# Vitamin D in At-Risk Populations

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# Outline

- Introduction
- Factors Influencing Endogenous Synthesis of Vitamin D
  - Sun exposure (latitude, time outdoors, clothing)
  - Skin pigmentation
  - Sunscreen use
  - Age
- Vitamin D and Obesity
  - Cross-sectional studies
  - Possible mechanisms
- Summary

# Introduction

Vitamin D is made in the skin upon exposure to UVB radiation.

**UVB Exposure**:
Season
Latitude
Time Outdoors

**Skin Exposure**:
Pigmentation
Sunscreen Use
Age

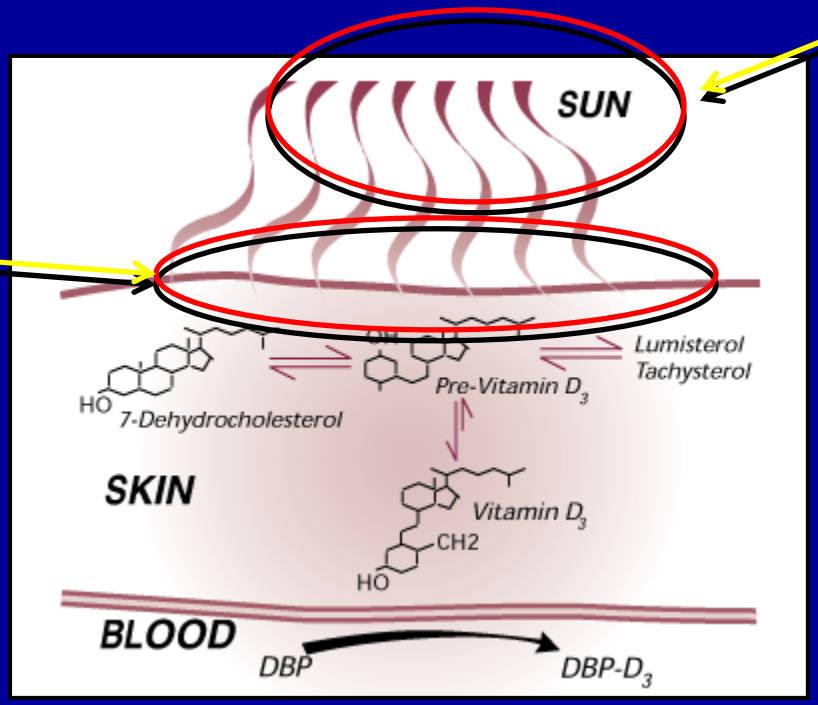
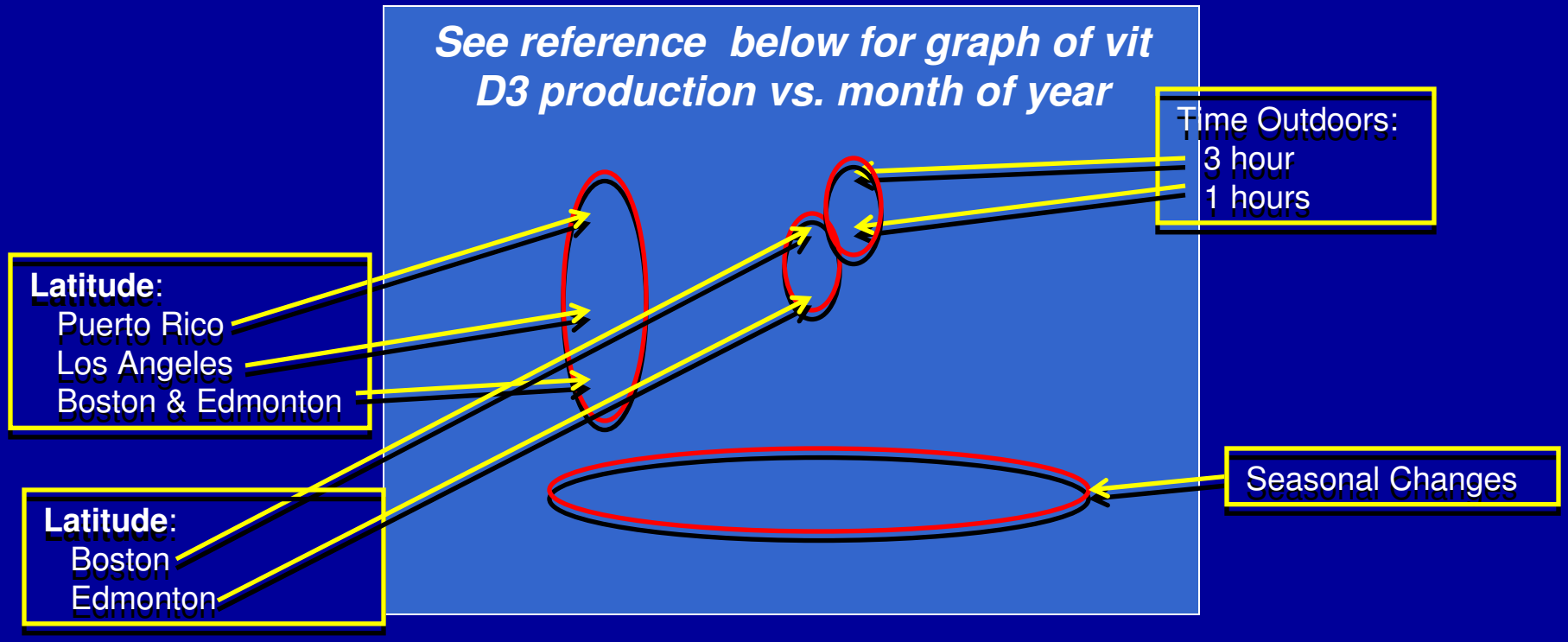



