Review of the public-health evidence of flour fortification impacting serum folate, neural tube defects, serum ferritin, and hemoglobin

Flour Fortification Initiative
A Public-Private-Civic Investment in Each Nation

Helena Pachón

4 March 2013

Flour Fortification Monitoring and Surveillance: Process and Possibilities

Acknowledgements

Gabrielle Fanning-Dowdell

Study types

EFFICACY

"The extent to which a specific intervention, procedure, regimen, or service produces a beneficial result under ideal conditions …Ideally, the determination of efficacy is based on the results of a randomized controlled trial."

EFFECTIVENESS

"**…**it is a measure of the extent to which a specific intervention, procedure, regimen, or service, when deployed in the field in the usual circumstances, does what it is intended to do for a specified population. A measure of the extent to which a health care intervention fulfills its objectives in practice."

This presentation will summarize results from effectiveness trials, conducted before and after fortification programs were initiated in countries. None of these results are from efficacy trials.

Porta 2008

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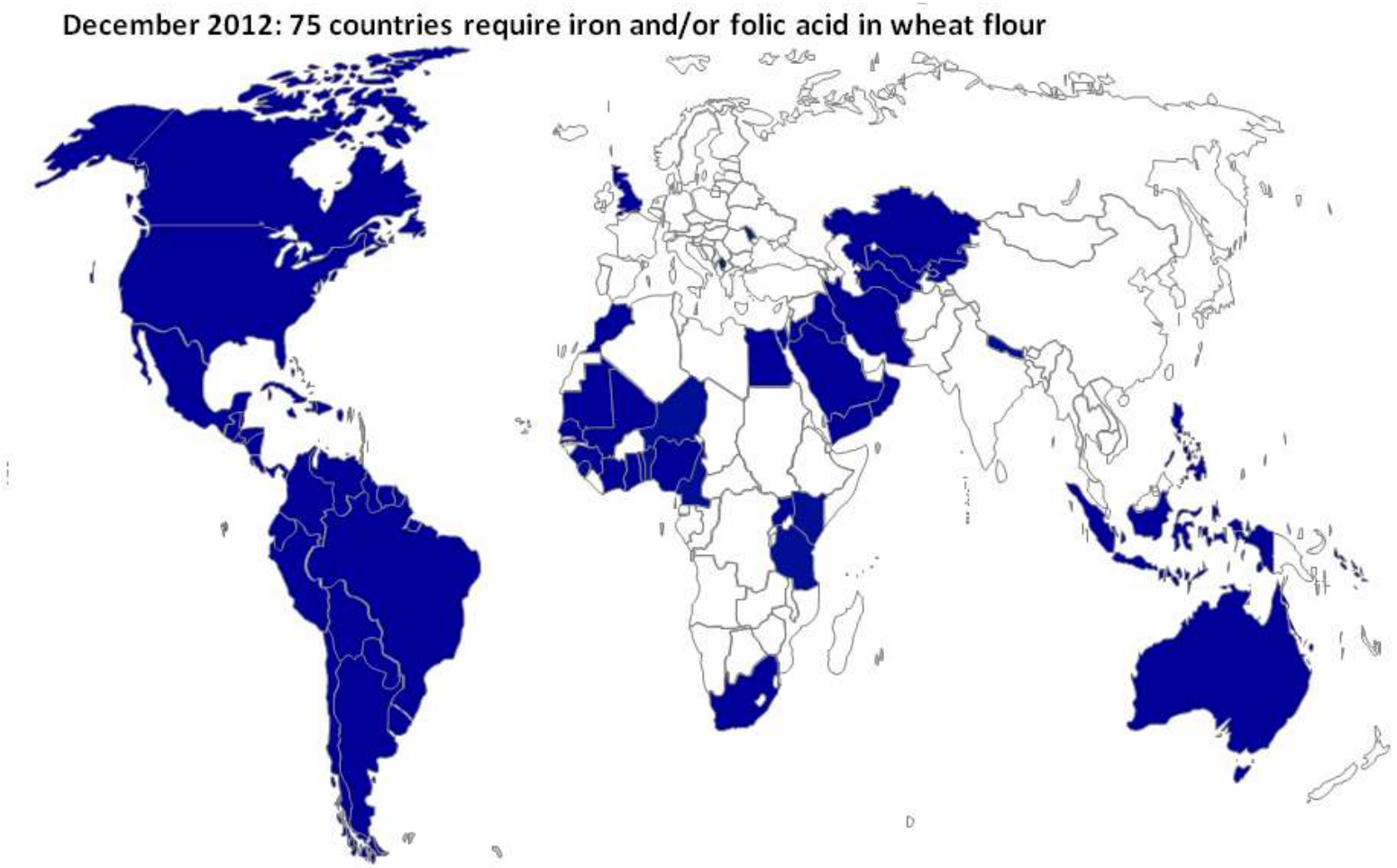
Countries that mandate wheat flour fortification with iron and/or folic acid



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All countries fortify flour with at least iron and folic acid except Australia which does not include iron, and Venezuela, the United Kingdom, and the Philippines which do not include folic acid. Source: Flour Fortification Initiative www.FFInetwork.org

