



Nutrient Data Needs to Address Vitamin D Insufficiency

Susan J. Whiting

University of Saskatchewan



Outline

- Background: why focus on vitamin D intake
- Current status of intake information:
 - USA and Canada intake
- Uses of nutrient information
 - The Nutrition Facts label
 - Research and surveillance needs
- Nutrient data needs of the near future:
 - Fortification
 - Agriculture/aquaculture practices



Background

- Vitamin D insufficiency and deficiency is at epidemic proportions for children and adults in the United States, Canada and other countries worldwide.
- Vitamin D is primarily obtained through skin synthesis but when this is reduced in winter or through sunscreen use, clothing, remaining indoors, then adequate dietary intake is needed to maintain sufficient vitamin D levels.

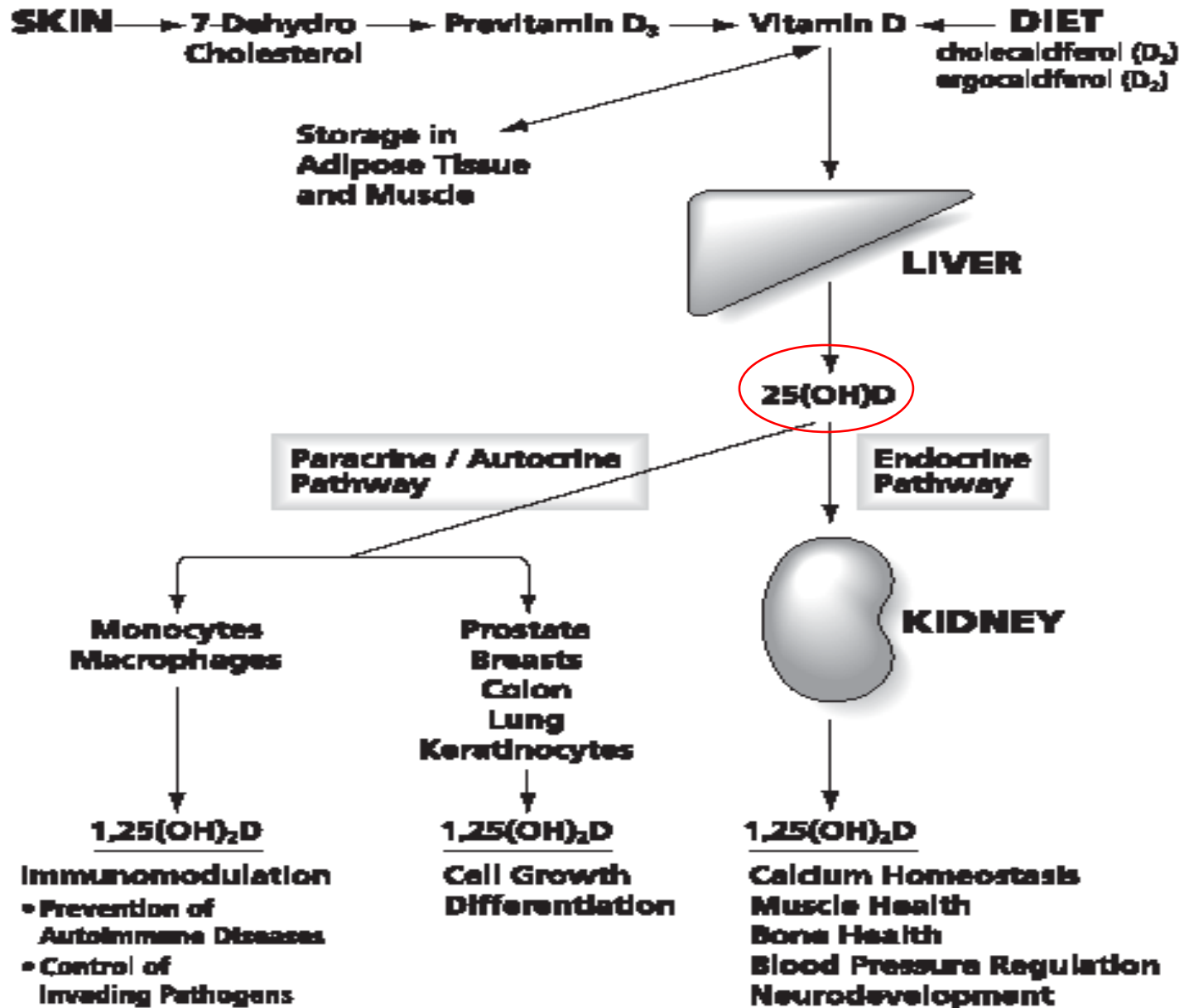
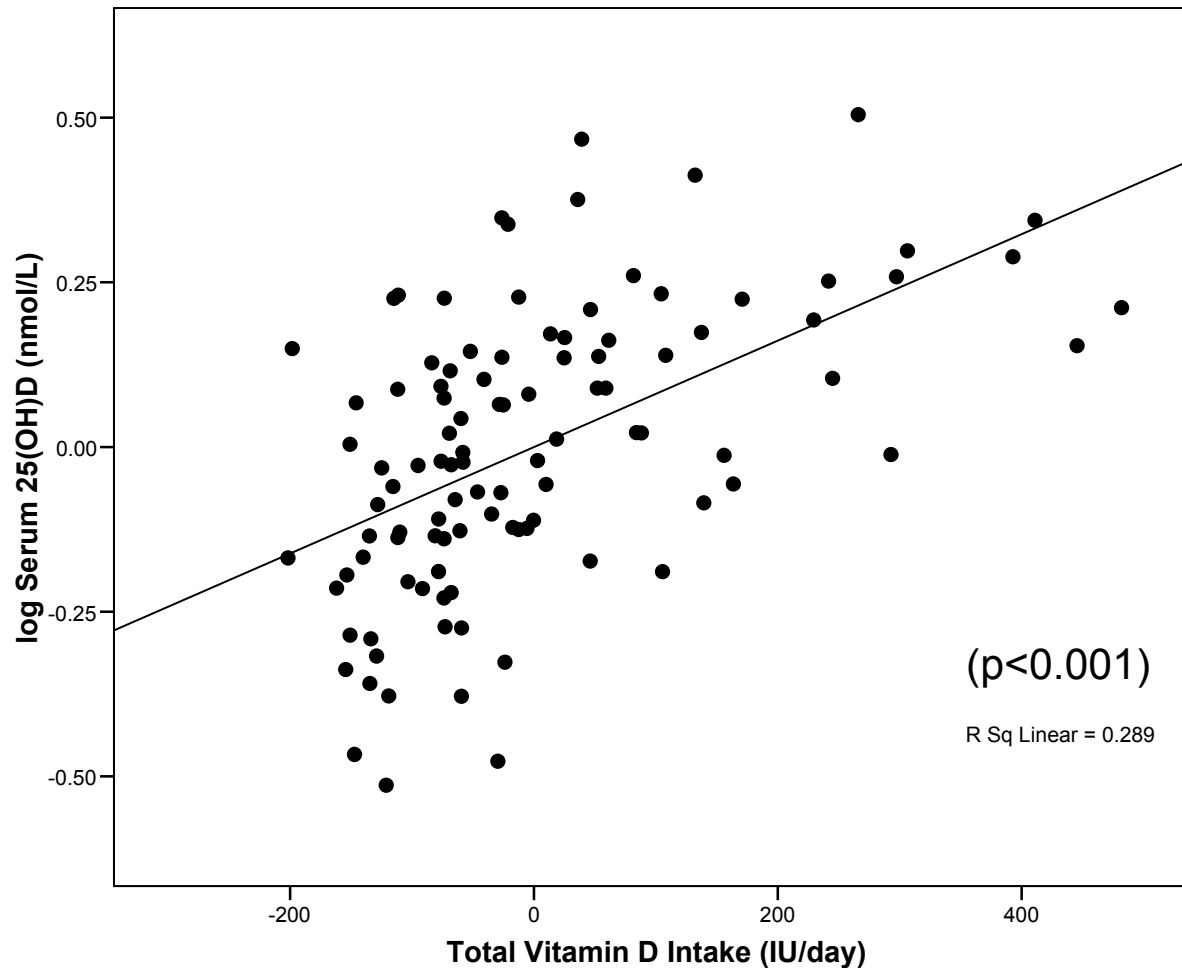


