Diagnosis & Treatment of Vitamin D Deficiency

Toronto ON CANADA November 3/09

SOURCES OF VITAMIN D

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Acknowledgements and Disclosures

Co-Investigators

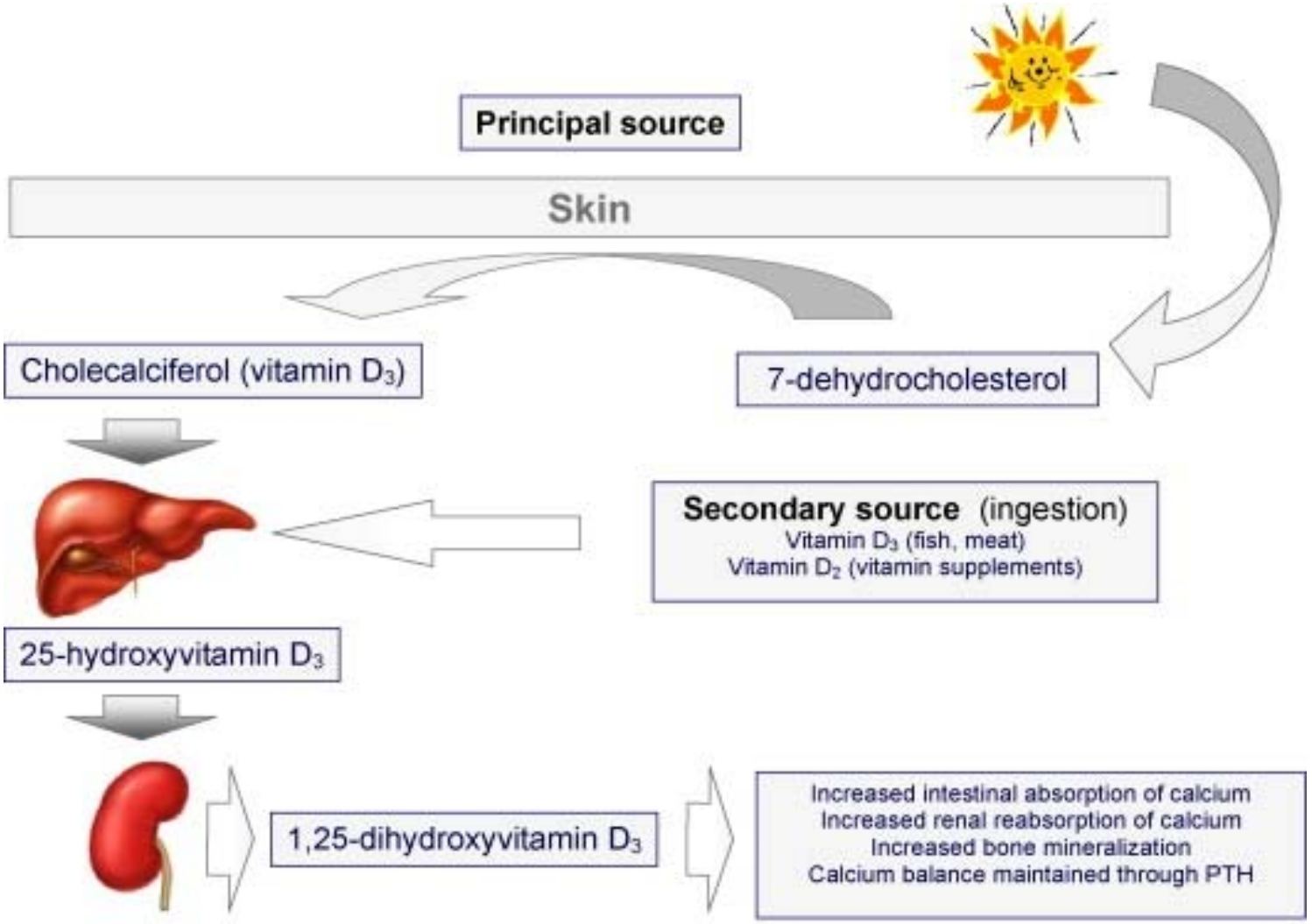
- Mona Calvo – FDA, Maryland
- Timothy Green – UBC, Vancouver
- Hassanali Vatanparast – Univ Sask

Disclosure:

Yoplait (France)	**Educational**
Dairy Farmers of Canada	**Educational and Consultant**
IADSA	**Educational**

Outline

- National vitamin D levels (25OHD)
  - What are influencing factors
- Sources of Vitamin D
  - Sun exposure
  - Food sources
  - Fortification
  - Supplements
- Strategies to improve status and consequences of inaction



Source: Perez-Lopez (2007) Vitamin D and its implications for musculoskeletal health in women: An Update. Mauritas, 58:117-137

Vitamin D is a World Wide Problem

- **Lack of access to UVB**
  - Workplace has moved indoors
  - Clothing, sun avoidance
  - Migration from sunny → winter climates
  - No recognition of this problem

  Presumption that dietary D is adequate e.g. fish, fortified milk

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It is now <u>not</u> possible to assume that sun exposure provides us with all the vitamin D we need

Vitamin Deficiency Worldwide

EUROPE

< 25 nmol/l

2-30% adults

- 75% older institutionalized

Netherlands

< 25 nmol/l F 14% M 8%

< 50 nmol/l F 56% M 45%

imigrants (non-western) **<25 nmol/l**

overall 40%

pregnant (e.g.turkish) 80%

Switzerland **< 50nmol/l**

nursing home: 90%

non-institut.: 57%

Italy **<25 nmol/l**

postMP women: 30%

ASIA

North India **< 50 nmol/l**

neonates 96%

school girls 91%

hosp. staff78%

pregnant women 84%

South-East Asia < 75 nmol/l

Thailand 47%

Malaysia 49%

Japan 90%

South Korea 92%

China (Bejing)

adolescent girls **< 50 nmol/ l** 89%

old men < 75 nmol/l 48%

MIDDLE EAST & AFRICA

- Adolescent girls **< 25 nmol/l**
  - Iran - 70%
  - Saudi Arabia - 80%
  - Lebanon 9-32%
- Elderly **< 25 nmol/l**
  - Iran 60-65%
  - Jordania60-65%
  - Lebanon 60-65%
  - Israel (Hosp.) 35%
- Neonates **<25 nmol/l** in 40-80%
  Saudi Arabia, Kuweit, UAE, Iran

AUSTRALIA

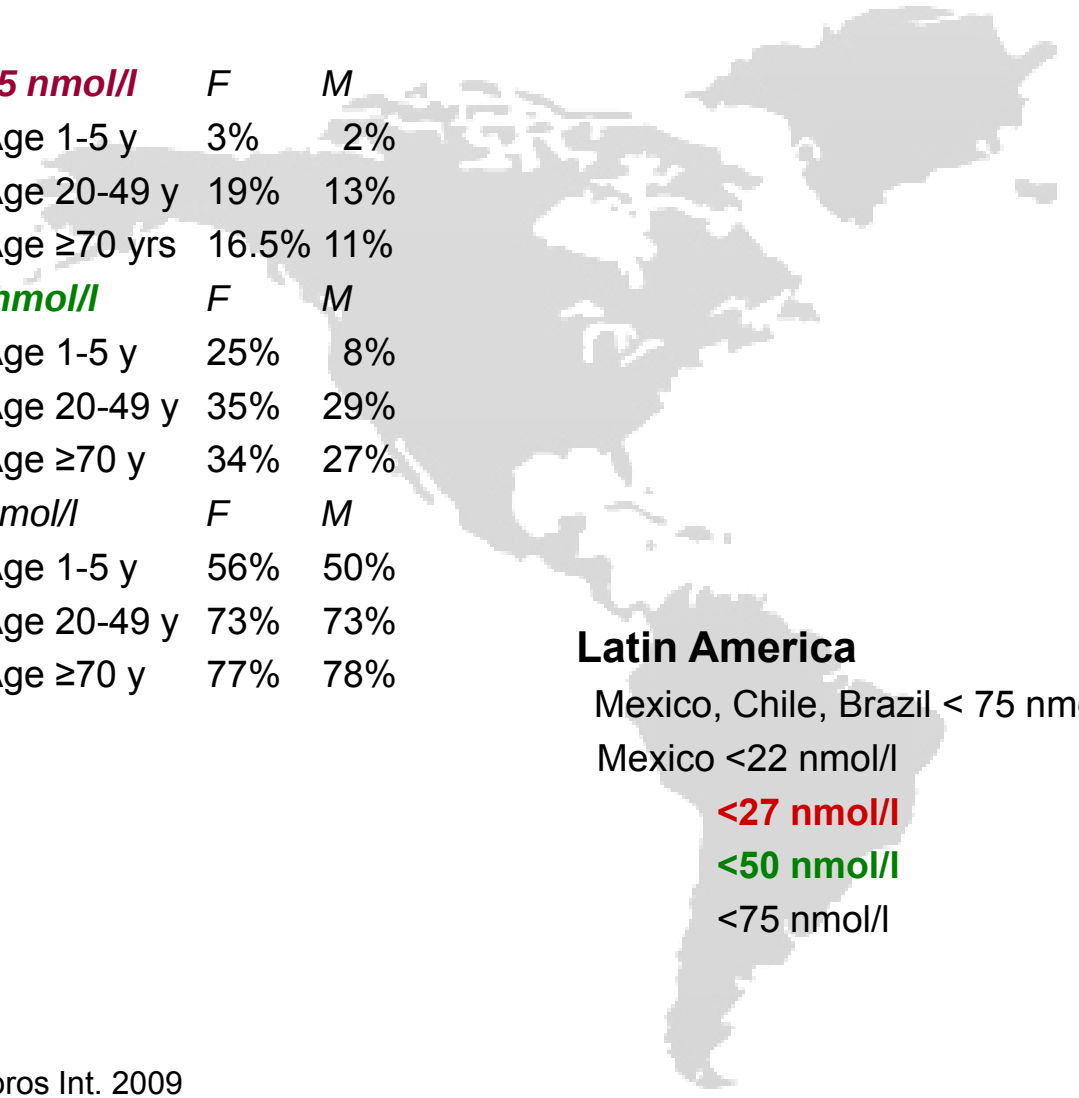
- Geelong study (20-92 yrs)
  < 50 nmol/l: 30-43%
  < 25 nmol/l 7-11%

