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Nutrition and Food Technology: Open Access

ISSN 2470-6086 | Open Access

REVIEW ARTICLE

Volume 9 - Issue 1

British Dietary Habits and Declining Nutrient Intakes

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Received: 31 May, 2024 | **Accepted:** 15 Jun, 2024 | **Published:** 17 Sep, 2024

Citation: Mason P, Aslam N, Jenkins G (2024) British Dietary Habits and Declining Nutrient Intakes 9(1): dx.doi.org/10.16966/2470-6086.185

Abstract

Vitamins, minerals and essential fatty acids are vital to health. In the UK, the National Diet and Nutrition survey rolling programme estimates the intake of a range of these essential nutrients and foods that contain them. Since this programme began in 2008/2009 nutrient intakes have not improved. The aim of this paper is to evaluate vitamin and mineral intakes in the latest iteration of the National Diet and Nutrition Survey and compare these intakes with those in 2008/2009 and where possible with similar data from UK surveys going back to 1997. This paper also analysed findings from a survey of reviewing people's knowledge, habits and opinions on nutrition, vitamin and mineral intakes and supplementation to contribute to the interpretation of findings from the NDNS. Consumption of the majority of the micronutrients measured in the NDNS fell from 2008/2009 to 2018/2019. These decreases were greater in women than men and particularly worrying in younger women especially for vitamin A, riboflavin, folate, calcium, magnesium, iron, zinc, iodine and selenium. Reductions of the same micronutrients in young men were also evident and only zinc intakes have improved in older men. Poor dietary intakes are due to confusion and lack of knowledge as to what constitutes a healthy diet, lack of time and the cost of healthy eating which has increased during recent years. Nutrients can be provided from a healthy diet, but this is not being achieved. Hence a multivitamin and multi mineral food supplement is the best policy to bridge these dietary gaps.

Keywords: Vitamins; Minerals; Essential fatty acids; National diet and nutrition survey; Healthy diet; Knowledge; Opinion; Cost of food; Food supplements; Dietary gap

Introduction

British dietary habits, and as a consequence, nutrient intakes, are a cause of public health concern. Unhealthy diets, which are common in the UK, account for 13 percent of all deaths [1]. Most of this is because poor diets cause obesity, high blood pressure, high blood cholesterol and type2 diabetes. Obesity is also linked to 13 different cancers [2]. Poor nutrition also results in inadequate micronutrient (e.g., vitamins and minerals) intakes. Vitamins and minerals are essential for people's health and below recommended intakes can result in poor growth and intellectual impairment in children. In adults, reduced cognitive function, impaired bone health, diminished cardiovascular and metabolic health and vision issues may occur [3].

The most recent UK National Diet and Nutrition Survey (NDNS) [4] shows that despite the establishment of UK dietary guidelines in 1994 [5], the current British diet falls far short. Data from the NDNS demonstrates that fewer than 1 percent of the population achieve all nine of the Eat well Guide recommendations [6]. Consumption of sugars, saturated fat and salt remain higher than the levels recommended, while intakes of fibre, fruit and vegetables and oily fish, which is the main source of omega-3 fatty acids, remain too low. Intakes of red meat, which is a source of highly bioavailable iron, zinc and vitamin B12, are falling. Intakes of several micronutrients including vitamin A, vitamin D, folic acid, iron, zinc, iodine and selenium remain lower than recommended amounts.

A multitude of factors may lead to poor diets, including confusion and lack of knowledge as to what constitutes a healthy diet. In a 2024 survey for the Health and Food Supplements Information Service (HSIS) [7] only 23 percent of respondents questioned knew that official dietary guidelines are found in the Eat well Guide. Lack of time with mealtimes needing to fit around work and other activities contribute to unhealthy diets. Allergies and intolerances which often lead to restrictive diets and the continuing increase in fad diets also add to poor eating habits.

Plant based diets, which can be healthy if properly planned, may be unhealthy when they are not researched and considered, leading to lack of micronutrients such as iron, zinc, iodine and vitamin B12. In the UK, 57 percent of daily energy intakes are derived from ultra-processed foods with an even higher proportion of adolescents (66 percent) [8] consuming these poor food sources. Many of these foods are low in micronutrient content but high in saturated fat, salt and sugars.

Access to nutritious foods in terms of cost and affordability has also become a significant barrier to healthy eating. Nearly half (47 percent)

of those in the HSIS survey feel they are eating less nutritious food than they were a few years ago. A total of 49 percent say this is because healthy foods and ingredients are too expensive. Over two thirds (67 percent) believe that healthy food has become less affordable.

Poor diets and the barriers to eating healthy foods are a cause of concern with significant risk for public health, which should be addressed.

The aim of this review is to provide an in-depth evaluation of the current state of the British diet using the findings from the UK National Diet and Nutrition Survey (NDNS) with a focus on micronutrient intakes and its health consequences. Using findings from the peer-reviewed literature and the recent (2024) survey commissioned by HSIS, we explore some of the reasons for diets having become so poor. Finally, we identify what can be done to bridge the dietary gaps and the role of dietary food supplements.

The National Diet and Nutrition Survey (NDNS)

The NDNS is a continuous cross-sectional survey that assesses the diet, nutrient intakes and nutritional status of the general population of the UK. A representative sample of 1000 people (500 adults, 500 children) over the age of 1.5 years takes part in the Rolling Programme each year. It is designed to collect quantitative information on food consumption, nutrient intake and vitamin and mineral status.

Dietary assessments are based on a paper food diary completed by the participants over 4 consecutive days, and retrospective coding of foods and portions by trained coders. Results are analysed for seven age groups:

- 1.5-3 years
- 4-10 years
- 11-18 years
- 19-64 years
- 65-74 years
- 75 years and over

Each of the age groups is split by sex in all except the youngest age group. The first survey using the current methodology was conducted in 2008 and the most recent in 2019 [4] with a follow-up study during COVID-19 [9].

The Health and Food Supplements Information Service (HSIS) Survey

This survey recruited 1019 respondents (n=464 males; 551 females; 4 non-binary; from the age of 18-60+) from 20 towns and cities in the UK between February 1 and February 5 (Table 1) [7]. A total of 83 percent of respondents were white British, 7 percent were black or black British and 6 percent Asian or Asian British. Fifty-five percent were in full time employment and 23 percent were unemployed.

The survey asked a total of 50 questions starting with the type of diet (e.g., meat eating, pescatarian, vegetarian) consumed and whether respondents take a vitamin and mineral supplement. The survey asked respondents to rate the healthiness and nutrient density of their diets, which nutrients they think could be missing and how they think they could improve their diets.

Table 1: HSIS survey respondent's demographics.

Age	Numbers
19-29 years	262
30-44 years	336
45-59 years	331
60+	90

Knowledge and engagement with diet was also evaluated, including:

- Awareness of vitamin and mineral recommended intakes.
- Government healthy eating guidelines.
- Whether respondents had researched healthy eating.
- Respondents' opinions on the confusion around healthy diets.
- Whether respondents thought nutrition plays a role in health.

They were questioned on the nutrients that support various aspects of health, whether they consider vitamin and mineral intakes impact their health, whether they take nutrient supplements and which population groups they think would benefit from vitamin and mineral supplements.

