.69

Table A12: Simulation BLS 4: High fortification level of the three product groups and flour fortifciation with 100 µg folic acid per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Std.Abw.)	Median	P 5	P 95	Min.	Max.
Men								
<19	39	1029	(448)	797	395	2011	342	2228
19 - <25	166	1069	(626)	942	380	2161	277	6299
25 - <51	898	876	(471)	762	387	1696	175	4031
51 - <65	447	768	(492)	664	359	1507	243	7796
≥ 65	213	675	(401)	588	321	1459	224	2934
Women								
<19	57	1127	(497)	933	414	2265	297	2722
19 - <25	196	958	(502)	819	343	2047	183	3915
25 - <51	1225	739	(365)	629	328	1589	84	4280
51 - <65	522	706	(629)	587	291	1270	126	7564
≥ 65	267	542	(245)	509	302	934	141	1514

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	5.46	1.57	4.74	1.36
19 - <25	6.06	9.70	7.00	11.22
25 - <51	5.74	59.71	2.23	23.19
51 - <65	8.67	39.70	1.83	8.39
≥ 65	13.92	37.77	0.47	1.29
all	**7.58**	**148.46**	**2.32**	**45.44**
Women				
<19	4.11	1.34	17.43	5.67
19 - <25	10.44	15.48	5.63	8.34
25 - <51	13.98	139.55	1.63	16.32
51 - <65	18.99	92.09	1.30	6.31
≥ 65	22.42	91.45	0	0
all	**16.40**	**339.90**	**1.77**	**36.64**

Table A13: Simulation BLS 5: Moderate fortification level of the three product groups and flour fortification with 150 µg folic acid per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
<19	39	970	(304)	870	523	1733	429	1874
19 - <25	166	956	(362)	901	423	1608	333	2886
25 - <51	898	842	(304)	808	442	1343	198	2132
51 - <65	447	759	(261)	729	405	1213	279	3169
≥ 65	213	695	(264)	663	364	1114	285	1649
Women								
<19	57	788	(206)	727	388	1322	278	1418
19 - <25	196	757	(243)	724	367	1207	214	1783
25 - <51	1225	689	(248)	648	356	1131	94	3655
51 - <65	522	698	(597)	631	322	1085	100	7665
≥ 65	267	575	(191)	557	367	859	177	1336

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	0	0	0	0
19 - <25	4.70	7.53	0.28	0.45
25 - <51	3.16	32.84	0	0
51 - <65	4.71	21.55	0.20	0.89
≥ 65	7.47	20.28	0	0
all	4.20	82.19	0.07	1.35
Women				
<19	6.58	2.14	0	0
19 - <25	6.49	9.62	0	0
25 - <51	8.33	83.14	0.46	4.62
51 - <65	10.99	53.29	0.75	3.62
≥ 65	9.61	39.21	0	0
all	9.04	187.41	0.40	8.24

Table A14: Simulation BLS 6: High fortification level for the three product groups and flour fortification with 150 µg folic aicd per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
<19	39	1177	(470)	954	523	2290	429	2325
19 - <25	166	1208	(645)	1074	454	2329	333	6456
25 - <51	898	1001	(491)	895	456	1844	198	4172
51 - <65	447	882	(504)	787	437	1617	279	7929
≥ 65	213	782	(419)	683	381	1563	285	3041
Women								
<19	57	1213	(502)	957	473	2420	328	2751
19 - <25	196	1050	(509)	923	407	2141	214	4009
25 - <51	1225	827	(376)	726	383	1696	94	4369
51 - <65	522	791	(635)	681	325	1357	131	7665
≥ 65	267	627	(256)	591	367	1047	177	1625

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
[years]	%	N	%	N
Men				
<19	0	0	8.93	2.57
19 - <25	4.70	7.53	10.33	16.54
25 - <51	2.21	22.93	3.12	32.48
51 - <65	3.47	15.89	1.93	8.84
≥ 65	7.47	20.28	2.18	5.92
all	**3.40**	**66.62**	**3.39**	**66.35**
Women				
<19	3.20	1.04	21.79	7.09
19 - <25	4.57	6.77	6.23	9.23
25 - <51	6.59	65.84	2.14	21.39
51 - <65	10.02	48.58	1.44	6.97
≥ 65	8.74	35.64	0	0
all	**7.62**	**157.87**	**2.16**	**44.69**

Table A15: Simulation BLS 7: Moderate fortification level of the three product groups and flour fortification with 200 µg folic acid per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
<19	39	1116	(339)	976	578	1999	515	2008
19 - <25	166	1094	(404)	1030	471	1802	384	3040
25 - <51	898	966	(345)	921	504	1529	220	2338
51 - <65	447	870	(287)	842	454	1360	313	3307
≥ 65	213	800	(295)	764	435	1286	348	1763
Women								
<19	57	874	(226)	818	445	1471	309	1594
19 - <25	196	849	(261)	816	423	1350	246	1881
25 - <51	1225	776	(266)	740	402	1256	104	3744
51 - <65	522	782	(605)	718	364	1209	104	7770
≥ 65	267	659	(213)	643	427	961	212	1442

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	0	0	0	0
19 - <25	2.19	3.51	2.04	3.27
25 - <51	1.98	20.55	0.04	0.43
51 - <65	1.83	8.40	0.20	0.89
≥ 65	2.94	7.97	0	0
all	**2.07**	**40.43**	**0.23**	**4.59**
Women				
<19	3.20	1.04	0	0
19 - <25	3.56	5.28	0	0
25 - <51	4.94	49.28	0.57	5.67
51 - <65	7.19	34.89	0.75	3.62
≥ 65	2.46	10.06	0	0
all	**4.85**	**100.55**	**0.45**	**9.29**

Table A16: Simulation BLS 8: High fortification level of the three product groups and flour forticication with 200 µg folic aicd per 100 g

Distribution characteristics of folate equivalents [µg/day]								
Age [years]	N	Mean	(Stan.dev.)	Median	P 5	P 95	Min.	Max.
Men								
<19	39	1322	(496)	1139	650	2425	515	2577
19 - <25	166	1346	(669)	1195	522	2509	384	6610
25 - <51	898	1125	(517)	1014	523	1981	220	4318
51 - <65	447	993	(519)	895	493	1723	313	8067
≥ 65	213	887	(440)	790	443	1695	348	3148
Women								
<19	57	1299	(509)	1020	546	2569	359	2781
19 - <25	196	1141	(518)	1037	468	2283	246	4107
25 - <51	1225	914	(389)	822	427	1803	104	4458
51 - <65	522	875	(643)	778	364	1502	136	7770
≥ 65	267	711	(271)	677	427	1128	212	1731

Proportion of persons below the reference values for folate equivalents and above the tolerable upper intake levels (UL) for synthetic folic acid				
Age [years]	< 400 µg/day folate equivalents		≥ 1000 µg/day synthetic PGA (UL)	
	%	N	%	N
Men				
<19	0	0	14.69	4.23
19 - <25	2.19	3.51	13.26	21.24
25 - <51	1.45	15.12	4.34	45.11
51 - <65	1.66	7.62	2.76	12.64
≥ 65	2.94	7.97	2.18	5.92
all	**1.75**	**34.22**	**4.55**	**89.14**
Women				
<19	2.16	0.70	23.10	7.52
19 - <25	2.44	3.61	7.15	10.60
25 - <51	3.89	38.82	3.03	30.28
51 - <65	6.23	30.19	1.44	6.97
≥ 65	2.46	10.06	0	0
all	**4.02**	**83.38**	**2.67**	**55.38**

6.3 Fortified foods included in the FKE LEBTAB Database

Table A17: Product group: Soft drinks

Frequency	Product	Folic acid [µg/100 g]	Code
1	MV-Nektar, Juppi light, Rewe	60	O1A6
1	Zitronenlimonade, St-Medardus Silber	30	O1AD
1	MV-12-Fruchtnektar, Redstar	39	O1AJ
1	MV-10-Fruchtnektar, Trinkgenuss, Granini	50	O1BH
1	Diaet-MV-Nektar, leichter Genuss, Granini	200	O1W0
1	MV-Nektar, Mueller	57	O1X0
1	Diaet-MV-10-Fruchtnektar, Burga	60	O2C0
1	Mehrfrucht-MV-Nektar, Valensina	230	O360
2	Aquarius	43	O1AH
2	MV-Nektar, Natreen	100	O1AZ
2	MV-Fruchtsaftgetraenk, Drink out, Junita	200	O1P0
2	MV-Getraenk, Raktiv	40	O3W0
3	MV-Nektar, Granini	200	O1A0
3	Limetten-Zitronen-Getraenk, Carolinen	30	O1A8
3	MV-12-Fruchtsaftgetraenk, Norma	30	O1A9
3	Vitamin-Diaetnektar, Flarom	100	O1C0
3	MV-Nektar, Natreen	53	O1N0
3	MV-10-Fruchtnektar, Sole vita	60	O2L0
3	Diaet-MV-Fruchtsaftgetraenk, Top light	16	O380
3	MV-Nektar, Vitamin 10 Plus, Granini	200	O3X0
3	Mehrfrucht-Vitamingetraenk, Vitapower	30	O480
3	Diaet-Limonade, Iso Aktiv, Rheinperle	40	O4E0
3	12-Fruchtnektar, Solevita	100	O4S0
4	Fruchtschluempfe, Capri Sonne	50	O2B0
4	12-Fruchtnektar, Exotik, m.Suessmolke	130	O4M0
4	MV-Fruchtsaftgetraenk, Christinen	16	O4O0
5	MV-12-Fruchtsaftgetraenk, Christinen	30	O1AT
5	MV-Diaetfruchtnektar, Ardey-Quelle	57	O1G0
5	Diaet-MV-Nektar, Dr.Koch	180	O2F0
5	MV-Nektar, Vitamin 10 plus, Granini	80	O340
6	12-Fruchtnektar, Summerhill	30	O1AL
6	MV-12-Fruchtnektar, Isabell Active	30	O1BA
7	Diaet-MV-Fruchtsaftgetraenk, Wesergold	30	O1AW
7	Diaet-MV-Nektar, Solevita	100	O4Z0
8	Diaet-MV-12-Fruchtnektar, Hardthof	30	O1AI
8	MV-12-Fruchtnektar, light, TIP	100	O1AQ
8	Diaet-MV-10-Fruchtnektar, Granini	80	O2T0
8	Mehrfruchtsaftgetraenk, Valensina	20	O4I0
8	Apfelfruchtsaftgetraenk, Vital, Valensina	20	O4L0
8	Power Team, Capri Sonne	15	O4N0
8	Aquarius, Sportgetraenk	62	UEQ0
9	Diaet-MV-Nektar, Selters	60	O3Q0
10	Diaetlimonade, Rheinfels fit	50	O1Q0
11	MV-Mehrfruchtnektar, Valensina	75	O4D0
12	Aktiv Fruehstueck, Pfir.Mara.Jogh., Becker	30	O1A5
12	Vitaminfruchtsaftgetraenk, Gerri	50	O3I0
12	MV-12-Fruchtnektar, Solevita	100	O430
13	Erfrischungsgetraenk, Fruchttiger, Eckes	30	O1AS
13	Diaet-MV-Nektar, Niederrhein Gold	100	O1L0
14	MV-Diaet-10-Fruchtnektar, Albi	100	O1AG
14	Fruchtsaftgetr.m.Fe, Apfel, Traube, Alete	7	WIAW
15	Diaet-MV-Nektar, Beckers Bester	90	O390
16	Fruehstuecksvitamine A-C-E.Becker	70	O1A7
16	MV-Mehrfruchtsaftgetraenk, Jufri light	60	O1AO
17	MV-Nektar, leicht, fam	70	O3G0
18	Diaet-MV-Nektar, Beckers Bester	90	O330

Table A17 contd.: Product group: Soft drinks

Frequency	Product	Folic acid [µg/100 g]	Code
19	MV-Nektar, Natreen	53	O3D0
19	MV-Nektar, Capri Sonne	23	O3R0
19	Diaetlimonade, fit light, Rheinperle	60	O3V0
19	Mehrfrucht-MV-Nektar, Valensina	140	O3Z0
19	Diaet-MV-Nektar, Beckers Bester	90	O4Q0
20	Vitamin-Zitronensprudel, Herzog	16	O4Y0
22	Diaetfruchtsaftgetraenk, ACE-Vital, Ardey	30	O1AP
22	MV-Saft ABC, Alete	100	WKK0
25	Diaet-MV-Mehrfruchtnektar, Moeller	30	O490
26	Diaet-MV-11-Fruchtnektar, Moeller	80	O3K0
29	Diaet-MV-Mehrfruchtnektar, Becker	70	O1AC
36	Diaet-MV-Fruchtsaftgetraenk, 17&4, Punica	40	O2O0
37	MV-Fruchtsaftgetraenk, Capri Sonne	30	O1AA
45	Iso light, River	30	O410
106	10-Frucht-Diaetnektar, Jacobi, Aldi	50	O1AB
128	Diaet-MV-12-Fruchtnektar, Jacobi	130	O2R0

