Beneris

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BENERIS

Vegetable case

Introduction

It is common knowledge that the consumption of vegetables increases with age, children being the population group having the lowest intakes of this food group. Spain is no exception, despite the fact that it comprises one of the countries adhering to the so-called Mediterranean Diet, which is characterised among others, by a relatively high consumption of vegetables. Low vegetable consumption leads to a decrease in the intake of certain nutrients that should be compensated by the consumption of other foods, such as fruits or by non-vegetable foods that have been fortified, so as to achieve adequate nutrient intake.

The present study analyses the intakes of vegetables, folate, vitamins A and C amongst Finnish, Spanish, and Irish children aged 3 to 6, as well as evaluating the possibilities of fortifying non-vegetable foods. The aim is to attain adequate and safe intakes of these nutrients for this population group.

Objectives:

1. To analyse the consumption of vegetables in children aged 3 to 6 (in Ireland only 6-year-olds) with the goal of identifying whether children with low levels of vegetable consumption have inadequate intakes of folate and vitamins A and C, which would make it recommendable to supplement/fortify foods with these vitamins.

2. To identify separately for each of the following nutrients-folate, vitamins A and C- a level of fortification/supplementation that is safe and adequate, where all children's intakes of folate and vitamins A and C are between average needs and highest acceptable levels of intake (UL).

Material and methods:

Vegetable case food consumption data were derived from the DIPP study, the Enkid Study, and from Irish food consumption survey. Food consumption and nutrient intake data from 3 to 6-year-old Spanish children were used (n=395; male=204, female=191). The subjects of the DIPP Study were participants of the Finnish Type I Diabetes Prediction and Prevention Project Nutrition Study. The Study participants were 3 (n=1045) and 6 (n=850) years of age living in two urban areas (Tampere and Oulu) in Finland. The study has been described in detail elsewhere (Räsänen et al. 2006).

ENKID STUDY: The Enkid study on the nutritional status and food habits of Spanish children and young people, is a cross-sectional population based survey that was carried out between 1998 and 2000 on a random sample of the Spanish population aged 2–24 y, (n=3534; 1629 boys and 1905 girls), selected by multistage random sampling procedures based on a population census. The dietary questionnaire used to assess nutritional status was: one 24-h diet recall per subject; and a second 24-h diet recall in 25% of the sample. The 24-h recalls were administered throughout the year in order to avoid the influence of seasonal variations. The questionnaires were conducted in the participant's home and were responded to by the parents or caretaker of the child. To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. In order to estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. The administration of two questionnaires in a subsample allowed for the adjustment of intakes for random intraindividual variation. The nutrient database software used for the study consisted of the Spanish database from Mataix et al (1998), completed with information from the French and British food composition tables. All field workers (43 dietitians) underwent a training period prior to data collection. Field work was completed between May 1998 and April 2000.

In preparing the data base for this analysis, data from 395 children aged 3 to 6 years derived from 24 hour recalls, which included 496 different food codes, were utilised. Food items were regrouped according to categories previously defined for the Beneris Vegetable case.

Methods

Children who ate the least amount of vegetables (lowest quartile) were evaluated. Their folate and vitamin A and C intakes were carefully studied. If the children's intakes of these nutrients were low (which was very likely), the optimal level of fortification / supplementation was sought (Hirvonen et al. 2007). For Ireland, only the data for vitamin C intake was available.

We used the EAR from the Nordic Nutrition Recommendations for all countries, since Spain and Ireland does not have EAR data available for these populations groups.
3 years: vitamin C 30 mg (EAR); folate+folic acid 80 mcg (EAR); folic acid 200 mcg (UL); vitamin A 300 mcg RE (EAR); retinol 800 mcg RE (UL).
4-6 years: vitamin C 40 mg (EAR); folate+folic acid 130 mcg (EAR); folic acid 300 mcg (UL); vitamin A 400 mcg RE (EAR); retinol 1100 mcg RE (UL) (children aged 4 and 5 were included in the 6 year old age group)

We investigated three nutrients: Vitamin C, vitamin A and folate. The basic idea was to identify the optimal fortification level, and if there was a need and possibility to fortify with those nutrients. We analysed age groups from 3 to 6 years and we did not separate groups by gender. We used eaten foods (not the ingredient level) in our evaluation.

1) We identified the group which had the lowest vegetable consumption (leaf vegetables, cabbages, fruit vegetables, onion-family vegetables, canned vegetables and edible fungi). We used quartile groups to classify consumption, separately for the ages of 3, 4, 5 and 6 years.

2) We investigated intake distributions of the lowest quartile group for each nutrient. If there were intakes below the average need level, there was a need to fortify the studied nutrient. We calculated these distributions from a single 24 hour recall.

3) The next step was to find the optimal fortification level for each vitamin analysed. This was identified with deterministic modeling
The food fortification analysis was conducted in the three food groups that were specified for the "vegetable case", which include:
I) Fruit juices, margarines, milks and yoghurt
II) All foods in option I) and breads
III) All foods in option II) and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters.

The same procedure was conducted for each vitamin and for each food group, which was as follows: In folate and vitamin A, we carried out fortification by adding step by step 1 µg nutrient per 100 kcal and for vitamin C: 1 mg of Vitamin C per 100 kcal. Then we estimated the intake distribution for all age groups from 3 to 6 years, adjusting for intraindividual variability.

The optimal fortification level was indentified when nutrient intake distribution was below the highest acceptable level and above the average need level. When the optimal level was not found, we chose the highest level where there was no population over the highest acceptable level. Finally we brought together conclusions of different food options (I-III) in age groups.

The Finnish results were adjusted for intra-individual variance and nuisance effects, since the food consumption data per participant consisted of only three consecutive food record days. The adjustment was done using the method of Nusser and co-workers (Nusser et al.1996). This method gives the long-run average of daily intakes (usual daily intake) by taking into account day-to-day – correlation and nuisance effects (such as day-of-week and interview sequence). It also allows exceptions from normality through grafted polynomial transformations and recognizes the measurement error associated with one-day dietary intakes. The estimations were done using the SAS based C-SIDE □ program.

In Irish data data on vitamin A or folate/folic acid could not be used, since their chemical format was not known.

<u>Results</u>

Spain

The distribution by age and sex is shown in table 1.

Table 1: Sample distribution by gender and age

		Age (years)				Total
		3	4	5	6	
Female	n	47	47	50	47	191
	% within Sex	24.6%	24.6%	26.2%	24.6%	100.0%
	% within Age (years)	48.5%	48.5%	52.6%	44.3%	48.4%
Male	n	50	50	45	59	204
	% within Sex	24.5%	24.5%	22.1%	28.9%	100.0%
	% within Age (years)	51.5%	51.5%	47.4%	55.7%	51.6%
TOTAL	n	97	97	95	106	395
	% within Sex	24.6%	24.6%	24.1%	26.8%	100.0%
	% within Age (years)	100.0%	100.0%	100.0%	100.0%	100.0%

Vegetable consumption:

The mean intake of vegetables in the study population was 58 g/day, although almost half of the children had not consumed vegetables the day prior to the interview (24 hour recall). Table 2 presents vegetable intake by age and gender.

Table 2. Distribution of vegetable consumption by age and gender

		Vegetables intake (g)						
Age (years)/sex		Mean	S.D.	P 5	P 25	P 50	P 75	P 95
3	Female	59.5	82.8	.0	.0	.0	100.0	200.0
	Male	61.6	84.4	.0	.0	20.0	100.0	240.0
	Total	60.6	83.2	.0	.0	15.0	100.0	240.0
4	Female	40.6	68.2	.0	.0	.0	70.0	130.0
	Male	60.1	94.8	.0	.0	.0	100.0	245.0
	Total	50.6	83.2	.0	.0	.0	80.0	205.0
5	Female	56.0	80.1	.0	.0	22.5	85.0	200.0
	Male	77.1	105.6	.0	.0	20.0	105.0	310.0
	Total	66.0	93.1	.0	.0	20.0	100.0	285.0
6	Female	60.2	107.5	.0	.0	.0	70.0	380.0
	Male	48.6	64.8	.0	.0	.0	100.0	210.0
	Total	53.7	86.1	.0	.0	.0	100.0	210.0
Total	Female	54.1	85.5	.0	.0	.0	80.0	200.0
	Male	60.9	87.2	.0	.0	15.0	100.0	245.0
	Total	57.6	86.3	.0	.0	11.0	100.0	240.0

Given that food intake data was derived from a single 24 hour recall, there were a large number of subjects with vegetable intakes =0 (n=193). Thus, the distribution of vegetable intake into quartiles could not be accurately conducted as the group with null intake exceeded 25%.

Folate, vitamin A and vitamin C intake:

The main food sources of folate in the population aged 3 to 6 were, in decreasing order, fruits (20%), cereals (18%) and vegetables (17%). The principal food contributors of vitamin A were milk (28%) and other dairy products, vegetables (20%), eggs (8%) and offals. And the main food sources of vitamin C were primarily fruits (62%), followed by vegetables (13%) and cereals.

The intake of these three vitamins according to quartiles of vegetable consumption are presented in table 3. As previously mentioned, the distribution of vegetable intake into quartiles could not be accurately conducted as all the subjects with 0 vegetable intake appear in the 1st quartile, leaving only 4 individuals in the 2nd quartile

Table 3. Folate, Vitamin A and Vitamin C intake by quartile of vegetable consumption

Vegetables intake (g) in quartiles		N	Mean	S D.	Median	Minimum	Maximum
1	Folate (µg) (total)	193	121.8	72.9	107.5	4.2	555.3
	vitamin A (µg) (total)	193	411.7	217.7	371.1	51.4	1568.1
	vitamin C (mg) (total)	193	69.8	78.7	45.2	0.2	645.0
2	Folate (µg) (total)	4	102.9	17.0	97.6	89.5	126.8
	vitamin A (µg) (total)	4	713.6	896.7	323.1	165.2	2043.1
	vitamin C (mg) (total)	4	95.9	62.0	116.0	5.3	146.2
3	Folate (µg) (total)	97	130.1	66.1	117.3	15.9	416.9
	vitamin A (µg) (total)	97	564.5	460.9	447.0	81.8	3583.4
	vitamin C (mg) (total)	97	84.8	65.4	68.1	6.4	292.3
4	Folate (µg) (total)	101	192.2	76.4	180.1	41.1	417.1
	vitamin A (µg) (total)	101	888.1	1005.2	610.3	84.3	7133.4
	vitamin C (mg) (total)	101	120.9	79.5	102.1	12.2	543.7
Total	Folate (µg) (total)	395	141.6	77.7	129.4	4.2	555.3
	vitamin A (µg) (total)	395	574.1	613.1	423.0	51.4	7133.4
	vitamin C (mg) (total)	395	86.8	78.3	69.0	0.2	645.0

Folate, vitamin A and C intake: Within the group of individuals with 0 vegetable intake, the percentage of intakes for vitamin A that were below the EAR was 23%, 44% were below the EAR for vitamin C and 78% were below the folate requirements (data derived from a single 24 hour recall without excluding under-reporters). These data demonstrate the need to fortify selected foods with these nutrients.

Fortification:

Fortification analysis contain data for three countries: Spain, Finland and Ireland. The results are presented as figures in the following chapters.

Spain

The three graphics presented in Figure 1 show the distribution of folate intake in the Spanish population (percentage of intakes below Recommended Intake (RI), Above UL and Outside RI-UL range) when the foods in group I (Fruit juices, margarines, milks and yogurt), group II (All foods in group I and breads), and group III (All foods in option II and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters) are fortified. The intake distribution for all age groups from 3 to 6 years was adjusted for intraindividual variability. Figure 2 presents the results for vitamin A and Figure 3 for vitamin C. For the latter, the increments shown correspond to milligrams.