Respondents were also asked about the affordability of healthy food and their specific knowledge and consumption practices with regards to vitamin D and probiotics.

Findings from the National Diet and Nutrition Survey (NDNS)

Sugars: The NDNS shows that despite a decline in intake of free sugars in both adults and children between 2008 and 2019 consumption remains high. According to the most recent 2020 data [9] free sugars intake, as a proportion of total energy intake, is highest in children aged 11 to 18 years. However, average consumption across all age groups exceeds the recommended maximum level of 5 percent. The percentage contribution of free sugars to total energy intake was significantly lower in 2008/2009 than in 1997 in children 4-10 years. Free sugars contributed 13.7-14.6 percent of total energy in 2008/2009 compared with 16.8 percent in 1997. These changes were not as marked in older children and there were no changes in these foods and nutrients in adults.

Saturated fat: Saturated fat intake as a proportion of total energy intake fell in youngsters between 1997 and 2008 and in both adult men and women between 2001/2002 and 2008/2009. However, there was no further significant change between 2008 and 2019. Across all age groups, consumption continues to exceed the dietary recommendation that saturated fat should make up no more than 10 percent of total daily energy intakes. Consumption of saturated fat is highest in women aged 65 years and over, accounting for 13.9 percent of their total energy intake in 2020.

Salt: Latest data taken from sodium levels in urine show that average salt intakes are higher than the recommended intake of 6g per day for adults. This is the case in all parts of the UK with available trend data suggesting that this is broadly stable over time across the four home nations, except in Scotland where there was a decline in salt intake between 2006 and 2016.

Fruit and vegetables: Most people in the UK eat fewer than the recommended five portions of fruits and vegetables a day. A total of 60 percent of people in England have a diet low in fruit and 45 percent a diet low in vegetables [10] with children aged 11-18 years eating the fewest. Between 2008 and 2019 there was an increase in women aged 19-64 years of 7 percentage points meeting the recommended intake for fruit and vegetables, but no change for other population groups. NDNS data from 2020 reveals that older children aged 11-18 consume an average of 2.8 portions a day, working age adults, age 19-64 years; consume 3.7 portions, and older adults 4.5 portions.

Comparing with fruit and vegetable intakes in the NDNS surveys of 4-18-year-olds in 1997 [11] fruit consumption increased in 4-18-year-olds from 55 to 84g. Consumption was also higher in boys 11-18 years daily increasing from 22 to 30g. In all youngsters the proportion of subjects eating some fruit in the 2008/2009 survey was higher than in 1997, increasing in boys 4-10 years from 77 to 91 percent and in boys of 11-18 years increasing from 56 to 71 percent bringing the proportion of boys eating some fruit in line with girls. Since the 2000/2001 survey [12] in adults there has been no significant change in fruit or vegetable consumption. The proportion of vegetables consumed did not change in any age group over this period apart from raw and salad vegetables in adult women which increased between 2000/2001 and 2008/2009.

Fibre: Fibre intake remains below dietary recommendations across all age groups. There was little change in fibre intakes between 2008 and 2019. While a quarter of children from 2-10 years old are meeting the recommended intake levels, just 4 percent of older children aged from 11 to 18 are doing so. Fibre intakes were significantly higher in 2008/2009 than in 1997 in children aged 4-10 years. No significant changes in fibre intakes were seen in children aged 11-18 years and adults. In adult men fibre intakes have increased but fell in adult women. The recommended amount is 30g daily for adults and varies for children depending on age.

Fish: The amount of fish we are eating remains static and significantly below the recommended guidelines of at least two portions of fish a week, one of which should be oily fish. Average consumption of all types of fish has changed very little between 2008 and 2019.

Mean daily consumption of oily fish, which is the main source of omega-3s was also below the recommended one 140g portion a week across all age groups. Oily fish intake is 56g for 19-64-year-olds and 84g for older people. Children eat about a tenth of a portion each week. With regards to the earlier surveys, some fish changed categories from oily to plain so it is not possible to compare intakes with data from 2008/2009.

Meat: Latest figures from 2020 indicate the average adult now eats below the recommended maximum of 70g a day of red and processed meat. However, there is a big gender difference, with men aged 19-64 years consuming 68g on average compared with women of the same age who consumed 38g.

These findings for intakes of sugars, saturated fat, salt, fruit and vegetables, fish, fibre and meat are reflected in the UK's micronutrient status levels (Table 2) with downward trends now seen across various vitamin and mineral levels (Table 3). Micronutrients of concern include vitamins A, folate, vitamin D, and minerals iron, zinc, iodine, selenium, calcium, magnesium and potassium.

Vitamin A: Vitamin A is a fat-soluble vitamin, essential for the maintenance of vision, healthy skin and mucous membranes. Sub-clinical deficiency can lead to increased susceptibility to infection and poor growth in children (Mason 2024).

The most recent NDNS-RP report [9] showed that mean intakes of vitamin A were above or close to the UK Reference Nutrient Intake (RNI) in all age/sex groups. However, mean intakes do not capture the nuance: recent intakes of vitamin A were below the UK Lower Reference Nutrient Intake (LRNI), a level at which deficiency occurs, in 8 percent of adults aged 65 years and over. This was the case also in 10 percent of adults aged 19-64 years, 18 percent of 11-18-year-olds, 11 percent of 4-10-year-olds and 9 percent of children aged 18 months to 3 years. Vitamin A intake overall has declined since 2008/2009 by 21 to 23 percent in children and teenage age groups, by 13 percent in adult groups with a decline of 29 percent in the elderly [9].

Folate (folic acid): Folate is a water-soluble B vitamin, which is essential for normal cell division, formation of red blood cells and brain function. Deficiency can result in tiredness, weakness, diarrhoea and appetite loss [13]. Women throughout their reproductive lives, particularly when planning a pregnancy and for the first three months of pregnancy, are recommended to take a 400 microgram folic acid supplement each day to reduce the risk of neural tube defects, such as spina bifida [14].

The most recent NDNS-RP report [4] showed that 10 percent of 11-18-year-old girls and 7 percent of 19-64-year-old women failed to achieve the LRNI for folate. Blood folate concentrations also decreased substantially over the last decade for most age/sex groups and the proportion of participants with folate concentrations indicating risk of anaemia increased.

Of significant concern is research that found that two thirds of women in the UK are not taking a folic acid supplement before pregnancy [15]. The proportion of women taking folic acid supplements before pregnancy declined from 35 percent in 1999-2001 to 31 percent in 2011-2012. The prevalence of supplementation increased with age; just 6 percent of women aged under 20 took folic acid supplements before pregnancy compared with 40 percent of women aged between 35 and 39 [16].

The NDNS-RP analysis [4] found that in women of childbearing age (16 to 49 years), red blood cell folate fell by around 20 percent over the survey period. Time-trend analysis of the proportion of women of childbearing age (16 to 49 years) with a red blood cell folate concentration below the threshold for increased risk of neural tube defects-affected pregnancies (748nmol/L) was conducted. This showed that such low folate increased from approximately two thirds to almost 90 percent over the course of the survey [4].

Vitamin D: Vitamin D is essential for healthy bones, muscles and teeth. The Scientific Advisory Committee on Nutrition (SACN) report on Vitamin D and Health [17] highlights the importance of vitamin D in protecting muscle strength and preventing rickets, osteomalacia and falls.

