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Dietary fibre and phytate; a balancing act. Results from 3 time points in a British Birth Cohort

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Abstract

An investigation was carried out to determine whether there were significant changes in the intake of dietary fibre (non-starch polysaccharide; NSP) and phytate of adult men and women in the UK from 1982 (aged 36 years) to 1999 (aged 53 years). The 1253 subjects studied were members of the Medical Research Council National Survey of Health and Development; a longitudinal study of a nationally representative cohort of births in 1946. Food intake was recorded in a 5-day diary at age 36 years in 1982, 43 years in 1989 and 53 years in 1999. The food composition database was amended with revised values for phytate. Outcome measures were mean intakes of total NSP and phytate by year, gender and food source. There were significant changes in total NSP and phytate intake over the 3 time-points. Intakes of NSP rose significantly between 1982 and 1999 for men and women but phytate intakes rose significantly only between 1989 and 1999. Cereal foods were the most important source of both NSP and phytate. Between 1989 and 1999 there was a significant increase in the contribution from pasta, rice and other grains. This study shows that an increase in dietary fibre that is in accordance with dietary guidelines would almost inevitably be accompanied by a rise in phytate. The increased dietary phytate is discussed in relation to its recognised inhibition of mineral absorption and its merits with regard to protection against some cancers and other diseases of an ageing population.

Keywords

Dietary fibre; NSP; Phytate; Dietary intake

Introduction

It is now well recognised that dietary fibre is an essential component of the diet for optimum health and, as such, is included as a priority for the UK Department of Health's food and health action plan(1). National dietary guidelines recommend an increase in the intake of non-starch polysaccharides (NSP) that are provided by a mixture of whole grains, vegetables and fruit. Phytate is a naturally occurring compound found in plant derived foods, particularly in grains and legumes where it is the primary storage compound of phosphorus that is released on germination to support the emerging seedling (2). Within the seed or

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grain the phytate is found mainly in the aleurone layer of wheat and barley, the embryo in maize and the seed coat of legumes. Thus an increase in the fibre of human diets is most often accompanied by an increase in the phytate content and the latter may have a considerable impact on the nutritional properties of foods. The major nutritional concern regarding phytate in the diet is its ability as a highly negatively charged ion to chelate and precipitate minerals such as iron, zinc, calcium and magnesium. The formation of these insoluble metal cation-phytate complexes at physiological pH levels is a major cause of poor mineral availability as these complexes are non-absorbable from the gastrointestinal tract (3). McCance and Widdowson (4) carried out the first human experiments on phytate and iron absorption. Dietary phytate was a major concern during wartime food rationing in the UK when the extraction of wheat flour and the proportion of the diet that was plant-based were considerably increased. Similarly, the phytate content of many predominantly plant based diets in the developing world today is of concern as intakes of minerals may already be marginal (5). Encouragement to eat high fibre foods, especially whole wheat bread, may also compromise the iron status of vulnerable groups, such as young women, in the developed world (6).

In view of the close association between dietary fibre and phytate, it was of interest to discover how these 2 constituents of the diet have changed over a period of time during which the health benefits of dietary fibre have been widely advertised. The National Diet and Nutrition Survey (NDNS) has reported on intakes of NSP in adults (7) but not phytate. Using the data provided by the Medical Research Council (MRC) National Survey of Health and Development (NSHD)(1946 Birth Cohort) we were able to examine trends over time for both phytate and NSP in the same sample of subjects at different time points.

Methods

Subjects

The MRC National Survey of Health and Development (NSHD), also known as the 1946 British Birth Cohort, is a longitudinal study of health based on a social class-stratified, random sample of 5362 singleton births in England, Scotland and Wales during the first week of March 1946. Throughout childhood and adult life, medical, social, educational and other information has been collected on twenty-one occasions. Research nurses made home visits at ages 36, 43 and 53 years, in 1982, 1989 and 1999 respectively and left diet diaries to be completed. The population interviewed at the age of 53 years was, in most respects, still representative of 53-year-olds native-born population (8). Of the 3035 cohort members who were contacted in 1999 there were 1263 individuals who had also provided dietary data in 1982 and 1989. Of these, there were 1253 subjects; 562 men and 691 women, for whom there were diet records of at least 3 days collected at each time point. This sub-sample forms the population for the current analysis. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the North Thames Multicentre Research Ethics Committee. Written informed consent was obtained from all subjects.