A. Mithal et al. Osteoporos Int. 2009

Vitamin D Deficiency Worldwide

USA

	F	M
< 37.5 nmol/l		
– Age 1-5 y	3%	2%
– Age 20-49 y	19%	13%
– Age ≥70 yrs	16.5%	11%
< 50 nmol/l		
– Age 1-5 y	25%	8%
– Age 20-49 y	35%	29%
– Age ≥70 y	34%	27%
< 75 nmol/l		
– Age 1-5 y	56%	50%
– Age 20-49 y	73%	73%
– Age ≥70 y	77%	78%



Latin America

Mexico, Chile, Brazil < 75 nmol/l	42-67%
Mexico <22 nmol/l	2%
<27 nmol/l	31%
<50 nmol/l	62%
<75 nmol/l	97%

A. Mithal et al. Osteoporos Int. 2009

Physiological Factors Affecting Need for Vitamin D

Age

- less skin synthesis; less ability to make 1,25D

Body Size and /or body fatness

- Need is relative to body size
- Adipose may “hoard” D and make less accessible to blood

Life stage: pregnancy and lactation

Skin pigmentation

- Melanin is natural sunscreen

Skin Synthesis of Vitamin D

- Time in sun (providing UVB present)
  - 1 MED (minimal erythymal dose = quantity of radiant energy required to produce the first perceptible redness) = 20,000 IU for naked individual
  - Recommend ¼ of dose
- Amount of skin exposed
  - Recommend at least 25% which is arms and legs

Webb & Engelsen 2006: cloudless day

Times For ¼ MED with 25% of skin = synthesis of 1000 IU

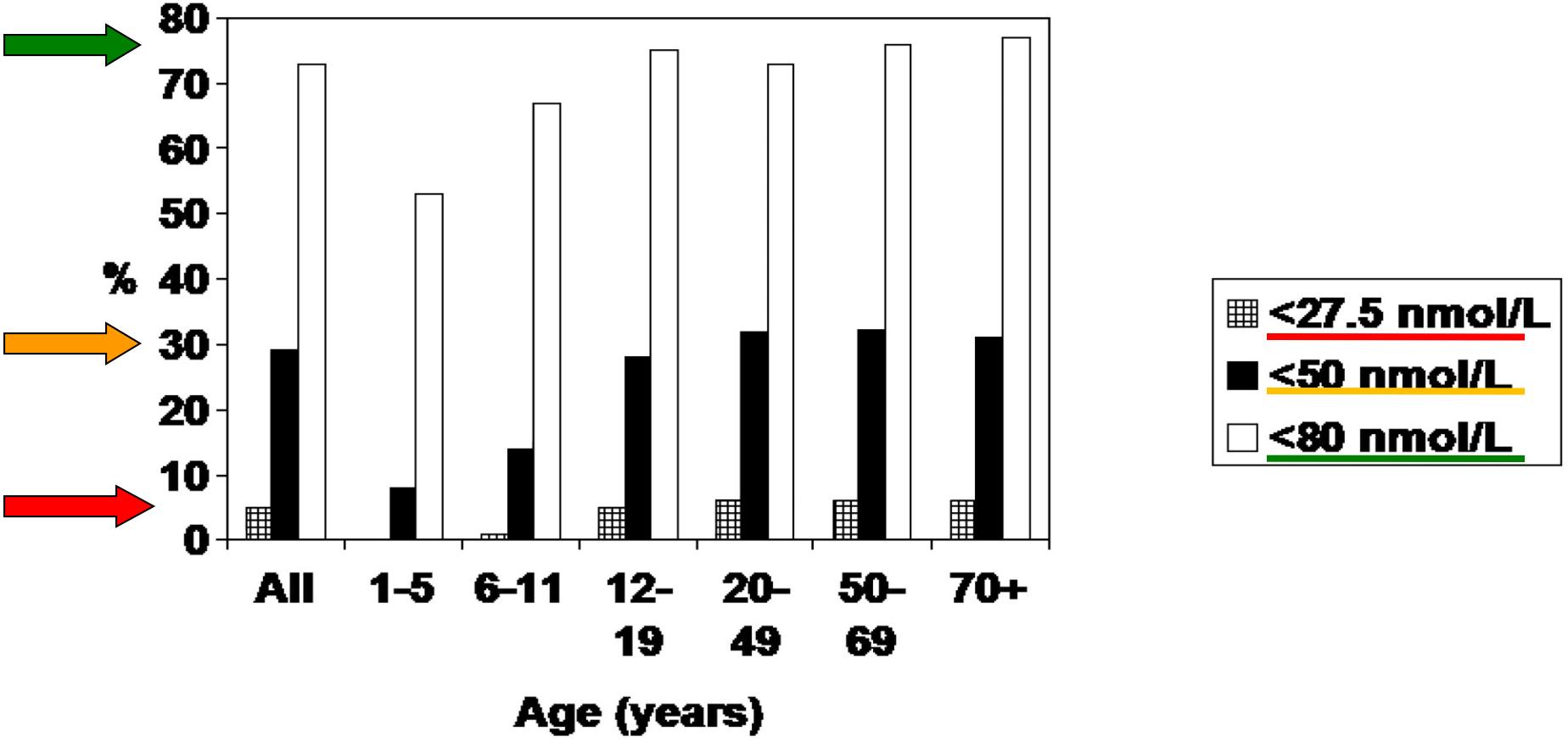
Skin Type	Time (minutes) at noon June 21 At 42.5 ºN
I - White burns easily	4
II - White – mostly burns	6
III - White - mostly tans	8
IV - Mediterranean	12
V - East Asian	15
VI - African	18