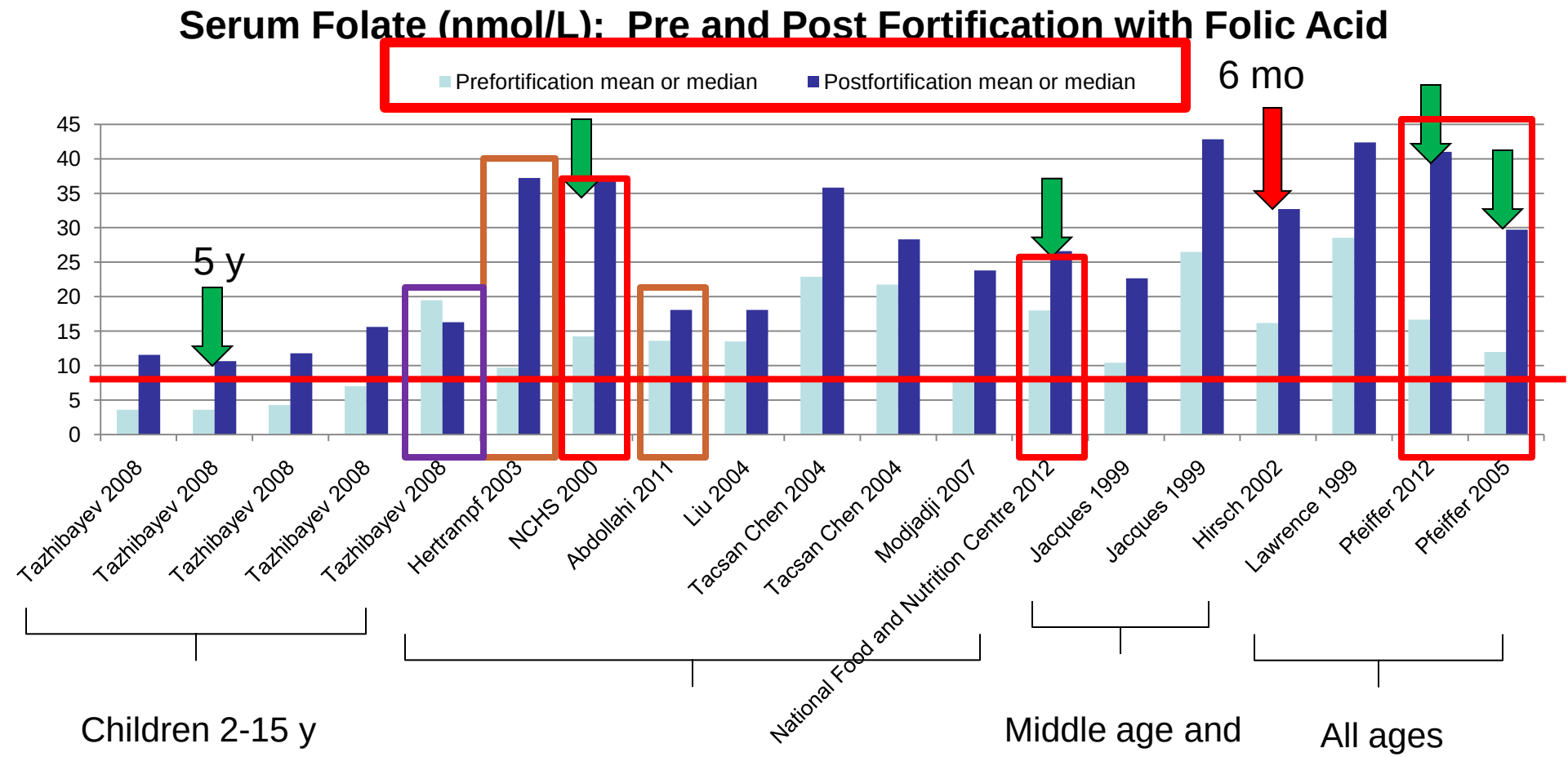
Recommendations on wheat and maize flour fortification

Table 1. Average levels of nutrients to consider adding to fortified wheat flour based on extraction, fortificant compound, and estimated *per capita* flour availability

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[2] 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	NR[3]	NR[3]	60	40
	High	NaFeEDTA	40	40	20	15
Folic Acid	Low or High	Folic Acid	5.0	2.6	1.3	1.0
Vitamin B_{12}	Low or High	Cyanocobalamin	0.04	0.02	0.01	0.008
Vitamin A	Low or High	Vitamin A Palmitate	5.9	3	1.5	1
Zinc[4]	Low	Zinc Oxide	95	55	40	30
	High	Zinc Oxide	100	100	80	70

WHO and partners 2009

Serum folate



FFI review 2013. Folic acid in flour ranged from 1.2-2.2 mg/kg.

