Nutrition Innovation Centre for Food and Health

An Update on Iodine in the UK diet: The Role of Milk

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'Global Excellence in Nutrition Research & Education'

Why do we need iodine?

- Iodine is a key component of the thyroid hormones (TH) **Thyroxine (T_4) and Triiodothyronine (T_3)**

- TH are needed for optimal reproductive function, metabolic regulation, foetal growth and brain development

- Adequate dietary iodine is particularly important in **pregnancy and infancy**

Role in neurodevelopment

Gestational period

1^{st} trimester	2^{nd} trimester	3^{rd} trimester
Brain development →		
Weeks 3 - 12: Foetal thyroid gland inactive Maternal T_4 needed for neurone proliferation and myelination	Foetal thyroid active, but reliance is still on maternal iodine supply	

- Inadequate supply of iodine and hence, thyroid hormones, in early pregnancy can potentially have irreversible and long-lasting adverse effects to cognitive development

- Adequate iodine stores pre-conception are particularly important

Iodine Deficiency

Causes of iodine deficiency

- Iodine is cycled in the atmosphere between seawater and rainfall
- Low soil concentrations are present in areas that are mountainous, far from the sea and prone to flooding
- Malnutrition, co-existing micronutrient deficiency and intake of goitrogens can all aggravate iodine deficiency in these regions

Consequences of iodine deficiency

	Health consequences of Iodine Deficiency
All ages	Goitre Hypothyroidism
Foetus	Spontaneous abortion Stillbirth Congenital anomalies Perinatal mortality
Neonate	Endemic cretinism Infant mortality
Child	Impaired mental function Delayed physical development Iodine-induced hyperthyroidism
Adults	Impaired mental function Iodine-induced hyperthyroidism

Adapted from: Vanderpump, (2014) *Clinical Medicine* **14** (6), s7-s11.

Assessing iodine status

- In healthy adults, 90% dietary iodine is excreted in urine with the rest taken up by the thyroid
- **Urinary iodine concentration (UIC)**, measured in spot urine samples, is the recommended biomarker for assessing recent dietary iodine intake in a population (median UIC µg/L)
- Adjusting for urinary creatinine reduces the effect of variation in urine volume (**iodine:creatinine** µg/g)

WHO, UNICEF & ICCIDD (2007) *Assessment of IDD and Monitoring their Elimination*, 3rd ed, Geneva: WHO

Classification of deficiency

	Median UIC µg/L	Iodine status
School-aged children, non-pregnant and non-lactating adults	<20	Severe deficiency
	20 - 49	Moderate deficiency
	50 – 99	Mild deficiency
	>100 (>110 µg/g urinary iodine:creatinine)	Adequate
Pregnancy	<150	Insufficient
	>150 (>183 µg/g urinary iodine:creatinine)	Adequate

WHO, UNICEF & ICCIDD (2007) *Assessment of IDD and Monitoring their Elimination*, 3rd ed, Geneva: WHO

Consequences of mild-to-moderate iodine deficiency in pregnancy

- **Australia**: 9 y old children, whose mothers had a gestational UIC <150µg/L throughout pregnancy, had poorer language skills (*n*=228)[1]
- **ALSPAC Study, UK:** Follow-up of 8-9 y old children found those whose mothers with urinary iodine:creatinine <150µg/g in their first trimester had lower IQ and reading skills (*n*=1040)[2]
- **Generation R Study, Netherlands**: Children born to mothers with low iodine: creatinine <136µg/g in early pregnancy had mild alterations in executive functioning at 4 y of age (*n*=692)[3]

[1] Hynes *et al,* (2013) *J Clin Endocrinol Metab*, **98** (5), 1954-1962; [2] Bath *et al,* (2013) *Lancet* **382** (9889), 331-7; [3] van Mil *et al*, (2012*) J Nutr* **142**, 2167- 2174

Dietary Requirements & Sources in the UK

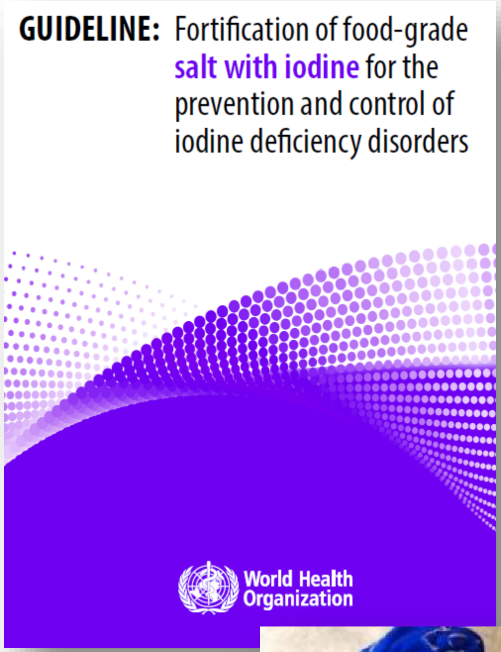
Dietary Requirements

Recommended Daily Amounts - µg/d

	Worldwide **WHO** Recommended Nutrient Intake[1]	**Europe** **EFSA** Adequate Intake[2]	**USA** **IOM** Recommended Daily Allowance[3]	**UK** **DH** Recommended Nutrient Intake[4]
Adults 19-50 yrs	150	150	150	140
Pregnant women	250	200	220	+ 0 i.e. 140
Lactating women	250	200	290	+ 0 i.e. 140

[1]World Health Organization/ Food and Agriculture Organization (2004); [2]European Food Safety Authority (2008); [3]Institute of Medicine (2001); [4]Department of Health, Committee on Medical Aspects of Food Policy (1991)

Dietary Sources of Iodine


GUIDELINE: Fortification of food-grade salt with iodine for the prevention and control of iodine deficiency disorders

