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Why consumers should be concerned about the iodine content of milk and milk-alternative beverages?

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Outline

- Relationship between kelp meal and milk iodine concentration
- Iodine function, nutrition, disorders, and metabolism
- Research data regarding the concentration of iodine in milk alternative beverages
- Relationship between iodine intake and recommendations
- Final considerations and questions

Kelp (*Ascophyllum nodosum*) and milk iodine

Use of kelp meal on organic dairy farms in the Northeast and Midwest US

- 59% of organic dairy farmers feed kelp meal in the Northeast (Antaya et al., 2015)
- 49% of organic dairy farmers feed kelp meal in Wisconsin (Hardie et al., 2014)
- 83% of organic dairy farmers feed kelp meal in Minnesota (Sorge et al., 2016)

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Why organic dairy farmers feed kelp meal in the Northeast?

- It improves body condition and overall animal appearance
- It decreases somatic cell count in milk, reproductive problems, and incidence of “pinkeye” (i.e., infectious bovine keratoconjunctivitis)
- It helps with control of nuisance flies during the grazing season

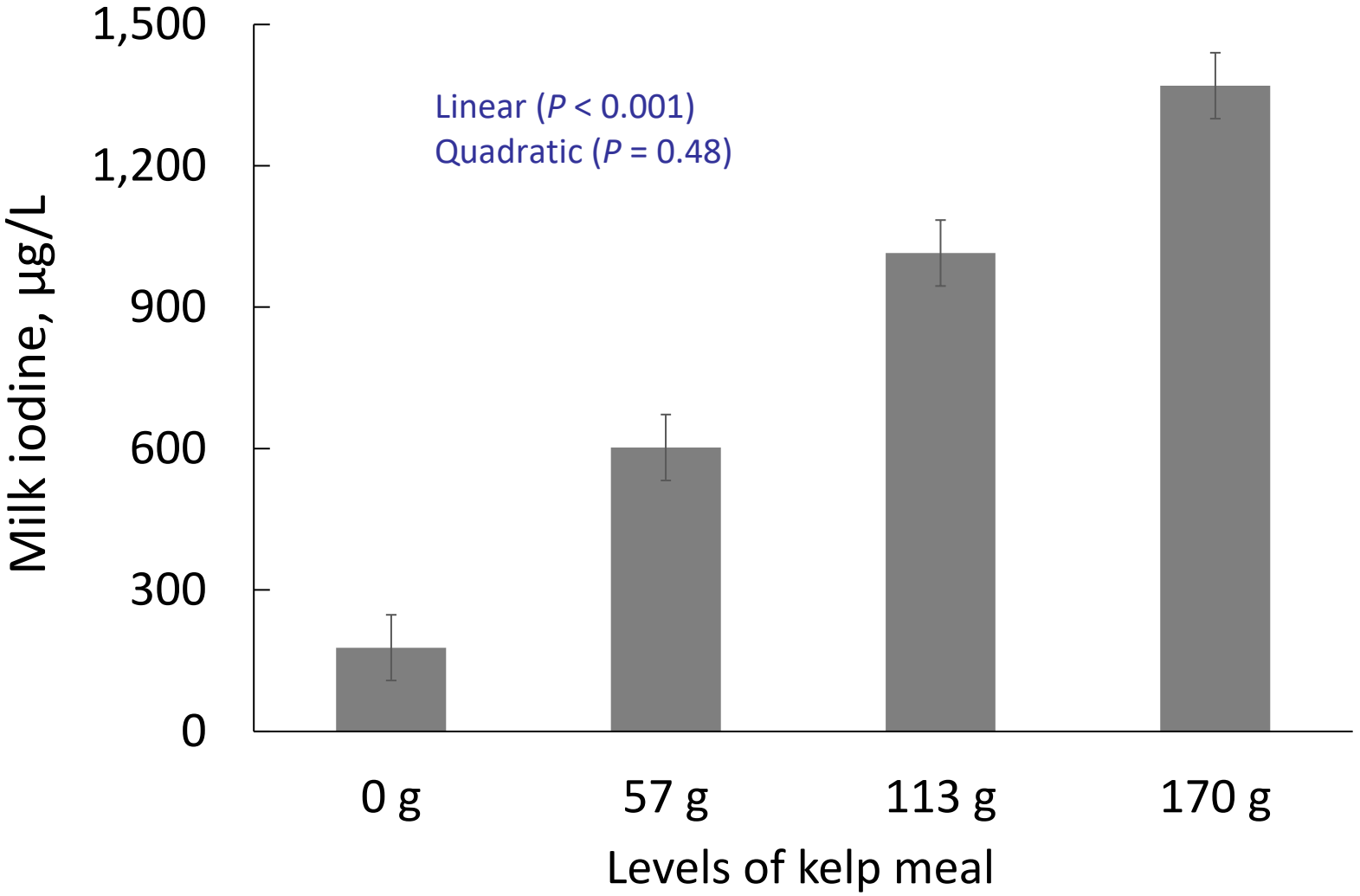
Source: Antaya et al. 2015 (J. Dairy Sci. 98:1991-2004)

Nutrient composition of kelp meal

Dry matter (DM), % as fed	92.2
Crude protein, % DM	10.2
Neutral detergent fiber, % DM	53.9
Acid detergent fiber, % DM	39.9
Crude fat, % DM	2.30
Ash, % DM	25.9
Ca, g/kg DM	13.1
Cl, g/kg DM	47.0
S, g/kg DM	28.4
K, g/kg DM	35.3
Na, g/kg DM	39.0
I, mg/kg DM	820

Source: Antaya et al. 2015 (J. Dairy Sci. 98:1991-2004)

Milk iodine increased linearly in organic dairy cows fed kelp meal during the winter season



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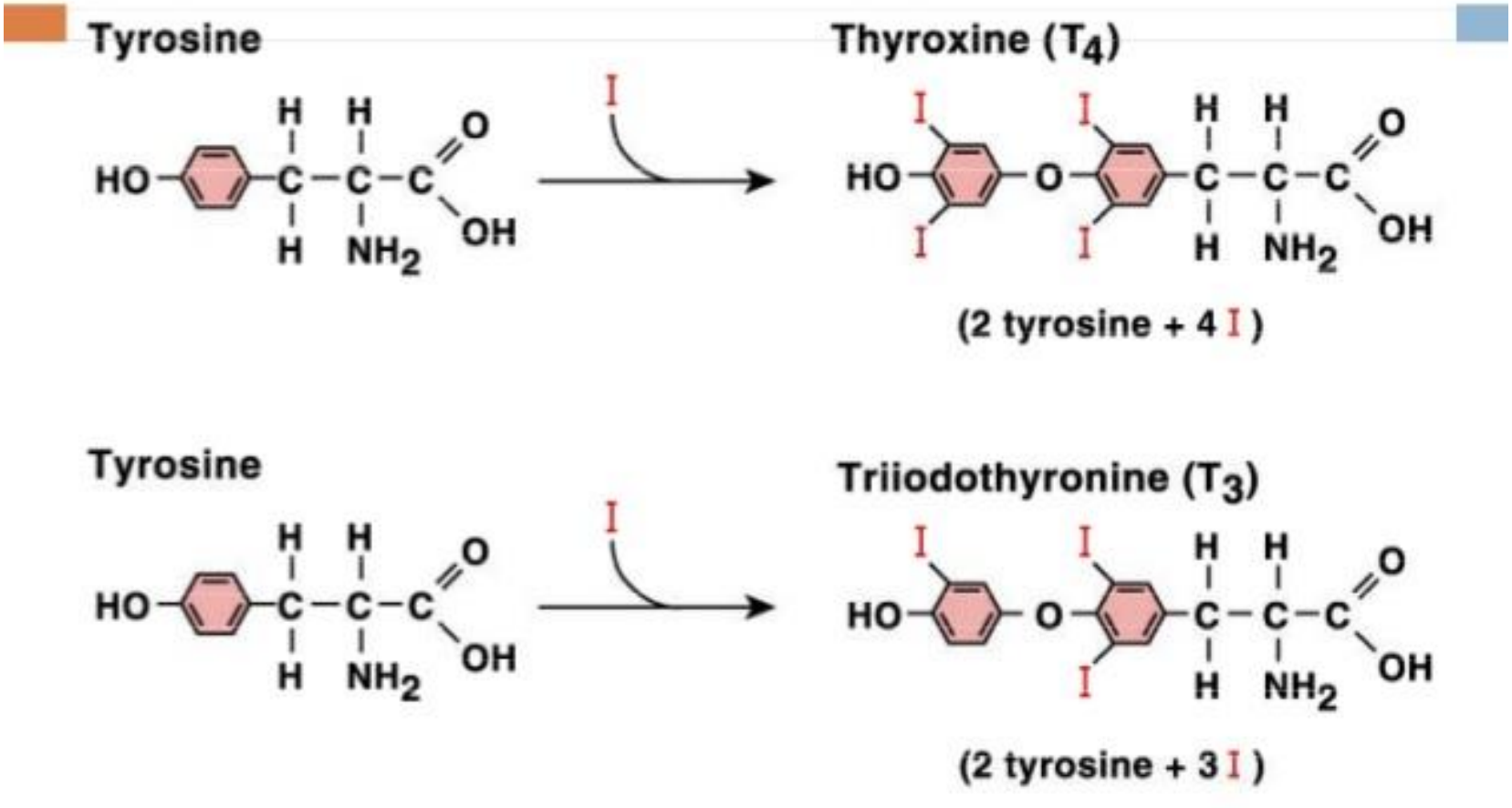
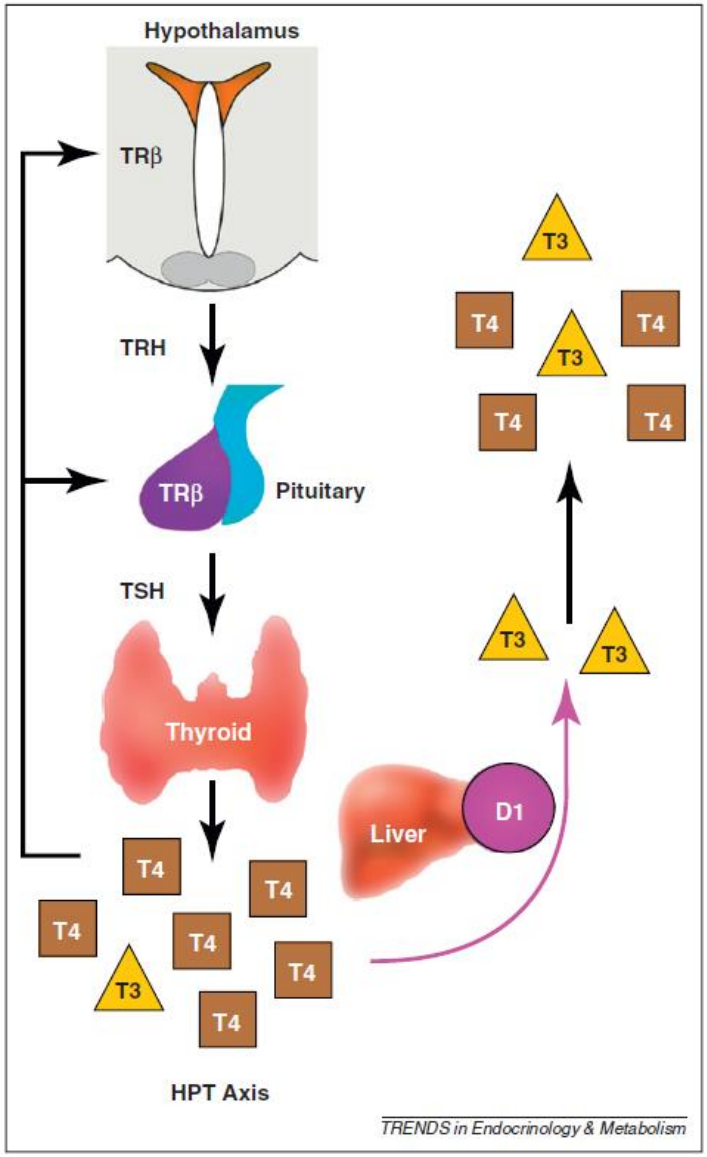
Source: Antaya et al. 2015 (J. Dairy Sci. 98:1991-2004)

Iodine function



The hypothalamic–pituitary–thyroid axis



TRβ = thyroid hormone receptor β
TRH = thyrotropin-releasing hormone
TSH = thyrotropin-stimulating hormone
HPT = hypothalamic–pituitary–thyroid axis
D1 = type 1 deiodinase

Source: Waung et al. 2012 (Trends Endocr. Met. 23:155-162)

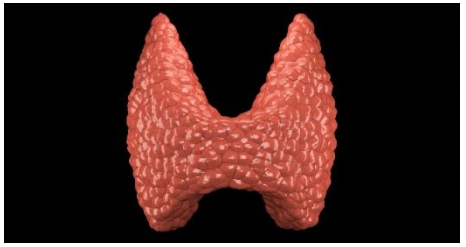
Tyroide hormone functions

- Regulation of metabolic processes essential for normal growth and development (Oetting and Yen, 2007; Cheng et al., 2010; Brent, 2012)

- Regulation of metabolism in adults (Oetting and Yen, 2007; Cheng et al., 2010; Brent, 2012)

- Stimulation of lipogenesis and lipolysis (Oppenheimer et al., 1991)

- Influence key metabolic pathways that control energy balance by regulating energy storage and expenditure (Oetting and Yen, 2007; Liu and Brent, 2010; Iwen et al., 2013)