Image from: http://www.wardelab.com/10-2.html

# Vitamin D & UVB Exposure

Season and latitude both influence the formation of photoproducts (previtamin D3, lumisterol & tachysterol) after exposure of 7-dehydrocholesterol in an *in vitro* human skin model.




Holick et al., 1988; Webb et al., 1988

# Vitamin D & UVB Exposure

Vitamin D is made in the skin upon exposure to UVB radiation.

**Skin Exposure**:
- Pigmentation
- Sunscreen Use
- Age

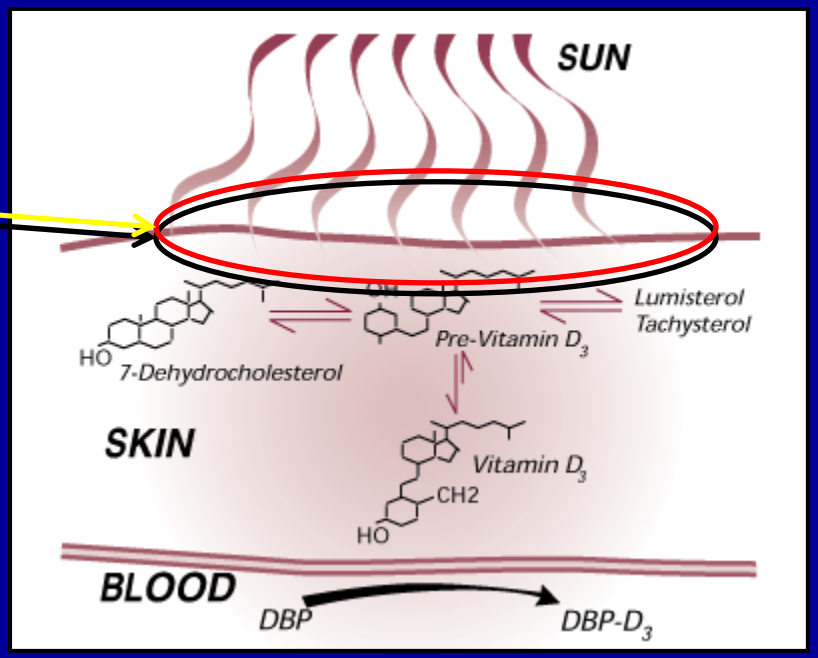
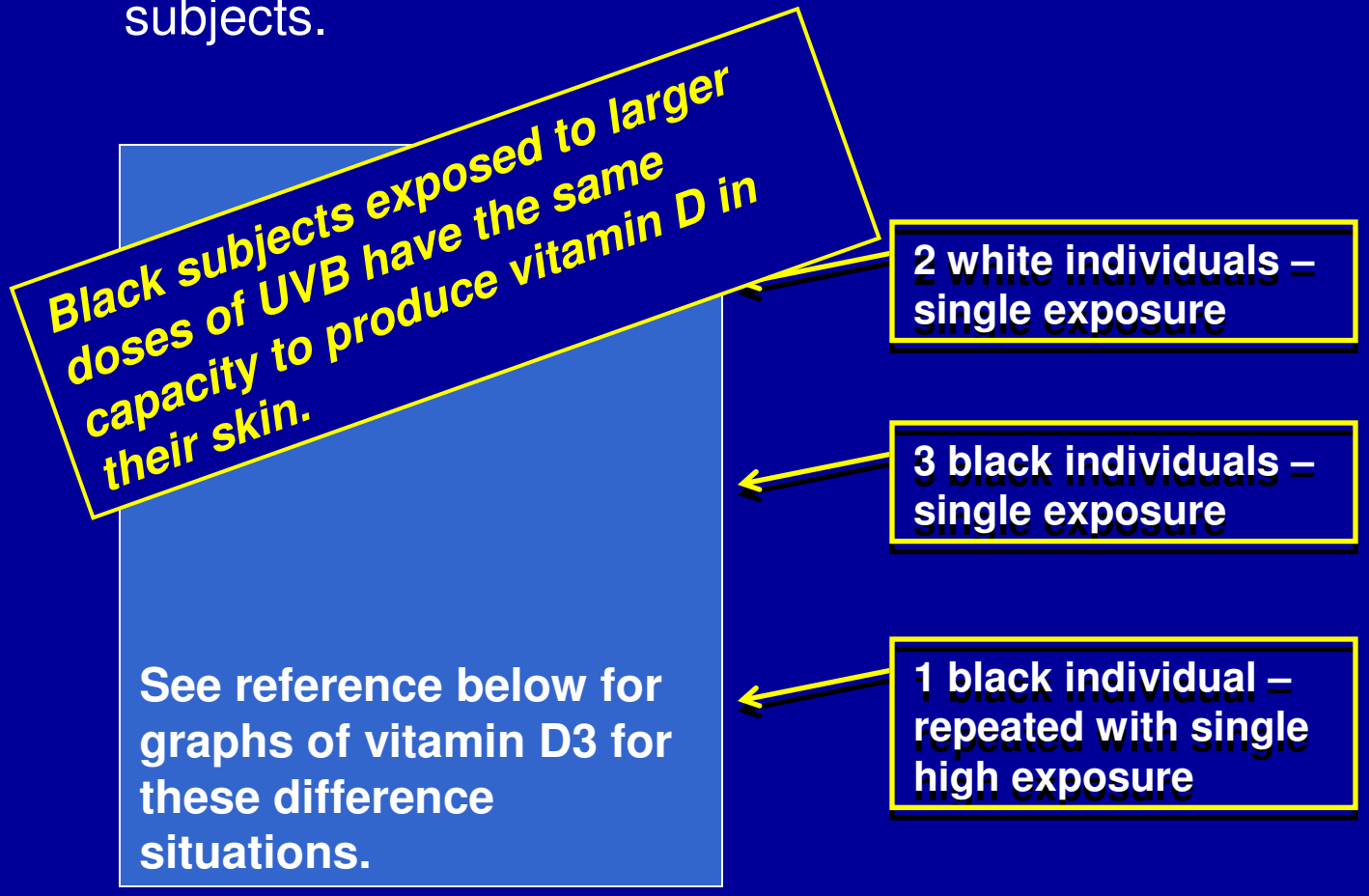



Image from: http://www.wardelab.com/10-2.html

# Vitamin D & UVB Exposure

- *In vivo* studies show that a single exposure to UVB (280-450 nm) increases serum vitamin D concentrations .
- Each participant received a single 1.5 MED determined for white subjects.




Clemens et al., 1982

# Vitamin D & UVB Exposure

*In vivo* studies in Asians (N=6; Indian & Pakistani) show similar vitamin D response to a single exposure to UVB (280-450 nm) as Caucasians (N=3), but at higher doses.

**See reference below for graphs of vitamin D3 for Asians and Caucasians over 8 days following UVB exposure.**

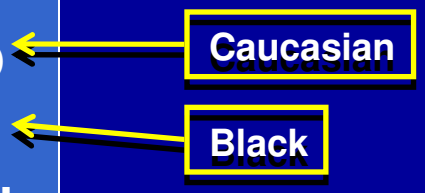
| | | |
|---|---|---|
| Mean dose to achieve MED: | 76 mJ/cm$^2$ | 41 mJ/cm$^2$ |

Lo et al., 1986

# Vitamin D & UVB Exposure

***Repeated*** biweekly exposures to UVB radiation over 6 weeks.

**See reference below for graphs of serum 25OHD concentrations over 6 weeks of UVB exposure.**




- MED dose for the fairest white participant was used on all subjects.
- Serum 25-OHD increased at the same rate in both black (N=7) and white (N=13) participants.