Figure taken from Whiting, SJ, Calvo MS, Stephensen C. Current Understanding of Vitamin D Metabolism, Nutritional Status and Role in Disease Prevention, in Coulston Anne & Carol J. Boushey *Nutrition in the Prevention & Treatment of Disease* Elsevier, Inc. 2008

Close relationship between intake and serum 25(OH)D is seen in winter in Canada





Health outcomes associated with low vitamin D status

Skeletal diseases

Rickets

Osteomalacia

Osteoporosis

Cancer

Breast

Prostate

Colon

Cardiovascular disease

Hypertension

Arteriosclerosis

Autoimmune diseases

Multiple sclerosis

Diabetes (Type 1)

Others e.g. IBS,
rheumatoid arthritis,
lupus

Malabsorption disorders

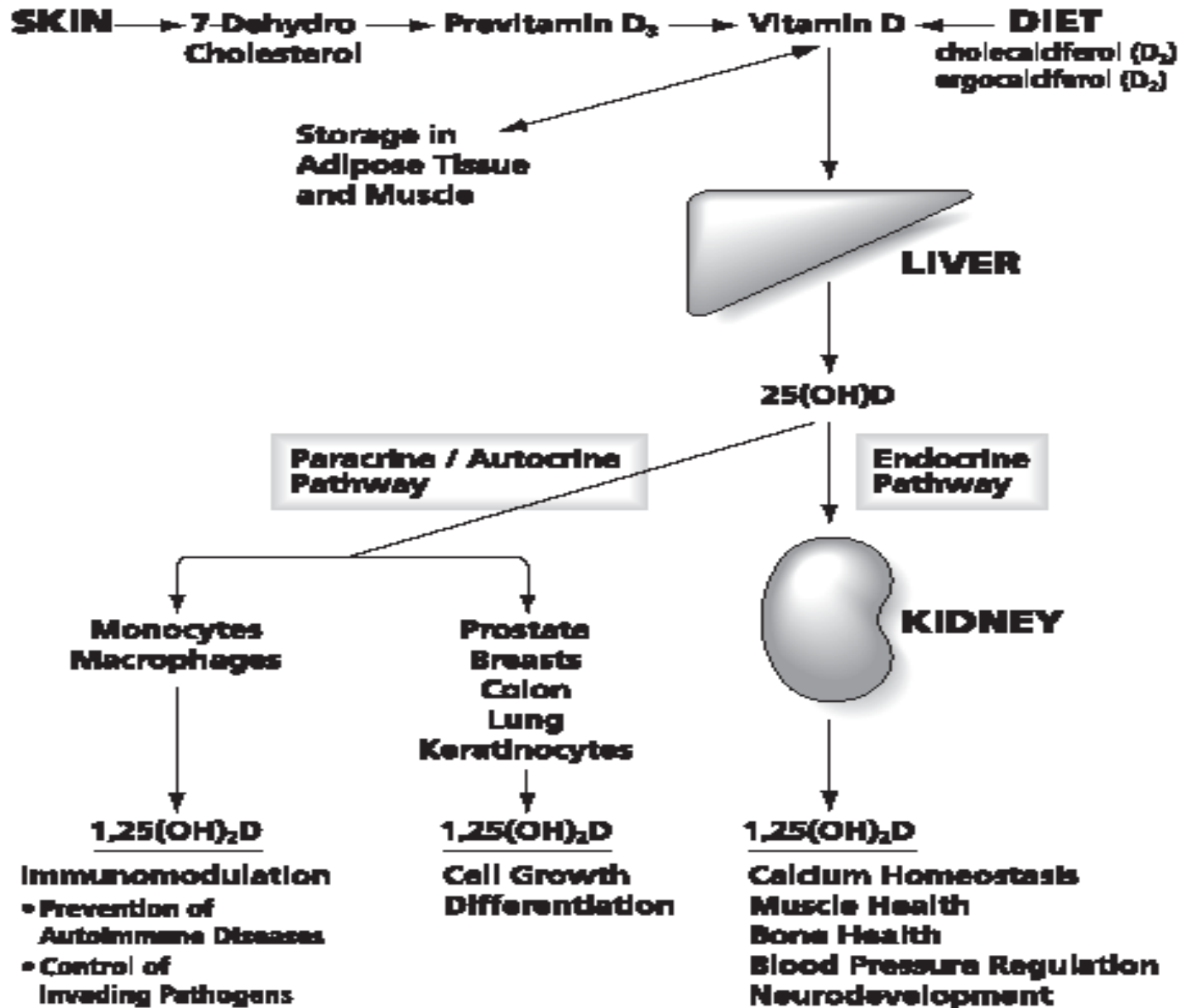
Crohn's

Celiac

Cystic Fibrosis

Microbial infections

Tuberculosis



Whiting, SJ, Calvo MS, Stephensen C. Current Understanding of Vitamin D Metabolism, Nutritional Status and Role in Disease Prevention, in Coulston Anne & Carol J. Boushey *Nutrition in the Prevention & Treatment of Disease* Elsevier, Inc.

Vitamin Status

Serum 25(OH)D	Category
< 20 nmol/L	Vitamin D deficiency
< 30 nmol/L	Not at risk for clinical rickets or osteomalacia
30 to 75 nmol/L	Vitamin D insufficiency
75-80 nmol/L	Threshold for vitamin D-dependent calcium absorption
90-100 nmol/L	Optimal vitamin D status for many chronic conditions, e.g., lower extremity function, fracture risk reduction, cancer
>220 nmol/L	Potential adverse effects are seen above this level

Table taken from Whiting, SJ, Calvo MS, Stephensen C. Current Understanding of Vitamin D Metabolism, Nutritional Status and Role in Disease Prevention, in Coulston Anne & Carol J. Boushey *Nutrition in the Prevention & Treatment of Disease* Elsevier, Inc. 2008

How to Achieve at least 75 nmol/L by diet (no sun exposure)

To get to 50 nmol/L 25(OH)D

**Raise 25(OH)D by ~ 3 nmol/L for 1 μ g
= 15 μ g [600 IU]**

To get from 50 nmol/L to 75 nmol/L

**Raise 25(OH)D by 1 nmol/L for 1 μ g
= additional 25 μ g [1000 IU]**

Total: 40 μ g [1600 IU] → 75 nmol/L]

