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UK Dietary Changes Over the Last Two Decades: A Focus on Vitamin & Mineral Intakes

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Abstract

Objective: The objective of this data analysis was to determine dietary changes over the last two decades in the United Kingdom. Particular emphasis was given with regard to vitamin and mineral intakes.

Methods: Data was extracted from two main surveys – The Department for Environment, Food and Rural Affairs (DEFRA) Family Food Survey and National Diet and Nutrition Survey Rolling Programme (NDNS-RP).

Results: Over the last two decades there have been significant linear changes for ten variables. Energy, fat, riboflavin, folate, vitamin D, iron, calcium and potassium significantly declined whilst improvements were observed for dietary protein and zinc. There have been comparatively few shifts in oily fish intakes whilst dietary fibre and fruit and vegetable intakes have significantly fallen. An analysis of NDNS-RP data which records additional micronutrients shows that vitamin A, magnesium, iodine and selenium intakes have also fallen significantly over the last decade. Females aged 11 to 18 years appear to be particularly vulnerable to nutrient shortfalls with intakes of eight micronutrients declining post 2008. Of these, more than 20 per cent had intakes of vitamin A, riboflavin, iron, calcium, magnesium, potassium, iodine, selenium and zinc below the Lower Reference Nutrient Intake.

Conclusions: We are on the cusp of a new decade yet dietary intakes continue to be in need of improvement. Ongoing nutritional surveillance is needed as ‘plant-based’ and ‘vegan’ trends may further influence dietary profiles. Whilst energy and fat intakes appear to have fallen, supplementary emphasis on the ‘nutritional density’ of diets is needed. In the meantime, taking a multi-vitamin and mineral supplement, and a fish oil (omega-3) supplement daily may help to bridge dietary gaps.

Introduction

In the 21st century the health landscape is changing – rising rates of Non-Communicable Diseases (NCD; those not caused by infectious agents), antimicrobial resistance and ageing populations are just some of the new factors shaping health and well-being [1,2]. Over one-half of the global disease burden is attributed to preventable NCDs with unhealthy diets being a central component of this [3]. Healthy diets are generally defined as: “eating patterns that include adequate nutrient intakes and sufficient but not excessive energy intake to meet the energy needs of the individual” [4].

Modern day populations, particularly the young, are suffering under diametrically opposed burdens with many being either underweight or having a high body-mass index [5]. This is compounded by sedentary lifestyles, poor diet diversity and a lack of nutrient dense food [5]. Unhealthy and low-quality diets are increasingly being linked to poor mental health and depression in children and adolescents [6]. The prevalence of type 2 diabetes is also rising amongst teenagers and young adults under the age of 40 years [7]. Subsequently preventative efforts to promote good nutrition earlier on in adulthood are ideally needed ‘ahead of’ age-related changes in physiology and disease onset [8].

A decade ago in 2006-07 poor diet-related ill health was projected to cost the UK National Health Service (NHS) £5.8 billion and overweight and obesity a further £5.1 billion [9]. Now, more than a decade on these costs and conditions do not appear to be receding. For example, the cost to the NHS of intravenous insulin infusions for hospitalised diabetic patients is estimated to be between £6.4-8.5 million for the first 24 hours alone [10]. For vitamin D it has been estimated that addressing inadequacy amongst pregnant women in England and Wales could reduce the number of pre-eclampsia cases by around 4126, equivalent to a net saving of £18.6 million for the NHS [11]. Similarly, iodine supplementation in pregnant women in the UK could make cost savings far beyond the health of the mother [12]. It is estimated that this strategy could save £199 per pregnant woman and have far-reaching societal benefits by improving the intelligence quotient of offspring [12].

The recent UK National Diet and Nutrition Survey Rolling Programme (NDNS-RP) analysis shows that diet quality has not improved much over the last 9 years and micronutrient intakes have deteriorated [13]. Oily fish intakes showed few changes over the 9-year period while red/processed meat and fibre intakes have declined [13]. Vitamin A intakes and folate intakes and status were found to have significantly reduced across all age and gender groups [13]. The proportion of women of childbearing age (defined as 16 to 49 years) with red blood cell folate levels below thresholds for increased risk of Neural-Tube Defect (NTD) affected pregnancies increased markedly from two-thirds to almost 90 per cent over the 9-year period [13].This data coincides with that from eight congenital anomaly registers in England and Wales showing that from 1991 to 2012 the prevalence of neural tube defect affected pregnancies was 1.25 per 1000 births indicating that folate shortfalls were ongoing [14].

Further data from years 5 to 9 of the NDNS-RP income analysis showed that those on higher incomes were closer to meeting some dietary recommendations [13]. Fruit and vegetable consumption increased with income (except in men ≥65 years) although overall mean intakes were below the 5-A-Day recommendation [13]. The percentage consuming oily fish also increased with income while mean intakes remained lower than guidelines during the four days over which they were monitored [13]. An earlier analysis of years 1 to 4 of the UK NDNS found that amongst children aged 2 to 18 years only 4.5 per cent met oily fish intake recommendations [15].

While it is well recognised that healthy dietary patterns are needed to reduce NCDs, long-term trends over time are not well established [16]. The NDNS-RP provides some interesting insights and the present paper aims to build on these and track dietary patterns, including vitamin and mineral intakes in the United Kingdom (UK) over the last 20 years. Data from the principal UK dietary surveys will be organised to assess specific life stages and gender differences.

Keywords: Dietary Trends; Micronutrients; Minerals; Supplements; Vitamins

Methods

In the UK two ongoing government surveys are conducted which track dietary patterns and vitamin and mineral intakes. The Department for Environment, Food and Rural Affairs (DEFRA) Family Food Survey is an annual publication that collects data from UK households using self-reported diaries and till receipts of all food and drink purchases over a two-week period [17]. Food quantities are reported in the diaries where possible but are otherwise estimated [17]. Energy and nutrient intakes are then derived using McCance and Widdowson's nutrient composition data [17]. For the present publication relevant data on: energy, protein, fat, vitamin A, riboflavin, folate, vitamin D, iron, calcium, magnesium, potassium, iodine, selenium, zinc was extracted from archived data for the period between 1996 and 2007.

The UK NDNS-RP is an ongoing cross-sectional survey [18]. It collects detailed quantitative information in relation to patterns of food consumption, nutritional intakes and status in the general UK population for those aged 1.5 years and over [18]. It uses a range of methods including a combination of 4-day food diaries, face-to-face computer assisted interviews, fasting blood samples and information about prescribed medications and supplements [19]. It has collected diet data from 4-day estimated diet diaries between 2008/09 and 2016/17 with a representative sample of around 1000 people (500 children and adults) taking part in the NDNS RP each year [13].

