

History of Food Fortification and Global Experience of Large Scale Food Fortification



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Enriching Food and Enriching Lives
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Food Fortification Initiative
Enhancing Grains for Healthier Lives

A large, light blue, semi-transparent graphic in the background. It features a globe with a grid of latitude and longitude lines. A leafy branch, similar to the one in the top right icon, is positioned above the globe, with its stem curving around the globe's equator. The entire graphic is centered on the page.

History of Food Fortification



Food Fortification in Ancient Times



“Legend has it that an ancient Persian physician prescribed **sweet wine laced with iron filings** for Jason and the Argonauts to strengthen the mythical sailors' resistance to spears and arrows during their quest for the Golden Fleece.”

<https://commons.wikimedia.org/w/index.php?curid=530868>



Food Fortification in Modern Times

Salt Fortification with Iodine Introduced in 1920s

Natural sources of iodine are scarce and goiter was endemic



<https://www.luxtravelcity.com/press-center/actualites/2014/12/20/18/Swiss-Travel-Experiences-1.jpg>



This Presentation

Milk



www.todayifoundout.com

Rice



www.onepointdestination.com

Wheat flour



www.importexportpalaninr.com

Oil



www.mediaite.com

Salt



thekingcrumbs.wordpress.com



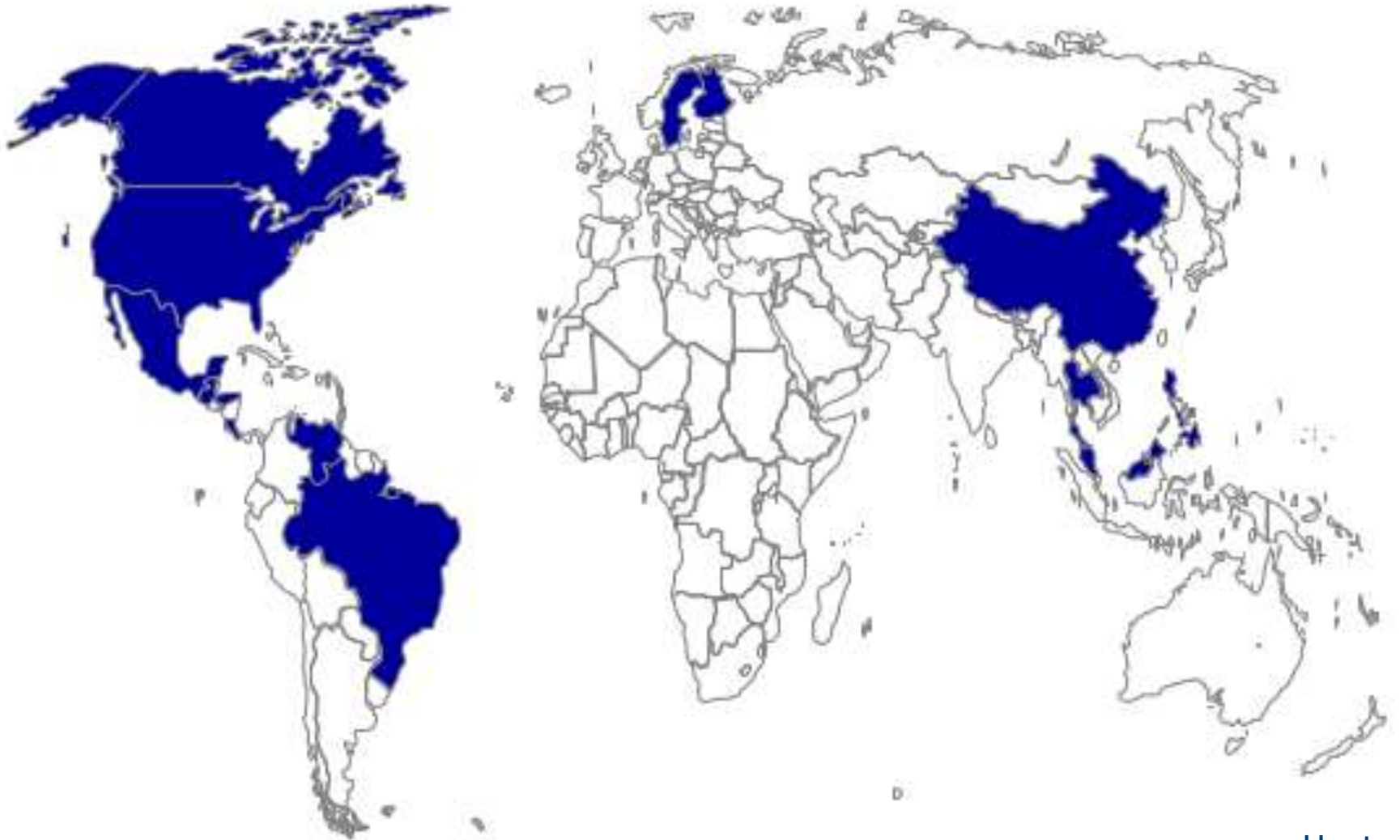
Mandatory milk fortification legislation first introduced in the 1930s



wikipedia



14 countries mandate milk fortification





Nutrients added to fortified milk

Nutrient	Number of countries (N=14)
Vitamin A	12*
Vitamin D	11†
Vitamin C	1 (Canada)
Calcium	1 (China)
Folic acid	1 (Costa Rica)
Iron	1 (Costa Rica)

* Finland & Sweden do not add vitamin A to fortified milk

† Costa Rica, Malaysia & Thailand do not add vitamin D to fortified milk



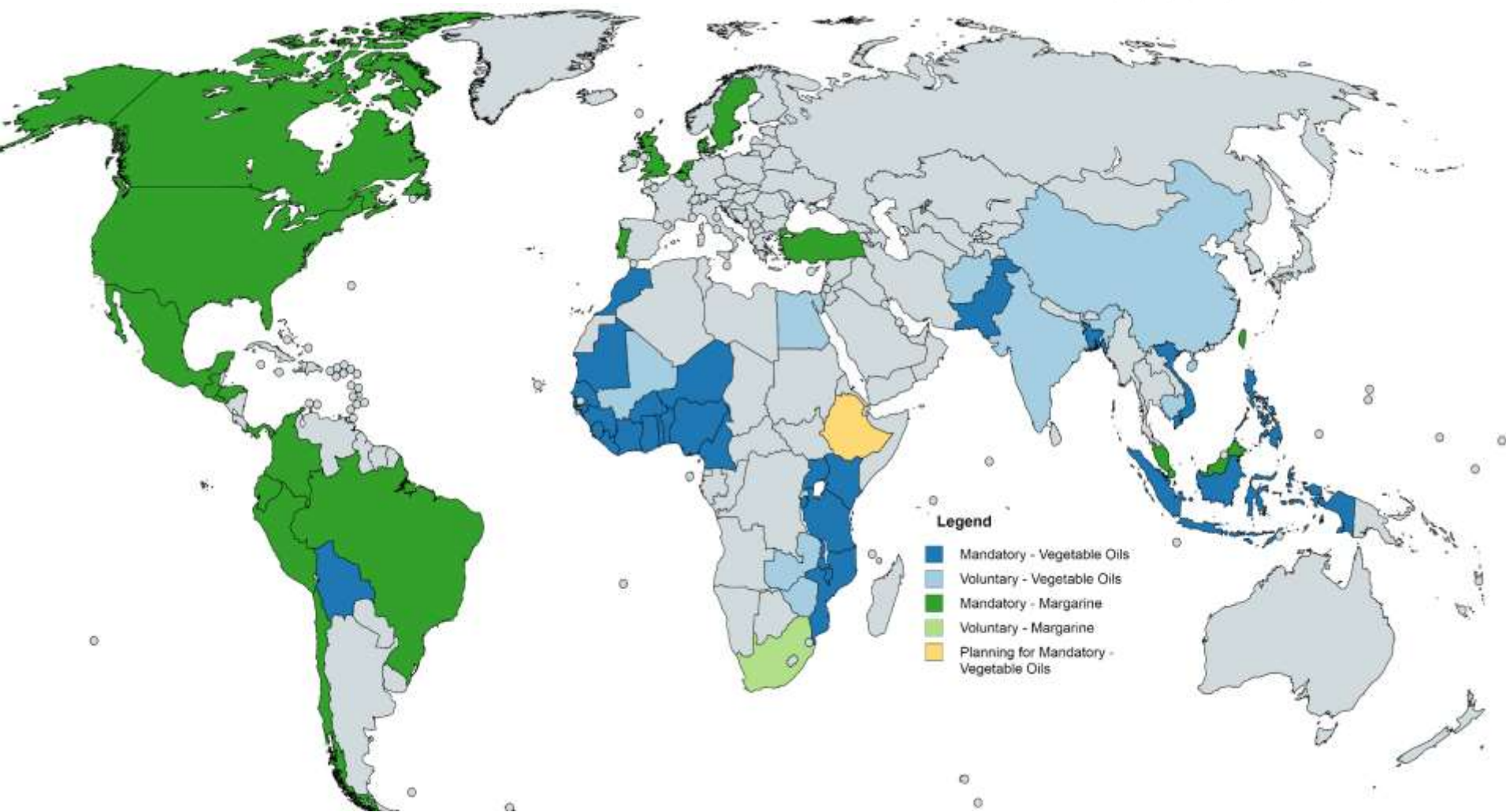
Mandatory oil fortification legislation first introduced in 1965



