The Need for Iodine

An update on the UK situation

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The issue of iodine deficiency in the UK is complex and evolving. The headline data from the National Diet and Nutrition Survey (NDNS) shows that iodine status in children and adults is adequate. However, in women of childbearing age the status is at the bottom end of the adequate range and, more importantly, there is a growing body of evidence from sub-national data to show that iodine status is low in pregnant women in the UK. This is of concern as various studies have linked suboptimal iodine status in pregnancy to impaired neurodevelopment in children. Furthermore, it seems that pre-pregnancy iodine status is as important as iodine status in pregnancy and so the message should focus on adequate iodine intake in women of childbearing age.

In the UK, the recommendation for adults is 140 µg/day, with no increment for pregnant women or lactating women.[1] This contrasts with recommendations from others; for example, the World Health Organization (WHO) recommendation in pregnancy and lactation is for 250 µg/day,[2] while the European Food Safety Authority (EFSA) recommend 200 µg/day.[3]

What happens when intake of iodine is inadequate?

Although a lot of research focuses on pregnancy, iodine deficiency disorders can affect all life-stages. The only known role of iodine is to produce thyroid hormones, T4 and T3.[4] Goitre (the increase in thyroid size) can develop when iodine intake is very low (i.e. severe deficiency) over an extended period. Even in the absence of visible goitre, moderate iodine deficiency can lead to increased thyroid size and hyperstimulation of the thyroid to maintain adequate thyroid hormone production. Prolonged and severe deficiency of iodine can lead to impaired thyroid hormone production and eventually hypothyroidism. However, it is very important to point out that overt hypothyroidism has many different causes (e.g. autoimmune) and is not necessarily related to low iodine intake.

Women of childbearing age

It is increasingly evident that pre-pregnancy iodine status is important because iodine can be stored in the thyroid gland and used during pregnancy to maintain thyroid-hormone production. Recent evidence from the UK has shown a positive association between pre-pregnancy iodine status and offspring IQ.[5] Observational evidence from Italy suggests that a prolonged exposure to adequate iodine results in a better thyroid hormone profile during pregnancy than when supplements are started once pregnancy is confirmed.[6] Therefore, the public-health message should focus on the importance of iodine for all women of childbearing age, particularly those who are planning a pregnancy.

Pregnancy and lactation

Various aspects of brain development are controlled by thyroid hormones, which makes iodine important when the brain is developing most rapidly – i.e. pregnancy and infancy, or the first 1000 days of life.[7] Severe deficiency during pregnancy can lead to cretinism,[4] which includes symptoms of impaired brain development and problems with hearing and motor function.[4] However, thanks to global efforts to eradicate iodine deficiency, there is now more concern of the effects of mild-to-moderate deficiency in pregnancy on child cognition. Here the evidence is not as strong as in severe deficiency (as it is mostly observational evidence) but in the last decade numerous studies have pointed to a negative effect of mild-to-moderate iodine deficiency in pregnancy on child neurodevelopment.[8] In the UK, low iodine status in the first trimester has been linked to lower IQ and reading accuracy and comprehension in children aged 8-9 years.[9] Other studies link mild-to-moderate deficiency to poorer motor development,[10, 11] cognition,[11] language scores,[10] working memory,[12] spelling,[13, 14] writing,[15] and ADHD-symptom scores.[16] More research is required on the effects of moderate iodine deficiency in pregnancy, especially a randomised controlled trial with neurodevelopmental outcomes.

What happens when intake of iodine is excessive?

Excessive intake can lead to hypothyroidism and/or hyperthyroidism.[4] The Tolerable Upper Limit (TUL) is 600 µg/day for adults and pregnant women (lower limits for children).[4] However, these limits are a guide only as those with long-standing iodine deficiency may respond adversely to intakes below the TUL (abrupt increases in iodine intake should be avoided). Kelp supplements have a very variable iodine concentration and can lead to excess intake and therefore should be avoided, particularly in pregnancy.[17]