Table A18: Product Group: Dairy products

Frequency	Product	Folic acid [µg/100 g]	Code
1	Multivitamin-Fruchtjoghurt, 1.5%F, Danone	114.0	A150
1	Milupino Kindermilch, Basis, Vanill, Banane	15.0	A1AI
1	LC1 Erdbeerjoghurt, 1.5%F, Nestle	27.2	A1AO
1	Kaba, Milchmischgetraenk	14.0	A1Y0
2	Milupino Kindermilch, Milupa	9.0	A170
2	Fruchtjoghurt 0.1%F, VitaLinea, Danone	24.0	A1AQ
2	Frucht-Buttermilch, Multi Aktiv, Weihenst.	44.6	A1AV
2	Vanillemilch, 1.5%F, Kabafit	30.0	A1T0
3	Multivitamin Drink, Yovol	30.0	A110
3	Multivitamin-Fruchtzwerge, Danone	60.0	A1V0
5	Fruchtzwerge Drink, Multivitamin, Danone	200.0	A1AJ
8	Fit-Milch, 1%F, MUH, Milchunion Hocheifel	40.0	A1AP
14	Multivitamin-Buttermilch, Mueller	80.0	A1E0
14	Fruchtzwerge-Drink, Danone	35.0	A1Z0

Table A19: Product Group: Cereals

Frequency	Product	Folic acid [µg/100 g]	Code
1	Optima Fruit'n Fibre, Kellogg's	250	G1A9
1	Goody Cao, Little Man, Lidl	170	G1AM
1	Frosties, Kellogg's	167	G1AY
1	Flaker Sugar, Little Man, Lidl	167	G1BA
1	Choco-Lumbus, Knusperflakes, Hipp	150	G1BD
1	Coco Crispies, Kellogg's	440	G1H0
1	Special K, Kellogg's	440	G1W0
1	Cracklin oat Bran, Kellogg's	160	G2F0
1	Cornflakes, Little Man, Lidl	440	G2Y0
1	Chocos&White, Kellogg's	170	G320
1	Kinder-Flakes"Schneewittchen", 1.5J, Hipp	120	TUB0
1	Honey Moby, Flakes, 1.5J, Hipp	120	TUE0
2	Frosties, Spice, Kellogg's	167	G1A1
2	Clusters, Nestle	170	G1A4
2	Crunchy Nut, Kellogg's	333	G1A7
2	Flakers, Little Man, Lidl	170	G1AP
2	Peanut Flakes, Granola, Penny Markt	200	G1AV
2	Rice Krispies, Kellogg's	440	G1C0
2	Choko Krunch, Kellogg's	440	G1M0

Table A19 contd.: Product Group: Cereals

Frequency	Product	Folic acid [µg/100 g]	Code
2	Kaengus, Nestle	200	G260
2	Goody Cao, Little Man, Lidl	333	G2G0
2	Chocapic, Nestle	200	G3F0
2	Bran Flakes, Kelloggs	170	G3K0
2	Multi Cheerios, Nestle	170	G3L0
2	10-Frucht-Vitamin-VK-Muesli, Schneekoppe	165	G3V0
3	Fruit'n Fibre, Kellogg's	160	G150
3	Bran Buds, Kellogg's	160	G170
3	Schokoships, Goldhand	200	G1AC
3	Choco Ball, Little Man	170	G2O0
3	Apfel Zimt Loops, Kellogg's	160	G2S0
3	Optima Fruit'n Fibre, Kellogg's	125	G340
4	Froot Loops, Kellogg's	167	G1AQ
4	Crunchy Nut, Kellogg's	440	G1F0
4	Clusters, Nestle	200	G240
4	Cornflakes, Schneekoppe	180	G2D0
4	Multi Cheerios, Nestle	200	G2P0
4	Kaengus, Nestle	170	G3N0
4	Flakers Sugar, Little Man, Lidl	200	G3Z0
5	Chombos, Kellogg's	167	G1A3
5	Mini Zimtos, Fit&Aktiv	200	G1AD
5	White Flakes, Gletscherkrone	167	G1AO
5	Chocos, Kellogg's	167	G1AW
5	Nut Feast, Kellogg's	160	G2H0
5	Rice Krispies, Kellogg's	160	G2R0
5	Kicker, Kellogg's	167	G350
5	Just Right, Kellogg's	125	G360
6	Cornflakes, Little Man, Lidl	200	G1AL
6	Apple Minis, Nestle	170	G1AT
6	White Flakes, Leckermatz, Plus	200	G1AU
7	Wheat&Nut, Fit&Aktiv	200	G1AJ
7	Frosties, Kellogg's	440	G1D0
7	Apfel Zimt Loops, Kelloggs	170	G3U0
8	Nougat Bits, Fit&Aktiv Vitalkost	200	G1A8
8	Clusters, Nestle	200	G2K0
8	Knusper-Fruehstueck, Nestle	200	G2V0
8	Flakers Schoko, Little Man	200	G380
9	Frosties, Kellogg's	167	G1A5
9	Schoko Flakes, Gletscherkrone	200	G1A6
9	Choco Smacks, Kellogg's	167	G1AH
9	Weetabix	170	G1AN
9	Honey Loops, Kellogg's	167	G1AZ
9	Vita-Flakes, Schneekoppe	200	G250
9	Trio, Nestle	200	G2L0
9	Nut Flakes, Fit&Aktiv	200	G3W0
10	Smacks, Kellogg's	167	G1BB
10	Flakers sugar, Little Man, Lidl	170	G2M0
10	Choc Blop, Granola	200	G3P0
11	Cini Minis, Nestle	170	G1A2
11	Honey Balls, Gletscherkrone	200	G1BC
11	Nut Feast m.Eisen, Kellogg's	127	G220
11	Kinder-Flakes"Gest.Kater", 1.5J, Hipp	120	TUA0
12	Choco Krispies, Kellogg's	167	G1AX
12	Golden Crackles, Kellogg's	160	G2C0
12	Cornflakes, Leckermatz, Ledi-Markt	200	G3Q0
12	Crispy Croco, 1.5J, Hipp	120	TUD0
13	Cini Minis, Nestle	200	G2Q0
13	Froot Loops, Kellogg's	167	G390
13	Chocapic, Nestle	170	G3I0
13	Honey Wheat, Lidl	200	G3X0

Table A19 contd.: Product Group: Cereals

Frequency	Product	Folic acid [µg/100 g]	Code
13	Zimties, Granola	200	G3Y0
14	Knusperfruehstueck, Nesquick, Nestle	170	G1AS
14	Toppas Traube, Kelloggs	127	G3G0
14	Golden Ball, Little Man, Lidl	200	G3M0
15	Fruit Rings, Gletscherkrone	167	G1AR
15	Knusperfruehstueck, Nesquick	200	G2I0
15	Bee Pops, Granola	200	G3O0
17	Nut Crisp, Gletscherkrone	200	G1AB
18	Crunchy Nut, Kellogg's	167	G1AG
19	Fruit Loops, Kellogg's	160	G2E0
19	Sporties, Nestle	170	G3E0
22	Splitz, Kellogg's	160	G160
22	Honey Ball, Gletscherkrone	167	G1AK
23	Trio, Nestle	170	G3B0
24	Schoko Chips, Leckermatz	200	G3R0
25	Cornflakes, Hahne	800	G1V0
26	Chombos, Kelloggs	170	G3C0
26	Clusters, Nestle	170	G3D0
26	Honey Nuts Loops, Kelloggs	170	G3S0
26	Aepple Minis, Nestle	170	G3T0
27	Choco Cornflakes, Kellogg's	170	G310
32	Frosties, Kellogg's	167	G1AA
35	Honig Pops, Smacks, Kellogg's	440	G1B0
35	Choco Crispies, Kellogg's	167	G330
35	Special K, Kelloggs	340	G3H0
40	Cornflakes mVit, Kellogg`s	440	G1A0
44	Zimt Chips, Gletscherkrone	200	G1AE
46	Toppas, Kellogg's	160	G1S0
46	Crunchy Nut, Kellogg's	170	G2X0
48	Coco Pops, Kellogg's	170	G2Z0
49	Honeynut Loops, Kellogg's	160	G190
53	Chocos, Kellogg's	160	G2A0
58	Toppas m.Eisen, Kellogg's	127	G270
64	Fruit Loops m.Eisen, Kellogg's	170	G210
67	Knusper-Fruehstueck, Nestle	170	G280
70	Crunchy Nut, Kellogg's	160	G120
88	Coco Pops, Kellogg's	160	G1T0
91	Smacks, Kellogg's	167	G1AF
94	Cini-Minis, Nestle	170	G3A0
108	Chocos m.Eisen, Kellogg's	170	G2W0
125	Frosties, Kellogg's	170	G230
134	Cornflakes, Kellogg's	333	G1AI
203	Frosties, Kellogg's	200	G1Z0
224	Smacks, Kellogg's	170	G2T0
240	Smacks, Kellogg's	160	G110
269	Cornflakes, Kellogg's	170	G2U0
272	Cornflakes, Kellogg's	160	G130

Table A20: Product Group: Sweets

Frequency	Product	Folic acid [µg/100 g]	Code
1	Kinder Reis-Sandwich, Milupino, Milupa	94.0	I1AC
1	MV-Bonbon, Granini	700.0	P1AC
1	Smacks-Riegel, Kelloggs	170.0	P1AJ
1	Vitamingenuss, Granini	1900.0	P1L0
1	MV-Lutscher, Biolabor	2000.0	P1S0
1	Fruchtgummibaerchen m.Honig u.Vit	400.0	P250
1	Nussnougatcreme, Multini plus	200.0	P270
2	Traubenzucker, DM-Drogerie	2080.0	P1AB
2	Choco Krispies Riegel, Kelloggs	170.0	P1AF

Table A20 contd.: Product Group: Sweets

Frequency	Product	Folic acid [µg/100 g]	Code
2	Vitaminbonbon, AS	426.0	P1R0
2	Tropic Dinos, Mafruvit	400.0	P260
2	Muesliriegel, Schoko weiss, Gletscherkrone	30.0	P2N0
2	Nutri Grain Morgenschnitte, Kelloggs	135.0	P2P0
2	MV-Bonbon, Kalfany	1200.0	P2R0
2	Muesliriegel, SB-Kerne, Gletscherkrone	30.0	P2U0
3	VK-Gebaeck, Blevita	200.0	I1W0
3	MV-Bonbon, Calcium plus, Wick	560.0	P140
3	Multifit-Eis, Eismann	500.0	P190
3	Nimm 2	413.0	P1D0
3	MV-Bonbon, Sula	700.0	P220
3	MV-Wassereis, Lidl	50.0	P2F0
4	Vitaminbonbon m.Sorbit u.Mannit, Sula	400.0	P1V0
4	fit mit 9	650.0	P210
4	Multifit-Eis, Eismann	400.0	P280
4	Baeren o.Zuckerzusatz, Efruti	400.0	P2H0
4	Multifit-Eiscreme, Eismann	97.0	P2J0
4	Muesliriegel Cocos, Gletscherkrone	30.0	P2K0
5	Vitamin-Fruehstueck, Schwartau	160.0	P150
5	Eiscreme Asterix, bofrost	8.0	P1Y0
5	Fruchtgummi Pepup, Haribo	200.0	P2Q0
5	Vitamini, Schwartau extra	160.0	Z1K0
6	Eiscreme mVit, Bofrost	500.0	P1I0
6	Marmelade, Vitamin-Fruehstueck, Schwartau	200.0	P290
8	Multi 12, MV-Bonbon	1300.0	P120
10	Muesliriegel, Schokolade, Gletscherkrone	30.0	P2S0
11	Dinosaurier-Kekse, De Beukelaer	100.0	I1E0
11	Dextropur plus	200.0	P2A0
11	Fruchtgummi, Vita plus	60.0	P2L0
11	Multifit-Eis, Eismann	133.7	P2M0
13	MV-Lutscher, Biolabor	800.0	P160
15	fit mit 9+1	1100.0	P230
20	Kinder Em-eukal	300.0	P1F0
31	Nimm 2	800.0	P2E0
40	Nimm 2 Lachgummi	200.0	P2D0
48	Dextropur plus	160.0	P1M0
52	Nimm 2	1500.0	P1N0