Wikipedia



27 countries mandate oil fortification





Nutrients added to fortified oil

Nutrient	Number of countries (N=27)	Range (mg/kg)
Vitamin A	27	6-55
Vitamin D	2*	0.075-1.0

* Morocco & Mozambique add vitamin D to fortified oil

mg/kg is the same as mcg/g is the same as parts per million (ppm)

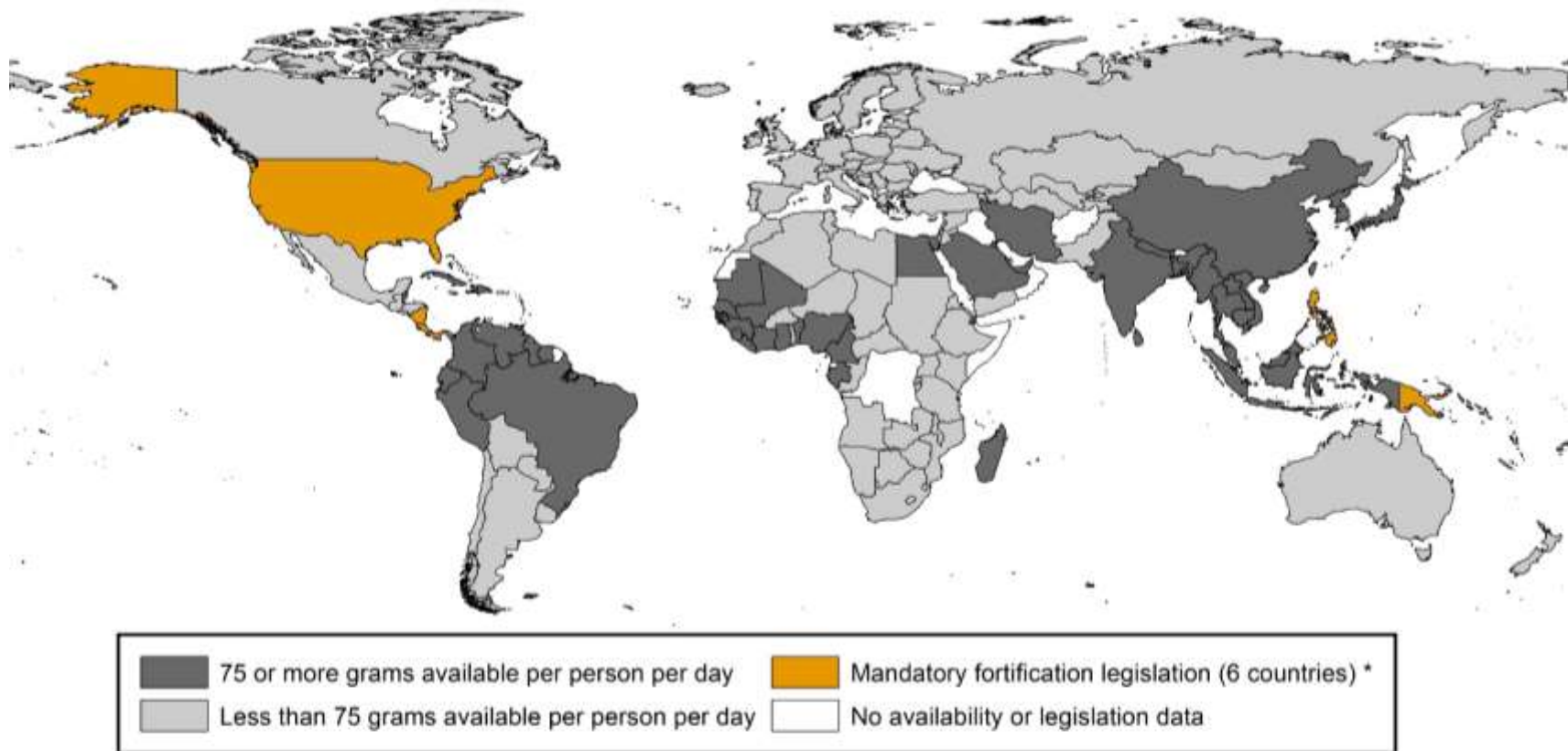


Mandatory rice fortification legislation first introduced in 1952





6 countries mandate fortification of rice



* Legislation has the effect of mandating grain fortification with at least iron or folic acid. This does not reflect how much grain is available in that country. Grain availability data from the Food and Agriculture Organization (2011). Legislation status from the Food Fortification Initiative (www.FFInetwork.org).



Vitamins in rice standard (mandatory countries)

Country	Fortification Levels (mg/kg)					
	Thiamin (B1)	Niacin (B3)	Pyridoxine (B6)	Folic Acid (B9)	B12	Vitamin E
Costa Rica	5.3	35	--	1.8	0.01	10.1
Nicaragua	5	40	4	1	0.01	--
Panama	5	40	4	1	0.01	--
Papua New Guinea	5	60	--	--	--	--
Philippines	--	--	--	--	--	--
USA	4.4-8.8	35.2-70.4	--	1.54-3.08	--	--
<i>No. countries</i>	5	5	2	4	3	1



Minerals in rice standard (mandatory countries)

Country	Iron (mg/kg)	Type of Iron	Selenium (mg/kg)	Zinc (mg/kg)
Costa Rica	--	--	0.105	7.5
Nicaragua	24	Ferric pyrophosphate	--	25
Panama	24	Ferric pyrophosphate	--	25
Papua New Guinea	30	Not specified	--	--
Philippines	60-90	Ferrous sulfate	--	--
USA	28.6-57.2	Not specified	--	--
<i>No. countries</i>	5	3	1	3