Dietary assessment

Details of the subjects and the dietary assessment methods have been reported previously (9). Subjects were asked to record all food and drink consumed both at home and away in 5-day diaries using household measures and estimated portion sizes according to detailed guidance notes and photographs provided at the beginning of the diary. The diaries were coded using the in-house program DIDO (10). The coded records were analysed using the in-house analysis program based on McCance and Widdowson's “The Composition of Foods” (11-14) that allows foods to be grouped as required for the purpose of identifying

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sources of particular nutrients. The groups described do not include the ingredients of composite foods such as meat dishes.

The original nutrient composition database contained limited information on the phytate content of foods (15, 16) and it was recognised that these foods had been analysed by outdated colorimetric methods. The food composition database was amended with replacement phytate values where appropriate, these being obtained from the data of Harland and Oberleas (17) bearing in mind that these data were for US foods. These more recent values were applied to the principal sources of phytate such as breads, breakfast cereals, rice, beans and nuts. These values were determined using more up-to date methods of HPLC analysis (18). It was recognised that due to differences in varieties, growth environments and food processing in the US these values may not have been entirely appropriate, especially for foods grown in the UK, but they were used in the absence of recent analytical data for British foods. Values for the phytate content of composite dishes were calculated from ingredients. Standard recipes as given in McCance and Widdowson were used where possible. Where no recipe was available, cereal content of foods was ascertained from the starch and NSP content. Vegetable content of mixed dishes was calculated from the beta-carotene and/or vitamin C content. The content of pulses in mixed dishes was derived by calculating the proportion of protein that was contributed from the pulses, meat contribution being identifiable from the haem iron content.

As the 1982 dietary data were analysed using the 4th edition of McCance and Widdowson (14) only values for Southgate fibre were available. In order to compare with the 1989 and 1999 fibre intake data, values for NSP were added to the 4th edition database by extrapolating from the cereals and vegetables nutrient composition tables (15, 16).

Statistical analysis

Data analysis was by SPSS for MS Windows 10. Means and 95% CI for phytate, NSP, iron and zinc intakes, and the molar ratios of phytate:iron and phytate:zinc were calculated at each time-point stratified by gender. General Linear Models, repeated measures, was used to identify significant changes over the three years, with *post hoc* Bonferroni comparisons.

Results

Results are from the population of 1253 individuals, from whom there were dietary records of at least 3 days collected in 1982 at age 36 years, 1989; age 43 years and 1999; age 53 years.

Table 1 shows the mean NSP, phytate, iron and zinc intakes and the phytate:iron and phytate:zinc ratios of both men and women in 1982, 1989 and 1999. Phytate intakes of men and women did not change between 1982 and 1989 but rose significantly between 1989 and 1999 ($p<0.005$). NSP intakes show a clear rising trend from 1982 to 1999, all 3 time points were significantly different ($p<0.05$). Intakes of both phytate and NSP were greater in men compared to women in all three years but the rise between 1989 and 1999 was more marked in women. When adjusted for total energy, intakes of both phytate and NSP were significantly higher in 1999 compared to previous time points and were significantly higher in women compared with men at all 3 time points ($p<0.001$). Phytate:iron and phytate:zinc ratios rose significantly between 1989 and 1999. In 1999 the phytate:iron ratio was significantly higher in women compared with men ($p = 0.024$) and the phytate:zinc ratio was significantly higher in women at all three time points ($p<0.02$).