Table A21: Product Group: Commercial infant formula[11]

Frequency	Product	Folic acid [µg/100 g]	Code
1	Hipp 1, P, Hipp	32.0	SCS0
1	Suedfruechte-MB m.Joghurt, P, 8Mo, Hipp	21.7	TAQ0
1	MB-Suedfruechte m.Joghurt, P, 8Mo, Hipp	21.7	TBA0
1	MB-Griess, P, 4Mo, Milasan	37.0	TDA0
1	Griess-MB, P, mJ, 4Mo, Humana	38.0	TE20
1	Birnen-Reis-MB, P, 4Mo, Humana	90.0	TE50
1	Schoko-MB, P, 4Mo, Humana	20.0	TEH0
1	Bananenbrei, MB, P, 4Mo, Humana	20.0	TEO0
1	Fruechte-MB, P, 4Mo, Humana	97.0	TER0
1	MB Feiner Keks, P, 6Mo, Alete	37.0	TG90
1	VK-MB, P, 6Mo, Alete	22.5	TGO0
1	Aletevit Gries-MB, P, 5Mo, Alete	23.0	TGP0
1	Basis VK-MB, P, 6Mo, Alete	22.5	TGW0
1	MB-Fruechte, P, 5Mo, Alete	25.0	TGY0
1	MB-Birchermuesli, P, 8Mo, Milupa	15.0	TK60
1	MB-Schoko, P, 6Mo, Milupa	15.0	TKR0
1	MB-Jogh-trop.Fruechte, P, 8Mo, Milupa	15.0	TKY0

[11] Please note: This group contains ready-to-eat formula and powder formula

Table A21 contd.: Product Group: Commercial infant formula

Frequency	Product	Folic acid [µg/100 g]	Code
1	Milubrei Schoko, P, mJ, 6Mo, Milupa	62.0	TL20
1	MB-Apfel-Karotte, P, mJ, 4Mo, Milupa	56.0	TL30
1	MB-Banane, P, 4Mo, Milupa	25.0	TLG0
1	Milubrei Fruechte, P, 6Mo, Milupa	67.0	TLO0
1	MB-Zwieback-Fruechte, P, 4Mo, Milupa	56.0	TLW0
1	Milubrei Apfel-Karotte, P, 4Mo, Milupa	56.0	TLY0
1	Frisch-MB, Babys Muesli, 6Mo, Alete	19.0	TR50
1	Kindergriess, 4Mo, Milupa	133.0	TRA1
1	Kindergriess, P, 4Mo, Hipp	60.0	TRC0
1	Sechskornbrei, P, 4Mo, Alete	19.0	TRI0
1	Junior-Brei Pfirsich-Orange, 8Mo, Alete	19.0	TS30
1	Frisch-MB-Reis, 4Mo, Alete	19.0	TS60
1	6-Korn-Brei, 8Mo, Humana	20.0	TS80
1	Muesli Aprikose-Cornflakes, 8Mo, Alete	19.0	TSR0
1	Pomps Kindergriess, 6Mo, Bestfoods	150.0	TT30
1	Abendbrei, MB, Mehrkorn, 6Mo, Alete	4.6	VK80
1	MB, Banane, 4Mo, Alete	4.6	VK90
1	VK-Fruechtebrei, MV, 6Mo, Alete	28.0	WLBL
1	MV-Fruechte, n4Mo, Alete	12.0	WLC5
1	Spaghetti i.Tomatensauce, Alete	13.0	WUL0
1	Kartoffelbrei&Fleischkloesschen, Alete	10.0	WUM0
2	Aletemil, P, Alete	45.0	SCG0
2	Milumil 1 o.Zucker, P, Milupa	78.0	SCT0
2	Humana Heilnahrung, P, Humana	31.0	SU50
2	HA-Brei Vanille, 4Mo, Alete	22.0	SUAL
2	Aprikosen-Milchbrei, P, 4Mo, Hipp	21.7	TA10
2	Vollkorn-MB, P, 6Mo, Hipp	20.0	TAL0
2	Vielkorn-MB m.Joghurt, P, 8Mo, Hipp	21.7	TAP0
2	Vielkorn-MB, P, mJ, 4Mo, Humana	95.0	TE10
2	Apfel-Griess-MB, P, 6Mo, Humana	80.0	TE30
2	Bananen-MB, P, mJ, 4Mo, Humana	98.0	TEZ0
2	MB-Banane, P, 4Mo, Alete	21.2	TG40
2	MB-Schokolade, P, 6Mo, Alete	31.0	THB0
2	MB-Fruechte, P, 4Mo, Alete	37.0	THE0
2	Fruechte-MB, P, 4Mo, Milupa	47.1	TII0
2	Hafer-VK-MB, P, 6Mo, Milupa	33.0	TIT0
2	MB-Banane, P, 4Mo, Milupa	25.0	TKB0
2	MB-Reis-Apfel-Honig, P, 4Mo, Milupa	25.0	TKD0
2	Milch-Griessbrei, P, 6Mo, Milupa	15.0	TKK0
2	MB-Fruechte, P, 6Mo, Milupa	15.0	TKV0
2	MB-Butterkeks-Biskuit, P, 6Mo, Milupa	67.0	TKX0
2	MB-Schoko-Fruechte, P, 8Mo, Milupa	15.0	TLC0
2	MB-Stracciatella, P, 8Mo, Milupa	62.0	TLR0
2	MB Milchreis, P, 6Mo, Milupa	67.0	TLT0
2	Muesli Aprikose-Cornflakes, 8Mo, Alete	19.0	TS40
2	Kinder-Flakes"Goldloeckchen", 1.5J, Hipp	120.0	TUC0
2	Apfelbrei, o.Milch, 4Mo, Humana	63.0	TVB0
3	Pre Aletemil, P, Alete	45.0	SAO0
3	Baby-fit 1, P, Humana	50.0	SCAA
3	Lactana B, P, Toepfer	80.0	SCU0
3	Milumil 2, m.Zucker, P, Milupa	68.0	SE90
3	Beba 2, P, Nestle	45.0	SEB0
3	Beba HA 1, P, Nestle	46.0	SUN0
3	Hafer-Fruechte-MB, P, 6Mo, Hipp	21.7	TA50
3	MB Kindergriess, P, 6Mo, Hipp	21.7	TA60
3	MB Milchreis, P, 4Mo, Hipp	21.7	TA70
3	Hafer-Fruechte-MB, P, 6Mo, Hipp	21.7	TAM0
3	VK-MB, P, 6Mo, Hipp	21.7	TAZ0
3	MB-Birnen-Reis, P, 4Mo, Humana	38.0	TEB0

Table A21 contd.: Product Group: Commercial infant formula

Frequency	Product	Folic acid [µg/100 g]	Code
3	Keksbrei, MB, P, 4Mo, Humana	20.0	TEM0
3	Birne-Reisbrei, P, mJ, Humana	38.0	TEX0
3	MB-Banane, P, 4Mo, Milupa	88.0	TG50
3	MB-Fruechte, P, 4Mo, Alete	31.0	TG80
3	Joghurtbrei Himbeeren, P, 8Mo, Alete	22.5	TGQ0
3	MB-Banane, P, 4Mo, Alete	22.5	TGT0
3	MB-Griess-Fruechte, P, 4Mo, Milupa	25.0	TK40
3	MB-Schoko-Nuss, P, 6Mo, Milupa	15.0	TK70
3	3Korn-MB, P, 4Mo, Milupa	25.0	TKE0
3	MB-Butterkeks-Biscuit, P, mJ, 6Mo, Milupa	62.0	TL10
3	Milubrei VK, P, mJ, 6Mo, Milupa	62.0	TL40
3	MB-Griess, P, 6Mo, Milupa	15.0	TLE0
3	MB-Joghurt-Fruechte, 8Mo, Milupa	15.0	TLH0
3	MB-Apfel-Vanille, P, 8Mo, Milupa	62.0	TLQ0
3	MB-Stracciatella, P, 8Mo, Milupa	62.0	TLV0
3	MB-Birne-Zwieback, P, 4Mo, Milupa	56.0	TLZ0
3	Frisch-MB, Kindergriess, 4Mo, Milupa	133.0	TRA4
3	Frisch-MB-Banane, 4Mo, Alete	19.0	TTF0
3	Fruchtsaftgetr.m.MV, n4Mo, Alete	12.0	WIBD
4	Pre Beba, P, Nestle	45.0	SAN0
4	Aletemil, P, Alete	45.0	SCZ0
4	Hippon 2, P, Hipp	188.0	SEC0
4	Humana SL Spezialbrei, P, Humana	20.0	SUV0
4	Hafer-Fruechte-MB, P, 6Mo, Hipp	21.7	TA30
4	MB-Griess, P, 6Mo, Humana	80.0	TE40
4	Vielkornbrei, MB, P, 4Mo, Humana	20.0	TEN0
4	Keksbrei, MB, P, mJ, 4Mo, Humana	20.0	TEP0
4	Cornflakes-MB, P, 8Mo, Humana	20.0	TEY0
4	MB Miluvit"mit", P, 4Mo, Milupa	88.0	TG70
4	MB-Griess, P, 5Mo, Alete	22.5	TGV0
4	Babys 1.MB Banane, P, 4Mo, Alete	31.0	THD0
4	MB-VK, P, 6MO, Milupa	15.0	TKL0
4	MB-Jogh-Pfirs-Apri-Marac, P, 8Mo, Milupa	15.0	TKW0
4	VK-MB, mJ, P, Milupa	15.0	TLA0
4	MB-Bircher-Muesli, P, 8Mo, Milupa	15.0	TLB0
4	Miluvit"mit", P, 4Mo, Milupa	25.0	TLF0
4	MB-Milchreis, P, 6Mo, Milupa	15.0	TLI0
4	MB-Apfel-Hafer, P, 6Mo, Milupa	15.0	TLK0
4	MB-MehrkornKindMuesli, P, 12Mo, Milupa	69.0	TLM0
4	Miluvit"mit", P, 8Mo, Milupa	62.0	TLN0
4	Milubrei Fruechte, P, 6Mo, Milupa	62.0	TLU0
4	6-Korn-Brei, 8Mo, Alete	19.0	TS50
4	Kindergriess, 4Mo, Humana	40.0	TSH0
4	Abend-MB, Griess, Vanille, 5Mo, Alete	9.0	VGQ0
5	Fruechte-MB, P, 5Mo, Hipp	21.7	TAY0
5	Bananen-MB, P, mJ, 4Mo, Humana	20.0	TET0
5	MB-Stracciatella, P, 8Mo, Milupa	60.0	TG30
5	VK-Milch-Muesli-Schoko, P, 12Mo, Milupa	69.0	TK30
5	MB-Fruechte, Milupa	25.0	TK80
5	MB Miluvit"mit", P, 6Mo, Milupa	67.0	TKG0
5	MB-Mehrkorn-Muesli, P, 12Mo, Milupa	62.0	TLP0
5	Schokoladenbrei, 6Mo, Alete	19.0	TR70
5	Frisch-MB Reis, 4Mo, Alete	19.0	TR80
5	Frischmilch-6-Korn-Brei, P, 6Mo, Alete	19.0	TRG0
5	Schokoladenbrei, P, 6Mo, Alete	19.0	TRM0
5	MV-Saft, n4Mo, Hipp	15.0	WKAG
5	Pfirsich i.Apfel&MV, 4Mo, Alete	28.0	WLB5
5	VK-Fruechte-Brei, MV, 6Mo, Alete	7.0	WLCN
6	Pre Hipp, P, Hipp	36.0	SAX0

