The role and challenges of increasing vitamin D in the food supply.

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~ 90% of vitamin D is derived from sunshine

~ 10% of vitamin D is derived from food

Number of factors limit capacity for vitamin D synthesis following UVB exposure….

- Skin pigmentation
- Age
- Cloud cover
- Pollution & ozone
- Clothing
- Sunscreen
- Sun avoidance
- Adiposity

Potential for exposure often limited in India!

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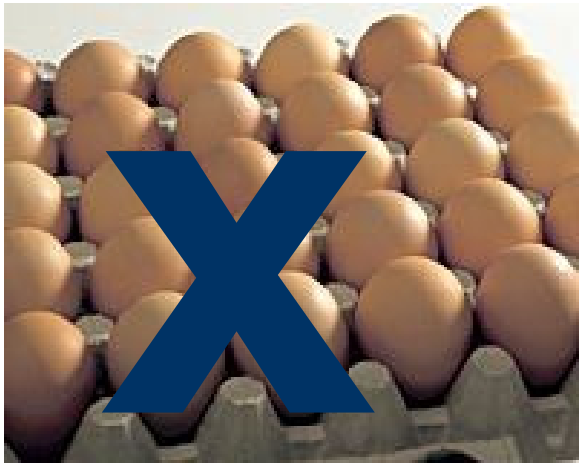

Problem?

Vitamin D (serum 25OHD) deficiency and sufficiency

- <12.5nmol/L = severe deficiency (rickets)
- < 25nmol/L = deficiency
- < 50 nmol/L = insufficiency
- Optimal concentration 75-100 nmol/L

Vitamin D status: Indian Studies

	Population	Age	Mean Vitamin D status
Marwaha et al, 2005	LSES School Girls Delhi		34.6 ± 17.43 nmol/l
	USES School Girls Delhi		29.4 ± 12.7 nmol/l
Zargar et al, 2007	Men, Kashmir Valley		37.7 ± 30 nmol/l
	Women, Kashmir Valley		13.8 ± 11 nmol/l
Goswami et al, 2008	Rural Males, Delhi		44.2 ± 24.2 nmol/l
	Rural Females, Delhi		26.9 ± 15.9 nmol/l
Sahu et al, 2008	Pregnant women, summer, Lucknow		55.5 ± 19.8 nmol/l
	Pregnant women, winter, Lucknow		27.3 ± 12.3 nmol/l
	Girls, winter		31.3 ± 13.5 nmol/l
Goswami et al, 2000	Pregnant women, Summer, Delhi		21.9 ± 10.73 nmol/l
	New Born, Summer, Delhi		16.72 ± 4.99 nmol/l
Goswami et al, 2000	Soldiers, males, winter, Delhi		41.17 ± 11.73 nmol/l
	Phys and nurses, winter, Delhi		17.97 ± 7.98 nmol/l

CV Harinarayan. Review. Vitamin D Status in India – Its implications and remedial measures. JAPI Vol. 57 January 2009

Vitamin D status: India

Population	Vitamin D status
Children and Adolescents	Numerous studies in north and south India in this age group have shown that 75 to 85% of the groups studied have varying degrees of Vitamin D deficiency or insufficiency
Middle age	Rural population in this age group have better vitamin D status as compared to the urban group
Post menopausal women	There are studies that show low vitamin D status in this population
Pregnant women	Studies have shown that pregnant women have low vitamin D status.
Geographic Locations	Studies from the Kashmir Valley have shown lower Vitamin D status
Sun Exposure	Indian paramilitary forces had better levels as compared to the civilian counterparts

High % of Indian population at risk of vitamin D deficiency!

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Need for intervention

- ✓ Food and beverage fortification
- ✓ Dietary supplements
- ✓ Advice on sun exposure

Food fortification

ADVANTAGES

- ✓ Helps ensure minimum dietary recommendations are met & can improve health
- ✓ Important tool to help prevent and treat nutrient deficiency
- ✓ Can prevent large scale deficiency disease

CONSIDERATIONS

- Food must be consumed by significant proportion of the population
- Must not interfere with product quality

DISADVANTAGES

- Can be costly

Global successes with vitamin D fortification

Milk: a case study

- Fortification of milk is common practice in some countries
  - e.g. Canada 4µg vitamin D/ 100mL
  - e.g. Finland 0.5µg vitamin D/ 100mL
  - e.g. US 0.9-1.3 µg vitamin D/ 100mL

- Small number of studies have assessed effect of vitamin D fortified milk on serum 25OHD
  - 5/5 studies reported a benefit (see O'Donnell et al., 2008. AJCN)
  - but large variation in dose, duration and numbers
  - greatest benefit seen in those with lowest status initially
  - increment of supplementation: each 1µg ↑ intake → > 1nmol/L ↑ in 25OHD concentration

