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Iodine in Pregnancy and Lactation

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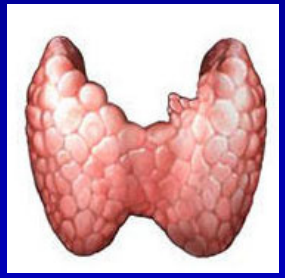
EXCEPTIONAL CARE. WITHOUT EXCEPTION.

Overview

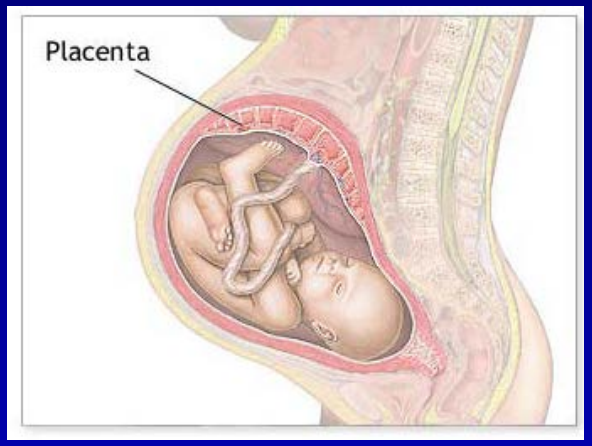
- Dietary iodine requirements & status assessment
- Consequences of iodine deficiency
- Consequences of iodine excess
- Current U.S. iodine nutrition status
- Sources of dietary Iodine
- Supplement recommendations



Increased demand for thyroid hormone (↑ 50%), requires an additional 50-100 µg iodine:
- Thyrotropic regulation by hCG
- Estrogen-mediated TBG increase

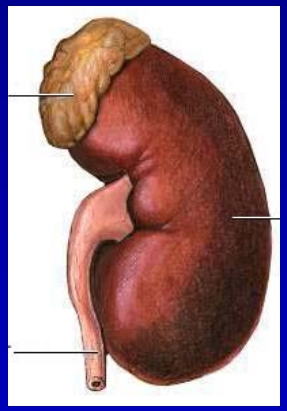
Increased Maternal Dietary Iodine Requirements in Pregnancy

Placental Type 3 deiodinase



Iodide transferred to the fetus

Increased renal iodine clearance (↑ 30-50%)



Increased Dietary Iodine Requirements in Lactation

- Normal lactating breast ducts concentrate iodide (via sodium iodide symporter), secreting it into milk

  Tazebay et al *Nat Med* 2000; 6:859-60

- Only source of iodine nutrition for breastfed infants

Recommended Daily Dietary Iodine Intakes

U.S. Institute of Medicine		WHO, UNICEF, ICCIDD	
	µg/day		µg/day
0-6 months (AI)	110	0-5 years	90
7-12 months (AI)	130		
1-8 years	90		
9-13 years	120	6-12 years	120
>13 years	150	>12 years	150
Pregnancy	220	Pregnancy	250
Lactation	290	Lactation	250

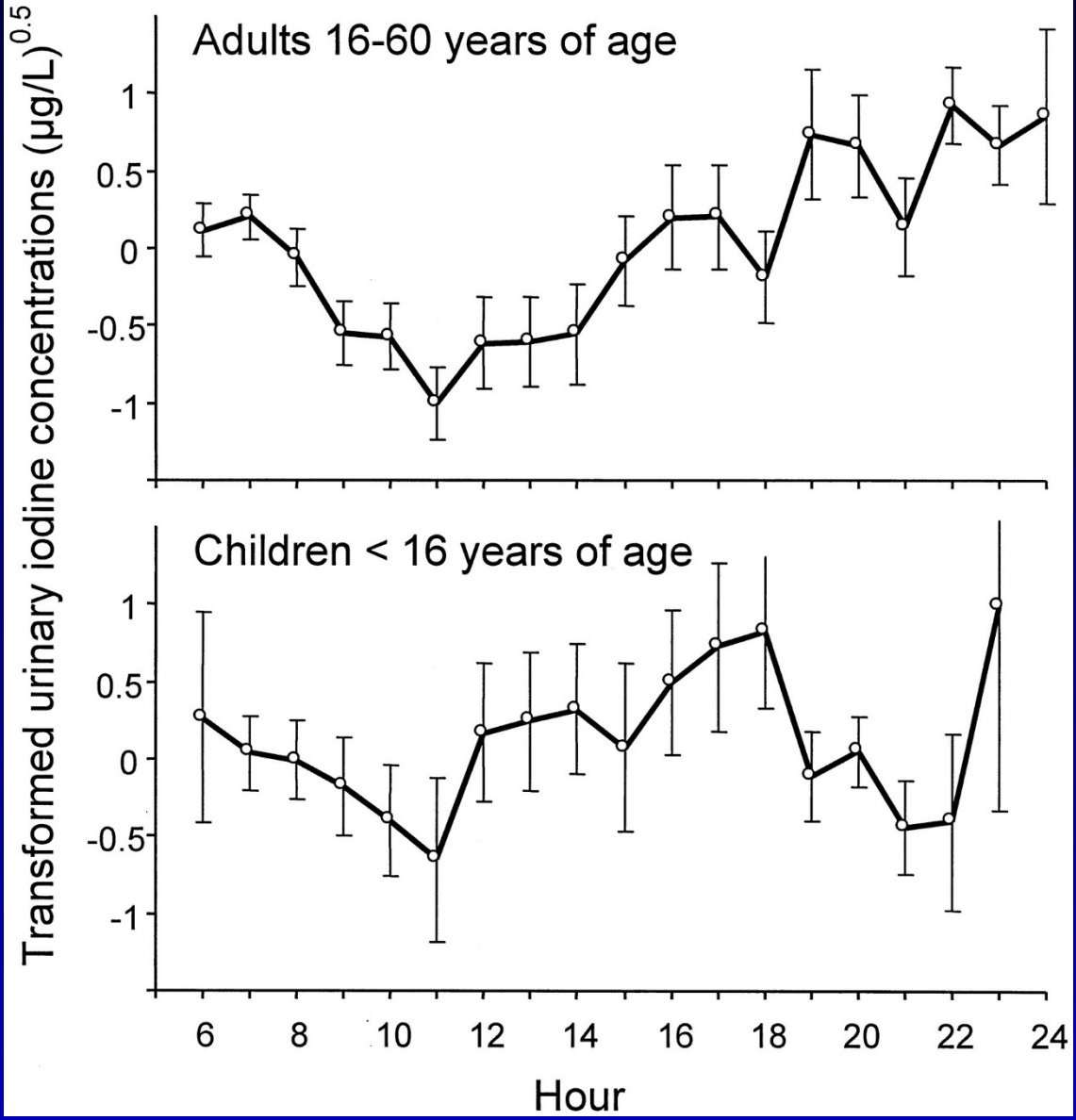
- U.S. Institute of Medicine 2006
- WHO, UNICEF, ICCIDD 2007

Urinary Iodine Values and Iodine Nutrition in Pregnancy and Lactation

Population group	Median Urinary Iodine Concentration (µg/L)	
	Optimal	Excessive
Non-pregnant adults	100-199	>299
Pregnant Women	150-249	≥500
Lactating Women	≥100	