Table A21 contd.: Product Group: Commercial infant formula

Frequency	Product	Folic acid [µg/100 g]	Code
6	Aptamil 1, P, Milupa	78.0	SC20
6	Milumil Drink, P, 12Mo, Milupa	67.0	SE10
6	Aponti 2, P	200.0	SEA0
6	Aptamil 2, P, Milupa	67.0	SEAE
6	Neslac, P, mJ, 12Mo, Nestle	140.0	SEAK
6	Pregomin, P, Milupa	30.0	SU10
6	Aptamil HA 2, P, Milupa	68.0	SUAA
6	Milupa SOM, P, Milupa	40.0	SUAG
6	Fruechte-MB, P, 5Mo, Hipp	21.7	TA40
6	Griess-MB, P, 6Mo, Hipp	21.7	TAN0
6	MB-Apfel-Banane-Zwieback, P, 6Mo, Humana	95.0	TE60
6	Schoko-MB, P, mJ, 4Mo, Humana	20.0	TEW0
6	MB-Schoko, P, 6Mo, Milupa	15.0	TK90
6	Miluvit"mit", P, 4Mo, Milupa	56.0	TLS0
6	Kindergriess, 6Mo, Diamant	50.0	TT50
6	Frisch-MB-Reis, 4Mo, Alete	19.0	TTN0
6	Frisch-MB-Banane, 4Mo, Alete	19.0	TTO0
6	Frisch-MB-Schoko, 6Mo, Alete	19.0	TTP0
7	Pre Milumil, P, Milupa	82.0	SAW0
7	Aponti 1, P	45.0	SC70
7	Basis-Brei HA1, P, Nestle, n4Mo	22.0	SUAB
7	Milubrei HA, P, Milupa	88.0	SUE0
7	Heilnahrung, P, Humana	44.0	SUX0
7	MB-Bircher-Muesli, P, 8Mo, Milupa	15.0	TKZ0
8	Milumil Drink, P, 12Mo, Milupa	67.0	SEN0
8	Beba HA, P, Nestle	46.0	SUS0
8	MB VK, P, 6Mo, Hipp	21.7	TA90
8	MB-Fruechte, P, 4Mo, Alete	22.0	THA0
8	MB-Suedfruechte, P, 6Mo, Milupa	15.0	TKO0
8	Miluvit"mit" MB-Griess, P, 6Mo, Milupa	62.0	TLX0
8	Muesli Aprikose-Cornflakes, 8Mo, Alete	19.0	TR60
9	Lactana B, P, Toepfer	80.0	SCK0
9	Milumil 3, P, 8Mo, Milupa	68.0	SE50
9	MB-Schokolade, P, 6Mo, Alete	22.5	TGX0
9	Milch-Reisbrei, P, 6Mo, Milupa	15.0	TKT0
9	Frisch-MB, Kindgriess, 5Mo, Alete	19.0	TTG0
10	Pre Aptamil, P, Milupa	78.0	SAL0
10	Aptamil, P, Milupa	67.0	SCD0
10	Aponti 2, P, Aponti	42.0	SEQ0
10	VK-Milchbrei, P, 6Mo, Hipp	21.7	TA20
10	MB Hafer-Fruechte, P, 6Mo, Hipp	21.7	TA80
10	MB-VK m.Fruechten, 8Mo, Alete	22.5	TGI0
10	MB-Griess, P, 5Mo, Milupa	25.0	TGZ0
11	Basis VK-MB, P, 6Mo, Alete	22.0	TGH0
11	MB-Fruechte, 5Mo, Alete	22.5	TGR0
12	Aletemil, P, Alete	45.0	SCR0
12	Milumil 3, P, Milupa	68.0	SEAC
12	Nektamil, P, 8Mo, Milupa	67.0	SEH0
12	Milumil HA 1, P, Milupa	50.0	SU80
12	Aptamil AR, P, Milupa	71.0	SUAM
12	Aletemil HA2, P, Nestle	44.0	SUL0
13	Aletemil 1, P, Alete	45.0	SC30
13	Milumil 2, m.Zucker, P, Milupa	68.0	SET0
13	Beba Start HA, P, Nestle	46.0	SUAC
13	Aponti HA, P, Aponti	46.0	SUAD
13	Aptamil AR, P, Milupa	67.0	SUAP
13	Sinlac, Spezialbrei, 4Mo, Nestle	22.0	SUQ0
13	Aptamil HA1, P, Milupa	50.0	SUW0
13	MB-VK-Muesli, P, 12Mo, Milupa	69.0	TK20

Table A21 contd.: Product Group:Infant formula

Frequency	Product	Folic acid [µg/100 g]	Code
13	HA-Brei, Banane, 4Mo, Alete	8.0	VGR0
14	Hippon 2, P, Hipp	32.0	SEL0
14	Fruechte-MB, P, mJ, 4Mo, Humana	20.0	TEQ0
15	Aletemil, Dauernahrung, P, Alete	45.0	SCL0
15	5-Korn-Milchnahrung, P, 12Mo, Alete	45.0	SE80
15	MB-VK m.Fruechten, P, 8Mo, Alete	22.0	TG10
15	Vielkorn-Flocken, P, 4Mo, Hipp	60.0	TRD0
15	Vielkorn-Flocken, Hipp	60.0	TSZ0
15	Honigschleim, P, 2Wo, Alete	90.0	TTH0
15	Apfelbrei, 4Mo, Humana	20.0	TVA0
16	Pre Humana 1, P, Humana	44.0	SAM0
17	Hipp 1, P, Hipp	36.0	SC40
17	MB-Griess, P, 4Mo, Alete	22.0	TG20
17	Miluvit"mit", P, 4Mo, Milupa	25.0	TK50
17	Honigschleim, P, 2Wo, Alete	90.0	TR40
17	Frisch-MB Schokolade, 6Mo, Alete	19.0	TR90
17	Kindergriessbrei, P, 5Mo, Alete	19.0	TRL0
18	Aptamil 3, P, Milupa	63.0	SEAF
18	Hipp 2, P, Hipp	36.0	SEW0
19	MB-Birne, P, 4Mo, Alete	22.0	THC0
20	Hipp 1, P	60.0	SC80
21	Aletemil 2 plus, P, Alete	140.0	SE60
22	Aptamil 1, P, Milupa	78.0	SCW0
22	Milupa SOM, P, Milupa	71.0	SUA0
22	Humana HA-Brei, P, mJ	67.0	SUAF
22	MB Miluvit"mit", P, 6Mo, Milupa	15.0	TKU0
22	FrischMB-Kindgriess, Alete, 5Mo	19.0	TTM0
23	Aptamil 1, P, Milupa	78.0	SC50
25	Hipp HA2, P, 4Mo	40.0	SUAQ
25	Milchgriessbrei, P, 4Mo, Humana	20.0	TES0
25	Miluvit"mit", P, 6Mo, Milupa	15.0	TLD0
26	Aletemil plus, P, 5Mo, Alete	45.0	SEM0
27	Beba HA 1, P, Nestle	46.0	SUM0
30	Humana baby-fit, P, Humana	44.0	SCQ0
31	Humana Folgemilch 2, P, Humana	125.0	SE30
32	Aptamil 2, P, Milupa	67.0	SER0
32	Aletemil HA2, P, Nestle	150.0	SUAN
32	Humana SL Spezialbrei, P, Humana	20.0	SUY0
32	Vielkorn-MB, P, mJ, 4Mo, Humana	20.0	TEV0
34	Hipp 1, P	60.0	SCF0
34	Humana SL, P, Humana	55.0	SUAJ
35	Hipp HA, P, Hipp	80.0	SUR0
35	Kindergriess, Diamant	100.0	TRY0
36	Aponti 2, P, Aponti	45.0	SEK0
36	Humana SL Spezial-Brei, P, 4Mo, Humana	20.0	SU40
38	Aletemil plus, P, 5Mo, Alete	42.0	SES0
39	Milasan 2, P, Milasan	100.0	SEAA
44	Hipp HA 1, P, Hipp	40.0	SUAH
45	Pre Humana, P	50.0	SAQ0
45	Milumil, P, Milupa	67.0	SCH0
47	Kindergriess, 4Mo, Humana	45.0	TSY0
48	Pre Aptamil, P, Milupa	78.0	SAU0
48	Beba HA 2, P, Nestle	44.0	SU20
51	Milumil 2, P, Milupa	68.0	SEZ0
52	Milumil HA 2, P, Milupa	68.0	SUF0
53	Beba 1, P, Nestle	44.0	SCX0
57	Pre Beba, P, Nestle	46.0	SAT0
57	Aptamil 1, P, Milupa	78.0	SCAB

Table A21 contd.: Product Group: Infant formula

Frequency	Product	Folic acid [µg/100 g]	Code
45	Aponti 2, P, Aponti	140.0	SE40
46	Aptamil 2, P, Milupa	67.0	SEX0
46	Pomps Kindergriess, 6Mo, Maizena	600.0	TRZ0
58	Kindergriess, 3Mo, Diamant	200.0	TSK0
59	Humana HA, P, Humana	50.0	SU60
59	Humana HA 2, P, Humana	120.0	SUH0
60	Beba HA 2, P, Nestle	150.0	SU70
66	Milupa SOM, P, Milupa	40.0	SUT0
73	Humana 1, P, mJ	50.0	SCY0
76	Humana Folgemilch, P, Humana	44.0	SEI0
80	Milumil 2, o.Zucker, P, Milupa	68.0	SEV0
83	Beba HA, P, Nestle	46.0	SUZ0
85	Humana SL, P, Humana	33.0	SUD0
86	Milumil 2, o.Zucker, P, Milupa	68.0	SEO0
88	Aptamil, P, Milupa	67.0	SCO0
91	Beba 2, P, Nestle	140.0	SEAD
91	Beba HA 1, P, Nestle	46.0	SU90
97	Humana Folgemilch, P, Humana	50.0	SEU0
98	Beba 1, P, Nestle	45.0	SCN0
98	Humana 2, P, Humana	44.0	SCP0
102	Beba 2, P, Nestle	140.0	SEY0
121	Humana SL, P, Humana	35.0	SU30
123	Hipp HA2, P, Hipp	40.0	SUAI
128	Beba 2, P, Nestle	43.0	SEP0
129	Humana SL, P, Humana	30.0	SUO0
134	Beba 1, P, Nestle	44.0	SC60
134	Milumil, P, Milupa	67.0	SCM0
135	Aptamil HA1, P, Milupa	50.0	SUAK
138	Beba 2, P, Nestle	45.0	SEG0
323	Beba HA 2, P, Nestle	150.0	SUI0

Table A22: Product Group: Beverage powder

Frequency	Product	Folic acid [µg/100 g]	Code
1	Pro-Well Trink-Molke, Pulver, Mertina	170.3	O8AJ
1	Fit Aktiv light, Multipower	360.0	O8AL
3	Beverage powder, Exotic, Uelzena	250.0	O870
4	Cacao Powder r, Kaba plus	820.0	O880
5	Fruit tea, Lidl	1667.0	O8AO
8	Beverage powder , Deesse drink	130.0	O830
9	Beverage powder, Vanilla, Kaba	200.0	O8AP
12	Fit Drink, Deesse	984.0	O6A0
14	Cellagon aurum	2000.0	O6B0
15	Fruit tea, flavoured, Carson, 1=3g	1300.0	O860
16	Teevita Orange tea, Lemon tea , 1=2, 5g	1600.0	O850
18	Baerenstarker Kindertee, Bad Heilbrunner	1670.0	O8AF
19	Fruit tea with vitamins , Milford, 1=2, 75g	1820.0	O8AA
21	Strawberry powder, Kaba	200.0	O8AH
22	Kaba plus	300.0	O8K0
28	Cacao powder, Kaba	200.0	O8AI
38	Teka fit, Tutti frutti Fruit tea, Tropic	1333.0	O810
51	Cacao powder, Vanilla, Strawberry, Kaba	500.0	O9A0
111	Beverage powder, Strawberry, Vanilla, Banana, Kaba	300.0	O8D0
116	Ovomaltine	541.0	O8P0
123	Fruit tea raspberry-strawberry, Aldi, 1=3g	1700.0	O8AC
129	Beverage powder, Vanilla, Strawberry, Banana, Kaba	400.0	O820
134	Cacao powder, Kaba	300.0	O8L0
397	Cacao powder, Kaba	400.0	O8X0

Table A23: Product Group: Food supplements (per 100 g)

Frequency	Product	Folic acid [µg/100 g]	Code
1	Palenum, P, Mead Johnson	400	UAD0
1	Energie Plus 19, P	200	UFM0
2	Isotonic 6+10, Uelzena	640	UEP0
3	Power play	300	UFK0
14	Isostar, fluessig	50	UE20

Table A24: Product Group: Food supplements (per single dose)