The present publication analysed data trends from when this survey first began in 2008. Data has been extrapolated from public data tables for Years 1-2 (2008/09-2009/10), Years 3-4 (2010/11-2011-12), Years 5-6 (2012/13-2013/14) and Years 7-8 (2014/15-2015/16). Data on energy, protein and fat intakes, free sugars, Association of Official Analytical Chemists (AOAC) fibre, fruit and vegetable, red and processed meat and oily fish intakes was used to assess dietary changes. For the micronutrients, data on vitamin A, riboflavin, folate, iron, calcium, magnesium, potassium, iodine, selenium and zinc intakes was extracted.

To assess dietary change 'percentage change' was calculated using baseline intakes values compared with latest survey data values. The 'absolute change' per year was estimated using the slope of the fitted regression lines and 'estimated percentage change' by fitting regression lines to the log-transformed values. Percentage change was presented for a change of 20 years to correspond to the periods used for baseline and most recent values. Differences in the trend by age group were assessed by including a year by age interaction term in the regression models.

Results

Dietary Changes

Using combined datasets from DEFRA and the UK NDNS-

RP enabled dietary comparisons to be made over the last two decades (Table 1) during which time there have been significant linear changes for ten variables. Energy, fat, riboflavin, folate, vitamin D, iron, calcium and potassium significantly declined while improvements were observed for dietary protein and zinc. In particular, averaged across the years, energy intake declined by 20.2 kcal, vitamin A by 6.8 µg and calcium by 6.3 mg per year. The estimated percentage change for vitamin D was a significant 26 per cent reduction in intake over 20 years.

Table 2 shows main dietary components and how these changed over the last decade. This table further demonstrates changes according to age group. Energy intakes (kcal/d) significantly reduced in 2015/16 amongst children aged 4 to 18 years compared with reported intakes in 2008/9. Amongst children aged 4 to 10 years there was a 7.4 percent decline in energy intake over this period. A trend towards reduced protein intakes was observed amongst younger (4 to10 years) and older (65+ years) phases of the life cycle but remained stable for those aged 11 to 64 years.

AOAC fibre intakes significantly decreased over the ten years, especially amongst those aged 4 to 18 years. For those aged 65 years and over the percentage achieving 5-A-Day reduced significantly from 36 per cent in 2008/9 to 26 per cent in 2015/16 – a 27.8 per cent reduction. As shown in Table 3a in terms of absolute change AOAC fibre and fruit and vegetables intakes differed significantly between the different age groups. Building on this Table 3b shows that percentage change per year also significantly differed by age for energy, AOAC fibre and fruit and vegetable portions. Reductions in dietary fibre were more evident amongst that aged 4-10 years (-1.14% per year) while a decline in daily fruit and vegetable intakes (-2.13% per year) was more common amongst those aged ≥65 years. Figures 1a, Figure 1b, Figure 1c further demonstrate the significant reductions in energy intake, fruit and vegetable intake and AOAC fibre.

Oily fish intakes have remained stable and consistently below dietary guidelines over the last decade. Weekly intakes for those aged 4 to 18 years were just 14 g – equivalent to one-tenth of a portion (140 g). Amongst adults aged 19 to 64 years average oily fish intakes were 56 grams per week –less than half a portion. Current guidance recommends two portions of fish per week, of which one should be oily; a portion is defined as 140 g [20]. Significant reductions in total red and processed meat intakes also occurred. This change was very marked in 2012 amongst adult populations aged 19 to 64 years and the trend towards reduced intakes was sustained until 2016. Overall, there was a 16 per cent reduction in red meat intakes with mean daily intakes reducing from 74 g/day in 2008 to 62g/d in 2016.

Micronutrients

Over the last two decades as shown in Table 1 there have been significant linear reductions for six nutrients – riboflavin, folate, vitamin D, iron, calcium and potassium. Since 1996 there has been a 21-22 per cent reduction in vitamin A and D intakes and a 10 per cent decline in riboflavin, folate and calcium intakes. Intakes of iron and potassium also declined over the 20-year period, by around 5 per cent.

Mean vitamin and minerals intakes from food sources are included in Table 4. Reported intakes are for the periods between 2008 and 2016. In terms of absolute change per year (Table 5a) there were statistically significant differences between age groups for vitamin A, calcium, magnesium, iodine and selenium during this time. Interestingly, vitamin A intakes reduced by 73.6µg/day, calcium by 12.1mg/day and iodine by 4.3µg/day amongst those ≥65 years for each year recorded after 2008. Using values for percentage change per year iron, calcium, magnesium, iodine and selenium intakes also differed significantly with age (Table 5b). Figures 2a, Figure 2b, Figure 2c, Figure 2d, Figure 2e, Figure 2f demonstrate the significant reductions in vitamin A, iron, calcium, magnesium, iodine and selenium.

Table 6 plots the percentage of UK individuals with micronutrient intakes below the Lower Reference Nutrient Intake (LRNI; level below which deficiency may occur). Overall, the proportion of UK children and adults with vitamin A intake below the LRNI appears to have risen. For example, amongst those aged 11-18 years 13 per cent had intakes below the LRNI in 2008 compared with 21 per cent in 2016. Folate intakes also appear to have declined amongst those aged 11 to 18 years. In 2008 4 per cent had intakes from food sources below the LRNI compared with 9 per cent in 2016.

It is also important to look at gender differences as mean values can hide pockets of deprivations. Table 7 shows that females aged 11 to 18 years are at particular risk of nutrient shortfalls with intakes of eight micronutrients declining post 2008. Of these, more than 20 per cent had intakes of vitamin A, riboflavin, iron, calcium, magnesium, potassium, iodine, selenium and zinc below the Lower Reference Nutrient Intake.

Discussion

The present article has sought to evaluate dietary changes, including vitamin and mineral intakes, over the last two decades. Whilst some survey data has reported on dietary trends over the last 9-years [13] few publications have gone back further than this.

Firstly, energy and total fat reductions were apparent in both the DEFRA and NDNS-RP datasets. This downward trend is likely to decline further or plateau as campaigns such as the calorie reduction scheme are rolled out [21]. The health effects of dietary fats, particularly saturated fats, have been labelled as one of the primary lifestyle changes to preventing coronary heart disease [22]. New science, however, is beginning to highlight that a greater emphasis should be placed on 'types' of dietary fat rather than total dietary fat as omega-6 and omega-3 fatty acids are both linked to lower heart disease risk [23]. Bearing this in mind it would be prudent for future surveys to collect data on fatty acids intakes.