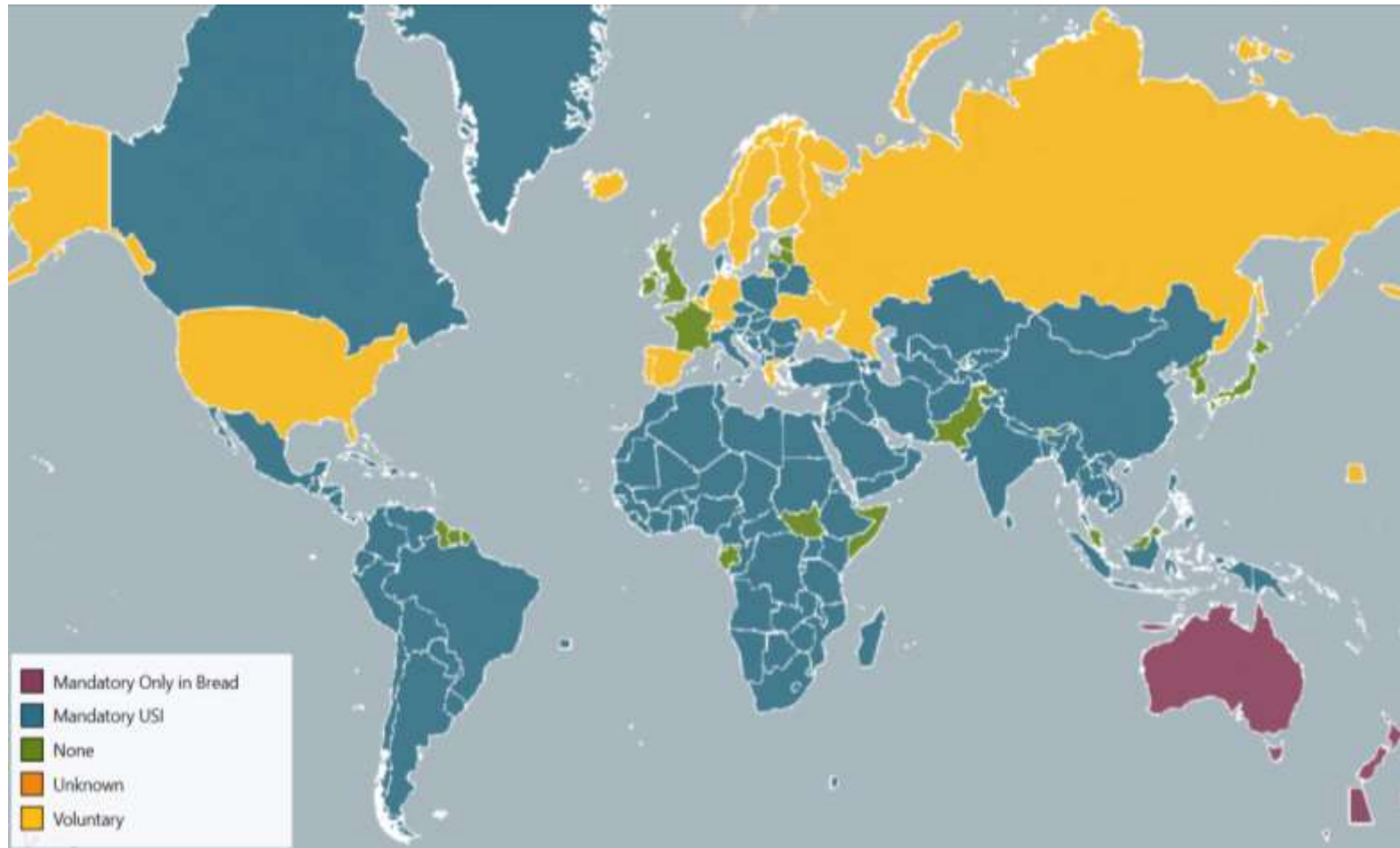
Mandatory salt fortification legislation first introduced in 1949



Wikipedia



130 countries mandate salt fortification





Nutrients added to fortified salt

Nutrient	Number of countries (N=130)
Iodine	130
Fluoride	4

mg/kg is the same as mcg/g is the same as parts per million (ppm)



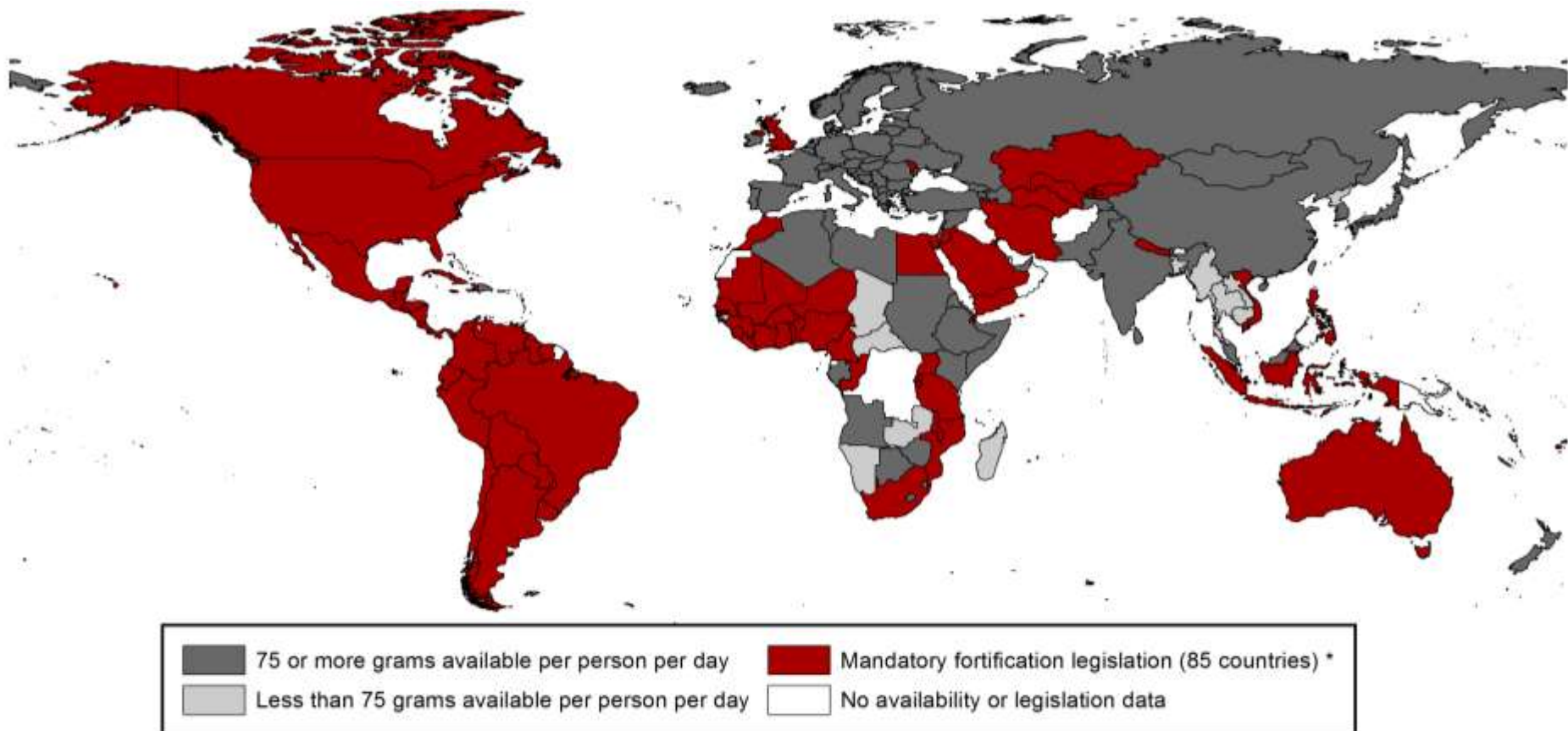
Mandatory wheat flour fortification legislation first introduced in 1942



wikipedia



85 countries mandate fortification of wheat flour



* Legislation has the effect of mandating grain fortification with at least iron or folic acid. This does not reflect how much grain is available in that country. Grain availability data from the Food and Agriculture Organization (2011). Legislation status from the Food Fortification Initiative (www.FFInetwork.org).