Folate - Group I

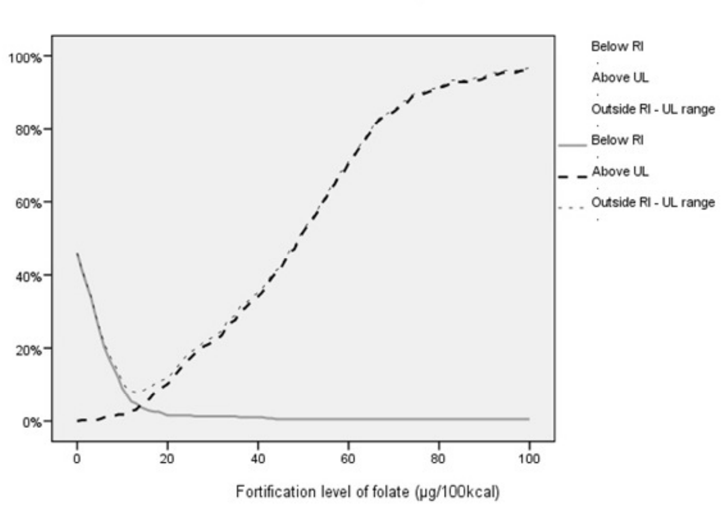


Figure 1. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-100 ug/kcal

Folate - Group II

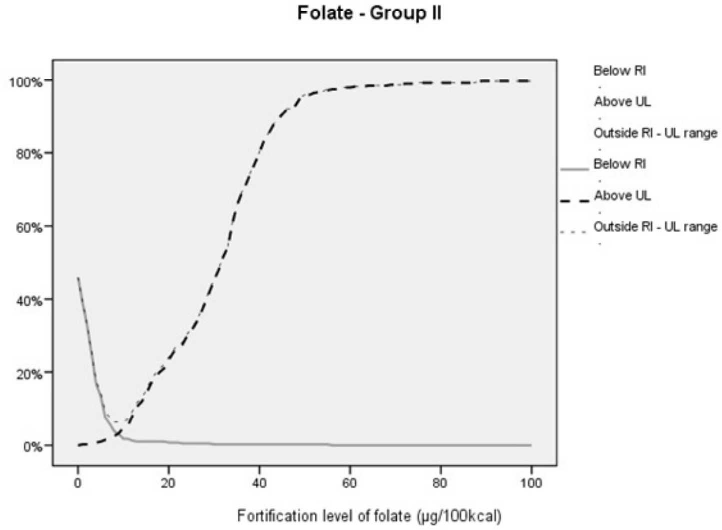


Figure 1. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-100 ug/kcal

Folate - Group III

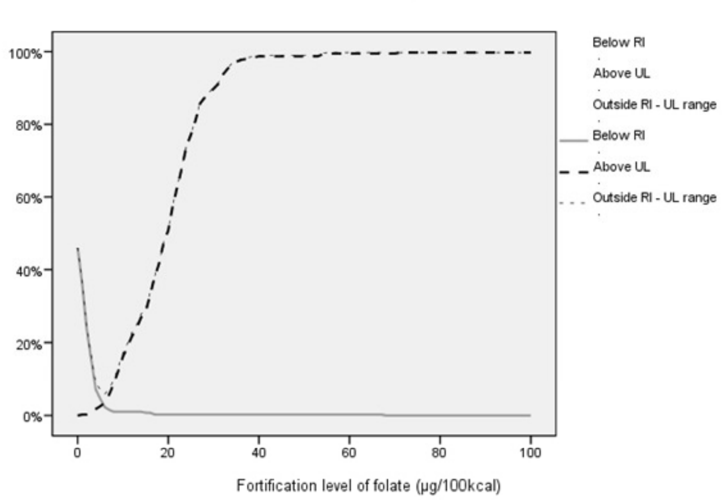


Figure 1. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0-15 ug/kcal

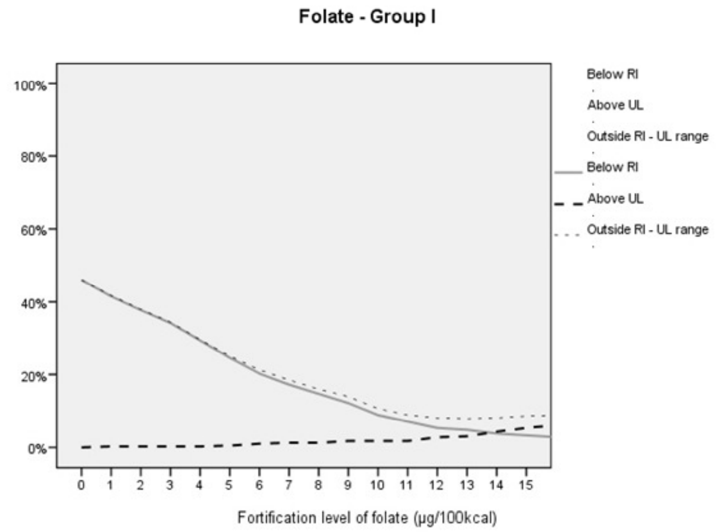


Figure 1. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-15 ug/kcal

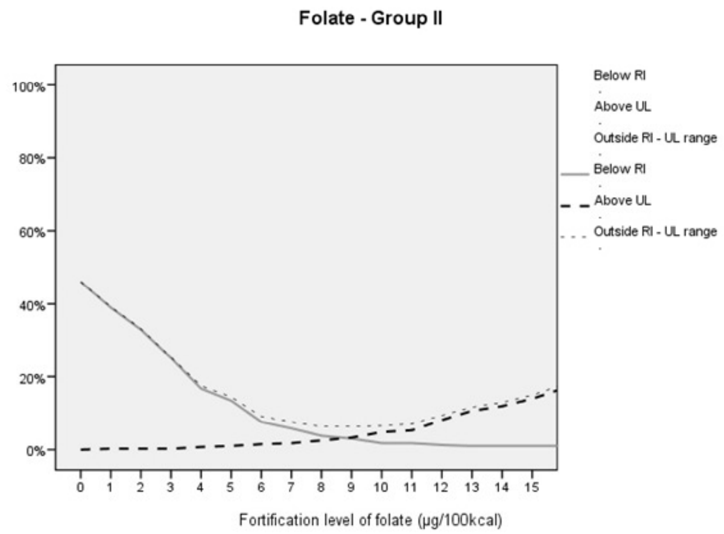


Figure 1. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-15 ug/kcal

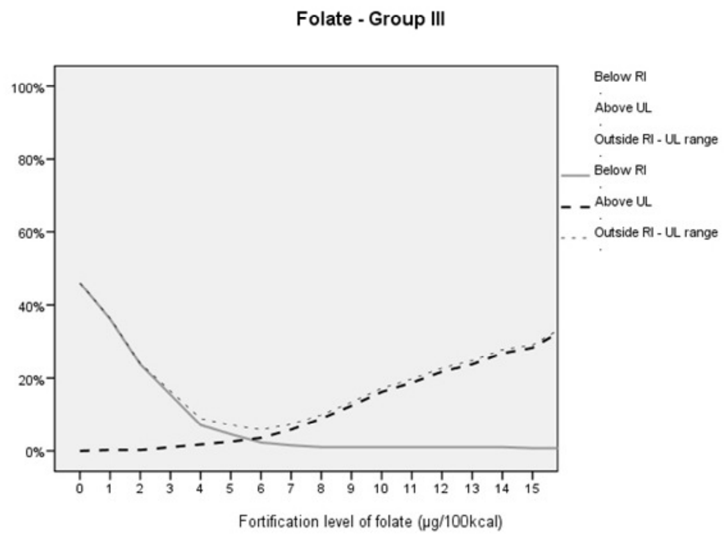


Figure 1. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0-15 ug/kcal

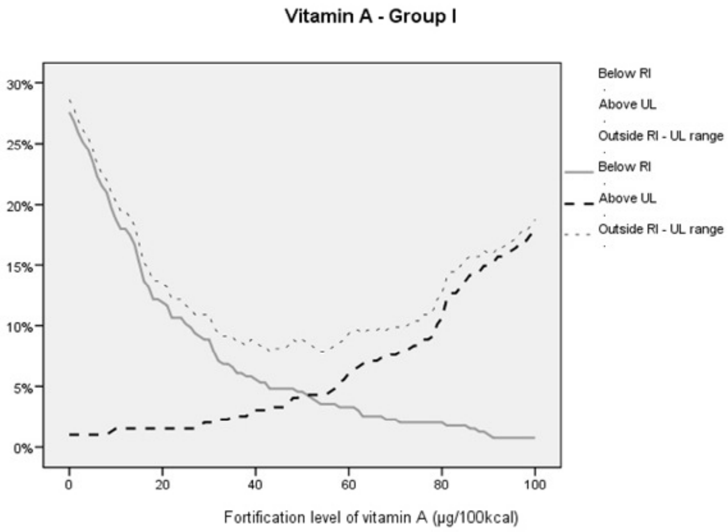


Figure 2. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-100 ug/kcal

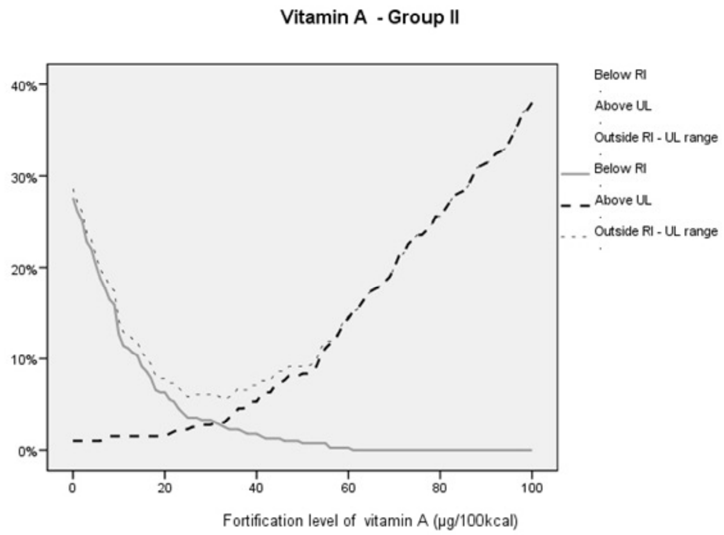


Figure 2. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-100 ug/kcal

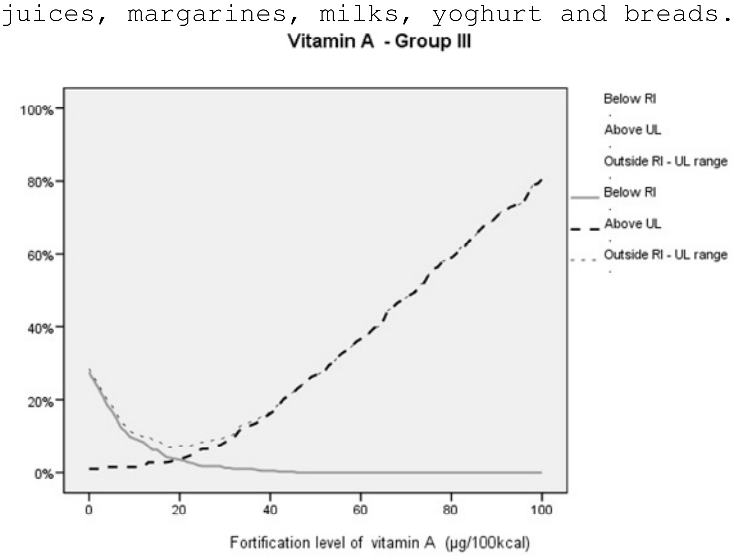


Figure 2. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0-100 ug/kcal

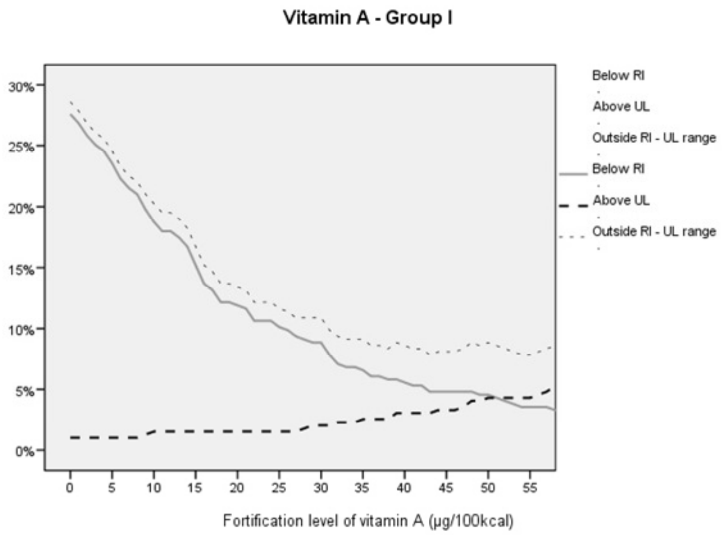


Figure 2. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-60 ug/kcal

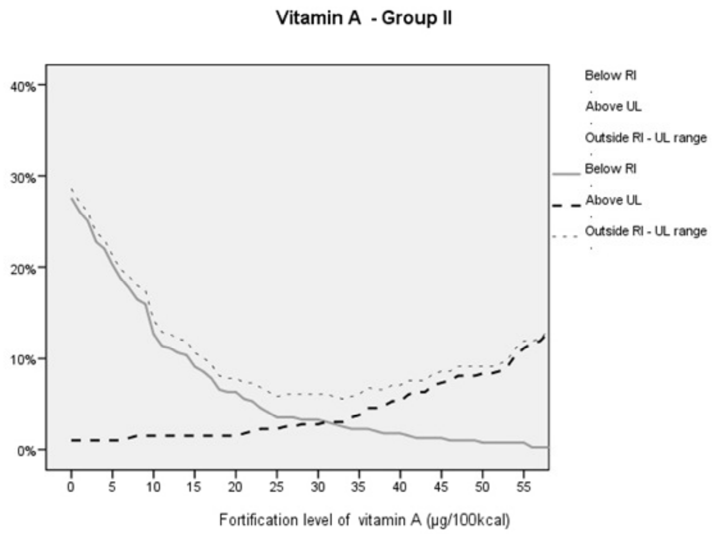