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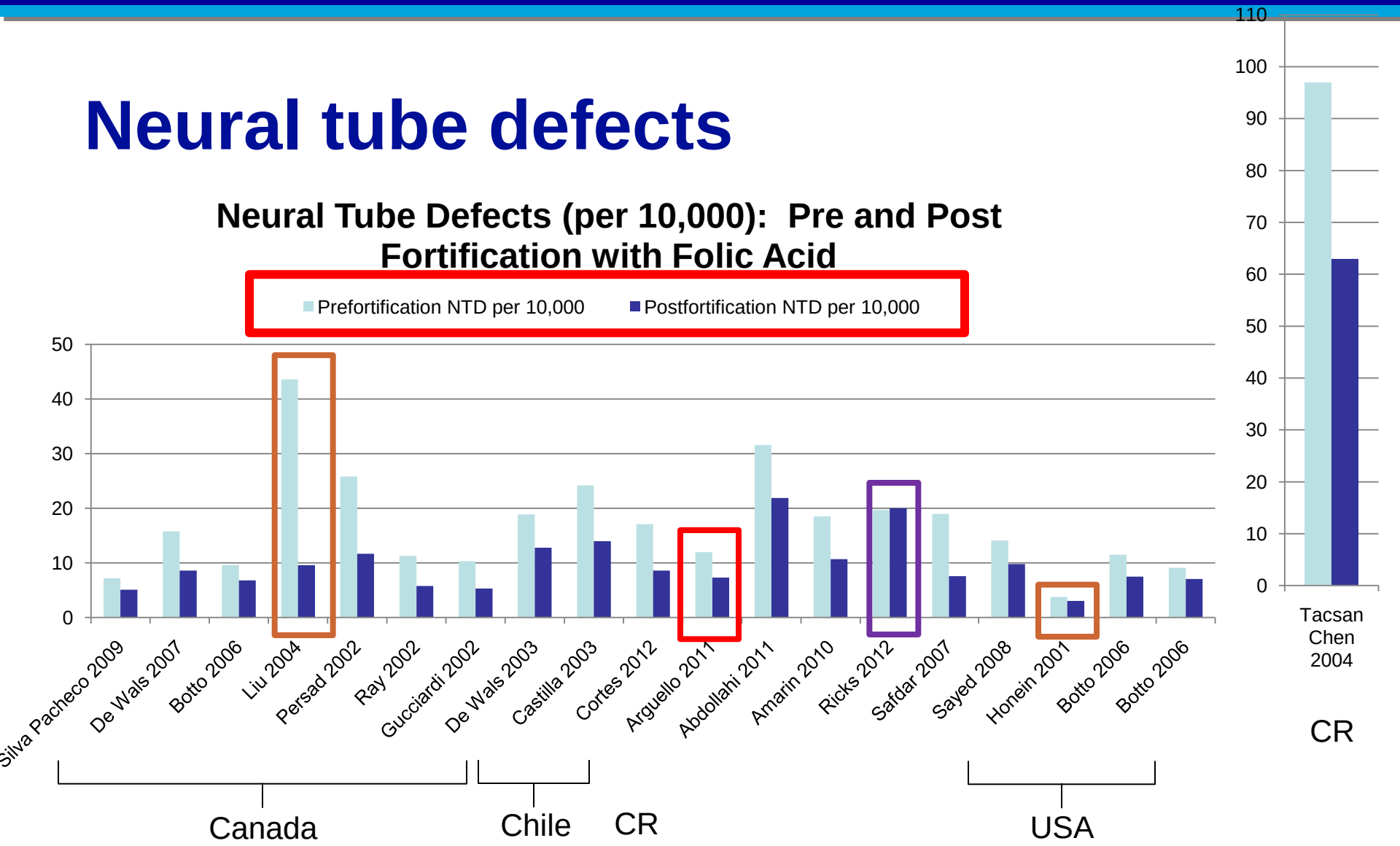
Neural tube defects



Brazil, Canada, Chile, Costa Rica, Iran, Jordan, Peru, Saudi Arabia, South Africa, USA

Adapted from FFI 2013

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

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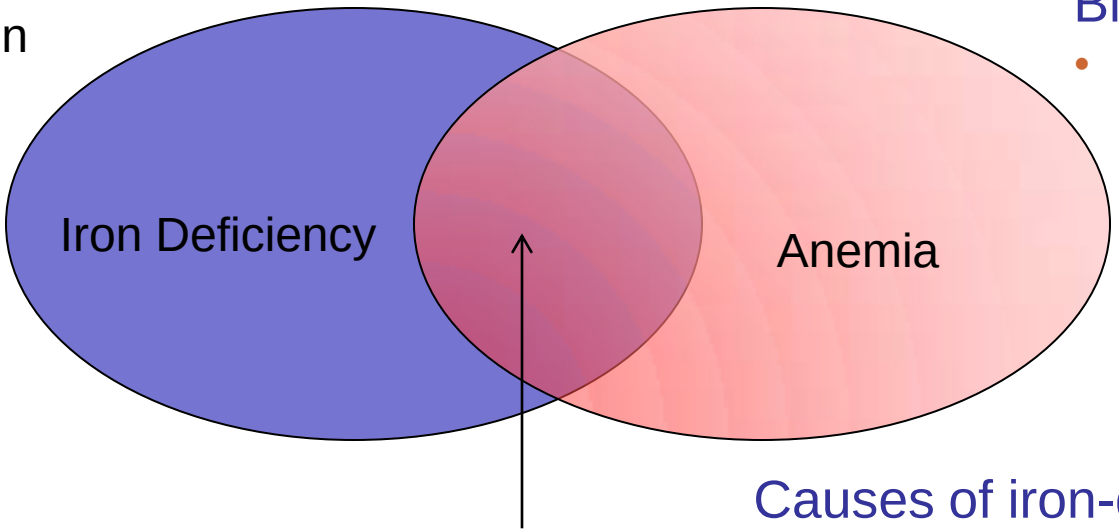
Iron deficiency vs anemia vs iron-deficiency anemia