Secondly, the present publication identified that the nutritional density of UK diets appears to be declining. Intakes of six key micronutrients - riboflavin, folate, vitamin D, iron, calcium and potassium have fallen over the last two decades [17]. The UK-NDNS demonstrates further reduction in four micronutrients - vitamin A, magnesium, iodine and selenium over the last decade. This collates to potential shortfalls in ten different micronutrients. These findings align with trend analysis of years 1 to 9 of the UK NDNS-RP where distinct downturns in vitamin A, iron and folate intakes (and status) and under consumption of oily fish was reported [13].

Explanations behind why intakes of certain nutrients appear to be receding are unclear. For vitamin A, milk and milk products, meat and meat products, fat spreads, vegetables and potatoes were some of the main dietary providers of vitamin A across the 9-years of the UK-NDNS [24]. It may be that suboptimal or reduced consumption of these could be impacting on vitamin A intake. Findings from the UK-NDNS-RP show that some of the main dietary providers of folate are cereals and cereal products, vegetables and potatoes and meat and meat products [24]. Again, it is possible that under consumption or trends away from these along with practices such as 'breakfast skipping' could be driving intakes down. Ongoing research is needed to better determine why such downturns are arising.

For iron, reductions appear to coincide with reduced meat intakes. The most recent Uk-NDNS shows mean intakes of red and processed meat have declined from 58 g/d in 2008 to 47 g/d by 2016 amongst women aged 19 to 64 [24]. Another analysis showed that UK females consuming less than 40 g total red meat daily were more likely to have reduced micronutrient intakes, especially zinc and vitamin D [25]. The findings demonstrate that there could be 'unintended' consequences where dietary shifts impact on micronutrient intakes. Oily fish consumption has remained stable over time but been consistently lower than dietary guidelines [13]. It is well recognised that oily fish is an important source of high-quality protein, vitamins, minerals and omega-3 fatty acids including eicosapentaenoic acid and docosahexaenoic acid, both of which play a valuable role in the promotion of health and disease prevention [26] yet intakes have failed to improve. Potential barriers to oily fish consumption have included its expense, its sensory properties and poor satisfaction with quality [27-29].

Turning to mineral intakes, it is possible that changes in soil mineral profiles could be impacting on levels in foods and therefore on intakes. Reductions in selenium intakes and status have been linked to the replacement of milled wheat grown in selenium rich North American soils with UK-sourced wheat grown in low selenium soils [30]. It is well documented that UK soils are deficient in selenium, zinc and copper [31]. An analysis of data from McCance and Widdowson's. The Composition of Foods 1st and 6th editions published over a 60-year period (1940-2002) has shown that the micronutrient profile of foods has receded – particularly phosphorous, potassium, potassium, calcium, iron and copper which was attributed to changes in growing and preparation methods [32].

Shortfalls in fruit and vegetable intakes could be another explanation for suboptimal fibre, vitamin and mineral intakes [33]. In 2016 just 8 per cent of 11 to 18 years olds consumed 5 portions of fruit and vegetables daily and a significant reduction in the proportion of older adults' ≥65 years achieving these benchmarks has also been observed.

Cost could be another barrier to healthy diets with some research indicating that the healthiest dietary patterns cost double the price of the least healthy diets (£6.63 versus £3.29 per day) [34]. Other research has proposed that consumers may have a poor understanding of what constitutes a healthy diet with habits, intentions, self-regulatory skills, the social and physical environment being some of the most critical determinants [35].

Further discrepancies between dietary intakes and public health guidelines could be attributed to modes of information dissemination. In the present analysis young people (11 to 18 years) had some of the most concerning nutritional profiles. In particular, 20 per cent of females in this age group have intakes of nine micronutrients below the LRNI. It could be that misinformation is influencing and confusing consumers, especially younger generations. One review of Facebook pages identified that online nutrition advice could be leading to confusion, scepticism and even averting away from dietary advice [36]. Another review of popular Facebook fitness groups concluded that 88.6 per cent of messages within these sites promoted harmful messages that could be to the detriment of health [37].

Interestingly, one study found that high Instagram use was associated with a greater tendency towards orthorexia nervosa – a compulsion to eat healthily [38]. Amongst the 680 participants with social media accounts a concerning 49 per cent had orthorexia nervosa – significantly higher than the lay population (<1%) [38]. Particular diets may also impact on nutritional profiles in different ways. For instance, a recent trial study found that folic acid deficiencies were most prevalent in omnivores (58%), vitamin B_6 and niacin deficiencies most common in vegetarians (58% and 34%, respectively) and zinc deficiencies in vegans (47%) [39]. Interestingly, despite negligible food intake of B_{12} in the vegan group, deficiency rates were low due to the widespread use of supplements [39].

Finally, when advocating dietary changes that involve "cutting back or cutting out" food groups the significance of sustaining micronutrient density should be emphasised. This is especially relevant to energy and/saturated fat reduction schemes. Typically, nutritional deficiencies and insufficiencies do not usually occur in isolation and multiple micronutrients shortfalls are often present in unison [40]. Micronutrients are needed not only to prevent deficiency disorders but for metabolic homeostasis and optimal health [41]. There is growing evidence that micronutrients may be of value for the prevention of conditions such as osteosarcopenic obesity (loss of bone and muscle along with increased adiposity) [41].

Certain micronutrients including vitamins A, C, D, E, B_2, B_6, B_{12}, folic acid, iron, selenium and zinc are needed for immune competence and immune function may be improved by restoring shortfalls to recommended levels [42]. Emerging evidence is also beginning to show that synergistic actions of vitamins with antibiotics could be used to combat multidrug-resistant superbugs - an ongoing modern challenge for healthcare professionals [43].

Future Directions

Government has an important role to play in addressing lifestyle behaviours and population health, reducing health disparities and chronic disease [44]. To support these aims there is a need for ongoing nutritional surveillance and research, as well as appropriate guidance relating to diet and physical activity [44]. Some view Government as paternalistic and favour individual choice although there is scope to unite and integrate diverse approaches [44]. This publication emphasises that the micronutrient density of diets should not be overlooked in future Government strategies or public health campaigns. This is particularly important given current emphasis on 'calorie reduction' where additional messaging about the nutritional density of diets should be built in.

In relation to nutritional surveillance a number of limiting factors exist in the datasets used and analysed. Ideally there should be uniformity in methods used across surveys, be it DEFRA and the UK-NDNS-RP or future multi-centred dietary surveys. When we refer to uniformity this relates to a number of factors including: dietary assessment methods used, food groups and micronutrients analysed and age cut-offs used to define population groups. It is also worth mentioning that the UK-NDNS does not currently report essential fatty acid intakes in its nutrition surveillance and its inclusion would be a valuable addition.