Figure 2. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-60 ug/kcal

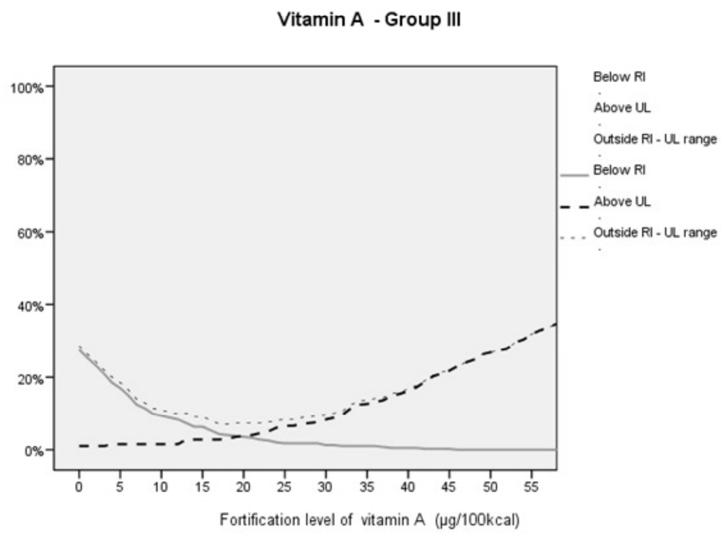


Figure 2. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0-60 ug/kcal

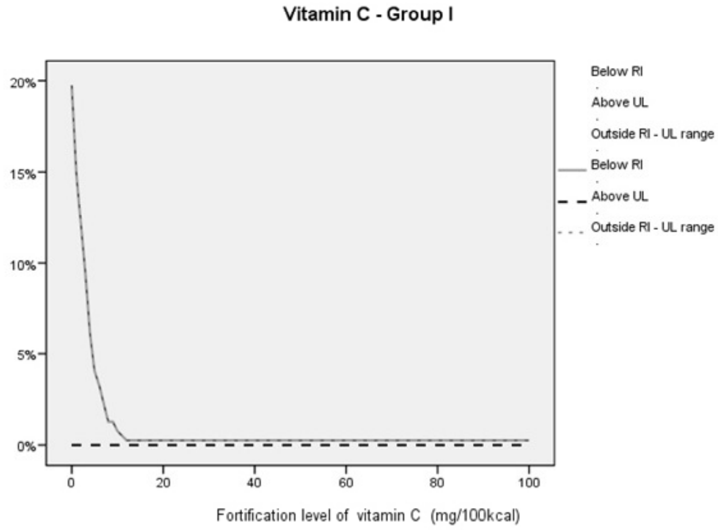


Figure 3. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-100 ug/kcal

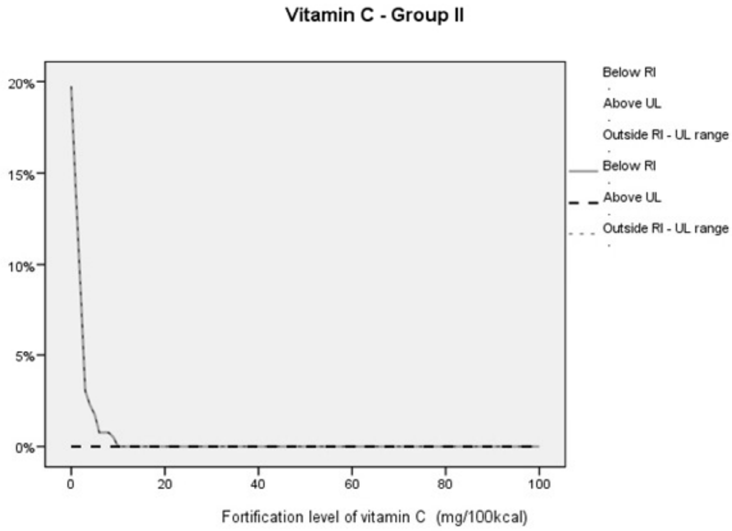


Figure 3. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-100 ug/kcal

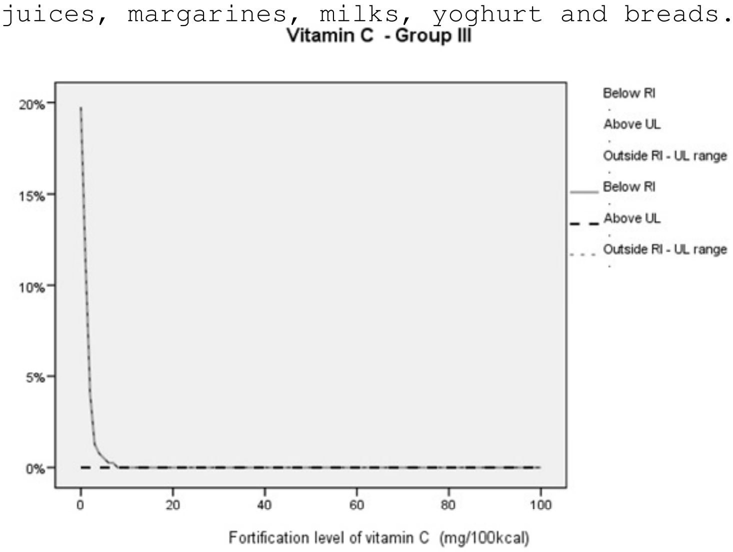


Figure 3. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0–100 ug/kcal

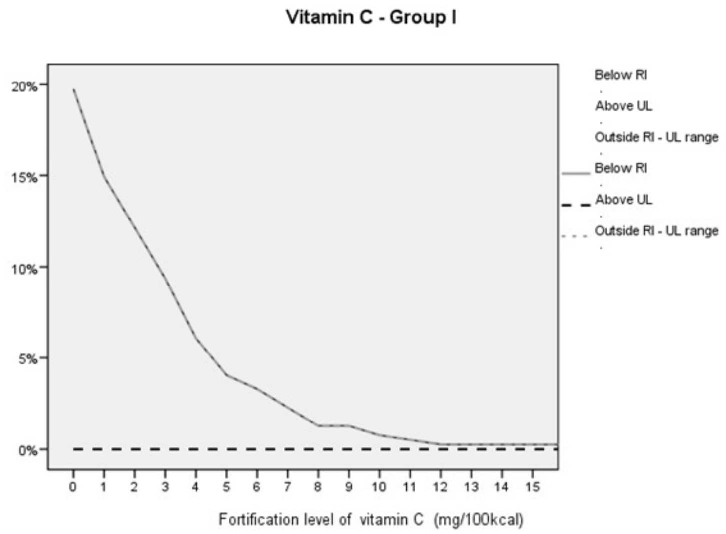


Figure 3. I)Fruit juices, margarines, milks and yoghurt. Fortification level 0-15 ug/kcal

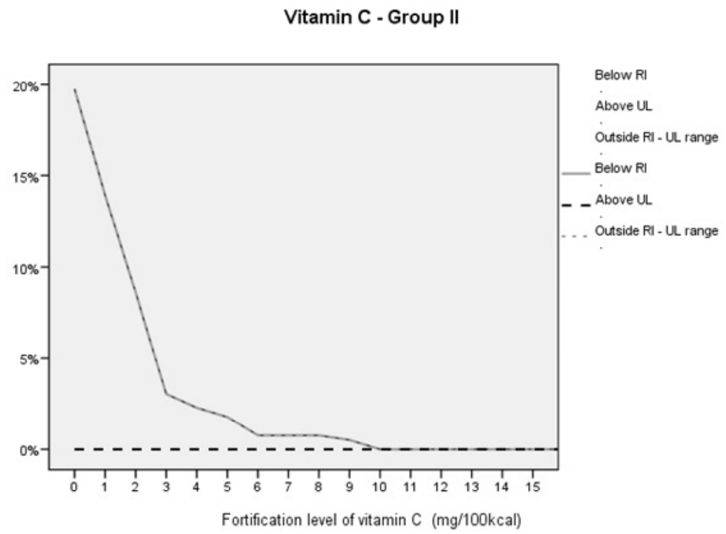


Figure 3. II)Fruit juices, margarines, milks, yoghurt and breads. Fortification level 0-15 ug/kcal

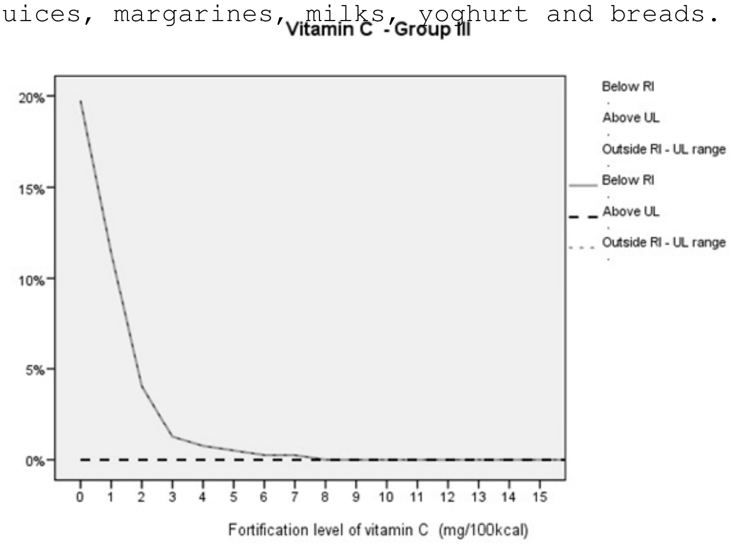


Figure 3. III)Fruit juices, margarines, milks, yoghurt, breads and curl milks, milk puddings, breakfast cereals, jams, sweets, chocolates, soft drinks, biscuits, snacks, dressings, ice creams, cheeses and mineral waters. Fortification level 0-15 ug/kcal

Variation of the percentage of intakes <EAR and >UL for folate, vitamin A and vitamin C according to fortification levels (from 0 to100 mcg (mg vit C) and the food group fortified.