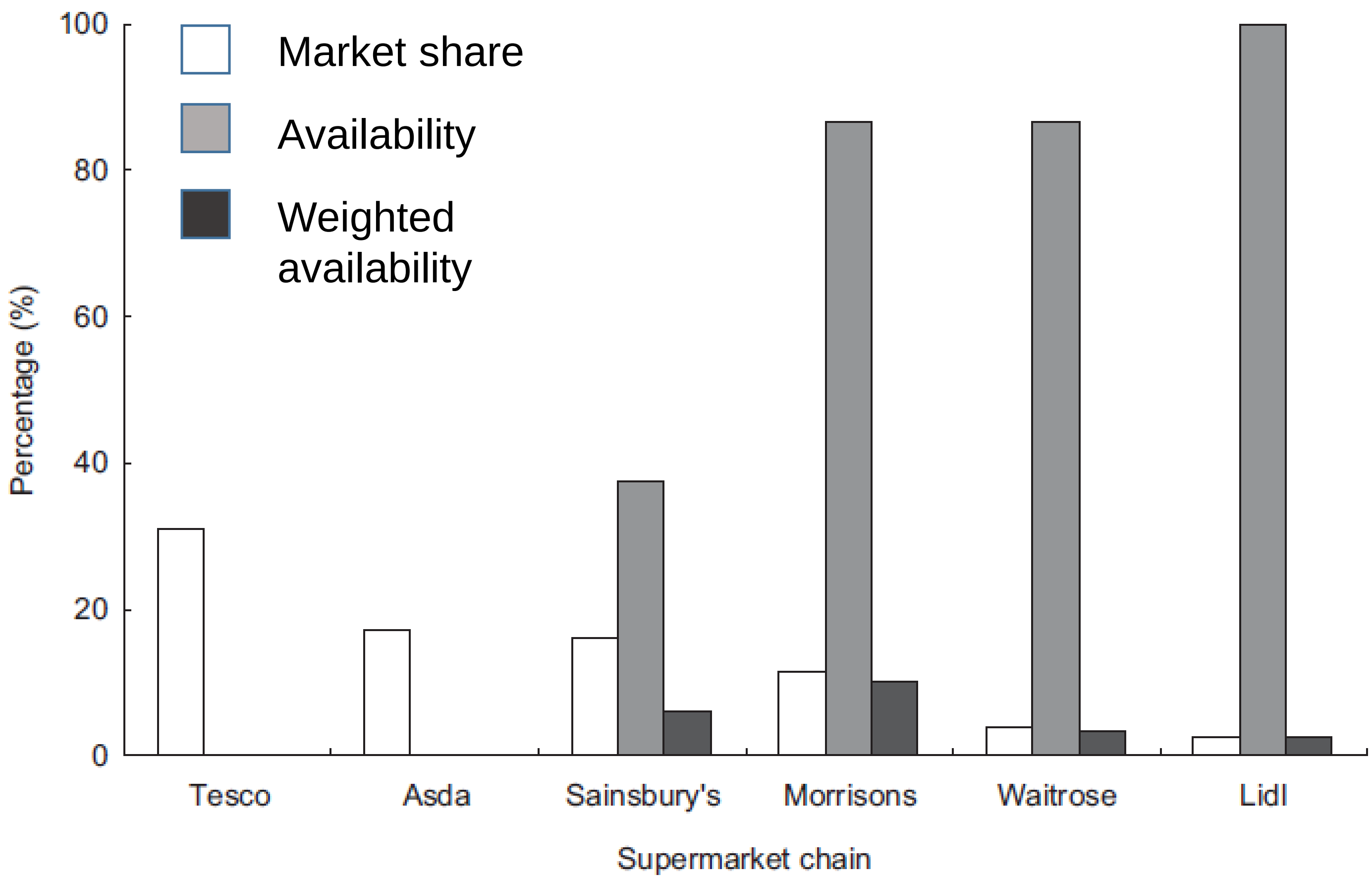
World Health Organization

- Universal salt iodisation (USI) remains the key strategy to eliminating IDD worldwide[1]
- Implemented in 128 countries with 70% households worldwide having access[1]
- Successful in reducing:
  - Goiter
  - Cretinism

[1]WHO, UNICEF & ICCIDD (2007) *Assessment of IDD and Monitoring their Elimination*, 3rd ed, Geneva: WHO; [2]Pearce, *et al* (2013) *Thyroid* 23(5), 523-528

