Vitamin D and UV Exposure – Benefits vs Risks, Barriers to Exposure and How Much Do We Need?

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Sun exposure and vitamin D

Latitude, ambient UVR, personal sun exposure, 25(OH)D – closely linked; which is the “real” risk factor?
Benefits vs. risks for UV exposure
Risks

• Skin disease
  – Malignant melanoma
  – Non-melanoma skin cancers
    • Basal cell carcinoma
    • Squamous cell carcinoma
    • Other rare skin cancers, e.g. Merkel cell carcinoma
  – Actinic keratoses, photoageing, melasma (40% in adult women; 20% in adult men, in SE Asia\(^1\))

• Eye diseases (cataracts, pterygium, etc)

• Immune suppression

Melanoma age-standardised incidence (ASI) rates in Australia 1982-2010

Melanoma incidence
Melanoma in SE Asia

Melanoma of skin: both sexes, all ages

NMSC incidence in Australia

BCC and SCC excision rate from 2000 to 2011

Average annual percentage change of counts per 100,000 persons for first excision of BCC or SCC

Cataract incidence in Vietnam

• “South-East Asia and the Western Pacific region, as determined by the World Health Organization, have the greatest need for assistance for vision impairment and blindness in the world.” WHO V2020

• Facts and Figures for Vietnam

<table>
<thead>
<tr>
<th>Eye health</th>
<th></th>
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<tbody>
<tr>
<td>Number of blind people</td>
<td>385,800 people</td>
</tr>
<tr>
<td>National blindness prevalence</td>
<td>3.1% (amongst people over 50 years)</td>
</tr>
<tr>
<td>Main causes of blindness</td>
<td>cataract (66% for people over 50 years), also glaucoma, posterior segment, trachoma, corneal scarring and refractive error</td>
</tr>
</tbody>
</table>

Source: Fred Hollows Foundation
• In Australia, time in the sun during leisure has been steadily decreasing over the past 30 years

BUT

• East Asian populations living in Australia change their sun exposure behaviour with longer time in Australia to be more like Australian-born and less like the typical behaviour in their country of origin

What are the implications for sun exposure behaviour, and therefore incidence of skin cancers (and eye diseases) in the future?

Benefits of sun exposure – not just vitamin D?

Production of vitamin D

Immune suppression$^1$

Other photoproducts with beneficial effects on health, e.g. nitric oxide$^3$

Effects on the microbiome with decreased risk of colonic cancers

Higher time outdoors decreases risk of myopia


Effect of UV irradiation on weight gain in mice fed a high fat diet$^2$
Is vitamin D deficiency common in Vietnam?

– Depends on how we measure it (which assay)
– Who we measure it on
  • General population
  • People being tested for vitamin D deficiency
  • Specific population groups
– When (in the year) we measure it
– What level we define as “deficient”
  • Not clear how to define this
DEQAS sample 417 (July 2012): ALTM 47.1 nmol/L

Measurement of 25(OH)D level

Results sorted in ascending order: range from <20 to >100

Slide courtesy of Dr Graham Carter, DEQAS
Not all LC-MS/MS are equal

International Vitamin D Standardisation Program

- Reference measurement procedure
- Separate measurement of 25(OH)D$_2$, 25(OH)D$_3$, c3-epimer of 25(OH)D$_3$
- Aim for $\leq$5 % bias in relation to the reference values
How much vitamin D is enough?

Breast cancer risk

Cardiovascular mortality

Most of any protective effect occurs with levels >50nmol/L

Rickets, osteomalacia – an effect of SEVERE vitamin D deficiency

Peterlik. Food and Function 2012
Vitamin D deficiency in Australians

Summer 2011-12

Winter 2011/12

Source: Australian Health Survey: Biomedical Results for Nutrients

Australian Health Survey, www.abs.gov.au
Vitamin D deficiency in Vietnamese populations

- In the Australian Health Survey\(^1\)
  - 425,400 people, or 57.9% of those born in SE Asia have 25(OH)D levels <50nmol/L (compared to 17% of Australian-born)

- In Vietnam

Maternal 25(OH)D at 32 weeks gestation in northern Vietnam\(^2\)

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25(OH)D < 50nmol/L in northern Vietnam

Overall prevalence:
30% of women;
16% of men

People aged 13-83y

1. Nguyen et al. Bone 2012
Is more always better?

Odds of prostate cancer (A)\(^1\) and tuberculosis (B)\(^2\) in relation to serum 25(OH)D concentration

Mortality rate adjusted for age, sex, race/ethnicity and season by 25(OH)D concentration. 15-year follow-up of NHANES III (n=15,099)\(^3\)

Balance: skin cancer vs. vitamin D

Skin cancer incidence

Our vitamin D is mainly UV-derived
Likely to be vitamin D-independent beneficial effects of sun exposure

Is it possible to achieve a UV dose to relevant structures for beneficial effects without incurring adverse effects?
Barriers to exposure

• Cultural
  – Dress
  – Norms relating to preferred skin colour

• Biological
  – Darker skin
  – Extreme sun protection

• Behavioural
  – Unable to get outdoors, e.g. disabled, elderly

• Photosensitivity diseases

Personal weekly erythemal dose in South Asians (SA) and Caucasians (C) in Manchester. Horizontal bars are cohort medians for the month.¹

¹Kift BJD 2013
How much UV do we need (for vitamin D)?
Vitamin D from sun exposure

• Many uncertainties!

• What we do know:
  – Response to sun exposure depends on starting vitamin D level
  – Increasing UV dose increases vitamin D production
  – Regular sun exposure results in a plateau in vitamin D level
  – Prolonged exposure results in breakdown of synthesised vitamin D
  – Everyone is different!

1. Rhodes et al J Invest Dermatol 2010; 130:1411-8;
What determines our skin cancer risk and vitamin D status

- UV levels and UVA vs UVB
  - Time of day, time of year
- Time in the sun

Modifiers of the balance point:
- Age, genetic make-up
- Use of sunscreen, shade
- Skin colour
Achieving balanced sun exposure

• Blanket rules e.g. according to location, not appropriate

• Need to be guided by the UV Index
  – For the location
  – For the time of year, time of day (noon vs. ends of day)

• Change the pattern of sun exposure
  – Always protect the head and neck and probably the back of the hands (most skin cancers occur here)
  – Brief exposures, frequently, to lots of skin
Biologically relevant UV dose

![Graph showing UV index for different times of day and locations]
## UV Index in Vietnam

<table>
<thead>
<tr>
<th>City</th>
<th>UVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanoi</td>
<td>6</td>
</tr>
<tr>
<td>Ha Long</td>
<td>8</td>
</tr>
<tr>
<td>Hue</td>
<td>9</td>
</tr>
<tr>
<td>Hoi An</td>
<td>9</td>
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<tr>
<td>Nha Trang</td>
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<tr>
<td>Phan Thiet</td>
<td>11</td>
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<tr>
<td>Mui Ne</td>
<td>11</td>
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<tr>
<td>Ho Chi Minh City</td>
<td>11</td>
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<tr>
<td>Phu Quoc</td>
<td>11</td>
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for 2 Nov 2014
Risks and benefits in the future

• Ozone recovery and climate change
  – Modest increase in UVR levels in tropics
  – Warmer temperatures ↑ skin cancer and vitamin D

• Globalisation
  – Changes in diets, cultures, vitamin D content of foods

• Urbanization

• Changes in lifestyles (more indoor living)

1. McKenzie et al. 2015 PPS in press
That’s all, folks

Slide courtesy of Prof AJ McMichael