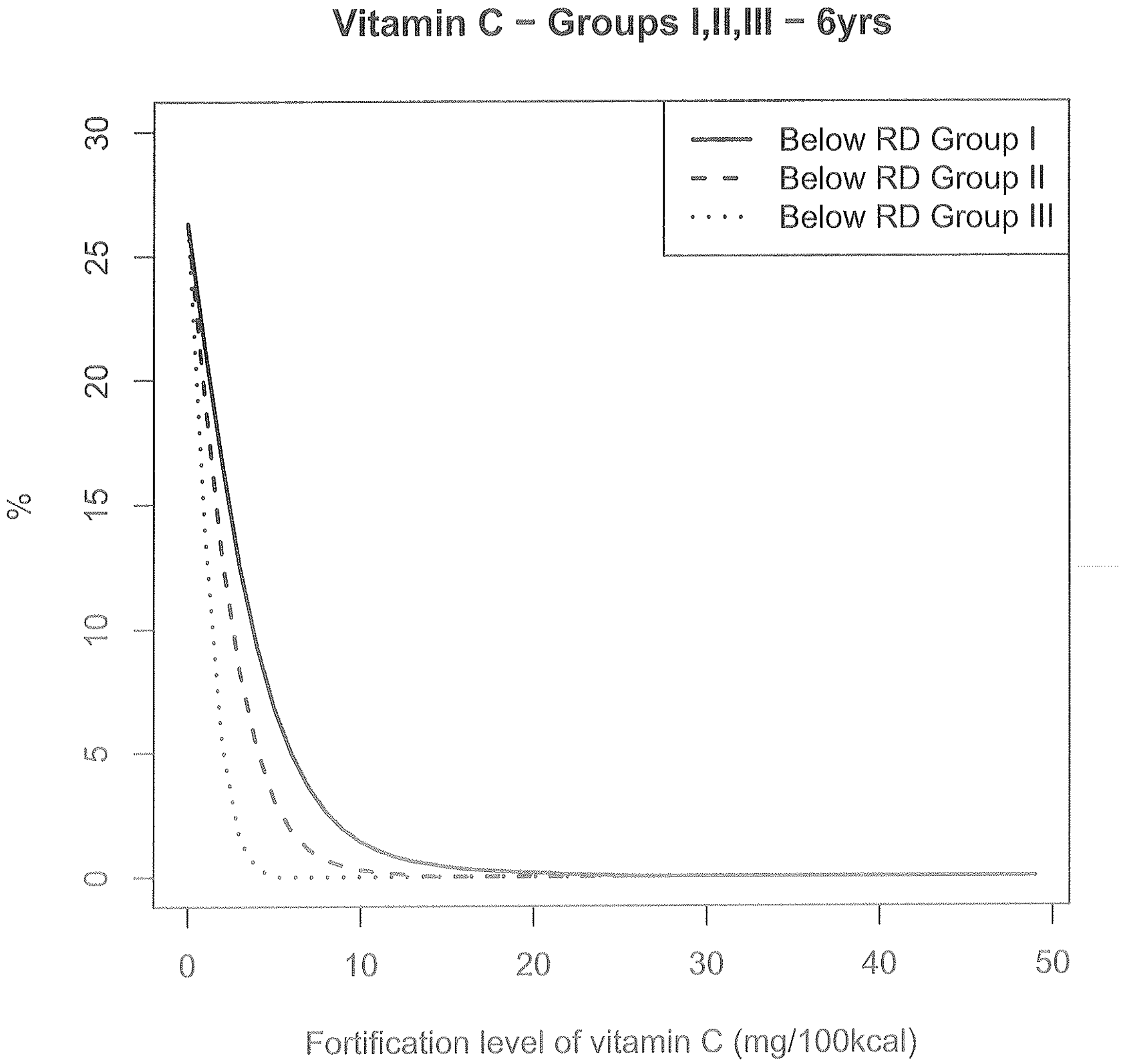
FORTIFICATION	FOLATE: % STUDY POPULATION						VITAMIN A: % STUDY POPULATION						VITAMIN C: % STUDY POPULATION		
	<EAR	>UL	<EAR	>UL	<EAR	>UL	<EAR	>UL	<EAR	>UL	<EAR	>UL	<EAR	<EAR	<EAR
	G1	G1	G2	G2	G3	G3	G1	G1	G2	G2	G3	G3	G1	G2	G3
0	46,1	0	46,1	0	46,1	0	27,6	1,0	27,6	1,0	27,6	1,0	19,7	19,7	19,7
1	41,5	0,3	39,0	0,3	36,2	0,3	26,8	1,0	26,1	1,0	25,3	1,0	14,9	13,9	11,4
2	37,7	0,3	32,9	0,3	23,8	0,3	25,8	1,0	25,1	1,0	23,3	1,0	12,2	8,6	4,1
3	34,2	0,3	25,1	0,3	15,4	1,0	25,1	1,0	22,8	1,0	21,0	1,0	9,4	3,0	1,3
4	29,4	0,3	16,7	0,8	7,1	1,8	24,6	1,0	22,0	1,0	18,5	1,5	6,1	2,3	0,8
5	24,6	0,5	13,4	1,0	4,6	2,5	23,5	1,0	20,3	1,0	17,0	1,5	4,1	1,8	0,5
6	20,3	1,0	7,6	1,5	2,3	3,5	22,3	1,0	18,7	1,0	14,9	1,5	3,3	0,8	0,3
7	17,2	1,3	5,8	1,8	1,5	5,8	21,5	1,0	17,7	1,3	12,4	1,5	2,3	0,8	0,3
8	14,7	1,3	3,8	2,5	1,0	8,9	21,0	1,0	16,5	1,5	11,4	1,5	1,3	0,8	0
9	12,2	1,8	3,0	3,3	1,0	12,4	19,7	1,3	15,9	1,5	9,9	1,5	1,3	0,5	0
10	8,9	1,8	1,8	4,8	1,0	16,2	18,7	1,5	12,7	1,5	9,4	1,5	0,8	0	0
11	7,1	1,8	1,8	5,3	1,0	18,7	18,0	1,5	11,4	1,5	8,9	1,5	0,5	0	0
12	5,3	2,8	1,3	8,1	1,0	21,8	18,0	1,5	11,1	1,5	8,4	1,5	0,3	0	0
13	4,8	3,0	1,0	10,6	1,0	23,8	17,5	1,5	10,6	1,5	7,3	2,8	0,3	0	0
14	3,8	4,3	1,0	11,9	1,0	26,8	16,7	1,5	10,4	1,5	6,3	2,8	0,3	0	0
15	3,3	5,3	1,0	13,9	0,8	28,4	15,2	1,5	9,1	1,5	6,3	2,8	0,3	0	0
16	2,8	6,1	1,0	16,7	0,8	33,2	13,7	1,5	8,6	1,5	5,3	2,8	0,3	0	0
17	2,5	7,6	1,0	18,5	0,3	38,0	13,2	1,5	7,8	1,5	4,3	2,8	0,3	0	0
18	2,5	8,1	1,0	20,0	0,3	41,8	12,2	1,5	6,6	1,5	4,1	3,0	0,3	0	0
19	2,0	9,4	1,0	21,0	0,3	47,6	12,2	1,5	6,3	1,5	3,8	3,5	0,3	0	0
20	1,5	10,1	0,8	23,3	0,3	50,9	11,9	1,5	6,3	1,5	3,5	3,8	0,3	0	0
21	1,5	11,6	0,8	25,3	0,3	57,7	11,6	1,5	5,6	1,8	3,3	4,1	0,3	0	0
22	1,5	13,2	0,8	26,8	0,3	62,8	10,6	1,5	5,3	2,0	2,8	4,6	0,3	0	0
23	1,5	14,7	0,5	27,6	0,3	68,1	10,6	1,5	4,6	2,3	2,5	5,1	0,3	0	0
24	1,5	16,2	0,5	29,9	0,3	73,9	10,6	1,5	4,1	2,3	2,0	6,1	0,3	0	0
25	1,5	17,2	0,5	31,4	0,3	77,2	10,1	1,5	3,5	2,3	1,8	6,6	0,3	0	0
26	1,3	18,5	0,5	33,4	0,3	81,0	9,9	1,5	3,5	2,5	1,8	6,6	0,3	0	0
27	1,3	19,2	0,5	35,9	0,3	85,8	9,4	1,5	3,5	2,5	1,8	7,1	0,3	0	0
28	1,3	20,5	0,5	39,0	0,3	87,3	9,1	1,8	3,3	2,8	1,8	7,3	0,3	0	0
29	1,3	21,0	0,5	42,0	0,3	88,6	8,9	2,0	3,3	2,8	1,8	7,6	0,3	0	0
30	1,3	21,8	0,3	45,3	0,3	89,9	8,9	2,0	3,3	2,8	1,3	8,4	0,3	0	0
31	1,3	22,5	0,3	48,1	0,3	91,1	7,8	2,0	3,0	3,0	1,3	8,9	0,3	0	0
32	1,3	23,5	0,3	51,6	0,3	93,7	7,1	2,3	2,8	3,0	1,0	9,6	0,3	0	0
33	1,3	25,8	0,3	54,2	0,3	95,2	6,8	2,3	2,5	3,0	1,0	11,4	0,3	0	0
34	1,3	27,1	0,3	60,5	0,3	96,5	6,8	2,3	2,3	3,5	1,0	12,4	0,3	0	0
35	1,3	27,8	0,3	65,6	0,3	97,2	6,6	2,5	2,3	3,8	1,0	12,7	0,3	0	0
36	1,0	30,4	0,3	68,9	0,3	97,7	6,1	2,5	2,3	4,6	1,0	13,2	0,3	0	0
37	1,0	30,9	0,3	71,4	0,3	98,0	6,1	2,5	2,0	4,6	0,8	13,7	0,3	0	0
38	1,0	32,2	0,3	74,4	0,3	98,2	5,8	2,5	1,8	4,8	0,5	14,9	0,3	0	0
39	1,0	33,4	0,3	77,2	0,3	98,5	5,8	3,0	1,8	5,3	0,5	15,4	0,3	0	0
40	1,0	34,2	0,3	80,0	0,3	98,7	5,6	3,0	1,8	5,3	0,5	16,2	0,3	0	0
41	1,0	35,4	0,3	83,5	0,3	98,7	5,3	3,0	1,5	6,1	0,5	17,2	0,3	0	0
42	0,8	37,5	0,3	85,3	0,3	98,7	5,3	3,0	1,3	6,3	0,3	18,7	0,3	0	0
43	0,8	39,2	0,3	87,6	0,3	98,7	4,8	3,0	1,3	6,3	0,3	20,3	0,3	0	0
44	0,5	40,8	0,3	89,1	0,3	98,7	4,8	3,3	1,3	7,1	0,3	21,0	0,3	0	0
45	0,5	41,8	0,3	90,6	0,3	98,7	4,8	3,3	1,3	7,3	0,3	21,8	0,3	0	0
46	0,5	44,1	0,3	91,9	0,3	98,7	4,8	3,3	1,0	7,6	0	23,0	0,3	0	0
47	0,5	46,3	0,3	91,9	0,3	98,7	4,8	3,5	1,0	8,1	0	24,1	0,3	0	0
48	0,5	47,1	0,3	93,2	0,3	98,7	4,8	4,1	1,0	8,1	0	24,8	0,3	0	0
49	0,5	49,9	0,3	95,2	0,3	98,7	4,6	4,1	1,0	8,1	0	26,3	0,3	0	0
50	0,5	51,9	0,3	95,7	0,3	98,7	4,6	4,3	0,8	8,4	0	26,8	0,3	0	0