Causes of iron deficiency:
- Deficient iron intake
- Excessive iron loss

Biological marker:
- Serum ferritin

Causes of anemia:
- Deficiency of iron, vitamin B12, folate, vitamin A
- Hemoglobinopathies
- Infections

Biological marker:
- Hemoglobin



Causes of iron-deficiency anemia:
- Iron deficiency

Biological marker:
- Serum ferritin & hemoglobin

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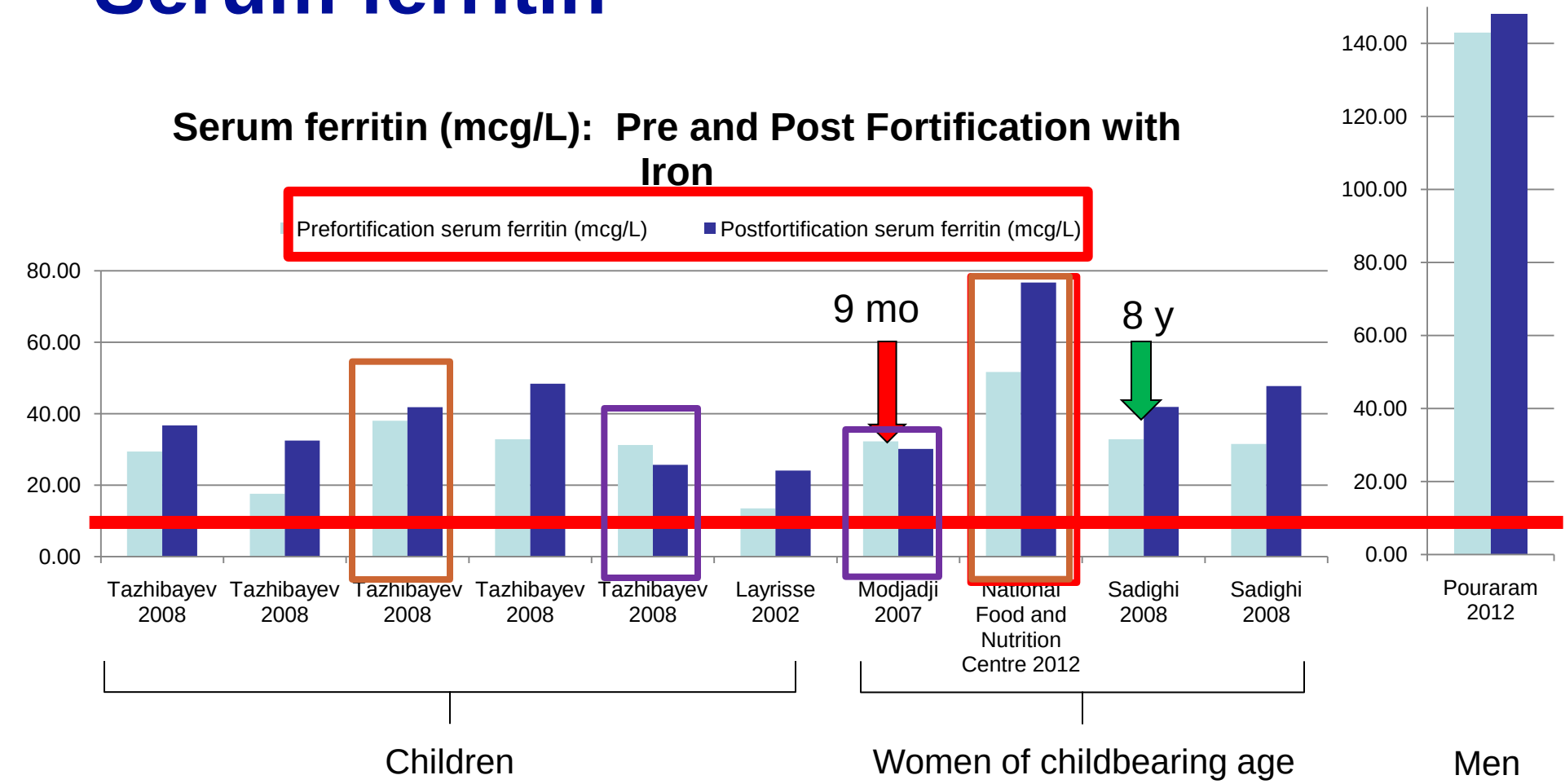
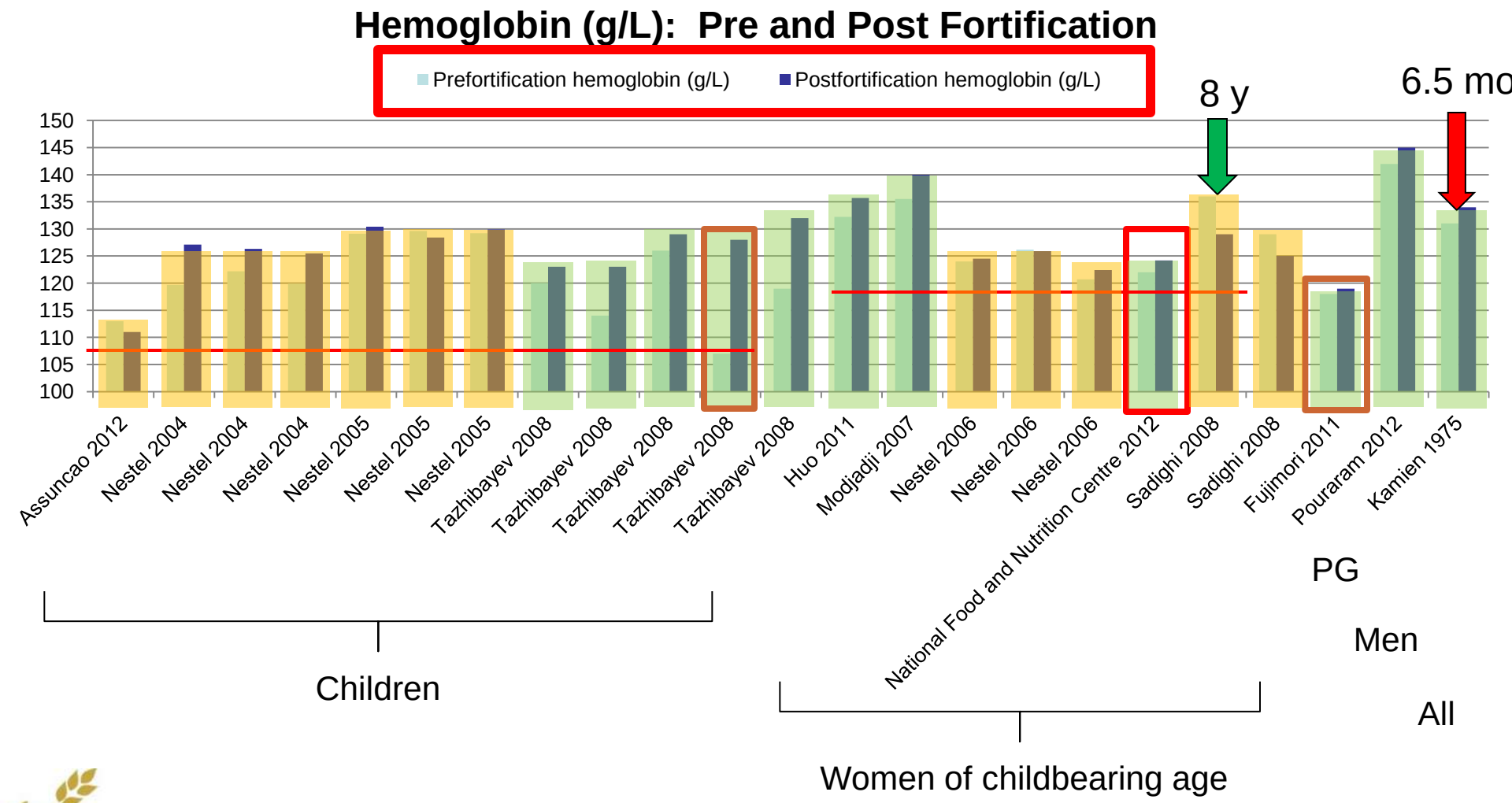
Zimmermann 2008; Gleason 2007; Scott 2007; West 2007; Cameron 2011