Nutrients added to fortified wheat flour

Nutrient	Number of countries (N=85)	Range (mg/kg)
Iron*	84	16.5-140
Folic acid	80	1-6.0
Thiamin (vitamin B1)	66	1.5-15
Riboflavin (vitamin B2)	64	1.3-9.6
Niacin (vitamin B3)	63	13-90
Zinc	30	15-116
Vitamin B12	24	0.0005-0.04
Vitamin B6	19	2.5-10.0
Vitamin A	13	0.5-3.0
Calcium	5	1100-3900
Vitamin D	4	0.01-0.015

* Iron compounds added include electrolytic, ferrous fumarate, ferrous sulfate, NaFeEDTA, reduced mg/kg is the same as mcg/g is the same as parts per million (ppm)



Summary (1)

- Mandatory food fortification has been successfully practiced for decades
- Currently, many countries mandate fortification of
 - Milk: 14
 - Oil : 27
 - Rice: 6
 - Salt : 130
 - Wheat flour: 85



Summary (2)

- Many nutrients are added to mandatorily fortified:
 - Milk: 2 minerals, 4 vitamins
 - Oil : 2 vitamins
 - Rice: 3 minerals, 6 vitamins
 - Salt : 2 minerals
 - Wheat flour: 3 minerals, 8 vitamins



Global Experience

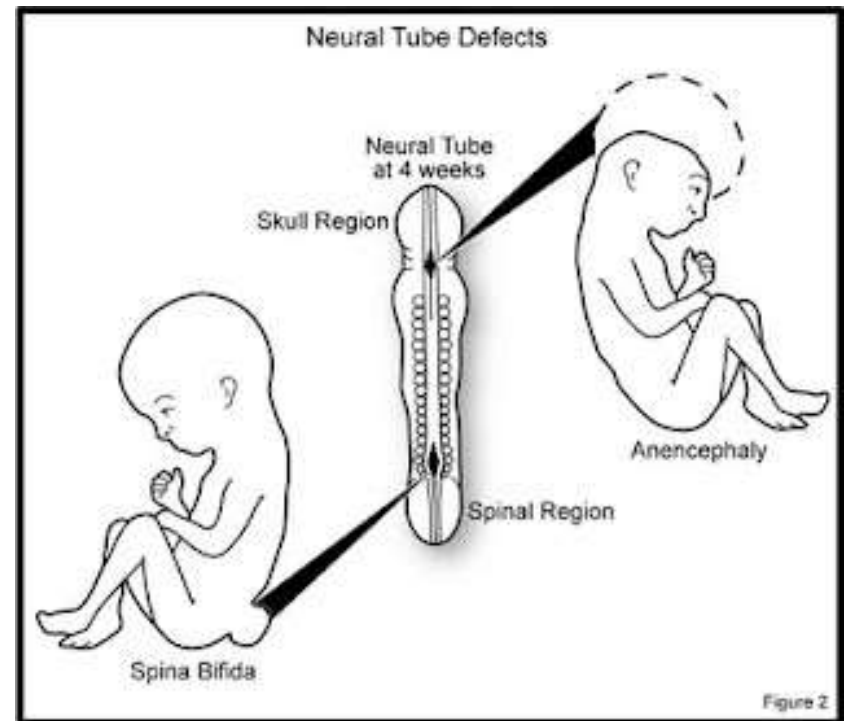
**Health Improvements Observed
from Large-Scale Food
Fortification:
Wheat Flour as an Example**



Neural tube defects and folic acid

Birth defect affecting the brain and spinal cord

- Occurrence of neural tube defects (NTDs) yearly
 - 324,000 global
 - 118,000 India
- ~75% are preventable if the mother has enough folic acid around conception

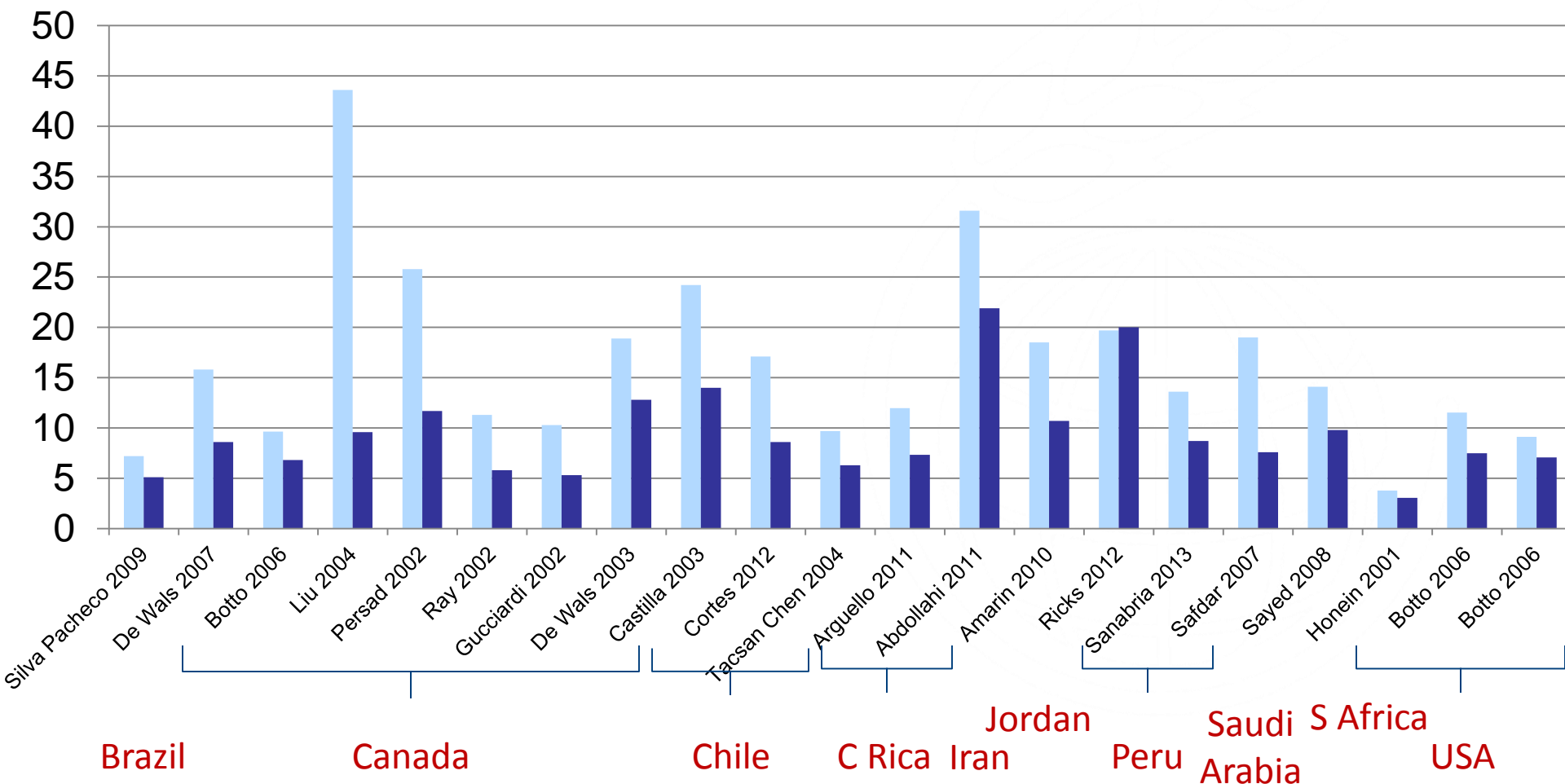


<http://www.thescienceofpregnancy.id.au>



Reductions in neural tube defects (NTDs) after flour fortification with folic acid was initiated

■ Prefortification NTD per 10,000 ■ Postfortification NTD per 10,000



Folic acid in flour ranged from 1.2-2.2 mg/kg

FFI 2012, updated 2015



Other health improvements attributable to fortified wheat flour

Nutrients in Flour	Outcome	Sources
Folic acid	Reduces folate deficiency	Colapinto 2011 Odewole 2013
Folic acid	Reduces folate-deficiency anemia	Odewole 2013
Iron	Reduces iron deficiency	Pachón 2015
Iron & other nutrients	Reduces anemia*	Pachón 2015