Iodised salt in the UK

Availability is low for UK households



Bath *et al,* (2014) *Public Health Nutr* **17**(2), 450-4

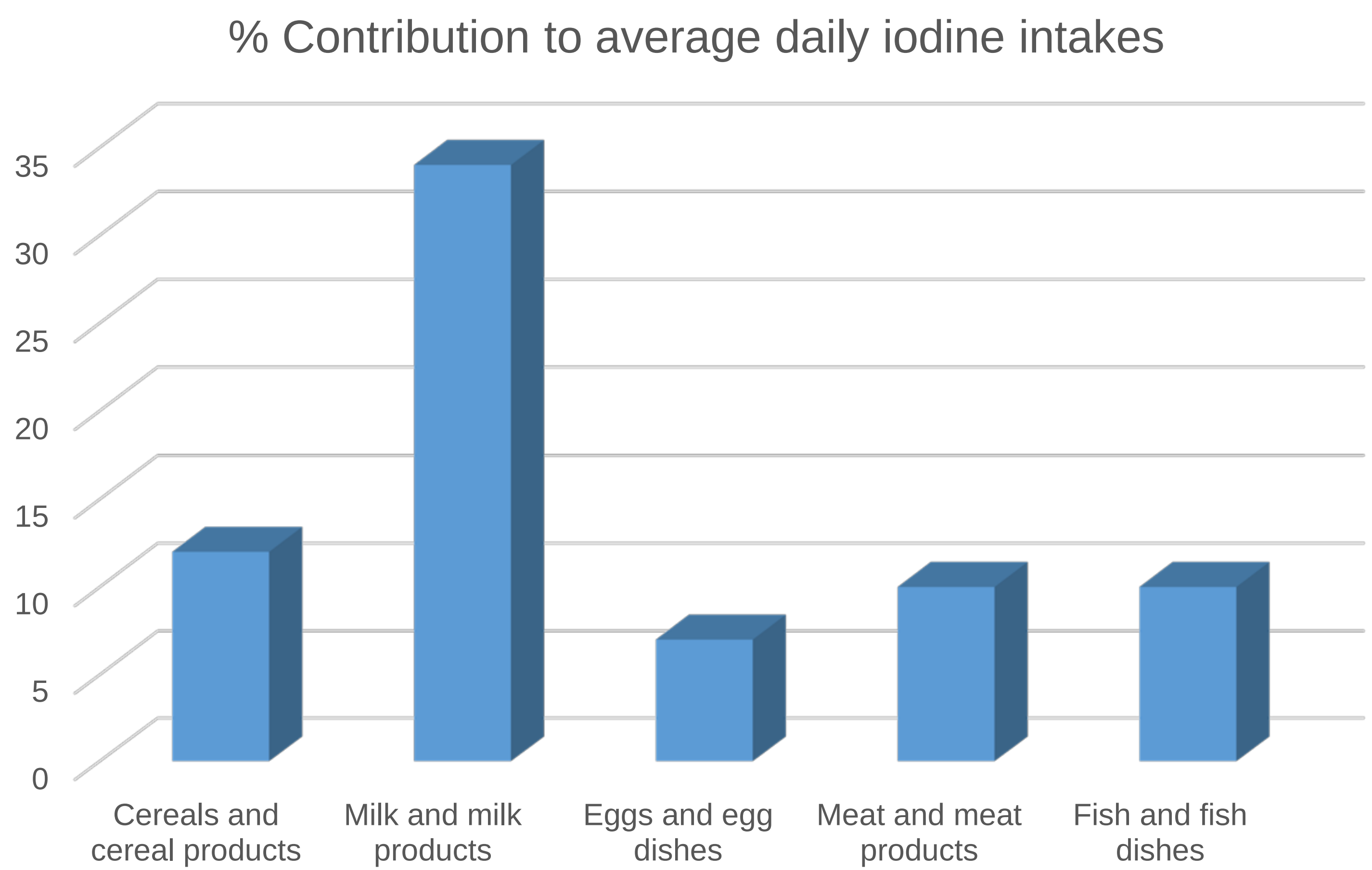
Food Sources

For populations without iodised salt

Foods of marine origin

Milk and dairy products

Contribution of UK foods to average daily iodine intakes



Bates *et al*, (2017) National Diet and Nutrition Survey (NDNS) Results from Years 7 and 8 (combined) of the Rolling Programme (2014/15 to 2015/16). Department of Health, Available from www.gov.uk/government/statistics/ndns-results

The Role of Cow's Milk

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Cow’s milk as a source of iodine

Animal diet

Country/ region

Farming practices

Processing

Concentrations are highly variable

Iodine concentrations in cow's milk produced in Northern Ireland

- Milk samples were collected weekly from May 2013 - April 2014 from two large NI creameries (*n*=376):
  - *Raw milk pre-homogenisation*
  - *Pasteurised: Whole, semi-skimmed and skimmed*
- Iodine was analysed (ICP-MS, LGC Group) to assess the effect of various factors to iodine concentrations

Ulster University

DAIRY COUNCIL NORTHERN IRELAND

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Comparing NI milk iodine concentrations with the rest of the UK

Study	Region	N	Milk type	Mean ± SD (µg/kg)	Season
O'Kane *et al*, (2018)	NI	376	Semi-skimmed, from processor	476 ± 64	April '13 – May '14
Stevenson *et al*, (2017)	Reading	48	Semi-skimmed, retail	427 ± 16	July-Dec '15
Payling *et al*, (2015)	Reading	12	Semi-skimmed, retail	474 ± 25	January '14
Bath *et al*, (2012)	SW. England	80	Semi-skimmed, retail	256 (142, 164)*	June-Aug '09
Food Standards Agency (2008)	UK wide	145	Semi-skimmed, retail	300	Ave of summer & winter

* Geometric mean (95% CI)

Factors affecting concentrations in NI milk

		Iodine concentration (µg/kg)		
Milk type	*n*	Mean	SD	*P*
Pasteurised†	36	475.9	63.5	0.275
Unpasteurised‡	12	451.7	71.9	
Skimmed	12	472.6	76.0	
Semi-Skimmed	12	466.6	62.6	0.696
Whole	12	488.5	53.3	
Winter	9	498.1[a,b]	30.6	
Spring	9	534.3[a]	53.7	**<0.001**
Summer	9	437.4[b,c]	48.9	
Autumn	9	433.6[c]	57.8	

† Mean of skimmed, semi-skimmed and whole milk samples
‡ Samples were collected pre-pasteurisation and pre-homogenisation

[a,b,c] values within a column with different superscript letters represent significance (P< 0.05)

O'Kane *et al* (2018) *Nutrients* **10**, 287

Implications for dietary intakes

- At these concentrations, NI milk could be contributing more to daily iodine intakes in all population groups than recognised by previous estimates[1]
- Season is likely to influence population intakes
- Caution is needed when using food composition data to estimate iodine intakes[2,3]
- Results emphasise the importance of monitoring milk concentrations and understanding sources of variability

[1]O'Kane *et al,* (2018) *Nutrients* **10**, 287
[2] Hennessy *et al,* (2017) *Eur J Clin Nutr* **72**, 410-419; [3]Carriquiry *et al*, (2016) *Am J Clin Nutr* **104**, 877S-887S

Can increasing milk consumption improve iodine status?