Recommendations for iodine intake (µg/d) by age or population group

US Institute of Medicine[1]		World Health Organization[2]	
Age or population group	RDA[3]	Age or population group	RNI[4]
Infants (0-12 months)	110-130	Children (0-5 yr)	90
Children (1-8 yr)	90	Children (5-10 yr)	120
Children (9-13 yr)	120		
Adults (≥ 14 yr)	150	Adults (> 12 yr)	150
Pregnancy	220	Pregnancy	250
Lactation	290	Lactation	250

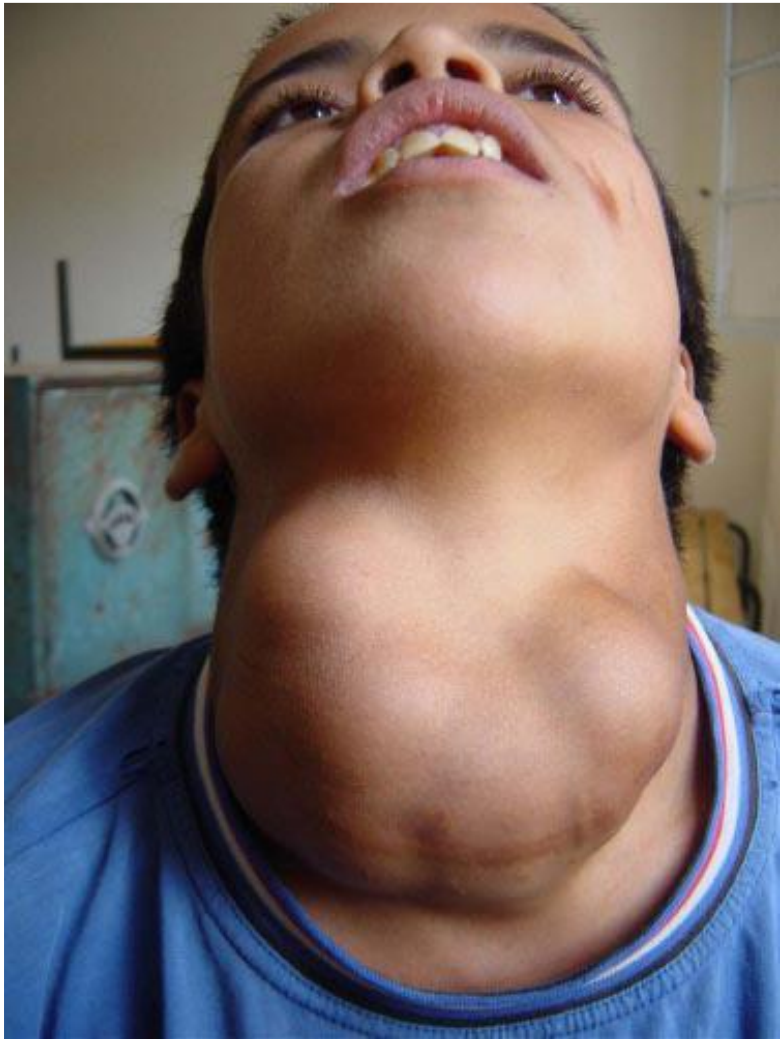
[1]US Institute of Medicine, Academy of Sciences (2001)
[2]World Health Organization (2007)
[3]RDA = recommended dietary allowance
[4]RNI = recommended nutrient intake

Spectrum of iodine defficiency disorders

PHYSIOLOGICAL GROUPS	HEALTH CONSEQUENCES OF IODINE DEFICIENCY
All ages	Goitre Hypothyroidism Increased susceptibility to nuclear radiation
Fetus	Spontaneous abortion Stillbirth Congenital anomalies Perinatal mortality
Neonate	Endemic cretinism including mental deficiency with a mixture of mutism, spastic diplegia, squint, hypothyroidism and short stature Infant mortality
Child and adolescent	Impaired mental function Delayed physical development Iodine-induced hyperthyroidism (IIH)
Adults	Impaired mental function Iodine-induced hyperthyroidism (IIH)

Source: Hetzel 1983 (Lancet 2:1126–1129)

Large nodular goiter in a 14-year old boy



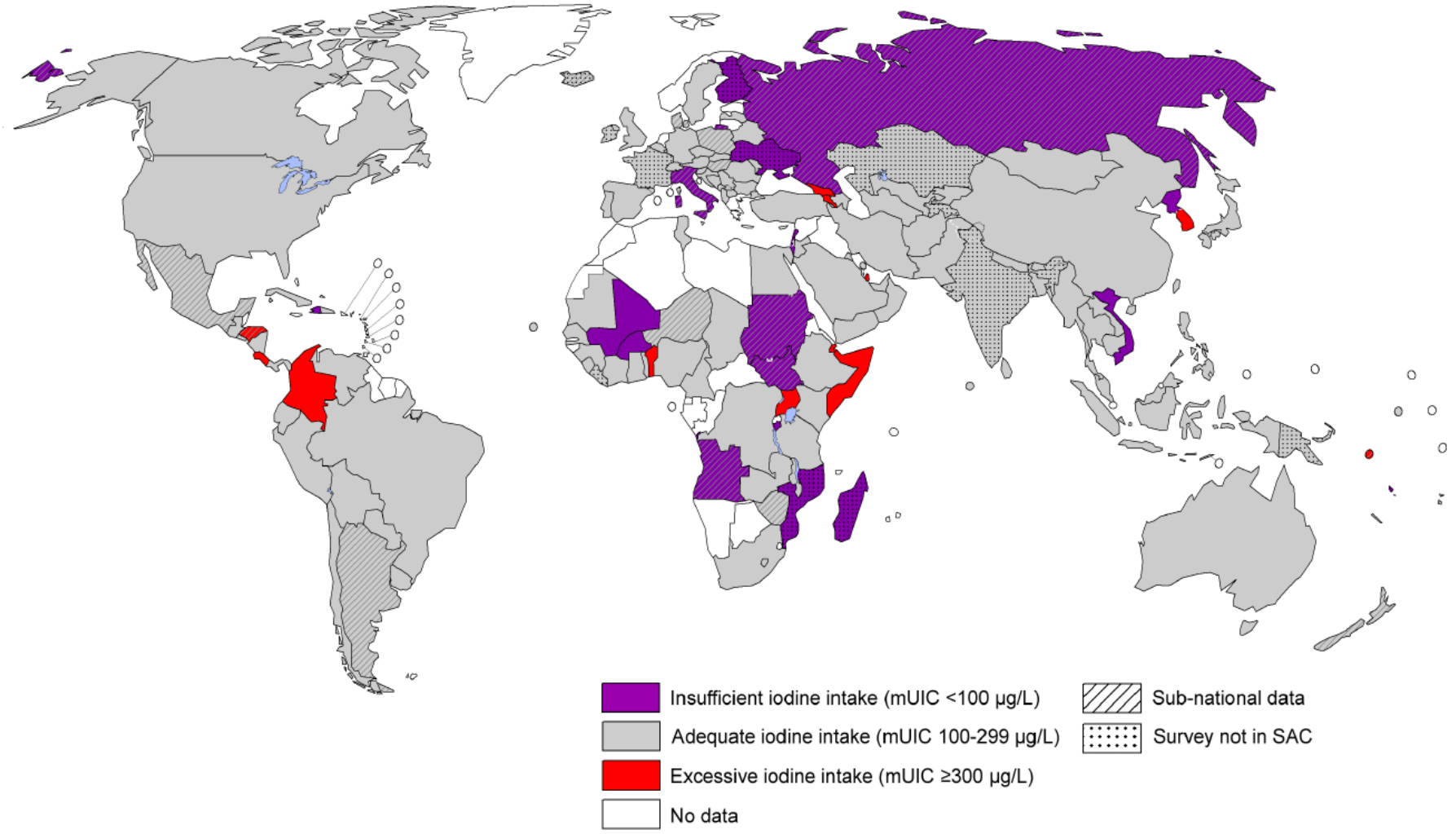
Source: Zimmermann 2009 (Endoc. Rev. 30:376–408)

Neurological cretinism (A) and myxedematous cretinism (B)

Source: Zimmermann, 2009 (Endoc. Rev. 30:376–408)

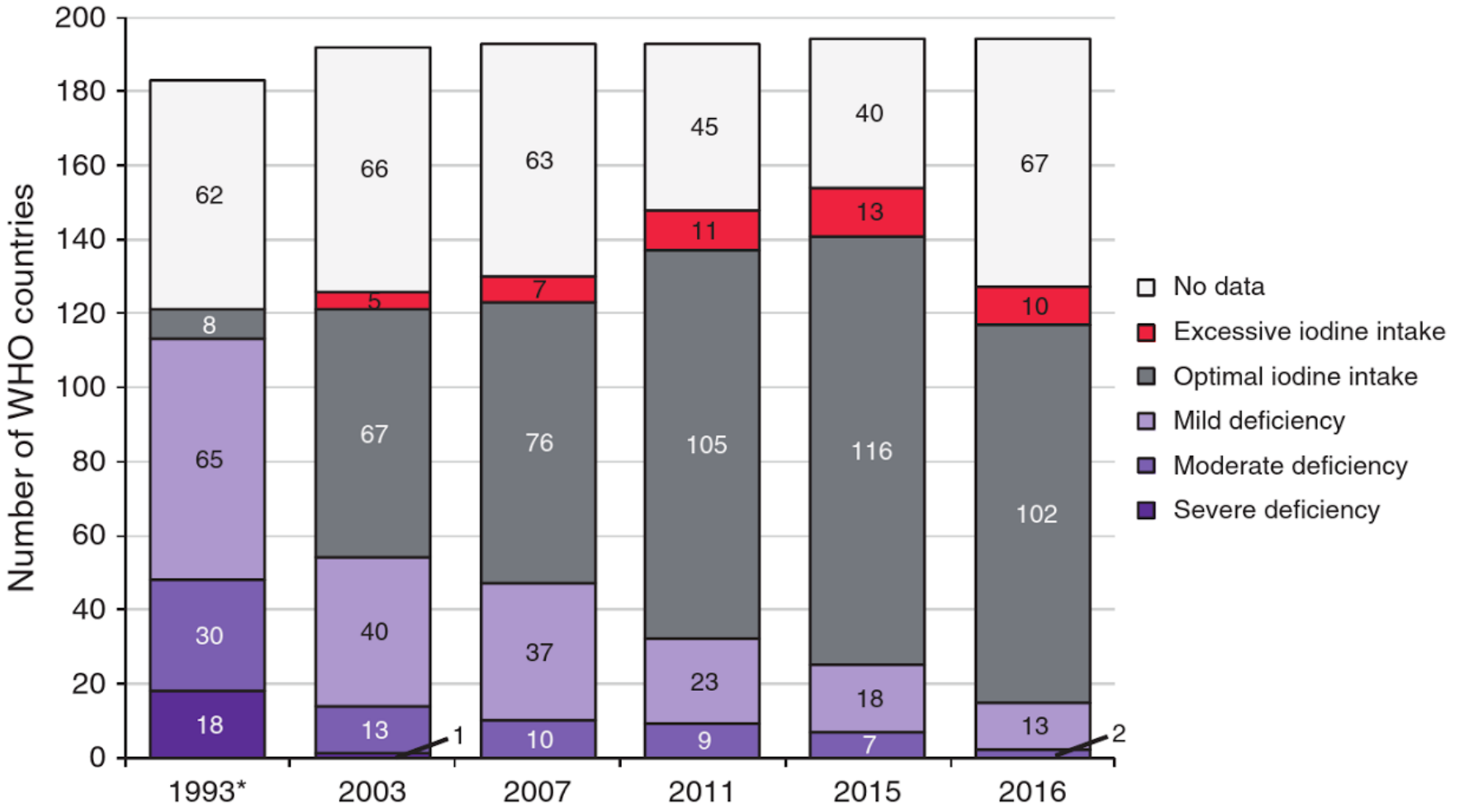
Global Scorecard of Iodine Nutrition 2017

Based on median urinary iodine concentration (mUIC) in school-age children (SAC) and adults



Source: The Iodine Global Network (2017)

Iodine intake based on urinary iodine concentration



Source: The Iodine Global Network (2017)