* When WHO recommendations for flour fortification with iron are followed

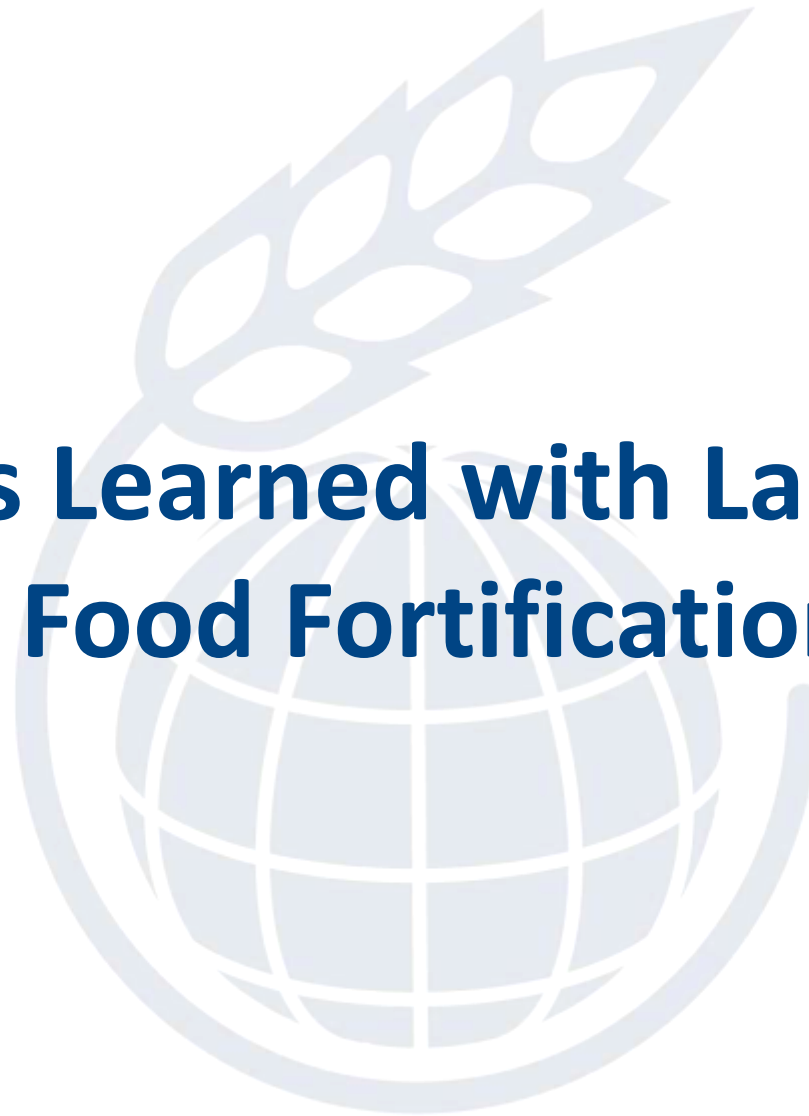


Summary

- Evidence from large-scale implementation
- Flour fortification with folic acid reduces
 - Neural tube defects
 - Folate deficiency
 - Folate-deficiency anemia
- Flour fortification with iron reduces
 - Iron deficiency
- Flour fortification with multiple nutrients reduces
 - Anemia if WHO recommendations are followed



Lessons Learned with Large Scale Food Fortification

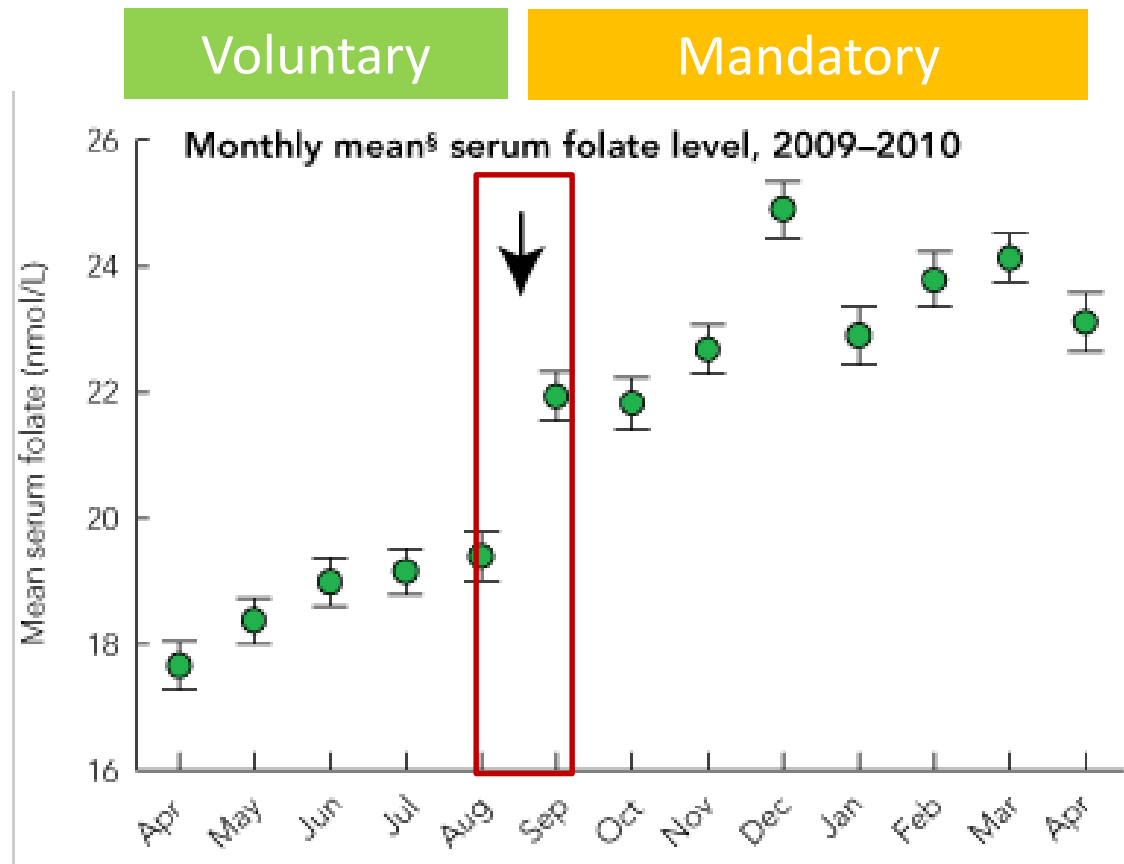




Mandatory fortification is more effective than voluntary fortification

Fortification with folic acid increases serum folate

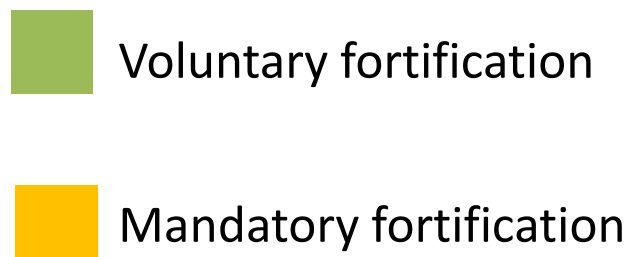
- Voluntary fortification began in 1995 in Australia
- Mandatory wheat flour fortification began in September 2009
- Analysis of 20,592 blood samples