O'Kane *et al,* (2018) *J Nutr* **148**, 401- 408

Selenium and Iodine in Milk Intervention Study (SIMI)

Screening potential participants
n 237

Eligible women of childbearing age
n 78

Intervention Group
n 39
430ml milk/day

Control Group
n 39
Usual milk consumption

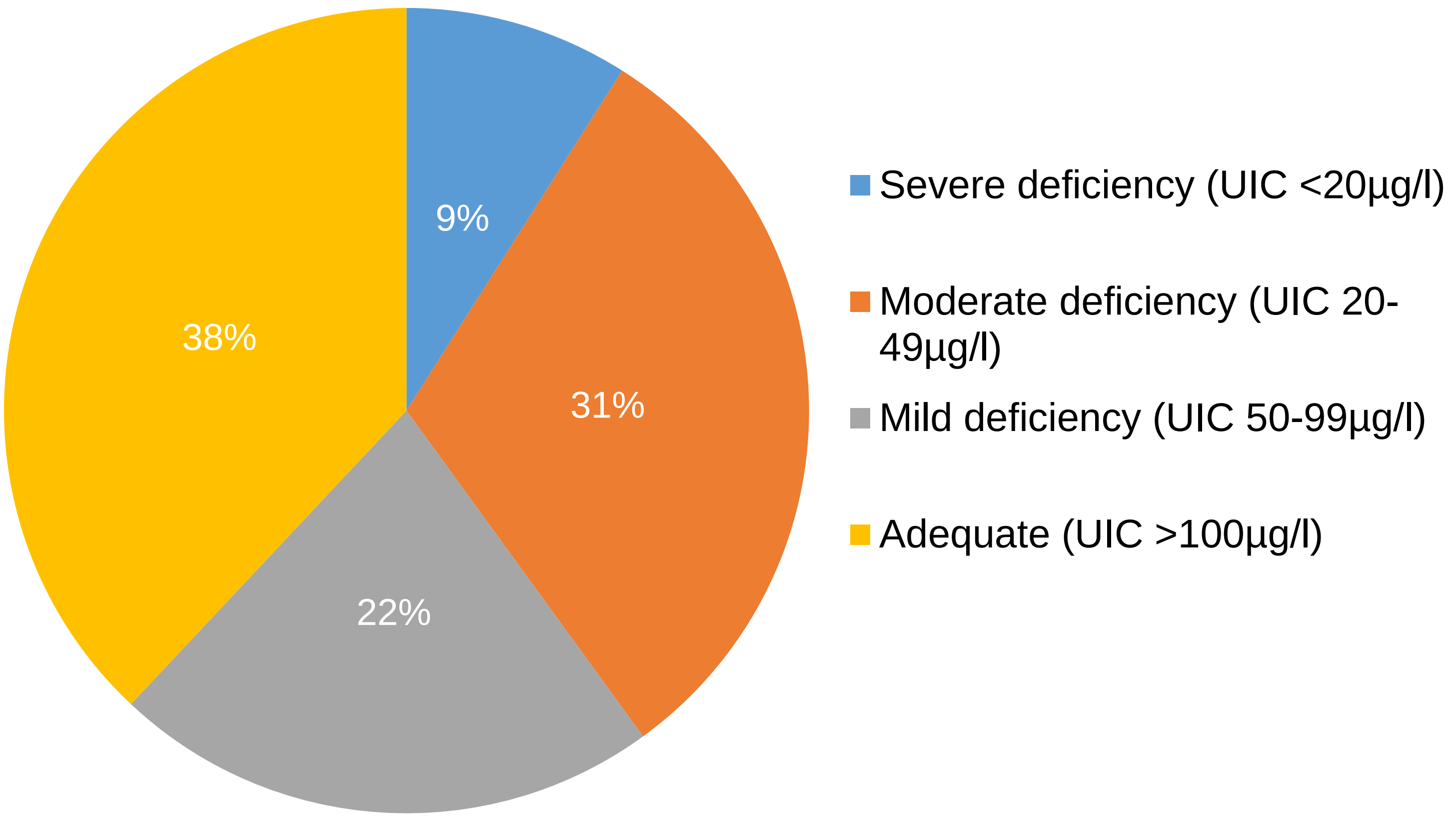
Baseline
(Week 0)

Mid-intervention
(Week 6)

Post-intervention
(Week 12)

Biological, anthropometric and dietary data

Prevalence of iodine deficiency



N= 78 women of childbearing age (median 26.5 years)

Results of milk intervention

- Following a modest increase in milk consumption (up to 430ml/d):
  - Iodine status ↑ by 35% (iodine:creatinine increased from 70 to 121µg/g)
  - Levels of iodine deficiency ↓ by 23%
  - No adverse effects on weight, BMI, blood pressure or waist:hip ratio

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O'Kane *et al,* (2018) *J Nutr* **148**, 401- 408

Deficiency in the UK: An Update

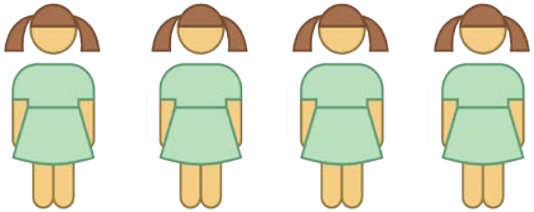
Ulster University

National survey of UK schoolgirls

THE UK IODINE GROUP

Vanderpump *et al*, (2011) *Lancet* **377** (9782), 2007-12

- Spot urine samples collected from 737 schoolgirls (14-15 y)
- 9 centres across the UK
- Median UIC = 80.1 µg/L indicating mild deficiency
- UIC was lowest in the summer months, among those with the lowest milk intakes and in Belfast area
- **Raised significant public health concern**