WHO *Public Health Nutr* 2007

Diurnal Urinary Iodine Concentration Variation



Als C et al *J Clin Endocrinol Metab* 2000;85:1367-9

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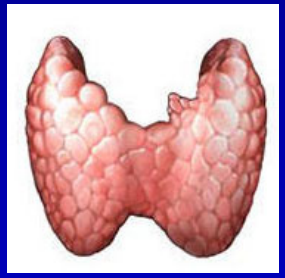
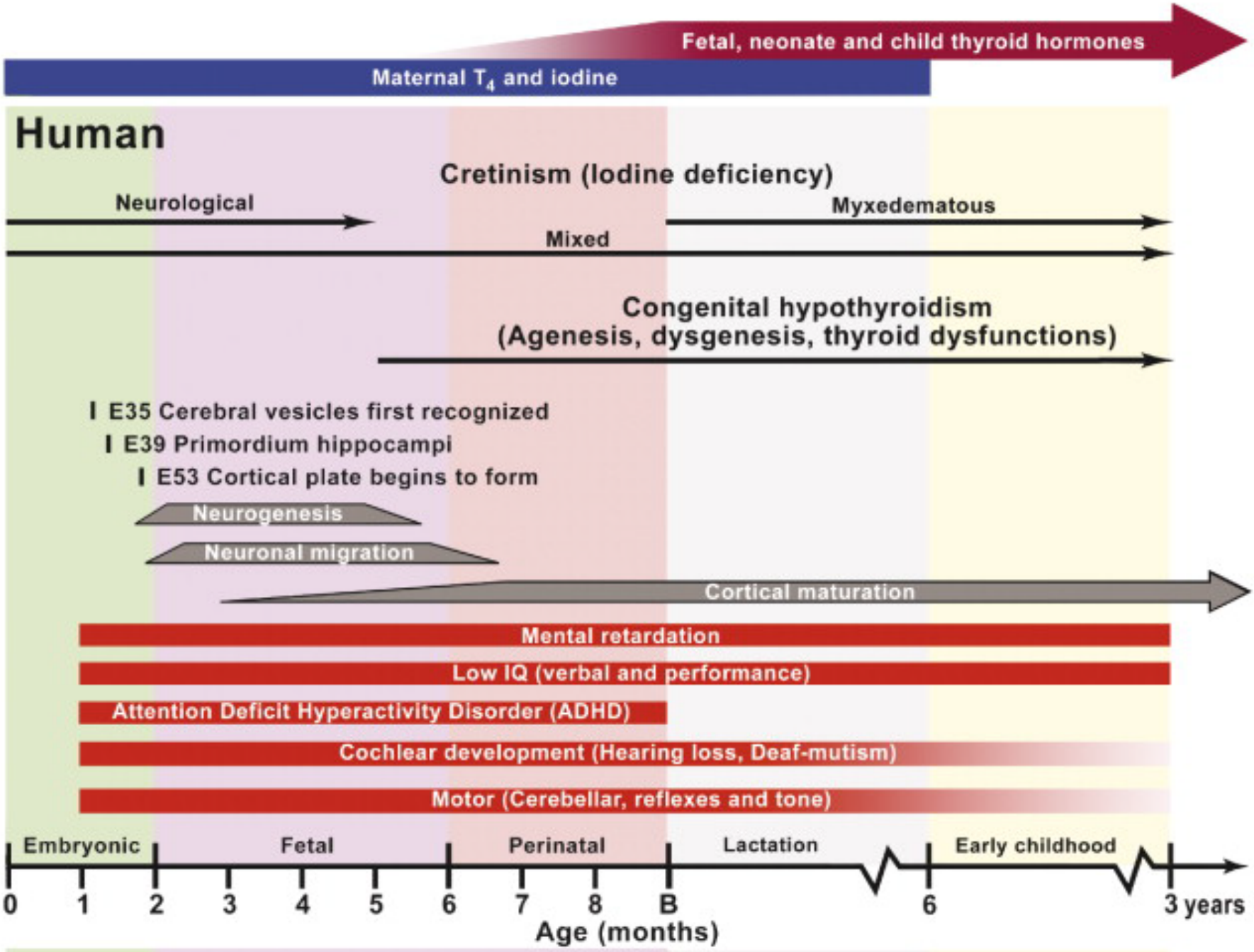


Spectrum of IDD

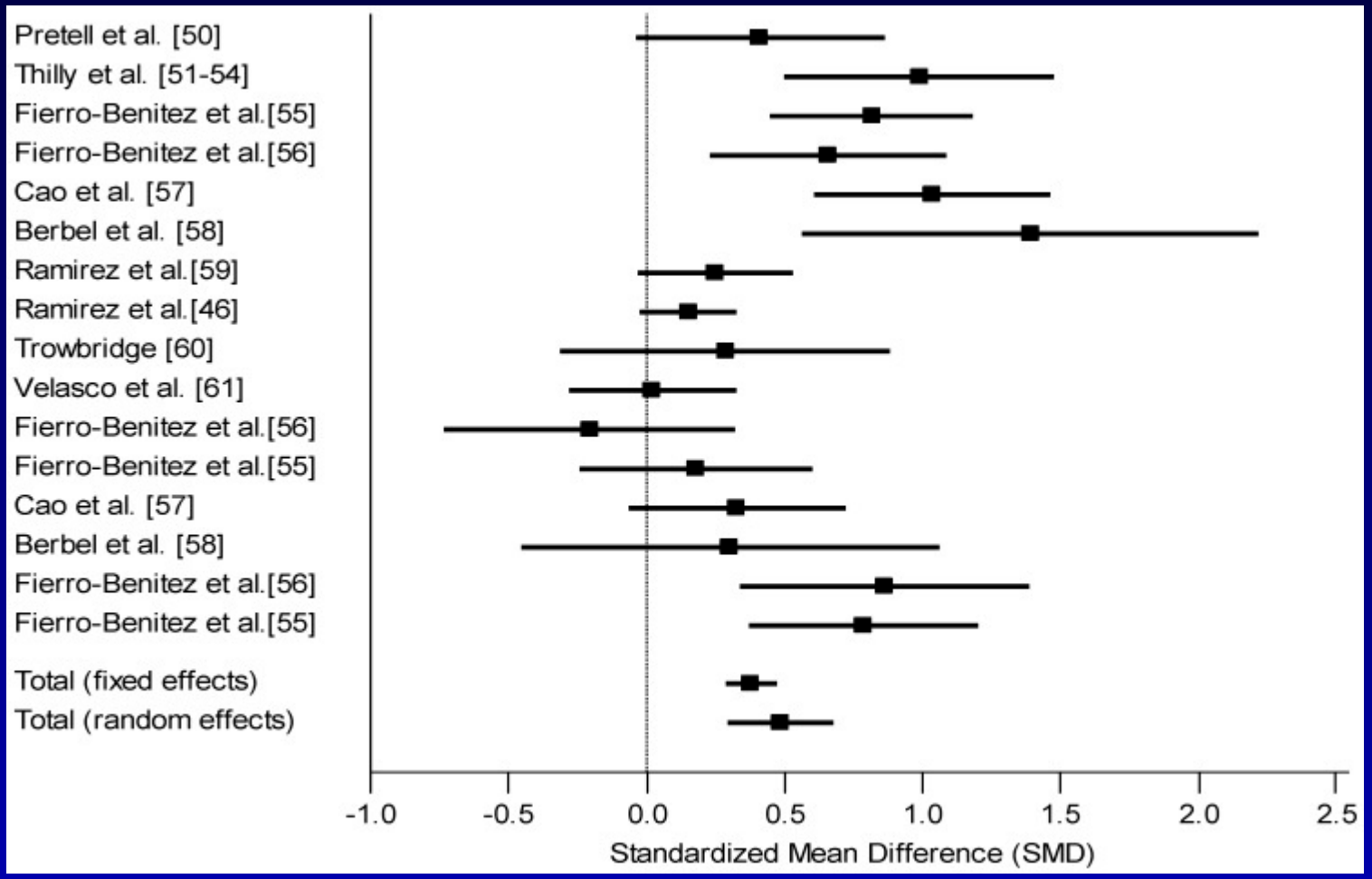
FETUS	Abortions Stillbirths Congenital anomalies Increased perinatal mortality Increased infant mortality Neurological cretinism: *mental deficiency, deaf mutism,* *spastic Diplegia squint* Myxoedematous cretinism: *mental deficiency, dwarfism, hypothyroidism* Psychomotor defects
NEONATE	Neonatal hypothyroidism
CHILD & ADOLESCENT	Retarded mental and physical development
ADULT	Goitre and its complications Iodine-induced hyperthyroidism (IIH)
ALL AGES	Goitre Hypothyroidism Impaired mental function Increased susceptibility to nuclear radiation

ICCIDD/UNICEF/WHO



Berbel et al. *Trends Endocrinol Metab* 2007;18:338-43

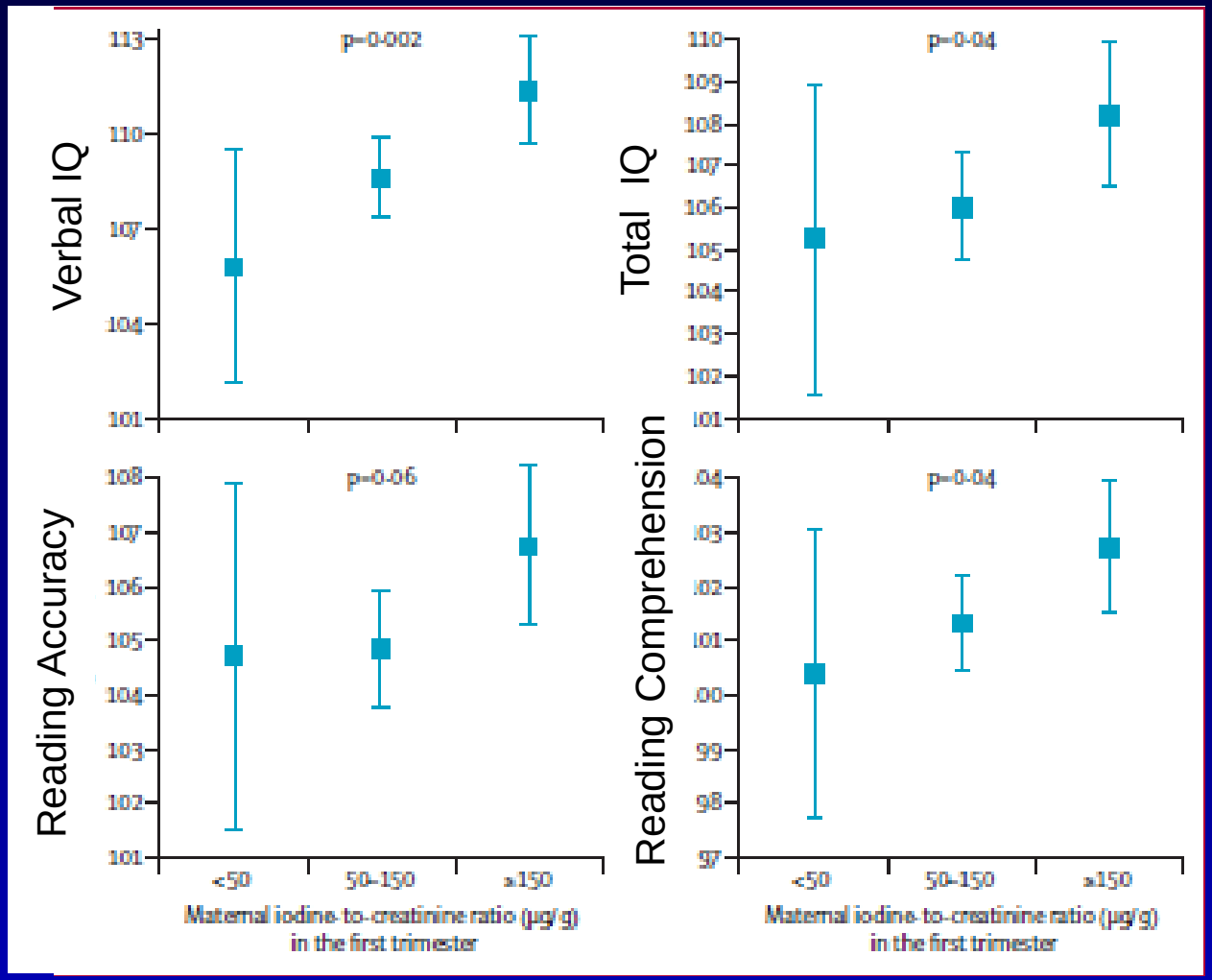
Maternal Iodine Supplementation and Child IQ Difference