Serum ferritin



FFI review 2013. Iron in flour ranged from 30-60 mg/kg. Iron compounds used were ferrous sulfate, ferrous fumarate, elemental iron, and electrolytic iron.

Hemoglobin



FFI review 2013. Nutrients added to flour were iron, zinc, folic acid (B9), thiamin (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), and vitamin A

Summary

Outcome	Favorable Result (n)*	Total Evaluated (n)**
Serum folate	18	19
Neural tube defects (NTDs)	19	20
Serum ferritin	9	11
Hemoglobin	11	23

* Favorable result (increased folate, ferritin, hemoglobin; decreased NTDs) in sub-group analyses
** Total number of sub-groups analyzed

Conclusions

Effectiveness studies of wheat and maize flour fortification programs reveal:

- Folic-acid fortification increases serum folate levels
- Folic-acid fortification decreases risk of neural tube defects (NTDs)
- Iron fortification increases serum ferritin levels
- Effect of fortification with one or multiple nutrients on hemoglobin levels is equivocal

For more information

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http://www.sph.emory.edu/~hpacho2/

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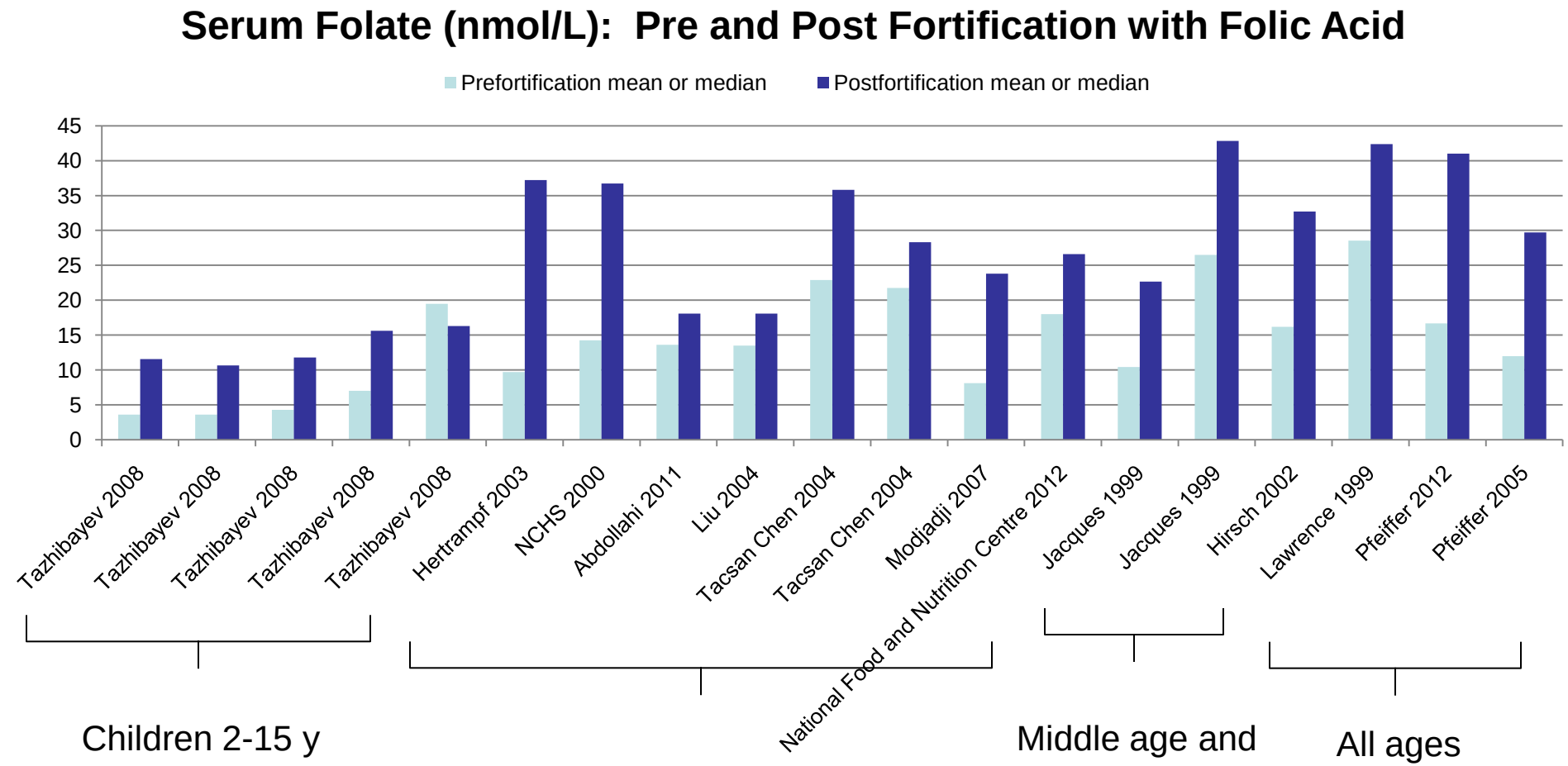

