

Vitamin D

The hidden deficiency

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Enhancing and promoting health for all

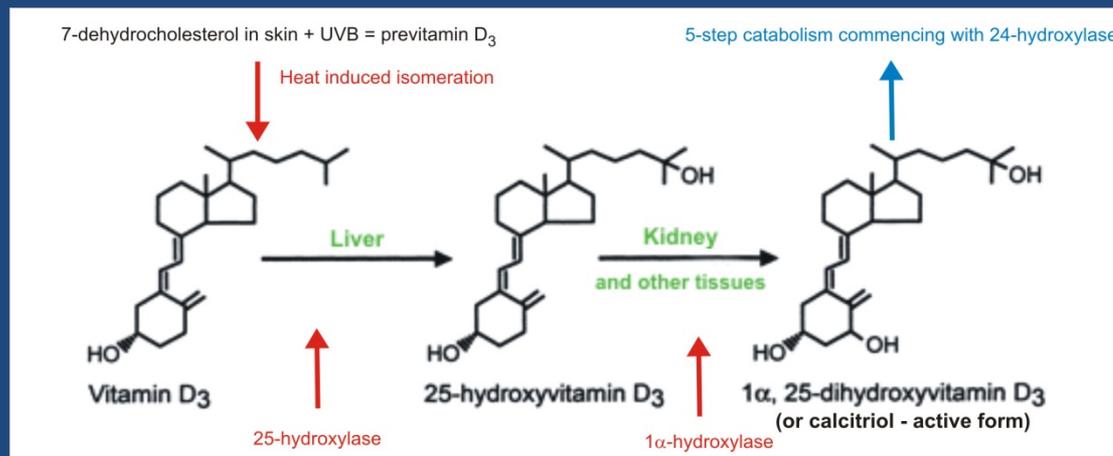


Overview

- Vitamin D – what, where from, how much
- The New Zealand situation – a changing picture
- Groups at risk
- Consequences of deficiency:
 - Bone and muscle
 - Maternal and infant
 - Other health conditions
- Solving problems

Vitamin D

- Synthesised in the skin in response to ultra-violet beta ($UV\beta$) radiation
- 25-Hydroxyvitamin D (25OHD) the inactive form circulates in the body until required



Numbers game

- Circulating 25OHD concentration measured in serum or plasma
 - Current NZ min for sufficiency = 50nmol/L
- Dietary intake measured in micrograms (μg) or International Units (IU)
 - $\mu\text{g} * 40 = \text{IU}$

Sun or supplement

- Sun exposure accounts for > 95% of vitamin D status in NZ population
- 15 mins in summer sun = 10,000 – 20,000 IU
- Minimal food fortification, and only in very small amounts
- Supplements: OTC – 1000 IU per day, prescription 50,000 per month
- NZ/Australian RDI = 200 – 600 IU/day

The changing face of NZ



Mid 1900's
Influx of immigrants from Northern Europe
and the United Kingdom
Very fair skin + New Zealand sun = ??

30 years later – evidence of skin cancer leads to strong anti-sun messages



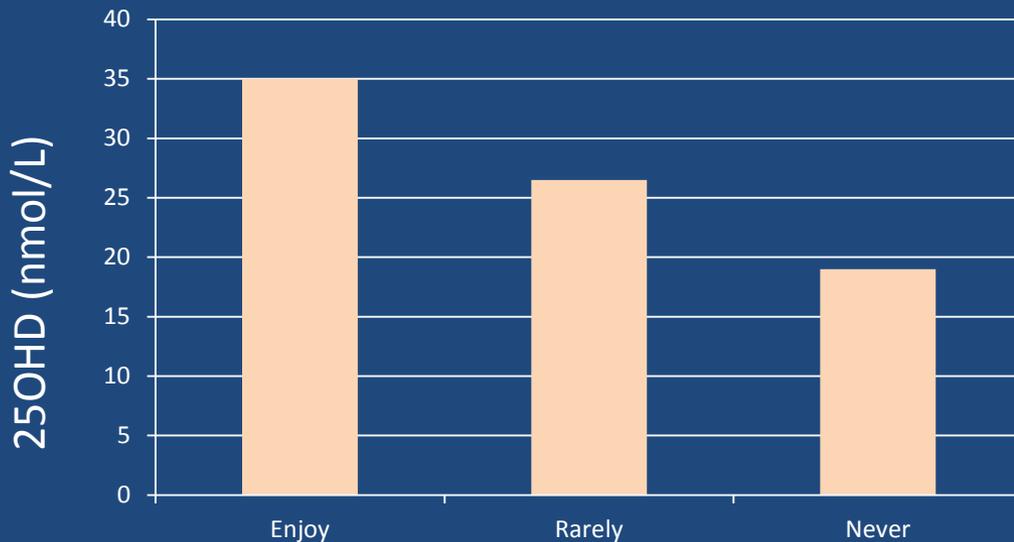
50 years later – skin colour, lifestyle, clothing choice, and public health messages impact on sun exposure behaviours