FORTIFICATION	FOLATE: % STUDY POPULATION <EAR G1	>UL G1	<EAR G2	>UL G2	<EAR G3	>UL G3	VITAMIN A: % STUDY POPULATION <EAR G1	>UL G1	<EAR G2	>UL G2	<EAR G3	>UL G3	VITAMIN C: % STUDY POPULATION <EAR G1	<EAR G2	<EAR G3
51	0,5	53,7	0,3	95,9	0,3	98,7	4,3	4,3	0,8	8,4	0	27,3	0,3	0	0
52	0,5	55,2	0,3	96,5	0,3	98,7	4,1	4,3	0,8	8,6	0	27,8	0,3	0	0
53	0,5	57,0	0,3	96,7	0,3	98,7	3,8	4,3	0,8	9,1	0	29,6	0,3	0	0
54	0,5	59,5	0,3	96,7	0,3	99,2	3,5	4,3	0,8	10,4	0	30,4	0,3	0	0
55	0,5	61,0	0,3	97,2	0,3	99,5	3,5	4,3	0,8	11,1	0	31,9	0,3	0	0
56	0,5	63,5	0	97,5	0,3	99,5	3,5	4,6	0,3	11,6	0	32,9	0,3	0	0
57	0,5	65,1	0	97,5	0,3	99,5	3,5	4,8	0,3	11,9	0	33,7	0,3	0	0
58	0,5	67,6	0	98,0	0,3	99,5	3,3	5,3	0,3	12,9	0	34,7	0,3	0	0
59	0,5	68,4	0	98,0	0,3	99,5	3,3	5,6	0,3	13,9	0	35,9	0,3	0	0
60	0,5	70,6	0	98,0	0,3	99,5	3,3	6,1	0,3	14,4	0	36,7	0,3	0	0
61	0,5	72,2	0	98,2	0,3	99,5	3,3	6,3	0	15,2	0	37,2	0,3	0	0
62	0,5	74,2	0	98,2	0,3	99,5	3,0	6,6	0	15,4	0	38,5	0,3	0	0
63	0,5	75,9	0	98,2	0,3	99,5	2,5	6,8	0	16,2	0	39,7	0,3	0	0
64	0,5	77,7	0	98,5	0,3	99,5	2,5	7,1	0	17,0	0	40,0	0,3	0	0
65	0,5	79,5	0	98,5	0,3	99,5	2,5	7,1	0	17,5	0	41,8	0,3	0	0
66	0,5	81,5	0	98,5	0,3	99,5	2,5	7,1	0	17,7	0	44,6	0,3	0	0
67	0,5	82,8	0	98,5	0,3	99,5	2,5	7,3	0	18,0	0	45,3	0,3	0	0
68	0,5	83,5	0	98,5	0	99,5	2,3	7,3	0	18,5	0	46,6	0,3	0	0
69	0,5	84,1	0	98,7	0	99,5	2,3	7,6	0	19,0	0	47,3	0,3	0	0
70	0,5	84,8	0	98,7	0	99,5	2,3	7,6	0	20,0	0	48,1	0,3	0	0
71	0,5	85,8	0	98,7	0	99,7	2,0	7,8	0	21,3	0	48,9	0,3	0	0
72	0,5	87,1	0	99,0	0	99,7	2,0	7,8	0	21,5	0	49,6	0,3	0	0
73	0,5	87,3	0	99,0	0	99,7	2,0	8,1	0	22,5	0	51,6	0,3	0	0
74	0,5	88,9	0	99,0	0	99,7	2,0	8,4	0	23,0	0	52,2	0,3	0	0
75	0,5	89,4	0	99,2	0	99,7	2,0	8,4	0	23,5	0	54,4	0,3	0	0
76	0,5	89,4	0	99,2	0	99,7	2,0	8,9	0	23,5	0	55,9	0,3	0	0
77	0,5	89,9	0	99,2	0	99,7	2,0	8,9	0	24,1	0	56,5	0,3	0	0
78	0,5	90,4	0	99,2	0	99,7	2,0	9,1	0	24,6	0	58,0	0,3	0	0
79	0,5	90,6	0	99,2	0	99,7	2,0	10,1	0	25,6	0	58,5	0,3	0	0
80	0,5	91,4	0	99,2	0	99,7	2,0	10,6	0	25,6	0	59,0	0,3	0	0
81	0,5	91,6	0	99,2	0	99,7	1,8	12,2	0	26,3	0	60,0	0,3	0	0
82	0,5	92,2	0	99,2	0	99,7	1,8	12,7	0	27,1	0	61,8	0,3	0	0
83	0,5	92,9	0	99,2	0	99,7	1,8	12,7	0	27,8	0	62,3	0,3	0	0
84	0,5	92,9	0	99,2	0	99,7	1,8	13,2	0	28,1	0	63,8	0,3	0	0
85	0,5	92,9	0	99,2	0	99,7	1,8	13,7	0	28,4	0	64,8	0,3	0	0
86	0,5	92,9	0	99,2	0	99,7	1,5	14,2	0	28,9	0	66,3	0,3	0	0
87	0,5	93,2	0	99,2	0	99,7	1,5	14,2	0	29,9	0	67,6	0,3	0	0
88	0,5	93,4	0	99,5	0	99,7	1,3	14,4	0	30,9	0	68,6	0,3	0	0
89	0,5	93,4	0	99,7	0	99,7	1,3	14,9	0	31,1	0	69,1	0,3	0	0
90	0,5	93,9	0	99,7	0	99,7	1,0	14,9	0	31,4	0	70,4	0,3	0	0
91	0,5	94,4	0	99,7	0	99,7	0,8	15,2	0	31,6	0	71,6	0,3	0	0
92	0,5	94,9	0	99,7	0	99,7	0,8	15,7	0	32,4	0	72,2	0,3	0	0
93	0,5	94,9	0	99,7	0	99,7	0,8	15,7	0	32,7	0	72,9	0,3	0	0
94	0,5	95,4	0	99,7	0	99,7	0,8	15,9	0	32,9	0	73,4	0,3	0	0
95	0,5	95,4	0	99,7	0	99,7	0,8	16,2	0	33,7	0	73,7	0,3	0	0
96	0,5	95,4	0	99,7	0	99,7	0,8	16,5	0	34,7	0	74,4	0,3	0	0
97	0,5	95,4	0	99,7	0	99,7	0,8	17,0	0	35,7	0	76,7	0,3	0	0
98	0,5	95,9	0	99,7	0	99,7	0,8	17,0	0	37,0	0	79,0	0,3	0	0
99	0,5	95,9	0	99,7	0	99,7	0,8	17,5	0	37,2	0	79,2	0,3	0	0
100	0,5	96,2	0	99,7	0	99,7	0,8	18,0	0	38,0	0	80,5	0,3	0	0

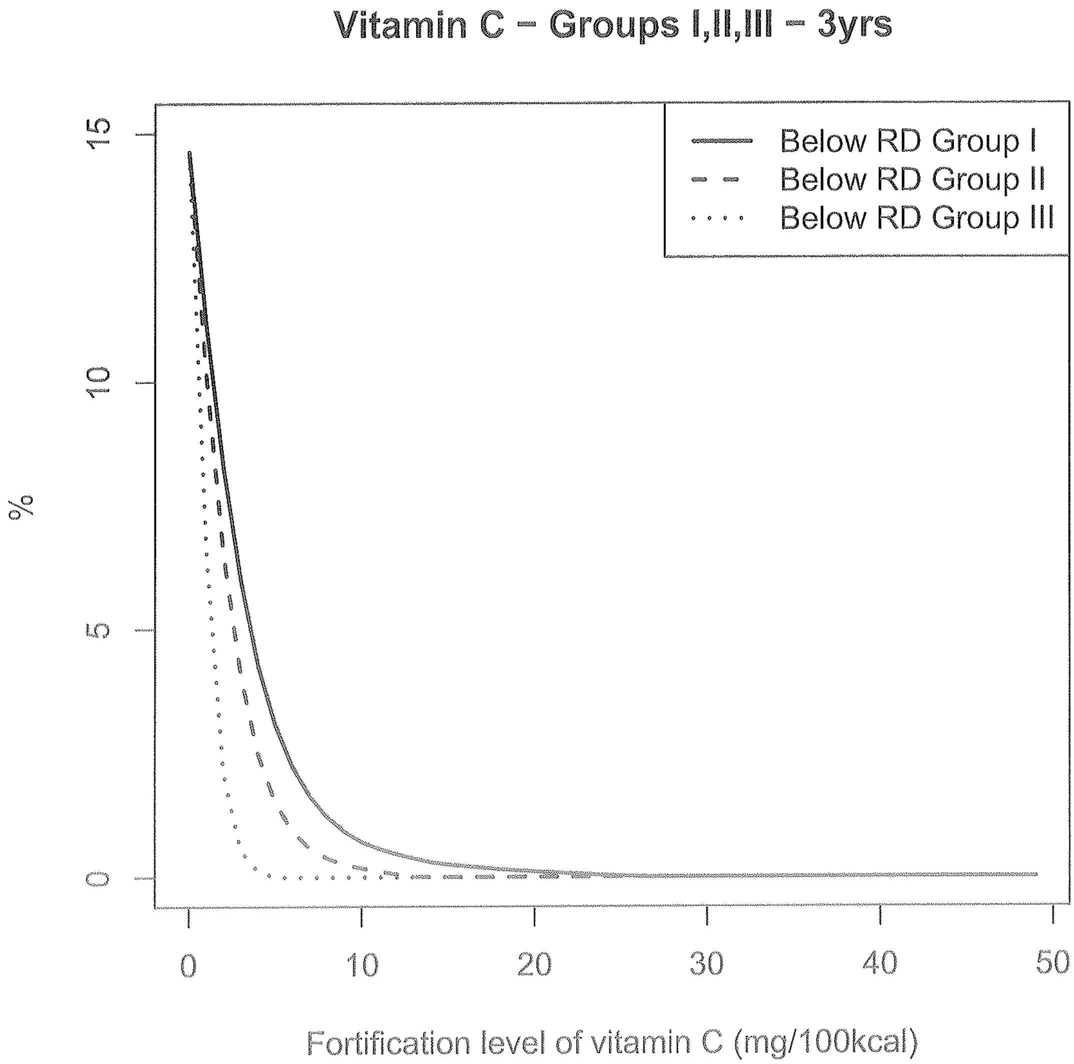
Vitamin C does not have an UL defined.

Finland

Fortification with vitamin C among 6–year-old children was very efficient in all scenarios. With fortification level 10 mg/100 kcal all children reached recommended dietary intake level in all scenarios. The following figures illustrate results with groups I, II and III for children of age three and six years separately.



Fortification with vitamin C among 3-year-old children was very efficient in all scenarios. With fortification level 25 mg/100 kcal all children reached recommended dietary intake level in all scenarios.