With respect to methods, it is well documented that food diaries can be subject to error due to subjects tending to report food consumption close to those socially desirable [45]. The method can influence food behaviour in respondents in order to simplify the registration of food intake and some subjects can experience difficulties in writing down the foods and beverages consumed or in describing the portion sizes [45]. With the advent of new technologies, it should be possible to develop an electronic means to capture detailed dietary data without the need for manual coding, and once validated these should be used consistently across future UK surveys [46]. Relevantly, it has been proposed that is could be of value to consider examining 'ratios' of micronutrients which could be beneficial in conveying how diet outcomes are related to health [47].

Finally, in the UK the 2016 referendum to leave the European Union has generated a new period of policy uncertainty. This could act as a barrier and hold back attempts to generate any updated dietary advice, including that which embeds new trends and sustainable policies or it could equally provide a fresh opportunity [48]. Whichever way things go micronutrients intakes should not be overlooked in any future dietary and/or policy updates.

Conclusions

It was contemplated by Thomas Edison a renowned American inventor that "The doctor of the future will no longer treat the human frame with drugs, but will rather cure and prevent disease with nutrition" [49]. Whilst this prophecy could come to fruition the present paper shows that dietary profiles have receded rather than improved. Declining intakes of energy, total fat, red meat and under consumption of fruit and vegetables and oily fish all appear to have a role in this.

Evidence-based information that encompasses dietary guidelines, trends and components of health without overlooking 'micronutrient density' now needs to be imparted to public sectors. In the meantime, topping up dietary intakes with a multi-vitamin and mineral supplement, and a fish oil (omega-3) supplement may help to plug some dietary shortfalls.

Author Contributions

ED is responsible for the planning, analysis and the write-up of the publication. ED critically reviewed the manuscript and approved the final version submitted for publication.

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Competing Interests Statement

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hsis.org. The article was written by the author alone and HSIS had no role in writing the publication. The author declares no competing interests. If you would like copies of the data tables please contact the corresponding author.

	1996	1997	1998	1999	2000	2001-02	2002-03	2003-04	2004-05	2005-06	2006	2007	2008/9-2009/10	(2010/1-2011/12)	(2012/13-2013/14)	(2014/15-2015/16)	% Change Since 1996	Absolute Change per year (se)	P value for trend	Estimated % change over 20 years (95% CI)	Trend
Energy (kcal/g)	2241	2168	2102	2056	2152	2098	2101	2079	2050	2082	2074	2052	1896	1825	1849	1860	-17	-20.2 (2.7)	<0.0001**	-17% (-22, -13)	↓
Protein (g/d)	70	70	70	68	72	72	72	71	71	72	72	71	77	74	74	77	10	0.36 (0.07)	0.0002**	10% (6, 14)	↑
Fat (g/d)	93	89	86	83	86	86	85	85	83	85	85	84	71	67	68	70	-25	-1.28 (0.20)	<0.0001**	-27% (-34, -20)	↓
Vitamin A^ (µg/d)	1040	1003	940	911	931	805	802	818	782	796	797	796	988	904	873	825	-21	-6.8 (3.8)	0.1	-12% (-26, 5)	↓
Riboflavin (mg/d)	1.8	1.9	1.8	1.8	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.6	1.5	1.6	1.6	-11	-0.018 (0.004)	0.001**	-19% (-26, -11)	↓
Folate (µg/d)	268	267	260	254	269	257	259	258	257	267	261	264	264	251	244	240	-10	-1.05 (0.31)	0.004**	-8% (-12, -3)	↓
Vitamin D (µg/d)	3.5	3.5	3.4	3.3	3.4	3.3	3.3	2.9	2.9	2.9	2.8	2.8	2.9	2.8	2.8	2.7	-22	-0.050 (0.006)	<0.0001**	-26% (-32, -19)	↓
Iron (mg/d)	11	11	11	11	11	11	11.1	11.2	11.2	11.5	10.9	10.7	10.8	10.5	10.4	10.5	-5	-0.034 (0.011)	0.008**	-6% (-10, -2)	↓
Calcium (mg/d)	910	908	891	881	967	937	936	930	906	921	918	908	824	790	827	821	-10	-6.3 (1.8)	0.004*	-13% (-20, -6)	↓
Magnesium (mg/d)	266	262	258	255	266	258	259	254	256	265	266	262	258	250	264	270	2	0.12 (0.27)	0.654	1% (-3, 5)	↑
Potassium (g/d)	3	2.9	2.9	2.9	3	2.89	2.89	2.86	2.86	2.94	2.93	2.9	2.84	2.73	2.82	2.87	-4	-0.007 (0.003)	0.011*	-5% (-20, -6)	↓
Iodine (µg/d)	--	--	--	--	--	--	--	--	--	--	--	--	164	155	160	156	--	-0.95 (0.90)	0.404	-	--
Selenium (µg/d)	--	--	--	--	--	--	--	--	--	--	--	--	48	48	49	50	--	0.35 (0.09)	0.056	-	--
Zinc (mg/d)	8.4	8.3	8.1	8	8.7	8.5	8.6	8.4	8.4	8.6	8.5	8.5	8.8	8.5	8.5	8.7	4	0.022 (0.009)	0.024*	5% (1, 9)	↑

Key: ^The total vitamin A content of the diet is usually expressed as retinol equivalents; 1µg retinol equivalent is equal to 1µg retinol or 6µg total carotene (β-carotene equivalent); *indicates $P<0.05$ and ** indicates $P<0.01$.

Table 1: Dietary & micronutrient changes over the last two decades.