Frequency	Product	Folic acid [µg/100 g]	Code
1	Aktivpunkt, A-Z Aktiv fuer Kids	125.0	YAA3
1	Tutti Diabetes, Ebsina	140.0	YAA4
1	Vita Plus, MV, 1Tab.=1g, Deesse	200.0	YAAE
1	Multivit extra, 1Tab., Hermes	160.0	YAAL
1	MV&Mineral, 1Tab., Prima	100.0	YAAO
1	Multivit Kind, Abtei	150.0	YAAR
1	Omnival, MV, 1Tab.	75.0	YAAS
1	Multivit Junior, 1Tab., Hermes	120.0	YAAT
1	MV-Pulver, 1=100mg, Spinnrad	80.0	YMB0
1	Omnival, MV&Ca&Mg, Tab., Rentschler	75.0	YMT0
2	MV&Mineral, 1Tab., Additiva	400.0	YAAF
2	Kinder-MV, Huxol, 1Tab.=4.5g	200.0	YAAH
2	MV&Mineral, 1Tab.=4.25g, Woelm	200.0	YK10
2	MV, 1Tab.=2.5g, Dr.Scheffler	50.0	YK40
2	MV Eunova S, 1Tab.	200.0	YK80
2	tetefit Junior-activ, 1Tab.	120.0	YM20
2	ZEUS Spezial-Konzept	150.0	YMR0
3	MV Plus, 1Tab.=3.1g, Hansal	160.0	YA20
3	Dextro Energen Multivit, 1Tab.=3.36g	6.7	YAAD
3	Juice Plus Frucht Mischung, 2Kapseln	100.0	YAAY
3	Juice Plus Gemuese Mischung, 2Kapseln	300.0	YAAZ
3	MV, Additiva, 1Tab.=4.5g, Scheffler	1100.0	YKL0
3	Multibionta, 1Tab.=4.5g, Merck	800.0	YKZ0
4	MV&Mineral, 1Tab., Topfitz	160.0	YKY0
4	Multibionta Junior, 1Tab.=4.5g, Merck	150.0	YMO0
5	Dino-multi	50.0	YMC0
6	Vit&Mineral, gesunde Plus, 1Tab., DM	200.0	YAAG
6	Biokid 10Vit&Ca, 1Tab., Biolabor	80.0	YAAN
6	MV&Min, Additiva, 1Tab.=4.5, Scheffler	1100.0	YME0
6	MV, 1Tab., Lichtenstein	500.0	YML0
6	Herbalife Formula 1, 1=10 g	34.5	YMX0
7	MV Kinder, mGlucose, 1Tab.=1.5, Abtei	150.0	YMP0
8	MV Kinder, 1Tab.=1.5g, Abtei	150.0	YK90
8	Herbalife Formula 3, 1Tab.=0.8g	130.0	YMY0
9	MV&Mineral, 1Tab., Centrum	200.0	YAAP
9	MV, 1Tab.=4.5g, Biolabor	160.0	YKU0
15	MV, 1Tab., Hermes	160.0	YMH0
18	Kindermultivit, Baerchen, 1Tab., DM	50.0	YAAJ
79	MV, Vitalis, 1Tab.=4.5g, Huxol	200.0	YM70

Table A25: Product Group: Juices

Frequency	Product	Folic acid [µg/100 g]	Code
1	MV-Saft, Heckl	200.0	N110
1	MV-Saft, Hitchcock Plusfit	168.0	N1B0
1	MV-Saft, Krings Herrath	200.0	N1S0
1	Tropen-Vollfrucht-MV-Saft, Loeffler	200.0	N2D0
2	MV-Saft, Gueldenkron	90.0	N2F0
2	MV-Saft, f.Kinder, Wesergarten	60.0	N2X0
3	MV-Saft, 11 plus 11, Rabenhorst	100.0	N2O0
4	MV-Saft, Multi 12	200.0	N1G0
4	MV-Saft, Vaihinger	60.0	N2M0
4	MV-Saft, Dietz	60.0	N2W0
4	Hohes C plus Milch	100.0	N2Z0
4	MV-Saft, n4Mo, Hipp	80.0	WIAH
5	MV-Saft, Schloss Veldenz	46.5	N2Q0
8	MV-Saft, Multi12, mMg	200.0	N140
11	MV-Saft, TOP 12	160.0	N1C0
11	MV-Saft ABC, 6Wo, Alete	77.0	WI80
12	Apfel-Traubensaft, Valensina	30.0	N2K0
15	MV-Saft, Hohes C	180.0	N160
19	MV-Saft, D.	168.0	N1A0
19	MV-Saft, Trink 10, Junior, Dr.Koch	60.0	N2E0
21	MV-Saft, Goldhand	100.0	N2L0
21	MV-Saft, 9Wo, Hipp	80.0	WKF0
24	MV-Saft, Krings Herrath	53.0	N130
32	MV-Saft, Trink 10, Dr.Koch	280.0	N1Z0
33	MV-Saft, Dr.Koch Trink 10	200.0	N1E0
35	MV-Saft, Trink 10, Dr.Koch	80.0	N180
75	MV-Saft, TOP 12	200.0	N1T0
78	MV-Saft, Krings Herrath	55.0	N2S0
79	MV-Saft, Trinkpaeckchen, Hohes C	100.0	N2U0
83	MV-Saft, Hohes C	80.0	N2G0
196	MV-Saft, Amecke	60.0	N1R0
198	MV-Saft, Amecke	100.0	N190
349	MV-Saft, Sterngold, Fruchtoase	200.0	N1F0
422	MV-Saft, Fruchtoase	100.0	N2P0

6.4 Results of the evaluation and calculations based on the DONALD Study

Table A26 Folate intake: Consumers of fortified foods and food supplements (FS)

Consumers		Folate intake [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	non-fortified	298	55.17	23.55	20.89	53.96	97.45
	fortified	298	67.57	57.62	9.09	50.37	188.31
	FS	298	0.00	0.00	0.00	0.00	0.00
	total without FS	298	122.75	55.50	60.07	108.82	247.63
	total with FS	298	122.75	55.50	60.07	108.82	247.63
female	non-fortified	291	48.38	22.88	14.80	45.48	91.45
	fortified	291	71.84	61.98	8.81	51.67	211.31
	FS	291	0.00	0.00	0.00	0.00	0.00
	total without FS	291	120.22	60.81	57.72	100.43	265.68
	total with FS	291	120.22	60.81	57.72	100.43	265.68
Age group 1 year							
male	non-fortified	217	75.62	24.88	40.17	73.11	122.89
	fortified	217	83.18	115.85	4.23	40.12	276.28
	FS	217	1.41	12.57	0.00	0.00	0.00
	total without FS	217	158.80	116.46	66.07	118.49	362.59
	total with FS	217	160.21	117.07	67.26	118.51	362.61
female	non-fortified	221	69.93	22.18	40.15	68.04	108.08
	fortified	221	57.76	63.27	5.02	39.98	163.63
	FS	221	0.06	0.91	0.00	0.00	0.00
	total without FS	221	127.69	66.60	67.07	111.45	235.98
	total with FS	221	127.75	66.54	67.07	111.45	235.98
Age group 2-3 years							
male	non-fortified	211	87.42	30.93	49.53	83.86	139.10
	fortified	211	92.14	127.97	4.31	47.94	377.29
	FS	211	4.22	24.11	0.00	0.00	0.00
	total without FS	211	179.56	129.87	67.51	140.19	460.60
	total with FS	211	183.79	130.76	67.51	143.51	460.60
female	non-fortified	235	81.24	25.13	44.96	78.30	128.79
	fortified	235	79.23	98.00	3.37	43.30	283.33
	FS	235	12.04	63.89	0.00	0.00	56.67
	total without FS	235	160.46	98.65	68.34	132.26	349.26
	total with FS	235	172.51	112.42	72.71	142.66	384.54
Age group 4-6 years							
male	non-fortified	372	100.73	32.33	56.17	94.71	162.95
	fortified	372	133.18	195.82	10.88	77.74	447.44
	FS	372	7.77	43.51	0.00	0.00	34.68
	total without FS	372	233.91	196.64	91.10	183.52	546.97
	total with FS	372	241.68	197.63	94.77	191.30	561.74
female	non-fortified	387	95.05	29.05	55.11	92.23	147.24
	fortified	387	103.92	117.29	6.46	62.90	354.28
	FS	387	8.22	47.51	0.00	0.00	36.27
	total without FS	387	198.97	120.48	86.51	164.07	457.32
	total with FS	387	207.20	127.65	91.80	168.21	461.42
Age group 7-9 years							
male	non-fortified	343	124.29	38.05	71.77	118.98	193.21
	fortified	343	140.72	170.00	14.05	87.95	389.30
	FS	343	7.04	35.86	0.00	0.00	13.60
	total without FS	343	265.01	169.40	125.43	219.82	536.72
	total with FS	343	272.05	173.80	125.43	224.39	538.85
female	non-fortified	333	113.13	36.22	60.93	110.43	177.36
	fortified	333	148.03	213.44	13.60	78.13	497.53
	FS	333	3.89	35.88	0.00	0.00	0.00
	total without FS	333	261.17	213.02	105.19	198.55	593.08
	total with FS	333	265.06	215.78	105.26	200.21	622.53

Table A26 contd. Folate intake: Consumers of fortified foods and food supplements (FS)

Consumers		Folate intake [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 10-12 years							
male	non-fortified	222	141.97	41.71	87.94	139.70	217.76
	fortified	222	185.07	218.24	17.34	115.63	579.65
	FS	222	22.52	112.19	0.00	0.00	90.67
	total without FS	222	327.04	220.42	146.68	264.45	697.22
	total with FS	222	349.55	235.08	155.28	274.35	799.99
female	non-fortified	210	134.41	48.14	70.41	127.70	235.44
	fortified	210	172.46	255.89	6.80	90.70	676.83
	FS	210	9.12	39.72	0.00	0.00	90.67
	total without FS	210	306.86	256.28	115.21	232.03	823.44
	total with FS	210	315.98	254.65	118.73	248.90	823.44
Age group 13-14 years							
male	non-fortified	111	165.10	55.01	92.82	159.85	274.19
	fortified	111	196.47	203.93	23.57	128.07	651.55
	FS	111	4.19	29.33	0.00	0.00	0.00
	total without FS	111	361.57	209.33	148.58	294.15	842.71
	total with FS	111	365.76	211.85	148.58	294.15	842.71
female	non-fortified	92	154.39	58.28	76.69	147.67	275.09
	fortified	92	145.25	133.71	3.40	92.96	428.12
	FS	92	11.70	50.78	0.00	0.00	113.33
	total without FS	92	299.64	151.16	124.41	273.62	574.68
	total with FS	92	311.34	147.64	126.85	285.84	574.68
Age group 15-18 years							
male	non-fortified	104	183.88	67.93	93.64	174.53	311.90
	fortified	104	210.69	246.99	0.00	138.04	680.00
	FS	104	34.14	134.00	0.00	0.00	226.67
	total without FS	104	394.56	261.47	138.89	339.69	847.25
	total with FS	104	428.71	270.76	155.87	370.19	947.94
female	non-fortified	90	159.11	60.70	70.92	153.56	270.69
	fortified	90	174.20	185.91	2.89	111.49	530.40
	FS	90	16.37	74.32	0.00	0.00	90.67
	total without FS	90	333.31	196.15	131.27	265.64	753.22
	total with FS	90	349.68	229.08	141.30	275.51	753.22

Table A27: Folate intake: Non-consumers of fortified foods and food supplements (FS)

Non-consumers		Folate intake [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	non-fortified	95	70.26	29.63	35.13	64.63	121.24
female	non-fortified	129	66.16	21.40	39.84	62.08	110.29
Age group 1 year							
male	non-fortified	185	90.70	33.05	50.44	84.82	160.13
female	non-fortified	216	85.46	24.77	48.81	82.33	130.76
Age group 2-3 years							
male	non-fortified	204	91.01	29.45	52.02	86.98	145.14
female	non-fortified	192	85.06	21.15	53.09	84.23	122.28
Age group 4-6 years							
male	non-fortified	209	106.12	34.08	57.17	102.82	169.17
female	non-fortified	220	99.34	28.75	56.85	96.95	151.51
Age group 7-9 years							
male	non-fortified	151	129.52	37.91	75.58	126.12	200.81
female	non-fortified	174	125.16	39.60	70.88	117.66	194.51
Age group 10-12 years							
male	non-fortified	137	150.71	49.13	89.54	142.00	251.20
female	non-fortified	136	131.27	37.53	73.09	129.33	192.33
Age group 13-14 years							
male	non-fortified	72	168.53	54.63	93.07	159.27	267.18
female	non-fortified	88	145.09	50.22	81.37	138.57	260.01

Table A27 contd.: Folate intake: Non-consumers of fortified foods and food supplements (FS)

Non-consumers		Folate intake [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 15-18 years							
male	non-fortified	89	187.52	59.22	103.13	184.19	291.41
female	non-fortified	101	155.13	65.98	72.18	142.85	267.71