Vitamin D in 'at risk' New Zealanders

- South Asian women in Auckland (von Hurst, 2009)
 - 235 women, mean age 40 years, recent migrants
 - Median 25OHD concentration 27.5 (18.0, 41.0) nmol/l.
 - 16% > 50 nmol/L
 - 43% < 25 nmol/l
 - 33 taking OTC supplements median 38 (24, 59) nmol/l

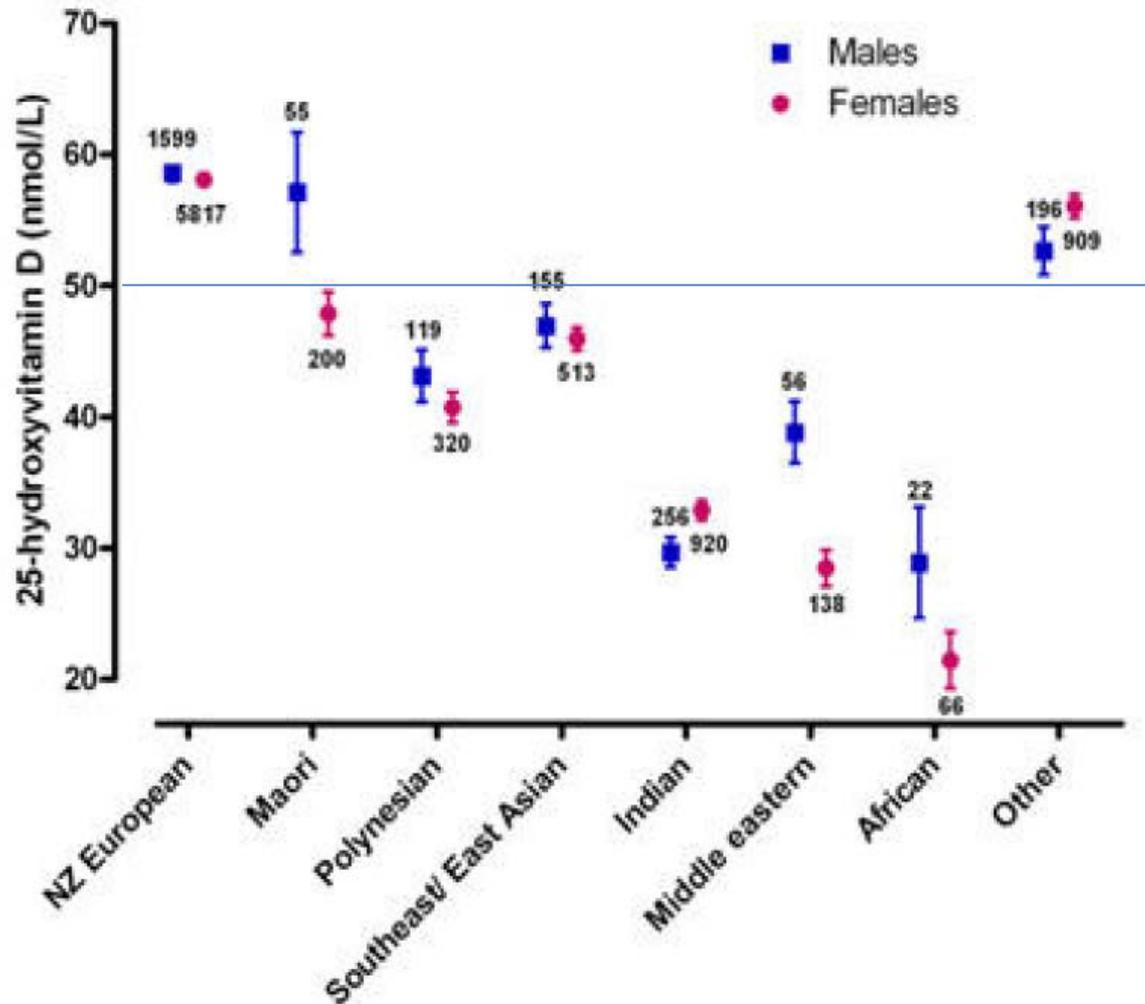
Effect of sun avoidance

- Factors affecting sun exposure



- 49% would spend more time in the sun but worried about skin cancer

Seasonally adjusted 25(OH)D conc. of 21,987 Auckland adults aged >18 years (17,265 women and 4722 men), stratified by ethnicity



(Bolland et al, 2008)

Vitamin D and bone

- Essential for healthy bones
 - Absorption of dietary calcium
 - Reabsorption of calcium in the kidney
 - Regulation of bone remodelling cycle
- 25OHD <25nmol/L
 - Rickets in children
 - Osteomalacia in adults
 - Osteoporosis in later life



Kalya Study

von Hurst et al, 2011

- Young women 20 – 29 years of age living in Auckland
- Caucasian (n=78), Chinese (n=29), Indian (n=30)
- August to November 2009
- Primary outcomes: Serum 25(OH), BMD, calcium intake



Description of participants

| | European (n=78) | Chinese (n=29) | Indian (n=30) |
|---|------------------------|----------------------|-----------------------|
| Age (years) | 23.5 ± 2.7 | 24.3 ± 2.7 | 24.2 ± 2.6 |
| Height (metres) | 1.67 ± 0.06 | 1.61 ± 0.05 | 1.59 ± 0.05 |
| Weight (kg) | 65.09 ± 11.60 | 52.31 ± 6.00 | 57.95 ± 10.44 |
| BMI | 23.3 ± 4.1 | 20.3 ± 2.0 | 22.8 ± 4.4 |