Webb & Engelsen 2006: cloudless day

Vitamin D Status in USA

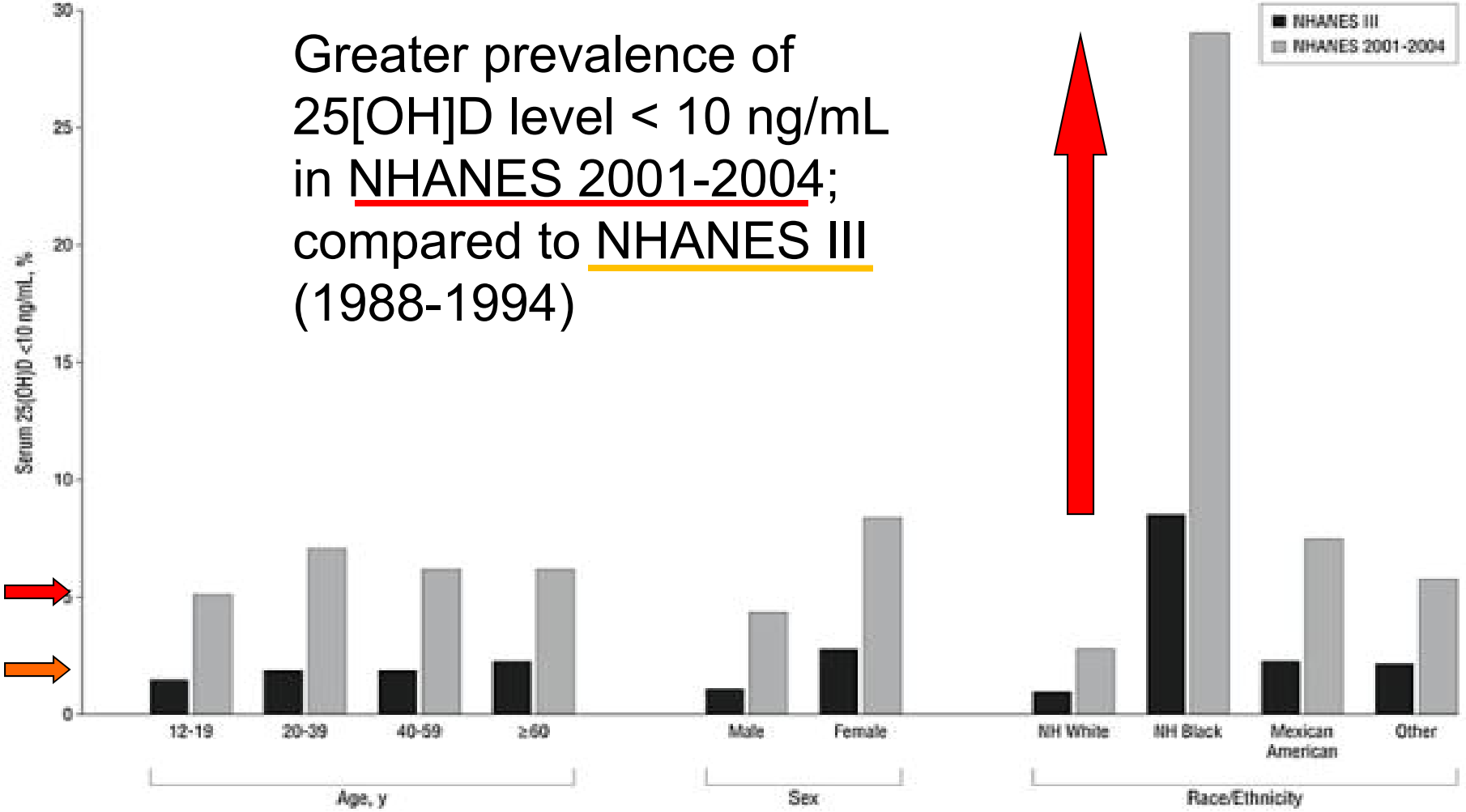
- A significant proportion of the population has at least several months of "vitamin D winter"
- Dietary intake from fortified milk, fortified cereals not accessible to all of the population
- Levels of 25(OH)D are not optimal for most of population, but very poor for African Americans (Black Americans)

Prevalence (%) of low serum 25(OH)D NHANES 2000-2004



Yetley, E. A Am J Clin Nutr 2008;88:558S-564S

Greater prevalence of 25[OH]D level < 10 ng/mL in NHANES 2001-2004; compared to NHANES III (1988-1994)

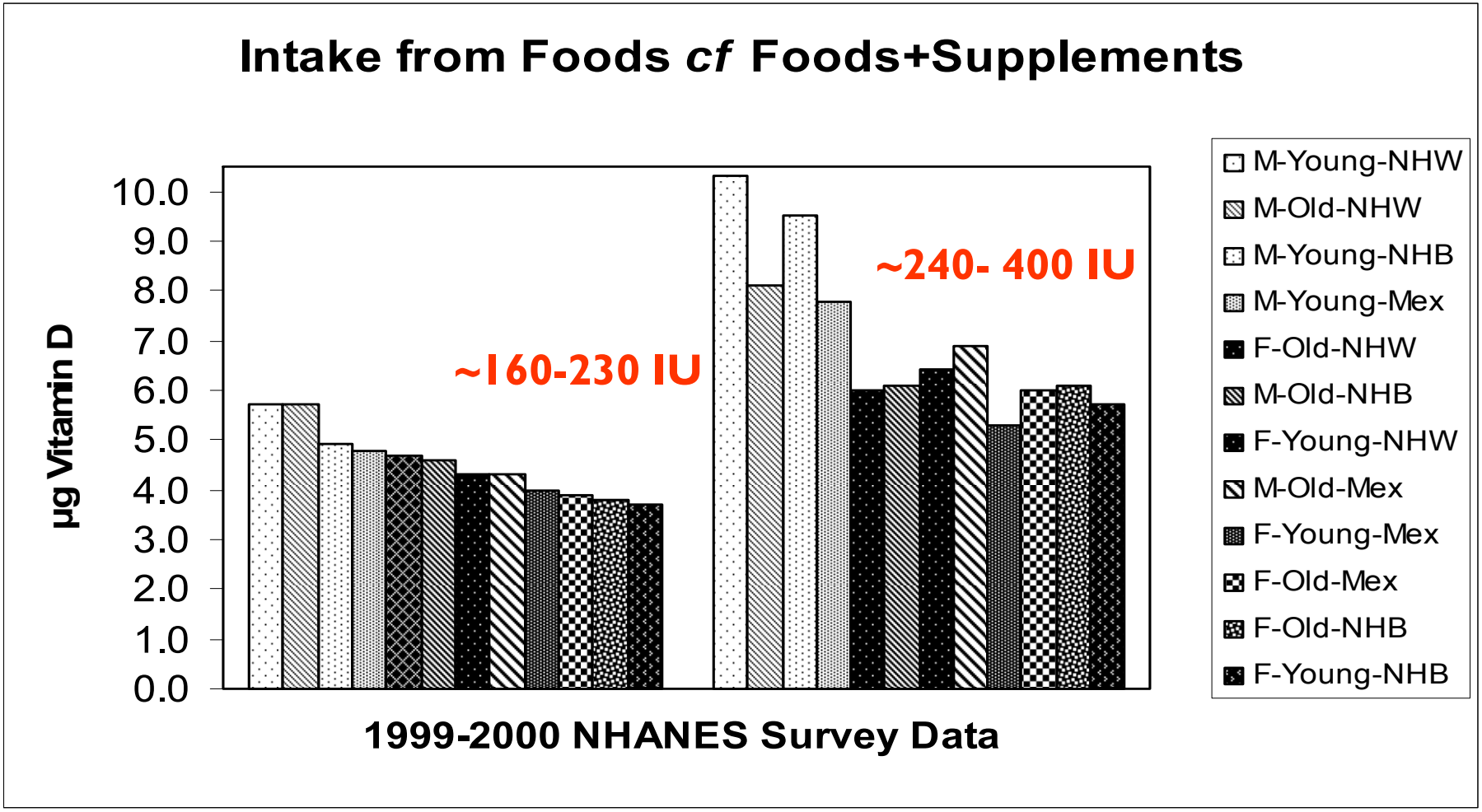


Demographic Differences and Trends of Vitamin D Insufficiency in the US Population, 1988-2004.

Wolters Kluwer Health | OvidSP

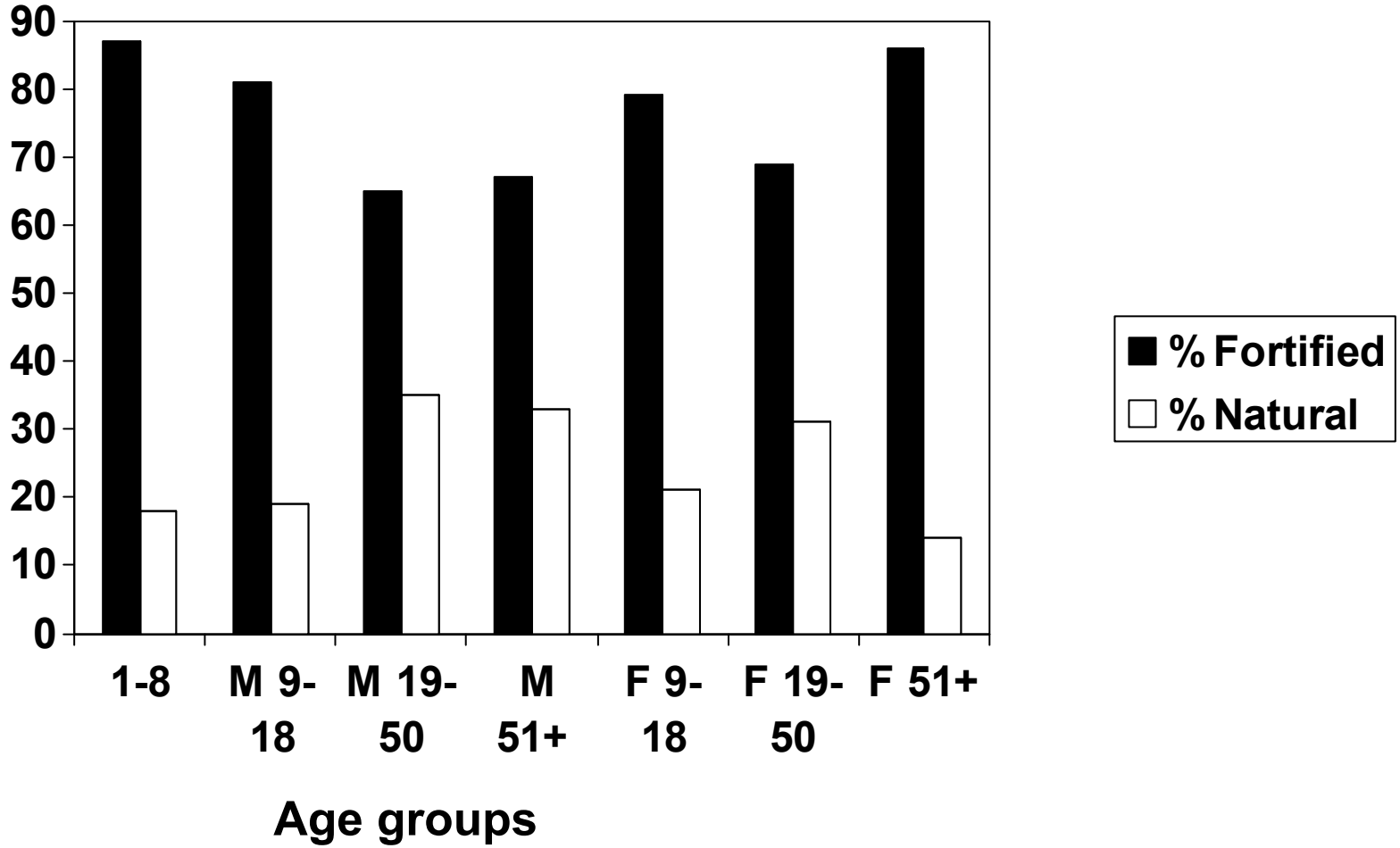
Ginde, Adit; MD, MPH; Liu, Mark; Camargo, Carlos; Jr MD, DrPH
Archives of Internal Medicine. 169(6):626-632, March 23, 2009.
doi: 10.1001/archinternmed.2008.604

