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Costs and benefits of iodine  
supplementation for pregnant women in  
a mildly to moderately iodine-deficient  
population: a modelling analysis

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Mark Monahan

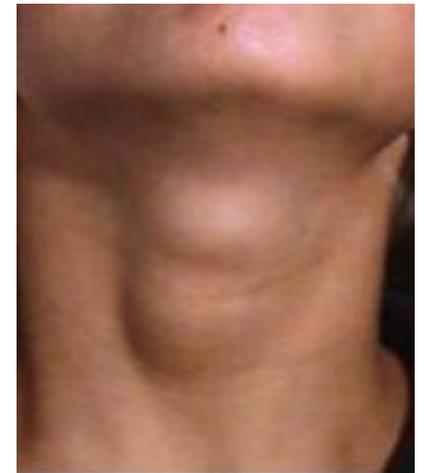
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# The Team

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# Iodine deficiency

- ❑ Major cause of goitre and hypothyroidism worldwide
- ❑ WHO identified in 7% of world's population
- ❑ Range from near 0% (Japan) to 80% (Andes, Zaire)
- ❑ Babies born with cretinism and low IQ
- ❑ Supplementation programmes



# Iodine status of UK

- UK cross-sectional study: 14-15 year old girls mildly iodine deficient (Vanderpump et al Lancet 2011;377:2007-2012)
- UK National Diet and Nutrition Surveys of Years 7 and 8 combined collected urinary iodine measurements of women of childbearing age (16 to 49 years)
  - Median urinary iodine concentration of 102 $\mu$ g/L
  - 17% of the population had values below 50 $\mu$ g/L
- While average values met the WHO criterion for adequate intake for the general population, they do not meet the criterion for iodine sufficiency in pregnant and lactating women (150-249 $\mu$ g/L)



# Iodine supplementation in pregnancy in mild/moderate iodine deficient populations

- Two controlled trials (Italy and Spain) reported higher development scores in infants of supplemented mothers but major issues in study design
- Non-significant lower developmental score in infants of women who took iodine containing multi-vitamins in pregnancy (Rebagliato et al. *Am J Epidemiol* 2013; 177: 944–53)
  - Developmental assessments at 16 months



# Case for an Randomised Control Trial

- RCT funded in Australia, but national recommendation to supplement in pregnancy - stopped
- RCT in Thailand and India – no difference in child cognitive outcomes – but mild iodine deficiency (UIC 100-150 $\mu$ g/L)
- We put proposal for trial of iodine supplementation in pregnancy with outcome of child IQ aged 3 years
  - Not funded
  - Positive about the economic model



# Stagnaro-Green (JAMA Dec 2012)

...However, a randomized placebo-controlled interventional trial in which some pregnant women do not receive iodine is unethical because increased iodine intake during pregnancy is already recommended by the WHO, ICCIDD, the ATA, the Endocrine Society, and the American Congress of Obstetricians and Gynecologists....



# Harms of iodine deficiency

- ❑ Iodine deficiency during pregnancy is linked to a permanent loss of IQ points of the unborn child (Taylor et al, Eur J Endocrinol 2013; 170: R1–R15 )
- ❑ Children of women who are mildly iodine deficient during their pregnancy had relatively lower IQ scores compared to children of iodine sufficient mothers (Bath et al Lancet 2013; 382: 331–17)
- ❑ Unclear whether iodine deficiency during pregnancy is associated with adverse pregnancy outcomes (Torlinska et al Nutrients 2018, 10, 291)
- ❑ Lower IQ has broad future economic societal costs



# Krakow Declaration on Iodine (18<sup>th</sup> April 2018)

## Widespread lack of iodine threatens brain development in children, scientists warn

**Scientists fear up to 50% of all new-borns in Europe do not reach their full cognitive potential due to iodine deficiency. Iodine is a micronutrient critical for children's brain development. Today with the Krakow Declaration on Iodine presented at the Jagiellonian University, scientists from the EU-funded project EUthyroid, supported by several stakeholder organisations, call on European policy-makers to support measures to eliminate iodine deficiency.**



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<https://www.iodinedeclaration.eu/declaration/>

# Iodine deficiency in the UK

- In recent years the UK is now believed to have become mildly iodine deficient
- No UK recommendations on iodine supplementation have been issued to pregnant women
- This research sought to highlight the large societal benefits of an iodine supplementation strategy



# The Economic model



- Weighed up the expected costs and benefits of iodine supplementation versus no iodine supplementation for pregnant women
- Conservative approach that limited the benefit of iodine supplementation and overestimated its potential harms
- Two separate analyses:
  1. Health service perspective that considered only health service costs
  2. Societal perspective that considered health service costs, education costs and the value of an IQ point