| Born in NZ (%) | 70.9 | 14.3 | 16.7 |
| Years in NZ | 19.4 ± 1.0 | 10.0 ± 1.2 | 9.9 ± 1.5 |
| Serum 25(OH)D (nmol/l) median (25,75th percentile) | 63 (50, 84) | 38 (28,51) | 22 (13,36) |
| Serum 25(OH)D (nmol/l) range | 27 - 147 | 20 - 105 | 5 - 114 |
| Percent ≤ 50 nmol/L | 24 | 75 | 86 |
| Percent ≤ 80 nmol/L | 69 | 97 | 97 |
| Dietary calcium (mg) median (25,75th percentile) | 1013 (791,1273) | 546 (441,667) | 642 (480,1106) |
| Parathyroid Hormone | 3.04 ± 0.91 | 3.90 ± 1.65 | 4.66 ± 1.76 |
| Lumbar Z-score ≤ -1.0 (%) | 19.0 | 32.0 | 40.0 |

Osteoporosis in New Zealand

- More than 3,000 New Zealanders break a hip each year. This figure is expected to rise to 4,800 in ten years time as our population ages.
- About a quarter of people who fracture a hip die within a year from related complications. One third never return home, and those that do lose their mobility and independence.
- 56% of women and 29% of men will suffer a fracture after the age of 60 because of osteoporosis.
- The estimated cost to New Zealand is \$1.1billion each year.
- In the next 50 years, the number of hip fractures for both men and women will more than double

Osteoporosis in Asia (IOF, 2015)

- It is projected that more than about 50% of all osteoporotic hip fractures will occur in Asia by the year 2050
- There is a higher incidence of hip fractures in men than in women in China
- South and South East Asiawidespread prevalence of hypovitaminosis D in both sexes and all age groups of the population