Overall, the NDNS shows that one in five people in the UK are deficient in vitamin D. In the most recent iteration of the NDNS, 10 percent of children aged 4-10 years, including 8 percent of boys and 13 percent of girls, had a serum concentration of vitamin D < 25nmol/litre, which is the UK threshold for deficiency [17]. Amongst youngsters 11-18 years old, 26 percent, including 15 percent of boys and 39 percent of girls, had vitamin D levels below the threshold. Amongst adults 19-64 years, 17 percent, including 16 percent of men and 19 percent women were deficient. Deficient levels were also present in 13 percent of adults over the age of 65 years, including 13 percent of men and 13 percent of women.

Sunshine, rather than food, is the main source of vitamin D and it is difficult to get recommended amounts of vitamin D from the diet. The SACN 2016 report recommends that all adults and children over the age of 1 year should consider taking a daily 10 microgram supplement of vitamin D throughout the year [17].

Iron: Iron has many roles in the body. It is particularly important for making haemoglobin, a protein contained in red blood cells that transports oxygen round the body. Iron also plays an essential role in maintaining a healthy immune system. A mild iron deficiency causes tiredness, lack of energy and increased susceptibility to infections.

Table 2: Micronutrient Changes over the Last Decade by Gender (percent below LRNI) (Data from NatCen Social Research 2020).

	2008/9-2009/10				(2010/11 - 2011/12)				(2012/13 - 2013/14)				(2016/17-2018/19)				(2016/17-2018/19)			
	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	9	18	12	10
Riboflavin (mg/d)	0	8	3	2	1	9	7	8	0	8	3	5	0	13	6	2	1	13	4	5
Folate (µg/d)	0	2	1	1	0	5	3	1	0	5	2	2	0	3	3	1	1	9	2	2
Iron (mg/d)	0	6	1	3	1	9	2	1	1	9	1	2	0	12	2	1	1	11	2	1
Calcium (mg/d)	0	8	3	2	2	9	7	5	1	12	4	3	2	11	7	2	1	14	4	5
Magnesium (mg/d)	0	26	16	18	1	30	16	20	0	27	12	16	0	27	14	13	1	33	12	14
Potassium (mg/d)	0	15	10	12	0	18	11	14	0	15	11	9	0	18	11	9	0	22	10	8
Iodine (µg/d)	1	7	5	0	4	11	8	2	5	16	5	5	6	14	9	3	6	19	8	4
Selenium (µg/d)	0	21	24	30	1	23	27	29	1	23	26	34	1	26	25	36	1	24	26	34
Zinc (mg/d)	5	12	9	11	9	11	10	8	4	17	6	6	9	18	7	7	8	20	6	9
Females																				
Vitamin A (µg/d)	5	14	5	1	9	15	5	2	12	18	8	4	11	24	10	8	13	18	8	7
Riboflavin (mg/d)	0	18	11	2	2	25	12	4	1	20	13	5	1	26	14	10	2	22	13	10
Folate (µg/d)	0	7	3	2	0	9	5	1	0	8	4	4	1	15	6	5	1	10	7	4
Iron (mg/d)	1	43	21	1	2	49	24	3	3	48	27	3	3	54	27	10	2	49	25	5
Calcium (mg/d)	2	15	6	3	3	23	10	5	1	19	8	8	1	22	11	11	1	16	9	7
Magnesium (mg/d)	1	51	9	8	5	54	14	8	3	48	11	15	3	50	11	18	3	47	11	11
Potassium (mg/d)	0	32	21	13	0	34	24	15	0	33	26	24	0	38	23	27	1	37	24	20
Iodine (µg/d)	3	19	9	2	6	26	12	3	7	26	11	8	4	27	15	7	8	28	12	7
Selenium (µg/d)	1	49	53	51	2	42	48	53	2	44	47	52	1	45	46	66	2	41	46	59
Zinc (mg/d)	10	20	4	1	11	25	5	2	13	22	6	3	14	27	8	7	15	16	7	4

Data is from food sources only. ↓Intakes have gone down. ↔ Intake.

Table 3: Trends in Vitamin and Mineral Intake between 2008/9 and 2018/19.

	4-10y	11-18y	19-64y	65+y
Males				
Vitamin A (µg/d)	↓	↓	↓	↓
Riboflavin (mg/d)	↓	↓	↓	↓
Folate (µg/d)	↓	↓	↓	↓
Iron (mg/d)	↓	↓	↔	↑
Calcium (mg/d)	↓	↓	↓	↓
Magnesium (mg/d)	↓	↓	↑	↑
Potassium (mg/d)	↔	↓	↔	↑
Iodine (µg/d)	↓	↓	↓	↓
Selenium (µg/d)	↓	↓	↓	↓
Zinc (mg/d)	↓	↓	↑	↑
Females				
Vitamin A (µg/d)	↓	↓	↓	↓
Riboflavin (mg/d)	↓	↓	↓	↓
Folate (µg/d)	↓	↓	↓	↓
Iron (mg/d)	↓	↓	↓	↓
Calcium (mg/d)	↑	↓	↓	↓
Magnesium (mg/d)	↓	↑	↓	↓
Potassium (mg/d)	↓	↓	↓	↓
Iodine (µg/d)	↓	↓	↓	↓
Selenium (µg/d)	↓	↑	↑	↓
Zinc (mg/d)	↓	↑	↓	↓

With more severe iron deficiency, symptoms such as heart palpitations, thinning hair, brittle nails, itchy skin and mouth sores or ulcers can develop.

During the past 20 years, iron intakes have reduced by over 10 percent overall [18-20]. Some age/sex groups had mean intakes of iron below the RNI. Substantial proportions had intakes below the LRNI, in particular girls aged 11-18 years and women aged 19-64 years. A total of 49 percent of girls aged 11-18 years and 25 percent of women aged 19-64 have intakes of iron below the LRNI, which increases the risk of iron deficiency anaemia [4].

Zinc: Zinc is an essential nutrient, found in cells throughout the body. Zinc helps the immune system fight off invading bacteria and viruses. The body also needs zinc for the metabolism of proteins, carbohydrates, reproductive hormones, lipids and nucleic acids (nucleic acids - NA - are key molecules that contain genetic information and participating in protein synthesis), and for the production of proteins and genetic material. During pregnancy, infancy, and childhood, the body needs zinc to grow and develop properly. Zinc also helps wounds heal and is important for proper sense of taste and smell. Deficiency can result in a variety of health issues, including growth retardation, hypogonadism in males, alopecia, and psychiatric disorders.

During the last two decades, some improvements have been seen for zinc intake, although not in all age/sex groups. An average yearly reduction in zinc intake of 0.1mg/day was observed in children aged 1.5-3 years, girls aged 4-10 years, boys aged 11-18 years and women aged 65 years and over [17-19]. The most recent NDNS-RP report [4] showed that mean intake of zinc was above or close to the RNI in all age/sex groups with the exception of children aged 4-10 and 11-18 years. A total of 18 percent of 11-18-year-olds, and 11 percent of 4-10-year-olds, have a zinc intake below the LRNI. A total of 6 percent of 19-64-year-olds and of people 65 and over have a zinc intake below the LRNI [4].

