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IODINE DEFICIENCY: THE RISK OF RESTRICTIVE DIETS

Rachel Wood
Specialist Paediatric Dietitian in Allergy & Gastroenterology, Royal Manchester Children's Hospital

Rachel works as a Paediatric Dietitian in a large tertiary children's hospital where she specialises in allergy and gastroenterology. She previously worked at Sheffield Children's Hospital. Allergy has become one of Rachel's main interests.

Food allergy is a major public health concern. This article will look at the real risk of becoming iodine deficient during infancy by avoiding not only milk, but other important food groups.

The perception of food allergy is far greater than confirmed allergy. Cows' milk allergy prevalence during infancy ranges from 1.9% to 4.9%, with perceived allergy in up to 17.5%.[1]

More and more infants, children and adults are following restrictive diets and seeking alternatives to dairy, either due to diagnosed allergies or as a lifestyle choice, with health professionals focusing on ensuring that calcium and vitamin D is supplemented.

Iodine is a mineral that forms part of the thyroid hormones T4 and T3. These hormones are necessary for regulating metabolism, thermoregulation, protein synthesis and growth. It is also a key component necessary for brain and neurological development, particularly during gestation.[2]

It has been shown that supplementing iodine at a population level and correcting mild deficiencies is beneficial for public health and the economy. The prevalence of iodine deficiency has reduced following an initiative by the World Health Organisation of using iodised salt and, although this was mandatory in many European countries, it was discretionary in the UK; but now, very little iodised salt is consumed in the UK.[3,4]

Supplementation of iodine in foods could prevent mild to moderate deficiencies that we know already exist from causing more serious health implications. Dietary intake data from the National Diet and Nutrition Survey (NDNS) indicates that at least one fifth of non-pregnant girls aged 11-18 years in the general population are at risk of low iodine intakes.[5]

What we do know is that the iodine content in foods can vary considerably dependant on where in the country cereals and crops are grown. This is due to inorganic iodine salts being water soluble and leached out of surface soils.

Geographical areas that are prone to ice, high rain, snow fall or floods have low iodine levels in the soil and, therefore, any crops grown here have low iodine content, making those who live in these areas at risk of iodine deficiency unless they receive alternative sources in the diet.[6] Iodine levels in cereals and grains, therefore, depend on the soil in which they are grown. Iodine levels in meat, chicken, eggs and dairy depend on the iodine content of animal feed.

Dairy and milk products are a major source of iodine in the diet (33% in adults and even higher in children and infants). The breakdown of foods that contribute to the population's iodine intake are shown in Tables 1 and 2.[6] There are also many varying

Table 1: Iodine content of selected foods in the UK (FSA, 2002)

Food	Description	Iodine content (μg/100g)
Mussels, cooked	Purchased	247 (DH, 2013a)
Cod, baked	Baked in the oven, flesh only	161 (DH, 2013a)
Egg yolk, boiled	Chicken eggs	137 (DH, 2013b)
Eggs, whole, boiled	Chicken eggs	52 (DH, 2013b)
Milk chocolate		51 (DH, 2013c)
Sea salt		50
Whole milk, pasteurised, average	Average of summer and winter milk	31
Semi-skimmed milk, pasteurised, average	Average of summer and winter milk	30
Skimmed milk, pasteurised, average	Average of summer and winter milk	30
Cheddar cheese	Mild and mature English cheddar	30
Ice cream, dairy	Vanilla flavours, soft scoop	30 (DH, 2013c)
Whole milk yoghurt, fruit	Assorted flavours including bio varieties	27
Kippers, grilled	Analysed without butter	24 (DH, 2013a)
Peanuts, plain	Kernels only	20
King prawns, cooked	Purchased	12 (DH, 2013a)
Tuna, canned	In brine, drained	12 (DH, 2013a)
Infant formula	Commercial products as made up	10-13[a]
Beer, bitter, canned		8 (Wenlock et al., 1982)[b]
Human milk, mature		7
Chicken breast	Grilled without skin, meat only	7
Butter, spreadable	75-80% fat	4 (DH, 2013c)
White bread, sliced		4
Spinach, raw	Baby spinach	4 (DH, 2013d)
Bananas	Flesh only, raw	3 (DH, 2013d)
Onions, raw	Standard onions (not red)	2 (DH, 2013d)

[a] data presented as μg/100ml. The term 'infant formula' refers to a food that can provide an infant with all its nutritional needs during the first six months of life. The data presented is the range for commercial products as declared on labels available in September 2013.