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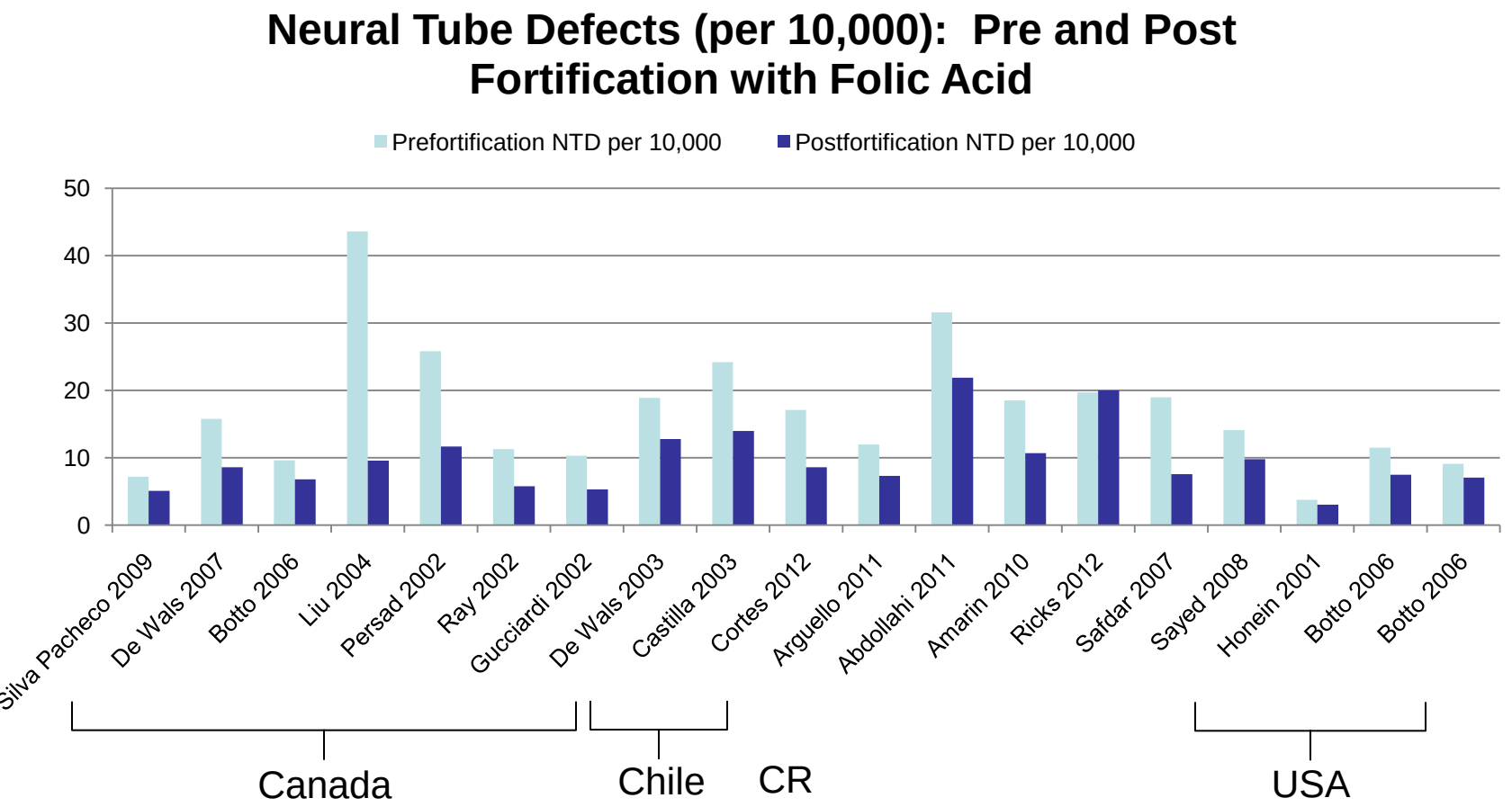
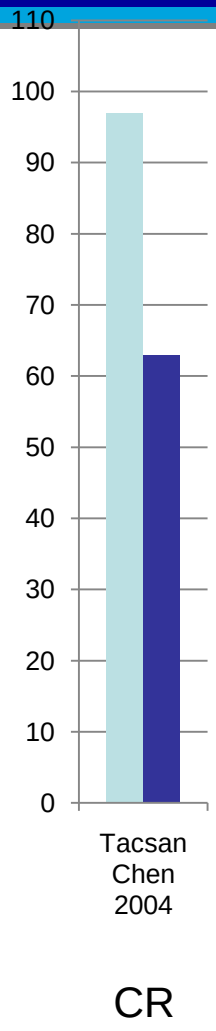