Iodine: Iodine is an essential component of the thyroid hormones Thyroxine (T4) and Triiodothyronine (T3). Thyroid hormones regulate many important biochemical reactions, including protein synthesis and enzymatic activity, and are critical determinants of metabolic activity. They are also required for proper skeletal and central nervous system development in foetuses and infants. Iodine also plays a part in immune function.

Iodine intake has been measured during the last two decades and consumption levels have decreased by 5 percent overall during that time period. A downward trend in iodine intake over time was observed for most age/sex groups [4,17-19].

The most recent NDNS-RP report [4] has shown that there was evidence of low intakes of iodine for children aged 11-18 years with 24 percent having an intake below the LRNI compared with 13 percent in 2008/2009. Again, intakes in women are worse than those of men. The proportion of 11-18-year-old girls not achieving the LRNI has increased from 19 to 28 percent and for women aged 19-64 the increase has been from 9 to 12 percent [4]. Given the crucial importance of iodine for the growing foetus these low iodine intakes in women of reproductive age are a cause for concern.

Selenium: Selenium is a constituent of more than two dozen selenoproteins that play critical roles in reproduction, thyroid hormone metabolism, DNA synthesis, and protection from oxidative damage and infection. Soil contains varying amounts of selenium, which has an impact on the selenium content of crops. Deficiency has been associated with poor cardiovascular health and thyroid function.

There was little change in selenium intakes over the survey period across the age/sex groups. However, in the latest iteration of the NDNS-RP [4], 32 percent of 11-18-year-olds, 36 percent of 19-64-year-old and 47 percent of those aged 65 and over had selenium intakes below the LRNI. For women across these age ranges the figures were 41 percent, 46 percent and 59 percent respectively [4].

Calcium: Calcium is the most abundant mineral in the body. It is important at all ages for strong bones and teeth. Calcium is also required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signalling and hormonal secretion.

During the last 20 years there has been an overall decline in calcium intakes of 20 percent. Mean intake of calcium was above the RNI in all age/sex groups with the exception of boys and girls aged 11-18 years. Almost one in seven adults (aged 19-64) and 15 percent of 11-18-year-olds had a calcium intake below the LRNI. Over the course of the NDNS-RP survey [4], commonly around 20 percent of girls aged 11-18 and around 10 percent of women aged 19 and over have had calcium intakes below the LRNI [4]. Such low intakes are likely to prejudice bone health and these population groups are likely to benefit from supplemental calcium [21].

Magnesium: Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation. Magnesium is required for energy production, oxidative phosphorylation, and glycolysis. It contributes to the structural development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium also plays a role in the active transport of calcium and potassium ions across cell membranes, a process that is important

to nerve impulse conduction, muscle contraction, and normal heart rhythm. Deficiency can include hypocalcaemia, hypokalaemia, cardiovascular and musculoskeletal issues.

In the latest iteration of the NDNS-RP [4], 40 percent of 11-18-year-olds, 12 percent of 19-64-year-olds and 13 percent of those aged 65 and over had selenium intakes below the LRNI. For women across these age ranges the figures were 47 percent, 11 percent and 11 percent respectively.

Potassium: The mineral potassium is the most abundant intracellular cation. Potassium is present in all body tissues and is required for normal cell function because of its role in maintaining intracellular fluid volume and transmembrane electrochemical gradients. Potassium has a strong relationship with sodium, the main regulator of extracellular fluid volume, including plasma volume.

During the last 20 years there has been an overall reduction in potassium intakes. The proportion of 11-18-year-olds not achieving the LRNI has increased from 23 to 30 percent since 2008/2009. For adults aged 19-64 the proportion not achieving the LRNI has increased from 16 to 17 percent, and for the over 65s this figure has increased from 13 to 15 percent. The situation is worse for women than men; the proportion of 11-18-year-old girls not achieving the LRNI has increased from 32 to 37 percent, for women aged 19-64 from 21 to 24 percent and for women of 65 and over the increase has been from 13 to 20 percent [4].

Omega 3 fatty acids: The UK NDNS does not routinely collect data on omega-3 intakes but oily fish, the main source of long chain omega-3s, is below recommended intakes in all population groups. The recommendation in adults is to consume 500mg combined Eicosapentaenoic Acid (EPA) / Docosahexaenoic Acid (DHA) which is equivalent to 140g oily fish each week (20g daily). Oily fish intake has increased during the past two decades in younger age groups (4-39 years) but not in those over the age of 40 in whom intakes have fallen [22]. However, while we have seen some increases in the consumption of oily fish, the UK's consumption of oily fish does not reach recommended consumption needs in any age group indicating a continuing shortfall in omega-3 intakes.

Which Population Groups Have Micronutrient Shortfalls?

Children 4-10 Years

Evaluation of the findings from the NDNS survey found some concerning trends in children when it comes to micronutrient status. In boys aged 4-10 years, 3 percent failed to achieve the LRNI for vitamin A in 2008/2009 which increased to 9 percent in 2018/2019. Equivalent figures for zinc were 5 percent increasing to 7 percent in 2018/2019. In girls aged 4-10 years, data revealed below LRNI intakes of vitamin A, with an increasing drop in levels from 5 percent in 2008/2009 to 13 percent in 2018/2019. Equivalent figures for zinc also showed shortfall growing from 10 percent to 15 percent and for iodine 3 percent to 8 percent.

Teenagers

Micronutrient intakes of teenagers have been of concern throughout the past three decades. In recent years, almost one third (30 percent) of teenagers fail to achieve the LRNI for iron, representing a 6 percent drop in intake levels from 2008/2009. Just under a fifth (18 percent) failed to achieve the LRNI for vitamin A compared with 13 percent in 2008/2009, 9 percent failed to achieve the LRNI for folate compared with 4 percent in 2008/2009. For calcium 15 percent failed to achieve the LRNI in the latest survey compared with 11 percent in 2008/2009. For zinc 18 percent of respondents failed to achieve the LRNI in the latest survey compared with 16 percent in 2008/2009. For iodine 24 percent failed to achieve the LRNI in 2018/10 compared with 13 percent in 2008/2009.

The situation with regards to11-18-year-olds improved somewhat between 1997 and 2008/2009 but then worsened again by 2018/2019. Proportions of children 11-18 years below the LRNI for calcium in 2008/2009 were significantly lower than in 1997 falling from 13 percent to 6 percent in boys and from 23 percent to 12 percent in girls. The proportions of children 11-18 years below the LRNI for zinc in 2008/2009 were also both significantly lower than in 1997 falling from 15 percent to 10 percent in boys and from 26 percent to 15 percent in girls. However, the proportions of 11-18-year-old boys with magnesium intakes below the LRNI increased from 23 to 26 percent between 1997 and 2008/2009.

Teenage Girls

Micronutrient shortfalls and declines in intakes are the worst in teenage girls. A substantial 43 percent of teenage girls failed to achieve the LRNI for iron in 2008/2009, and this has only increased since, ranging from 48 to 54 percent over the survey period of 2008/2009 to 2018/19. Similarly, the percentage of teenage girls not reaching the LRNI for iodine increased from 19 to 28 percent in this period. In 2008/2009, 14 percent of 11-18-year-old girls did not achieve the LRNI for vitamin A, a figure that has increased to as high as 24 percent in recent years; 18 percent for riboflavin, increasing to as high as 26 percent in recent years, and 15 percent in calcium, increasing to as high as 23 percent over the survey period. Equivalent figures for potassium are 37 percent increasing from 32 percent and 28 percent, an increase from 19 percent, for iodine.