7.4 point IQ difference in supplemented vs. unsupplemented groups

K Bougma et al. *Nutrients* 2013;5:1384-416.

Child IQ in Relation to First-Trimester Maternal Urinary Iodine: ALSPAC



SC Bath et al. *Lancet* 2013;382(9889):331-7.

Maternal Iodine and Child Neurodevelopment: Cohort Studies

- Maternal UIC <150 µg/L associated with lower child spelling, grammar, reading age 9
- Lower maternal iodine intakes associated with child language delays age 3, ADHD symptoms age 8
- Low maternal UIC associated with poorer receptive/expressive language age 6, 12, 18 months

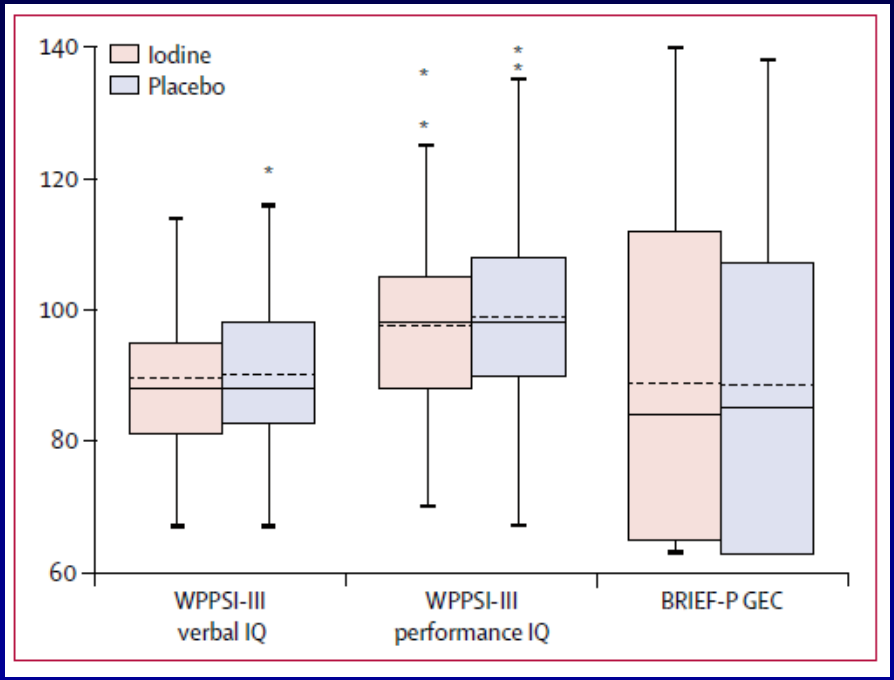
KL Hynes et al. *J Clin Endocrinol Metab* 2013;98:1954-62
Abel MH et al. *J Nutr* 2017;147(7):1314-1324
Abel MH, et al. *Nutrients* 2017;9(11)
Markhus MW et al. *Nutrients* 2018;10(9)

Iodine supplementation in Mild-to-Moderate Iodine Deficiency: Systematic Review

- Controlled trials assessing child neurodevelopment are lacking
- Gestational iodine supplements reduced maternal thyroid volume and, in some studies, improved thyroid function

Taylor PN et al. *Eur J Endocrinol* 2014;170:R1-15

RCT: Effect of Iodine Supplementation in Pregnancy on Child Neurodevelopment



Neurodevelopmental outcomes age 5-6

- Bangalore, India and Bangkok, Thailand
- n=832; mean 10.7 weeks gestation at baseline
- Baseline MUIC 132 µg/L
- 200 µg I/day vs. placebo

Gowachirapant S. et al. *Lancet Diabetes Endocrinol.* 2017;5(11):853-863

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

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 £11 967) 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.

Lancet Diabetes Endocrinol 2015;3(9):715-22

Overview

- Dietary iodine requirements & status assessment
- Consequences of iodine deficiency
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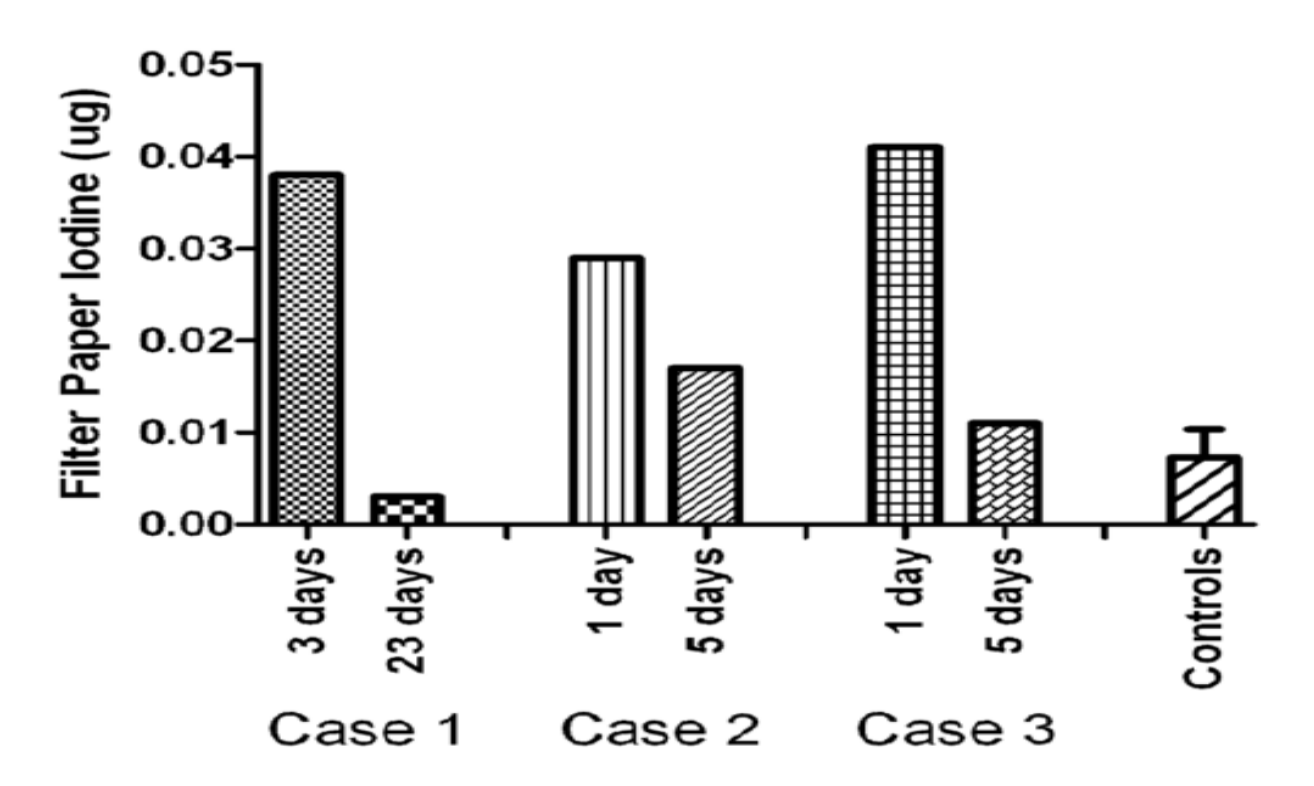
Iodine-Induced Hypothyroidism