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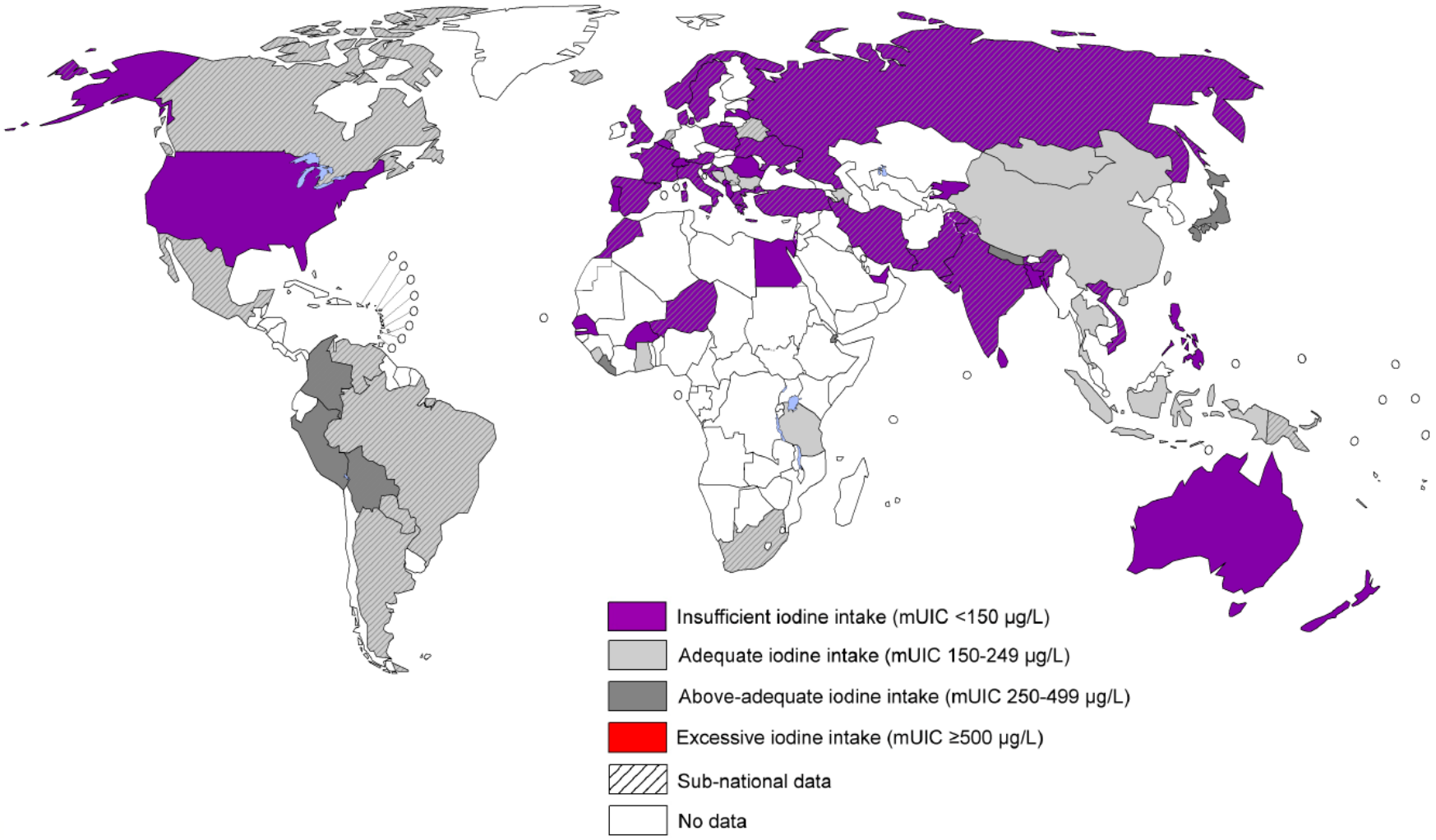
Global Scorecard of Iodine Nutrition 2017

Based on median urinary iodine concentration (mUIC) in pregnant women



Source: The Iodine Global Network (2017)

Milk-alternative drinks market

- Global market is on track to reach $16.3 billion in 2018, up from $7.4 billion in 2010 (Innova Market Insights, 2017)

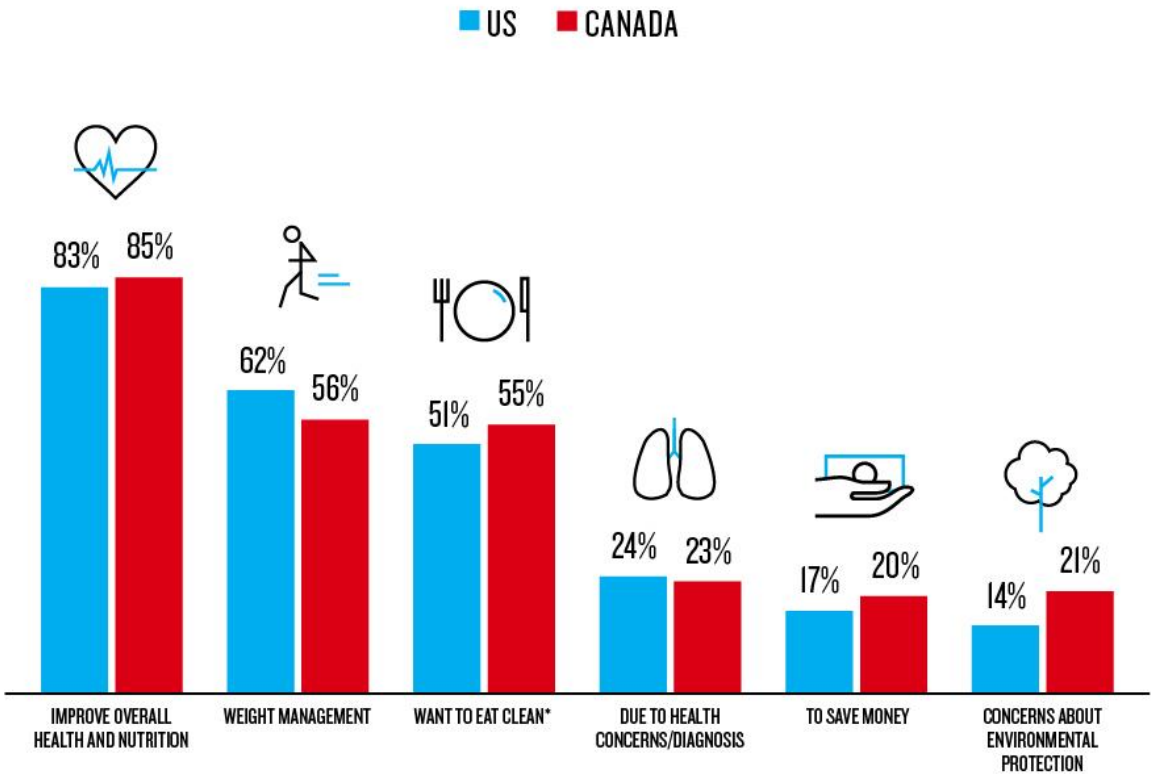
- Leading this market growth are companies dedicated to developing innovative processes and formulations featuring hemp, flax, pistachio, hazelnuts, almond among others (Innova Market Insights, 2017)

- China has been showing a compound annual growth rate of 18.7% forecast between 2010 and 2018 compared with 10% in the US (Innova Market Insights, 2017)

- A key factor in this growth is continued consumer desire for lactose-free, dairy-free, plant-based, and vegan options (Innova Market Insights, 2017)

NUTRITION AND WEIGHT CONTROL ARE THE TOP REASONS TO INCLUDE MORE PLANTS

Top reasons from those wanting to incorporate more plant-based foods



*Incorporate more foods that are unprocessed or minimally processed
Source: Nielsen, Homescan Panel Protein survey, April 2017 (U.S.)
Source: Nielsen Panelviews survey, March 2017 (Canada)

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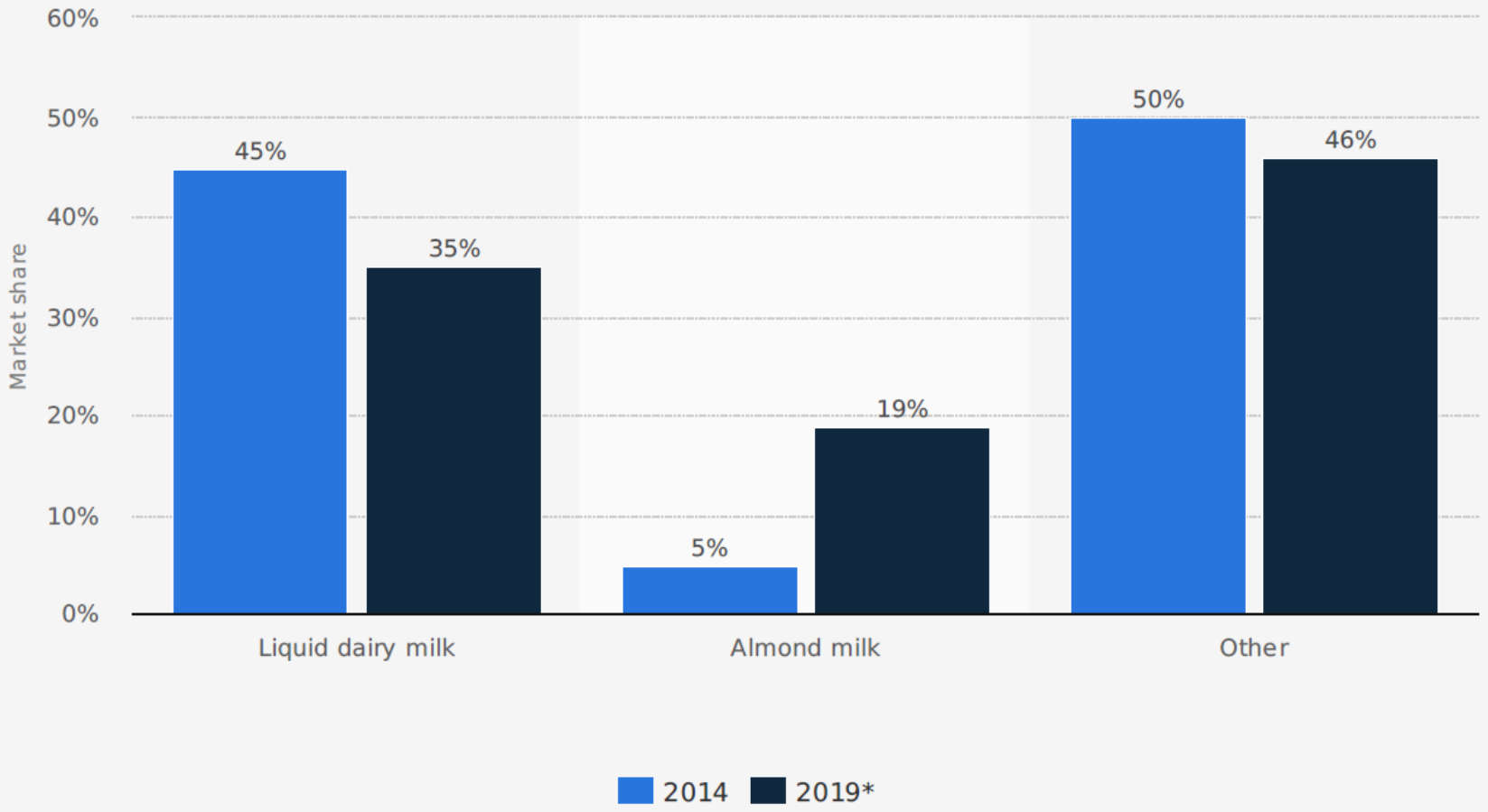
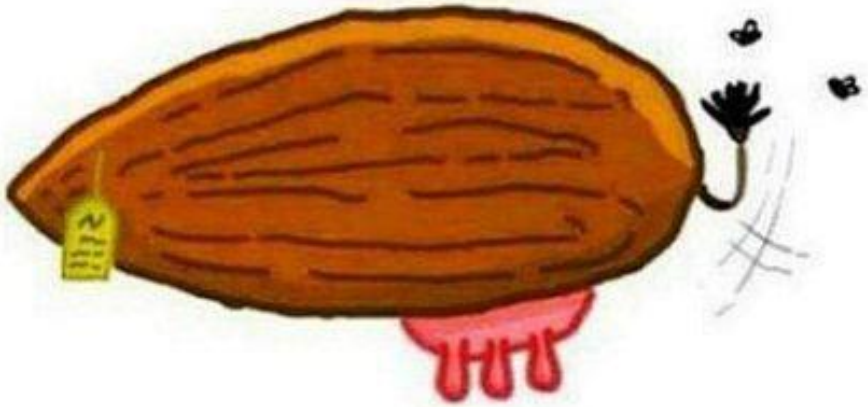
Market share of dairy and dairy alternative beverages in the United States in 2014 and 2019, by category



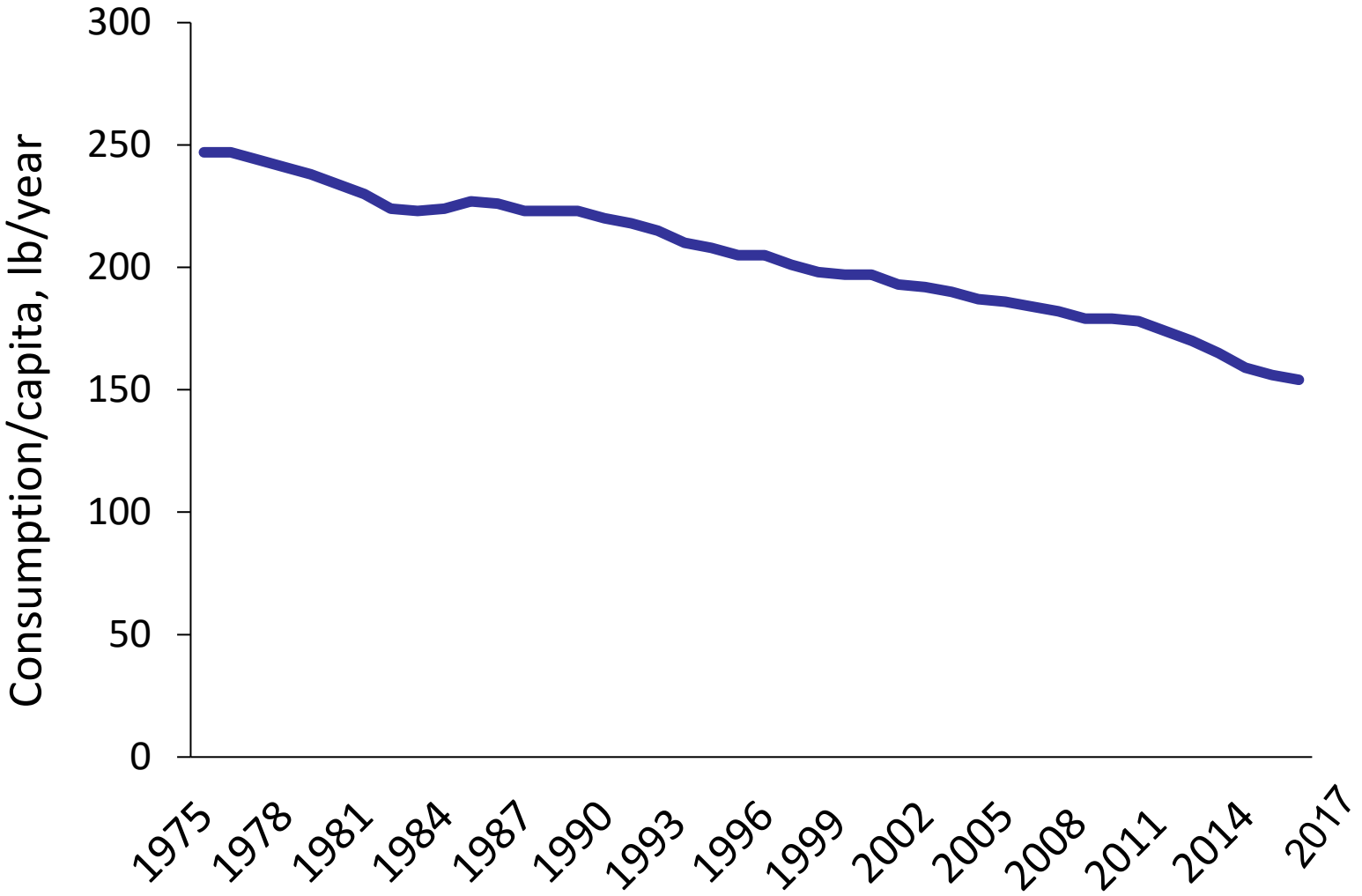
Source
Packaged Facts; Website (ticgums.com)

Additional Information:
United States; Packaged Facts; 2014



The most difficult part of being vegan is waking up at 5am to milk the almonds...