Most worrying is folate, for which the proportion of 11-18-year-old girls not achieving the LRNI has almost doubled over the survey period from 6 to 10 percent with a peak of 15 percent. Whilst the proportion of teenage girls failing to achieve the LRNI for magnesium has fallen from 51 percent in 2008/2009, the proportion is still very high at 47 percent. For selenium 49 percent failed to achieve the LRNI in 2008/2009 and this was still 41 percent in 2018/2019. Figures for zinc have also shown an improvement but 16 percent of 11-18-year-old girls still failed to achieve the LRNI in 2018/2019 compared with 20 percent a decade earlier [4].

Teenage Boys

A proportion of teenage boys also fail to achieve the LRNI for several nutrients, though intakes are not quite so poor as for teenage girls. In 2008/2009, 12 percent of 11-18-year-old boys did not achieve the LRNI for vitamin A and this had increased to 18 percent not achieving the LRNI by 2018/2019. Similarly with vitamin B2, 13 percent of 11-18-year-old boys did not achieve the LRNI in 2018/2019, an increase from 8 percent in 2008/2009. For folate 9 percent did not achieve the LRNI in 2018/2019 compared with 6 percent a decade earlier. For calcium the increase was from 8 percent to 14 percent, for iron 6 to 11 percent, for magnesium 26 to 33 percent, potassium 15 to 22 percent, iodine 7 to 19 percent, selenium 21 to 24 percent and finally for zinc 20 percent of 11-18-year-old boys did not achieve the LRNI in 2018/2019 compared with 12 percent in 2008/2009.

Adult Women

Women of childbearing age and middle years (19-64 years) have also shown a downturn in micronutrient intakes. The proportion

not achieving the LRNI for folate has more than doubled from 3 to 7 percent over the course of the survey; for vitamin A this proportion has grown from 5 to 8 percent with a peak of 10 percent, for iron this has increased from 21 to 25 percent with a peak of 27 percent, for iodine from 9 to 12 percent with a peak of 15 percent, and for calcium from 6 to 9 percent with a peak of 11 percent (NatCenSocial Research, 2020). These figures are very worrying in the context of women during their childbearing years whose pregnancies are nurturing the next generation. Comparing with the data from 2000/2001, in women, proportions below the LRNI were slightly lower in 2008/2009 compared with in 2000/2001 for a number of micronutrients, including vitamin A, folate, zinc and magnesium. Vitamin D status has not changed significantly over 30 years but 19 percent of adult women had vitamin D levels below the threshold of 25nmol/litre in 2018/2019.

Adult Men

Men aged 19-64 years have also shown a downturn in a few micronutrient intakes between 2008/2009 and 2018/2019. For vitamin A, 10 percent failed to achieve the LRNI in 2008/2009, a proportion that increased to 12 percent in 2018/2019 with equivalent figures for iodine of 5 to 8 percent and selenium of 24 to 26 percent. For zinc, magnesium and potassium the proportions of men failing to achieve the LRNI improved but worsened to a slight extent for folate, iron and calcium.

Comparing with the situation in 2000/2001, in men, proportions below the LRNI were slightly higher in 2008/2009 for a number of micronutrients, including folate, calcium, zinc and iodine. There have been no significant changes in vitamin D status in adult men over 30 years but 16 percent of men were vitamin D deficient in 2018/2019.

Older People

Over the last decade, people over the age of 65 years have also seen increases in the proportions of people failing to achieve the LRNI for vitamin A, iron, calcium, magnesium, potassium, iodine and zinc. In older women, the proportion not achieving the LRNI for iron has increased from 1 percent to 5 percent with a peak of 10 percent over the survey period. The proportion failing to achieve the LRNI for calcium has more than doubled from 3 to 7 percent, with a peak of 11 percent. For potassium there has been a growth in this figure from 13 to 20 percent with a peak of 27 percent. For zinc, 1 percent of older women failed to achieve the LRNI in 2008/2009, but this has now increased to 4 percent with a peak of 7 percent.

Amongst older men, below LRNI intakes for vitamin A doubled from 5 percent to 10 percent and for calcium the increase was from 10 percent to 14 percent by 2018/2019. Proportions of older men failing to achieve the LRNI for iron, magnesium, potassium and zinc improved [4]. Vitamin D status has not changed significantly in older people with 13 percent below the UK threshold of 25nmol/litre in 2018/2019.

Reasons for Poor Diet and Micronutrient Intake: Findings from the 2024 HSIS Survey

Overall, the findings from this real-world survey indicated that the majority of Britons have little or no awareness of the importance of nutrients and their role in healthy living. There is huge confusion and lack of awareness around what a healthy diet should look like. There is limited understanding around the role of probiotics and many Britons do not get much exposure to vitamin D from sunshine. There appeared to also be confusion about multivitamins and multi minerals in that just 13 percent said they would take them to improve their diet.

What Types of Diets Are Consumed By Britons?

Britons consume a range of diet types:

- 78 percent of respondents were meat eaters; this included 80 percent of men and 77 percent of women.
- 8.5 percent (equal proportions of men and women) were vegetarian.
- 6.1 percent were pescatarian (5.5 percent of men, 6.5 percent of women).
- 2.5 percent were vegan (2.2 percent of men, 2.7 percent of women).

The proportion of meat eaters was higher in older age groups (84 percent of those > 60 *vs* 75percent19-29-year-olds) whereas 11 percent of 18-29-year-olds were vegetarians compared with 4.5 percent of 45-59-year-olds.

What Do Britons Think About Their Diets?

Britons have a range of opinions on their diets:

- 74 percent believe that good nutrition is crucial for general health and wellbeing.
- 36 percent admit to not eating breakfast.
- 23 percent acknowledged that they would not be concerned if they did not consume fruit or vegetables for a few days, as this is part of their normal eating habits.
- 26 percent noted to snacking in front of the TV every day.
- Eight in ten have paid more attention to their diet as they've become older.
- Four in ten say they will review their diet to help with wellness problems, but only if their health is not improving.
- 49 percent would like to eat more nutritious food.
- 41 percent want to lose weight.

When Asked On A Scale Of 1-10 How Healthy They Thought Their Diets Were:

- Men and women gave their diets a score of six.
- Vegans rate their diet the highest at seven out of ten.
- Older people (> 60) scored their diet 6.8.
- 18-29-year-oldsscored their diet 5.6.

On the same scale, men gave their diet a 5.9 score on nutrient density and women noted 5.6 with a sliding scale for those aged under the age of 60 years (6.4) and 18-29-year-olds at a 5.3 score.

Overall, 91 Percent Said Their Food Choices Could Be Healthier If They Included Certain Foods That Could Improve Their Diets:

- 42 percent) think that red meat could upgrade their diet (46 percent of men, 39 percent of women). This applied to half of 18-44-year-olds and 25 percent of those >60.
- 90 percent identified both fruit and vegetables.
- 81 percent noted nuts and seeds.
- 78 percent identified wholegrain cereals.
- 80 percent named fish.
- 69 percent acknowledged eggs, 62 percent poultry and 48 percent dairy.