Brazerol et al., 1988

# Vitamin D & UVB Exposure

- Sunscreen blocks UVB in the range that is necessary for synthesis of previtamin $D_3$.
- Controlled studies have found lower amounts of previtamin $D_3$ with sunscreen use.

*Question*: Does typical use of sunscreen (SPF-17) lead to decreased serum 25-OHD concentrations?

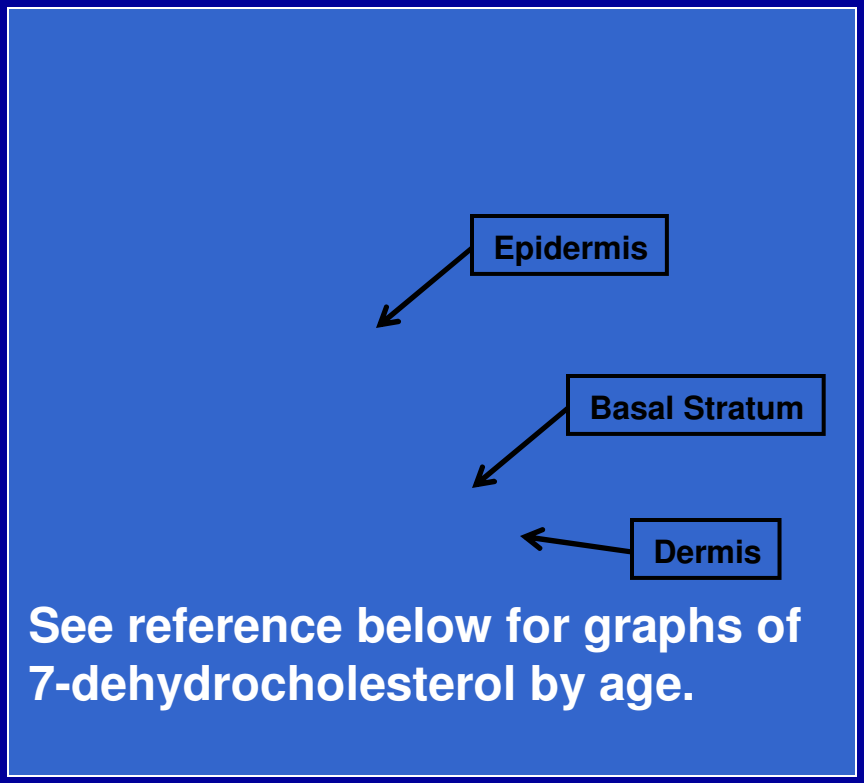
- Typical application may not cover all exposed areas of skin.
- Sunscreen may wear off throughout the day.

*Answer:*

- Double blind randomized controlled trial (n=113, aged >40 y)
- Sunscreen (SPF-17) vs. placebo cream over a summer in Australia
- No difference in the change in 25OHD among treatment groups

Marks et al., 1995

# Vitamin D & UVB Exposure




**See reference below for graphs of 7-dehydrocholesterol by age.**

- Caucasian human skin samples (ages 8-92)
- Different skin layers were isolated and irradiated with 295 nm
- The capacity to photosynthesize previtamin D3 decreases significantly with age.

MacLaughlin & Holick, 1985

# Vitamin D & UVB Exposure
# - Summary -

- Potential UVB exposure varies by season, latitude, and time spent outdoors.
- Varying levels of skin pigmentation have similar capacities to synthesize vitamin D, but at low and infrequent levels of sun exposure, vitamin D synthesis is less efficient among darker pigmented individuals.
- Sunscreen inhibits vitamin D synthesis, but change in 25-OHD concentrations with “normal” use was similar to placebo.
- Older individuals have decreased capacity to synthesize vitamin D in the skin.

# Vitamin D & Obesity

Numerous epidemiological studies have shown that obese individuals have lower 25-OHD concentrations.