[b] data presented as μg/100ml. The iodine content of beer and lager available in the UK has not been analysed as part of Public Health England's rolling programme of nutrient analysis since the late 1970s. As such, composition data may not be representative of the beverages currently on the market.

factors that contribute to how much iodine is in our cows' milk, i.e. how much iodine is supplemented in animal feed; cleaning equipment used in dairy farms always used to be cleaned with iodised salts, contributing to exposure and quantity of iodine in milk (there has been a reduction in the use of this in recent years) and the use of a cow fodder fortified with iodine in winter months.

In recent years, we have seen 'organic' foods becoming more popular, but it is important to note that organic milk is reared from cows that don't receive the feed containing fortified iodine and is 42% lower than conventional milk.[7] This also contributes to the public health concern. High levels of iodine are, however, found in marine fish and shellfish[7] (see Table 1), mainly due to the high levels of iodine in sea water and brine. Despite this, 'sea and mined salt' is not a good source of iodine due to the evaporation process to form salt.

As you can see from Table 2, which is the National Diet and Nutrition Survey 2008/09-2009/10, dairy products contribute a large amount of the general population's intake of iodine. This is likely due to the quantity consumed. For example, fish has a high iodine content, but may only be eaten twice a week compared to dairy which does have a lower iodine content (see Table 1), but which is consumed daily in various forms such as cheese, yoghurt and milk. Therefore, there are

Table 2: Percent contribution of selected food groups to daily mean iodine intakes for adults aged 19-64 years in 2008/09 to 2009/10[c]

Milk and milk products total,	33%
of which cows' milk	23%
Fish and fish dishes	11%
Beer and lager	11%
Cereal and cereal products	10%
Eggs and egg dishes	6%
Other	29%

[c] Secondary analysis of data from the NDNS 2008/09 – 2009/10 (Bates et al, 2011). Food sources only (excluding supplements).

Table 3: UK Dietary Reference Values for iodine (DH, 1991)

Age	Lower Reference Nutrient Intake (LRNI) (µg/day)	Reference Nutrient Intake (RNI) (µg/day)
0-3 months	40	50
4-6 months	40	60
7-9 months	40	60
10-12 months	40	60
1-3 years	40	70
4-6 years	50	100
7-10 years	55	110
11-14 years	65	130
15-18 years	70	140
19-50 years	70	140
50+ years	70	140
Pregnancy	No increment	
Lactation	No increment	

contributory factors on a national level that can impact on the general population's risk of iodine deficiency.

IODINE DEFICIENCY

The body's own methods of homeostasis are very efficient at regulating thyroid hormone levels. If iodine levels fall below 100mcg, iodine uptake increases as well as the production of thyroid hormone. If levels fall below 10-20mcg per day, hypothyroidism occurs. Goitre is the earliest clinical sign of deficiency. Goitre is a swelling in the neck or larynx as a result of enlargement of the thyroid gland. It is associated with dysfunction of the thyroid gland and can range from a small lump to a very large mass. Globally, over 90% of the cases are associated with iodine deficiency.

The Avon and Longitudinal study of Parents and children (ALSPAC) in 2013 enrolled 1,040 pregnant women in their first trimester and assessed the maternal iodine status and their child's IQ at age eight years and reading ability at age nine years. This study showed that children of women with lower iodine levels were more likely to have scores in the lowest quartile for verbal IQ, reading accuracy and reading comprehension. The lower the iodine levels the lower the scores.[2] This shows that iodine plays a crucial role in brain and neurological development, particularly during gestation, and it is vital that this is supplemented during pregnancy.

MEASURING IODINE

It is extremely difficult to accurately measure the amount of iodine in foods using dietary analysis, as the exact composition in food is uncertain and would vary greatly across the country. It is

Table 4: Recommended daily and annual iodine supplementation (WHO, 2007)

Population group	Daily dose of iodine supplement (µg/d)	Single annual dose of iodized oil supplement (mg/y)
Pregnant women	250	400
Lactating women	250	400
Women of reproductive age (15–49 y)	150	400
Children < 2 years[a,b]	90	200

[a] for children 0–6 months of age, iodine supplementation should be given through breast milk. this implies that the child is exclusively breastfed and that the lactating mother received iodine supplementation as indicated above.
[b] these figures for iodine supplements are given in situations where complementary food fortified with iodine is not available, in which case iodine supplementation is required for children of 7–24 months of age.

also very difficult to accurately measure iodine in an individual. Measuring the Urinary Iodine Excretion (UIE) over 24 hours is the reference standard for assessing iodine deficiency in a population.