A total of 75.9 percent agreed that sugar would not improve their diet, while 71 percent felt the same about cream and butter and 65 percent felt the same about starchy foods, including bread and cereals.

What Do Britons Know About Healthy Eating?

Amongst those surveyed, 38 percent did not know what the government's healthy eating guidelines were called, while 23 percent guessed 'The Eat well Guide'. Whilst 43 percent have researched healthy eating advice during the last year, three in ten have not researched it for last ten years.

Eight in ten Britons believe that there is confusion around what to eat for a healthy, nutritious diet. A total of 55 percent of Britons believe that people aged under 30 know more about nutrition and healthy eating than older Britons with 95 percent believing that health and nutrition should be taught in schools.

Cost of Healthy Eating

The cost of healthy food is increasing. A report from the Food Foundation found that healthy foods are twice as expensive as less healthy foods. The report found that 1000 calories worth of fruit and vegetables cost almost £12. This is compared to £5.82 for 1000 calories worth of foods high in fat and sugar, £4.61 for milk and dairy products and £1.25 for bread, pasta, rice and potatoes [23].

A total of 67 percent of those surveyed agreed that healthy food has become less affordable. Forty-seven percent feel they are eating less nutritious food than they were a few years ago, while 49 percent noted the fact that healthy foods and ingredients are too expensive. Price is the most important factor for 41 percent when purchasing food, followed by taste for 29 percent.

What Do Britons Think About Their Nutrient Intake?

There is significant lack of knowledge about nutrient intakes with 48 percent having no idea what the recommended daily intake levels of nutrients are. This applied to:

- 44 percent of men and 52 percent of women.
- 63 percent of those in the 60+ age group.
- 38 percent of 18-29-year-olds.
- 41 percent of 30-44-year-olds.
- 61 percent of 45-59-year-olds.

Respondents do consider their nutrient intake but with only partial understanding. Six in ten think about which nutrients could be missing from their diet with more 18-29-year-olds (73 percent) giving thought to this than those aged over the age of 60 (49 percent). Thirty-eight percent of those surveyed have been told they have a nutrient deficiency. This includes 49 percent of 18-29-year-olds.

When Asked About Their Consumption Of Different Nutrients:

- 37 percent believe they consume enough vitamin C.
- 33 percent think they consume enough calcium.
- 32 percent think they have enough vitamin D.
- 30 percent and 23 percent respectively think they consume enough iron and omega-3 fats.
- 18 percent think their zinc and 17 percent their magnesium intake is fine.

More than a fifth (21 percent) did not know about any nutrients. One in ten thought they might be short of iodine and/or selenium.

However, 31 percent think they could consume more vitamin D, 28 percent think similarly about iron, 23 percent about omega-3 fats and 22 percent about vitamin C and vitamin B12. Twenty percent thought they could consume more zinc, 19 percent more magnesium, 18 percent more B vitamins and 16 percent more calcium. Again, more than a fifth (21 percent) did not know.

Eight In Ten Believe That Different Nutrients Are Helpful At Varying Life Stages And That The Following Groups Of People Should Top Up Their Vitamins And Minerals:

- Elderly people (45 percent).
- People with specific health conditions (39 percent).
- Pregnant or breastfeeding women (37 percent).
- Middle aged women (28 percent).
- Middle aged men (21 percent).
- Babies and toddlers (20 percent).
- School aged children (18 percent).
- People taking part in sports and exercise (17 percent).
- Students (11 percent).
- None of the above (nutrient requirements can be obtained from the diet; noted by 4 percent).

Food Supplements

Almost two thirds (63.5 percent; equal proportions of men and women) take a vitamin and mineral supplement. Food supplements are used less frequently by older age groups including 51 percent of those aged over 60 years, 57 percent of 40-59 years old, 71 percent of 30-44-year-olds, and 66 percent of 18-29-year-olds. Pescatarians are most likely to take a supplement (86 percent), followed by vegetarians (77 percent) and vegans (76 percent).

Probiotics

The HSIS real world survey included a snapshot of views and understanding of probiotics. Probiotics are defined as "live microorganisms (e.g. bacteria and yeasts) that, when administered in a viable form and adequate amounts, are beneficial to human health" [24].

A total of 58 percent of those surveyed would not be able to answer confidently if questioned about where to find probiotics in their diet.

Britons Believe That the Below Foods Contain Probiotics:

- Yoghurt (58 percent).
- Kefir (33 percent).
- Cheese (18 percent).
- Pickled vegetables (17 percent).
- Bananas (12 percent).

A total of 57 percent believe that a lack of probiotics in their diet would impact their health and wellbeing including gut health, for 73 percent, immune function for 49 percent, fatigue for 33 percent, headaches for 18 percent and dehydration for 16 percent.

Vitamin D and Sun Exposure

The Department of Health recommends that the UK population should take a vitamin D supplement at 10 micrograms daily particularly through the autumn, winter and spring months when sun exposure is too low to make vitamin D in the skin.

When it comes to sun exposure, three in ten Britons expose their face and arms a few times a week, 29 percent get sun most days of the week, while 22 percent noted the fact that their face and arms rarely get sun exposure.

A total of 74 percent of respondents don't take a vitamin D supplement; 35 percent admit they had not thought about it before, while 21 percent believe they get enough vitamin D from the sun. A total of 37 percent of respondents said vitamin D should be taken all year round, whilst6 percent said it should only be taken during winter and spring.

Discussion

Taken Together, The Below Show Some Concerning Findings:

- This in-depth analysis of micronutrient intakes from the most recent NDNS-RP [4] with other data analysis where possible from earlier surveys going back to 1997.
- The findings from the real-world research survey of 1000 UK adults, their diets, opinions about their food and nutrient intakes, together with respondent knowledge and opinions about vitamin and mineral supplements and personal use of food supplements.

This review aimed to evaluate micronutrient intakes across the UK population from the ages of 4 years old to those aged over 65 years according to gender and different age groups: 4-10 years; 11-18 years; 19-64 years and over 65 years.

Firstly, there are sizeable proportions of the UK population failing to achieve the LRNIs for all the micronutrients measured in the NDNS: vitamin A, vitamin B2, folate, calcium, iron, magnesium, potassium, iodine, selenium and zinc.

In addition, below LRNI intakes have increased between 2008/2009 and 2018/2019 for the majority of nutrients, to a greater extent in females than in males. Interestingly proportions of NDNS participants with below LRNI intakes were higher in many cases in 1997 and 2000/2001 than in 2008/2009 and then worsened again by 2018/2019.

Across gender and age groups it is young women whose micronutrient intakes are, and have been for three decades, the most concerning particularly as they will be the mothers of future generations. But there have been down turns in males of all ages too. And older people are not exempt from poor nutrient consumption habits.

These findings vary by micronutrients as well as age groups and gender.

Vitamin A

A total of 18 percent of 11-18-year-olds have vitamin A intakes below the LRNI. Vitamin A intake overall has declined since 2008/2009 by 21 to 23 percent in children and teenage age groups; by 13 percent in adult groups with a decline of 29 percent in the older people. Vitamin A is crucial for preserving the integrity of the epithelial tissues in the eye, urinary, gastrointestinal and respiratory tracts. Vitamin A is also important for immunity. Subclinical deficiency can increase the risk of infection especially in children. The UK government recommends that all children aged 1-5 years take a supplement containing vitamin A, C and D.