Status of Vitamin D Intake in USA



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

Most food-derived vitamin D intake is from fortified foods (NHANES 1999-2000)



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

There is reliance on Fortification and Supplementation to achieve current intakes

NonHispanic White Women = 7.3 µg/d ~ 300 IU

Milk# – 39 % = mandatory fortification

Cereal# – 3 % = discretionary fortification

Other – 18 % = fish, margarine, eggs

Suppl. – 40 %

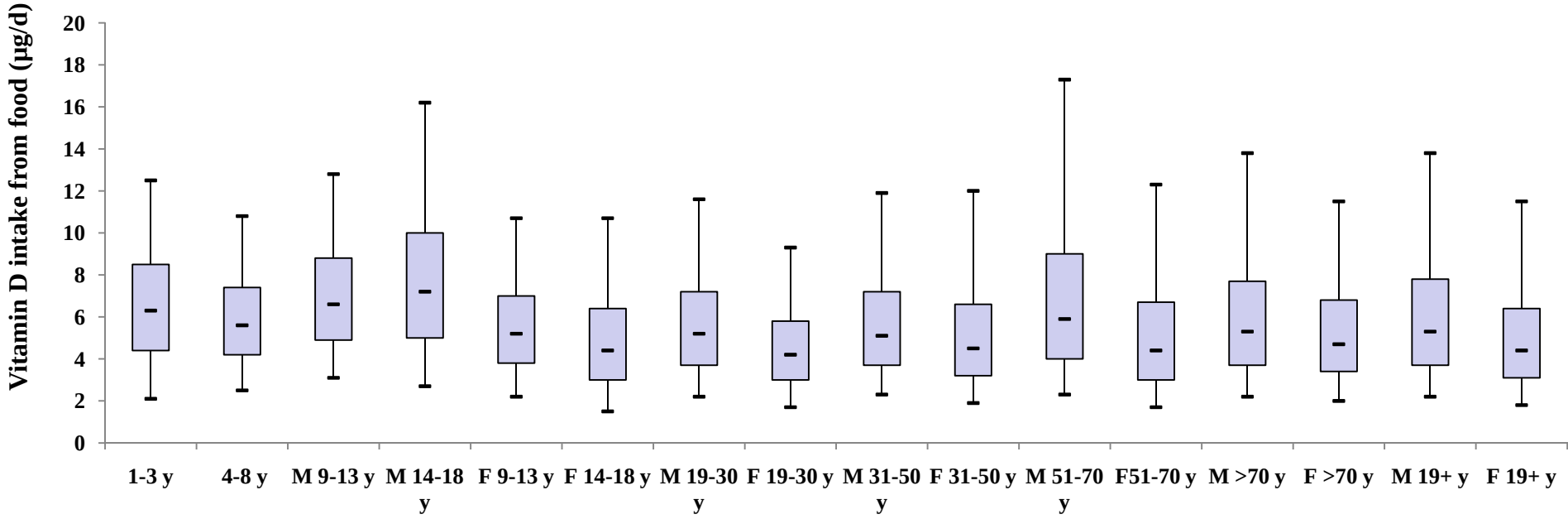
What we know about Canada

- Most of the population lives above 43ºN
  - At least 5 months of “vitamin D winter”
- Food is fortified with vitamin D
  - Milk has 2.5 µg (100 IU) per 250 mL serving
    - Yogurt less, cheese none; margarine a small amt
- Canadians eat salmon, sardines, char, sea trout = good sources of D

Box Plot of Vitamin D intake of Canadians

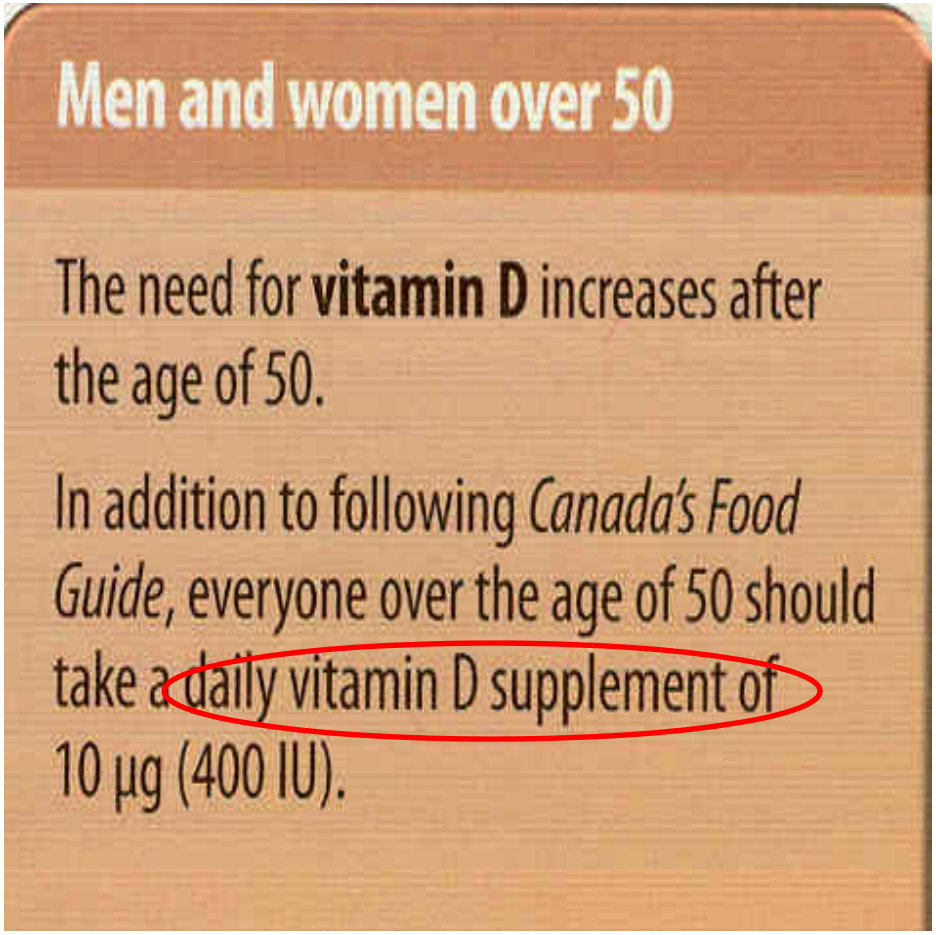
2004 Canadian Community Health Survey

Food intake only



Values in ascending order: lower error bar: 5 percentile; lower border of the box: 25 percentile, "-" inside box: median, upper border of the box: 75 percentile; upper error bar: 95 percentile