- Failure of homeostatic mechanism (escape from the Wolff-Chaikoff effect)
- Susceptible individuals
  - Thyroid autoimmunity
  - Fetus

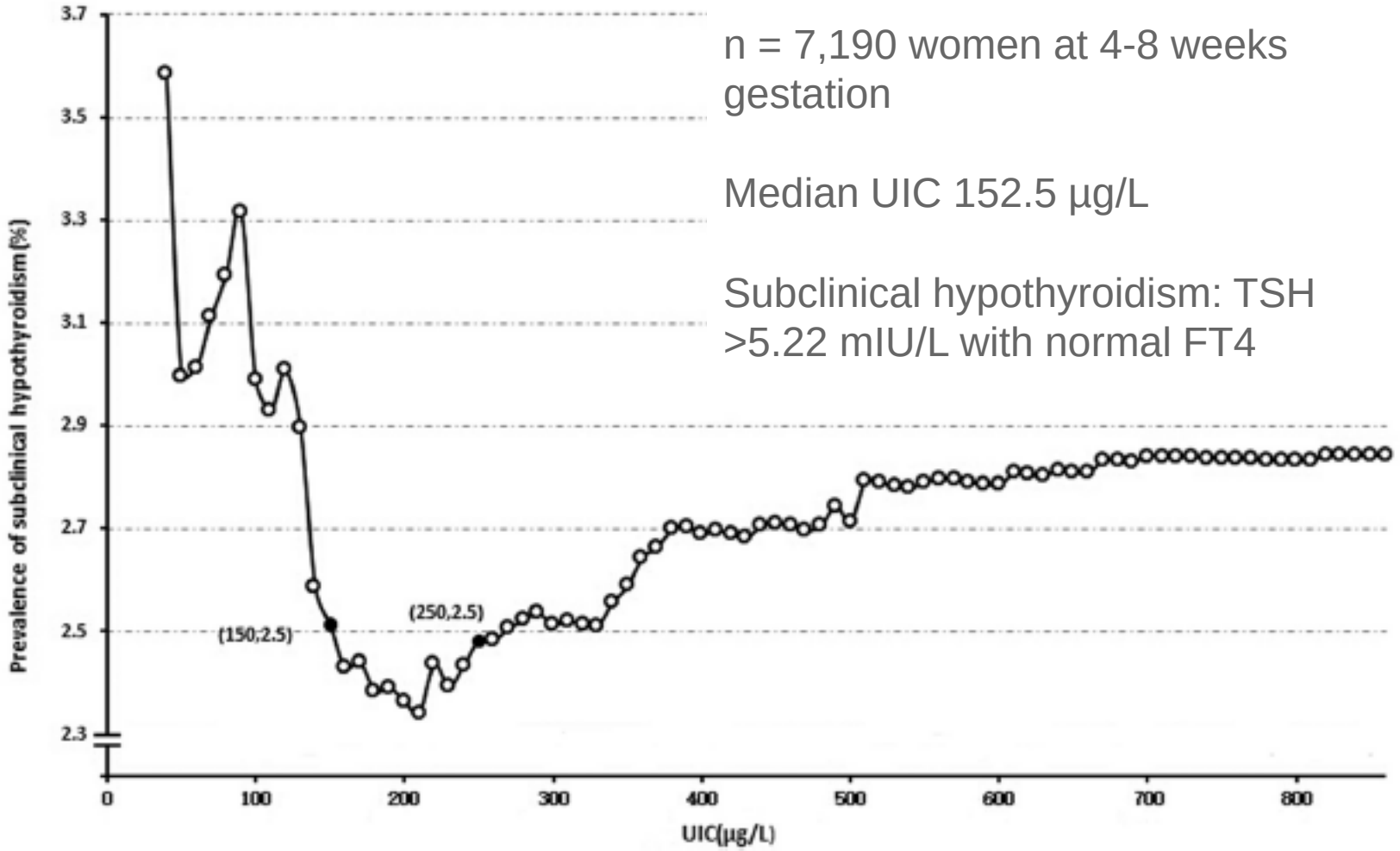
Congenital Hypothyroidism From Excess Prenatal Maternal Iodine Ingestion



TSH: >100 419 217

Connelly KJ et al. *J Pediatr* 2012;161:760-2

Subclinical Hypothyroidism And UIC In Pregnant Women



n = 7,190 women at 4-8 weeks gestation

Median UIC 152.5 μg/L

Subclinical hypothyroidism: TSH >5.22 mIU/L with normal FT4

X Shi et al. *J Clin Endocrinol Metab* 2015;100:1630-8

Tolerable Upper Limits for Iodine Exposure

U.S. Institute of Medicine		WHO, UNICEF, ICCIDD	
	µg/day		µg/day
0-12 months	unknown	Infants	180
1-3 years	200	Pregnancy	500
4-8 years	300	Lactation	500
9-13 years	600		
14-18 years	900		
19-50 years	1,100		

- U.S. Institute of Medicine 2006
- WHO, UNICEF, ICCIDD 2007

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- Assessment of iodine sufficiency
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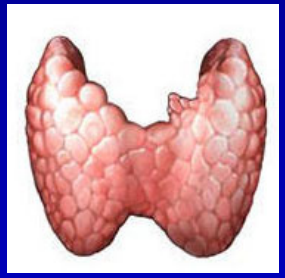
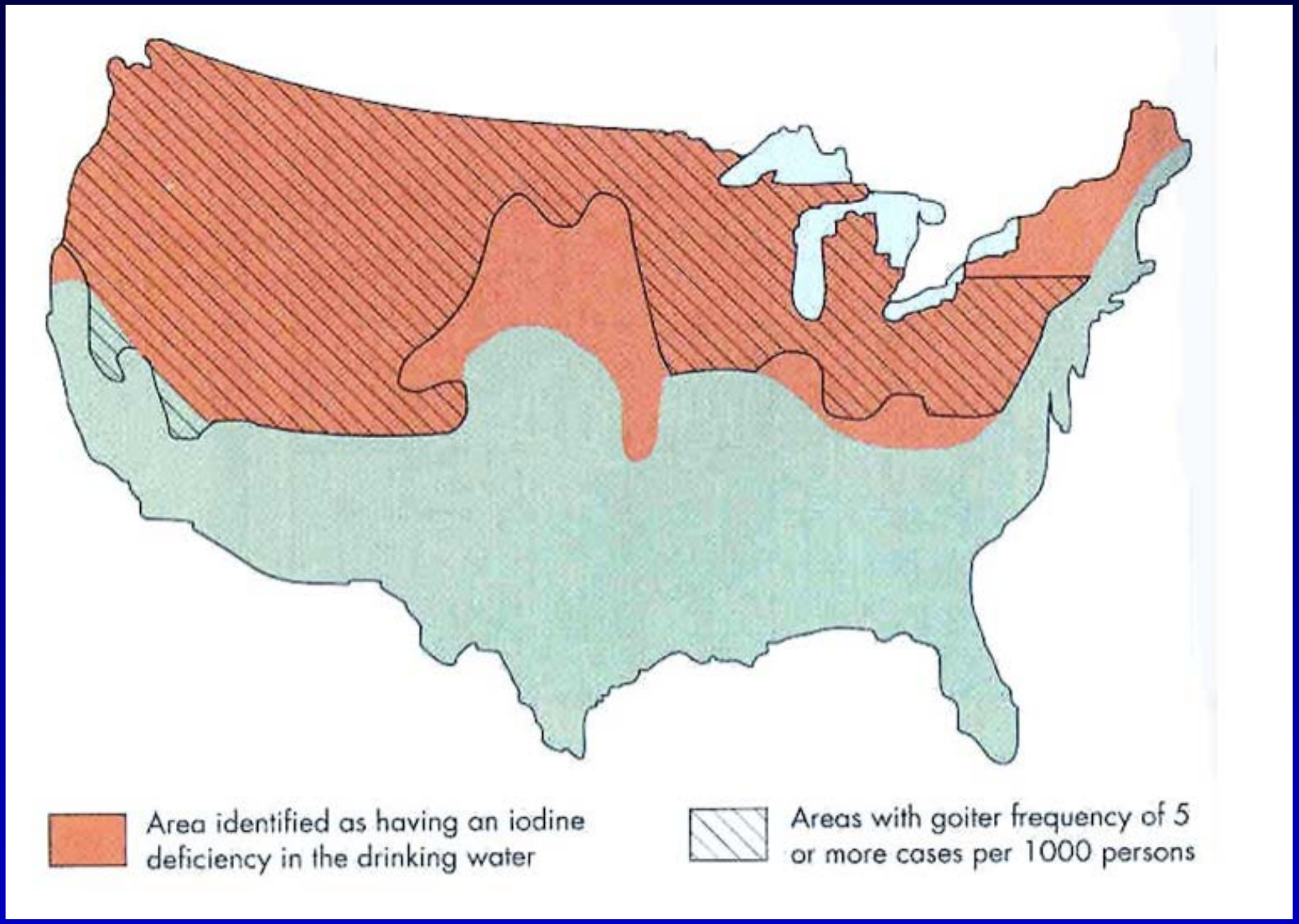
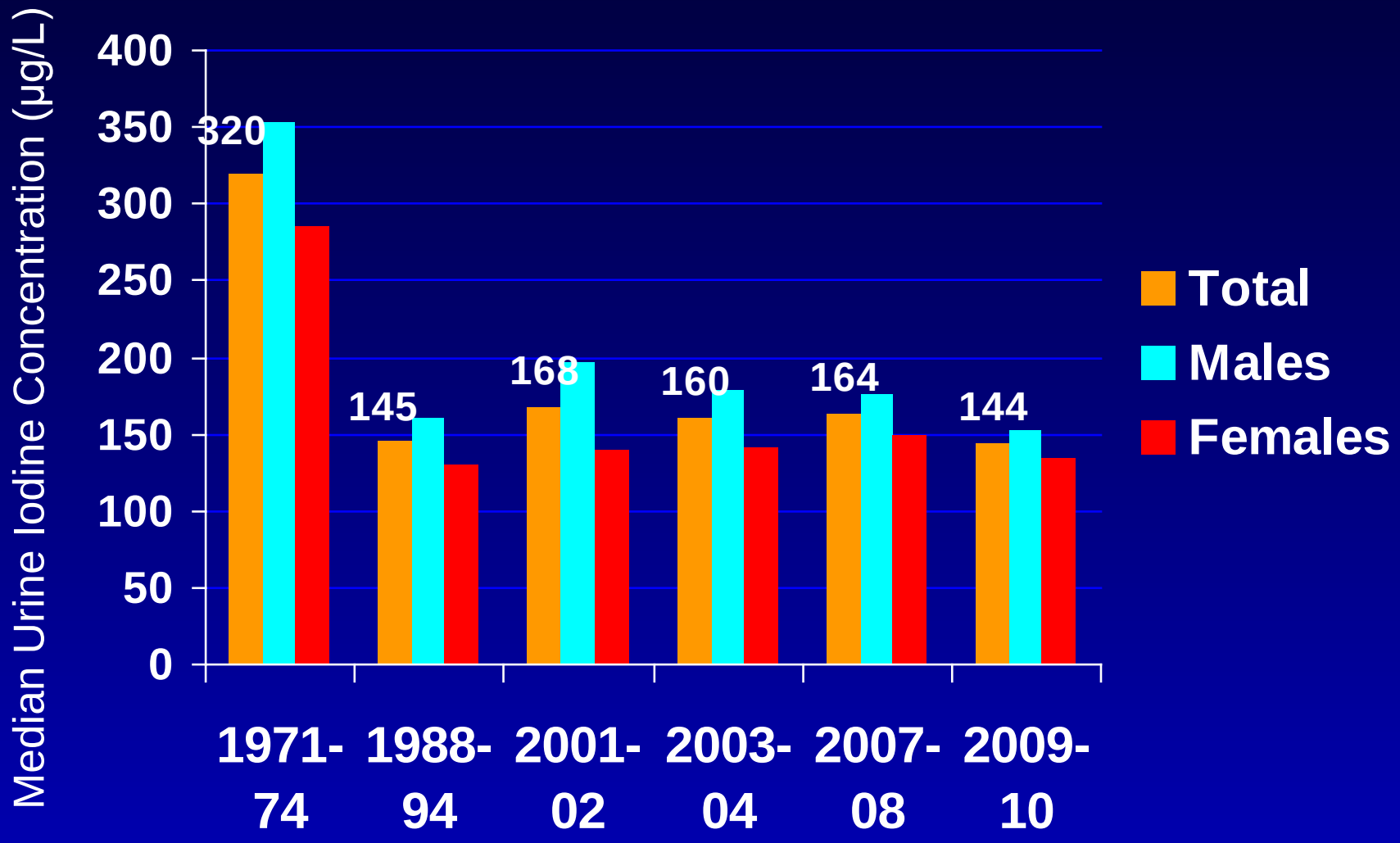