Tables 2 and 3 show the mean daily intake of NSP and phytate of men and women respectively from the principal sources. Also shown are the percent contribution to total

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NSP and phytate from these sources. The sources shown do not add up to the total NSP and phytate as there was also a contribution from composite dishes such as those based on meat that are not included. Bread and breakfast cereals were the main sources of both NSP and phytate at every time point but between 1989 and 1999 there was a significant increase in the quantity derived from pasta, rice and other grains in both men and women. There was no change in men's intake of NSP and phytate from bread between the 3 time points while that of women rose significantly between 1982 and 1999. The contribution from breakfast cereals rose between 1982 and 1989 but fell again, although not significantly in 1999. The contribution from sweet cereal products also fell in 1999.

NSP from vegetables, potatoes and fruit all rose between 1982 and 1889 but while NSP from fruit continued to rise in 1999 that from potatoes fell as did the phytate contribution. After combining fruit and all vegetables (including pulses but not potatoes) it was found that the increase in NSP from these foods between 1982 and 1999 was significantly greater in women than men; $p < 0.001$ (results not shown).

Discussion

Investigation of the diets in this cohort over a period of 17 years has shown an increased intake of NSP accompanied by an increase in the phytate content of the diet. While NSP intake increased continuously from 1982 to 1999 the increase in phytate occurred in the latter 10 years. This can be attributed to the greater consumption of fruit and vegetables (not important sources of phytate) between 1982 and 1989 that predated the greater consumption of cereal foods such as pasta, rice and wholegrain products that occurred between 1989 and 1999.

The lack of recent reports of phytate intakes in the UK may be due to the paucity of good quality data on the phytate content of foods. As a plant component, phytate content of foods is very variable and can depend on genotype, environmental conditions during growth and sampling procedures. Furthermore, endogenous phytases may reduce the inositol hexaphosphate content to a variable extent during storage and food processing, resulting in inositol phosphates with fewer numbers of phosphate groups that have lower metal binding capacities(19). Most of the data presently available in the UK are now very old, many of the analyses having been carried out before 1978 using a colorimetric method that included these partially hydrolysed inositol phosphates. It is recognised the main limitation of the present study is that the phytate data on which this report is based are a mixture of some of the old values and some relatively new, the latter based on HPLC analyses of foods in the US (18).

The other limitation of this study may be that the members of a long-running cohort may not be representative of the general population as those individuals who continue to contribute to the study may have particular characteristics with regard to diet and health. In addition, secular changes cannot be separated from changes due to an ageing population. The number of subjects who completed a diary in 1999 was much lower than in the preceding years and the subjects who provided data at all three time points were less representative of the general population; more than half were from non-manual occupational social classes. Despite the limitations of the cohort, the fibre intake in 1999 was very close to that of the age matched subjects of the National Diet and Nutrition Survey (NDNS) of adults assessed in 2000-2001; 16.4 and 14 g/day for men and women respectively, aged 50-64 years (7). This intake is still lower than the recommended average of 18g/day (20). The proportion of NSP derived from bread consumed by men was very similar in the NSHD compared with NDNS: 22 and 21% respectively, but women in the NSHD obtained a greater proportion from bread than those in the NDNS; 24% compared with 17%. As we have reported previously, bread consumption by this cohort fell from 1982 to 1999 (9), but as the NSP from bread has risen in this period it would indicate that the bread that was consumed had a higher fibre content. The consumption of breakfast cereals rose in the NSHD cohort between 1982 and 1999 (9), but the NSP from this source in 1999 was less than that reported from the NDNS. The increase in fibre intake in the NSHD cohort through the years could be in response to the frequent health messages, both in advertising and from the Health Service, concerning the health benefits of dietary fibre. The majority of the subjects in the present study, members of the 1946 cohort who have been studied at all 3 time points, were from non-manual occupational social classes (8) who tend to have a greater degree of literacy and are more health-aware. The fact that older people are more responsive to such messages is shown by the data from the NDNS survey that show intakes of NSP rising with age (7). Alternatively these may be changes in dietary choices associated with ageing. The NDNS survey reported that the older group of adults (50-64 years) consumed more breakfast cereals, sweet cereal products, vegetables and fruit than the 19-24 year age group while the latter consumed more pasta, rice and miscellaneous grains (21). In respect of this last food group the NSHD cohort were not representative, increasing their intake of these foods three fold between 1982 and 1999(9), which may, perhaps be a reflection of the bias towards non-manual social classes who are more innovative with regard to food choices. Older women, for whom the increase in the 1999 NSHD survey was proportionally greater than for men, may increase their intake of high fibre foods, especially cereal grains, to counteract constipation and to improve gastro-intestinal function.