Table A28: Folate acid intake in fortified flour (100 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	Wheat flour	393	6.91	9.75	0.00	2.75	27.48
	Rye flour	393	0.77	3.09	0.00	0.00	3.70
	Wheat						
	Wholemeal flour	393	3.27	7.20	0.00	0.00	21.33
	Rye						
	Wholemeal flour	393	0.56	2.06	0.00	0.00	4.27
	Flour total	393	11.52	12.16	0.00	8.27	35.82
female	Wheat flour	420	5.20	7.96	0.00	1.12	22.75
	Rye flour	420	0.67	1.98	0.00	0.00	5.50
	Wheat						
	Wholemeal flour	420	2.75	6.76	0.00	0.00	16.70
	Rye						
	Wholemeal flour	420	0.43	1.71	0.00	0.00	3.15
	Flour total	420	9.05	10.70	0.00	5.27	30.19
Age group 1 year							
male	Wheat flour	402	23.21	16.04	3.75	19.66	53.84
	Rye flour	402	2.82	4.91	0.00	0.00	12.70
	Wheat						
	Wholemeal flour	402	2.52	5.99	0.00	0.00	14.85
	Rye						
	Wholemeal flour	402	0.72	1.94	0.00	0.00	5.60
	Flour total	402	29.27	16.05	8.37	27.06	60.80
female	Wheat flour	437	20.81	13.08	2.04	19.93	44.39
	Rye flour	437	2.26	4.41	0.00	0.00	11.88
	Wheat						
	Wholemeal flour	437	2.29	5.17	0.00	0.00	13.59
	Rye						
	Wholemeal flour	437	0.96	3.52	0.00	0.00	5.28
	Flour total	437	26.32	14.21	6.08	24.76	52.49
Age group 2-3 years							
male	Wheat flour	415	32.69	19.63	7.36	29.37	67.95
	Rye flour	415	4.15	6.37	0.00	1.35	17.30
	Wheat						
	Wholemeal flour	415	2.04	6.33	0.00	0.00	11.88
	Rye						
	Wholemeal flour	415	1.09	4.09	0.00	0.00	6.38
	Flour total	415	39.96	20.11	13.47	35.92	77.58
female	Wheat flour	427	30.23	16.29	6.91	28.31	59.58
	Rye flour	427	3.32	5.33	0.00	0.80	13.94
	Wheat						
	Wholemeal flour	427	1.91	5.97	0.00	0.00	11.91
	Rye						
	Wholemeal flour	427	1.30	3.79	0.00	0.00	6.96
	Flour total	427	36.76	15.72	14.96	34.54	64.93

Table A28 contd.: Folate acid intake in fortified flour (100 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/Day]					
		N	Mean	Std	P5	P50	P95
Age group 4-6 years							
male	Wheat flour	581	47.49	24.49	14.02	43.84	91.43
	Rye flour	581	5.13	8.77	0.00	1.33	24.48
	Wheat						
	Wholemeal flour	581	2.50	7.82	0.00	0.00	14.92
	Rye						
	Wholemeal flour	581	1.43	4.69	0.00	0.00	10.11
	Flour total	581	56.56	24.38	22.69	53.65	98.95
female	Wheat flour	607	42.05	21.97	10.92	39.15	79.53
	Rye flour	607	4.08	6.76	0.00	0.84	16.91
	Wheat						
	Wholemeal flour	607	2.28	6.67	0.00	0.00	14.24
	Rye						
	Wholemeal flour	607	1.30	4.20	0.00	0.00	7.79
	Flour total	607	49.71	21.55	18.89	47.42	85.78
Age group 7-9 years							
male	Wheat flour	494	64.28	33.00	16.40	62.89	125.39
	Rye flour	494	5.51	9.76	0.00	0.00	26.68
	Wheat						
	Wholemeal flour	494	3.14	9.29	0.00	0.00	19.58
	Rye						
	Wholemeal flour	494	1.58	4.71	0.00	0.00	9.76
	Flour total	494	74.51	31.47	29.07	71.40	128.79
female	Wheat flour	507	53.16	27.55	13.57	51.65	105.46
	Rye flour	507	5.41	8.90	0.00	1.58	23.28
	Wheat						
	Wholemeal flour	507	1.96	5.48	0.00	0.00	11.08
	Rye						
	Wholemeal flour	507	1.51	4.63	0.00	0.00	11.22
	Flour total	507	62.04	26.38	24.42	59.50	109.89
Age group 10-12 years							
male	Wheat flour	359	73.74	36.36	18.40	71.24	138.74
	Rye flour	359	7.36	13.42	0.00	0.73	37.98
	Wheat						
	Wholemeal flour	359	2.98	9.01	0.00	0.00	18.71
	Rye						
	Wholemeal flour	359	1.72	6.90	0.00	0.00	11.21
	Flour total	359	85.81	36.76	32.73	81.84	154.98
female	Wheat flour	346	62.79	31.53	18.22	60.18	117.52,
	Rye flour	346	5.96	10.23	0.00	1.20	23.85
	Wheat						
	Wholemeal flour	346	2.29	6.51	0.00	0.00	17.79
	Rye						
	Wholemeal flour	346	1.40	4.25	0.00	0.00	9.49
	Flour total	346	72.44	30.15	27.88	68.40	126.57
Age group 13-14 years							
male	Wheat flour	183	84.34	41.92	22.40	81.21	164.60
	Rye flour	183	6.38	11.41	0.00	0.00	28.27
	Wheat						
	Wholemeal flour	183	2.86	9.17	0.00	0.00	21.54
	Rye						
	Wholemeal flour	183	0.95	3.69	0.00	0.00	7.11
	Flour total	183	94.53	40.90	34.77	89.97	177.77

Table A28 contd.: Folate acid intake in fortified flour (100 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
female	Wheat flour	180	63.91	34.07	15.02	60.38	127.91
	Rye flour	180	6.17	10.20	0.00	0.00	24.35
	Wheat Wholemeal flour	180	2.10	8.46	0.00	0.00	8.86
	Rye Wholemeal flour	180	1.36	5.33	0.00	0.00	8.18
	Flour total	180	73.53	33.22	28.60	71.11	131.09
Age group 15-18 years							
male	Wheat flour	193	93.83	45.87	22.81	92.24	178.69
	Rye flour	193	7.12	13.64	0.00	0.00	38.16
	Wheat Wholemeal flour	193	2.48	8.95	0.00	0.00	19.71
	Rye Wholemeal flour	193	1.51	4.99	0.00	0.00	8.74
	Flour total	193	104.94	45.11	35.19	100.38	179.50
female	Wheat flour	191	58.37	35.82	12.17	51.65	123.54
	Rye flour	191	6.85	10.93	0.00	1.58	36.67
	Wheat Wholemeal flour	191	5.18	18.60	0.00	0.00	25.07
	Rye Wholemeal flour	191	1.04	3.88	0.00	0.00	6.47
	Flour total	191	71.45	37.06	24.45	65.43	158.25

Table A29: Folic acid intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	Wheat flour	393	10.36	14.63	0.00	4.12	41.22
	Rye flour	393	1.16	4.64	0.00	0.00	5.55
	Wheat Wholemeal flour	393	4.91	10.80	0.00	0.00	32.00
	Rye Wholemeal flour	393	0.84	3.09	0.00	0.00	6.41
	Flour total	393	17.28	18.24	0.00	12.40	53.74
female	Wheat flour	420	7.79	11.94	0.00	1.69	34.13
	Rye flour	420	1.00	2.97	0.00	0.00	8.25,
	Wheat Wholemeal flour	420	4.13	10.13	0.00	0.00	25.05
	Rye Wholemeal flour	420	0.65	2.56	0.00	0.00	4.73
	Flour total	420	13.57	16.05	0.00	7.90	45.29
Age group 1 year							
male	Wheat flour	402	34.82	24.06	5.63	29.48	80.76
	Rye flour	402	4.23	7.37	0.00	0.00	19.05
	Wheat Wholemeal flour	402	3.78	8.99	0.00	0.00	22.28
	Rye Wholemeal flour	402	1.07	2.91	0.00	0.00	8.40
	Flour total	402	43.90	24.07	12.56	40.59	91.19
female	Wheat flour	437	31.21	19.62	3.05	29.90	66.59
	Rye flour	437	3.39	6.62	0.00	0.00	17.82
	Wheat Wholemeal flour	437	3.43	7.76	0.00	0.00	20.39
	Rye Wholemeal flour	437	1.44	5.28	0.00	0.00	7.92
	Flour total	437	39.47	21.32	9.11	37.14	78.73

Table A29 contd.: Folic acid intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 2-3 years							
male	Wheat flour	415	49.04	29.45	11.04	44.06	101.93
	Rye flour	415	6.23	9.55	0.00	2.03	25.95
	Wheat						
	Wholemeal flour	415	3.05	9.50	0.00	0.00	17.83
	Rye						
	Wholemeal flour	415	1.63	6.14	0.00	0.00	9.57
	Flour total	415	59.95	30.16	20.21	53.88	116.37
female	Wheat flour	427	45.35	24.43	10.37	42.47	89.38
	Rye flour	427	4.98	8.00	0.00	1.20	20.91
	Wheat						
	Wholemeal flour	427	2.87	8.95	0.00	0.00	17.86
	Rye						
	Wholemeal flour	427	1.95	5.69	0.00	0.00	10.44
	Flour total	427	55.15	23.59	22.44	51.81	97.39
Age group 4-6 years							
male	Wheat flour	581	71.24	36.73	21.03	65.76	137.15
	Rye flour	581	7.69	13.16	0.00	2.00	36.72
	Wheat						
	Wholemeal flour	581	3.75	11.73	0.00	0.00	22.38
	Rye						
	Wholemeal flour	581	2.14	7.03	0.00	0.00	15.16
	Flour total	581	84.83	36.57	34.03	80.48	148.43
female	Wheat flour	607	63.08	32.96	16.38	58.73	119.30
	Rye flour	607	6.12	10.14	0.00	1.25	25.37
	Wheat						
	Wholemeal flour	607	3.41	10.01	0.00	0.00	21.35
	Rye						
	Wholemeal flour	607	1.95	6.30	0.00	0.00	11.69
	Flour total	607	74.56	32.32	28.34	71.12	128.67
Age group 7-9 years							
male	Wheat flour	494	96.42	49.51	24.61	94.34	188.08
	Rye flour	494	8.27	14.65	0.00	0.00	40.02
	Wheat						
	Wholemeal flour	494	4.71	13.94	0.00	0.00	29.37
	Rye						
	Wholemeal flour	494	2.38	7.07	0.00	0.00	14.64
	Flour total	494	111.77	47.20	43.60	107.10	193.19
female	Wheat flour	507	79.75	41.32	20.35	77.47	158.20
	Rye flour	507	8.11	13.35	0.00	2.37	34.93
	Wheat						
	Wholemeal flour	507	2.94	8.22	0.00	0.00	16.61
	Rye						
	Wholemeal flour	507	2.27	6.94	0.00	0.00	16.83
	Flour total	507	93.06	39.57	36.63	89.25	164.84
Age group 10-12 years							
male	Wheat flour	359	110.61	54.53	27.59	106.86	208.11
	Rye flour	359	11.04	20.13	0.00	1.10	56.98
	Wheat						
	Wholemeal flour	359	4.46	13.52	0.00	0.00	28.07
	Rye						
	Wholemeal flour	359	2.58	10.34	0.00	0.00	16.81
	Flour total	359	128.71	55.14	49.09	122.76	232.47,

Table A29 contd.: Folic acid intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
female	Wheat flour	346	94.18	47.30	27.32	90.26	176.28
	Rye flour	346	8.95	15.34	0.00	1.80	35.78
	Wheat						
	Wholemeal flour	346	3.43	9.76	0.00	0.00	26.69
	Rye						
	Wholemeal flour	346	2.10	6.37	0.00	0.00	14.24
	Flour total	346	108.66	45.23	41.81	102.60	189.85
Age group 13-14 years							
male	Wheat flour	183	126.51	62.89	33.60	121.82	246.91
	Rye flour	183	9.57	17.12	0.00	0.00	42.40
	Wheat						
	Wholemeal flour	183	4.29	13.75	0.00	0.00	32.31
	Rye						
	Wholemeal flour	183	1.42	5.54	0.00	0.00	10.67
	Flour total	183	141.80	61.35	52.15	134.95	266.66
female	Wheat flour	180	95.86	51.11	22.52	90.57	191.87
	Rye flour	180	9.25	15.30	0.00	0.00	36.52
	Wheat						
	Wholemeal flour	180	3.15	12.69	0.00	0.00	13.29
	Rye						
	Wholemeal flour	180	2.03	7.99	0.00	0.00	12.27
	Flour total	180	110.30	49.83	42.91	106.66	196.63
Age group 15-18 years							
male	Wheat flour	193	140.74	68.80	34.21	138.36	268.04
	Rye flour	193	10.67	20.46	0.00	0.00	57.24
	Wheat						
	Wholemeal flour	193	3.72	13.42	0.00	0.00	29.57
	Rye						
	Wholemeal flour	193	2.26	7.48	0.00	0.00	13.11
	Flour total	193	157.41	67.67	52.79	150.58	269.25
female	Wheat flour	191	87.56	53.73	18.25	77.48	185.30
	Rye flour	191	10.27	16.40	0.00	2.37	55.00
	Wheat						
	Wholemeal flour	191	7.78	27.89	0.00	0.00	37.60
	Rye						
	Wholemeal flour	191	1.56	5.82	0.00	0.00	9.71
	Flour total	191	107.17	55.59	36.68	98.14	237.37