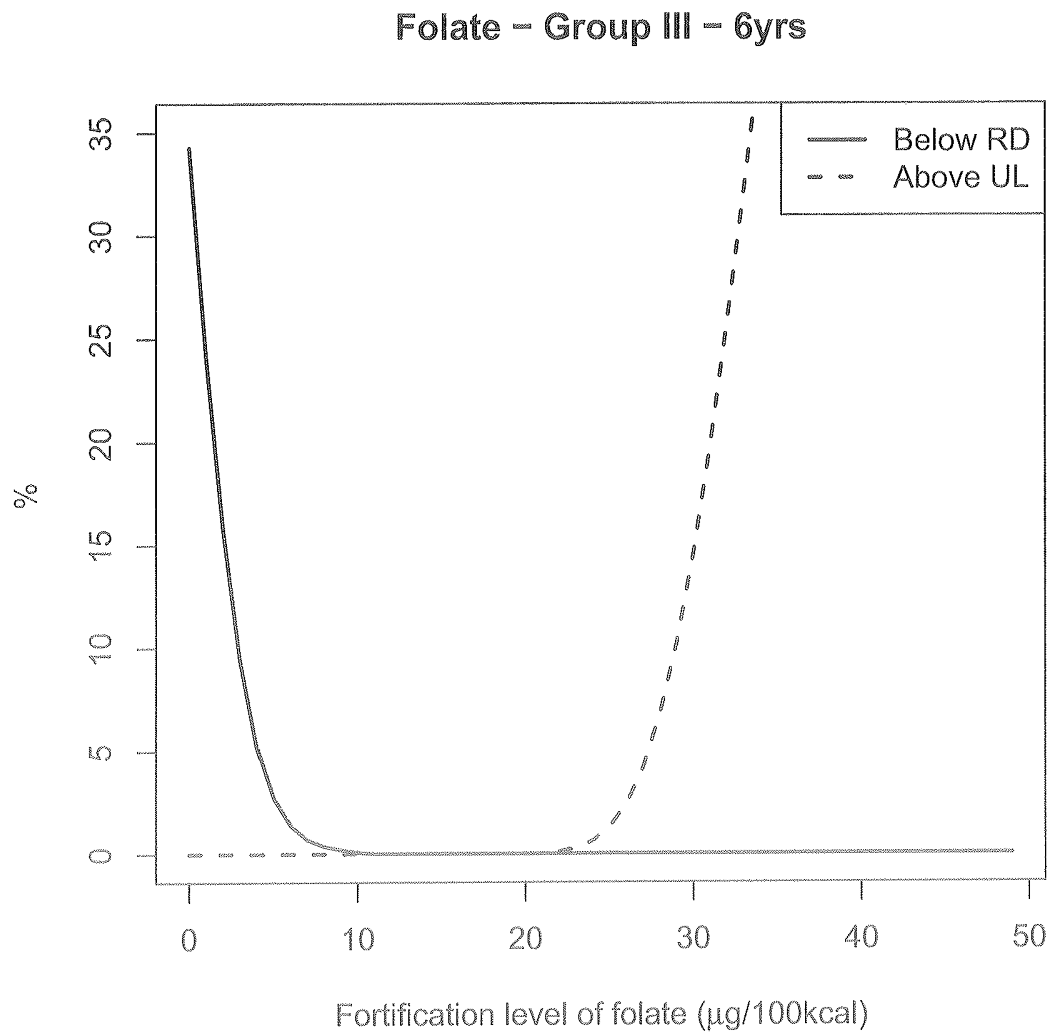


Fortification outcomes with vitamin C among the Finnish children.

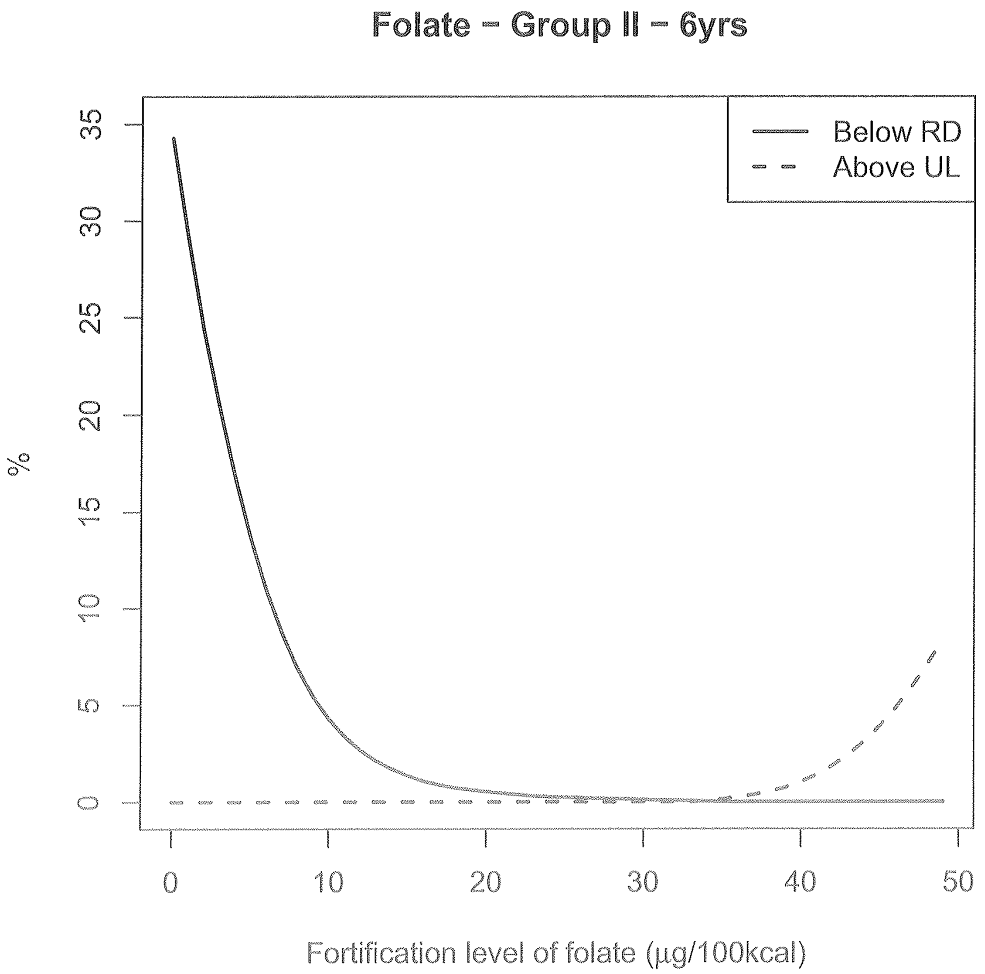
	Vitamin C, mg/100kcal					
Fortification	3 yrs			6 yrs		
	<RD G1	<RD G2	<RD G3	<RD G1	<RD G2	<RD G3
0	14.63%	14.63%	14.63%	26.31%	26.31%	26.31%
1	11.14%	10.12%	6.52%	21.25%	19.16%	13.84%
2	8.25%	6.48%	2.09%	16.66%	12.85%	5.28%
3	5.99%	4.07%	0.55%	12.48%	8.24%	1.46%
4	4.26%	2.50%	0.12%	9.27%	5.13%	0.34%
5	3.08%	1.52%	0.00%	6.77%	3.06%	0.03%
6	2.24%	0.93%	0.00%	4.93%	1.82%	0.00%
7	1.64%	0.59%	0.00%	3.58%	1.09%	0.00%
8	1.23%	0.39%	0.00%	2.61%	0.66%	0.00%
9	0.92%	0.25%	0.00%	1.91%	0.44%	0.00%
10	0.71%	0.18%	0.00%	1.42%	0.27%	0.00%
11	0.58%	0.11%	0.00%	1.06%	0.19%	0.00%
12	0.47%	0.06%	0.00%	0.81%	0.13%	0.00%
13	0.38%	0.01%	0.00%	0.63%	0.07%	0.00%
14	0.30%	0.00%	0.00%	0.51%	0.01%	0.00%

15	0.25%	0.00%	0.00%	0.41%	0.00%	0.00%
16	0.22%	0.00%	0.00%	0.31%	0.00%	0.00%
17	0.19%	0.00%	0.00%	0.26%	0.00%	0.00%
18	0.16%	0.00%	0.00%	0.22%	0.00%	0.00%
19	0.13%	0.00%	0.00%	0.18%	0.00%	0.00%
20	0.11%	0.00%	0.00%	0.15%	0.00%	0.00%
21	0.09%	0.00%	0.00%	0.13%	0.00%	0.00%
22	0.07%	0.00%	0.00%	0.10%	0.00%	0.00%
23	0.05%	0.00%	0.00%	0.07%	0.00%	0.00%
24	0.03%	0.00%	0.00%	0.05%	0.00%	0.00%
25	0.02%	0.00%	0.00%	0.02%	0.00%	0.00%
26	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%
27	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
28	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
29	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
30	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
31	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
32	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
33	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
34	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
35	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
36	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
37	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
38	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
39	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
40	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
41	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
42	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
43	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
44	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
45	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
46	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
47	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
48	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
49	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

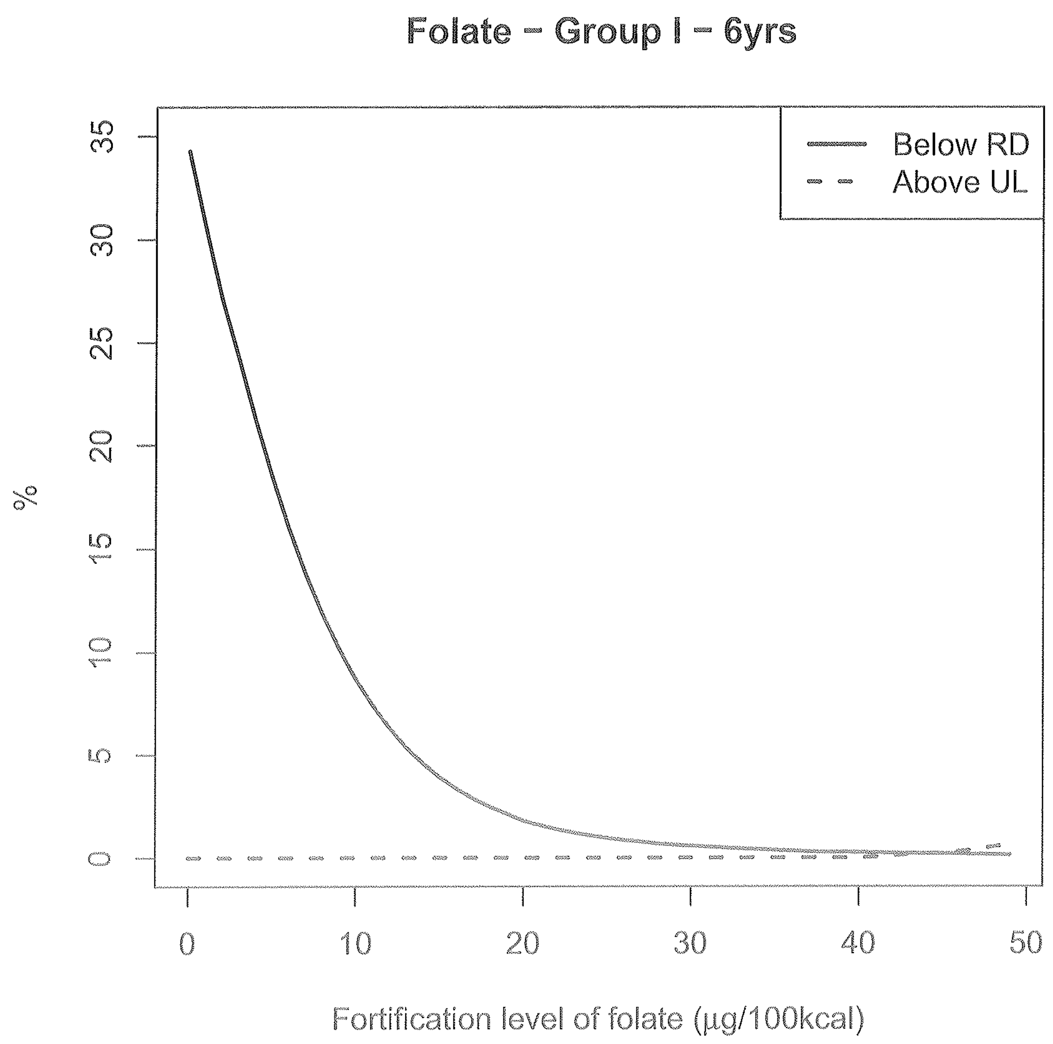
Among 6–year-old children fortification with folic acid was efficient with scenario III. Between the fortification level 10 µg/100 kcal and 22 µg/100 kcal folate intake was both adequate and safe. However, above fortification level 22 µg/100 kcal the proportion exceeding the UL increased sharply.