There are many investigations into the phytate content of cereal based diets with regard to improving mineral availability in several developing countries (5, 22-24) but few describing intakes in the UK. Data from weighed 7day food records collected from 76 adults in Scotland in 1986 were analysed using the phytate values from McCance and Widdowson and intakes of 713 and 582 mg/day for men and women respectively were reported (25). This was close to the mean reported from the present study. The NDNS survey of British adults 2000-2001 did not report phytate intakes, but a secondary analysis found that the median intake of adults (19-64 years) in the survey was 809mg/day, compared to the median of 616mg/day found in the NSHD in 1999 (26). The median phytate:zinc ratio was also higher, 9.7 compared to 6.8 and, although not reported, the iron:phytate ratio was also probably higher as intakes of iron and zinc were very similar in the NDNS and the NSHD. As the intake of NSP was greatest in the older age group of the NDNS the probability is that the phytate intake was also correspondingly higher which would make the disparity between the NSHD and NDNS phytate intakes even greater. Without knowing what data on phytate content of foods were available to those analysing the NDNS data it is difficult to speculate on these differences.

As people in the UK are being encouraged to consume more high fibre foods, especially whole grain cereals (27), we should be aware that this would inevitably encompass an increase in dietary phytate. Whether this is viewed as a disadvantage or a benefit would depend on the section of the population under consideration. Iron deficiency anaemia is a problem in the UK as it is worldwide. In the UK 44% of dietary iron is provided by cereals and cereal products and, of this, 16% is provided by wholemeal bread and high fibre breakfast cereals. Healthy young women with initially sufficient iron stores who ate high fibre bread for 4 months had its significantly reduced serum ferritin and haemoglobin levels (6). The addition of phytase to the bread in this intervention did not alleviate the effect on the iron status but it has been shown in another trial that a sour-dough fermentation can increase availability of iron in bread (19). Navert *et al.* showed that the length of time that bread was leavened determined the phytate content of bread and subsequently the zinc absorption in man (28) but in the UK most bread is manufactured using the Chorleywood

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process during which the traditional 2-4 hour fermentation is replaced by a few minutes of intense mechanical agitation (29).

Bio-availability of non-haem iron is much less than that of haem iron and data from the NSHD cohort showed that the dietary intake of haem iron and non haem iron fell between 1989 and 1999 (30). Comparison with a nationally representative sample of the same age shows that total haem iron intake of the 1946 cohort in 1999 was only slightly lower than that reported by the NDNS (7). Eight per cent of women of this age (50-64 years) in the NDNS had serum ferritin concentrations below the lower limit of normal (31). This indicates that even in women above childbearing age factors that inhibit iron absorption are still relevant. However, factors other than phytate that influence iron bioavailability have to be taken into account. Using the dietary data from the NSHD cohort, it was found that the iron that is available for absorption after the enhancing or inhibiting effects of dietary factors consumed concurrently with the iron, calculated using the algorithm of Rickard *et al*, remained fairly constant over the 17 year period (32). The inhibitory effect of phytate on iron absorption in the NSHD in 1999 was overpowered by the enhancing effect of vitamin C, the intake of which had risen dramatically over that period (9). However fruit and vegetable consumption and vitamin C intakes were lower in the younger age groups of the NDNS so the balance between phytate (inhibitory) and vitamin C (enhancing) may not be so favourable.