**See reference below for graph of sunlight hours/day and serum 25-OHD concentrations by month of year for women with BMIs above and below the median BMI.**

433 Women with BMIs above (n=218) and below (n=215) the median (25.4) followed longitudinally.

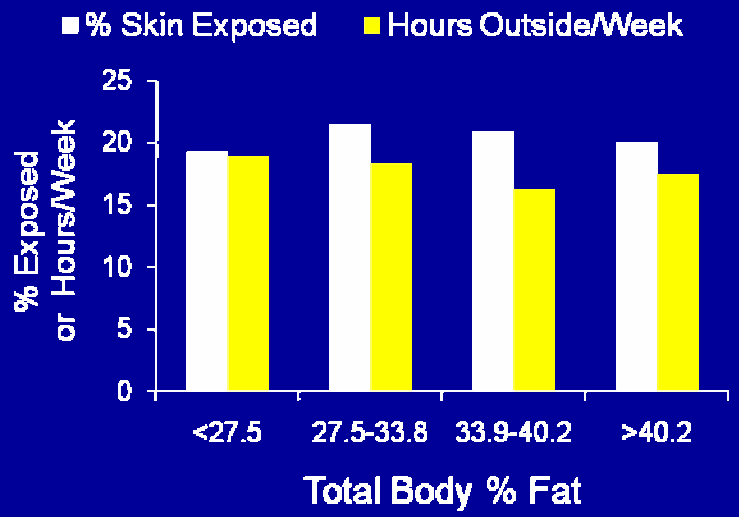
- Decreased time outdoors?
- Decreased ability to synthesize vitamin D in the skin?
- Decreased absorption or increased clearance?

Need et al., 1993

# Vitamin D & Obesity

*Decreased time outdoors?*

- 381 adults aged 65+ years
- Baseline data from a randomized Ca & vitamin D supplementation trial




Serum 25-OHD decreased with increasing % body fat even controlling for covariates.

No difference in % skin exposed, hours outside/week, or sunscreen use with increasing % body fat.


Harris et al., 2007

# Vitamin D & Obesity

- *Decreased ability to synthesize vitamin D in the skin?*

  In vitro studies to look at synthetic capacity of skin from obese (N=2) & non-obese (N=2) individuals:

No difference in % conversion of provitamin $D_3$ (7-DHC) to vitamin $D_3$.

Normal: 9.4%

Obese: 9.6%

Wortsman et al., 2000

# Vitamin D & Obesity

- *Decreased absorption or increased clearance?*
  - 38 healthy whites: 19 normal weight (BMI<25 kg/m$^2$) & 19 obese (BMI>30 kg/m$^2$)
  - Avoid dairy products 1 week prior to test
  - After overnight fast oral dose of 50,000IU vitamin $D_2$ was given
  - Blood taken at baseline and 6, 10, and 24 hours after dosing

**See reference below for graphs of vitamin D2 over 24 hours in normal-weight and obese individuals.**

Serum vitamin $D_2$ concentrations at 24 hours were lower in obese (open squares) compared to normal weight individuals (black circles)

*Is this due to decreased absorption or increased clearance?*

Wortsman et al., 2000

# Vitamin D & Obesity

- *Decreased absorption or increased clearance?*
  - 38 healthy whites: 19 normal weight (BMI<25 kg/m$^2$) & 19 obese (BMI>30 kg/m$^2$) were irradiated with 1 single suberthymic dose of UVB
  - Blood taken 1 hour before and 24 hour after UVB exposure

**See reference below for graphs of vitamin D3 at baseline and 24 hours in normal-weight and obese individuals and peak serum vitamin D3 by body weight.**

Serum vitamin $D_3$ before
hours after (white b
group into

Skin from obese & normal weight subjects had similar capacity to produce vitamin $D_3$; therefore, these results suggest a difference in clearance.

rum vitamin $D_3$ 24 hours after UVB exposure correlated with weight and was lower in heavier than lighter individuals (black circles=obese, white squares=normal weight).

Wortsman et al., 2000

# Vitamin D & Obesity
# - Summary -

Numerous epidemiological studies have shown that obese individuals have lower 25-OHD concentrations.

- Decreased time outdoors?

  *Decreased time outdoors does not explain the lower 25-OHD in obese vs. non-obese individuals.*

- Decreased ability to synthesize vitamin D in the skin?

  *Conversion of previtamin $D_3$ to vitamin $D_3$ in skin is not different between obese & non-obese individuals.*

- Decreased absorption or decreased clearance?

  *Vitamin D from both UVB exposure and oral dosing are reduced in blood after 24-hours. These results indicate that the lower vitamin D levels in obese individuals are probably due to increased clearance (sequestration into fat?).*

# Vitamin D & Obesity
# - Summary -

In summary, obese individuals need more sunlight exposure or higher doses of vitamin D to maintain similar levels of 25-OHD as non-obese individuals.

# References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