Canada Food Guide 2007 recommendations

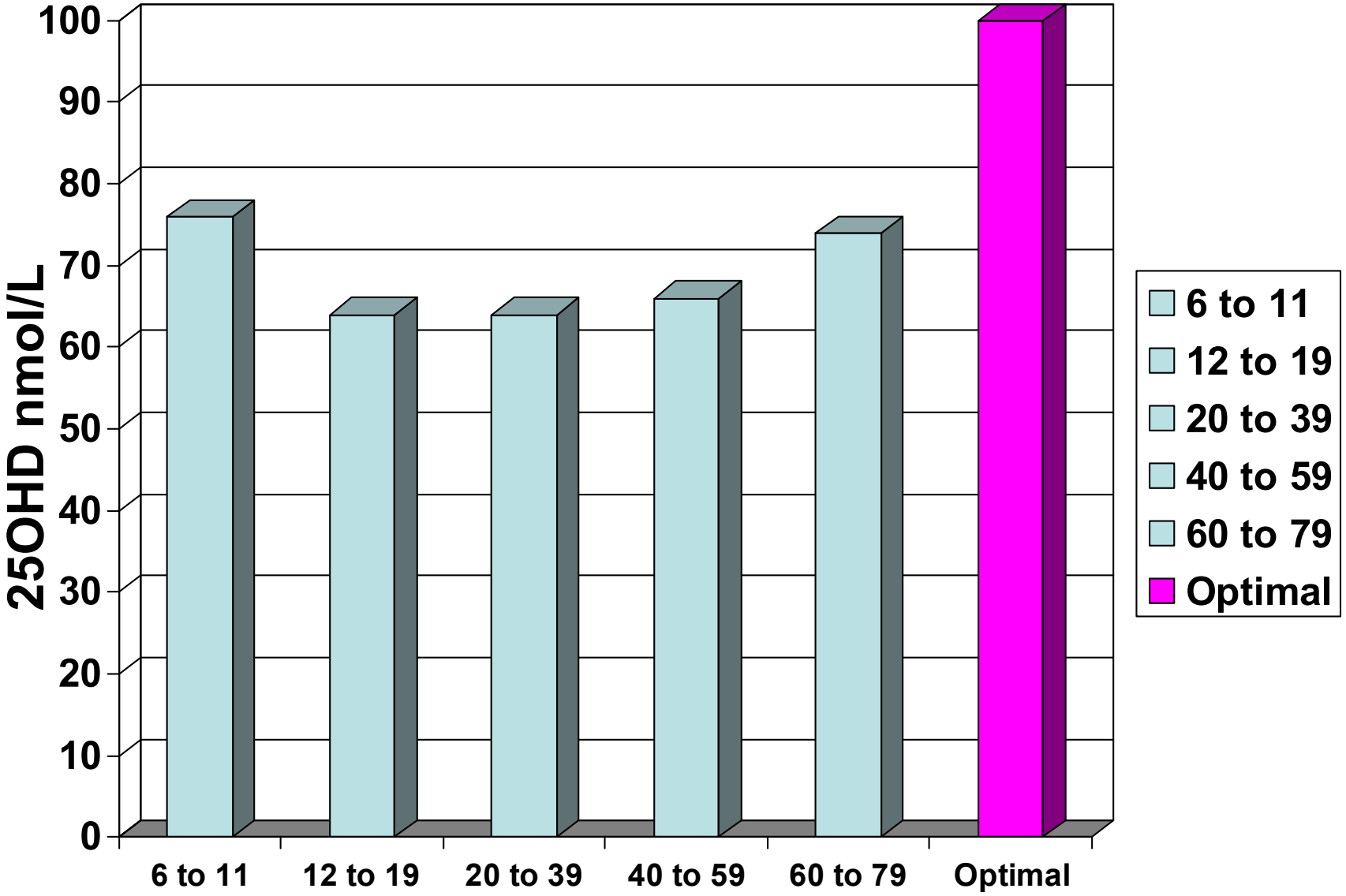


Men and women over 50

The need for **vitamin D** increases after the age of 50.

In addition to following *Canada's Food Guide*, everyone over the age of 50 should take a daily vitamin D supplement of 10 µg (400 IU).

Canadian Health Measures Survey 2007-08 (1 year)



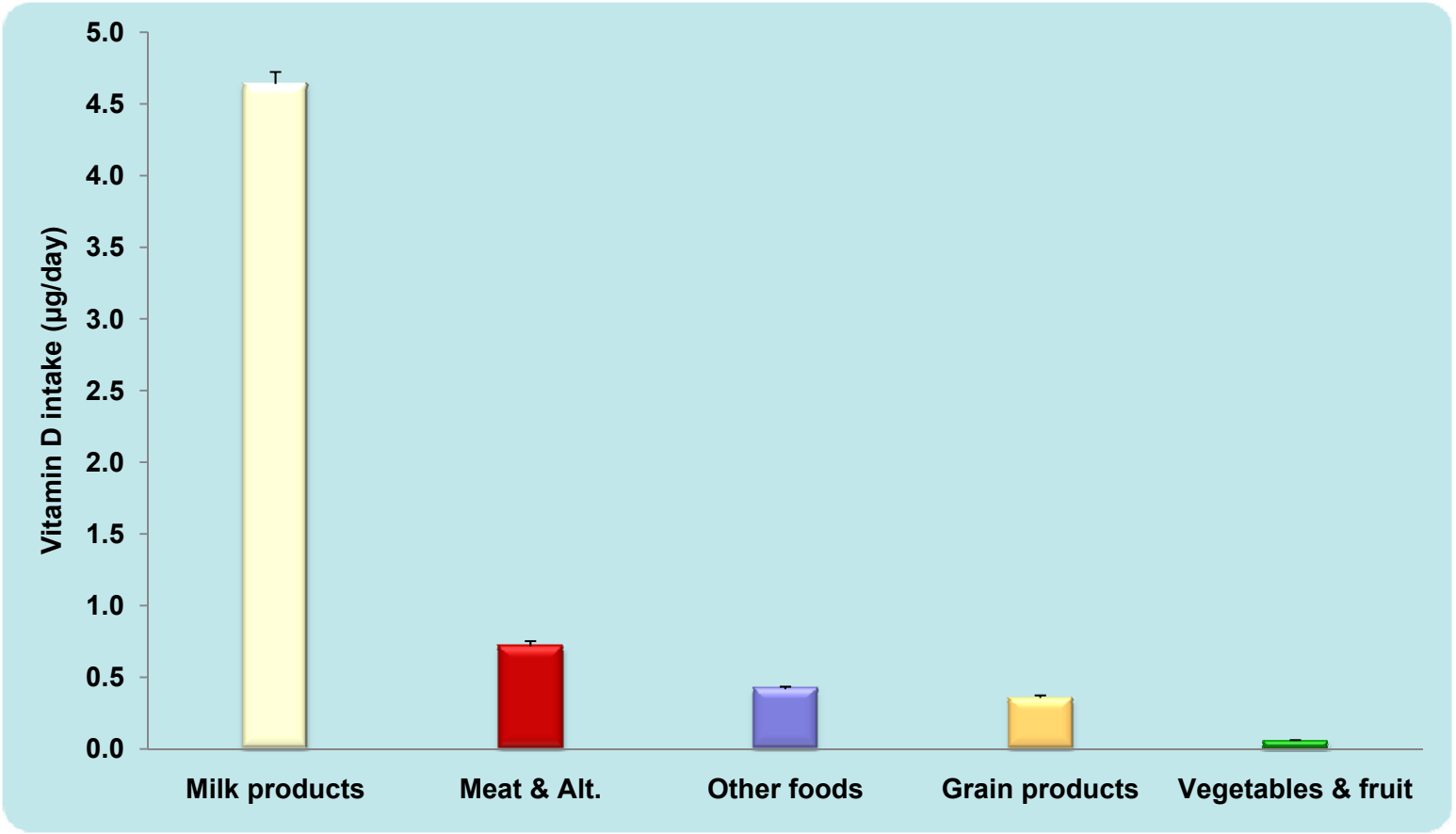
Vitamin D status of Canadians
Serum 25(OH)D levels

Serum25(OH)D	6-11 y	12-19 y	20-39 y	40-59 y	60-79 y
nmol/L	76	64	64	66	74
% < 75 nmol/L	~50	~70	~70	~70	~50