Folate (Folic Acid)

Findings for folate (folic acid) are extremely concerning, particularly for women of reproductive age, who are recommended to take a folic acid supplement when planning a pregnancy and for the first three months of pregnancy. In pregnancy, folate deficiency is associated with preterm delivery, low birth weight, foetal retardation and neural tube defects.

Folic acid supplementation during the periconceptual period reduces the risk of Neural Tube Defects (NTDs) [24-26]. However, two thirds of women in the UK are not taking a folic acid supplement before pregnancy [15] and there has been a decline in women taking supplements since 2001 with only 6 percent of women under the age of 20 now taking folic acid compared with 40 percent of women aged between 35 and 39 [16].

Interpretation of red blood cell folate findings in the NDNS indicates that nine out of ten women of child-bearing age now have such low levels of folate that if they became pregnant, their child would be at increased risk of neural tube defects [4].

Vitamin D

Vitamin D status in the UK is very poor with one in five people having levels falling below the threshold level for deficiency. This is worrying given the vital role of vitamin D in bone and muscle health. Vitamin D is essential for the intestinal absorption of calcium, magnesium and phosphorus and for the release of calcium from osteoclasts (bone cells) for remodelling of bone [13].

Vitamin D deficiency is associated with oxidative stress in skeletal muscle that influences the mitochondrial function and increases the risk of skeletal muscle atrophy [27]. Good muscle health is important for mobility, strength and stability, as well as reducing the risk of falls.

Low vitamin D status is also associated with poor metabolic function. Vitamin D supplementation has been shown in systematic reviews to prevent type 2 diabetes [28-30].

Particularly concerning are 11-18-year-old girls amongst whom 39 percent are deficient in vitamin D. Moreover, a study in UK primary care found that amongst 210, 502 patients who had a vitamin D test, one third were deficient (with deficiency identified as a blood level below 30nmol/litre). Deficiency among ethnic minority groups ranged from 43 percent among those of mixed ethnicity to 66 percent in Asians [31].

Selenium

Sizeable gaps exist between the intakes of selenium, iron, iodine, zinc and magnesium and recommended intakes. Gaps for all three nutrients are particularly sizeable for girls aged 11-18 years and for selenium in women of all ages. Men fare slightly better for selenium intakes but large proportions of men of all ages do not achieve the LRNI. Dietary deficiencies of selenium are common in the context of soil selenium deficiency and European soil selenium tends to be low [32]. Selenium acts as a cofactor in many enzyme reactions, also playing a role in redox function, production of active thyroid hormone, and immune function. Selenium also constitutes selenoproteins such as glutathione peroxidase, thioredoxin reductase, and selenoprotein-P [13,33]. Selenium deficiency has a negative impact on spermatogenesis, immune competency, thyroid function, cardiovascular diseases, and mood swings [33].

Iron

Iron intakes in women of all ages were worryingly low and fell between 2008/2009 and 2018/2019. Iron deficiency is prevalent in pre-menopausal women not only due to poor iron intake but also due to menstrual losses and the fact that the Reference Nutrient Intake (RNI) is higher for women of reproductive age (14.8mg daily) compared with the RNI for men (8.7mg daily). Intake of red meat, a source of highly bioavailable iron as well as zinc, has fallen in recent years, particular in women with women aged 19-64 years eating an average of 38g daily. It

is challenging for women of reproductive age to consume enough iron from the diet to cover menstrual losses and achieve the recommended target. Iron deficiency, even sub-clinical iron deficiency, significantly compromises health. Symptoms of iron deficiency include fatigue, apathy, paleness, weakness, breathing difficulty upon exertion, and decreased resistance for cold temperatures with considerable impact on work output [13].

Iodine

Iodine plays a key role in thyroid hormone synthesis. Thyroid hormone is essential for regulating human development and growth. Thyroid hormone is necessary for optimum foetal and postnatal development and growth of the central nervous system [13]. During the early stages of pregnancy, maternal iodine deficiency may lead to iodine deficiency disorder, which causes permanent neurological damage and mental retardation in the offspring. In this context it is serious that the proportion of 11-18-year-old women not achieving the LRNI for iodine has risen from 19 to 28 percent with equivalent figures for women aged 19-64 years of 9 and 12 percent.

Zinc

Zinc is needed for the proper functioning of over 200 enzymes and is crucial for normal growth and development, immune system function, DNA and protein synthesis and cell division. Zinc intakes have worsened in children aged 4-10 years with 15 percent not achieving the LRNI in 2018/2019 compared with 10 percent in 2008/2009. Zinc deficiency increases susceptibility to infection and can delay wound healing.

Magnesium

Below LRNI intakes of magnesium occur throughout the population but are especially evident in 11-18-year-olds of both sexes, but mostly females. Whilst there has been some improvement in intakes between 2008/2009 and 2018/2019, 47 percent of 11-18-year-old females have intakes below the LRNI. Magnesium deficiency is linked with colorectal cancer, osteoporosis, hypertension, metabolic syndrome, and diabetes. In human primary cell cultures, magnesium deficiency results in mitochondrial DNA damage, increased telomere shortening, activation of cell-cycle arrest proteins, and premature senescence (ageing of cells) [34].

Omega-3 Fatty Acids

It is also of concern that intakes of oily fish are below the recommended weekly intake of 140g. One portion of oily fish is equivalent to 450-500mg Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA) each day.Omega-3 fatty acids are important for eye, brain and heart health. A secondary analysis of the NDNS (2008-2016) [21] found that younger generations, women of childbearing age and pregnant mothers appear to be at particular risk of oily fish and omega-3 shortfalls.

Health Consequences

Overall, the most recent NDNS findings like those of earlier years are concerning because micronutrients are fundamental to good health and wellness. Lack of nutrients may have serious well-being consequences for any part of the body, including the brain, eyes, cardiovascular system, respiratory system, bones and muscles. Health consequences will depend on which micronutrients are absent but diets lacking in vitamins and minerals often have shortfalls across several vital wellness areas.

Micronutrient Intakes in Other Countries

The UK is not the only country where low micronutrient intakes have been found. In the United States (US) data from the National Health and Nutrition Examination Survey (NHANES) 2005-2016 showed that a significant number of Americans did not meet recommendations for vitamins and minerals essential for the immune function. Specifically, in all adults (>19 years), 45 percent of the US population had a prevalence of inadequacy (percentage of the population below the Estimated Average Requirement - EAR) for vitamin A; 46 percent for vitamin C; 95 percent for vitamin D; 84 percent for vitamin E, and 15 percent for zinc; 11 percent for vitamin B6; 12 percent for folate; 6 percent for copper; 5 percent for iron, and <1 percent for selenium [35]. The effect of taking food supplements was to reduce prevalence of inadequacy to 35 percent for vitamin A; 33 percent for vitamin C; 65 percent for vitamin D; 60 percent for vitamin E and 11 percent for zinc.