	Years 1-2 2008/9-2009/10				Years 3-4 (2010/11 - 2011/12)				Years 5-6 (2012/13 - 2013/14)				Years 7-8 (2014/15-2015/16)				% Change Since 2008			
	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y
Total energy intake (kcal/d)	1548	1816	1896	1710	1515	1735	1825*	1682	1462**	1779	1849	1643	1432**	1716**	1860	1633	-7.4	-5.5	-1.9	-4.5
Protein intake (g/d)	55.5	65.4	76.7	70.5	54.4	65.3	73.7	69.1	54.1	67.1	74.4	68.8	53.4	65.4	76.9	67.4	-3.7	0	0	-4.4
Fat intake (g/d)	58.9	69	70.6	66.7	55.8	65.1	67.1	63.1	54.4	66.5	67.8	60.9	53.5	64.9	69.5	61.6	-9.1	-5.9	-1.6	-7.6
Free sugars (g/d)	61.5	78.4	61.8	50.3	63.2	74.3	58.6	52.7	55.6	76.3	61.6	49	52.2	67.1	57.1	49.7	-15.3	-14.4	-7.6	-1.2
AOAC fibre (g/d)	14.9	16.1	18.5	18.1	14.7	15.5	18	18.8	14.1*	15.9	18.4	18	14.0**	15.3*	19	17.5	-6	-4.9	2.7	-3.3
Fruit and Vegetables† (g/d)	199	178	286	313	206	161	273	318	201	174	278	301	193	168	298	279	-3	-5.6	4.1	-10.9
Fruit and Vegetables (portions/d)	--	2.8	4.1	4.4	--	2.6	3.9	4.5	--	2.8	4	4.2	--	2.7	4.2	3.9	--	0	0	-11.3
Fruit and Vegetable (% achieving 5-A-Day))	--	10	29	36	--	6	27	37	--	8	27	35	--	8	31	26*	--	-20	6.8	-27.8
Red and Processed Meat (g/d)	46	64	74	65	43	57	68*	62	42	59	65**	67	38**	53	62**	59	-17.4	-17.2	-16.2	-9.2
Oily Fish (g/d)	2	2	8	12	2	2	7	14	2	4	8	12	2	2	8	12	0	0	0	0
Oily fish (g/wk)††	14	14	56	84	14	14	49	98	14	28	56	84	14	14	56	84	--	--	--	--

Key: †Does not include juice. ††Oily fish intakes were multiplied up. **Source:** Data Extracted from: PHE (2018) Data Tables. The UK NSNS Undertook statistical comparisons for: Years 3-4 vs Years 1-2, Years 5-6 vs Years 1-2, Years 7-8 vs Years 1-2; *indicates $P<0.05$ and ** indicates $P<0.01$. Comparisons were only performed where the goodness-of-fit statistic R-squared was above 5%.

Table 2: Dietary Changes over the Last Decade.

	Absolute change per year (SE), p value				**P value for difference in effect by age group**
	4-10y	11-18y	19-64y	65+y	
Total energy intake (kcal/d)	-20.5 (1.5) P=0.006	-12.8 (8.3) P=0.26	-4.2 (7.5) P=0.63	-13.5 (2.0) P=0.02	P=0.10
Protein intake (g/d)	-0.33 (0.05) P=0.025	0.09 (0.23) P=0.73	0.07 (0.44) P=0.90	-0.48 (0.08) P=0.025	P=0.10
Fat intake (g/d)	-0.88 (0.18) P=0.039	-0.54 (0.35) P=0.26	-0.13 (0.43) P=0.79	-0.87 (0.34) P=0.13	P=0.13
Free sugars (g/d)	-1.78 (0.62) P=0.11	-1.60 (0.73) P=0.16	-0.56 (0.50) P=0.38	-0.27 (0.39) P=0.56	P=0.050
AOAC fibre (g/d)	-0.16 (0.03) P=0.037	-0.10 (0.07) P=0.29	0.10 (0.09) P=0.40	-0.13 (0.11) P=0.37	P=0.031*
Fruit and Vegetables† (g/d)	-1.15 (1.23) P=0.45	-0.85 (1.94) P=0.70	2.05 (2.61) P=0.52	-5.95 (2.22) P=0.12	P=0.013*
Fruit and Vegetables (portions/d)	-	-0.005 (0.026) P=0.87	0.02 (.03) P=0.60	-0.09 (0.03) P=0.12	P=0.011*
Fruit and Vegetable (% achieving 5-A-Day))	-	8.0 (0.82) P=0.002	28.5 (0.96) P<0.001	33.5 (2.5) P=0.001	P=0.020*
Red and Processed Meat (g/d)	-1.25 (0.19) P=0.023	-1.55 (0.61) P=0.13	-1.95 (0.26) P=0.017	-0.65 (0.84) P=0.52	P=0.16
Oily Fish (g/d)	0	0.1 (0.26) P=0.74	0.05 (0.13) P=0.74	-0.1 (0.26) P=0.74	P=0.78
Oily fish (g/wk)††	0	0.7 (1.85) P=0.74	0.35 (0.93) P=0.74	-10.45 (6.30) P=0.74	P=0.78
Key: *indicates P<0.05 and ** indicates P<0.01.					

Table 3a: Absolute change per year (dietary changes).

	Percentage change per year (95% CI), p value				**P value for difference in effect by age group**
	4-10y	11-18y	19-64y	65+y	
Total energy intake (kcal/d)	-1.34%	-0.72%	-0.22%	-0.81%	P=0.027*
	(-1.77, 0.90)	(-2.72, 1.32)	(-1.95, 1.53)	(-1.31, -0.30)	
	P=0.006	P=0.26	P=0.64	P=0.021	
Protein intake (g/d)	-0.60%	0.14%	0.09%	-0.69%	P=0.055
	(-1.01, -0.20)	(-1.34, 1.64)	(-2.40, 2.63)	(-1.18, -0.21)	
	P=0.024	P=0.73	P=0.90	P=0.025	

Fat intake (g/d)	-1.56%	-0.81%	-0.18%	-1.36	P=0.068
	(-2.84, -0.26)	(-2.99. 1.42)	(-2.81, 2.52)	(-3.62, 0.95)	
	P=0.035	P=0.26	P=0.80	P=0.13	
Free sugars (g/d)	-3.05%	-2.18%	-0.93%	-0.54	P=0.057
	(-7.36, 1.46)	(-6.38, 2.21)	(-4.40, 2.66)	(-3.80, 2.82)	
	P=0.10	P=0.16	P=0.38	P=0.55	
AOAC fibre (g/d)	-1.14%	-0.63%	0.51%	-0.72	P=0.020*
	(-2.10, -0.16)	(-2.54, 1.31)	(-1.59, 2.65)	(-3.35, 1.98)	
	P=0.037	P=0.29	P=0.41	P=0.37	
Fruit and Vegetables† (g/d)	-0.58%	-0.48%	0.71%	-1.98%	P=0.059
	(-3.17, 2.08)	(-5.28, 4.57)	(-3.19, 4.77)	(-5.08, 1.22)	
	P=0.44	P=0.72	P=0.52	P=0.12	
Fruit and Vegetables (portions/d)	-	-0.17%	0.49%	-2.13%	P=0.026*
		(-4.22, 4.04)	(-2.92, 4.02)	(-5.53, 139)	
		P=0.87	P=0.60	P=0.12	
Fruit and Vegetable (% achieving 5-A-Day))	-	-	-	-	-
Red and Processed Meat (g/d)	-2.94%	-2.62%	-2.84%	-1.06%	P=0.16
	(-5.00, -0.84)	(-6.86, 1.81)	(-4.21, -1.45)	(-6.54, 4.75)	
	P=0.027	P=0.12	P=0.013	P=0.51	
Oily Fish (g/d)	0	3.53%	0.67%	-0.77%	P=0.83
		(-30.2, 53.6)	(-6.70, 8.62)	(-9.10, 8.33)	
		P=0.74	P=0.74	P=0.74	
Oily fish (g/wk)††	0	3.53%	0.67%	-0.77%	P=0.83
		(-30.2, 53.6)	(-6.70, 8.62)	(-9.10, 8.33)	
		P=0.74	P=0.74	P=0.74	
Key: *indicates P<0.05 and ** indicates P<0.01.					