Organization and Date	Age Group	Recommendation	Notes
Institute Of Medicine - DRIs 1997	1-50 y 51-70 y 71+ y	5.0 µg (200 IU) 10 µg (400 IU) 15 µg (600 IU)	Many experts indicate a need for revision as these intakes will not maintain optimal 25(OH)D levels.
Osteoporosis Society of Canada 2002	19-50 y 51+ y	10 µg (400 IU) 20 µg (800 IU)	For osteoporosis prevention (with calcium); and for osteoporosis treatment (adjunct, with calcium)
Dietary Guidelines for Americans, 2005	Men and women	25 µg (1000 IU)	“Older adults, people with dark skin, and people exposed to insufficient ultraviolet band radiation (i.e. sunlight) should consume extra vitamin D from vitamin D-fortified foods and/or supplements”
Canadian Cancer Society 2007	19 + y	25 µg (1000 IU)	Due to our northern latitude...we recommend that Canadian adults consider taking a vitamin D supplement.... [of]1000 international units (IU) a day during fall and winter months. If you: are elderly; have dark skin; don't go outside very much; wear clothing covering most of your skin. ... you should take a vitamin D supplement of 1000IU every day, all year round.

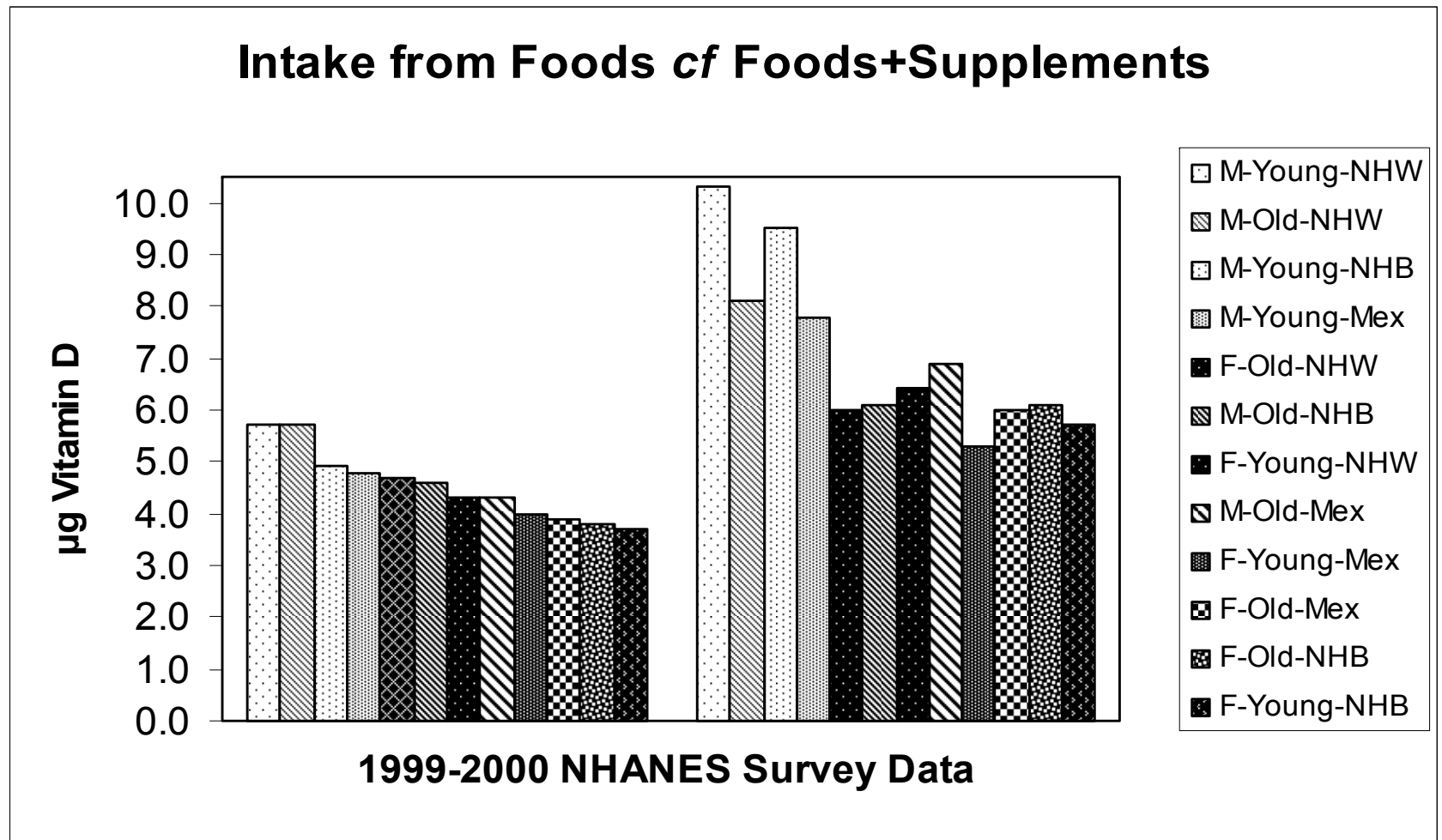
Table taken from Whiting, SJ, Calvo MS, Stephensen C. Current Understanding of Vitamin D Metabolism, Nutritional Status and Role in Disease Prevention, in Coulston Anne & Carol J. Boushey *Nutrition in the Prevention & Treatment of Disease* Elsevier, Inc. 2008



Why 25 μg (1000 IU)?