THE HUFFINGTON POST

Iodine Deficiency Could Spell Big Problem For UK

Posted: 06/01/2011 6:30 pm EDT | Updated: 08/01/2011 5:12 am EDT

The INDEPENDENT

Babies at risk as girls fail to get enough iodine

70 per cent of schoolgirls aged 14-15 had levels below 100 micrograms per litre, or a mild deficiency

BBC NEWS

Worrying levels of iodine deficiency in the UK

Mail Online

Teenage girls' low iodine levels put 'future babies at risk'

MNT SINCE 2003

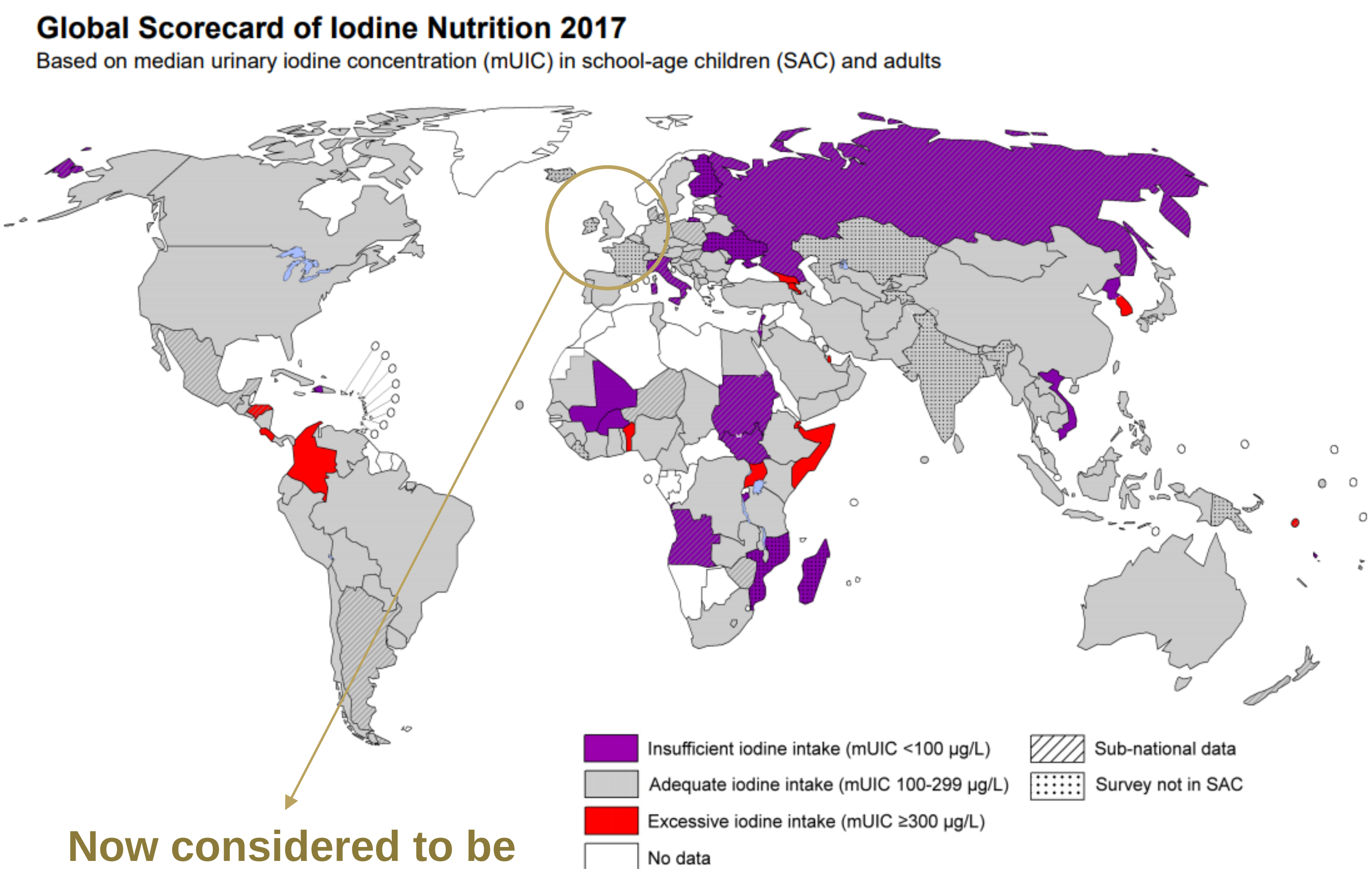
68% of 14-15 year old girls in UK iodine deficient - health risk for them and their future offspring

Iodine status in the UK: An Update

Urinary iodine concentration µg/L in NDNS spot urine samples

	Adults (19- 64 yrs)		Women of childbearing age (16- 49 yrs)	
	Year 6 (2013/14)	**Years 7 – 8 (2014/15 2015/16)**	**Year 6 (2013/14)**	**Years 7 – 8 (2014/15 2015/16)**
Median	119	105	117	102
20^{th} – 80^{th} percentile	63 – 208	59 – 188	65 - 198	54 - 193
% below 100µg/L	41	46	40	47
% below 50µg/L	13	14	11	17
% below 20µg/L	2	2	1	0

What about the UK?