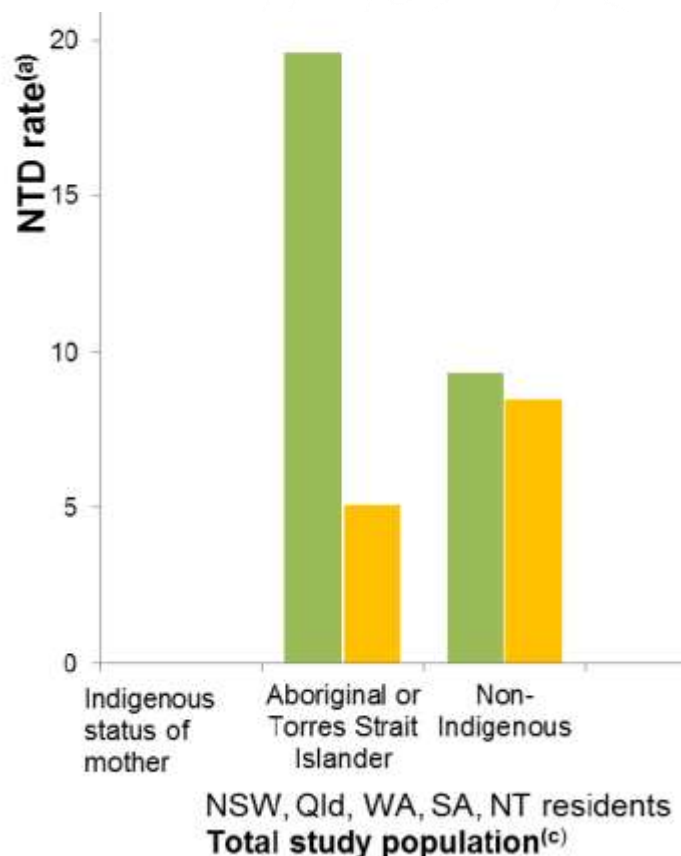


Mandatory fortification is more effective than voluntary fortification

Fortification with folic acid reduces NTDs



NTDs per 10,000 conceptions that resulted in a birth





Lesson learned (1)

Mandatory fortification is more effective than voluntary fortification for improving health outcomes



Fortification is most feasible & sustainable in a modern milling industry

- Fortifying at small mills is *technically* feasible but challenging to **sustainably implement**
 - Small mills require consistent personnel training and often financial support (for equipment and premix)
 - Large numbers of mills require high government capacity to monitor and regulate



<http://www.satakeindia.com/>



<http://www.pdi-global.org/Site/how2donate.asp>



Fortification is most feasible & sustainable in a modern milling industry

	Costa Rica	Philippines
Mandatory rice fortification	Yes	Yes
Rice milling companies (number)	11	~11,000
National rice supply fortified (%)	100%	<1%

“(Costa Rica) MOH was able to demonstrate its authority to enforce the legislation...”

“Limited government budgets to monitor thousands of milling companies...”



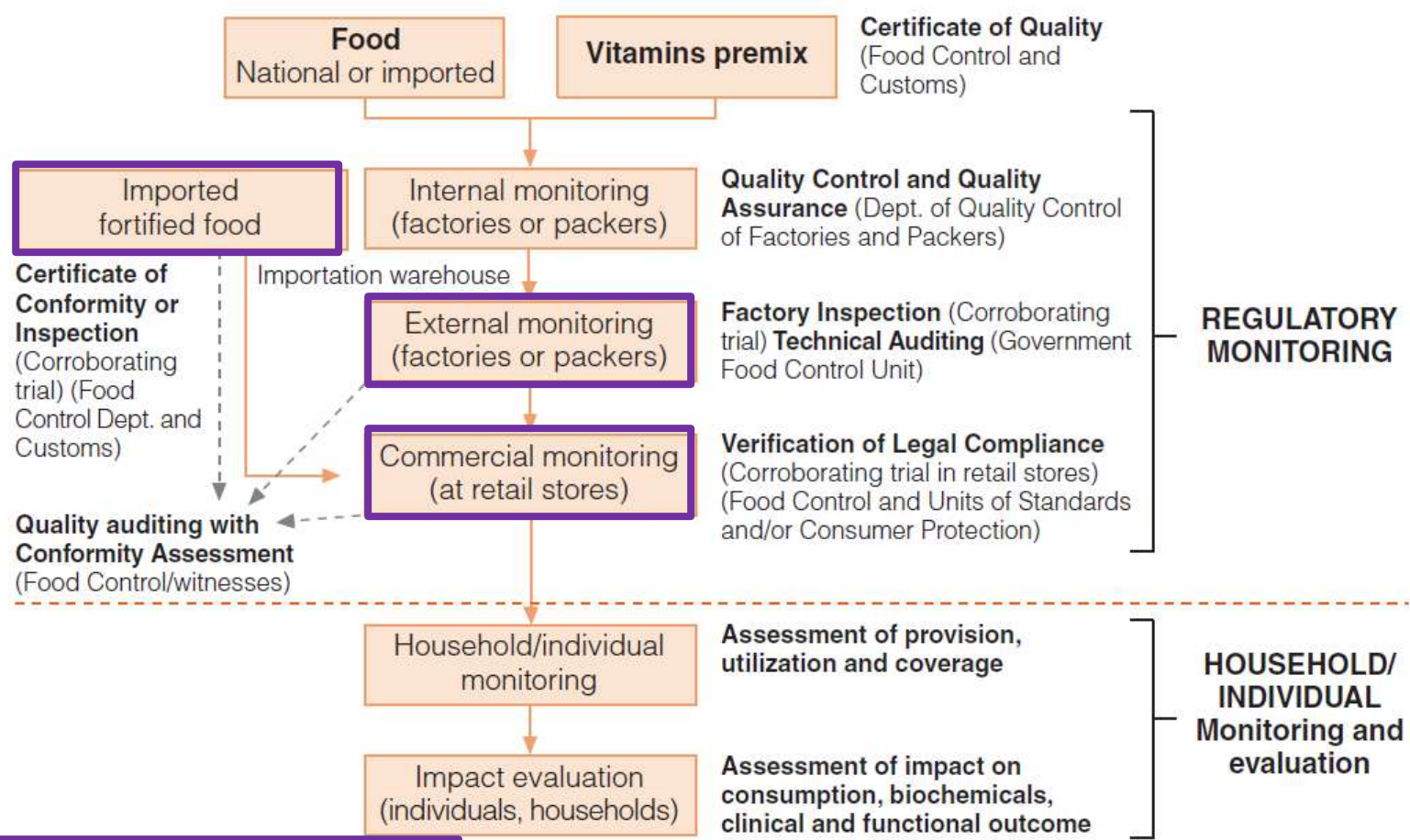
Lesson learned (2)

Fortification is most feasibly & sustainably implemented through a modern, centralized milling industry