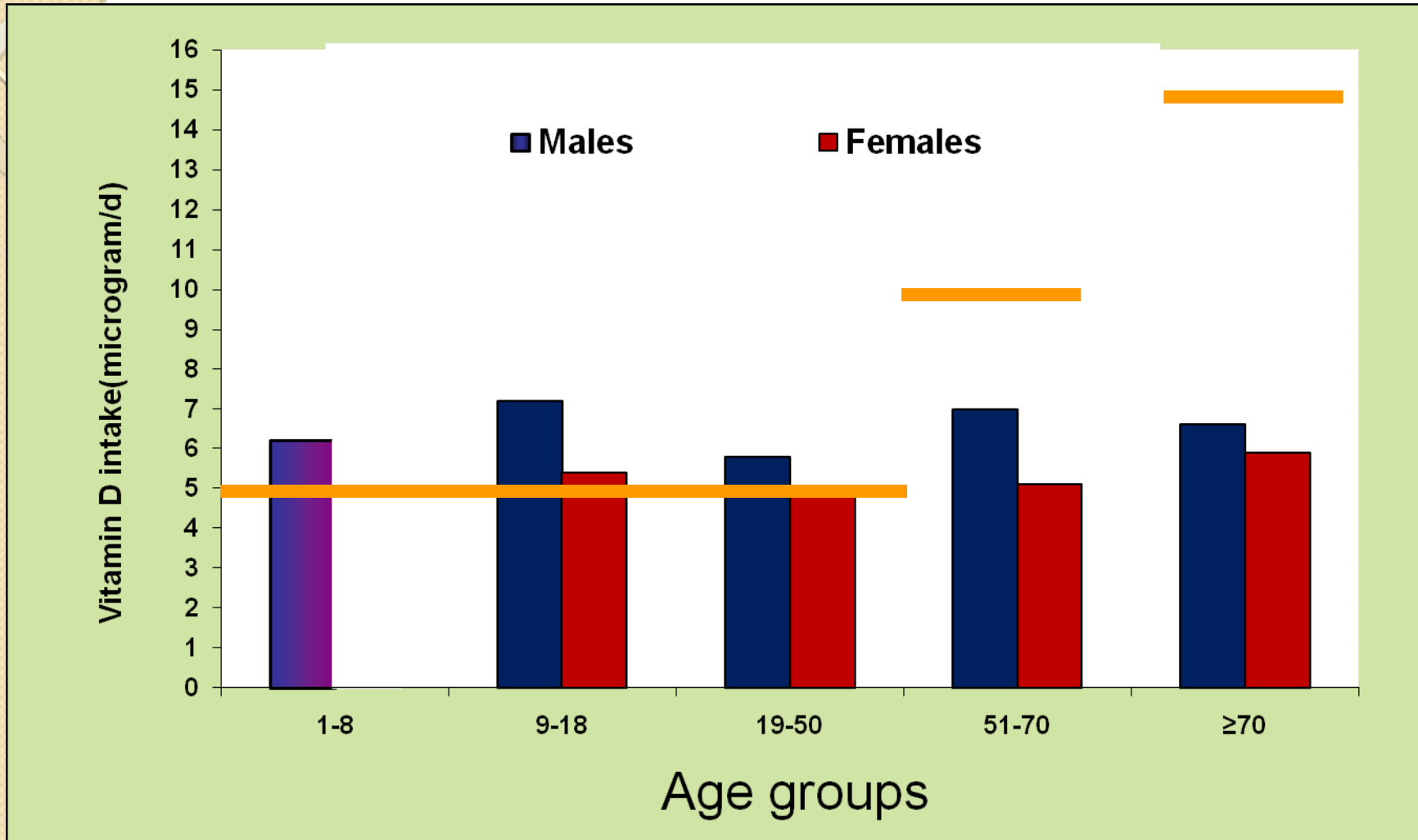
- **Raises 25(OH)D by at least 25 nmol/L**
 - 10 μg (400 IU) only raises by 10 nmol/L
 - 400 IU does prevent rickets
- **Puts many people over 75-90 nmol/L**
 - Effective for disease prevention
- **Safe** (< UL of 50 μg (2000 IU))
 - Diet contributes 5 μg (200 IU)
- **Convenient and affordable**

Current Status of Vitamin D Intake: USA



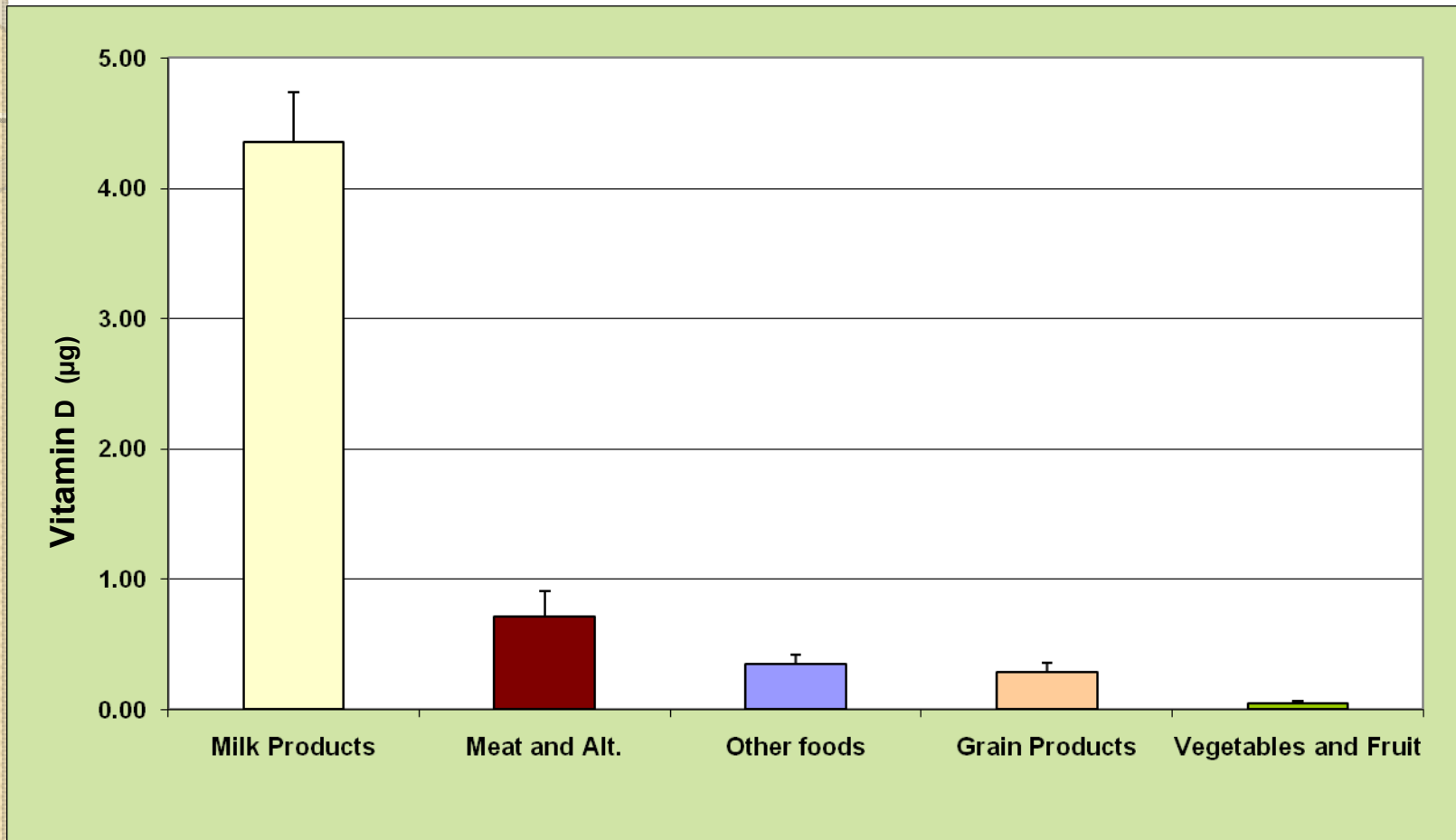
Calvo et al. *J Nutrition* 2006 ; Moore et al. *J Nutr* 2005