Milk: a case study

Study and location	Characteristics				Dietary Source				Absolute mean change in serum calcidiol	
	Population	IG *n*	CG *N*	Age (years)	IG	CG	Daily vitamin D intake from fortified food (µg)	Duration	IG (nmol/l)	CG (nmol/l)
Chee *et al.*, (2003) Malaysia (3 ° 7' N)	Postmenopausal women	91	82	59 ± 3	Skimmed milk powder	Usual diet	IG: 10	24 months	17.3 ± 13.3	2.8 ± 13.1[1]
Daly *et al.*, (2006) Australia (37 ° 47' S)	Free living men ≥ 50 years	76	73	61.9 ± 7.7	Fortified milk	Usual diet	IG: 20	24 months	4.2 ± 20.0	14.4 ± 20.3
Keane *et al.*, (1998) Ireland (53 ° 22' N)	Elderly persons	18	24	78.1	Fortified milk	Unfortified milk	IG: 5 CG:0.1	12 months	22.25 ± 10.90	6.75 ± 10.92[2]
Lau *et al.*, (2001) China (22 ° 17' N)	Postmenopausal women	95	90	56.9	Milk powder	No intervention	IG:6	24 months	23.2±[1]	Not estimable
McKenna *et al.*, (1995) Ireland (53 ° 22' N)	Younger adults	52	50	22.6 (17-54)[3]	Fortified skimmed milk	Unfortified skimmed milk	IG: 3.4 CG:0.9	5 months	15 ± 21.1	31.0 ± 24.2[1]

★ Increase to greater than 70nmol/L observed

Adapted from O'Donnell et al., 2008 AJCN

Fortification is effective – so what level?

- First need to better understand vitamin D status of the population and identify at risk groups of the population
- Also need to determine dietary intakes in population as a whole
- Has been suggested that ideal vitamin D status is 25OHD of 70-100nmol/L
- What is the gap in India?
- What level of dietary intake of vitamin D would ensure this level met?

Dietary recommendations for vitamin D

- ICMR – no RDA
- Codex NRV - 5µg/day
- EU ranges from 0-15 µg/day
- USA – DRI ranges from 5-10µg/day
  IOM currently reviewing DRI for vitamin D. Verdict due May 2010
- Argued by some academics that intakes should be much higher than currently recommended by most countries
- 20-25 µg/day sufficient to maintain serum 25OHD at 70-100nmol/L in adult Caucasians
- Is this transferable to the Indian population?? Research needed! Then can set RDA

Food fortification

- For **national/regional fortification**, food must be consumed by significant proportion of the population
  - WHO – food should provide ~ 97.5% of the population with an intake that meets their nutrient needs without exceeding tolerable upper intake level
  - At least 50% of the population must consume fortified food
  - Doesn't hold true for vitamin D!

- For **private** company any appropriate food could be fortified

- Fortification must not interfere with product quality (e.g. shelf life, taste, odour and appearance)
- Must be bioavailable source of nutrient

Foods which can be fortified & level of fortification

- Limited number of foods can be fortified:

  - Fruit juice
  - Milk & dairy products
  - Margarine & vegetable oils
  - Health food drinks
  - Breads, cereals & cereal bars

- Level of fortification would depend on what food is fortified
- Average consumption of food to be fortified needs to be determined
- Intakes of vitamin D in the population need to be understood too
- Effects of food fortification need to be monitored

Issues associated with vitamin D fortification

- Technical issues
- Regulatory issues
- Safety

Technical issues

- Vitamins degrade, vitamin D fairly stable when compared to others – certain other nutrients promote such degredation
- Both D_2 and D_3 are susceptible to autoxidation & photoxidation at high humidities & temperatures: lipid soluble antioxidants like BHA, BHT often incorporated to promote stability
- Large amount of data suggests D_2 to be comparatively less stable, less bioavailable and less potent than D_3. However, recently this thought has been questioned.

Technical issues continued

- Appropriate overages may need to be added, depending on shelf life & formulation. Impact on costing & feasibility
  - The overages for vitamin D would range from 10-50 % depending on the following various factors like:
    - - Product format (powders, drinks, bars etc)
    - - Water activity & moisture levels in the product
    - - Extent & level of exposure to oxygen
    - - Presence of pro-oxidants like minerals in the product
    - - Type of packing material used to pack the product
- Difficult to analyse – no universal method. Low amounts added to food; can be difficult to detect

Regulatory issues

- Vitamin D fortification permitted in foods
- No upper limit to fortification unlike that proposed in EU
- Use of antioxidants has regulatory implications

Safety

- Excess synthesis due to sunlight does not occur
- Excess consumption → hypervitaminosis D (400-1250nmol/L) – infants at high risk
- UK guidance level 25µg/day
- EU UL & US TUIL = 50 µg/day
- Argued that values based on old data

- 'Toxicity occurs at > 500nmol/L ≡ 500 µg/day' Heaney (2008)
- Vieth (1999) argues toxicity at >1000 µg/day
- Hathcock et al (2007) safe upper level for adults at 250 µg/day

Conclusions

- Vitamin D status of the Indian population a concern in parts
- Exposure to UV not sufficient to maintain status in some parts
- Natural dietary sources not acceptable to population on the whole

- Action needs to be taken to remedy
- Food fortification can form part of the solution
- But is only part of the solution; need integrated public health strategy to include advice on sensible UV exposure and advice on consumption of vitamin D fortified foods.

- More research needed to understand:
  - Vitamin D status of population as a whole & specific groups
  - Vitamin D intake of population & specific groups
  - Need to determine appropriate vitamin D intake to meet desirable status

Conclusions

- An RDA for vitamin D should be set in India
- What this level should be, based on improving vitamin D status, is not currently known and requires further research

- In terms of food fortification
  - Number of candidate foods could be fortified
  - Level of food fortification depends on vehicle
  - But food distribution patterns in India not uniform and therefore may limit success
  - Private label fortification can help

Thank you!