Neural tube defects





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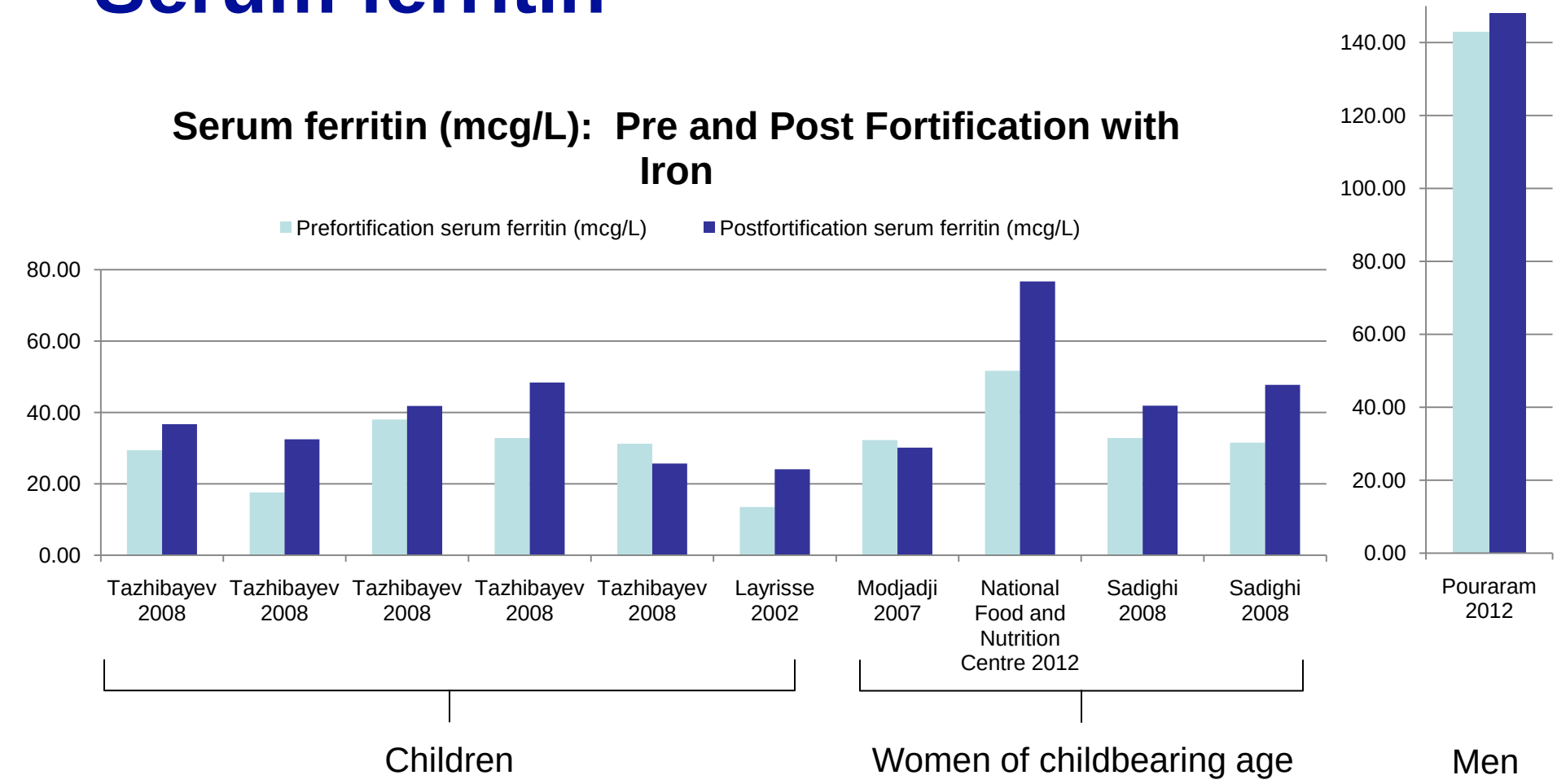
Serum ferritin