So far we have considered phytate as an anti-nutritional factor, primarily with reference to iron deficiency anaemia, which, in the UK, is mainly a concern of pre-menopausal women. However, studies, reviewed by Greiner *et al*. (3) have shown that dietary phytate may not be an undesirable component of plant foods with respect to men and older women. Phytate may protect against some cancers (33-35). It has been suggested that by binding metals such as copper and iron, which could initiate oxidation reactions in the colon, phytate may protect the epithelial cells from oxidant exposure and possible mutation (36). It has been suggested that the apparent relationship between the incidence of colon cancer and fibre intake may, in part, be due to the protective effect of the phyate that accompanies the fibre (37). Phytate has also been shown to lower serum cholesterol and triglycerides in experimental animals (38) and to reduce the blood glucose response to a carbohydrate load (39). Phytate has also been found to be an inhibitor of the formation of kidney stones and, *in vitro*, shown to inhibit calcification in bovine pericardium (40, 41) and also to have a neuro-protective effect in a cell culture model of Parkinson's disease (42). In the NSHD cohort, now approaching old age, these beneficial properties of phytate may be of more significance than the negative effect on mineral balance, especially as the increased vitamin C has been shown to counter-act the phytate inhibition (32), and the corresponding increase in fibre intake is now well recognised to be desirable.

Our longitudinal study of dietary fibre and phytate shows that, as the intake of fibre increases, which is in accordance with dietary guidelines, phytate intakes, mainly from cereal foods, also increase. Extrapolating from this cohort to the general population it may be that higher phytate intakes will be deleterious to the availability of iron, calcium and zinc in vulnerable groups such as children and young women. On the other hand, when considering older people such as those in the 1946 cohort, there would appear to beneficial effects of phytate on chronic disease. When making recommendations nutritionists should consider this balance of anti-nutritional and beneficial properties with care.

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Table1

Mean (95% CI) non-starch polysaccharide (NSP) (g/day and g/MJ/day)), phytate (mg/day and g/MJ/day), iron (mg/day) zinc (mg/day) intakes, phyate:iron and phytate:zinc molar ratios of British men and women of the NSHD 1946 Birth Cohort

	Men (n 562)			Women (n 691)		
	1982 (36 years)	1989 (43 years)	1999 (53 years)	1982 (36 years)	1989 (43 years)	1999 (53 years)
NSP g/day	13.5 (13.1,13.9)[a]	14.3 (13.8,14.8)[b]	15.5 (15.0,15.9)[c]	11 (10.7,11.3)[a]	12.5 (12.1,12.8)[b]	14.3 (13.9,14.6)[c]
Phytate mg/day,	662 (626,698) [a]	666 (634,698) [a]	715 (684,747) [b]	566 (536,597) [a]	562 (537,587) [a]	647 (622,671) [b]
NSP g/MJ/day	1.3 (1.3,1.4) [a]	1.4 (1.3,1.4) [a]	1.7 (1.6,1.7) [b]	1.5 (1.5,1.65) [a]	1.6 (1.6,1.7) [a]	1.9 (1.9,2.0) [b]
Phytate mg/MJ/day	65 (62,69) [a]	65 (62,68) [a]	76 (73,80) [b]	78 (74,83) [a]	72 (69,75) [a]	86 (83,89) [b]
Iron mg/day,	13.1 (12.8,13.4) [a]	14.1 (13.7,14.5) [b]	12.7 (12.4,13.0) [a]	10.6 (10.3,110) [a]	11.7 (11.4,11.9) [b]	10.8 (10.6,11.1) [a]
Phytate:iron ratio	4.2 (4.0,4.4) [a]	4.0 (3.8,4.1) [a]	4.8 (4.6,5.0) [b]	4.4 (4.2,4.6) [a]	4.1 (3.9,4.2) [a]	5.1 (4.9,5.4) [b]
Zinc mg/day,	11.1 (10.8,11.3) [a]	11.0 (10.8,11.3) [a]	10.4 (10.2,10.6) [b]	8.4 (8.3,8.6)	8.6 (8.4,8.8)	8.4 (8.2,8.6)
Phytate:zinc ratio	5.7 (5.5,6.0) [a]	5.9 (5.6,6.1) [a]	6.8 (6.5,7.0) [b]	6.3 (6.0,6.6) [a]	6.3 (6.1,6.5) [a]	7.5 (7.3,7.8) [b]