Why are Canadian Children and older adults faring better than Americans

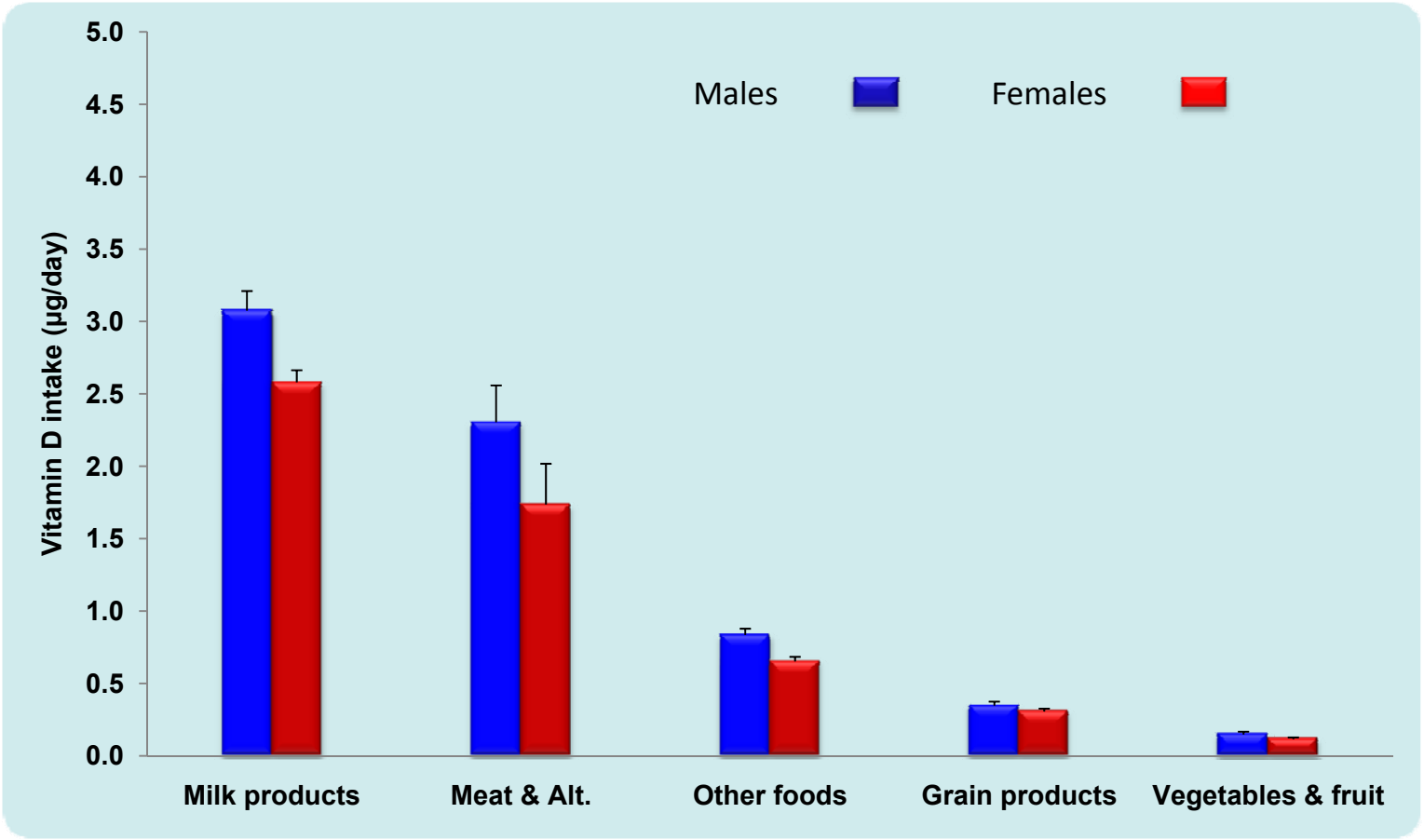
Canadian Health Measures Survey, 2007-08
Preliminary data released July 2009

Food sources of vitamin D, Canadian Children 1-8 years



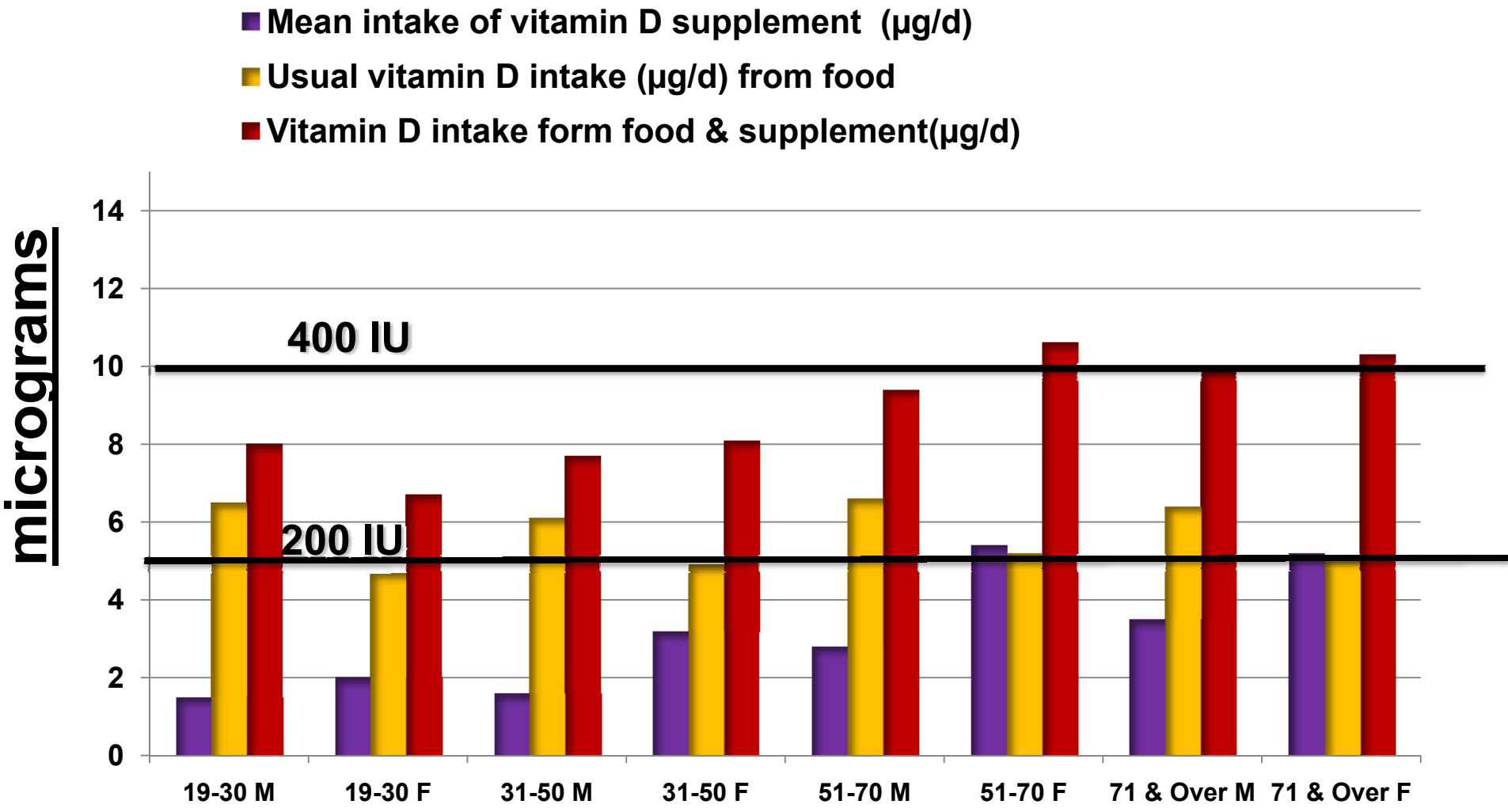
CCHS 2.2, 2004

Food sources of vitamin D, Canadian adults 9 yrs and older



CCHS 2.2, 2004

Supplements improve D intakes of Canadians (2004 survey data)



Strategies to increase vitamin D in foods

1. Increase amount of D and # foods fortified with D: other dairy foods (beyond fluid milk)
2. High vitamin D feed and addition of 25(OH)D to meat (functions as tenderizer)
3. Enrichment through irradiation
   - yeast in making bread = now available in USA
   - mushrooms = now available in USA
4. “Home” fortification

Baker's Inn Seven Grain

Nutrition Facts

Serving Size 1 Slice (43g)
Servings Per Container 16

Amount Per Serving	
Calories 100	Calories from Fat 15
	% Daily Value*
Total Fat 2g	**3**%
Saturated Fat 0g	**0**%
Trans Fat 0g	
Cholesterol 0mg	**0**%
Sodium 230mg	**10**%
Total Carbohydrate 19g	**6**%
Dietary Fiber 2g	**8**%
Sugars 3g	
Protein 4g	

Vitamin A	0%	Vitamin C	0%
Calcium	[illegible]	Iron	8%
Vitamin D	8%	Thiamine	8%
Riboflavin	[illegible]	Niacin	8%
Vitamin B6	8%	Folic Acid	8%
Vitamin B12	8%	Zinc	8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