Table 3b: Percentage change per year (dietary changes).

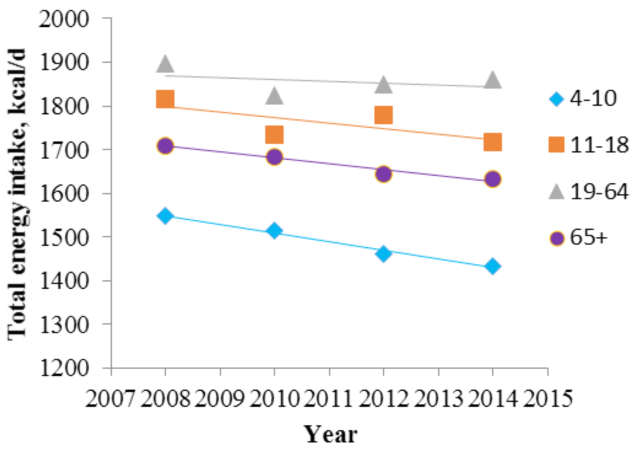

Figure 1a: Trends in total energy intake (kcal/day).

Figure 1b: Trends in fruit and vegetable intake (g/day).

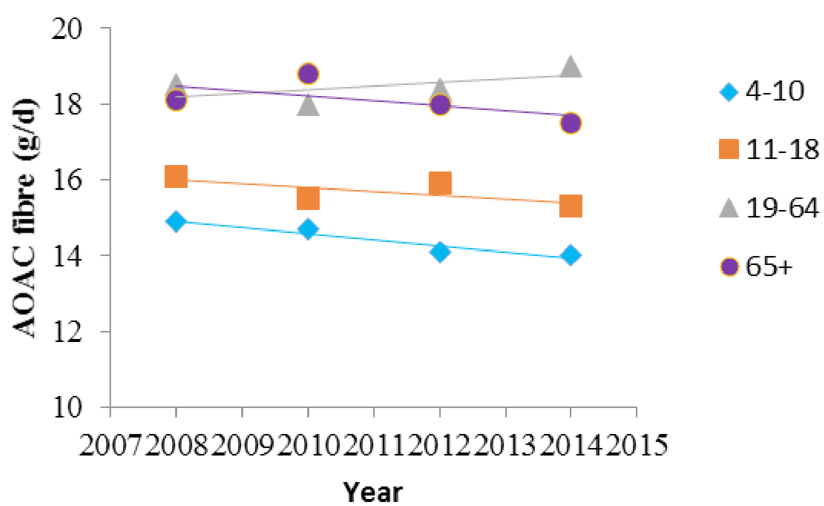

Figure 1c: Trends in AOAC dietary fibre (g/day).

	2008/9-2009/10				(2010/11 - 2011/12)				(2012/13 - 2013/14)				(2014/15-2015/16)			
	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y
Vitamin A (µg/d)	666	680	988	1349	635	643	904	1332	599	626	873	970	521	549	825	979
Riboflavin (mg/d)	1.5	1.4	1.6	1.7	1.5	1.4	1.5	1.6	1.5	1.5	1.6	1.7	1.3	1.4	1.6	1.6
Folate (µg/d)	197	215	264	263	192	206	251	267	183	208	244	240	169	193	240	232
Vitamin D (µg/d)	1.9	2.1	2.9	3.2	2.1	2.1	2.8	3.5	1.9	2.4	2.8	3.3	2	2.1	2.7	3.2
Iron (mg/d)	8.7	9.7	10.8	10.2	8.7	9.5	10.5	10.2	8.2	9.6	10.4	10	7.9	9.2	10.5	9.4
Calcium (mg/d)	801	778	824	868	806	786	790	835	781	800	827	791	739	762	821	802
Magnesium (mg/d)	192	209	258	244	191	207	250	249	188	215	264	243	185	207	270	242
Potassium (mg/d)	2150	2341	2842	2827	2148	2272	2728	2834	2115	2358	2820	2755	2043	2249	2865	2736
Iodine (µg/d)	134	124	164	189	129	127	155	187	129	126	160	173	122	119	156	165
Selenium (µg/d)	33	40	48	45	32	40	48	46	32	42	49	46	31	41	50	44
Zinc (mg/d)	6.4	7.4	8.8	8.3	6.3	7.3	8.5	8.4	6.1	7.5	8.5	8.1	6	7.2	8.7	7.9

Table 4: Micronutrient Changes over the Last Decade (mean daily intakes).

	Absolute change per year (SE), p value				**P value for difference in effect by age group**
	4-10y	11-18y	19-64y	65+y	
Vitamin A (µg/d)	-23.6 (3.9)	-20.5 (4.24)	-26.0 (3.8)	-73.6 (25.4)	P=0.003*
	P=0.027	P=0.040	P=0.020	P=0.10	
Riboflavin (mg/d)	-0.03 (0.02)	0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)	P=0.10
	P=0.23	P=0.74	P=0.74	P=0.55	
Folate (µg/d)	-4.65 (0.71)	-3.2 (1.10)	-3.95 (0.72)	-6.0 (2.0)	P=0.20
	P=0.023	P=0.10	P=0.032	P=0.10	
Vitamin D (µg/d)	0.01 (0.03)	0.02 (0.04)	-0.03 (0.01)	-0.01 (0.04)	P=0.52
	P=0.87	P=0.74	P=0.051	P=0.82	
Iron (mg/d)	-0.15 (0.03)	-0.07 (0.03)	-0.05 (0.03)	-0.13 (0.05)	P=0.06
	P=0.051	P=0.16	P=0.25	P=0.11	
Calcium (mg/d)	-10.55 (3.74)	-1.7 (4.17)	1.40 (4.60)	-12.1 (4.2)	P=0.015*
	P=0.11	P=0.72	P=0.79	P=0.10	
Magnesium (mg/d)	-1.20 (0.17)	0.10 (1.03)	2.50 (1.53)	-0.6 (0.74)	P=0.012*
	P=0.020	P=0.93	P=0.24	P=0.50	