U.S. Goiter Belt (pre-1920s)

– 26 - 70% of children had goiter

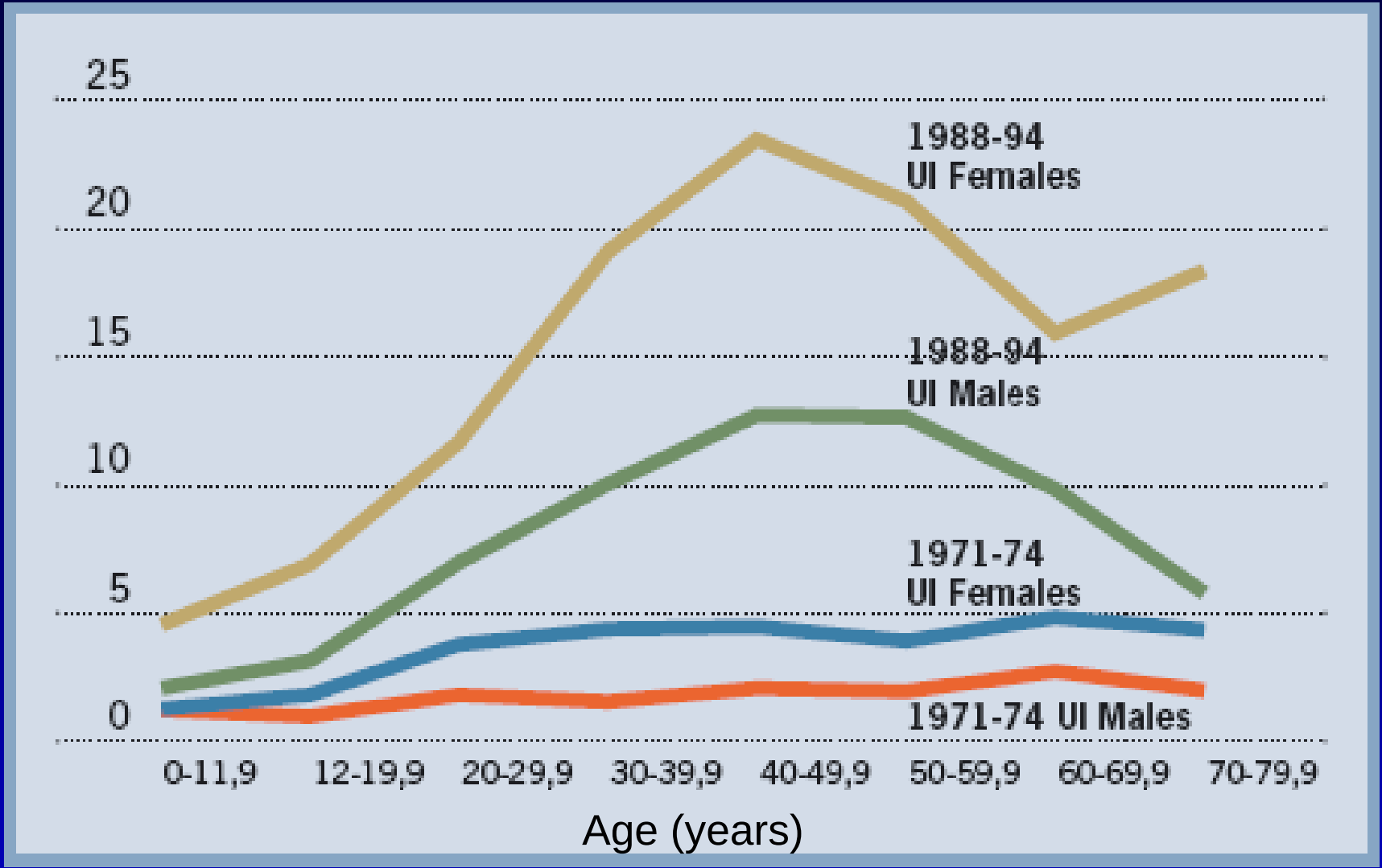


Median U.S. Urinary Iodine Concentration NHANES 1971-2004



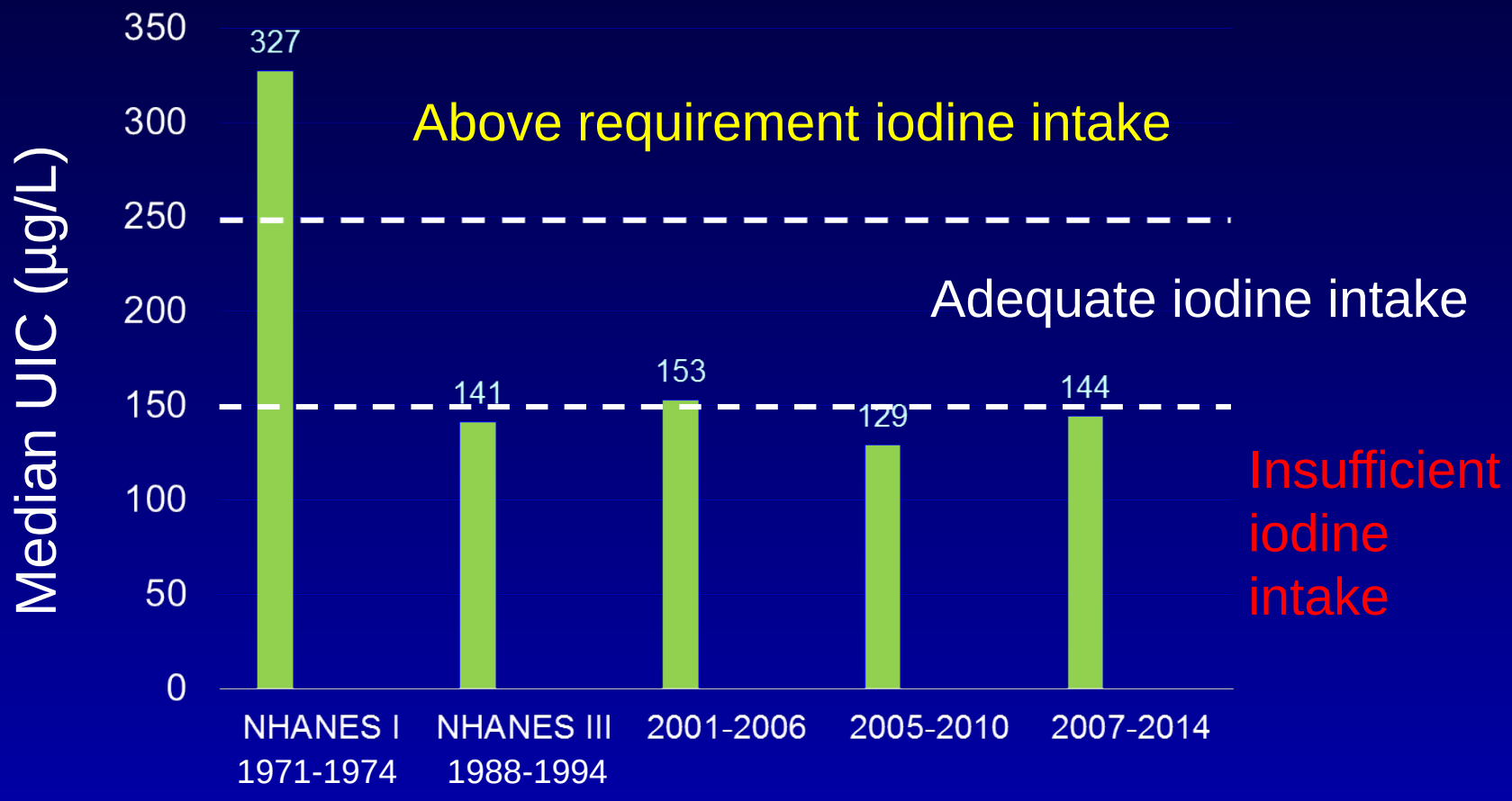
Hollowell et al. *JCEM* 1998; 83:3401-8; Caldwell et al. *Thyroid* 2005;15:692-9; Caldwell et al. *Thyroid* 2008;18:1207-14; Caldwell et al. *Thyroid* 2011;21:419-27; Caldwell et al, *Thyroid* 2013; 23:927-37

% of U.S. Population with Urinary Iodine <50µg/L: NHANES I and NHANES III



Hollowell, *JCEM* 1998; 83:3401-8

Median UIC In Pregnant US Women



Hollowell JG et al. *J Clin Endocrinol Metab*1998; 83:3401-8