Milk consumption per capita in the US



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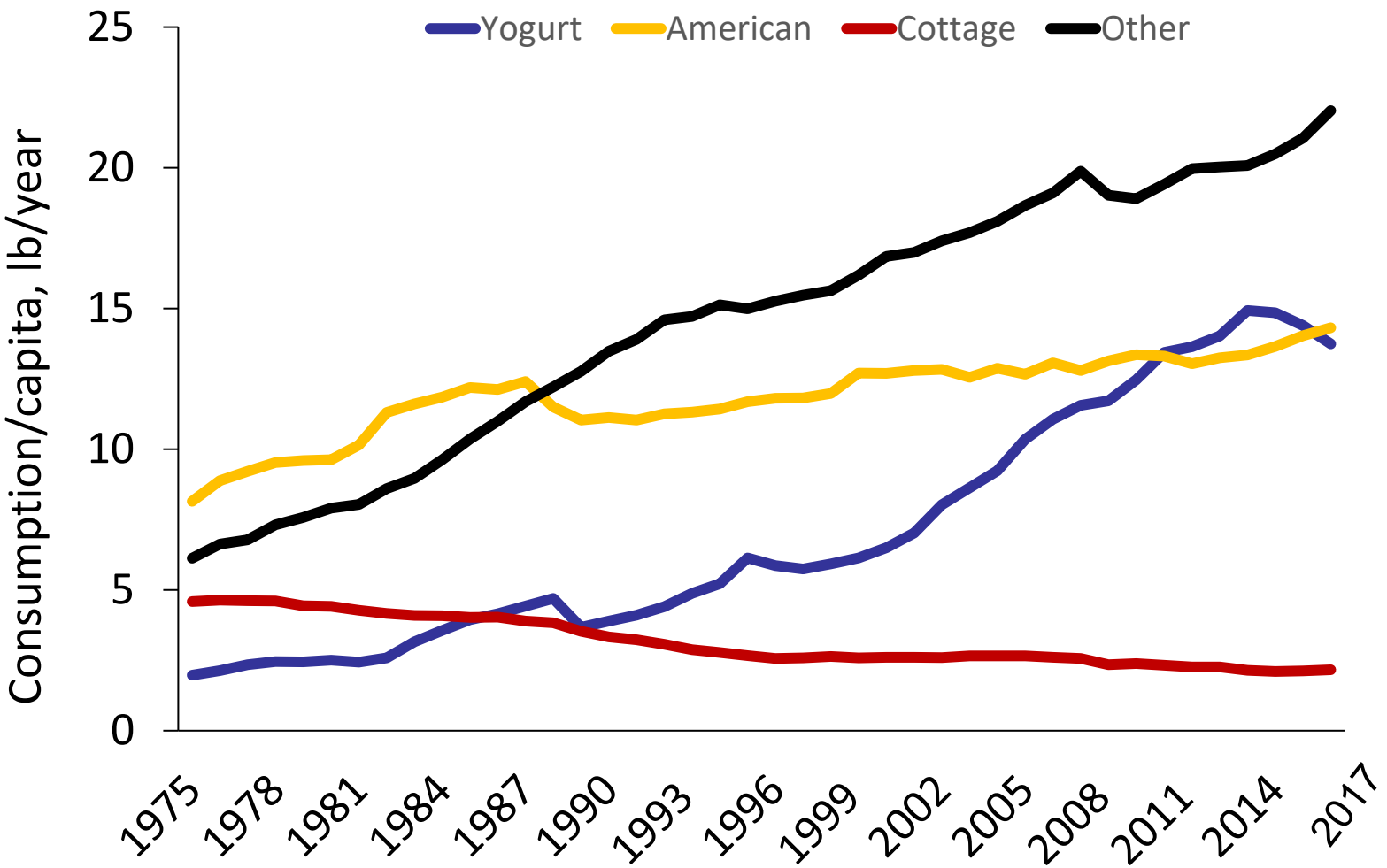
Sources: USDA NASS-ERS (accessed October, 2017)

Dairy products consumption per capita in the US



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Sources: USDA NASS-ERS (accessed October, 2017)

British Journal of Nutrition, page 1 of 8

doi:10.1017/S0007114517002136

Iodine concentration of milk-alternative drinks available in the UK in comparison with cows' milk

Sarah C. Bath[1], Sarah Hill[2], Heidi Goenaga Infante[2], Sarah Elghul[1], Carolina J. Nezianya[1] and Margaret P. Rayman[1]*

[1]*Department of Nutritional Sciences, Faculty of Health and Medical Sciences, University of Surrey, Guildford, Surrey GU2 7XH, UK*
[2]*LGC Limited, Queens Road, Teddington, Middlesex TW11 0LY, UK*

(Submitted 13 March 2017 – Final revision received 23 June 2017 – Accepted 14 July 2017)

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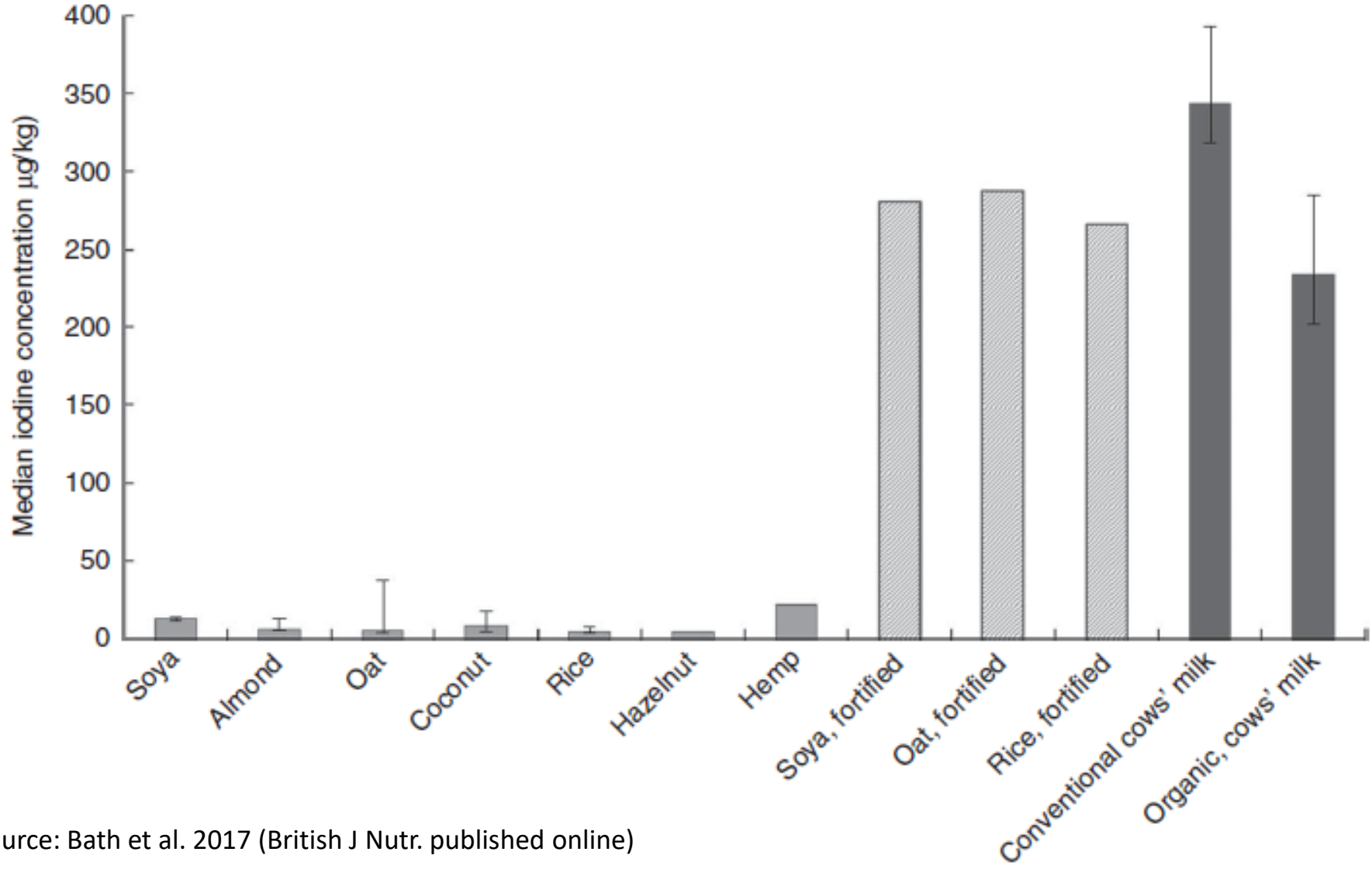
Bath et al. (2017) study methods

- The initial survey included 20 grocery stores and 28 brands of milk-alternative drinks were identified

- Iodine concentration of 7 types of milk alternative drinks (soy, almond, coconut, oat, rice, hazelnut, and hemp) was determined via ICP-MS in 47 products

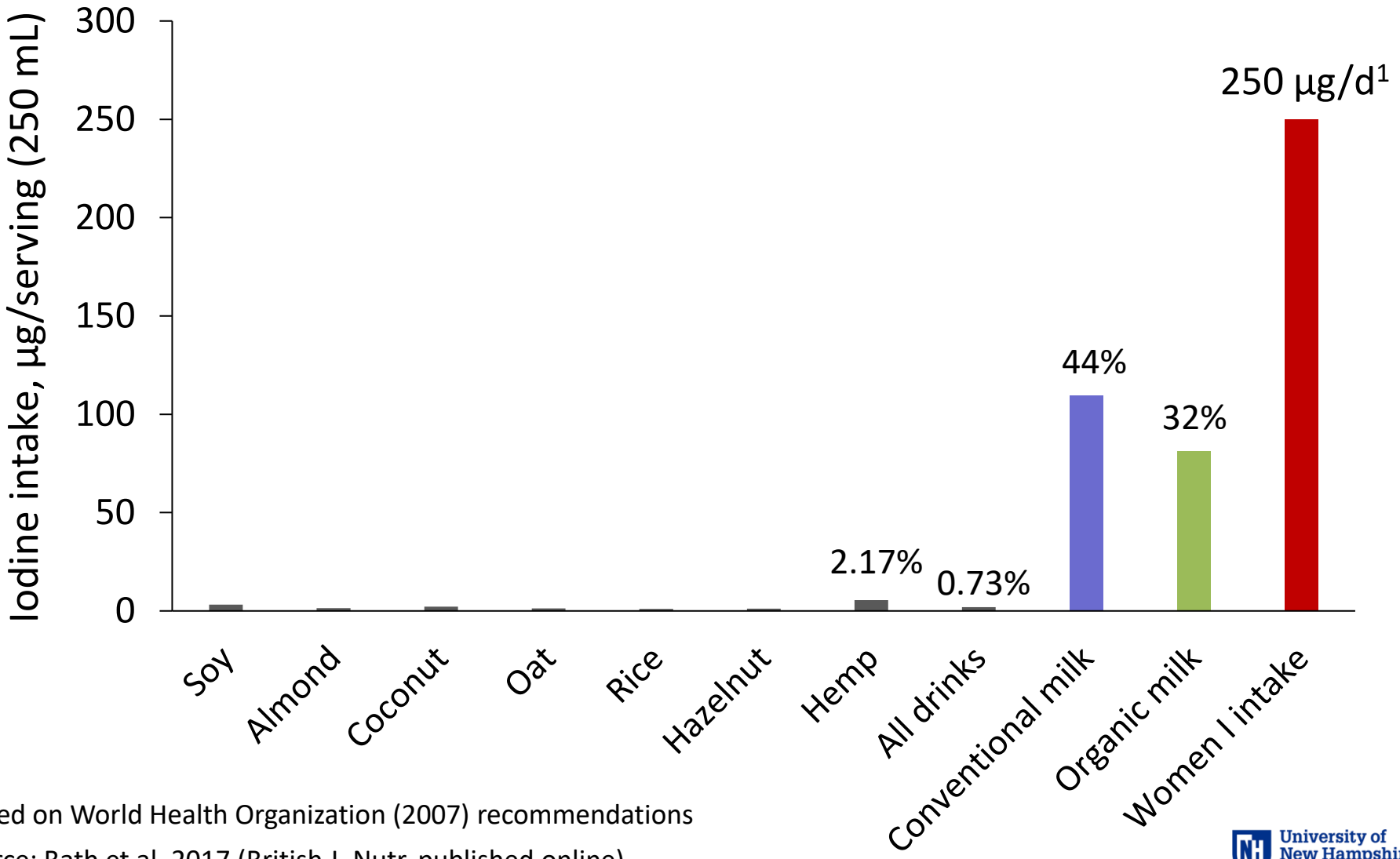
- For comparison, winter samples of conventional (n = 5) and organic (n = 5) cows' milk were included