Potassium (mg/d)	-17.7 (5.5)	-9.5 (12.8)	8.05 (15.43)	-17.6 (5.6)	P=0.10
	P=0.09	P=0.53	P=0.65	P=0.09	
Iodine (µg/d)	-1.80 (0.45)	-0.80 (0.79)	-0.95 (0.90)	-4.3 (0.79)	P=0.001**
	P=0.058	P=0.42	P=0.40	P=0.032	
Selenium (µg/d)	-0.30 (0.07)	0.25 (0.19)	0.35 (0.09)	-0.15 (0.24)	P=0.003**
	P=0.051	P=0.33	P=0.056	P=0.60	
Zinc (mg/d)	-0.07 (0.01)	-0.02 (0.03)	-0.015 (0.040)	-0.08 (0.03)	P=0.13
	P=0.010	P=0.60	P=0.74	P=0.13	
Key: *indicates P<0.05 and ** indicates P<0.01.					

Table 5a: Absolute change per year (micronutrient changes).

	Percentage change per year (95% CI), p value				P value for difference in effect by age group
	4-10y	11-18y	19-64y	65+y	
Vitamin A (µg/d)	-3.90%	-3.30%	-2.80%	-6.20%	P=0.062
	(-7.0, -0.7)	(-6.4, -0.1)	(-4.4, -1.3)	(-14.8, 3.3)	
	P=0.035	P=0.048	P=0.016	P=0.10	
Riboflavin (mg/d)	-2.10%	0.30%	0.30%	-0.60%	P=0.076
	(-7.2, 3.2)	(-3.5, 4.4)	(-3.3, 4.1)	(-4.2, 3.1)	
	P=0.23	P=0.74	P=0.74	P=0.55	
Folate (µg/d)	-2.50%	-1.60%	-1.60%	-2.40%	P=0.19
	(-4.3, -0.7)	(-3.8, 0.8)	(-2.7, -0.4)	(-5.6, 1.0)	
	P=0.027	P=0.10	P=0.029	P=0.09	
Vitamin D (µg/d)	0.30%	0.70%	-1.10%	-0.30%	P=0.56
	(-5.2, 6.0)	(-6.7, 8.6)	(-2.1, 0.02)	(-5.1, 4.7)	
	P=0.86	P=0.74	P=0.051	P=0.82	
Iron (mg/d)	-1.70%	-0.70%	-0.50%	-1.30%	P=0.025*
	(-3.5, 0.03)	(-2.2, 0.7)	(-1.7, 0.8)	(-3.4, 0.8)	
	P=0.051	P=0.16	P=0.26	P=0.12	
Calcium (mg/d)	-1.40%	-0.20%	0.20%	-1.40%	P=0.016*
	(-3.4, 0.7)	(-2.5, 2.1)	(-2.3, 2.7)	(-3.6, 0.7)	
	P=0.11	P=0.72	P=0.79	P=0.10	
Magnesium (mg/d)	-0.60%	0.05%	1.00%	-0.20%	P=0.012*
	(-1.0, -0.2)	(-2.0, 2.2)	(-1.6, 3.6)	(-1.5, 1.1)	
	P=0.021	P=0.93	P=0.25	P=0.50	

Potassium (mg/d)	-0.80%	-0.40%	0.30%	-0.60%	P=0.09
	(-2.0, 0.3)	(-2.8, 2.0)	(-2.1, 2.7)	(-1.5, 0.2)	
	P=0.09	P=0.53	P=0.66	P=0.09	
Iodine (µg/d)	-1.40%	-0.70%	-0.60%	-2.40%	P=0.010*
	(-2.9, 0.1)	(-3.4, 2.1)	(-3.0, 1.9)	(-4.3, -0.5)	
	P=0.060	P=0.41	P=0.41	P=0.033	
Selenium (µg/d)	-0.90%	0.60%	0.70%	-0.30%	P=0.002**
	(-1.9, 0.01)	(-1.4, 2.7)	(-0.04, 1.5)	(-2.6, 2.0)	
	P=0.051	P=0.32	P=0.056	P=0.59	
Zinc (mg/d)	-1.1	-0.30%	-0.20%	-0.90%	P=0.054
	(-1.6, -0.6)	(-2.1, 1.6)	(-2.1, 1.8)	(-2.4, 0.6)	
	P=0.010	P=0.59	P=0.75	P=0.12	
Key: *indicates P<0.05 and ** indicates P<0.01.					

Table 5b: Percentage change per year (micronutrient changes).

Figure 2a: Trends in vitamin A intake (µg/d).

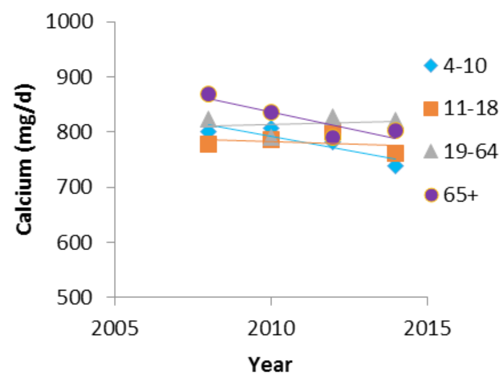

Figure 2c: Trends in calcium intake (mg/d).

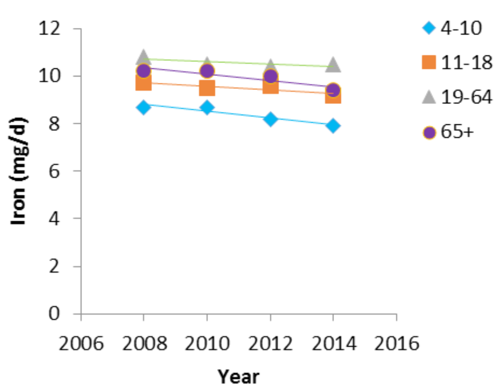

Figure 2b: Trends in iron intake (mg/d).

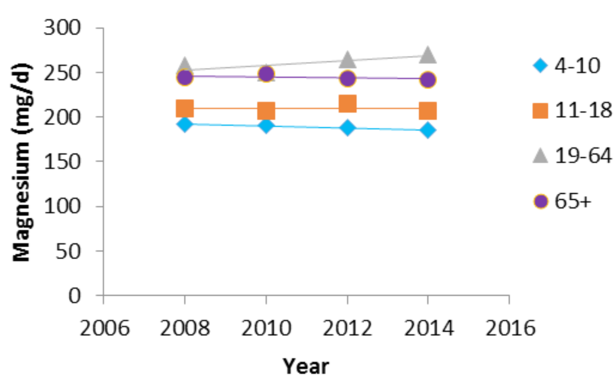

Figure 2d: Trends in magnesium intake (mg/d).