Perrine CG et al. *Thyroid* 2019;29(1):153-154

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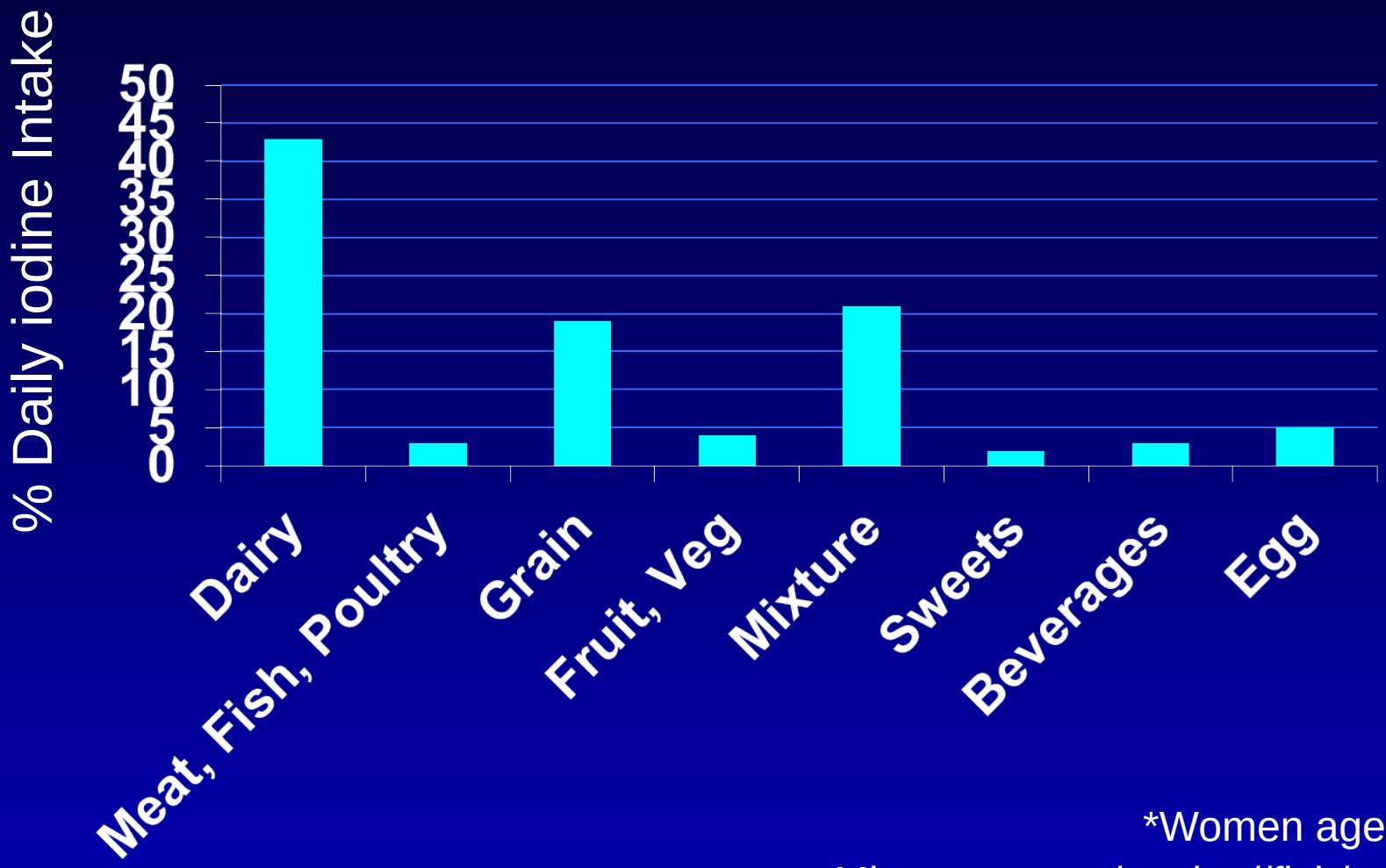
Median Iodine Content of Adult* Diets 2008-2012 FDA Total Diet Study

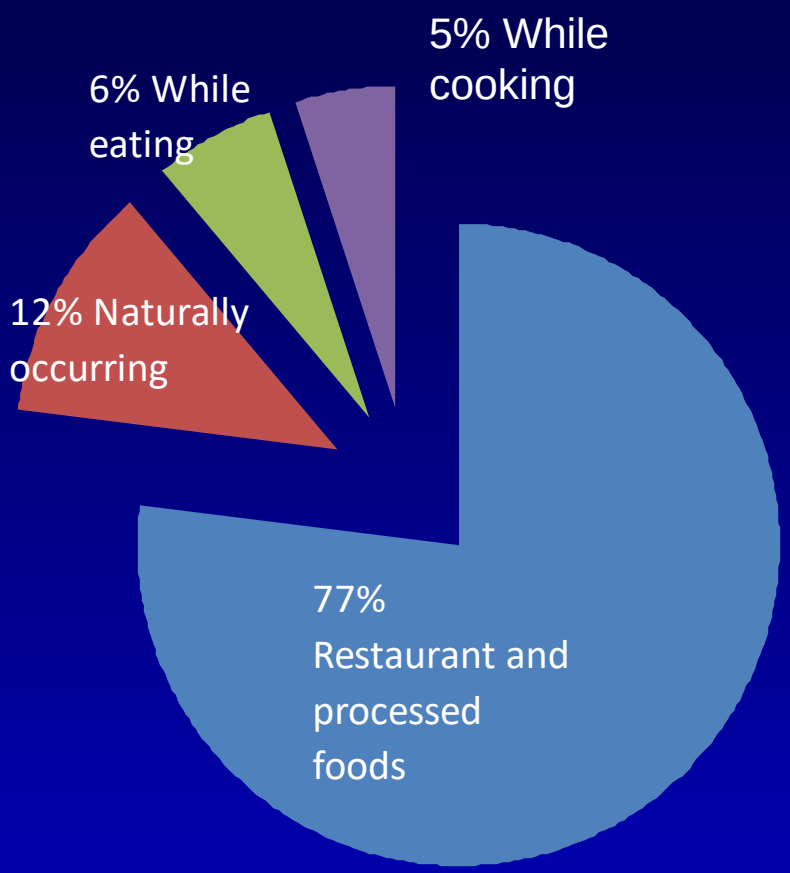


*Women age 25-30

Mixtures: meat/poultry//fish/grain/veg

E Abt et al. *J Expo Sci Environmen Epidemiol* 2018;28:21-30

Salt in the U.S. diet



- ~77% of salt in U.S diet from restaurant/processed food, usually not iodized
- ~11% table salt added at the table or in cooking, 53% of table salt in U.S. is iodized at 60-100 ppm
- ~50% of reproductive age women never/rarely use table salt