Median iodine concentration in milk and milk alternatives



Source: Bath et al. 2017 (British J Nutr. published online)

Iodine intake per serving of milk and milk alternatives relative to recommended iodine intake for pregnant and lactating women



[1]Based on World Health Organization (2007) recommendations

Source: Bath et al. 2017 (British J. Nutr. published online)

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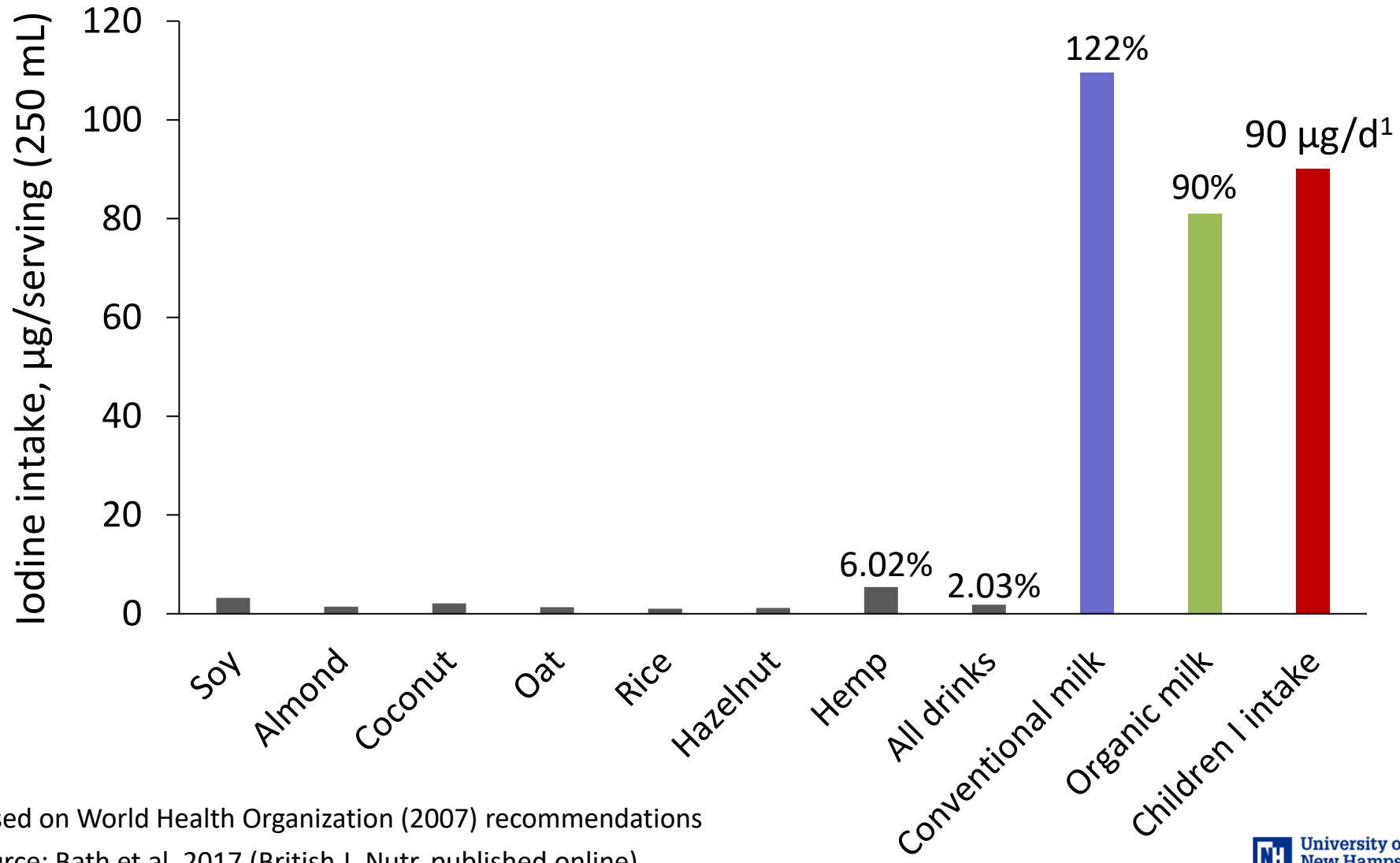
Iodine intake per serving of milk and milk alternatives relative to recommended iodine intake for children (0-5 yr)



[1]Based on World Health Organization (2007) recommendations

Source: Bath et al. 2017 (British J. Nutr. published online)

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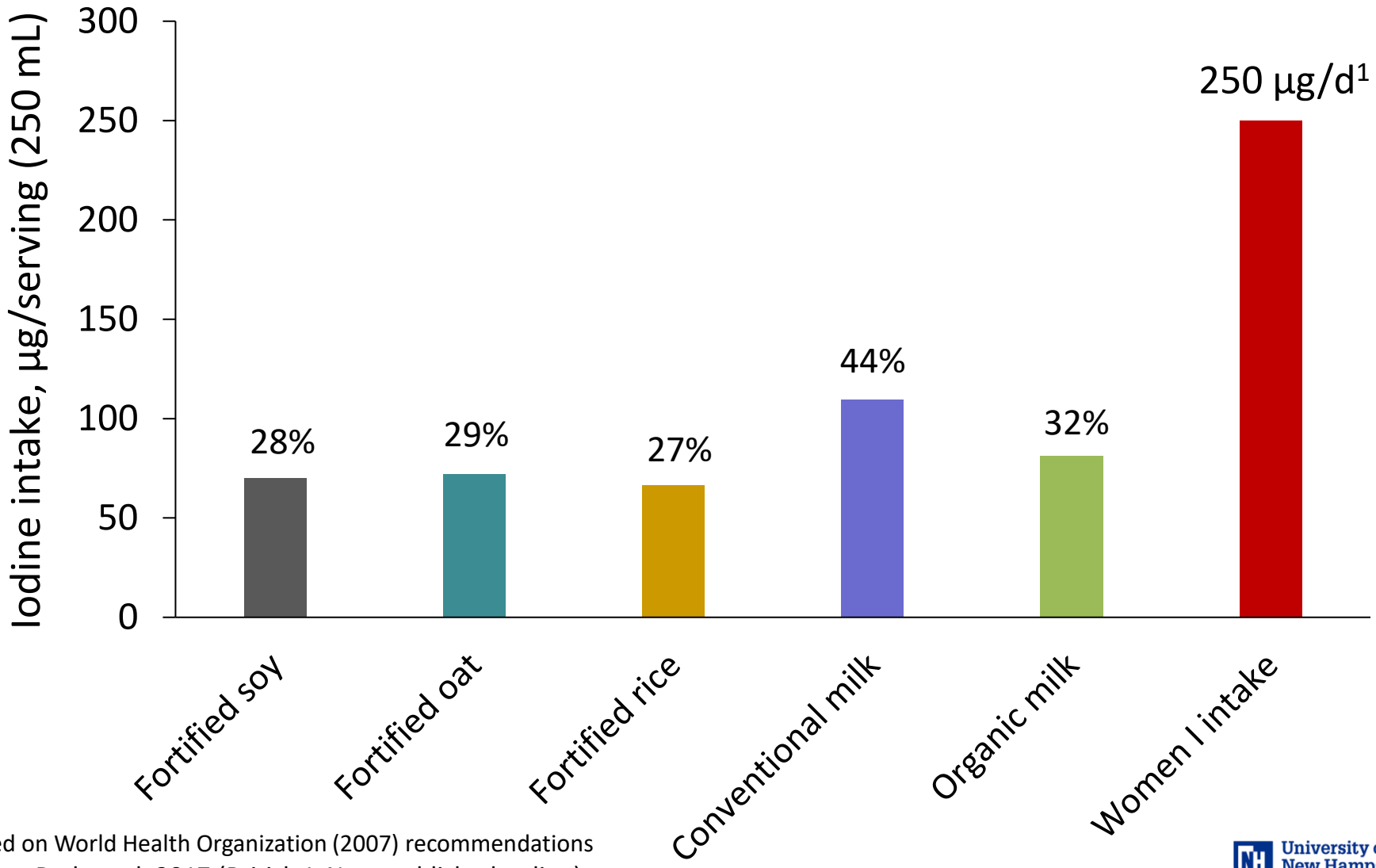
Iodine intake per serving of milk and fortified milk alternatives relative to recommended iodine intake for pregnant and lactating women



[1]Based on World Health Organization (2007) recommendations
Source: Bath et al. 2017 (British J. Nutr. published online)

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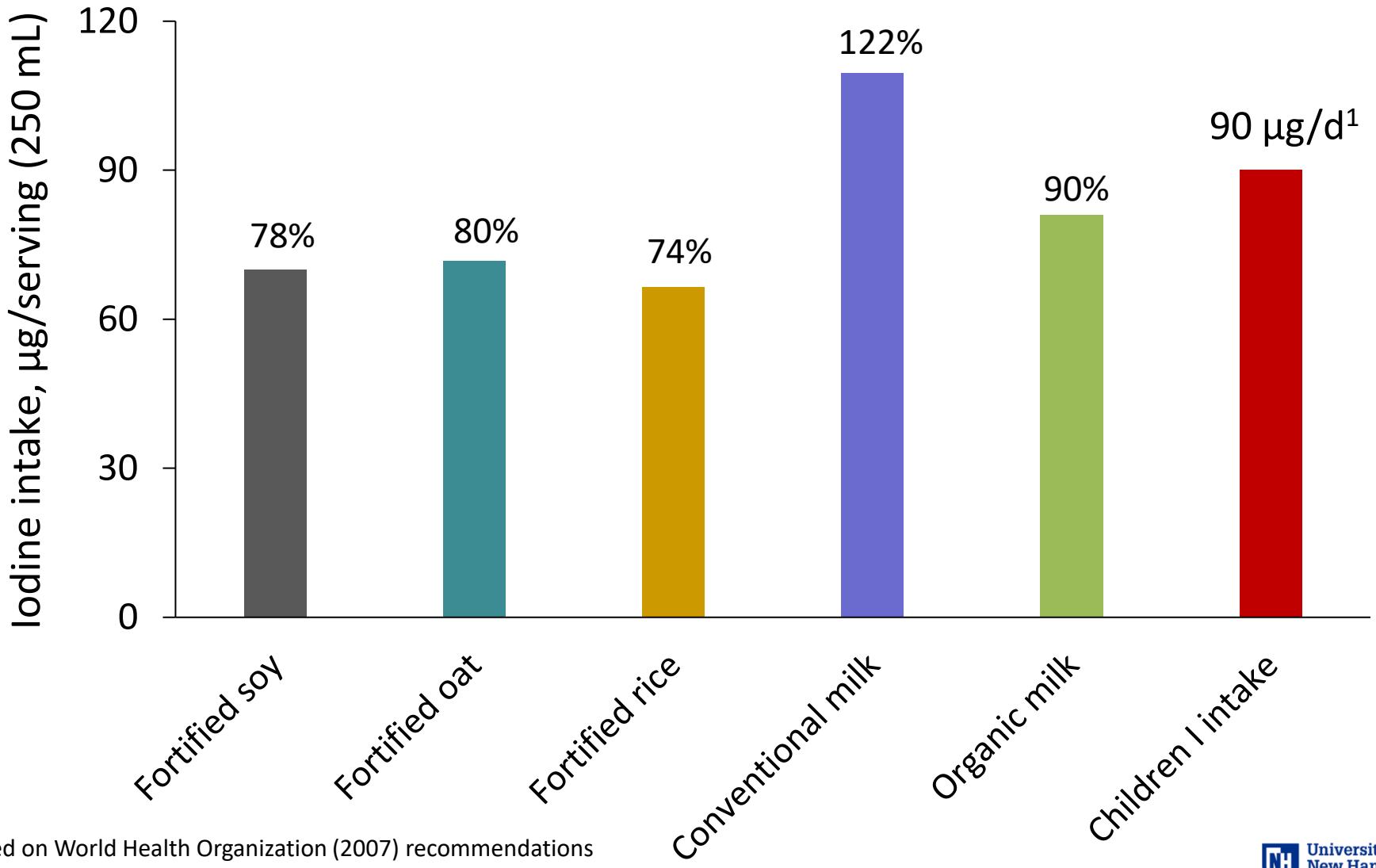
Iodine intake per serving of milk and fortified milk alternatives relative to recommended iodine intake for children (0-5 yr)[1]



[1]Based on World Health Organization (2007) recommendations
Source: Bath et al. 2017 (British J. Nutr. published online)

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THYROID
Volume 26, Number 9, 2016

DOI: 10.1089/thy.2016.0239

Iodine Content in Milk Alternatives

Wendy Ma,[1] Xuemei He,[2] and Lewis Braverman[2]