Rickets

- Research shows re-emergence of rickets in New Zealand children
- In 1998, Starship hospital, 12/18 cases were South Asian children (Block, 2002)
- Key risk factors for rickets in NZ children: dark skin, Indian and African ethnicity, exclusive breast-feeding (Wheeler, 2015)

Muscle strength

- Maternal vit D status associated with offspring muscle strength (Harvey et al, 2014)
- Status associated with gait speed and grip strength in older adults (Carrasco et al, 2014)
- Trials in athletes – significant performance improvements when levels $<25\text{nmol/l}$ (von Hurst et al 2015)
- Muscle pain alleviated with supplementation in deficient adults (Badsha, 2009)

Pregnancy

- Maternal vitamin D deficiency impacts on fetal bone at 19 weeks (Mahon, 2009)
- 25OHD > 50nmol/L associated with 2.66-fold increased risk of GDM (Zhang, 2008)
- Shorter gestation (Morley 2006)
- SGA baby, respiratory infection risk increased
- Emerging research:
 - Brain size, mental health
 - Auto immune diseases: Type 1 DM, multiple sclerosis

Maternal and infant status closely related



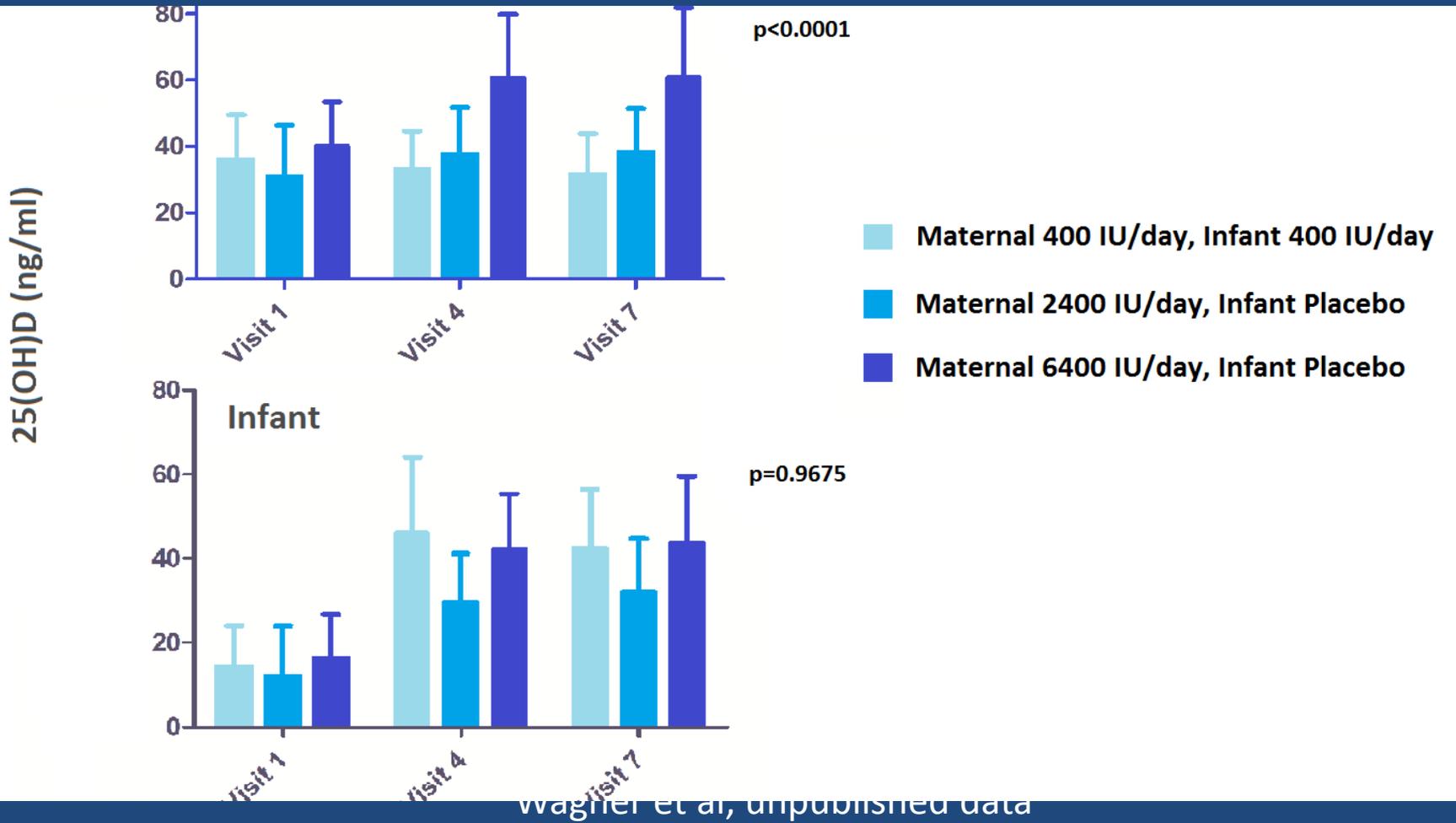
| Locale | Study participants | | 25(OH)D (nmol/L) Mean (SD) | Reference |
|--------|--------------------|---|-------------------------------|----------------|
| Delhi | N=29 | Urban mothers, 23 (5) years, summer | 21.8 (10.7) | Goswami (2000) |
| | N=29 | Newborns of mothers above | 16.6 (5.0) | |
| UAE | N=90 | New mothers | 25.6 (10.0) | Saadi (2009) |
| | N=92 | Newborns of mothers above (2 x twins) | 13.7 (9.9) | |
| Delhi | N=342 | Lactating mothers, 24.6 (2.8) years | 19.5 (8.3) | Marwaha (2011) |
| | N=342 | Exclusively breastfed infants, 6-8 weeks | 22.2 (10.5) | |
| Delhi | N=180 | Lactating mothers | 27.1 (14.4) | Seth (2009) |
| | N=180 | Exclusively breastfed infants, 2-24 weeks | 28.8 (20.7) | |