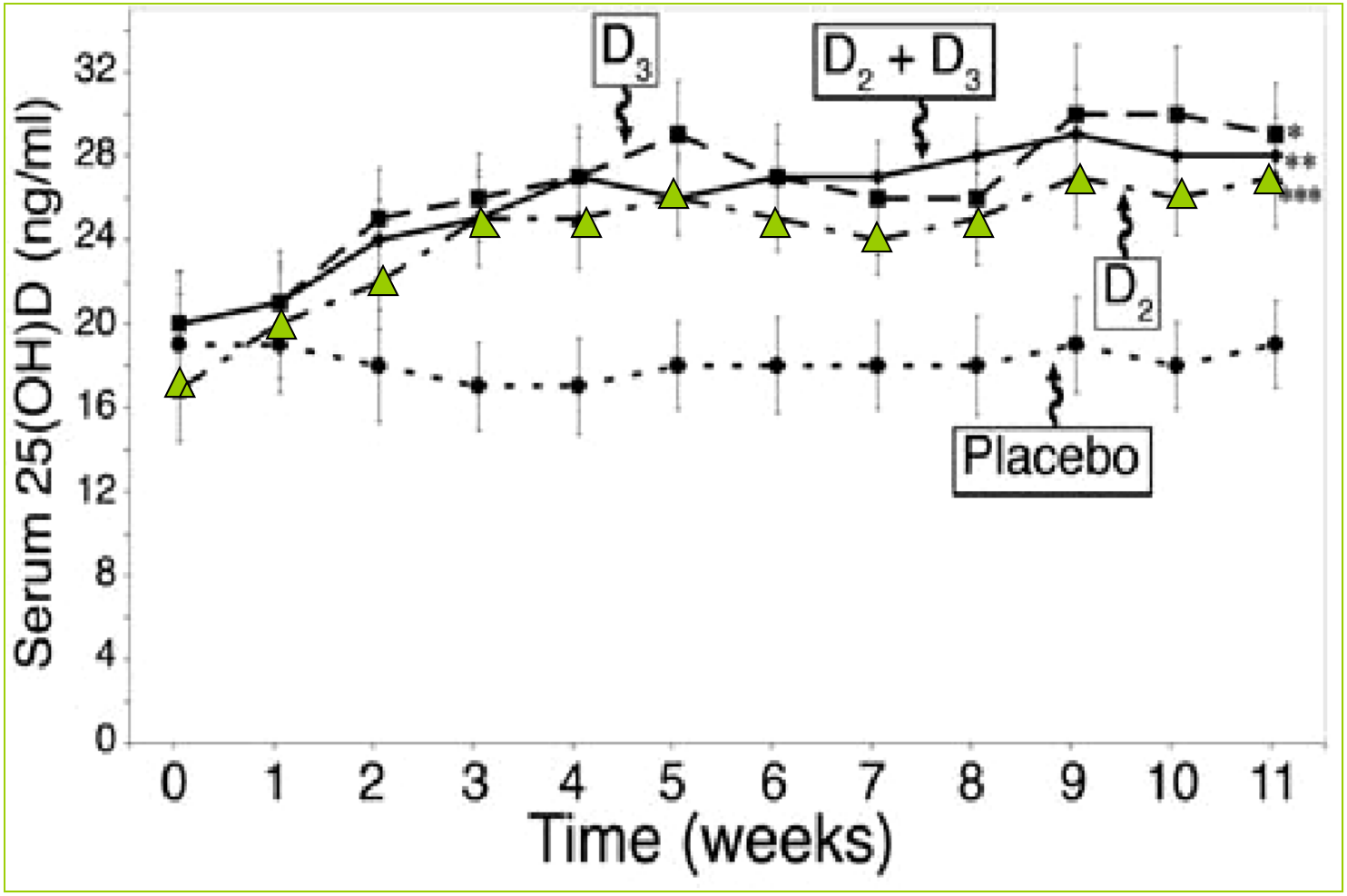
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

- Good Source of Whole Grain
- Good Source of Calcium, Folic Acid & Vitamin D
- No Trans Fat
- Good Source of 7 More Vitamins & Minerals
- Good Source of Fiber

INGREDIENTS: WATER, UNBLEACHED ENRICHED WHEAT FLOUR (FLOUR, BARLEY MALT, FERROUS SULFATE (IRON), "B" VITAMINS (NIACIN, THIAMINE MONONITRATE (B1), RIBOFLAVIN (B2), FOLIC ACID)), WHOLE WHEAT FLOUR, CRACKED WHEAT, MOLASSES, HIGH FRUCTOSE CORN SYRUP, WHEAT GLUTEN, YEAST, CORN GRITS, SOYBEAN OIL. CONTAINS 2% OR LESS OF: WHEAT BRAN, SUNFLOUR SEEDS, ROLLED OATS, BARLEY FLAKES, DARK RYE FLOUR, MILLET, FLAXSEEDS, BUCKWHEAT FLOUR, CRACKED TRITICALE, SOY FIBER, CALCIUM SULFATE, SALT, OAT FLAKES, VINEGAR, DOUGH CONDITIONERS (SODIUM STEAROYL LACTYLATE, MONO AND DIGLYCERIDES, ETHOXYLATED MONO AND DIGLYCERIDES, DATEM AND/OR CALCIUM DIOXIDE), YEAST NUTRIENTS (MONOCALCIUM PHOSPHATE, AMMONIUM SULFATE AND/OR AMMONIUM CHLORIDE), ENZYMES, CORNSTARCH, WHEAT STARCH, ENRICHMENT (FERROUS SULFATE (IRON), ZINC OXIDE, NIACIN, CALCIUM SULFATE, VITAMIN D, PYRIDOXINE HYDROCHLORIDE (B6), RIBOFLAVIN (B2), FOLIC ACID, THIAMINE MONONITRATE (B1), VITAMIN B12), SOY FLOUR, SOY LECITHIN, CALCIUM PROPIONATE (TO RETAIN FRESHNESS), CONTAINS WHEAT AND SOYBEANS.
120604C


Excellent source of Vitamin D
Dole
100% Vitamin D
low calorie
low fat
3g carbs
Sliced Portobello Mushrooms
Go to MushroomLovers.com for information and delicious mushroom recipes.
Nutrition Facts
Serv Size 3 oz (85g)
Servings 2
Calories 20
Fat Cal. 0
Amount/serving %DV* Amount/serv. %DV*
Total Fat 0g 0% Total Carb 3g 1%
Sodium 15mg 0% Fiber 1g 4%
Potassium 300mg 9% Protein 3g
Vitamin D 100% Vitamin C 2% · Iron 2%
Distributed by Oakshire Mushroom Sales, LLC, under license
Kennett Square, PA 19348,
1-888-355-2077, Product of USA
0 33383 67601 2
NET WT. 6 OZ. (170G)
DOLE is a registered trademark of Dole Food Company, Inc.
Best if Refrigerated

Yeast, mushrooms: provide Vitamin D2



Holick, M. et al. (2008) Vitamin D2 is as Effective as Vitamin D3 in Maintaining Circulating Concentrations of 25-Hydroxyvitamin D. J Clin Endocrinol Metab.93:677-681.

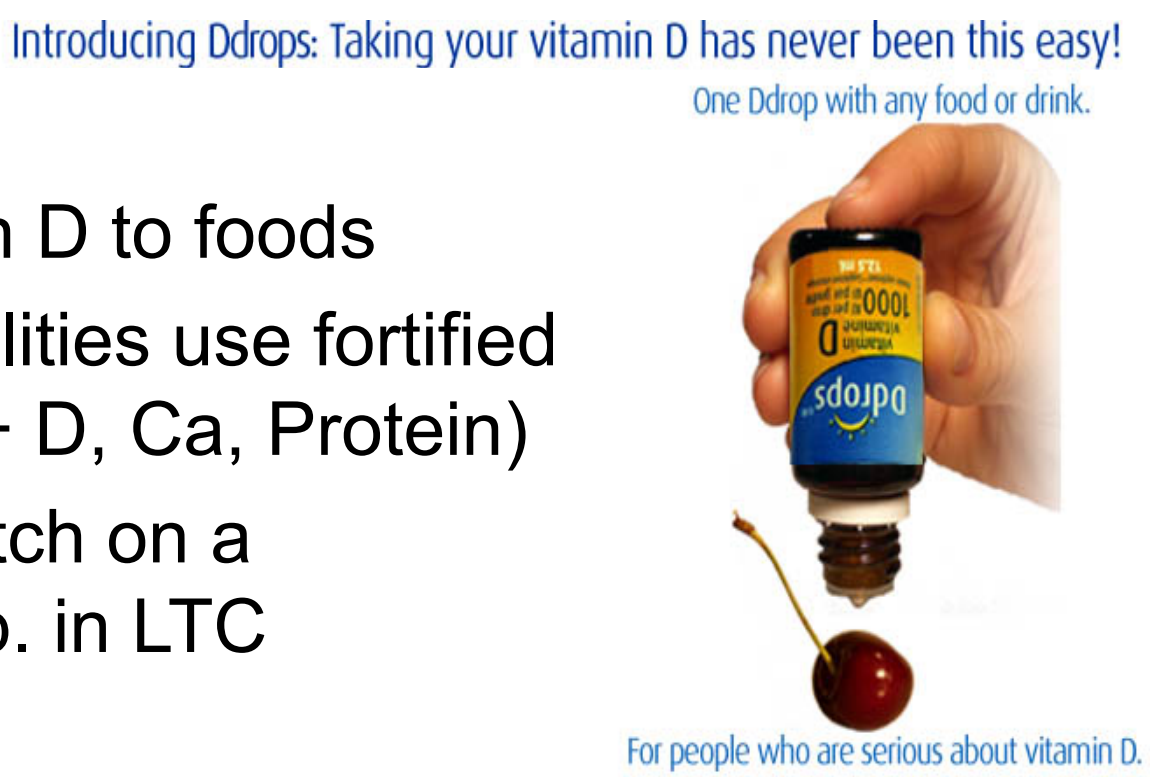
Vitamin D Fortification in USA allows for more products to be fortified