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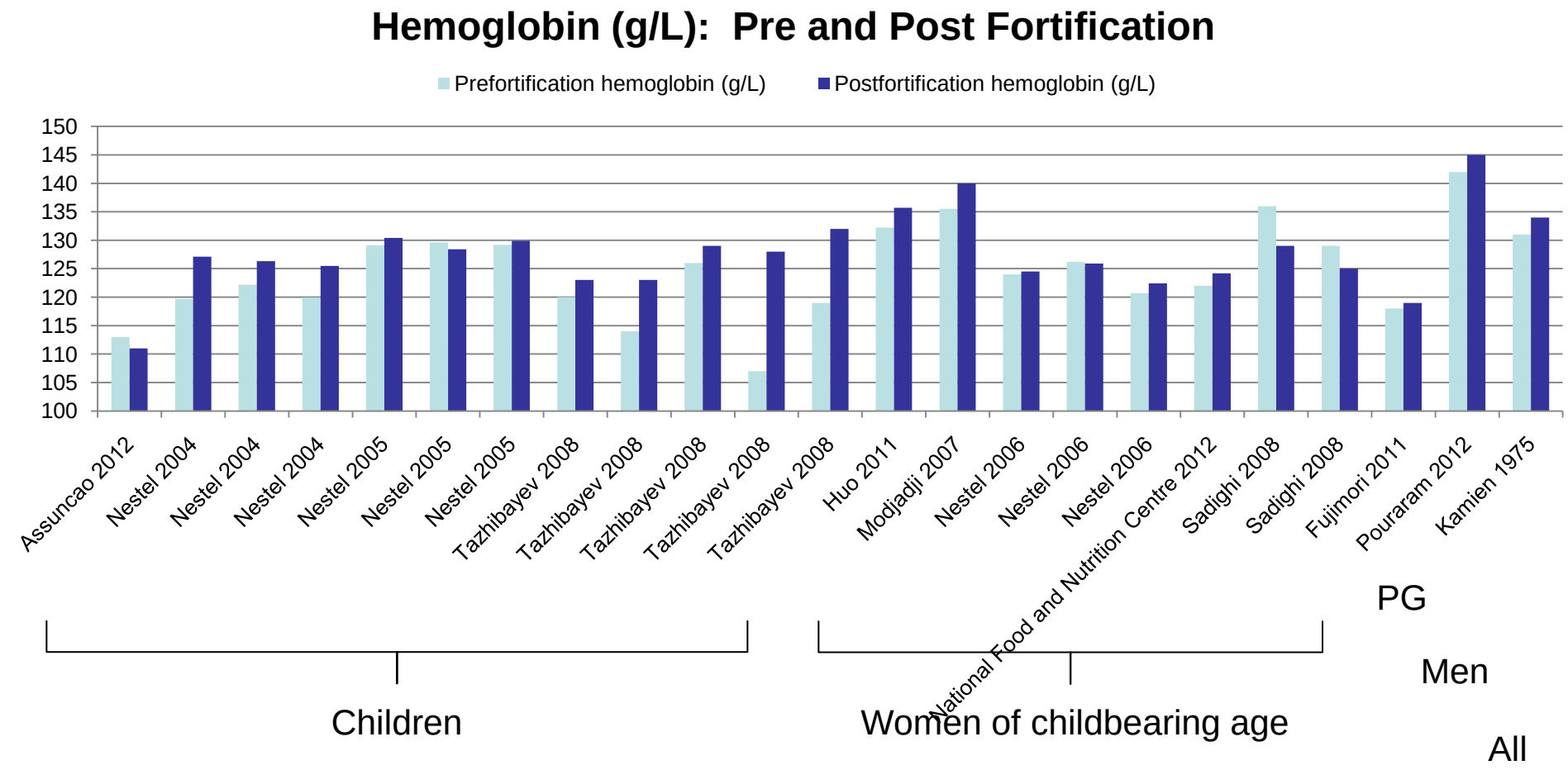

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