Ma et al. (2016) study methods

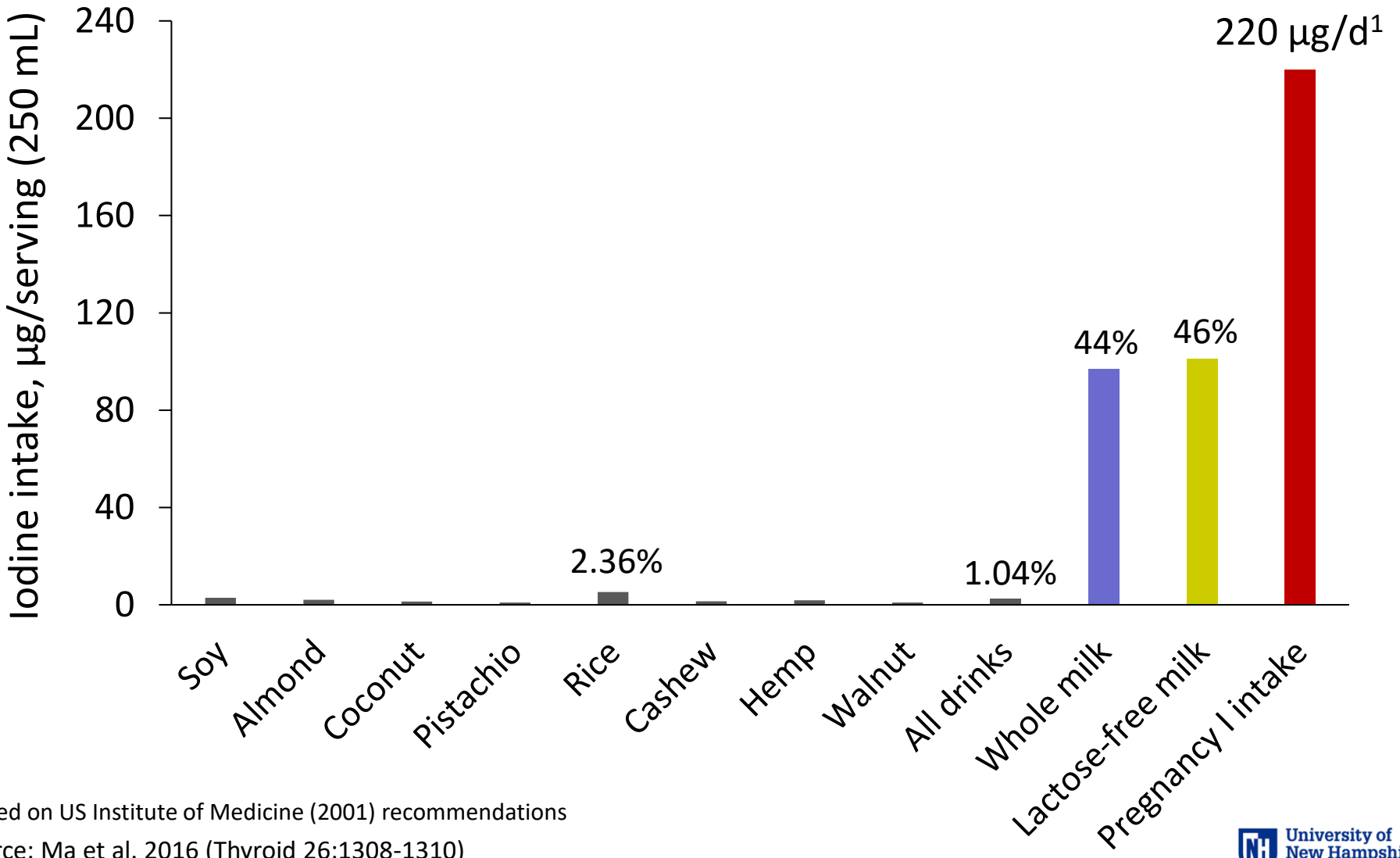
- A total of 30 brands of milk alternatives were analyzed from 16 different companies
- Total iodine concentrations were measured using the chloric acid digestion with spectrophotometric detection of the Sandell–Kolthoff reaction method
- Types of milk alternatives were derived from a variety of nuts and plants such as soy, walnut, coconut, cashew, rice, and others
- For comparison, whole milk and 100% lactose-free, fat-free milk were used

Iodine concentration in milk alternative drinks

Type/title	*Brand*	*Iodine content (μg/250 mL)*
Almond Milk	Almond Dream	3.2
Almond Breeze Original	Blue Diamond Almonds	0.5
Unsweetened Almond Milk	Califa Farms	6.9
Coconut Almond Milk	Califa Farms	6.2
Coconut Milk	Coconut Dream	6.7
Coconut, Almond, and Chia drink	Dream Blends	1.6
Real Pistachio Unsweetened	Elmhurst Harvest: Plant-Based Milk Alternatives	0.9
Real Walnut Unsweetened	Elmhurst Harvest: Plant-Based Milk Alternatives	0.9
Real Walnut Original	Elmhurst Harvest: Plant-Based Milk Alternatives	0.9
Unsweetened Vanilla Hempmilk	Living Harvest Tempt	1.8
Original Almondmilk	Lucerne	2.1
Plain Organic Soymilk	Organics	2.9
Almond Milk Vanilla	Organics	2.1
Vanilla Soy Milk	Organics	2.8
All Natural Ultra Soy Non-Dairy Beverage	Pacific Foods	2.4
Rice Dream	Rice Dream	5.2
Cashew Milk Vanilla Unsweetened	Silk	1.4
Almond Milk Original	Silk	0.8
Almond Coconut Blend Unsweetened	Silk	0.8
Caramel Almonds + Cashews	Silk	5.6
Rich Dark Chocolate + Walnuts	Silk	2.7
Soymilk Original	Silk	3.6
Chocolate Coconut Milk	SO Delicious Dairy Free	1.6
Vanilla Coconut Milk	SO Delicious Dairy Free	1.1
Coconut Milk Original Sugar Free	SO Delicious Dairy Free	0.8
Coconut Milk Unsweetened	SO Delicious Dairy Free	0.8
Coconut Milk Original	SO Delicious Dairy Free	7.5
Walnut Almond Blend	SO Delicious Dairy Free	5.3
SoyMilk Original Enriched	Soy Dream	10.9
Soymilk Vanilla	Soy Slender	2.7
Soymilk	Westsoy	3
	Mean	*3.1*
	Standard deviation	*2.5*

Source: Ma et al. 2016 (Thyroid 26:1308-1310)

Iodine Intake per serving of milk and milk alternatives relative to recommended iodine intake for pregnant women



[1]Based on US Institute of Medicine (2001) recommendations

Source: Ma et al. 2016 (Thyroid 26:1308-1310)

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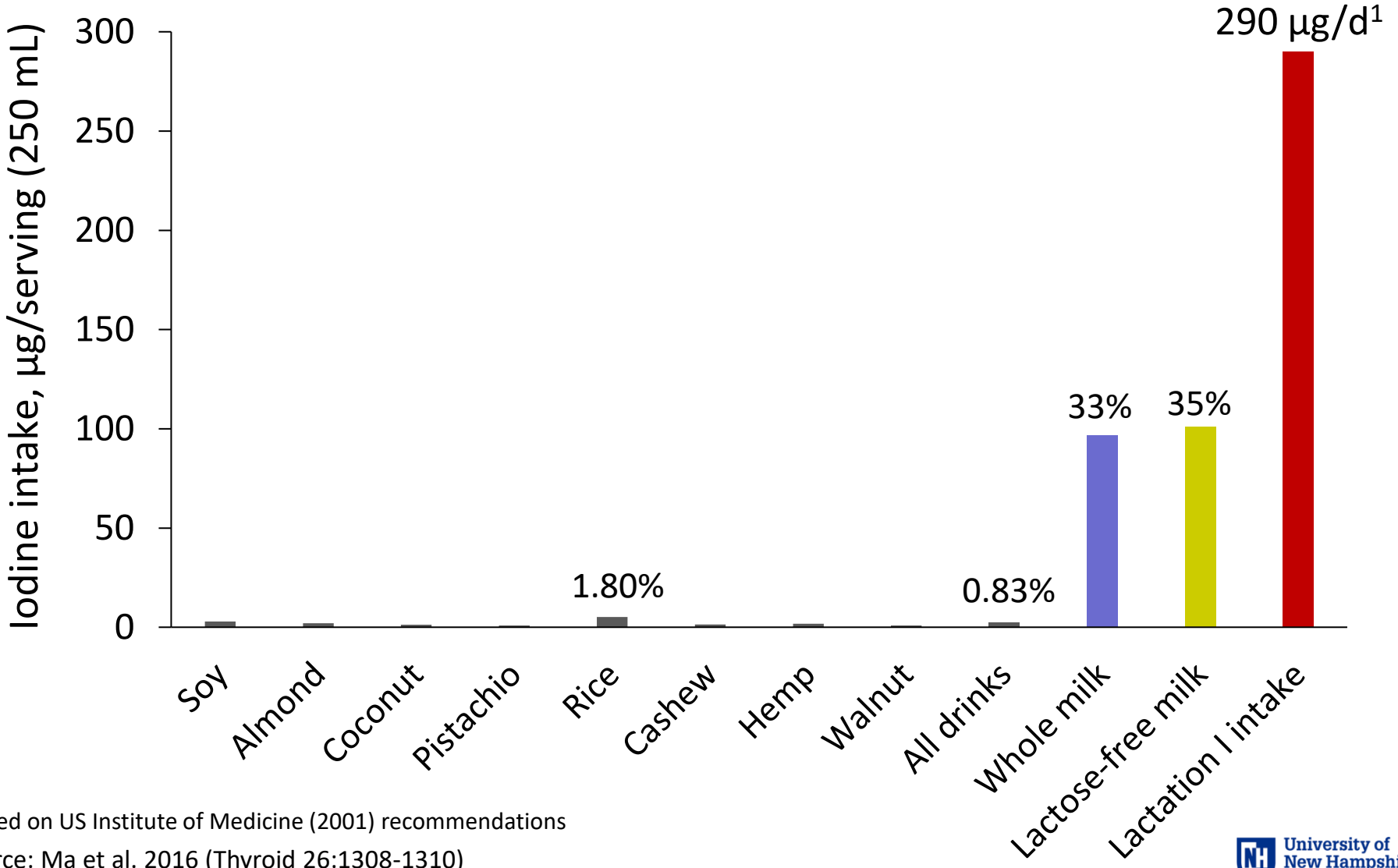
Iodine intake per serving of milk and milk alternatives relative to recommended iodine intake for lactating women



[1]Based on US Institute of Medicine (2001) recommendations

Source: Ma et al. 2016 (Thyroid 26:1308-1310)

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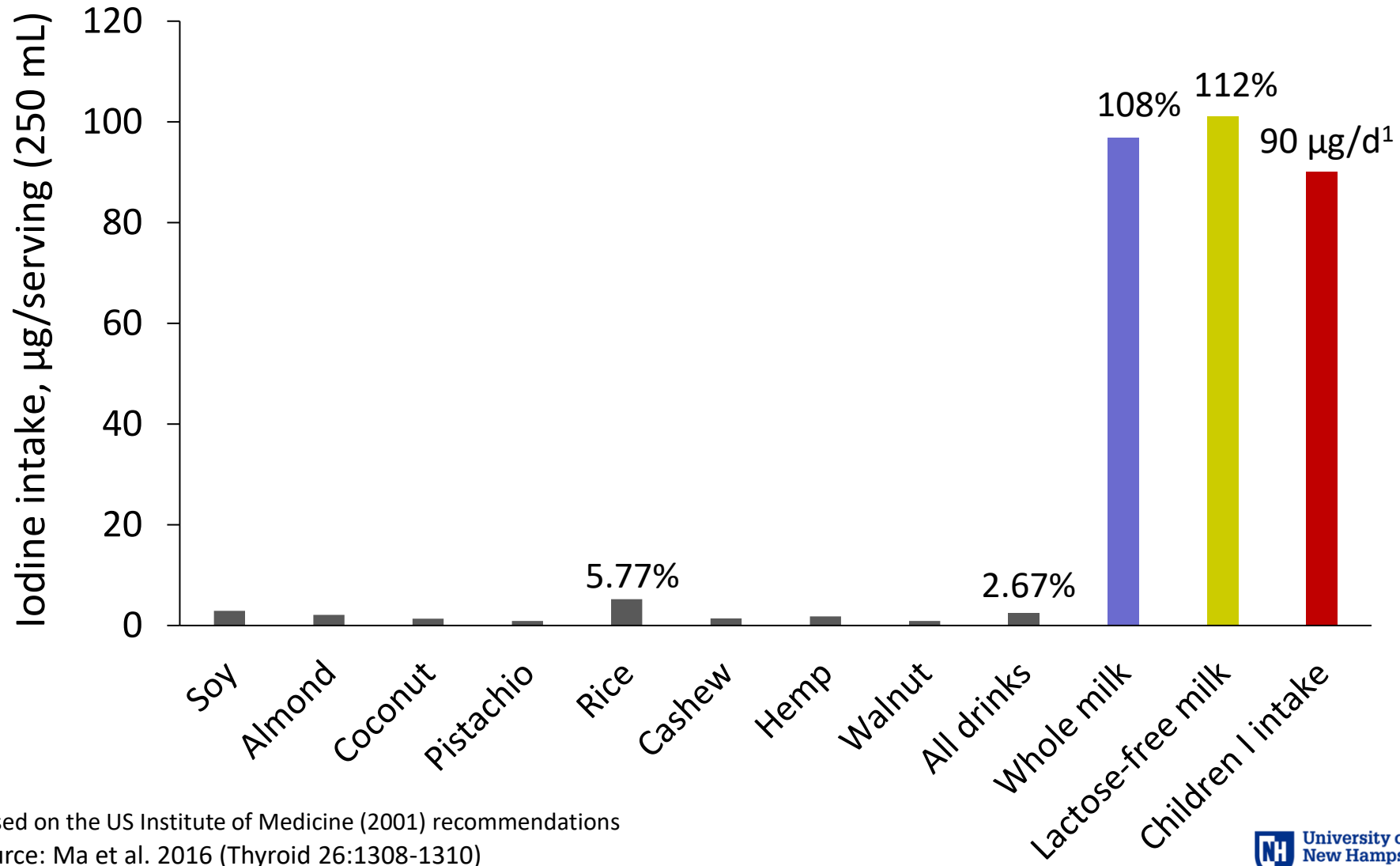
Iodine Intake per serving of milk and milk alternatives relative to recommended iodine intake for children (1-8 yr)



[1]Based on the US Institute of Medicine (2001) recommendations

Source: Ma et al. 2016 (Thyroid 26:1308-1310)

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See corresponding editorial on page 443.