The Thrasher Study

Wagner CL, et al. A randomized trial of vitamin D supplementation in 2 community health center networks in South Carolina. American journal of obstetrics and gynecology. 2013;208(2):137 e1-13.

- 2000 and 4000 IU/day during pregnancy associated with improved maternal and neonatal vitamin D status compared to their baseline
- Compared to 2000 IU group, overall rate increase of 25(OH)D per month greater in 4000 IU group ($p < 0.05$)
- Compared to infants in 2000 IU group, infant 25(OH)D higher in 4000 IU group ($p < 0.024$)

NICHD Vitamin D Lactation Study



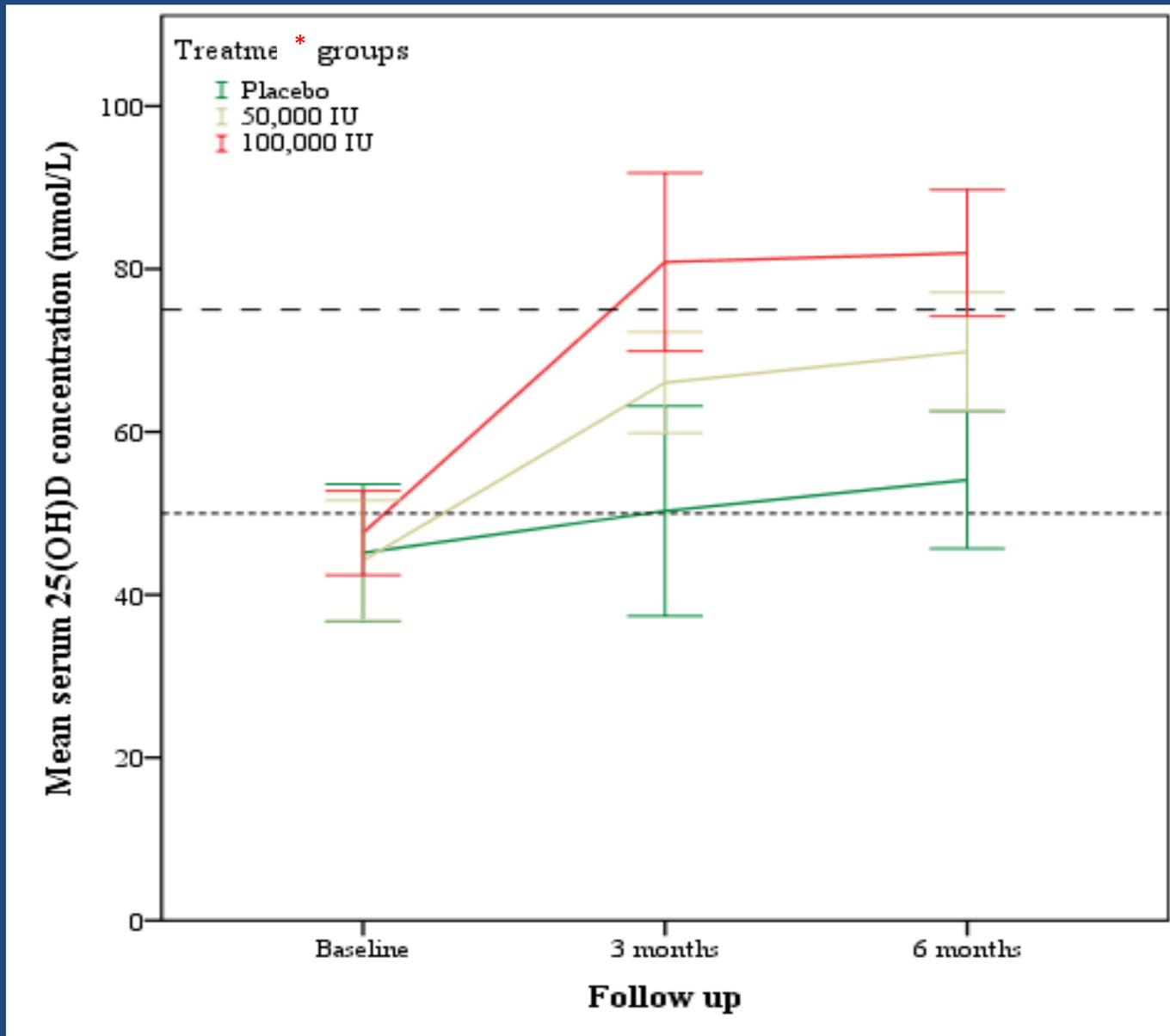
wagner et al, unpublished data

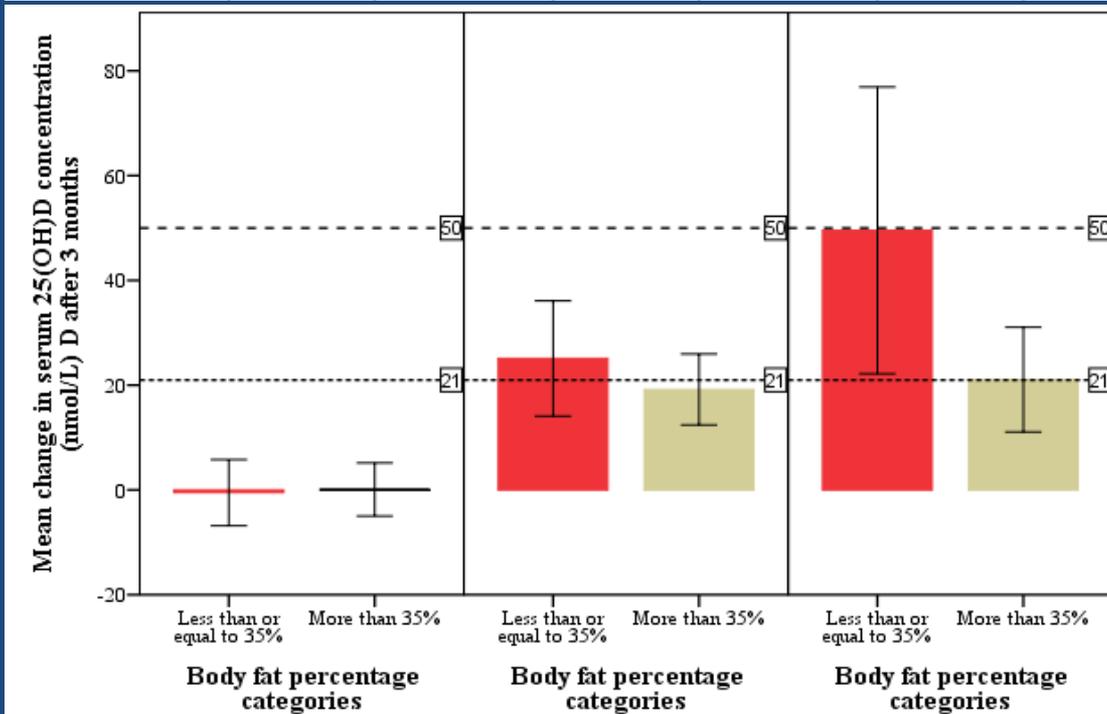
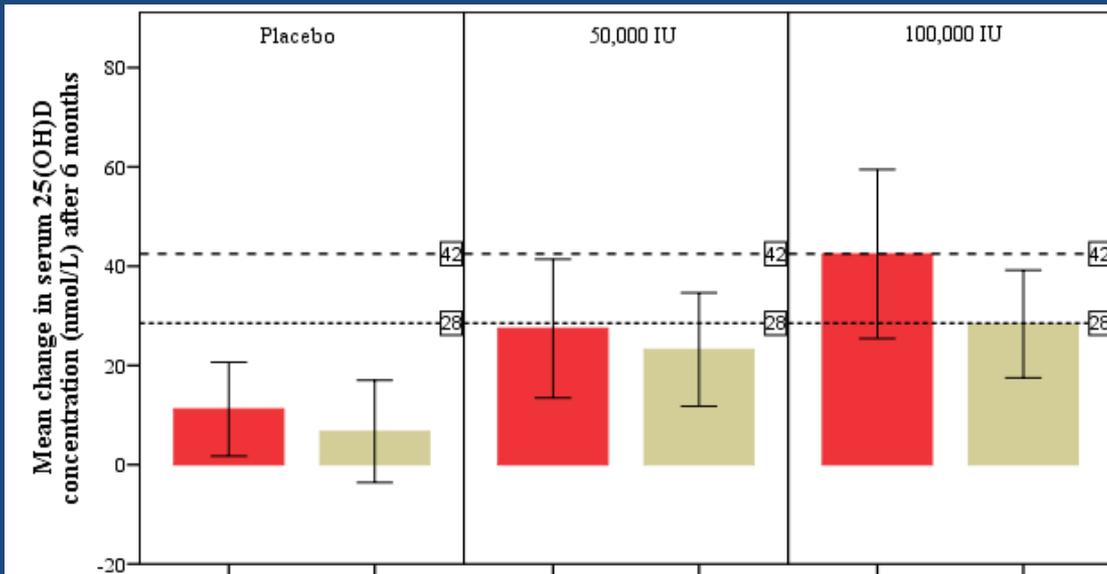
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Other health conditions

- Respiratory infection
 - Antimicrobial peptide expression
 - Protection of tight junctions in mucosal tissue
- Metabolic syndrome
 - Insulin secretion
 - Insulin resistance
 - Blood pressure
- Cancer
 - Pro-differentiation
 - Anti-proliferative

Response to supplementation





Error Bars: 95% CI

Supplementation

- The standard prescription dose of cholecalciferol 50,000IU/month may not be adequate for many of those people identified as being at high risk
- It appears that there is not a linear relationship between dose and 25(OH)D response
- Individual response to supplementation is highly variable
- Monthly vs daily doses – risks and benefits unclear
- Because we don't measure 25(OH)D we don't know what concentrations are being achieved
- No suitable supplement currently funded for infants and children

Summary

- South Asian women living in New Zealand are at high risk of vitamin D deficiency
- Little is known about the status of other Asian ethnicities in New Zealand, but deficiency is likely
- This has implications for bone health and possibly other metabolic conditions
- Implications for muscle strength, therefore physical activity in vitamin D deficient adults and children
- Infants and children of vit D deficient mothers will be deficient, at high risk of rickets and infections
- Supplementation in pregnancy and lactation must be addressed