Table A30: Folic acid intake from fortified flour (200 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	Wheat flour	393	13.82	19.50	0.00	5.49	54.96
	Rye flour	393	1.54	6.19	0.00	0.00	7.41
	Wheat						
	Wholemeal flour	393	6.55	14.40	0.00	0.00	42.67
	Rye						
	Wholemeal flour	393	1.13	4.13	0.00	0.00	8.55
	Flour total	393	23.03	24.32	0.00	16.53	71.65
female	Wheat flour	420	10.39	15.93	0.00	2.25	45.51
	Rye flour	420	1.33	3.96	0.00	0.00	11.00
	Wheat						
	Wholemeal flour	420	5.51	13.51	0.00	0.00	33.40
	Rye						
	Wholemeal flour	420	0.87	3.41	0.00	0.00	6.31
	Flour total	420	18.10	21.40	0.00	10.53	60.39

Table A30 contd: Folic acid intake from fortified flour (200 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 1 year							
male	Wheat flour	402	46.43	32.08	7.50	39.31	107.68
	Rye flour	402	5.64	9.83	0.00	0.00	25.40
	Wheat						
	Wholemeal flour	402	5.04	11.98	0.00	0.00	29.70
	Rye						
	Wholemeal flour	402	1.43	3.87	0.00	0.00	11.20
	Flour total	402	58.54	32.09	16.75	54.12	121.59
female	Wheat flour	437	41.62	26.16	4.07	39.87	88.78
	Rye flour	437	4.52	8.83	0.00	0.00	23.75
	Wheat						
	Wholemeal flour	437	4.58	10.34	0.00	0.00	27.19
	Rye						
	Wholemeal flour	437	1.92	7.04	0.00	0.00	10.56
	Flour total	437	52.63	28.43	12.15	49.52	104.97
Age group 2-3 years							
male	Wheat flour	415	65.38	39.27	14.72	58.75	135.91
	Rye flour	415	8.31	12.73	0.00	2.70	34.60
	Wheat						
	Wholemeal flour	415	4.07	12.67	0.00	0.00	23.77
	Rye						
	Wholemeal flour	415	2.17	8.19	0.00	0.00	12.76
	Flour total	415	79.93	40.22	26.94	71.83	155.16
female	Wheat flour	427	60.46	32.58	13.83	56.62	119.17
	Rye flour	427	6.64	10.67	0.00	1.60	27.88
	Wheat						
	Wholemeal flour	427	3.82	11.94	0.00	0.00	23.82
	Rye						
	Wholemeal flour	427	2.61	7.59	0.00	0.00	13.92
	Flour total	427	73.53	31.45	29.92	69.09	129.86
Age group 4-6 years							
male	Wheat flour	581	94.99	48.97	28.04	87.68	182.87
	Rye flour	581	10.26	17.54	0.00	2.67	48.96
	Wheat						
	Wholemeal flour	581	5.01	15.64	0.00	0.00	29.84
	Rye						
	Wholemeal flour	581	2.86	9.38	0.00	0.00	20.21
	Flour total	581	113.11	48.76	45.37	107.30	197.91
female	Wheat flour	607	84.11	43.94	21.83	78.30	159.07
	Rye flour	607	8.16	13.52	0.00	1.67	33.82
	Wheat						
	Wholemeal flour	607	4.55	13.35	0.00	0.00	28.47
	Rye						
	Wholemeal flour	607	2.60	8.40	0.00	0.00	15.58
	Flour total	607	99.42	43.10	37.78	94.83	171.56
Age group 7-9 years							
male	Wheat flour	494	128.56	66.01	32.81	125.79	250.78
	Rye flour	494	11.02	19.53	0.00	0.00	53.35
	Wheat						
	Wholemeal flour	494	6.27	18.58	0.00	0.00	39.17
	Rye						
	Wholemeal flour	494	3.17	9.43	0.00	0.00	19.52
	Flour total	494	149.02	62.93	58.14	142.80	257.59

Table A30 contd: Folic acid intake from fortified flour (200 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Folate acid intake from fortified (100 µg/100 g) wheat and rye flour [µg/day]					
		N	Mean	Std	P5	P50	P95
female	Wheat flour	507	106.33	55.09	27.13	103.30	210.93
	Rye flour	507	10.81	17.80	0.00	3.16	46.57
	Wheat						
	Wholemeal flour	507	3.91	10.96	0.00	0.00	22.15
	Rye						
	Wholemeal flour	507	3.02	9.25	0.00	0.00	22.44
	Flour total	507	124.08	52.76	48.84	118.99	219.79
Age group 10-12 years							
male	Wheat flour	359	147.49	72.71	36.79	142.48	277.48
	Rye flour	359	14.73	26.84	0.00	1.47	75.97
	Wheat						
	Wholemeal flour	359	5.95	18.03	0.00	0.00	37.43
	Rye						
	Wholemeal flour	359	3.45	13.79	0.00	0.00	22.41
	Flour total	359	171.61	73.52	65.45	163.69	309.97
female	Wheat flour	346	125.58	63.06	36.43	120.35	235.04,
	Rye flour	346	11.93	20.46	0.00	2.40	47.70
	Wheat						
	Wholemeal flour	346	4.57	13.01	0.00	0.00	35.59
	Rye						
	Wholemeal flour	346	2.80	8.49	0.00	0.00	18.99
	Flour total	346	144.88	60.30	55.75	136.80	253.13
Age group 13-14 years							
male	Wheat flour	183	168.68	83.85	44.80	162.42	329.21
	Rye flour	183	12.76	22.83	0.00	0.00	56.53
	Wheat						
	Wholemeal flour	183	5.72	18.33	0.00	0.00	43.08
	Rye						
	Wholemeal flour	183	1.90	7.38	0.00	0.00	14.23
	Flour total	183	189.06	81.80	69.54	179.93	355.54
female	Wheat flour	180	127.81	68.14	30.03	120.76	255.83
	Rye flour	180	12.34	20.40	0.00	0.00	48.70
	Wheat						
	Wholemeal flour	180	4.20	16.93	0.00	0.00	17.73
	Rye						
	Wholemeal flour	180	2.71	10.66	0.00	0.00	16.35
	Flour total	180	147.06	66.44	57.21	142.21	262.18
Age group 15-18 years							
male	Wheat flour	193	187.66	91.73	45.62	184.48	357.38
	Rye flour	193	14.23	27.27	0.00	0.00	76.32
	Wheat						
	Wholemeal flour	193	4.97	17.90	0.00	0.00	39.43
	Rye						
	Wholemeal flour	193	3.02	9.98	0.00	0.00	17.48
	Flour total	193	209.87	90.22	70.39	200.77	358.99
female	Wheat flour	191	116.74	71.64	24.34	103.31	247.07
	Rye flour	191	13.70	21.87	0.00	3.16	73.34
	Wheat						
	Wholemeal flour	191	10.37	37.19	0.00	0.00	50.14
	Rye						
	Wholemeal flour	191	2.08	7.77	0.00	0.00	12.94
	Flour total	191	142.89	74.12	48.91	130.85	316.50

Table A31: Folate intake in total from fortified flour (100 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified (100 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	non-fortified	393	58.82	25.94	22.32	55.82	101.97
	fortified	393	51.24	57.92	0.00	37.55	178.01
	flour 100 µg	393	19.58	20.67	0.00	14.05	60.90
	FS	393	0.00	0.00	0.00	0.00	0.00
	total	393	129.64	59.59	51.13	118.76	251.68
female	non-fortified	420	53.84	23.87	16.34	51.19	96.02
	fortified	420	49.78	61.32	0.00	36.16	179.11
	flour 100 µg	420	15.38	18.19	0.00	8.95	51.33
	FS	420	0.00	0.00	0.00	0.00	0.00
	total	420	119.00	63.50	45.56	103.55	244.66
Age group 1 Year							
male	non-fortified	402	82.56	29.85	43.85	76.96	140.79
	fortified	402	44.90	94.61	0.00	5.15	204.68
	flour 100 µg	402	49.76	27.28	14.24	46.00	103.35
	FS	402	0.76	9.25	0.00	0.00	0.00
	total	402	177.98	96.24	90.45	154.08	329.18
female	non-fortified	437	77.60	24.72	41.32	74.36	119.62
	fortified	437	29.21	53.44	0.00	0.75	129.20
	flour 100 µg	437	44.74	24.16	10.33	42.10	89.23
	FS	437	0.03	0.65	0.00	0.00	0.00
	total	437	151.58	59.03	87.36	138.06	256.98
Age group 2-3 years							
male	non-fortified	415	89.18	30.23	51.13	85.13	142.42
	fortified	415	46.85	102.15	0.00	1.09	235.96
	flour 100 µg	415	67.94	34.18	22.90	61.06	131.88
	FS	415	2.15	17.30	0.00	0.00	0.00
	total	415	206.12	113.04	99.35	177.93	416.02
female	non-fortified	427	82.95	23.48	46.98	80.73	124.64
	fortified	427	43.60	82.66	0.00	6.74	189.34
	flour 100 µg	427	62.50	26.73	25.43	58.72	110.38
	FS	427	6.63	47.73	0.00	0.00	0.00
	total	427	195.68	98.27	102.80	168.60	376.54
Age group 4-6 years							
male	non-fortified	581	102.67	33.04	56.26	96.74	164.43
	fortified	581	85.27	169.17	0.00	27.20	359.27
	flour 100 µg	581	96.14	41.44	38.57	91.21	168.22
	FS	581	4.97	34.99	0.00	0.00	0.00
	total	581	289.06	177.94	133.24	254.41	577.01
female	non-fortified	607	96.61	28.99	55.32	93.34	148.24
	fortified	607	66.25	106.12	0.00	27.20	293.13
	flour 100 µg	607	84.50	36.63	32.12	80.61	145.83
	FS	607	5.24	38.13	0.00	0.00	0.00
	total	607	252.61	119.61	127.31	221.19	483.33
Age group 7-9 years							
male	non-fortified	494	125.89	38.05	72.30	121.03	194.03
	fortified	494	97.70	155.76	0.00	45.33	347.71
	flour 100 µg	494	126.67	53.49	49.42	121.38	218.95
	FS	494	4.89	30.04	0.00	0.00	0.00
	total	494	355.15	168.17	188.41	320.15	636.20
female	non-fortified	507	117.26	37.81	63.33	112.22	185.22
	fortified	507	97.23	186.66	0.00	37.40	415.93
	flour 100 µg	507	105.47	44.84	41.52	101.15	186.82
	FS	507	2.56	29.12	0.00	0.00	0.00
	total	507	322.51	192.23	161.53	276.22	633.56

Table A31 contd.: Total folate intake from fortified flour (100 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified (100 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 10-12 years							
male	non-fortified	359	145.31	44.82	87.94	139.90	234.40
	fortified	359	114.44	193.67	0.00	47.60	425.63
	flour 100 µg	359	145.87	62.49	55.64	139.13	263.47
	FS	359	13.92	88.82	0.00	0.00	0.00
	total	359	419.54	224.04	204.83	361.40	831.49
female	non-fortified	346	133.17	44.24	73.09	128.52	212.10
	fortified	346	104.67	216.29	0.00	28.02	463.53
	flour 100 µg	346	123.15	51.26	47.39	116.28	215.16
	FS	346	5.53	31.24	0.00	0.00	0.00
	total	346	366.53	227.82	173.11	310.02	730.85
Age group 13-14 years							
male	non-fortified	183	166.45	54.74	93.07	159.85	267.18
	fortified	183	119.17	185.47	0.00	49.13	566.67
	flour 100 µg	183	160.70	69.53	59.11	152.94	302.21
	FS	183	2.54	22.89	0.00	0.00	0.00
	total	183	448.86	207.50	224.06	396.28	853.52
female	non-fortified	180	149.84	54.53	79.03	145.52	261.00
	fortified	180	74.24	119.96	0.00	0.00	379.67
	flour 100 µg	180	125.00	56.48	48.63	120.88	222.85
	FS	180	5.98	36.68	0.00	0.00	0.00
	total	180	355.07	150.30	179.96	307.16	656.49
Age group 15-18 years							
male	non-fortified	193	185.56	63.92	97.24	175.54	297.52
	fortified	193	113.53	209.32	0.00	0.00	467.90
	flour 100 µg	193	178.39	76.69	59.83	170.65	305.14
	FS	193	18.40	99.62	0.00	0.00	79.33
	total	193	495.88	255.84	223.68	428.60	1027.19
female	non-fortified	191	157.01	63.41	70.92	150.22	270.69
	fortified	191	82.08	154.24	0.00	0.00	425.00
	flour 100 µg	191	121.46	63.00	41.57	111.23	269.02
	FS	191	7.71	51.52	0.00	0.00	0.00
	total	191	368.26	208.85	160.85	308.88	780.98