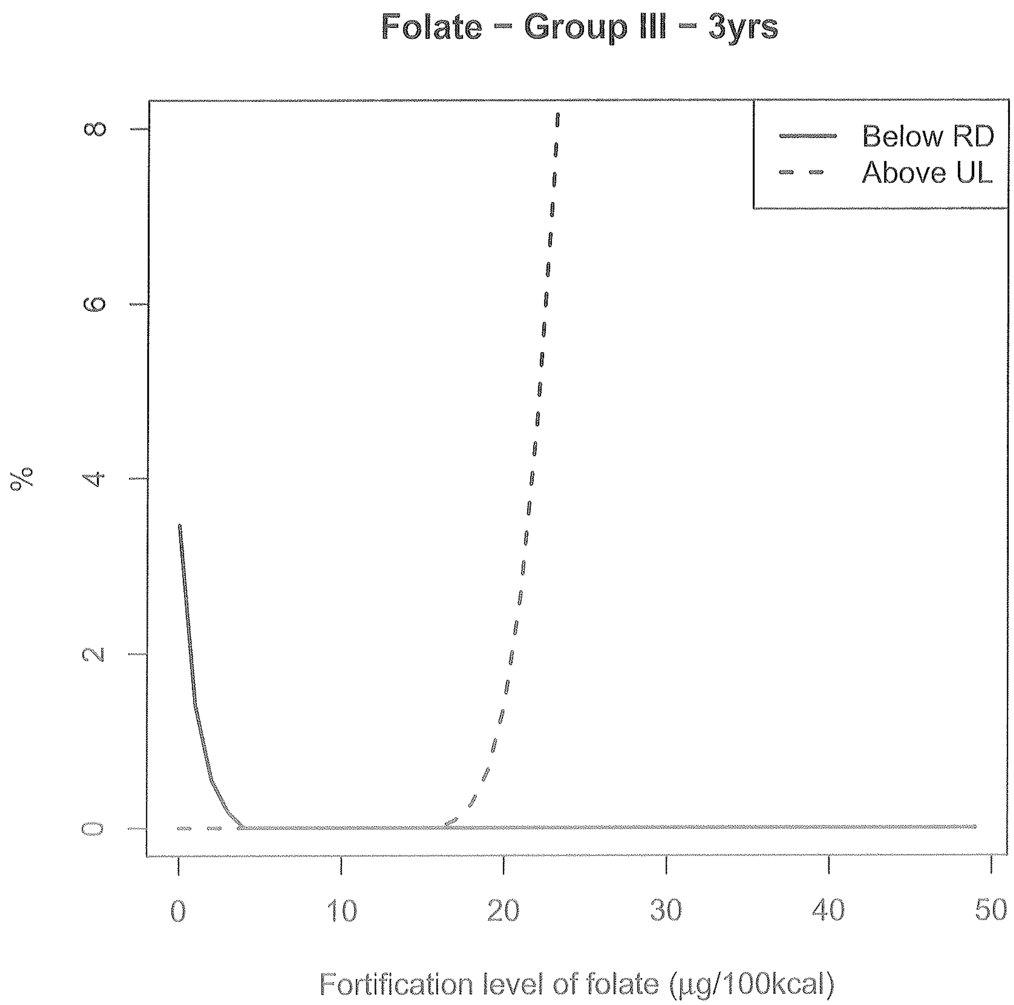
In scenario II among 6-year-old children fortification with folic acid was also efficient. With fortification level around 30 µg/100 kcal folate intake was both adequate and safe, but the proportion of exceeding the UL increased moderately above that level.



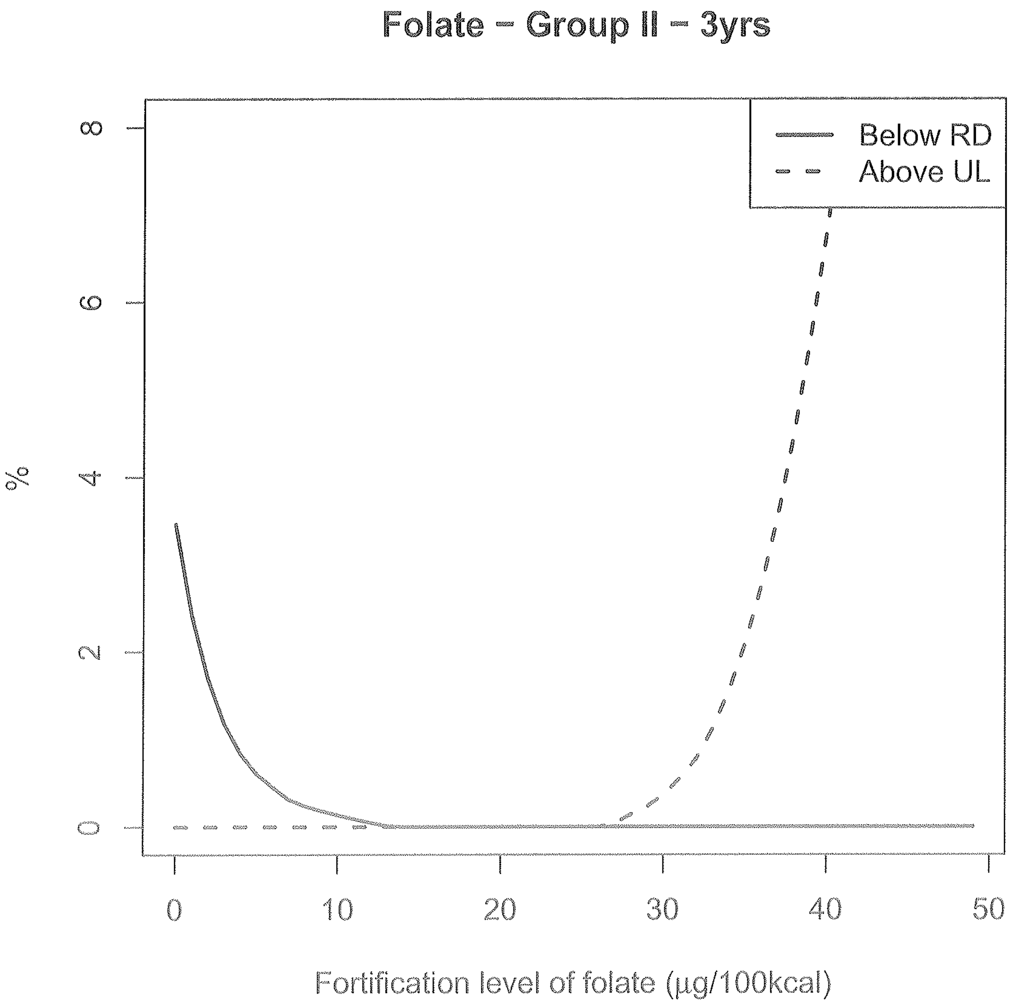
In scenario I1 among 6–year-old children fortification with folic acid was also efficient. With fortification level around 45 µg/100 kcal folate intake was both adequate and safe, but the proportion of exceeding the UL increased slowly above that level.



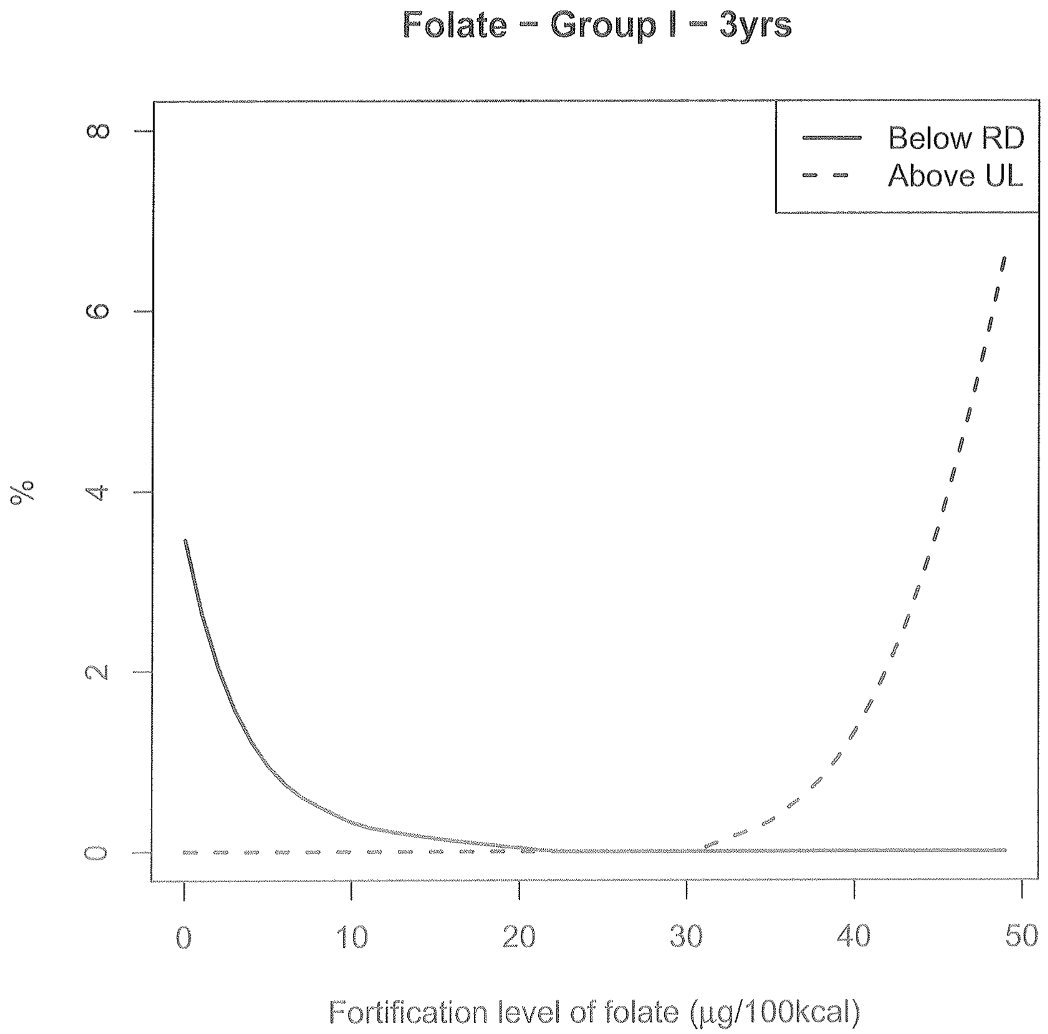
In scenario III among 3–year-old children fortification with folic acid was very efficient. With fortification between 3 µg/100 kcal and 18 µg/100 kcal folate intake was both adequate and safe, but the proportion of exceeding the UL increased sharply above that level.



In scenario II among 3–year-old children fortification with folic acid was very efficient. With fortification between 12 µg/100 kcal and 17 µg/100 kcal folate intake was both adequate and safe, but the proportion of exceeding the UL increased sharply above that level.



In scenario I among 3-year-old children fortification with folic acid was very efficient. With fortification between 21 µg/100 kcal and 31 µg/100 kcal folate intake was both adequate and safe, but the proportion of exceeding the UL increased sharply above that level.