Unlike superscripts indicate significant difference, $p<0.05$

Table 2

Mean (95% CI) non-starch polysaccharide (NSP) (g/day) and phytate (mg/day) intakes of British men of the NSHD 1946 Birth Cohort, by year of dietary survey and by principal food sources (n=562) and percentage (S.E.) contribution to total from each food group

	1982 (36 years)		1989 (43 years)		1999 (53 years)	
	NSP g/day	**Percent of total**	**NSP g/day**	**Percent of total**	**NSP g/day**	**Percent of total**
Rice/pasta/grains	0.23 (0.18,0.28) [a]	1.6 (0.2)	0.27 (0.20,0.34) [a]	1.7 (0.2)	0.62 (0.53,0.71) [b]	3.8 (0.2)
Bread	3.39 (3.2,3.58)	24.7 (0.5)	3.41 (3.25,3.59)	24.3 (0.5)	3.42 (3.25,3.59)	22.4 (0.5)
Breakfast cereals	1.08 (0.94,1.22) [a]	7.1 (0.4)	1.50 (1.32,1.68) [b]	8.9 (0.5)	1.27 (1.12,1.42) [ab]	7.3 (0.4)
Sweet cereals *	1.15 (1.08,1.23) [a]	8.4 (0.3)	1.19 (1.10,1.28) [a]	8.4 (0.3)	0.88 (0.81,0.94) [b]	5.8 (0.2)
Vegetables	2.37 (2.27,2.47) [a]	18.2 (0.4)	2.69 (2.56,2.82) [b]	19.6 (0.4)	2.56 (2.42,2.67) [b]	16.6 (0.3)
Pulses/nuts	0.80 (0.70,0.90)	5.8 (0.3)	0.77 (0.70,0.85)	5.4 (0.3)	0.84 (0.74,0.94)	5.3 (0.3)
Potatoes	2.13 (2.22,2.40) [a]	18.5 (0.4)	2.44 (2.33,2.55) [a]	12.8 (0.3)	1.63 (1.57,1.70) [b]	16.8 (0.4)
Fruit	1.07 (0.97,1.16) [a]	7.5 (0.3)	1.39 (1.19,1.58) [b]	8.7 (0.3)	2.04 (1.87,2.2) [c]	11.9 (0.4)
	Phytate mg/day	Percent of total	Phytate mg/day	Percent of total	Phytate mg/day	Percent of total
Rice/pasta/grains	31 (25,36) [a]	4.7 (0.4)	35 (29,41) [a]	5.2 (0.5)	70 (57,84) [b]	8.0 (0.51)
Bread	255 (229,281)	33.2 (0.9)	225 (212,239)	34.3 (0.7)	225 (208,242)	30.1 (0.8)
Breakfast cereals	103 (87,118) [a]	12.1 (0.7)	146 (126,167) [b]	16.4 (0.8)	134 (117,150) [b]	15.1 (0.7)
Sweet cereals	58 (53,63) [a]	10.2 (0.4)	35 (31,38) [b]	5.8 (0.3)	38 (34,41) [b]	6.0 (0.3)
Vegetables	37 (35,39) [a]	7.1 (0.2)	46 (42,50) [b]	8.0 (0.3)	37 (34,40) [a]	5.8 (0.2)
Pulses/nuts	43 (38,48)	7.4 (0.4)	47 (41,52)	7.3 (0.4)	53 (45,61)	7.2 (0.4)
Potatoes	88 (84,91) [a]	18.3 (0.5)	85 (82,88) [a]	13.8 (0.4)	73 (68,77) [b]	13.6 (0.4)
Fruit	1 (1,1)	0.7 (0.1)	1 (1,1)	0.5 (0.1)	2 (1,2)	0.3 (0.0)