Association between noncow milk beverage consumption and childhood height

Marie-Elssa Morency,[1,4] *Catherine S Birken,*[1,5–7] *Gerald Lebovic,*[2,4] *Yang Chen,*[4] *Mary L'Abbé,*[1] *Grace J Lee,*[4] *and Jonathon L Maguire,*[1–7] *and the TARGet Kids! Collaboration*

[1]Department of Nutritional Sciences and [2]Institute for Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada; [3]Department of Pediatrics and [4]Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada; and [5]Department of Pediatrics, [6]Division of Pediatric Medicine and the Pediatric Outcomes Research Team, and [7]Child Health Evaluative Sciences, Peter Gilgan Centre for Research and Learning, Hospital for Sick Children, Toronto, Ontario, Canada

Morency et al. (2017) study

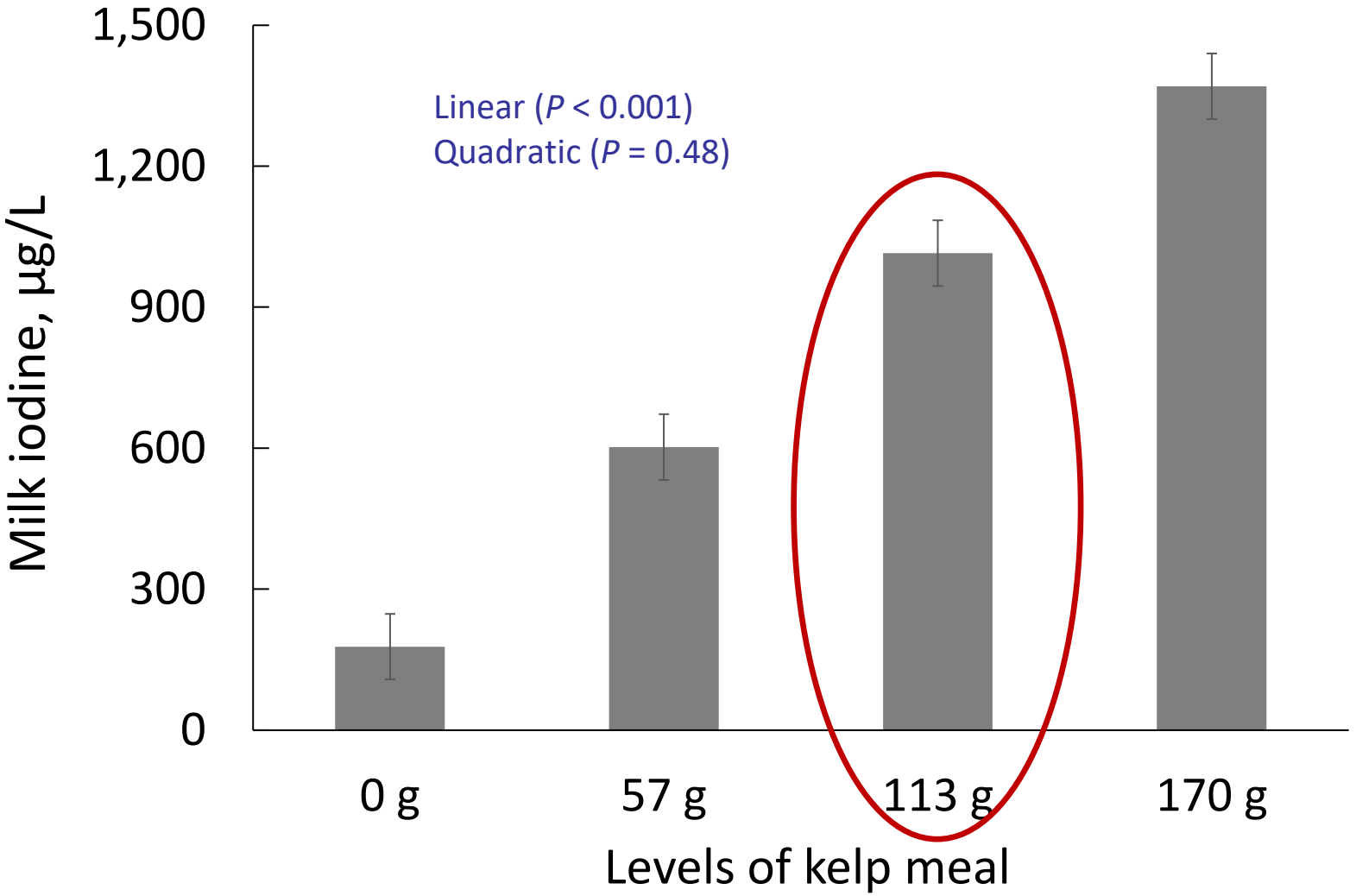
- 5,034 healthy Canadian children aged 2–3 yr old were enrolled in this cross-sectional study

- Multivariable linear regression was used to determine the association between milk alternatives consumption and height taking into account age, sex, BMI, maternal ethnicity and height, and neighborhood income

- A dose-dependent association was observed between greater milk alternative consumption and lower height ($P < 0.0001$)

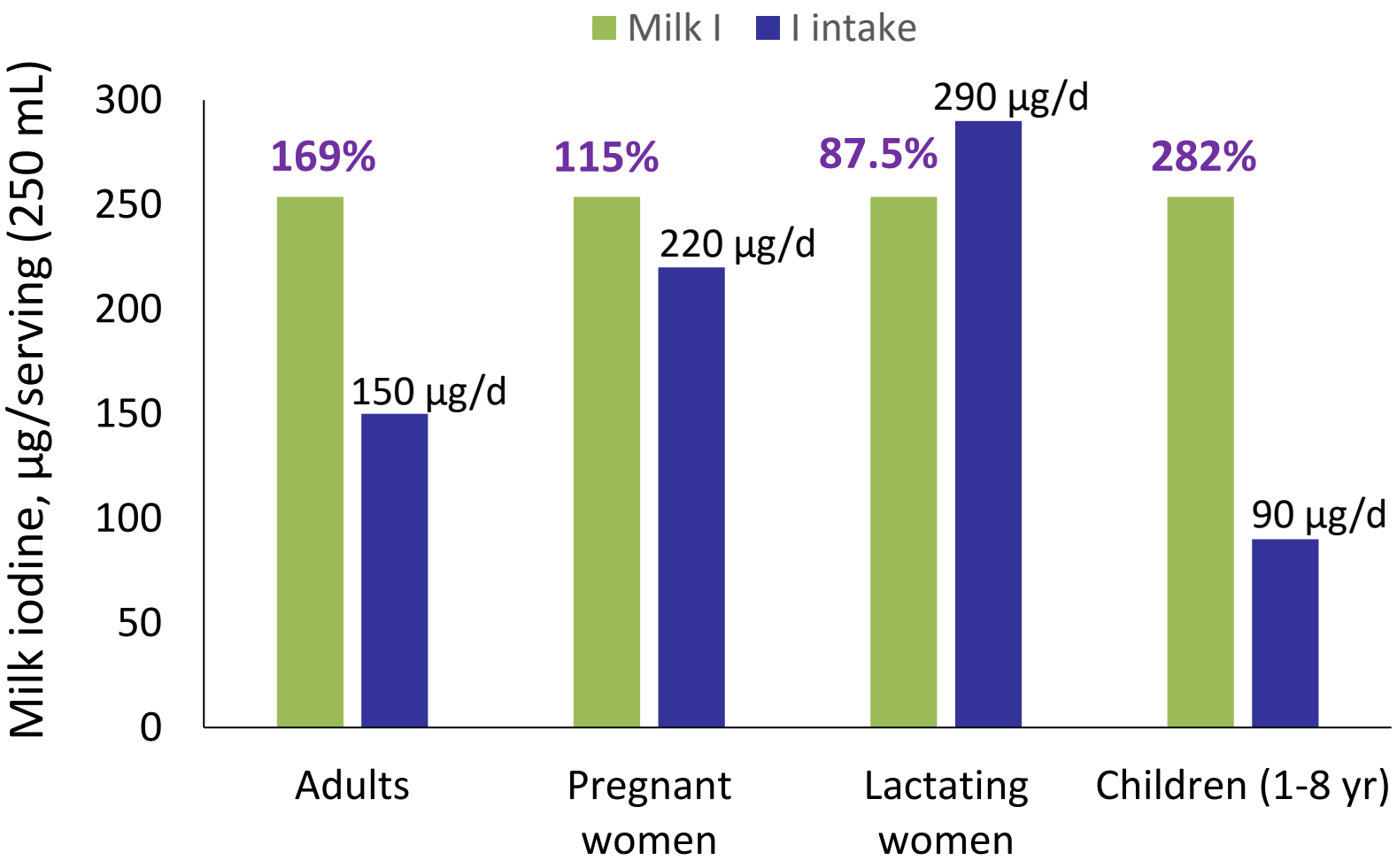
- The height difference for a child aged 3 yr consuming 3 cups/d of milk alternatives compared with 3 cups/d of cow milk was 1.5 cm

Milk iodine increased linearly in organic dairy cows fed kelp meal during the winter season



Source: Antaya et al. 2015 (J. Dairy Sci. 98:1991-2004)

Iodine Intake per serving of milk from cows fed 113 g of kelp meal relative to recommended iodine intake for adults[1]



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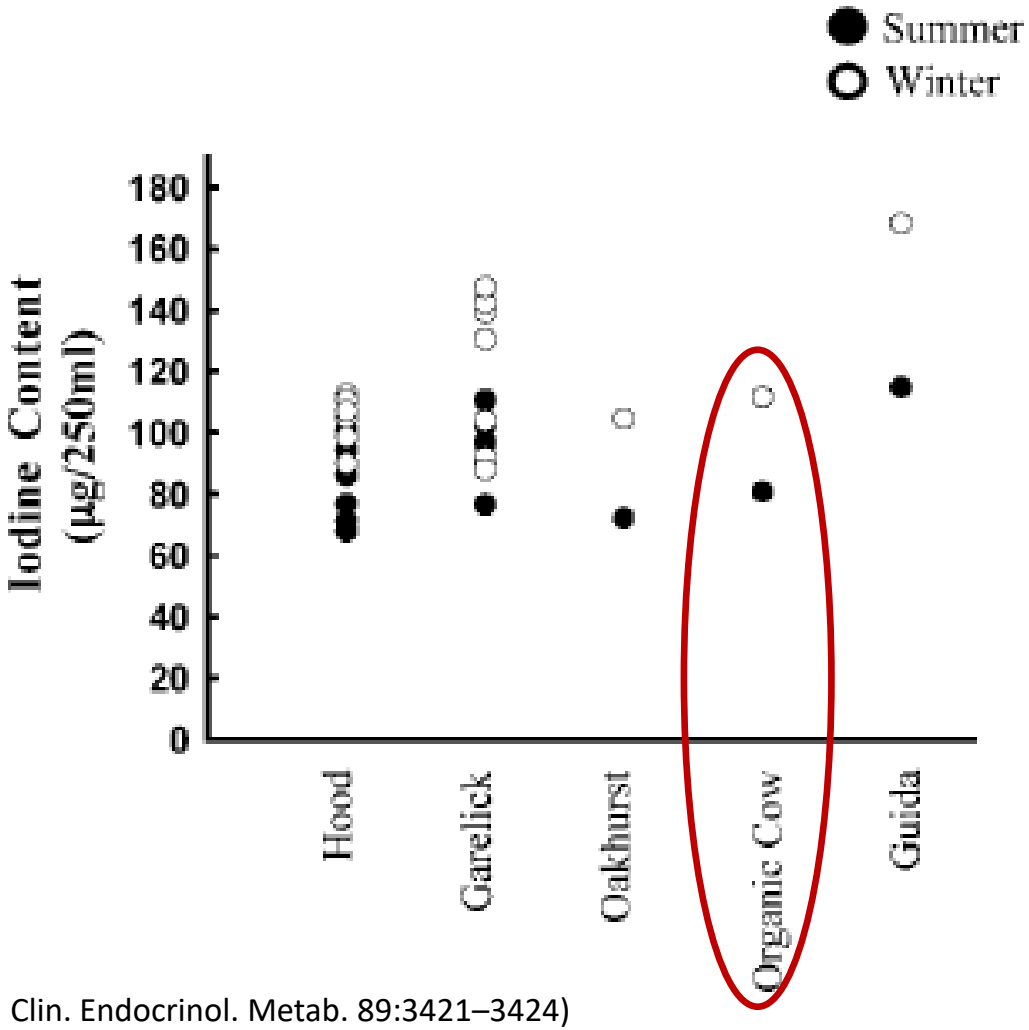
[1]Based on the US Institute of Medicine (2001) recommendations

Tollerable upper limits for iodine intake

US Institute of Medicine[1]		World Health Organization[2]	
Age or population group	µg/d	Age or population group	µg/d
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		