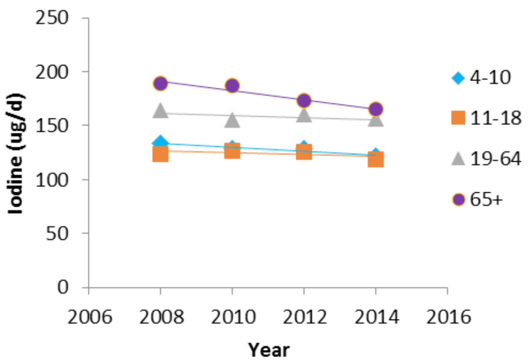

Figure 2e: Trends in iodine intake (µg/d).

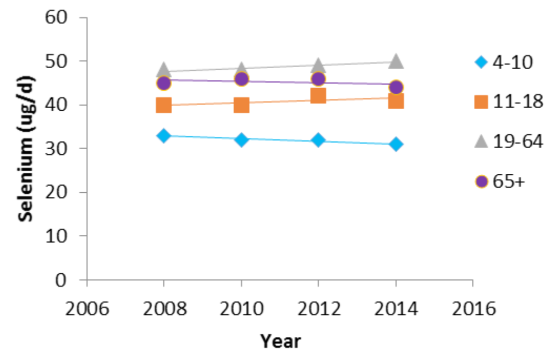

Figure 2f: Trends in selenium intake (µg/d).

	2008/9-2009/10				(2010/11 - 2011/12)					(2012/13 - 2013/14)					(2014/15-2015/16)					Trend
	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y
Vitamin A (µg/d)	4	13	8	3	7	13	8	3	10	16	8	4	12	21	13	7	↓	↓	↓	↓
Riboflavin (mg/d)	0	13	7	2	1	17	10	6	0	13	8	5	1	20	10	6	↔	↓	↔	↓
Folate (µg/d)	0	4	2	1	0	4	4	1	0	4	3	3	1	9	5	3	↔	↓	↔	↓
Iron (mg/d)	0	24	11	2	2	29	13	2	2	28	14	3	2	32	15	6	↓	↓	↓	↓
Calcium (mg/d)	1	11	5	2	3	16	9	5	1	15	6	6	1	16	9	7	↔	↓	↓	↓
Magnesium (mg/d)	1	38	12	12	2	41	15	14	1	37	12	15	1	38	13	16	↔	↔	↔	↓
Potassium (mg/d)	0	23	16	13	0	26	18	14	0	24	18	17	0	28	17	19	↔	↓	↓	↓
Iodine (µg/d)	2	13	7	1	5	18	10	3	6	21	8	7	5	20	12	5	↓	↓	↓	↓
Selenium (µg/d)	1	35	38	42	1	32	38	42	2	33	36	44	1	38	36	52	↔	↔	↑	↓
Zinc (mg/d)	8	16	6	5	10	17	8	5	8	19	6	4	11	22	8	7	↔	↓	↔	↓
Data is from food sources only. ↓Intakes have gone down. ↔ Intakes show no distinct trend; much the same. ↑ Intakes have improved.																				

Table 6: Overall Micronutrient Changes over the Last Decade (% below LRNI).

	2008/9-2009/10				(2010/11 - 2011/12)				(2012/13 - 2013/14)				(2014/15-2015/16)				Trend			
	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y	4-10y	11-18y	19-64y	65+y
Males																				
Vitamin A (µg/d)	3	12	10	5	6	10	12	2	7	14	11	4	13	19	16	6	↓	↔	↔	↔
Riboflavin (mg/d)	0	8	3	2	1	9	7	8	0	8	3	5	0	13	6	2	↔	↓	↔	↔
Folate (µg/d)	0	2	1	1	0	5	3	1	0	5	2	2	0	3	3	1	↔	↔	↔	↔
Iron (mg/d)	0	6	1	3	1	9	2	1	1	9	1	2	0	12	2	1	↔	↓	↔	↑
Calcium (mg/d)	0	8	3	2	2	9	7	5	1	12	4	3	2	11	7	2	↔	↓	↔	↔
Magnesium (mg/d)	0	26	16	18	1	30	16	20	0	27	12	16	0	27	14	13	↔	↔	↔	↑
Potassium (mg/d)	0	15	10	12	0	18	11	14	0	15	11	9	0	18	11	9	↔	↔	↔	↑
Iodine (µg/d)	1	7	5	0	4	11	8	2	5	16	5	5	6	14	9	3	↓	↓	↔	↔
Selenium (µg/d)	0	21	24	30	1	23	27	29	1	23	26	34	1	26	25	36	↔	↑	↔	↑
Zinc (mg/d)	5	12	9	11	9	11	10	8	4	17	6	6	9	18	7	7	↔	↑	↑	↑
Females																				
Vitamin A (µg/d)	5	14	5	1	9	15	5	2	12	18	8	4	11	24	10	8	↓	↓	↓	↓
Riboflavin (mg/d)	0	18	11	2	2	25	12	4	1	20	13	5	1	26	14	10	↔	↓	↔	↓
Folate (µg/d)	0	7	3	2	0	9	5	1	0	8	4	4	1	15	6	5	↔	↓	↔	↓
Iron (mg/d)	1	43	21	1	2	49	24	3	3	48	27	3	3	54	27	10	↓	↓	↓	↓
Calcium (mg/d)	2	15	6	3	3	23	10	5	1	19	8	8	1	22	11	11	↑	↓	↓	↓
Magnesium (mg/d)	1	51	9	8	5	54	14	8	3	48	11	15	3	50	11	18	↓	↔	↔	↑
Potassium (mg/d)	0	32	21	13	0	34	24	15	0	33	26	24	0	38	23	27	↔	↓	↔	↑
Iodine (µg/d)	3	19	9	2	6	26	12	3	7	26	11	8	4	27	15	7	↔	↓	↓	↑
Selenium (µg/d)	1	49	53	51	2	42	48	53	2	44	47	52	1	45	46	66	↔	↑	↑	↑
Zinc (mg/d)	10	20	4	1	11	25	5	2	13	22	6	3	14	27	8	7	↓	↓	↓	↑
Data is from food sources only. ↓Intakes have gone down. ↔ Intakes show no distinct trend; much the same. ↑ Intakes have improved.																				

Table 7: Micronutrient Changes over the Last Decade by Gender (% below LRNI).

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