Now considered to be adequate at the population level

www.ign.org/scorecard

Iodine status in the UK: An Update

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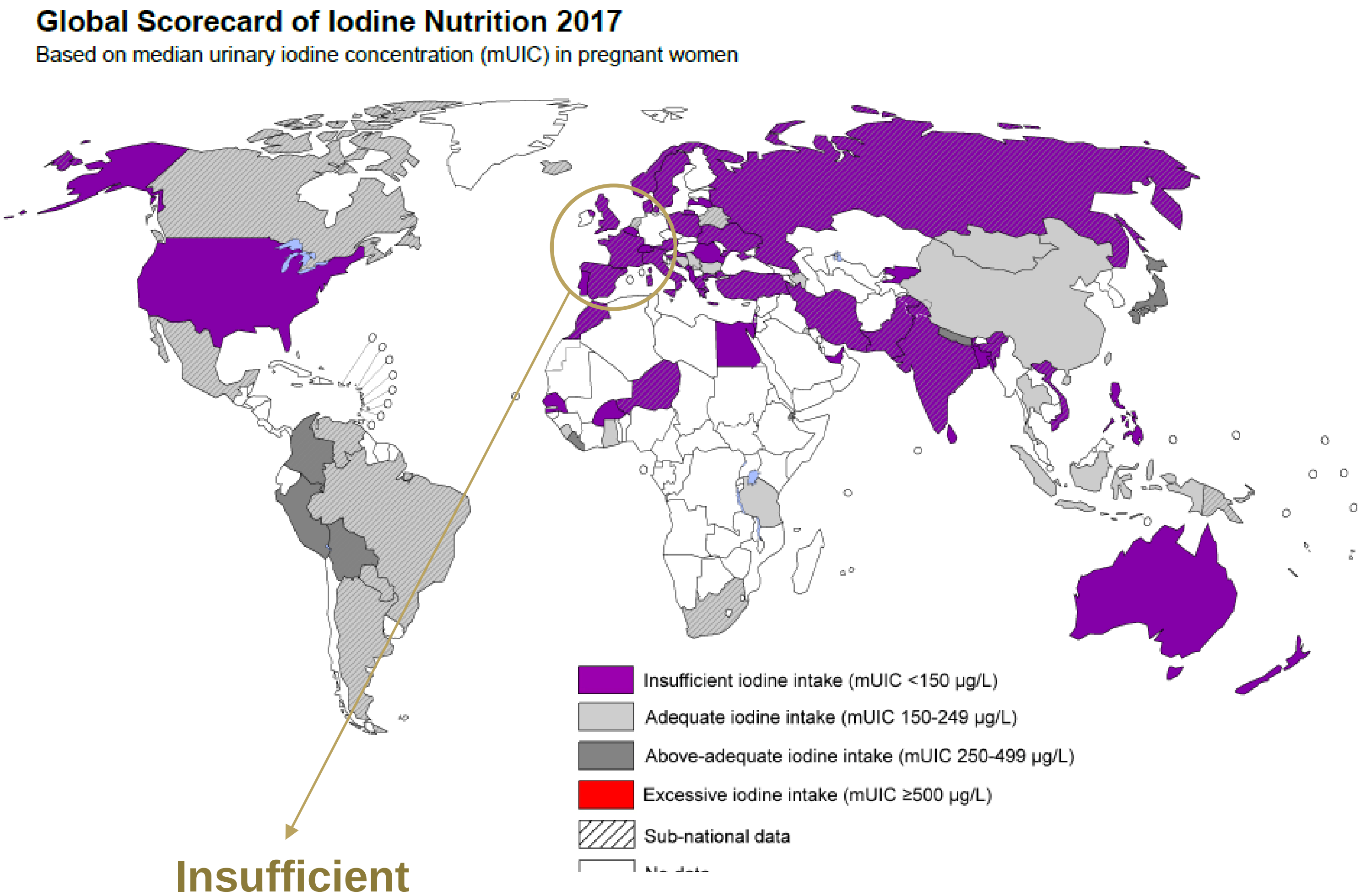
Recent studies of iodine status in the UK:

Pregnant women

Authors	n	Gestational weeks	Season of sampling	Median UIC µg/L*
Barnett *et al*, (2002)	433	11.5	-	137
Pearce *et al*, (2010)	480	<16	All year	117
Bath *et al*, (2013)	1040	<13	All year	91.1
Bath *et al*, (2014)	100	12	Summer	85.3
Furmidge-Owen *et al*, (2014)	228 222 212	12 20 35	All year	42.0 52.0 69.4

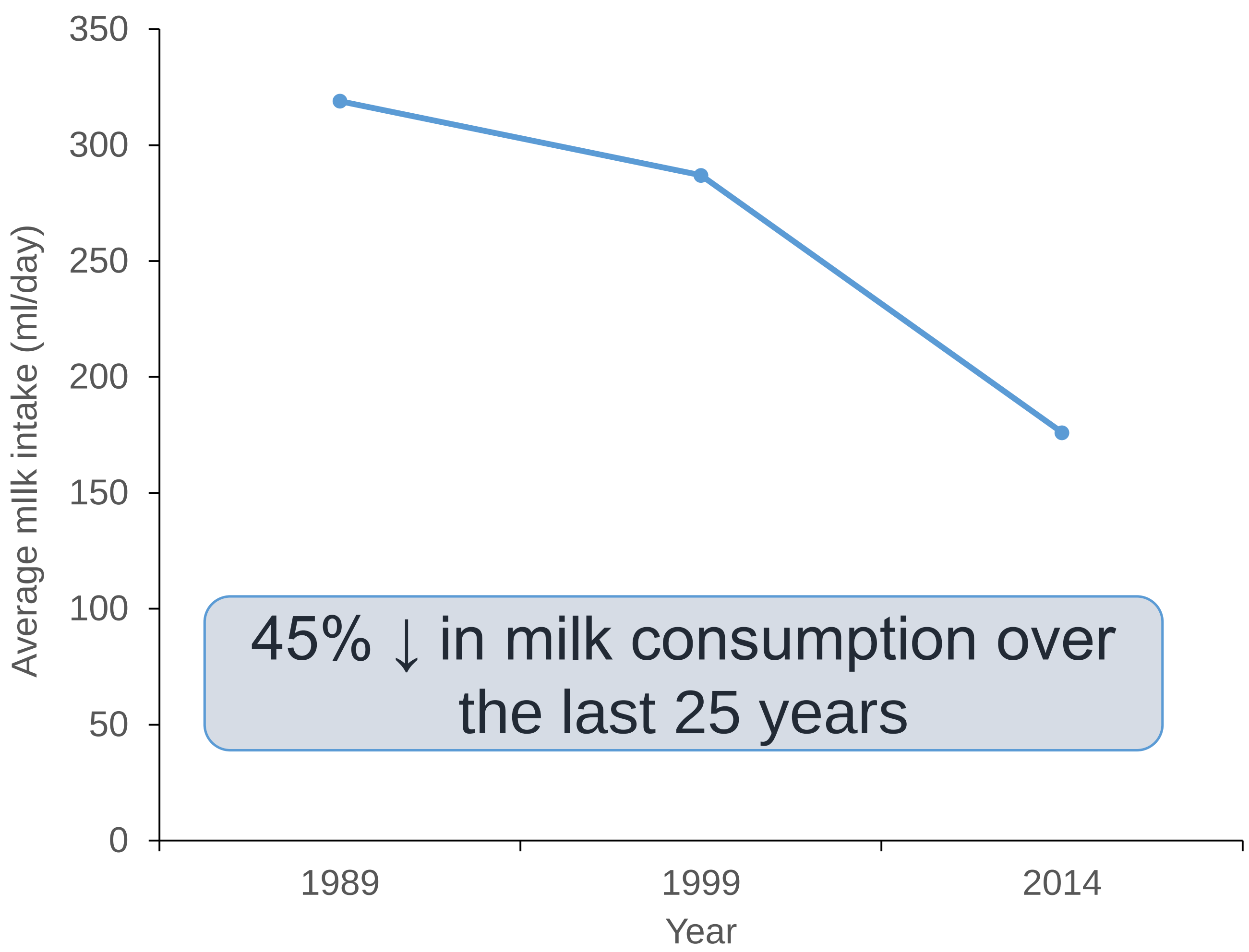
* WHO criteria for iodine adequacy in pregnancy: ≥150 µg/L