# Benefits of iodine supplementation

- Main benefit from iodine supplementation is preventing IQ loss for unborn infant
- A higher IQ for the unborn infants meant less children requiring neurodevelopmental impairment related health costs and special education costs
- The monetary value of an IQ point is identified in a literature review



# What is a IQ point worth?

- Literature review showed most of the studies valued IQ's effect on earnings
- Additional IQ point raises earnings by roughly 1%
- Monetary Value of an additional IQ point for the unborn infants cohort: £3,377
  - 1% of the projected future earnings of the unborn infants cohort in today's money



# Model assumptions

- Cost of the daily iodine supplementation similar to pregnancy multivitamin tablets
- Mother will be iodine sufficient with supplementation
- Iodine tablets will only benefit women who were iodine deficient
- IQ gains for the infants dependent on the severity of iodine deficiency
  - Mild to moderate iodine deficient: 2.20 IQ points
  - Severe iodine deficient: 3 IQ points

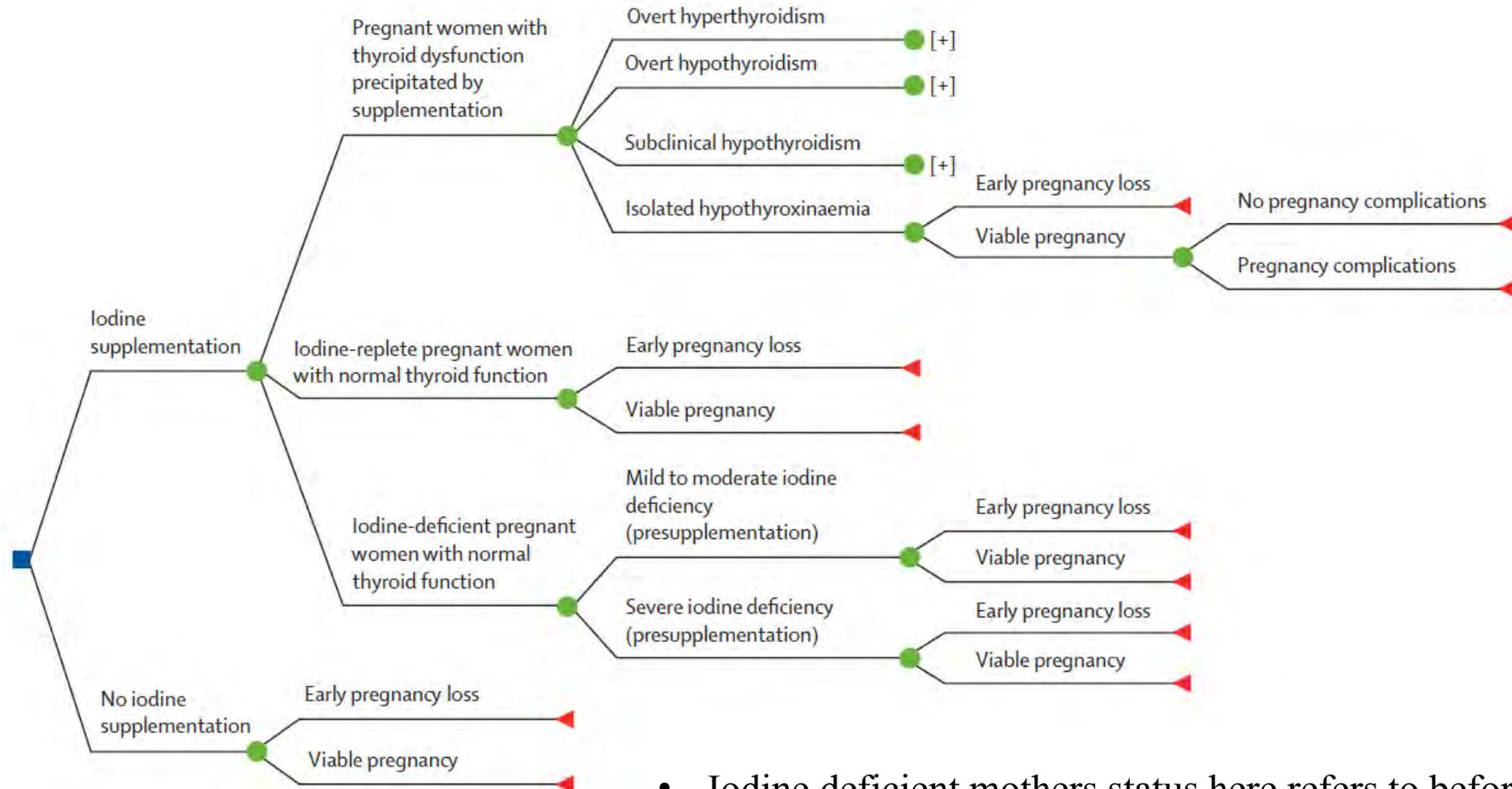


# “Harms” of iodine supplementation

- Model assumes hypothetical 0.25% of pregnant women suffer adverse thyroid dysfunction linked to iodine supplementation
  - Overt Hyperthyroidism, Overt Hypothyroidism, Subclinical Hypothyroidism, and Isolated Hypothyroxinemia
- Children of these women with adverse thyroid dysfunction did not have an increase in IQ after supplementation
- Children of women with overt and subclinical hypothyroidism, and isolated hypothyroxinemia during pregnancy are assumed to suffer from IQ loss (7 points)



# Economic model structure



- Iodine deficient mothers status here refers to before supplementation
- The model is identical at every node ending with [+]



# Pregnancy complications

- Model considered pre-eclampsia, preterm birth, and late pregnancy loss/stillbirth
- Pregnant women with thyroid dysfunction linked to iodine supplementation were given a higher incidence of pregnancy complications
  - Used highest incidence of pregnancy complications and conservative assumptions to overestimate adverse outcomes arising from supplementation



# What were our findings?

- Iodine supplementation overall increased the child's IQ by 1.22 points, saved the UK NHS £199 and society £4476 per pregnant woman
  
- Additionally, we changed some of model inputs to see if it would impact the results



# Sensitivity analysis scenarios

- Reducing the IQ gains from iodine supplementation
- Reducing the numbers of mothers with iodine deficiency
- Reducing the monetary value of an IQ point
- Doubling the pregnancy loss rate
- Doubling the discount rate of future cost savings
- Reducing the health cost savings



# Discussion: Model assumptions



- Cards were stacked against iodine supplementation
- Results were robust to sensitivity analyses
- Monetary value of an IQ point is an underestimate



# Summary

- Pregnant women in UK are likely mildly-moderately iodine deficient
- Iodine supplementation strategy is cost-effective
- Uncertainties remain regarding effects of iodine deficiency on obstetric outcomes