This, however, is very timely and impractical particularly in a clinic setting. Compliance from the individual is also often poor; therefore, a single non fasting casual urine sample is most often done. Unfortunately, the UIE can vary according to recent iodine intakes, so isn't a true reflection of a deficiency. It is also influenced by age, gender, ethnicity and geographical location.[6]

CASE REVIEWS

We are presented with a very real risk of iodine deficiency within our population. Within our tertiary allergy service, we have had three cases of goitre linked with iodine deficiency and, from investigating this further, it appears that Cheetham et al[8] published a case review in the BMJ on this exact issue, entitled: *Dietary restriction causing iodine-deficient goitre*. The case they present is of a four-year-old boy with mixed IgE and non-IgE mediated food allergies with symptoms of chronic urticaria, atopic dermatitis, asthma and seasonal allergic rhinitis. The boy follows a very restrictive diet avoiding dairy, wheat, egg, cod, fish, shellfish, peanuts and tree nuts. As with the cases I have experienced, the child in Cheetham's review has been following a restrictive diet since infancy. They become somewhat 'fearful' of trying these new foods even if the gold standard food challenges prove that tolerance and anxiety levels of the entire family are high, particularly around eating and mealtimes. All cases were resolved with adequate iodine supplementation. This, however, raises the question of could this have been prevented.

One case was breastfed until three years of age; mum was excluding dairy and, although informed about calcium and vitamin D supplementation, she never considered that iodine would also be required. Yet, we know from the NDNS[5] that one fifth of young females are already at risk of deficiency; then, to follow a restrictive diet during lactation only perpetuates this risk for mother and child, not only leading to symptoms such as goitre, but quite possibly affecting the brain development of the infant. Quite often these children become 'fussy' with eating and the idea of replacing this scary white liquid with an alternative becomes non-negotiable. It is useful to note that other than the well-known soya brand for one- year-olds, none of the alternative shop-bought milks are fortified with iodine.

IMPORTANT FACTORS TO CONSIDER

- With children on restrictive diets aim to normalise the diet as soon as possible. Often allergies are outgrown, but major food groups are never reintroduced fully back into the diet causing nutritional deficiencies.
- Prevent pregnant women/mothers/ teenage girls from avoiding important food groups un-necessarily, or ensure suitable supplementation of diet.
- Selenium and iodine work together in the thyroid – deficiency of selenium affects the utilisation of iodine; therefore, ensure that there are no other nutritional deficiencies.

- Severe iron deficiency if not treated affects the utilisation of iodine.
- Prevention rather than treatment for those on restrictive diets:
  - Suitable vitamin and mineral supplement containing iodine;
  - Encourage infant formula if age appropriate;
  - Full diet history from mum and child and monitoring;
  - Regular dietary input to help liberalise the diet as soon as possible.

SUMMARY

Iodine deficiency is on the rise and the government should be making it a public health priority. It certainly raises questions that deficiency can be linked with children's behaviour and intellectual progress, but also raises the risk of developing goitre.

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Questions relating to: *Iodine deficiency: the risk of restrictive diets* Type your answers below, download and save or print for your records, or print and complete by hand.	
Q.1	Why is iodine an essential mineral in the human diet?
A	
Q.2	What are the main dietary sources of iodine in the UK and why?
A	
Q.3	What factors contribute to the level of iodine found in dairy and milk products?
A	
Q.4	Explain the risks to health of iodine deficiency.
A	
Q.5	What are the difficulties in measuring iodine levels in individuals?
A	
Q.6	Explain how a restrictive diet can be problematic for those with food allergies.
A	
Q.7	Why can a restrictive diet place a young mum at greater risk of iodine deficiency?
A	
Q.8	What are the dietetic factors to consider with children on a restrictive diet?
A	
Q.9	Describe nutritional prevention methods for those on a restrictive diet.
Please type additional notes here . . .	