Government monitoring is essential in fortification

A monitoring and evaluation system for food fortification programmes

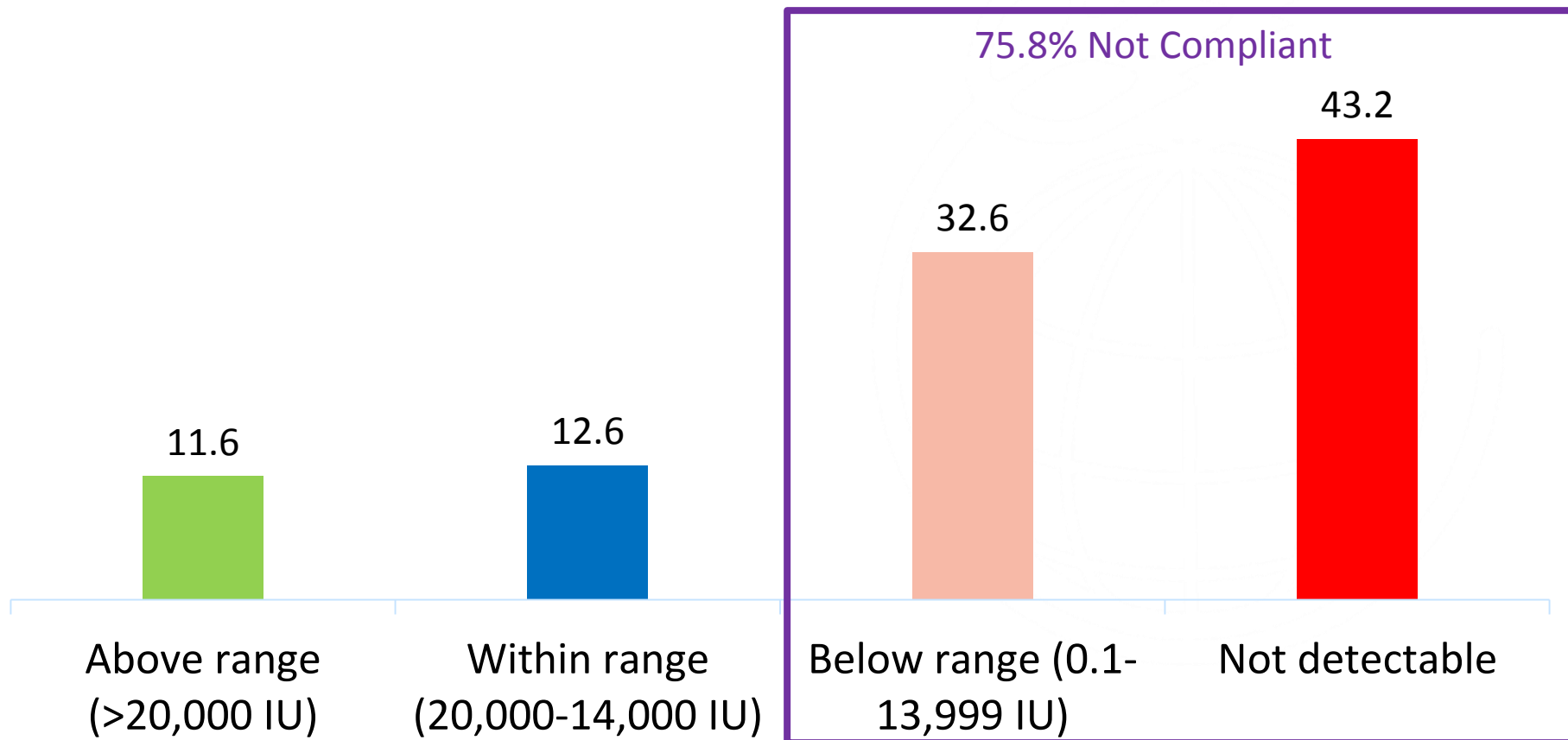


Government monitoring activities



Concern that lack of monitoring & enforcement leads to low compliance

Percentage of Vitamin A Compliance in Oils



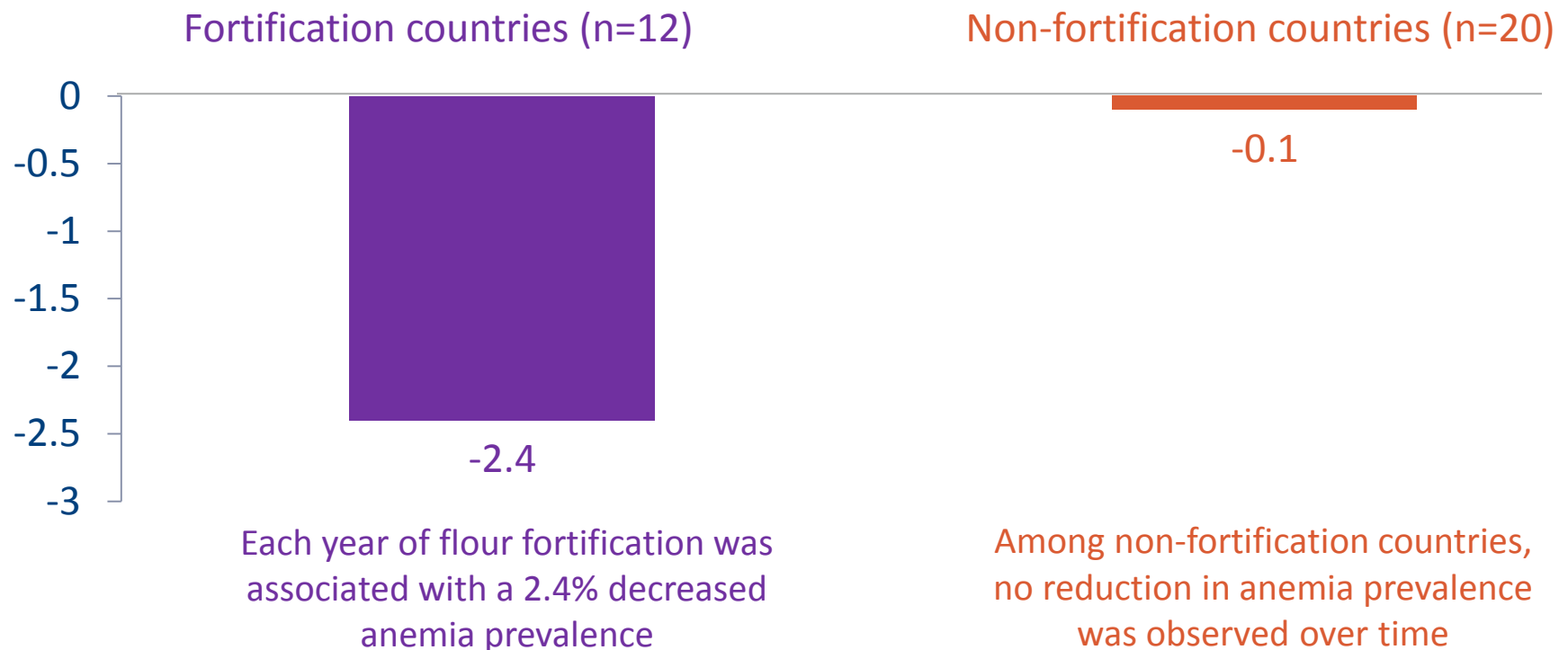


Lesson learned (3)

Government monitoring and enforcement can enhance fortification compliance by producers and importers



Flour fortification is associated with a decreased anemia prevalence in non-pregnant women



Analysis controlled for Human Development Index and malaria



Most fortification countries followed WHO recommendations



Recommendations on Wheat and Maize Flour Fortification Meeting Report: Interim Consensus Statement

Nutrient	Flour Extraction Rate	Compound	Level of nutrient to be added in parts per million (ppm) by estimated average per capita wheat flour availability (g/day) ¹			
			<75 ¹ g/day	75-149 g/day	150-300 g/day	>300 g/day
Iron	Low	NaFeEDTA	40	40	20	15
		Ferrous Sulfate	60	60	30	20
		Ferrous Fumarate	60	60	30	20
		Electrolytic Iron	60 ²	60 ²	60	40
	High	NaFeEDTA	40	40	20	15

Low-extraction flour: NaFeEDTA, ferrous sulfate, ferrous fumarate, electrolytic iron

High-extraction flour: NaFeEDTA

Use WHO-recommended Iron Compounds	
Yes (n=11)	No (n=1)
Bolivia Costa Rica (wheat*) Fiji Honduras Jordan Mexico (maize*) Nicaragua Peru Philippines Senegal Uzbekistan	Indonesia
*predominant grain in country	