In an Australian Health Survey published in 2015 [36], 73 percent of females and 51 percent of males aged 2 years and over did not meet their calcium requirements based on their intakes from food. Females were much more likely to have inadequate iron intakes from foods than males, with 23 percent not meeting their requirements compared with 3 percent of males. A total of 9 percent of adult females did not meet their requirements for folate based on their intakes from foods. Approximately 7 percent of males and 16 percent of females had inadequate thiamine intakes. This was consistently higher for females than for males across all age groups over 19 years. A total of 2 percent of males and 8 percent of females did not meet their iodine requirements.

A review of published data also indicated a relatively high prevalence of inadequate micronutrient intakes for adults in Europe, ranging from 11 percent to 30 percent for copper, folate, selenium, iodine, vitamin B12 and vitamin C [37]. Subclinical micronutrient deficiencies have been found in older people in Germany. The prevalence of subclinical vitamin D and vitamin B12 deficiencies were high, with 52 percent and 27.3 percent of individuals having low 25OHD (<50nmol/L) and low vitamin B12 concentrations (<221pmol/L), respectively. Furthermore, 11 percent had low iron (men <11.6µmol/L, women <9.0µmol/L) and 8.7 percent had low folate levels (<13.6nmol/L) [38].

Factors Compromising the UK Diet

Several factors may have contributed to the findings from the UK NDNS, including the reduction of meat consumption; a desire to lose weight plus confusion as to what constitutes a healthy diet.

Intakes of red meat, which is a highly bioavailable source of iron, zinc and vitamin B12, has fallen in recent years with women consuming on average 38g daily. In the HSIS survey, more than a fifth (22 percent) of participants did not eat meat. A systematic review of studies evaluating plant-based diets [39] found that intake and status of vitamin B12, vitamin D, iron, zinc, iodine, calcium and bone turnover markers were generally lower in plant-based dietary patterns compared to meat-eaters. Veganism is associated with low intake of vitamins B2, niacin (B3), B12, D, iodine, zinc, calcium, potassium and selenium [40].

Many people are trying - and likely need to - lose weight. Diets promoted for weight loss (e.g., low carbohydrate, high protein, very low calorie) can prejudice micronutrient intakes [41] as may the elimination of one or more food groups [42] and the use of some commercial weight loss diets [43] Lack of time and working long hours is often cited as a key reason for poor diets, including low fruit and vegetable intakes, particularly in young people [44].

Confusion as to what constitutes a healthy diet also contributes to poor diets. A US study showed that exposure to contradictory nutrition information impacted on motivation to eat certain foods and vitamin intakes [45]. Nutrition uncertainty in the UK has been associated with reduced fruit and vegetable intakes [46]. Respondents in the HSIS study knew the importance of a healthy diet, but the majority (80 percent) thought there was considerable confusion about what healthy eating is, which was reflected in their poor knowledge of the government's healthy eating guidelines.

Participants in the HSIS real world research survey did not rate the health of their diets highly and the majority thought they could be improved with fruit and vegetables, wholegrain cereals, fish, eggs and dairy. While micronutrient intakes were not measured in the HSIS survey, the fact that participants thought they were short of nutrients, such as vitamin C, vitamin D, iron, zinc, selenium and iodine, and 38 percent had been told they had a vitamin and mineral deficiency accords with the findings of the NDNS. Vitamin D is a particular case in point. Three quarters of those in the HSIS real world research study did not follow the government recommendation to take a vitamin D supplement and 70 percent did not appear to have adequate sun exposure. It is not surprising that vitamin D status is so poor in the UK.

The Role of Vitamin and Mineral Supplements in Bridging the Dietary Gap

While vitamins and minerals can in theory be obtained from a healthy diet, the findings from the UK NDNS and the HSIS real world research study demonstrate that this does not occur with some potential explanations as to why. Evidence shows that a multivitamin and multi mineral supplement can help bridge these dietary gaps. Two thirds of the HSIS survey participants took a food supplement at the time of the survey and eight out of ten thought that vitamin and mineral supplements were useful at different life stages. Other consumer research [47] found that half of adults in the UK took food supplements. The pandemic has increased the use of food supplements, and a recent report [48] found that over two thirds of the UK population takes vitamin and mineral supplements, confirming the data from the HSIS real world research survey.

Multivitamin and multi mineral supplements are intended for the maintenance of health and studies have shown that they are effective in bridging dietary gaps [49]. A US study found that 51 percent of the population who took a multivitamin and multi mineral supplement which provided more than nine nutrients, effectively bridged the dietary gaps created by shortages of several nutrients in the diet [50].

Multivitamin and multi mineral supplement use at any frequency was associated with a lower prevalence of inadequacy ($p<0.01$) for 15/17 nutrients examined in a US study. Except for calcium, magnesium, and vitamin D, frequent multivitamin and multi mineral supplement use (≥ 21 days/30 days) virtually eliminated inadequacies of the nutrients examined, and was associated with significantly lower ratios of deficiency for the examined nutrient biomarkers except for iron [51].

A further US study based on nationally representative data in 10,698 adults from National Health and Nutrition Examination Surveys (NHANES) 2009-2012, found dietary food supplement use is associated with increased micronutrient intakes, decreased inadequacies, with greater benefits seen among older adults [52]. A US nursing practice paper recommended that food supplementation with a multivitamin and multi mineral supplement is an effective approach to bridge many nutritional gaps and can be recommended for numerous patients with poor diet quality [53].

A further US analysis aimed to assess contributions of sporadic and consistent multivitamin and multi mineral use to total usual micronutrient intakes and associated nutritional biomarkers among middle-aged to older US adults aged over 51 years, stratified by obesity status. Self-reported dietary intake and laboratory measures from the National Health and Nutrition Examination Survey were used in these analyses. The National Cancer Institute method was used to assess usual intakes of 18 micronutrients. Compared with food alone, multivitamin and multi mineral use was associated with a lower prevalence of inadequacies and improved nutritional biomarker status for folate, iodine, selenium, and vitamins B6, B12, and D. Consistent use decreased the prevalence of inadequacy for most micronutrients assessed [54].

Conclusion

Vitamins, minerals and omega-3 fatty acid intakes are not improving in the UK. Infact, this review has shown that the consumption of the majority of the micronutrients measured in the NDNS fell from 2008/2009 to 2018/2019. These decreases are greater in women than men and are particularly worrying in younger women especially for vitamin A, riboflavin, folate, calcium, magnesium, iron, zinc, iodine and selenium. Reductions of the same micronutrients in young men were also evident and only zinc intakes have improved in older men.

There are many reasons for these poor dietary intakes. This includes the increased popularity of plant-based diets, confusion and lack of knowledge as to what constitutes a healthy diet, and long working hours and lack of time, as well as the cost of healthy eating which has increased during recent years.

A multivitamin and multi mineral food supplement can effectively and safely bridge the nutrient gaps. While the HSIS real-world research study showed about two thirds of Britons have taken a food supplement, many do not consume supplements consistently on a daily basis. Furthermore, not all food supplement users take a multivitamin and multi mineral formulation which as this review makes clear is likely to be the most helpful because of the poor intakes of various nutrients that our bodies need daily. Hence a multivitamin and multi mineral food supplement is the best policy.

Funding

The authors Dr Gill Jenkins, Dr Nisa Aslam and Dr Pamela Mason received funding from the Health & Food Supplements Information Service (HSIS) - www.hsis.org. The review was written by the authors alone and HSIS had no role in writing the publication. The authors declare no competing interests.

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