UK Pregnant Women



www.ign.org/scorecard

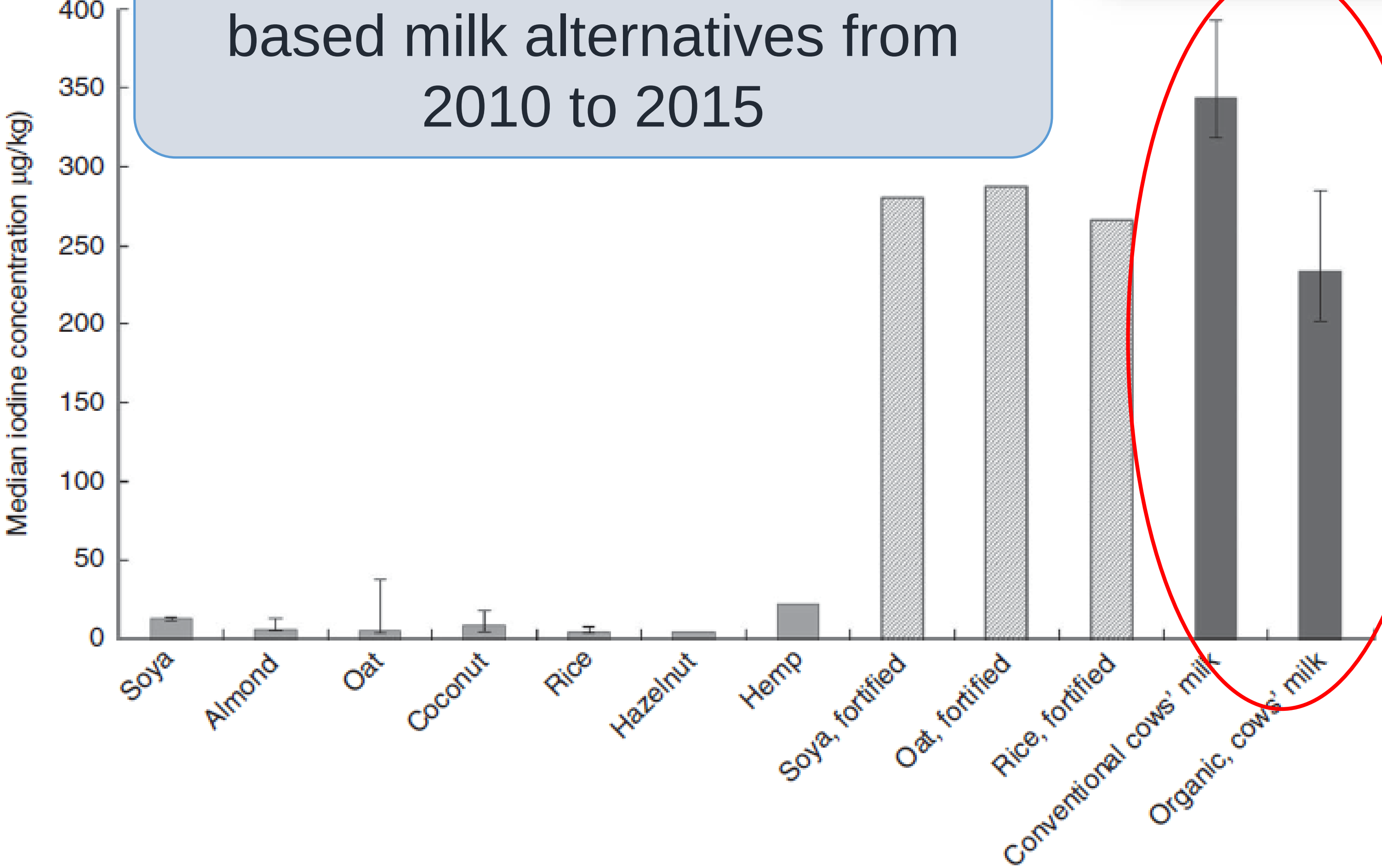
Declining milk consumption



Department for Environment, Food and Rural Affairs (DEFRA), (2017); Bates *et al, (*2016); Mintel, (2017)