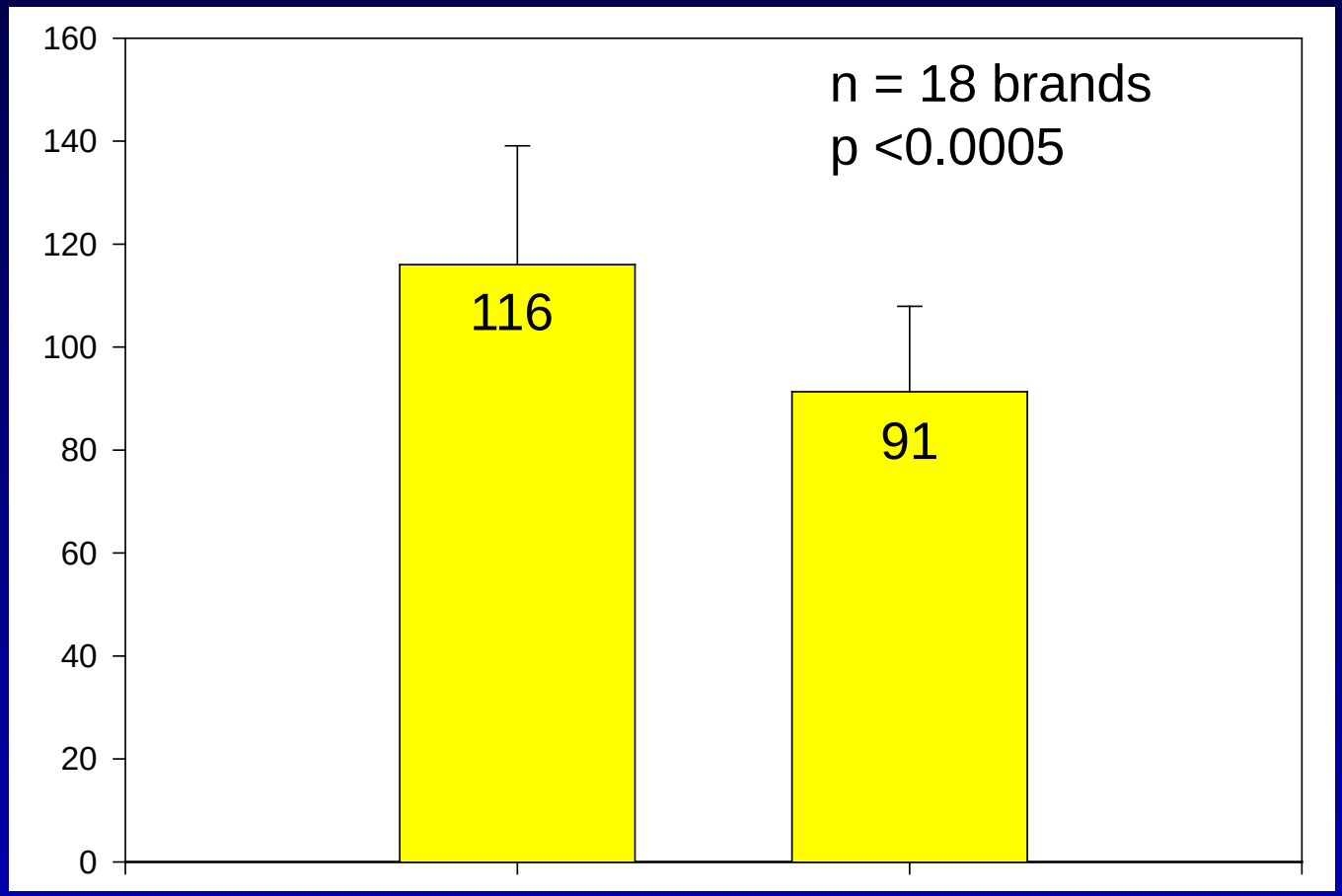
Mattes & Donnelly. *J Am Coll Nutr* 1991;10(4):383-93.
Maalouf J et al. *Nutrients* 2015;1691-5

Bread Iodine Content

- Iodate dough conditioners used starting 1940s. Use ↓ 1970s-1990s.
- Boston-area supermarkets 2001-2002:
  - 20 brands measured
  - 3 breads >313 µg I/slice
  - Others 2.2-54 µg I/slice (mean 10 µg/slice)

Pearce et al *J Clin Endocrinol Metab* 2004; 89:3421-4

Mean Iodine Content of New England Cows' Milk by Season



Pearce et al *J Clin Endocrinol Metab* 2004; 89:3421-4

Iodine Sources in U.S. Cows' Milk

- Cattle feed
  - Cows' milk iodine content increased 300-500% 1965-1980 due to increased I in cattle feed
  - Organic iodine ethylenediamine dihydroiodine (EDDI) content of cattle feed limited 1986 to 10mg/cow/day
- Iodophor disinfectant in teat dip/udder wash
  - Up to 1% available iodine

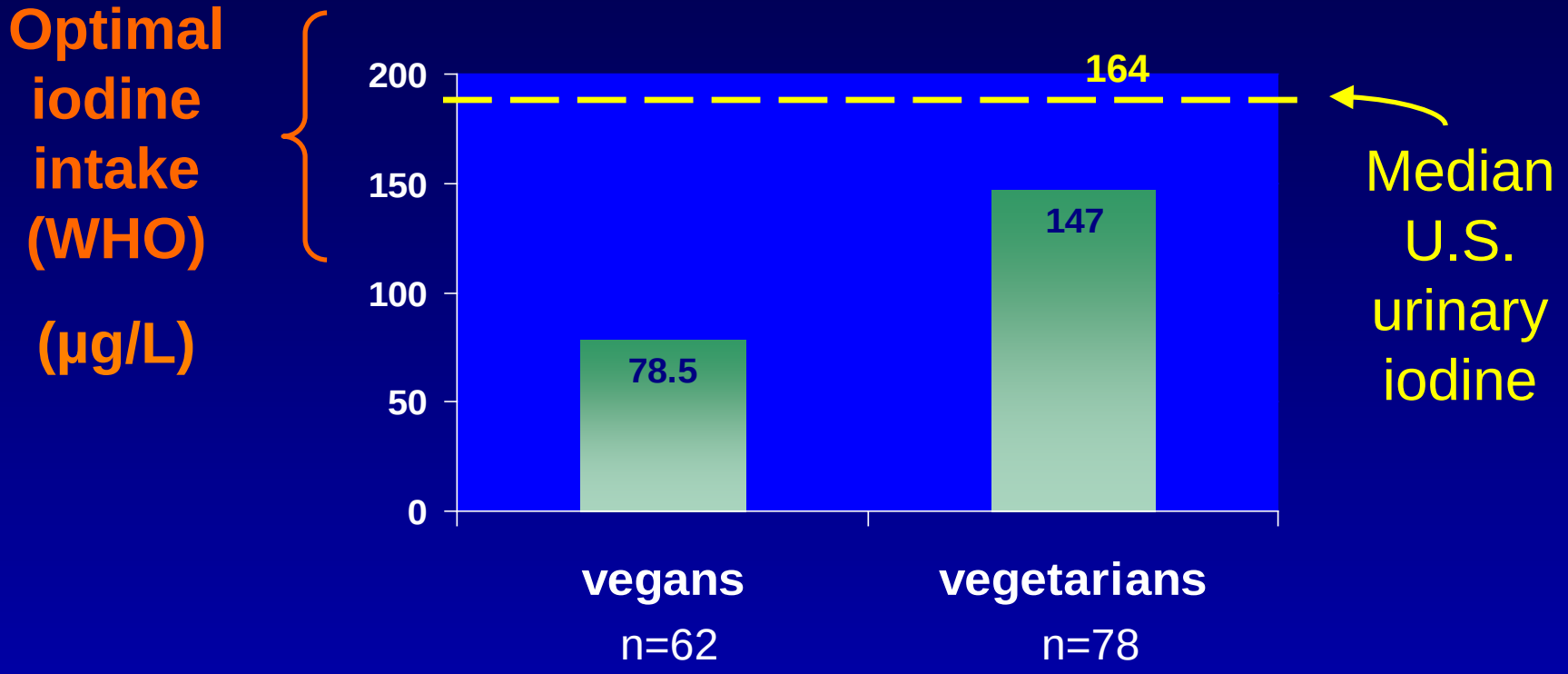
Pearce et al *J Clin Endocrinol Metab* 2004; 89:3421-4

The Example of Australia…

- Late 1980s: median urinary iodine values 200 µg/L
- <10% of the population uses iodized salt
- Iodophor cleaners eliminated by the dairy industry
- 1999: median urinary iodine value 64 µg/L in healthy volunteers

Gunton et al. *MJA* 1999; 171:467-70
Li et al. *Asia Pac J Clin Nutr* 2001; 10:200

Median Urinary Iodine Levels in U.S. Vegetarians and Vegans



Leung AM et al, *J Clin Endocrinol Metab* 2011;96:E1303-7.