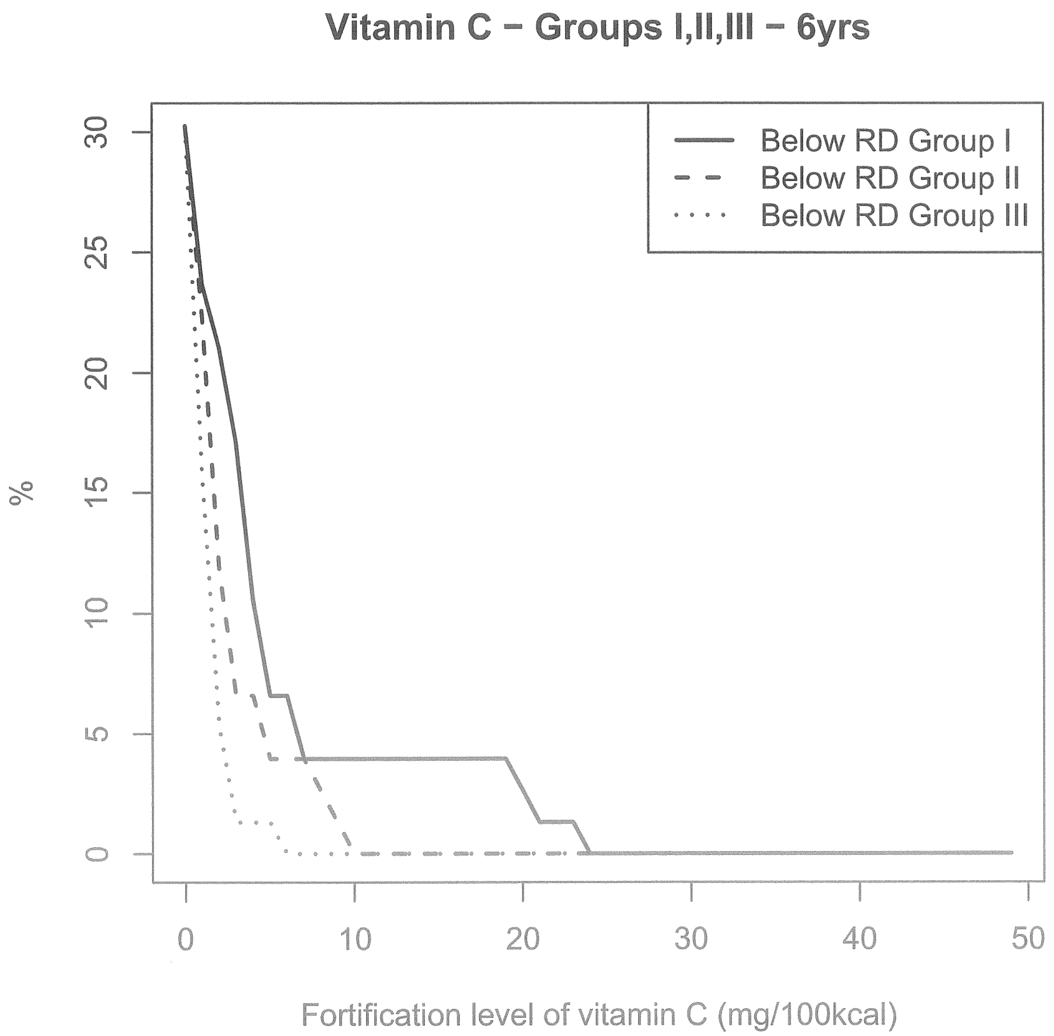
Summary of the fortification outcomes with folic acid among the Finnish children.

Folate (folic acid), µg/100kcal											
3 yrs						6 yrs					
<RD G1	>UL G1	<RD G2	>UL G2	<RD G3	>UL G3	<RD G1	>UL G1	<RD G2	>UL G2	<RD G3	>UL G3
3.46%	0.00%	3.46%	0.00%	3.46%	0.00%	34.27%	0.00%	34.27%	0.00%	34.27%	0.00%
2.65%	0.00%	2.42%	0.00%	1.42%	0.00%	30.59%	0.00%	29.12%	0.00%	24.32%	0.00%
2.03%	0.00%	1.69%	0.00%	0.55%	0.00%	27.08%	0.00%	24.36%	0.00%	15.84%	0.00%
1.56%	0.00%	1.18%	0.00%	0.19%	0.00%	24.23%	0.00%	20.48%	0.00%	9.44%	0.00%
1.21%	0.00%	0.84%	0.00%	0.00%	0.00%	21.23%	0.00%	16.83%	0.00%	5.21%	0.00%
0.94%	0.00%	0.60%	0.00%	0.00%	0.00%	18.47%	0.00%	13.66%	0.00%	2.71%	0.00%
0.75%	0.00%	0.45%	0.00%	0.00%	0.00%	15.98%	0.00%	10.97%	0.00%	1.37%	0.00%
0.60%	0.00%	0.31%	0.00%	0.00%	0.00%	13.76%	0.00%	8.73%	0.00%	0.69%	0.00%
0.50%	0.00%	0.24%	0.00%	0.00%	0.00%	11.87%	0.00%	6.91%	0.00%	0.36%	0.00%
0.41%	0.00%	0.19%	0.00%	0.00%	0.00%	10.17%	0.00%	5.44%	0.00%	0.19%	0.00%
0.32%	0.00%	0.14%	0.00%	0.00%	0.00%	8.68%	0.00%	4.28%	0.00%	0.08%	0.00%
0.27%	0.00%	0.09%	0.00%	0.00%	0.00%	7.40%	0.00%	3.38%	0.00%	0.00%	0.00%
0.23%	0.00%	0.05%	0.00%	0.00%	0.00%	6.31%	0.00%	2.67%	0.00%	0.00%	0.00%
0.20%	0.00%	0.01%	0.00%	0.00%	0.00%	5.36%	0.00%	2.12%	0.00%	0.00%	0.00%
0.17%	0.00%	0.00%	0.00%	0.00%	0.00%	4.57%	0.00%	1.69%	0.00%	0.00%	0.00%
0.15%	0.00%	0.00%	0.00%	0.00%	0.00%	3.90%	0.00%	1.36%	0.00%	0.00%	0.00%
0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	3.34%	0.00%	1.08%	0.00%	0.00%	0.00%

0.10%	0.00%	0.00%	0.00%	0.00%	0.09%	2.87%	0.00%	0.88%	0.00%	0.00%	0.00%
0.08%	0.00%	0.00%	0.00%	0.00%	0.27%	2.47%	0.00%	0.73%	0.00%	0.00%	0.00%
0.06%	0.00%	0.00%	0.00%	0.00%	0.65%	2.14%	0.00%	0.61%	0.00%	0.00%	0.00%
0.04%	0.00%	0.00%	0.00%	0.00%	1.40%	1.79%	0.00%	0.53%	0.00%	0.00%	0.00%
0.02%	0.00%	0.00%	0.00%	0.00%	2.66%	1.57%	0.00%	0.45%	0.00%	0.00%	0.00%
0.01%	0.00%	0.00%	0.00%	0.00%	4.62%	1.38%	0.00%	0.38%	0.00%	0.00%	0.10%
0.00%	0.00%	0.00%	0.00%	0.00%	7.41%	1.21%	0.00%	0.31%	0.00%	0.00%	0.27%
0.00%	0.00%	0.00%	0.00%	0.00%	11.09%	1.08%	0.00%	0.27%	0.00%	0.00%	0.63%
0.00%	0.00%	0.00%	0.00%	0.00%	15.64%	0.95%	0.00%	0.24%	0.00%	0.00%	1.28%
0.00%	0.00%	0.00%	0.00%	0.00%	20.95%	0.85%	0.00%	0.21%	0.00%	0.00%	2.41%
0.00%	0.00%	0.00%	0.04%	0.00%	26.86%	0.76%	0.00%	0.18%	0.00%	0.00%	4.19%
0.00%	0.00%	0.00%	0.14%	0.00%	33.16%	0.68%	0.00%	0.16%	0.00%	0.00%	6.75%
0.00%	0.00%	0.00%	0.23%	0.00%	39.64%	0.62%	0.00%	0.14%	0.00%	0.00%	10.20%
0.00%	0.00%	0.00%	0.36%	0.00%	46.09%	0.58%	0.00%	0.11%	0.00%	0.00%	14.57%
0.00%	0.04%	0.00%	0.55%	0.00%	52.33%	0.53%	0.00%	0.09%	0.00%	0.00%	19.80%
0.00%	0.11%	0.00%	0.77%	0.00%	58.22%	0.49%	0.00%	0.07%	0.00%	0.00%	25.74%
0.00%	0.18%	0.00%	1.11%	0.00%	63.68%	0.45%	0.00%	0.05%	0.00%	0.00%	32.20%
0.00%	0.24%	0.00%	1.54%	0.00%	68.65%	0.41%	0.00%	0.04%	0.06%	0.00%	38.97%
0.00%	0.34%	0.00%	2.08%	0.00%	73.10%	0.37%	0.00%	0.02%	0.15%	0.00%	45.79%
0.00%	0.48%	0.00%	2.75%	0.00%	77.03%	0.33%	0.00%	0.00%	0.24%	0.00%	52.47%
0.00%	0.61%	0.00%	3.55%	0.00%	80.48%	0.29%	0.00%	0.00%	0.36%	0.00%	58.83%
0.00%	0.80%	0.00%	4.49%	0.00%	83.46%	0.27%	0.00%	0.00%	0.53%	0.00%	64.74%
0.00%	1.03%	0.00%	5.57%	0.00%	86.03%	0.27%	0.00%	0.00%	0.73%	0.00%	70.10%
0.00%	1.32%	0.00%	6.81%	0.00%	88.23%	0.26%	0.00%	0.00%	1.02%	0.00%	74.89%
0.00%	1.65%	0.00%	8.19%	0.00%	90.10%	0.24%	0.03%	0.00%	1.39%	0.00%	79.08%
0.00%	2.05%	0.00%	9.71%	0.00%	91.68%	0.23%	0.09%	0.00%	1.86%	0.00%	82.70%
0.00%	2.50%	0.00%	11.37%	0.00%	93.01%	0.22%	0.14%	0.00%	2.43%	0.00%	85.79%
0.00%	3.04%	0.00%	13.16%	0.00%	94.14%	0.20%	0.20%	0.00%	3.11%	0.00%	88.40%
0.00%	3.60%	0.00%	15.07%	0.00%	95.08%	0.19%	0.24%	0.00%	3.91%	0.00%	90.57%
0.00%	4.28%	0.00%	17.08%	0.00%	95.87%	0.18%	0.30%	0.00%	4.84%	0.00%	92.37%
0.00%	5.01%	0.00%	19.18%	0.00%	96.53%	0.17%	0.40%	0.00%	5.89%	0.00%	93.85%
0.00%	5.80%	0.00%	21.37%	0.00%	97.08%	0.15%	0.52%	0.00%	7.08%	0.00%	95.05%
0.00%	6.66%	0.00%	23.61%	0.00%	97.54%	0.14%	0.63%	0.00%	8.39%	0.00%	96.03%

Ireland

Fortification with vitamin C decreased efficiently the proportion of those children below the recommended dietary intake (RDI) for vitamin C. In fortification level 23 mg/100 kcal all children were above RDI in all scenarios. The figure presents all groups for six year old children.



Fortification outcome with vitamin C among the Irish children..

	Vitamin C, mg/100kcal		
	6 yrs		
Fortification	<RD G1	<RD G2	<RD G3
0	0.302632	0.302632	0.302632
1	0.236842	0.223684	0.157895
2	0.210526	0.118421	0.052632
3	0.171053	0.065789	0.013158
4	0.105263	0.065789	0.013158
5	0.065789	0.039474	0.013158
6	0.065789	0.039474	0
7	0.039474	0.039474	0

8	0.039474	0.026316	0
9	0.039474	0.013158	0
10	0.039474	0	0
11	0.039474	0	0
12	0.039474	0	0
13	0.039474	0	0
14	0.039474	0	0
15	0.039474	0	0
16	0.039474	0	0
17	0.039474	0	0
18	0.039474	0	0
19	0.039474	0	0
20	0.026316	0	0
21	0.013158	0	0
22	0.013158	0	0
23	0.013158	0	0
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0	0	0
35	0	0	0
36	0	0	0
37	0	0	0
38	0	0	0
39	0	0	0
40	0	0	0
41	0	0	0
42	0	0	0
43	0	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0

Conclusions

In all countries fortification with vitamin C was efficient in diminishing the proportion of those children with low vitamin C intake. It was also safe, since vitamin C does not have tolerable upper intake level and is regarded safe even in high intake levels. In contrast, fortification with folic acid and vitamin A was more problematic: both for vitamin A and folic acid in Spain there was no fortification level in which all the population would have been above RDI and below UL at the same time. In Finland such level could be found for folic acid, but the area was rather narrow. In Finland fortification simulations for vitamin A were not even performed, since intake without fortification was excessive in a significant proportion of the children.

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