Mean vitamin D intake of Canadians



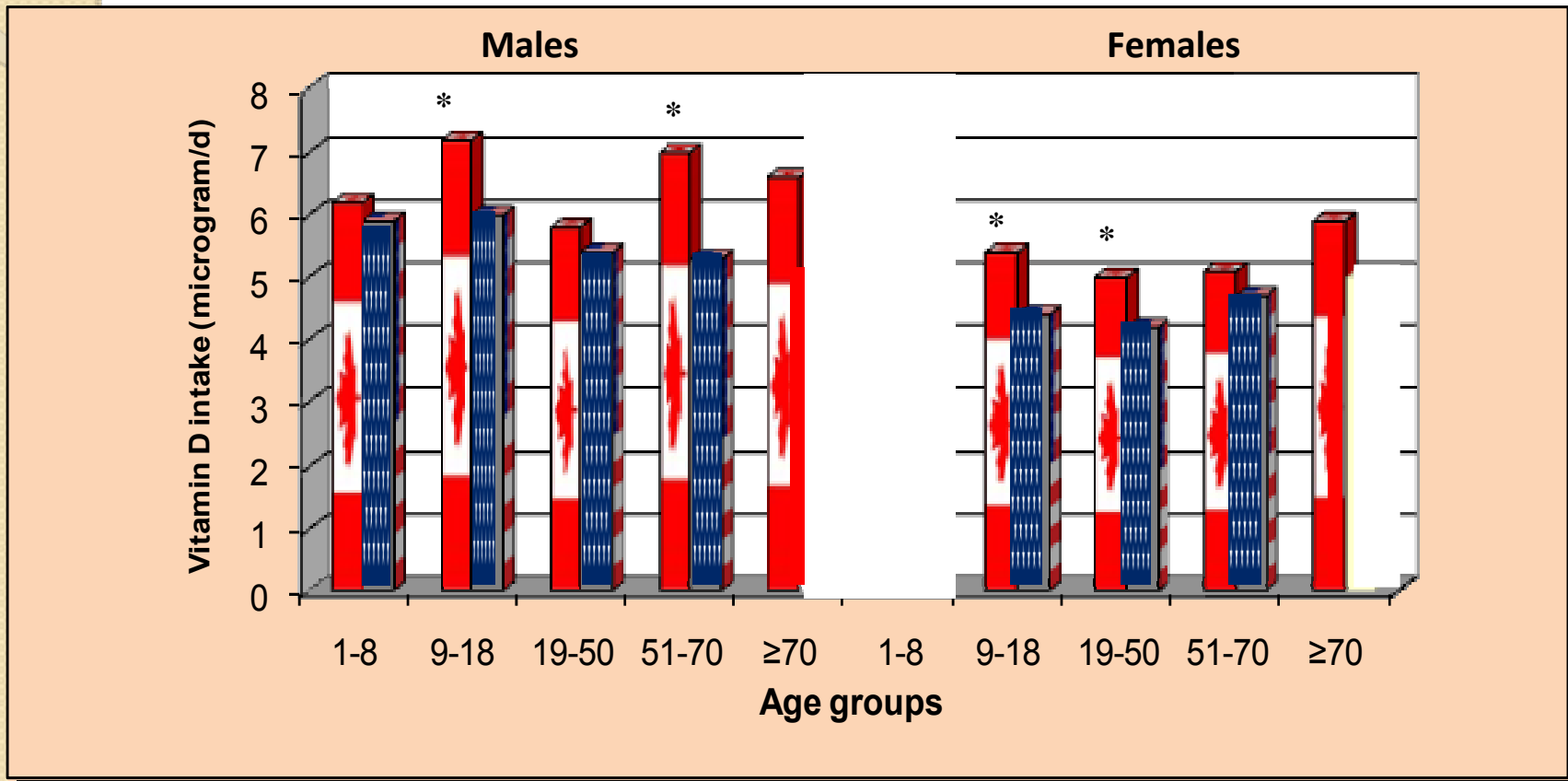
DRI Adequate intake value for vitamin D

Food sources of vitamin D in Canada



Data from the Canadian Community Health Survey (Cycle 2.2, 2004)

Mean daily intake of vitamin D from food in Canada & in the USA



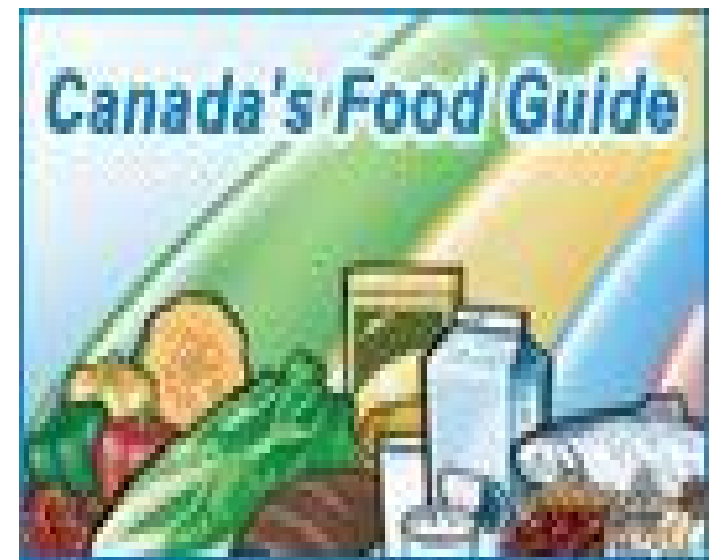
* $P < 0.05$

Canada's Food Guide (2007)

- Adults >50 y

To meet current DRI of 10 μg and 15 μg , cannot expect to obtain from food:

- 2 serv. of milk plus a supplement of 400 IU
 - Exceed AI for 50-70y
 - Meet AI for > 70y