Table A32: Total folate intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified (150 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	non-fortified	393	58.82	25.94	22.32	55.82	101.97
	fortified	393	51.24	57.92	0.00	37.55	178.01
	flour 150 µg	393	29.37	31.00	0.00	21.08	91.35
	FS	393	0.00	0.00	0.00	0.00	0.00
	total	393	139.43	64.20	51.66	127.86	258.03
female	non-fortified	420	53.84	23.87	16.34	51.19	96.02
	fortified	420	49.78	61.32	0.00	36.16	179.11
	flour 150 µg	420	23.08	27.29	0.00	13.43	76.99
	FS	420	0.00	0.00	0.00	0.00	0.00
	total	420	126.69	68.08	46.01	113.12	261.55
Age group 1 year							
male	non-fortified	402	82.56	29.85	43.85	76.96	140.79
	fortified	402	44.90	94.61	0.00	5.15	204.68
	flour 150 µg	402	74.64	40.92	21.35	69.00	155.03
	FS	402	0.76	9.25	0.00	0.00	0.00
	total	402	202.86	99.54	100.54	178.30	356.42

Table A32 contd.: Total folate intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified (150 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
female	non-fortified	437	77.60	24.72	41.32	74.36	119.62
	fortified	437	29.21	53.44	0.00	0.75	129.20
	flour 150 µg	437	67.10	36.25	15.49	63.14	133.84
	FS	437	0.03	0.65	0.00	0.00	0.00
	total	437	173.95	64.59	98.29	159.43	279.07
Age group 2-3 years							
male	non-fortified	415	89.18	30.23	51.13	85.13	142.42
	fortified	415	46.85	102.15	0.00	1.09	235.96
	flour 150 µg	415	101.91	51.28	34.35	91.59	197.83
	FS	415	2.15	17.30	0.00	0.00	0.00
	total	415	240.09	120.07	115.52	210.66	455.93
female	non-fortified	427	82.95	23.48	46.98	80.73	124.64
	fortified	427	43.60	82.66	0.00	6.74	189.34
	flour 150 µg	427	93.75	40.10	38.15	88.09	165.57
	FS	427	6.63	47.73	0.00	0.00	0.00
	total	427	226.93	102.48	119.38	202.91	410.08
Age group 4-6 years							
male	non-fortified	581	102.67	33.04	56.26	96.74	164.43
	fortified	581	85.27	169.17	0.00	27.20	359.27
	flour 150 µg	581	144.22	62.17	57.85	136.81	252.33
	FS	581	4.97	34.99	0.00	0.00	0.00
	total	581	337.13	184.29	155.97	303.17	625.20
female	non-fortified	607	96.61	28.99	55.32	93.34	148.24
	fortified	607	66.25	106.12	0.00	27.20	293.13
	flour 150 µg	607	126.76	54.95	48.18	120.91	218.74
	FS	607	5.24	38.13	0.00	0.00	0.00
	total	607	294.86	125.62	145.57	269.38	543.05
Age group 7-9 years							
male	non-fortified	494	125.89	38.05	72.30	121.03	194.03
	fortified	494	97.70	155.76	0.00	45.33	347.71
	flour 150 µg	494	190.00	80.24	74.12	182.07	328.42
	FS	494	4.89	30.04	0.00	0.00	0.00
	total	494	418.48	178.08	227.10	384.84	716.89
female	non-fortified	507	117.26	37.81	63.33	112.22	185.22
	fortified	507	97.23	186.66	0.00	37.40	415.93
	flour 150 µg	507	158.20	67.27	62.27	151.72	280.23
	FS	507	2.56	29.12	0.00	0.00	0.00
	total	507	375.25	197.95	188.83	336.51	684.30
Age group 10-12 years							
male	non-fortified	359	145.31	44.82	87.94	139.90	234.40
	fortified	359	114.44	193.67	0.00	47.60	425.63
	flour 150 µg	359	218.80	93.74	83.45	208.70	395.21
	FS	359	13.92	88.82	0.00	0.00	0.00
	total	359	492.48	236.70	244.41	443.56	930.60
female	non-fortified	346	133.17	44.24	73.09	128.52	212.10
	fortified	346	104.67	216.29	0.00	28.02	463.53
	flour 150 µg	346	184.73	76.89	71.08	174.42	322.74
	FS	346	5.53	31.24	0.00	0.00	0.00
	total	346	428.10	236.26	210.42	375.00	811.16
Age group 13-14 years							
male	non-fortified	183	166.45	54.74	93.07	159.85	267.18
	fortified	183	119.17	185.47	0.00	49.13	566.67
	flour 150 µg	183	241.06	104.29	88.66	229.41	453.32
	FS	183	2.54	22.89	0.00	0.00	0.00
	total	183	529.22	222.25	263.99	477.97	958.91
female	non-fortified	180	149.84	54.53	79.03	145.52	261.00
	fortified	180	74.24	119.96	0.00	0.00	379.67
	flour 150 µg	180	187.50	84.71	72.94	181.32	334.28
	FS	180	5.98	36.68	0.00	0.00	0.00

Table A32 contd.: Total folate intake from fortified flour (150 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified (150 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 15-18 years							
male	non-fortified	193	185.56	63.92	97.24	175.54	297.52
	fortified	193	113.53	209.32	0.00	0.00	467.90
	FS	193	18.40	99.62	0.00	0.00	79.33
	total	193	585.08	273.60	271.98	533.97	1091.65
female	non-fortified	191	157.01	63.41	70.92	150.22	270.69
	fortified	191	82.08	154.24	0.00	0.00	425.00
	flour 150 µg	191	182.18	94.50	62.36	166.84	403.53
	FS	191	7.71	51.52	0.00	0.00	0.00
	total	191	428.99	224.12	188.14	369.42	860.81

Table A33: Total folate intake from fortified flour (200 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified group (200 µg/100 g) flour [µg/day]					
		N	Mean	Std	P5	P50	P95
Age group 6-12 months							
male	non-fortified	393	58.82	25.94	22.32	55.82	101.97
	fortified	393	51.24	57.92	0.00	37.55	178.01
	flour 200 µg	393	39.16	41.34	0.00	28.11	121.80
	FS	393	0.00	0.00	0.00	0.00	0.00
	total	393	149.22	70.04	53.46	135.06	276.20
female	non-fortified	420	53.84	23.87	16.34	51.19	96.02
	fortified	420	49.78	61.32	0.00	36.16	179.11
	flour 200 µg	420	30.77	36.39	0.00	17.90	102.66
	FS	420	0.00	0.00	0.00	0.00	0.00
	total	420	134.38	73.51	46.17	119.99	279.65
Age group 1 year							
male	non-fortified	402	82.56	29.85	43.85	76.96	140.79
	fortified	402	44.90	94.61	0.00	5.15	204.68
	flour 200 µg	402	99.52	54.56	28.47	92.00	206.71
	FS	402	0.76	9.25	0.00	0.00	0.00
	total	402	227.74	104.53	112.98	202.60	387.65
female	non-fortified	437	77.60	24.72	41.32	74.36	119.62
	fortified	437	29.21	53.44	0.00	0.75	129.20
	flour 200 µg	437	89.47	48.33	20.66	84.19	178.45
	FS	437	0.03	0.65	0.00	0.00	0.00
	total	437	196.32	71.78	107.85	179.06	316.02
Age group 2-3 years							
male	non-fortified	415	89.18	30.23	51.13	85.13	142.42
	fortified	415	46.85	102.15	0.00	1.09	235.96
	flour 200 µg	415	135.88	68.37	45.80	122.12	263.77
	FS	415	2.15	17.30	0.00	0.00	0.00
	total	415	274.06	128.99	126.87	245.21	515.24
female	non-fortified	427	82.95	23.48	46.98	80.73	124.64
	fortified	427	43.60	82.66	0.00	6.74	189.34
	flour 200 µg	427	125.00	53.46	50.86	117.45	220.76
	FS	427	6.63	47.73	0.00	0.00	0.00
	total	427	258.18	108.19	136.33	235.62	449.28
Age group 4-6 years							
male	non-fortified	581	102.67	33.04	56.26	96.74	164.43
	fortified	581	85.27	169.17	0.00	27.20	359.27
	flour 200 µg	581	192.29	82.89	77.14	182.42	336.44
	FS	581	4.97	34.99	0.00	0.00	0.00
	total	581	385.21	192.67	179.08	352.30	685.05

Table A33 contd.: Total folate intake from fortified flour (200 µg/100 g) for the entire study group (consumers and non-consumers)

Age group		Total folate intake from fortified group (200 µg/100 g) Flour [µg/day]					
		N	Mean	Std	P5	P50	P95
female	non-fortified	607	96.61	28.99	55.32	93.34	148.24
	fortified	607	66.25	106.12	0.00	27.20	293.13
	flour 200 µg	607	169.01	73.26	64.23	161.21	291.66
	FS	607	5.24	38.13	0.00	0.00	0.00
	total	607	337.11	133.88	165.89	318.25	595.70
Age group 7-9 years							
male	non-fortified	494	125.89	38.05	72.30	121.03	194.03
	fortified	494	97.70	155.76	0.00	45.33	347.71
	flour 200 µg	494	253.33	106.98	98.83	242.77	437.90
	FS	494	4.89	30.04	0.00	0.00	0.00
	total	494	481.82	191.25	255.74	449.07	811.26
female	non-fortified	507	117.26	37.81	63.33	112.22	185.22
	fortified	507	97.23	186.66	0.00	37.40	415.93
	flour 200 µg	507	210.93	89.69	83.03	202.29	373.63
	FS	507	2.56	29.12	0.00	0.00	0.00
	total	507	427.98	205.96	215.48	391.53	761.78
Age group 10-12 years							
male	non-fortified	359	145.31	44.82	87.94	139.90	234.40
	fortified	359	114.44	193.67	0.00	47.60	425.63
	flour 200 µg	359	291.74	124.98	111.27	278.27	526.94
	FS	359	13.92	88.82	0.00	0.00	0.00
	total	359	565.41	252.61	279.37	518.58	1042.62
female	non-fortified	346	133.17	44.24	73.09	128.52	212.10
	fortified	346	104.67	216.29	0.00	28.02	463.53
	flour 200 µg	346	246.30	102.52	94.78	232.56	430.32
	FS	346	5.53	31.24	0.00	0.00	0.00
	total	346	489.68	247.09	243.84	436.97	881.66
Age group 13-14 years							
male	non-fortified	183	166.45	54.74	93.07	159.85	267.18
	fortified	183	119.17	185.47	0.00	49.13	566.67
	flour 200 µg	183	321.41	139.06	118.21	305.88	604.42
	FS	183	2.54	22.89	0.00	0.00	0.00
	total	183	609.57	241.15	295.37	549.64	1082.91
female	non-fortified	180	149.84	54.53	79.03	145.52	261.00
	fortified	180	74.24	119.96	0.00	0.00	379.67
	flour 200 µg	180	250.01	112.95	97.25	241.76	445.71
	FS	180	5.98	36.68	0.00	0.00	0.00
	total	180	480.07	179.75	249.49	442.39	789.28
Age group 15-18 years							
male	non-fortified	193	185.56	63.92	97.24	175.54	297.52
	fortified	193	113.53	209.32	0.00	0.00	467.90
	flour 200 µg	193	356.79	153.38	119.66	341.31	610.29
	FS	193	18.40	99.62	0.00	0.00	79.33
	total	193	674.27	295.30	319.73	611.60	1239.94
female	non-fortified	191	157.01	63.41	70.92	150.22	270.69
	fortified	191	82.08	154.24	0.00	0.00	425.00
	flour 200 µg	191	242.91	126.00	83.15	222.45	538.04
	FS	191	7.71	51.52	0.00	0.00	0.00
	total	191	489.72	242.53	223.09	427.18	929.63

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