Unlike superscripts indicate significant difference, $p<0.05$

* Sweet cereals includes cakes, biscuits and puddings

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Table 3

Mean (95% CI) non-starch polysaccharide (NSP) (g/day) and phytate (mg/day) intakes of British women of the NSHD 1946 Birth Cohort, by year of dietary survey and by principal food sources (n=691) and percentage (S.E) contribution to total from each food group

	1982 (36 years)		1989 (43 years)		1999 (53 years)	
	NSP g/day	**Percent of total**	**NSP g/day**	**Percent of total**	**NSP g/day**	**Percent of total**
Rice/pasta/grains	0.28 (0.21,0.34) [a]	2.1 (0.2)	0.23 (0.17,0.30) [a]	1.6 (0.1)	0.54 (0.49,0.6) [b]	3.8 (0.2)
Bread	2.56 (2.42,2.69) [a]	23.5 (0.5)	2.64 (2.53,2.75)	21.7 (0.4)	2.75 (2.64,2.87) [b]	19.6 (0.4)
Breakfast cereals	1.13 (0.98,1.27) [a]	8.3 (0.5)	1.33 (1.19,1.47) [b]	9.3 (0.4)	1.25 (1.13,1.37) ab	8.0 (0.4)
Sweet cereals [*]	1.08 (1.02,1.15) [a]	10.1 (0.3)	1.13 (1.06,1.20) [a]	9.3 (0.3)	0.8 (0.74,0.85) [b]	5.7 (0.2)
Vegetables	2.06 (1.9,2.1) [a]	19.9 (0.4)	2.49 (2.4,2.57) [b]	20.9 (0.3)	2.6 (2.5,2.7) [b]	18.3 (0.3)
Pulses/nuts	0.48 (0.43,0.53) [a]	4.3 (0.2)	0.54 (0.49,0.6)	4.3 (0.2)	0.64 (0.57,0.71) [b]	4.2 (0.2)
Potatoes	1.41 (1.34,1.48) [a]	14.5 (0.4)	1.97 (1.88,2.06) [b]	11.3 (0.3)	1.27 (1.22,1.32) c	14.8 (0.4)
Fruit	1.26 (1.17,1.35) [a]	10.9 (0.3)	1.62 (1.50,1.73) [b]	11.9 (0.3)	2.56 (2.41,2.72) [c]	16.7 (0.4)
	Phytate mg/day	Percent of total	Phytate mg/day	Percent of total	Phytate mg/day	Percent of total
Rice/pasta/grains	34 (27,41) [a]	5.2 (0.4)	28 (22,34) [a]	4.8 (0.3)	73 (61,86) [b]	9.3 (0.54)
Bread	208 (190,226) [a]	34.0 (0.9)	181 (171,190) [b]	33.1 (0.7)	191 (180,203)	28.7 (0.6)
Breakfast cereals	125 (105,144)	14.7 (0.8)	134 (117,151)	18.5 (0.8)	128 (114,141)	17.0 (0.7)
Sweet cereals	50 (47,53) [a]	11.7 (0.4)	32 (30,35) [b]	6.3 (0.2)	35 (32,38) [b]	5.9 (0.2)
Vegetables	35 (33,36) [a]	8.6 (0.3)	43 (39,47) [b]	8.5 (0.3)	39 (36,41) [b]	6.8 (0.2)
Pulses/nuts	30 (26,34)	6.0 (0.3)	35 (31,39)	6.4 (0.3)	46 (39,53)	6.5 (0.4)
Potatoes	52 (49,54) [a]	14.0 (0.5)	65 (62,67) [b]	12.2 (0.3)	54 (51,56) [a]	11.2 (0.4)
Fruit	1 (1,1)	0.8 (0.1)	1 (1,1)	0.9 (0.1)	2 (2,3)	0.5 (0.0)

Unlike superscripts indicate significant difference, p<0.05

[*] Sweet cereals includes cakes, biscuits and puddings