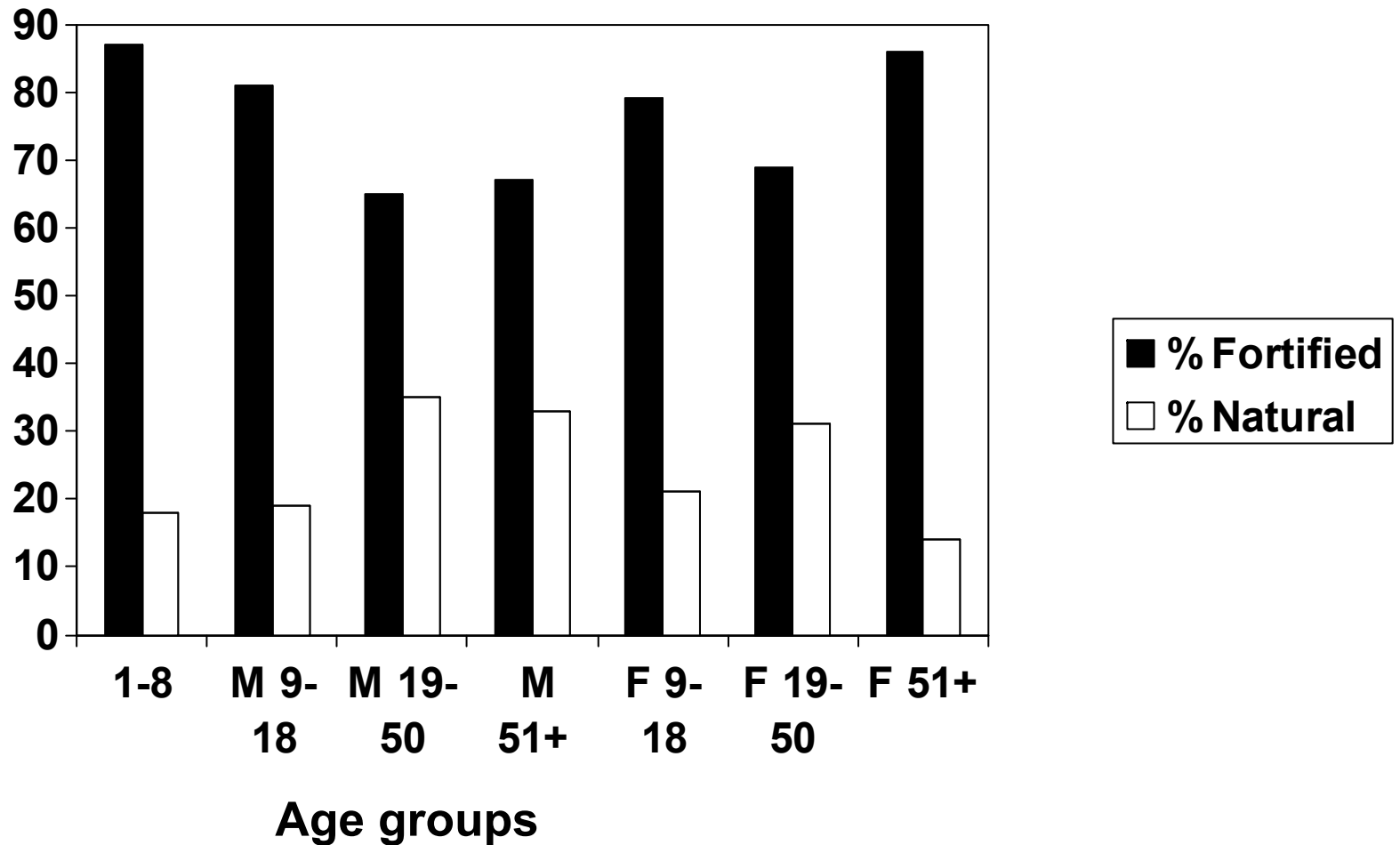




Why Differences in USA vs Canada

- Fortification differences
 - Staple foods
 - Mandatory vs discretionary
- Demographics
 - Lactose intolerance
 - Fish consumption: salmon vs tuna
- Nutrient database differences

% Vitamin D intake from foods that is fortified or from natural sources (NHANES 1999-2000)



Calvo et al. *J Nutrition* 2006 ; Moore et al. *J Nutr* 2005

Vitamin D Fortification in USA

Category of food	21 CFR citation	Fortification status	Maximal level allowed ¹	Surveyed products fortified with vitamin D	
				Estimate of fortified products	Usual fortification level
Cereal flours and related products					
Enriched Farina	137.305	Optional	350 IU/100 g	Few	
Ready-to-eat breakfast cereals	137.305	Optional	350 IU/100 g	Most	40–140 IU (10–35% DV)
Enriched rice	137.350	Optional	90 IU/100 g	None	None
Enriched corn meal products	137.260	Optional	90 IU/100 g	None	None
Enriched noodle products	139.155	Optional	90 IU/100 g	None	None
Enriched macaroni products	139.115	Optional	90 IU/100 g	Very few	40 IU/252 g (10% DV)
Milk					
Fluid milk	131.110	Optional	42 IU/100 g	All	400 IU/quart or 946 mL
Acidified milk	131.111	Optional	42 IU/100 g	All	400 IU/quart or 946 mL
Cultured milk	131.112	Optional	42 IU/100 g	All	400 IU/quart or 946 mL
Concentrated milk	131.115	Optional	42 IU/100 g	All	400 IU/quart or 946 mL
Nonfat dry milk fortified with A and D	131.127	Required	42 IU/100 g	All	400 IU/quart or 946 mL
Evaporated milk, fortified	131.130	Required	42 IU/100 g	All	400 IU/quart or 946 mL
Dry whole milk	131.147	Optional	42 IU/100 g	All	400 IU/quart or 946 mL
Milk products					
Yogurt	131.200	Optional	89 IU/100 g	Few	40–80 IU/RACC ²
Low fat yogurt	131.203	Optional	89 IU/100 g	Few	40–80 IU/RACC ²
Nonfat yogurt	131.206	Optional	89 IU/100 g	Few	40–80 IU/RACC ²
Margarine	166.110	Optional	331 IU/100 g	Few	40–140 IU/RACC
Calcium-fortified fruit juices and drinks ³	172.380	Optional	100 IU/RACC	NA ⁴	100 IU/RACC

¹ Maximal level of vitamin D that can be added in accordance with 21 CFR 184.1 (b) (2) for the category of food.

² RACC, reference amount customarily consumed or the US FDA regulatory serving size.

³ Vitamin D₃ may be added, at levels not to exceed 100 IU per serving, to 100% fruit juices, excluding fruit juices that are specially formulated or processed for infants, which are fortified with > 33% of the RDI of calcium per serving.

⁴ NA, not appropriate; it is premature to evaluate the number of products in the market place given that the regulation was approved in April 2003.

Source: Calvo, M.S., Whiting, S.J. & Barton, C.N. Vitamin D Fortification in the United States and Canada: Current Status and Data Needs. Am. J Clin. Nutr. 2004

Vitamin D Fortification in Canada

Added

Maximum Level (IU/amount)

Mandatory

- Margarine
- Cow milk
- Plant-based milk

530 IU (13 µg)/100g

344 IU (8.6 µg)/Liter

344 IU (8.6 µg)/Liter

Discretionary

- Ca-fortified fruit juice
- Yogurt (using fortified milk)

344 IU (8.6 µg)/Liter

20 IU (0.5 µg/100g)

Amt on label



Fortification Practices in USA and Canada: optional (op) or mandatory (mn) (μg)/100g