- Further studies are needed



# Costs and benefits of iodine supplementation for pregnant women in a mildly to moderately iodine-deficient population: a modelling analysis



Mark Monahan, Kristien Boelaert, Kate Jolly, Shiao Chan, Pelham Barton, Tracy E Roberts

## Summary

**Background** Results from previous studies show that the cognitive ability of offspring might be irreversibly damaged as a result of their mother's mild iodine deficiency during pregnancy. A reduced intelligence quotient (IQ) score has broad economic and societal cost implications because intelligence affects wellbeing, income, and education outcomes. Although pregnancy and lactation lead to increased iodine needs, no UK recommendations for iodine supplementation have been issued to pregnant women. We aimed to investigate the cost-effectiveness of iodine supplementation versus no supplementation for pregnant women in a mildly to moderately iodine-deficient population for which a population-based iodine supplementation programme—for example, universal salt iodisation—did not exist.

**Methods** We systematically searched MEDLINE, Embase, EconLit, and NHS EED for economic studies that linked IQ and income published in all languages until Aug 21, 2014. We took clinical data relating to iodine deficiency in pregnant women and the effect on IQ in their children aged 8–9 years from primary research. A decision tree was developed to compare the treatment strategies of iodine supplementation in tablet form with no iodine supplementation for pregnant women in the UK. Analyses were done from a health service perspective (analysis 1; taking direct health service costs into account) and societal perspective (analysis 2; taking education costs and the value of an IQ point itself into account), and presented in terms of cost (in sterling, relevant to 2013) per IQ point gained in the offspring. We made data-supported assumptions to complete these analyses, but used a conservative approach that limited the benefits of iodine supplementation and overestimated its potential harms.

**Findings** Our systematic search identified 1361 published articles, of which eight were assessed to calculate the monetary value of an IQ point. A discounted lifetime value of an additional IQ point based on earnings was estimated to be £3297 (study estimates range from £1319 to £11967) for the offspring cohort. Iodine supplementation was cost saving from both a health service perspective (saving £199 per pregnant woman [sensitivity analysis range –£42 to £229]) and societal perspective (saving £4476 per pregnant woman [sensitivity analysis range £540 to £4495]), with a net gain of 1.22 IQ points in each analysis. Base case results were robust to sensitivity analyses.

**Interpretation** Iodine supplementation for pregnant women in the UK is potentially cost saving. This finding also has implications for the 1.88 billion people in the 32 countries with iodine deficiency worldwide. Valuation of IQ points should consider non-earnings benefits—eg, health benefits associated with a higher IQ not germane to earnings.

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