[1]US Institute of Medicine, Academy of Sciences (2001)
[2]World Health Organization (2007)

Iodine concentration in conventional and organic milk during the summer and winter seasons



Source: Pearce et al. 2004 (J. Clin. Endocrinol. Metab. 89:3421–3424)

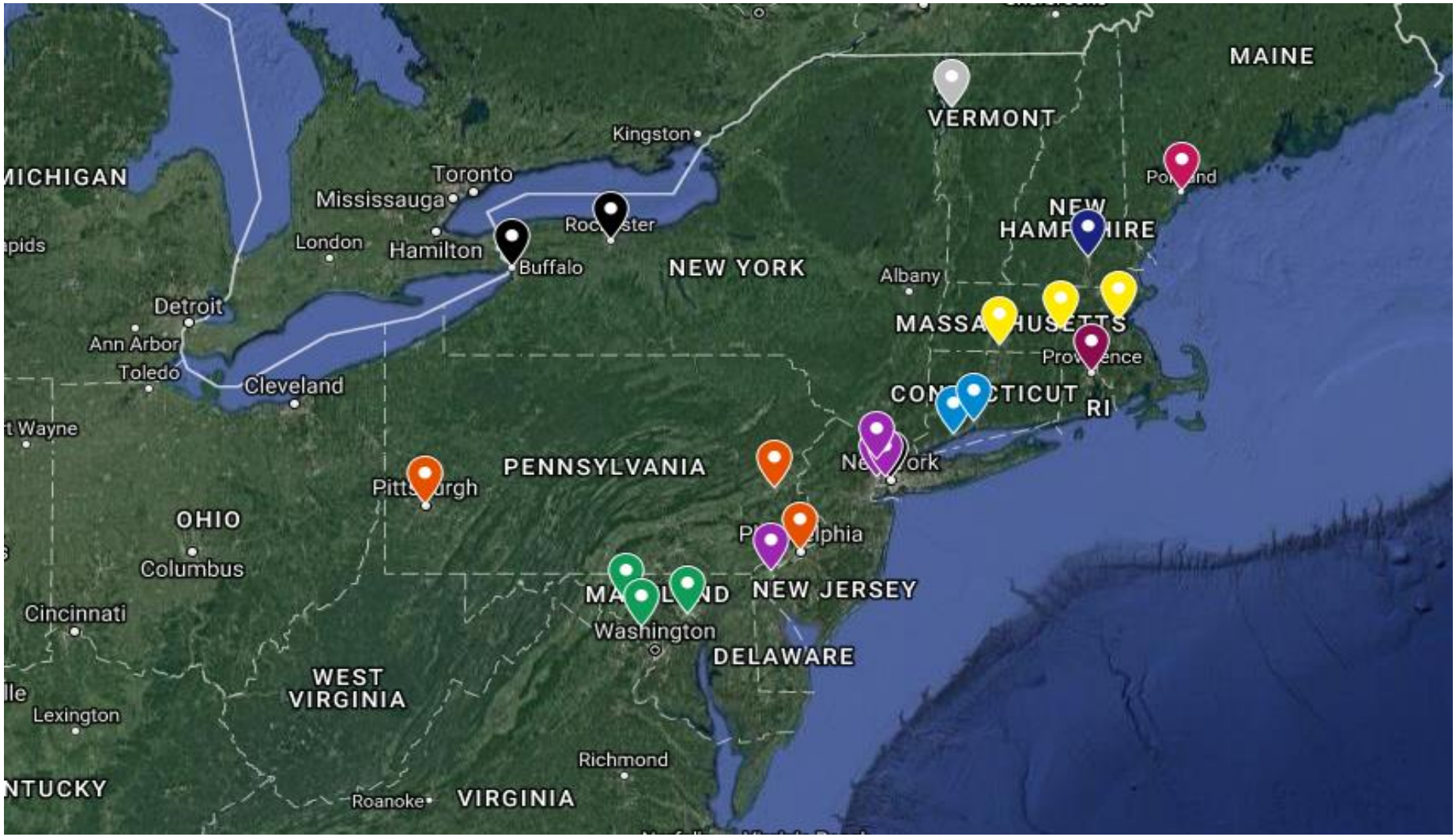
Unraveling challenges and opportunities of kelp meal supplementation in northeastern organic dairies

Funding source: Northeast SARE
$215,000

NORTHEAST SARE
Sustainable Agriculture Research & Education

University of New Hampshire

Retail milk iodine survey in the Northeast



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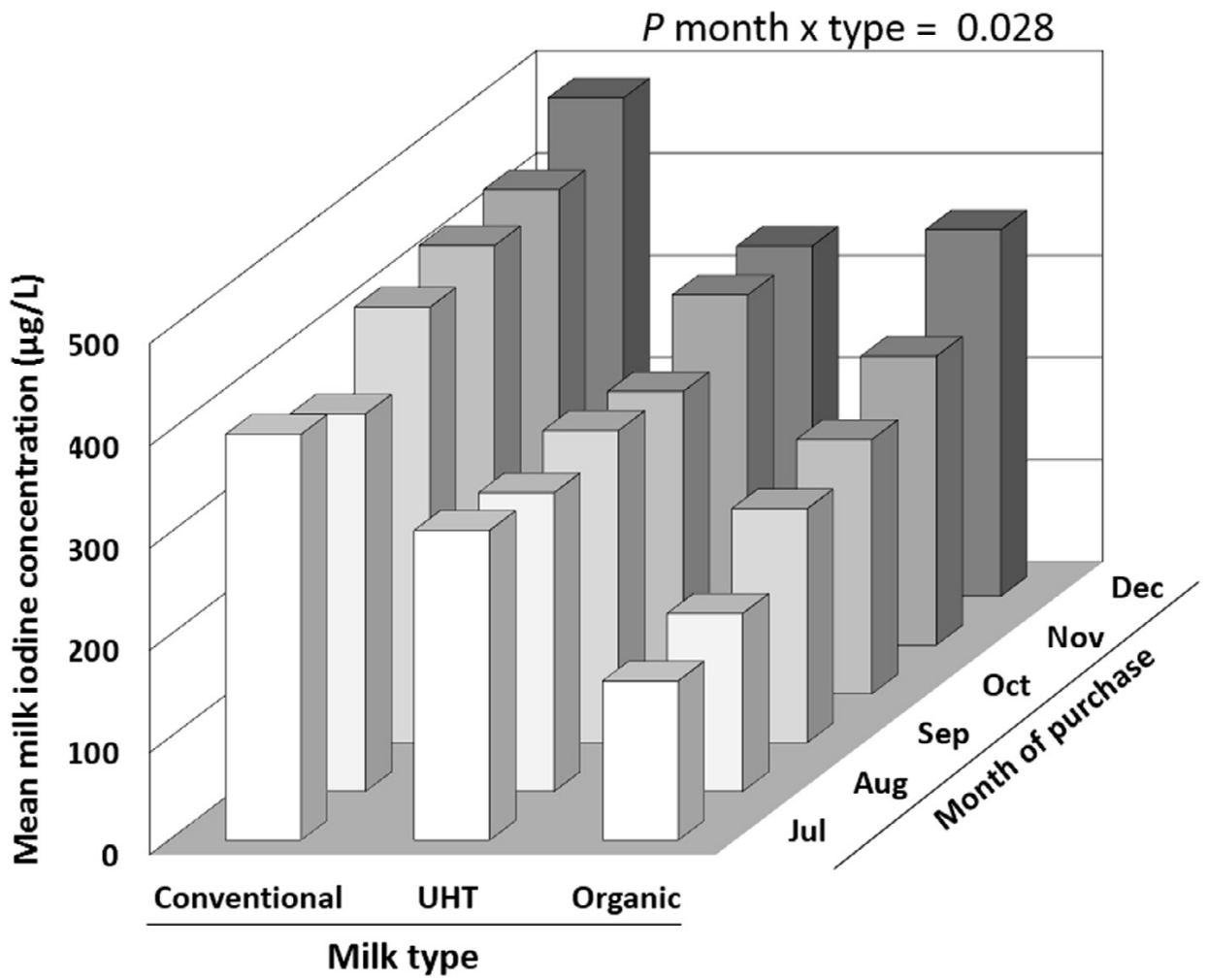
Retail milk iodine survey in the Northeast

State	# Obs.	# Cities	# Stores	Organic	Conventional
NY	905	3	16	17	28
PA	636	3	12	18	28
MA	484	3	11	15	23
NJ	443	3	9	10	20
MD	360	2	8	12	16
CT	292	2	4	9	18
NH	159	1	2	6	8
ME	154	1	2	6	9
RI	144	1	2	4	13
VT	123	1	2	7	11
DE	105	1	3	3	5
DC	78	1	2	4	7
Total	3,883	22	73	111	186

Interaction effect of milk type and month of purchase on the iodine concentration in different types of milk



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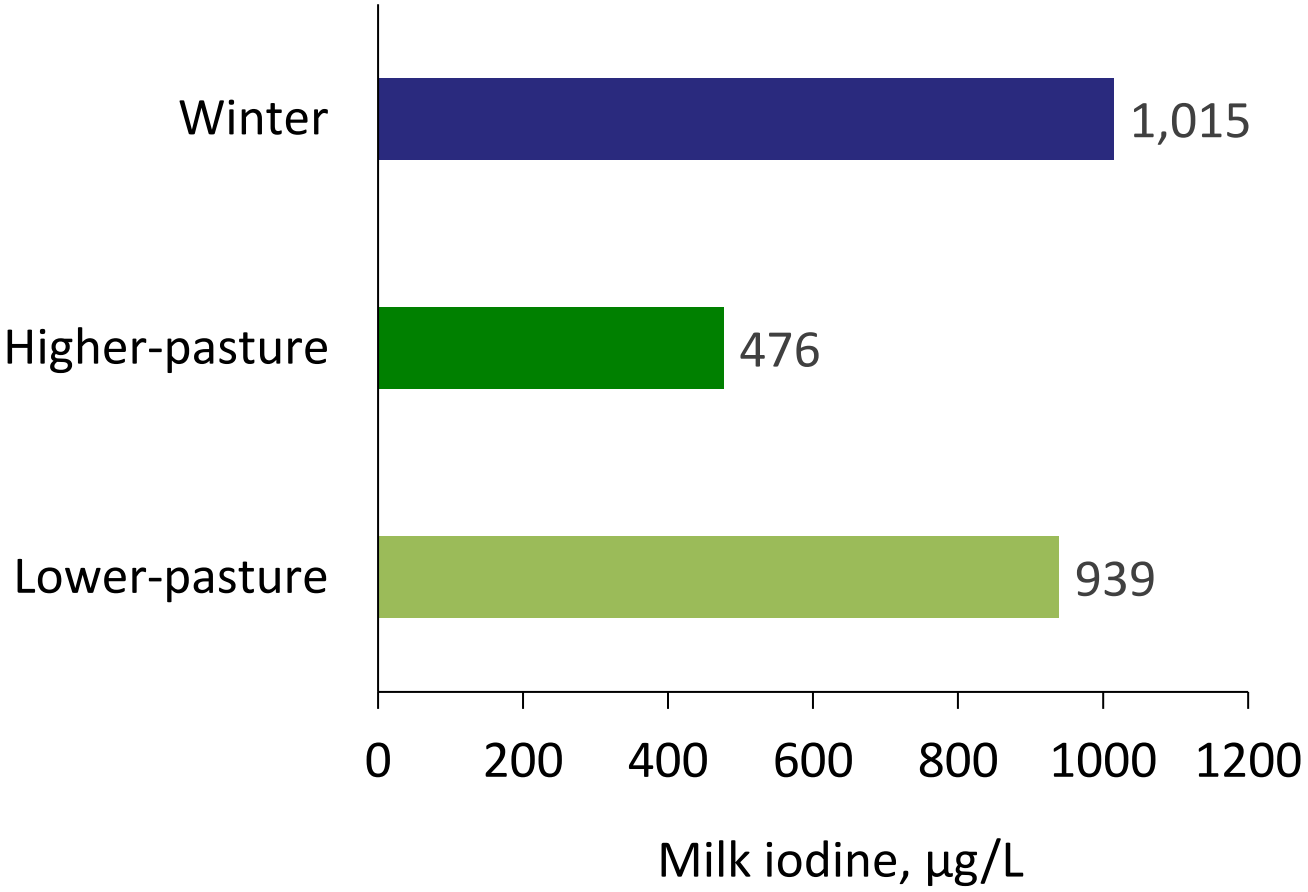
Source: Stevenson et al. 2018 (Food Chem. 239: 551–555)

Milk iodine concentration in organic-certified cows fed 113 g of kelp meal during the winter[1] and summer seasons[2]



[1]Winter study: Antaya et al. 2015 (J. Dairy Sci. 98:1991-2004)
[2]Summer study: Brito et al. (unpublished)

Final considerations

- Globally, 29.8% of school-age children (246 million) and 30% of the world population (~2.2 billion) are estimated to have insufficient iodine intake (Ma and Skeaff, 2017)

- Perhaps one of the most important developments in modern medicine, second only to the development of antibiotics and vaccines, is the development of efforts to eradicate the iodine deficiency disorders (Sistrunk and van der Haar, 2017)

- In the US, consumption of milk-alternatives is increasing in detriment of milk consumption, which may have implications on iodine status of vulnerable populations (e.g., children, pregnant and lactating women, vegans)

- Based on data presented, iodine concentration in milk-alternative beverages is too low and these products should be supplemented with iodine

- Sodium consumption is also declining due to potential risks associated with heart diseases and hypertension

Acknowledgments

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United States Department of Agriculture
National Institute of Food and Agriculture

Questions?


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