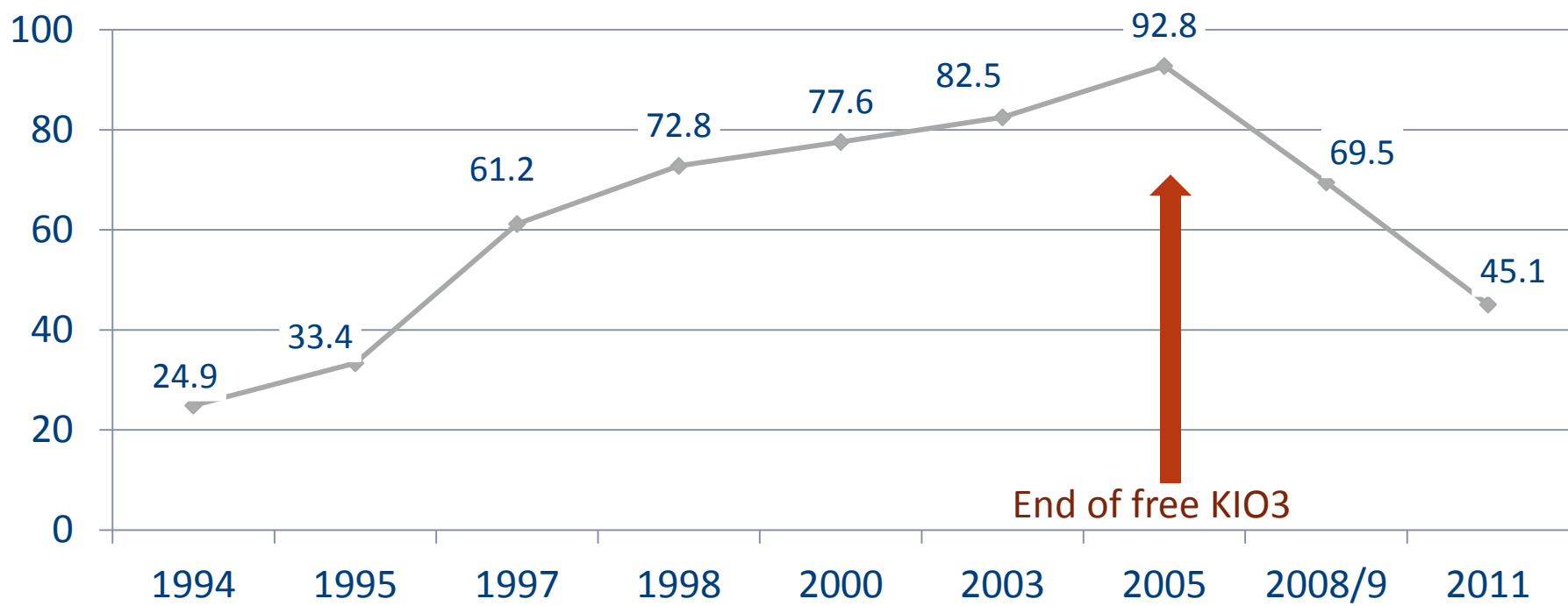
Lesson learned (4)

In setting fortification standards, all countries should aim to follow WHO recommendations for flour fortification



Household use of adequately iodized salt fell after supplies of potassium iodate ended in Viet Nam

Households with Adequately Iodized Salt (%)



Ref: National IDD Surveys and Multiple Cluster Indicator Survey in 2011

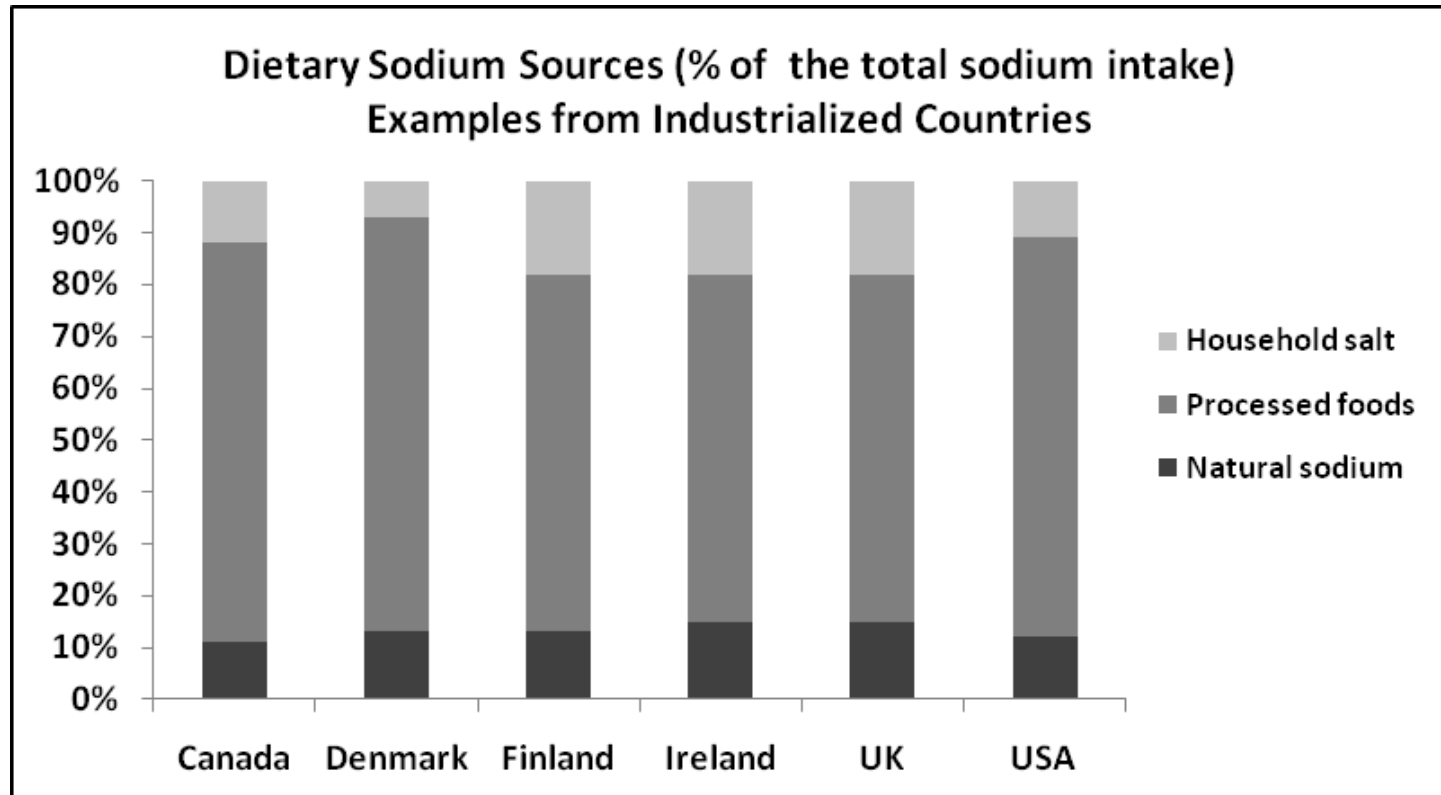


Lesson learned (5)

For long-term sustainability of fortification, it is not necessary or useful to provide free vitamin and mineral premix



Processed foods are the main sources of sodium in industrialized countries



Only half of countries with mandatory salt iodization specify that salt used in processed foods should be iodized



Lesson learned (6)

Important to periodically monitor food consumption patterns, so that the food fortification program can be adjusted as needed



Summary (1)

- Global experience has provided a number of lessons for successful implementation of fortification
 - Mandatory fortification is more effective than voluntary fortification for improving health outcomes
 - Fortification is most feasibly & sustainably implemented through a modern, centralized milling industry
 - Government monitoring and enforcement can enhance fortification compliance by producers and importers



Summary (2)

- Global experience has provided a number of lessons for successful implementation of fortification
 - In setting fortification standards, all countries should aim to follow WHO recommendations for flour fortification
 - For long-term sustainability of fortification, it is not necessary or useful to provide free vitamin and mineral premix
 - Important to periodically monitor food consumption patterns, so that the food fortification program can be adjusted as needed



Conclusions

- Mandatory food fortification has been successfully practiced for decades throughout the globe
- Currently, many countries mandate food fortification
- Food fortification improves public health outcomes
- Global experience has provided a number of lessons for successful implementation of fortification



Acknowledgements

- Rita Bhatia
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For more information:

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