USA

Breakfast cereals (op) 8.7

Grain prod. pastas (op) 2.2

Milk, fortified (mn) 1.0

Milk products (op) 2.0

Margarine (op) 8.2

Ca- fortified juice (op) 1.0

Canada

--

--

Milk, fortified (mn) 1.0

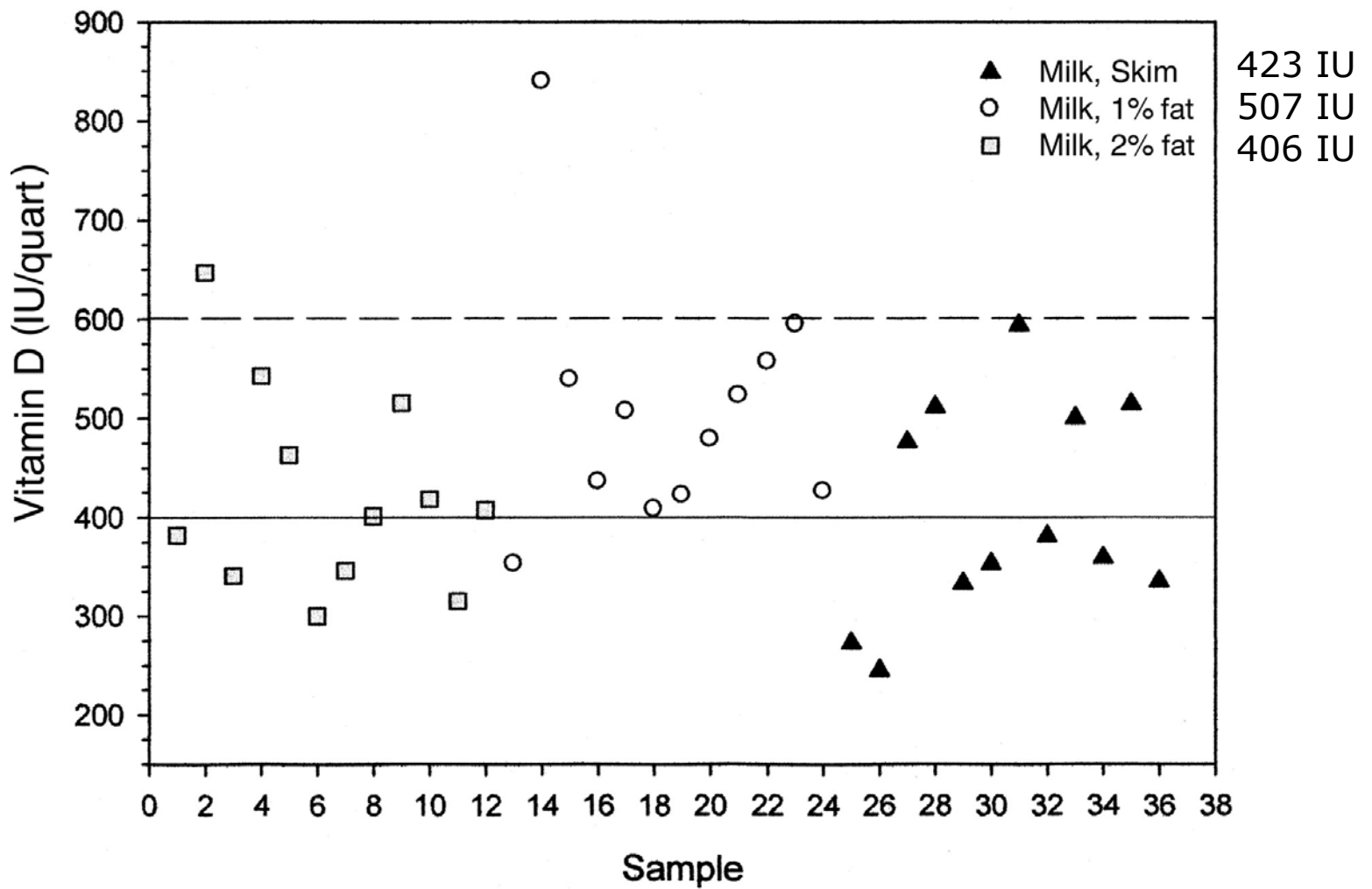
Milk products* (op) 2.0

Margarine (mn) 8.2

Ca- fortified juice (op) 1.0

*If use Ca-fortified milk

Vitamin Content of Milk



Source: Holden et al., AJCN 2008S



Mushrooms as a Source of Vitamin D₂

- In previous USDA values:
 - Sun dried shiitake mushrooms, 36g (1/4 cup cooked) 2.8 µg (110 IU)
- Research is showing that UV irradiation of mushrooms will ↑ levels
 - Process can be controlled; product can be labeled

Fish Sources of Vitamin D	µg (IU)/100 g
----------------------------------	----------------------

Salmon, canned	5.60 (224)
-----------------------	-------------------

Tuna, canned	0.92 (37)
---------------------	------------------

Wild Atlantic salmon (raw)	6.37 (255)
-----------------------------------	-------------------

Farmed salmon (raw)	6.03 (241)
----------------------------	-------------------

Sockeye salmon	17.66 (706)
-----------------------	--------------------

Whitefish	3.5 (140)
------------------	------------------

[error in CNF shows 12-15 (480-600)]

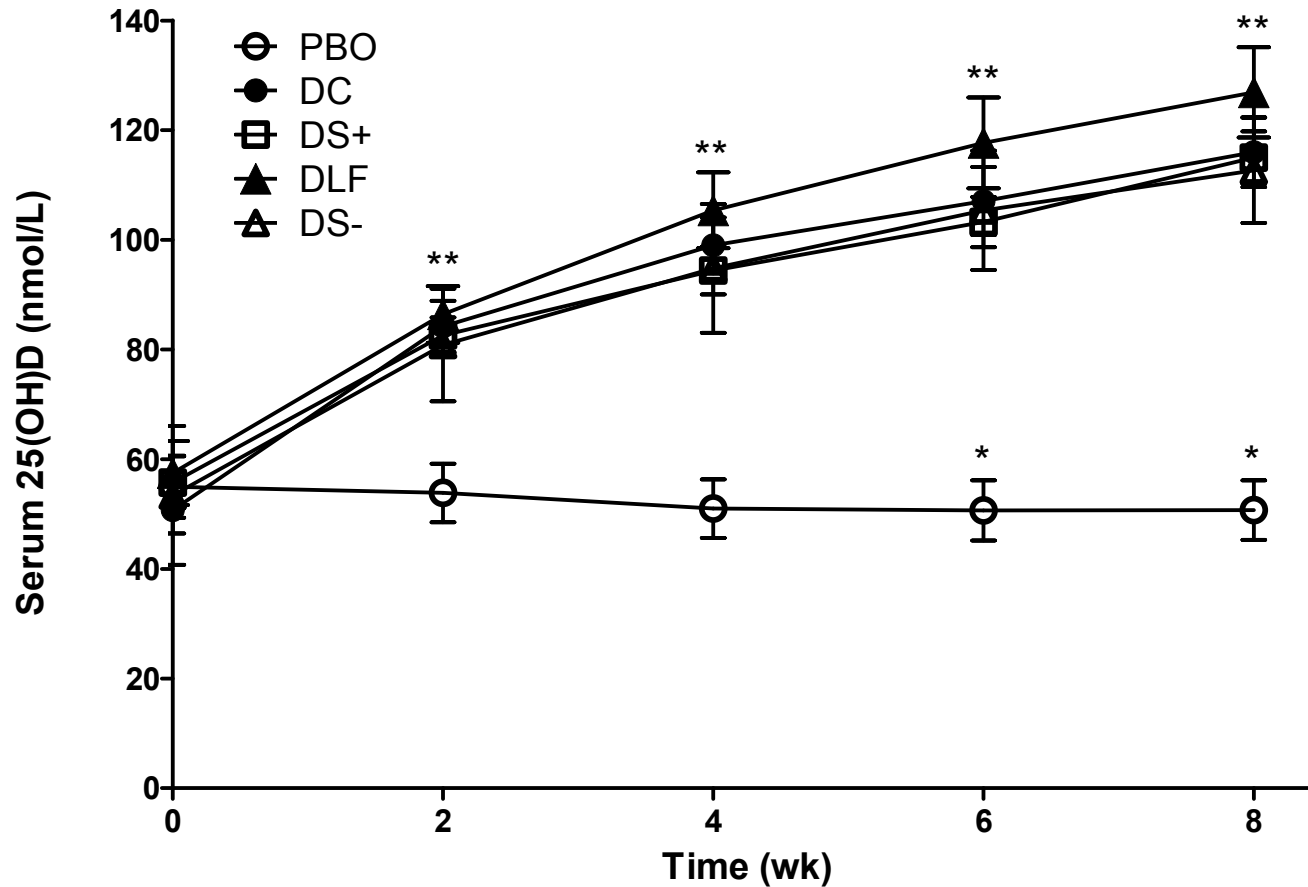
Fastfood fillet (white fish)	0.96 (38)
-------------------------------------	------------------



Food Composition Needs

- Remain up-to-date on new food products and agricultural practices
- Fortification/enrichment strategies to come shortly include:
 - cheese
 - bread made with irradiated yeast
 - irradiated mushrooms

Wagner et al. cheese study: evidence that vitamin D in cheese including low fat, raises 25(OH)D to the same extent as supplement



Wagner et al. 2008 in press J Nutr



Use of Nutrient Information

- The Nutrition Facts label
 - Vitamin D not required
 - Does appear on foods fortified with D
 - Doesn't always appear in foods naturally high in vitamin D (canned fish)
- US label DV = 400 IU (10 µg)
- Canadian label DV = 200 IU (5 µg)