Iodine status in the UK

In 2009, a study of 14-15-year-old girls from nine areas of the UK found mild iodine deficiency (median 80 µg/L)[18] and prompted concern that deficiency may be more common than previously thought. In 2013, spot-urine samples began to be collected as part of the NDNS for the purposes of monitoring iodine status, therefore providing nationally representative data. The results are available for two years from the Rolling Programme (Year 6 and Year 7/8) and show iodine sufficiency in all age groups, as the median urinary iodine concentration value is above the cut-off of 100 µg/L.[19] **Figure 1** shows selected results from the NDNS data, focusing on children (boys and girls) and women (as an indicator of pre-pregnancy status). Although technically iodine sufficient, women of childbearing age in NDNS (defined as 16-49 years) have a median urinary iodine concentration of 102 µg/L, at the bottom of the adequate range (100-299 µg/L) but below the level of adequacy for pregnancy (150-249 µg/L; see **Figure 2**). This suggests that young women in the UK have borderline iodine sufficiency, and a proportion are likely to be deficient. Indeed, when examining the dietary data from the NDNS, 27% of girls 11-18 years have an iodine intake below the Lower Reference Nutrient Intake (LRNI).

For children aged 4-10 years, in the NDNS, the median (in Year 7/8) is more comfortably in the adequate range at 166 µg/L;[19] this may be explained by the higher intake of milk (the main dietary source) in children than in adults. We have also found iodine sufficiency (median urinary iodine concentration of 144 µg/L) in a pilot study of 8-10-year-old children from three regions of the UK.[20]

As the NDNS does not include pregnant women, assessment of iodine status in this vulnerable group is based on localised studies only. Data from nine areas of the UK all show that pregnant women have a urinary iodine concentration below the WHO cut-off for adequacy in pregnancy and are mildly-to-moderately iodine deficient (**Figure 2**).[22-24]

There are limited data on iodine status in lactation, but a small study in Scotland has found deficiency in this group.[29] Importantly, there are no UK data on iodine status in infants.

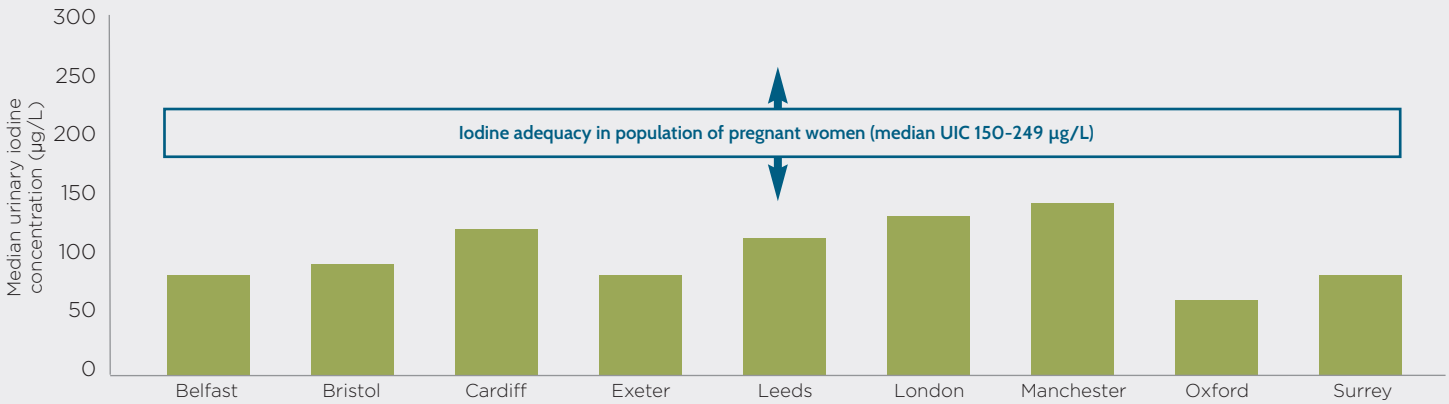
Figure 1: Median Urinary Iodine Concentration from Children and Women in NDNS

(from Year 6 and Year 7/8 of the Rolling Programme (2013/4 and 2014/15-2015/16)

The red line shows the threshold for iodine sufficiency according to World Health Organisation *et al.*[21]

Figure 2: Urinary Iodine Concentration from UK Studies of Pregnant Women

(from Belfast,[24] Bristol,[9] Cardiff,[25] Exeter,[26] Leeds, London and Manchester,[23] Oxford,[27] and Surrey[28])



The UK picture is therefore complex – there is not widespread iodine deficiency in all population groups but there is deficiency in pregnancy. The current methodology for monitoring populations (i.e. comparing the median to cut-offs) does not allow for calculation of the proportion of individuals who are deficient. In the UK, iodine intake and status is dependent on individual food choice as there is no national policy for iodine fortification, as is common in many countries.[30] Therefore, although the national picture may point to sufficiency in adults and children, this will not be the case for a proportion of individuals who do not consume iodine-rich foods; there are several groups who are at risk of iodine deficiency (see **Figure 3**).