Category of food	21 CFR citation	Fortification status	Maximal level allowed[1]	Surveyed products fortified with vitamin D: Estimate of fortified products	Surveyed products fortified with vitamin D: 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

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

Home Fortification

- Adding vitamin D to foods
- Many LTC facilities use fortified milk powder (+ D, Ca, Protein)
- Drops may catch on a alternative esp. in LTC



Encourage Supplement Use

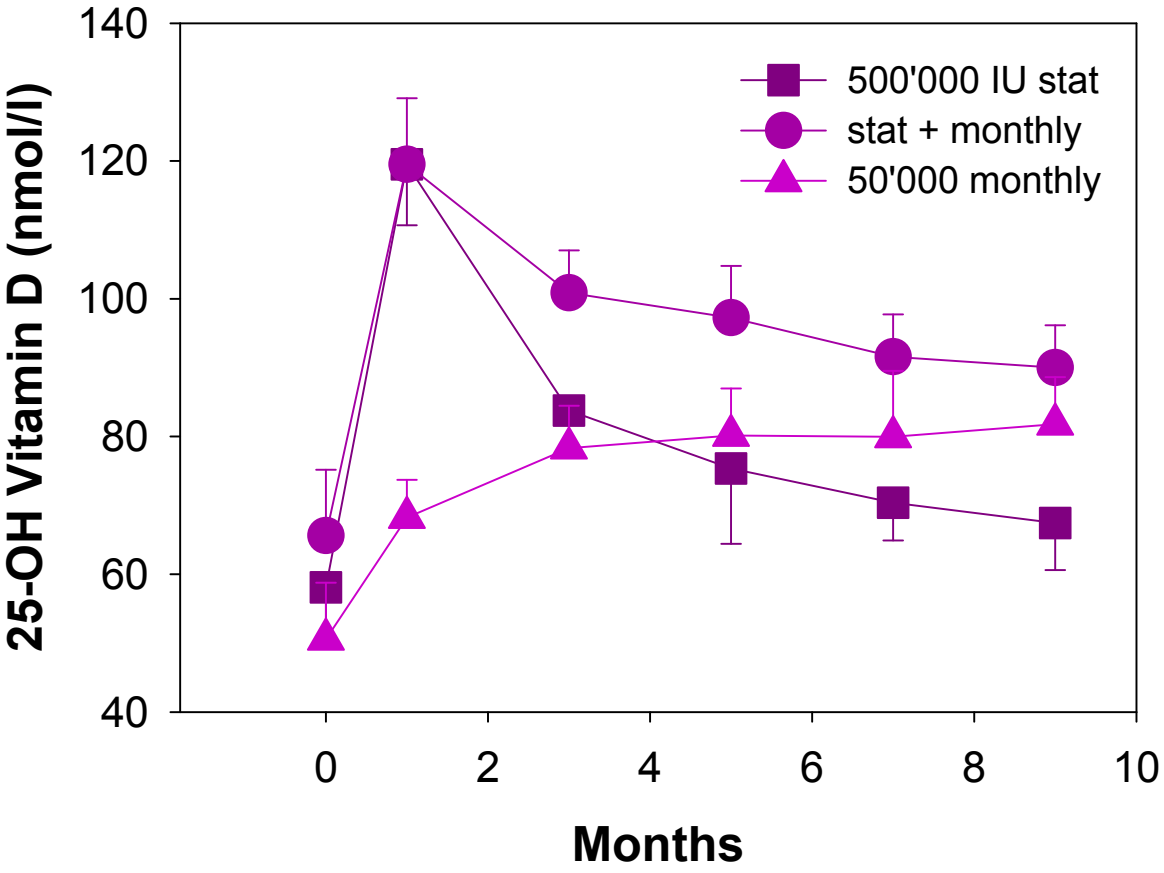
Authoritative agencies recommending 1000 IU

- **USDA in 2005 Dietary Guidelines**
  = those who are older or those who lack sun-exposure
- **Canadian Dermatology Association**
  – as this group promotes sun avoidance
- **Canadian Cancer Society**
  – in winter and all year for those at-risk
- **National Osteoporosis Foundation 2008**
  – for adults who are at-risk for vitamin D deficiency

Safety of Vitamin D

- There is a UL for vitamin D of 50 µg (2000 IU) in USA/Canada
  - UL of 1000 IU for infants
- By definition a UL is safe
- Experts say intakes of **~10,000 IU/day**, which can bring 25(OH)D up to 250 nmol/L, are safe
- For repletion, intakes above the UL are required and necessary

Oral High Dose Vitamin D Supplementation



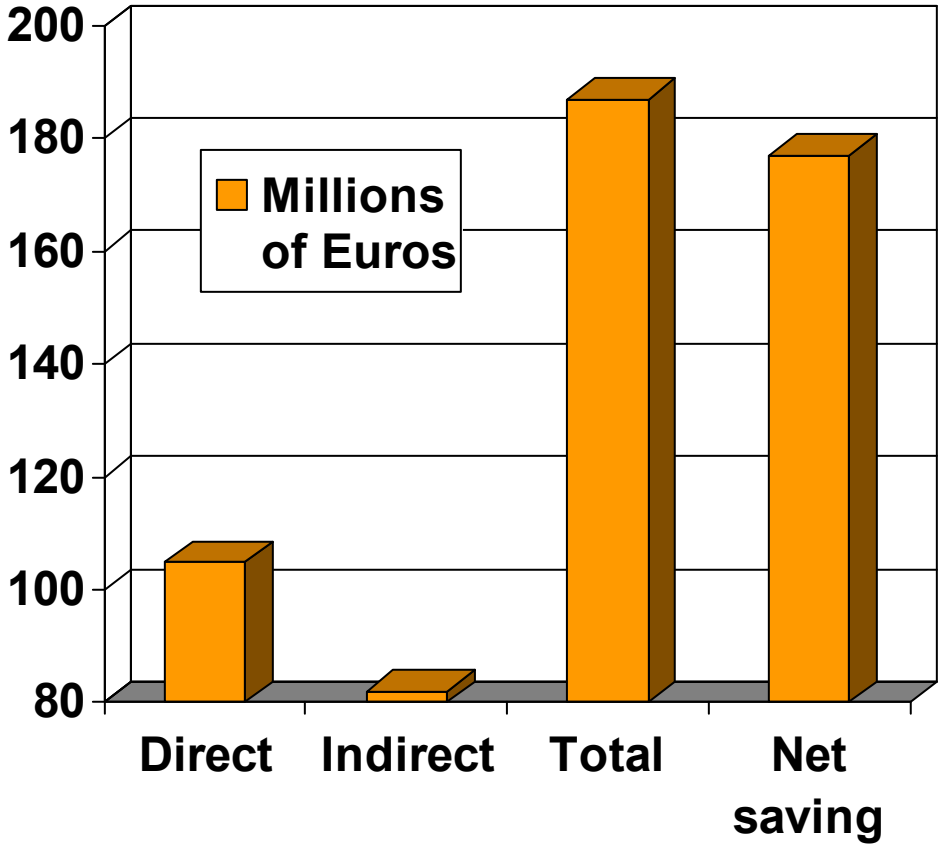
C.Bacon et al. Osteoporos Int 2009;20:1407–1415

Estimated benefit of improved vitamin D status in reducing economic burden of disease in western Europe

Grant et al. 2009 Prog Biophys Mol Biol

If Raise 25(OH)D levels to 100 nmol/L, using a supplement,

Reduce burden on healthcare



Conclusions

The amount of vitamin D needed to protect against bone loss, cancer, poor immunity, diabetes and cardiovascular disease exceeds what we can get from diet.

Sun-induced synthesis of vitamin D is compromised during winter and with many factors (clothing, being indoors) that prevent UVB radiation reaching skin.

A combination of diet (fortification needed), sun exposure, and supplement use is needed to maintain healthy levels.