BRUNSWICK®



CANADIAN-CANADIENNES

Sardines®

USA Label

Source of omega-3 polyunsaturates
 Excellent source of protein and vitamin D
 Good source of calcium and iron

Source de polyinsaturés oméga-3
 Excellente source de protéines et Vit D
 La bonne source de calcium et fer



in lemon
 sauce
 à la sauce
 au citron

Net 106g
 Drained/égouttée
 92g

Nutrition Facts		Amount / Teneur		% DV / % VQ*		Amount / Teneur		% DV / % VQ*		% DV / % VQ*	
Valeur nutritive		Fat / Lipides 12 g		18 %		Sodium / Sodium 260 mg		11 %		Vit A 2 %	
Serving Size 1 can (92 g drained)		Saturated / saturés 2.5 g		12 %		Potassium / Potassium 290 mg		8 %		Vit C 2 %	
Portion 1 boîte (92 g égouttée)		+ Trans / trans 0 g				Carbohydrate / Glucides 0 g		0 %		Calcium 25 %	
Calories 190		Omega-6 / oméga-6 3 g				Fibre / Fibres 0 g		0 %		Iron / Fer 15 %	
		Omega-3 / oméga-3 1.5 g				Sugars / Sucres 0 g				Vit E 110 %	
		Monounsaturated / monoinsaturés 5 g				Protein / Protéines 20 g					
		Cholesterol / Cholestérol 110 mg									

* DV = Daily Value / VQ = valeur quotidienne



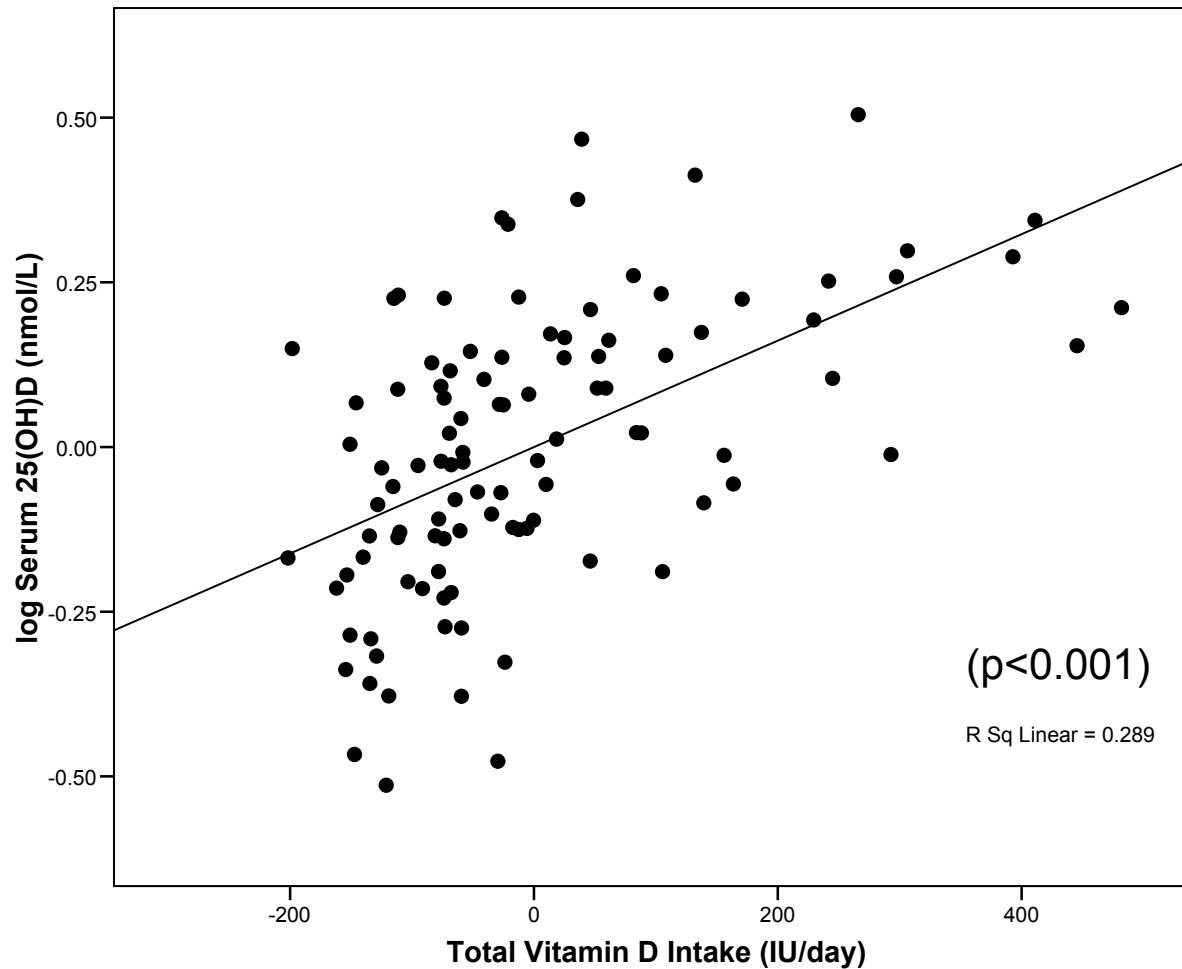
Nutrition Facts			
Serving Size 1/2 cup (30g)			
Servings Per Container About 17			
Amount Per Serving	Whole Grain Total	with 1/2 cup skim milk	
Calories	110	150	
Calories from Fat	10	10	
% Daily Value**			
Total Fat 1g*	1%	1%	
Saturated Fat 0g	0%	0%	
Polyunsaturated Fat 0g			
Monounsaturated Fat 0g			
Cholesterol 0mg	0%	1%	
Sodium 190mg	8%	11%	
Potassium 90mg	3%	8%	
Total Carbohydrate 23g	8%	10%	
Dietary Fiber 3g	10%	10%	
Sugars 5g			
Other Carbohydrate 15g			
Protein 2g			
Vitamin A	10%	15%	
Vitamin C	100%	100%	
Calcium	100%	110%	
Iron	100%	100%	
Vitamin D	10%	25%	
Vitamin E	100%	100%	
Thiamin	100%	100%	
Riboflavin	100%	110%	
Niacin	100%	100%	
Vitamin B ₆	100%	100%	
Folic Acid	100%	100%	
Vitamin B ₁₂	100%	110%	
Pantothenic Acid	100%	100%	
Phosphorus	8%	20%	
Magnesium	6%	10%	
Zinc	100%	100%	
Copper	4%	4%	
* Amount in Cereal: A serving of cereal plus skim milk provides 1g total fat, less than 5mg cholesterol, 290mg sodium, 290mg potassium, 23g total carbohydrate (11g sugars) and 7g protein.			
** Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.			
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		71g	90g

U.S. - Canadian Differences in Labeling Vitamin D Content of Foods

Canadian Nutrition
Facts Panel would
show:

20% DV 50%
DV with milk

Research & Surveillance Needs: Dietary Assessment



Gozdzik et al, 2008, submitted



Significance

- In the absence of sun exposure, dietary intakes of vitamin D are needed
- Obtaining Vitamin D values is challenging due to changes in fortification, farming, aquaculture practices.
- Dietary intakes of vitamin D are important for consumer education (e.g. labels), for research, and for accurate monitoring of population intakes .