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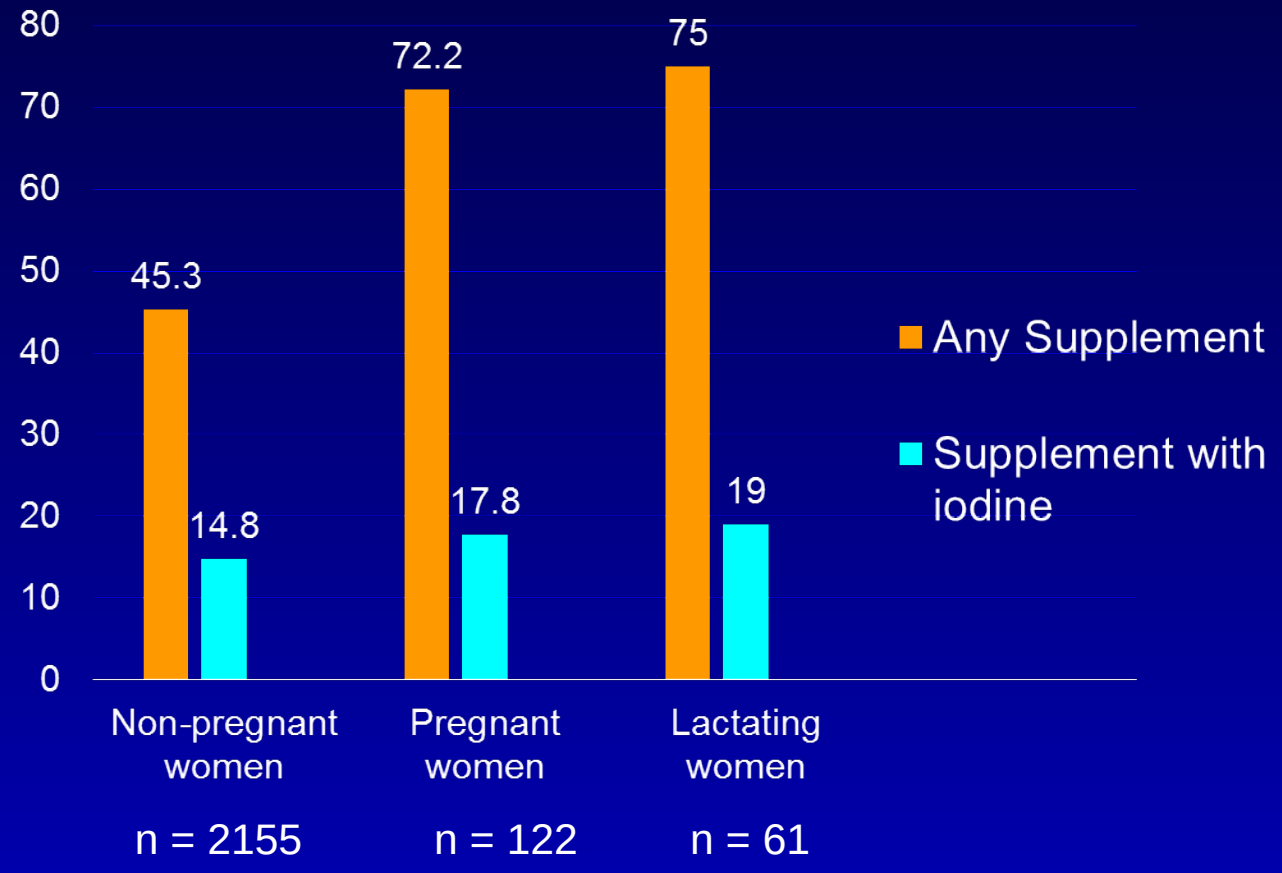
U.S. and European Guidelines

Women who are planning to be pregnant or are pregnant or breastfeeding should supplement their diet with a daily oral supplement that contains 150 µg of iodine.

- Alexander EK, Pearce EN et al. *Thyroid* 2017;27(3):315-389.
- De Groot L et al. *J Clin Endocrinol Metab* 2012;97:2543-65
- SG Obican et al. *Birth Defects Res A Clin Mol Teratol* 2012;94: 677-682
- AAP Council on Environmental Health. *Pediatrics* 2014;133:1163-6
- JH Lazarus et al. *Eur Thyroid J* 2014;3:76-94.

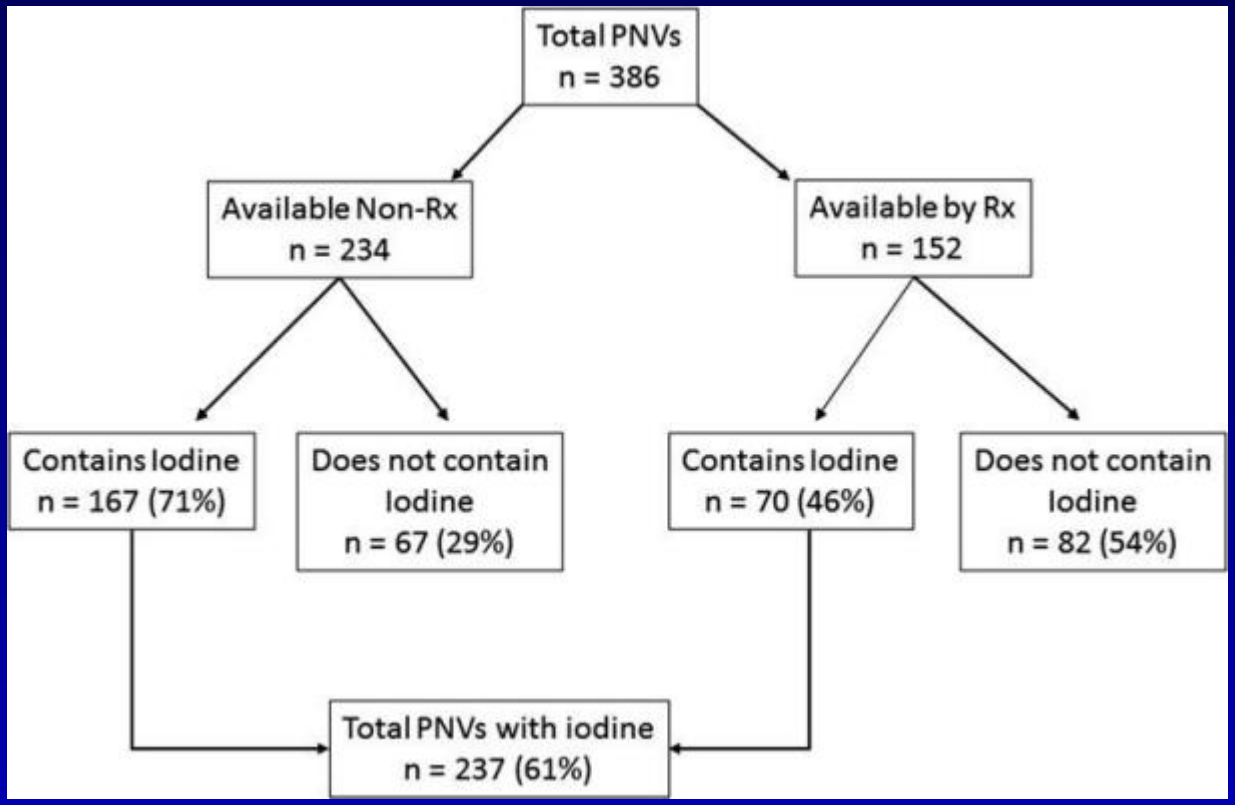
Percentage of Reproductive-Age U.S. Women Reporting Supplement Use Within 30 Days

Based on NHANES 2011-2014



Gupta PM et al. *Nutrients* 2018;10(7)

Proportion of U.S. Prenatal Multivitamins Containing Iodine



Lee SY et al. *Thyroid* 2017;27(8):1101-2

Conclusions

- Iodine status can be determined at the population, but not individual, level
- Pregnant women/fetuses are particularly vulnerable to iodine deficiency disorders and to iodine excess
- Mild iodine deficiency has re-emerged among pregnant U.S. women
  - Recommend iodine-containing prenatal multivitamin 150 µg/day