Dietary sources

Salt in the UK is not iodised, unless specifically labelled as iodised salt (including sea/rock salt). Fish is a good source of iodine but the iodine content is variable – for example, salmon has a relatively low iodine concentration (~14 µg/100 g), while cod (~190 µg/100 g) and haddock have a high concentration (~325 µg/100 g).[31] Milk and dairy products are the main source of iodine in the UK diet, for all age groups, providing 33% of adult intake and 51% of 4-10-year-old intake of iodine.[19] A glass (200 ml) of cows' milk contains 50-100 µg (36-71% of the adult RNI); the wide range is because of seasonal variation – summer milk contains less iodine than winter milk as a result of farming practice.[31] Eggs are also a good source (two provide 1/3 of the adult recommendation).

There is currently no official advice for women in the UK to take an iodine supplement during pregnancy. If a supplement is considered (not kelp), this should ideally be started around three months before pregnancy to avoid an abrupt increase in iodine intake.

Groups at-risk of iodine deficiency (see Figure 3)

Most dietary sources of iodine are animal-based and therefore vegans and vegetarians are at risk (although vegetarians will be less at risk if consuming milk and eggs).[32, 33] With the rise in veganism, and movements such as Veganuary (following a vegan diet in January), more people may risk iodine deficiency unless awareness is raised. Iodine is often overlooked (unlike vitamin B12 and calcium) when diets are restricted,[34] and UK research has found poor knowledge of iodine sources and the importance of iodine.[35, 36]

For individuals who are not able to consume iodine-rich foods (or only in small quantities), a suitable iodine supplement may be required. It is not easy to buy iodine as a single-nutrient supplement but it is frequently sold as a kelp supplement, which is not recommended.[17] Instead, iodine should be in the form of potassium iodide/potassium iodate with a dose that is not more than 150 µg/day.

Assessing iodine status

There is no method for assessing iodine status in an individual. Although urinary iodine concentration is used at a population level, this is not suitable for individuals. This is because: 1) urinary iodine concentration is affected by urine dilution; 2) urinary iodine concentration reflects recent intake rather than usual diet; and 3) the WHO cut-offs have not been validated for use in individuals. The only way to determine likely risk of deficiency is to conduct a dietary assessment (i.e. referral to a dietitian).

Milk-alternatives and plant-based diets

As milk is an important dietary source of iodine in the UK, it is vital that iodine is considered when individuals use milk-alternatives. This is an increasing issue, as milk-alternative drinks are a popular choice, for various reasons. Furthermore, suggestions for moderate dairy product intake for environmental sustainability (e.g. EAT Lancet Commission on Food, Planet, Health[37] and the British Dietetic Association [BDA] One Blue Dot Toolkit[38]) may lead to more people choosing milk-alternative drinks, which could have a negative effect on iodine intake, unless the milk-alternative drinks are fortified with iodine.

The iodine content of milk-alternative drinks is very low – we found that unless milk-alternative drinks were fortified with iodine, they had an iodine concentration that was around 2% of that of cows' milk.[39] At the time of our study, just one company provided drinks with added iodine, but today a few more drinks are available on the UK market that are fortified with iodine. These fortified drinks contain between 13 and 30 µg iodine/100 ml, so a glass would provide 19-43% of the adult RNI. Most of the available milk-alternative drinks are still not iodine-fortified, but as this is a rapidly-changing situation, consumers need to check product labels (for the concentration and the form of iodine used for fortification – which should not be via seaweed).

Conclusion

Although adults and children in the UK are classified as iodine sufficient, a considerable proportion are at risk of deficiency. The issue is particularly problematic in pregnancy and greater awareness of the role of iodine and dietary sources is needed – both amongst the public and healthcare professionals. With increased use of milk-alternative drinks (unless fortified with iodine), and increased popularity of vegan/plant-based diets, there is potential for iodine status to worsen unless alternative sources are used. The BDA Iodine Food Fact sheet can be used for practical advice.[31]

Figure 3: Groups Likely to be At-risk of Iodine Deficiency

- Vegans
- Vegetarians
- Those with allergy/intolerance to dairy, fish or eggs
- Individuals who consume dairy, fish or eggs in small quantities.

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