Alternative milk drinks

38% ↑ in purchases of plant-based milk alternatives from 2010 to 2015



Bath *et al,* (2017) *Br J Nutr* **118**, 525-532; DEFRA (2017) Family Food Datasets. Available at: www.gov.uk/government/statistical-data-sets/family-food-datasets; Srednicka-Tober *et al,* (2016) *Br J Nutr* **115**, 1043- 1060; Bath & Rayman, (2016) *Br J Nutr* **116**, 3-6

Lack of Awareness

- An Ulster-conducted survey of 520 UK females reported poor iodine knowledge and awareness. Iodine knowledge was greatest among those with intakes above the RNI[1]

- Just 12% of Glaswegian pregnant women surveyed were aware of the need for greater iodine[2]

[1] O'Kane *et al,* (2016) Br J Nutr **116**(10), 1728- 1735
[2] Combet *et al*, (2015) Br J Nutr **225**(1), 208-17

How can we improve iodine intakes?

Ulster University

Is supplementation the answer?

- WHO recommend that, in countries where USI is not implemented, supplements should be given to pregnant women
- However, there are as yet no clear benefits to supplementing pregnant women in areas of mild-to-moderate deficiency[1-5]
- Potential risk of thyroid disorders and autoimmunity[6,7]
- Only 50% of pregnancies in the UK are planned

[1]Berbel *et al*, (2009); [2]Velasco *et al*, (2009); [3]Santiago *et al*, (2013); [4]Zhou et al, (2013); [5]Gowachirapant e*t al*, (2017); [6]Rebagliato *et al*, (2013); [7]Zimmermann & Boelart (2015)

Considerations for future research

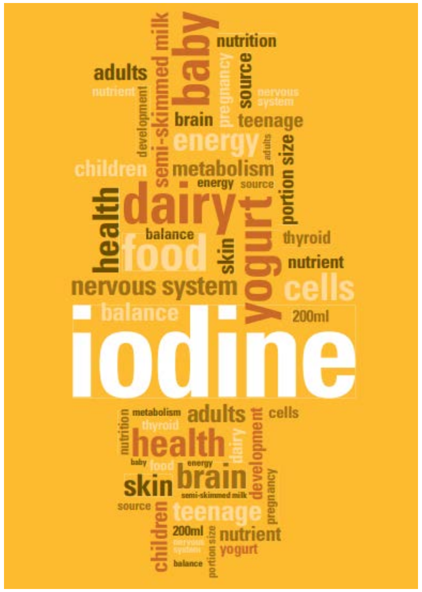
- Regular monitoring of iodine status at the population level, particularly in pregnant women

- Improved analysis of food sources and understanding of the factors influencing food composition variability and the impact on dietary assessment

- Greater evidence required to determine the effects of supplementing pregnant women with mild-to-moderate deficiency on child cognitive outcomes

Education

- Education campaigns aimed at young women and also, health professionals who provide information to pregnant women



The Dairy Council
www.milk.co.uk

BDA The Association of UK Dietitians

Food Fact Sheet

Iodine

This Food Fact Sheet will tell you more about iodine, its food sources and how much you need.

What is iodine?

Iodine is a mineral that is important for health. It is needed to make the thyroid hormones. These hormones are needed for many body processes including growth, regulating metabolism and for the development of a baby's brain during pregnancy and early life.

Do we get enough iodine in the UK?

For many years iodine intake in the UK was thought to be more than adequate but recent research has shown mild iodine deficiency in schoolgirls and pregnant women. There is now concern that many adult women may not be getting enough iodine, particularly in pregnancy.

How much iodine do I need?

Life stage	Iodine required per day (mcg)*
Adults	150
Pregnant women	200
Breastfeeding women	200

*European Food Safety Authority (EFSA) recommendations.

What happens if I do not have enough iodine?

A low intake of iodine over a long period of time may cause your thyroid to work harder to keep the right amount of thyroid hormones in your blood. This can mean that your thyroid increases in size in order to trap iodine – this swelling, or "goitre", may be visible in your neck. However, visible goitre due to low iodine intake is rare in the UK. It is more likely that having too little iodine in your diet may lead to low levels of thyroid hormones. If you have a deficiency of iodine when you are pregnant, your baby's brain may not develop as well as it could and this could affect your child's ability to learn in later years,for instance, lower IQ or poorer reading ability.

Before and during pregnancy and breastfeeding

As iodine is required from the early stages of pregnancy, you should make sure you have been having enough iodine in your diet for several months before you get pregnant. This is because you can build up good stores of iodine in your thyroid before you become pregnant which helps it to function well during pregnancy. Therefore if you are of childbearing age, and especially if you are planning a pregnancy, you should ensure that you meet the adult requirement for iodine.

During pregnancy, the amount of iodine you need increases. This is because you have to make sufficient thyroid hormones to transfer to your baby to help its brain develop correctly. You also have to supply all the iodine that the baby needs. Iodine deficiency in pregnancy may have serious consequences for your child so it is very important that you meet that higher iodine requirement if you are pregnant. Breastfeeding mums still need a higher amount of iodine, so their breast milk has enough iodine for their baby. This is because the brain is still developing at that early stage.

Where is iodine found in the diet?

Iodine is found in a range of foods, the richest sources being fish and dairy products. Seaweed is a concentrated source of iodine, but it can provide excessive amounts (particularly so in the case of brown seaweed such as kelp) and therefore eating seaweed more than once a week is not recommended, especially during pregnancy. White fish contains more iodine than oily fish.

BDA Iodine Fact Sheet
www.bda.uk.co.uk

Promotion of food sources

- Promotion of most important food sources
- Role of dairy industry and health promotion bodies
- Conduct research aimed at improving knowledge and overcoming common misperceptions of milk as an unhealthy food

Thank you!

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- Edel Fitzgerald

- **Study Participants**

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