Vitamin D production and UV exposure – a systematic review

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Abstract. Vitamin D is essential for human well-being. Skin conversion of 7-dehydrocholesterol to previtamin D3 by UVB radiation from sun exposure remain the most abundant source of vitamin D for most humans. There is evidence that a relatively high proportion of people in many different countries, including in Australia and New Zealand, have low vitamin D status. However exposure to the sun causes skin cancer and it is therefore critical to develop a public health message that balances both the risks and benefits of sun exposure. This is very difficult given the current state of knowledge about how much sun exposure is needed to optimise vitamin D in different environments, at different times of the year, and in people with different phenotypes. We have therefore conducted a systematic review of all literature pertaining to the effect of either natural or artificial radiation on levels of 25-hydroxyvitamin D (25(OH)D), the marker used as an indicator of vitamin D status. We will synthesise and describe the current literature and gaps that need to be addressed.

Background

It has been long established that UV radiation increases vitamin D levels in humans. However, the increase of vitamin D depends on the amount of skin exposed, location, season, personal UV radiation exposure, vitamin D supplementation, body mass index (BMI) and physical activity (Kimlin et al. 2014). Artificial UV has been used to irradiate humans in the laboratory to study its effect on their vitamin D levels. However, a recent study has found artificial UVB to be at least 8 times more effective in inducing 25(OH)D synthesis than solar UVR when approximately same amount of skin is exposed (Datta et al. 2012).

Methods

The systematic review was conducted according to the PRISMA standards (Moher et al. 2009). We searched PubMed, Web of Science, Scopus and Cochrane for English-language literature from 1980 to September 2013 for studies on association between vitamin D status (defined by serum 25-hydroxyvitamin D, 25(OH)D concentration) and UV exposure. Search terms included *Vitamin D, 25-hydroxyvitamin D, 25OHD, vitamin D deficiency, ultraviolet radiation, UV, UVB, solar UV, sun exposure, sunlight* and related terms. Only articles published in peer-reviewed journals were included. Studies on animals and skin samples were excluded. Studies on people with specific health conditions such as psoriasis, rickets, multiple sclerosis, hyperparathyroidism, etc. were also excluded. There was heterogeneity in the methods used to assess the outcomes among the studies.

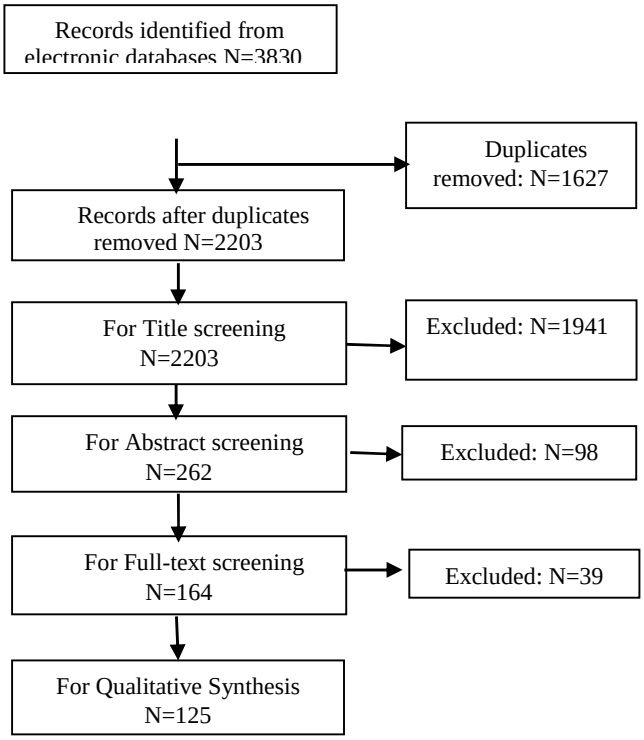

Figure1. PRISMA flow diagram for study inclusion

Results

We identified 125 studies that matched our selection criteria. Eighty-eight of the studies were observational and 37 were experimental. Of the 88 observational studies 54 studies were cross-sectional, 33 prospective cohort and 1 was a case control study. Sixty-three studies used questionnaires to measure the participants' UV exposure while 11 studies used UV dosimeters. Only fourteen of the 37 experimental studies were randomized controlled trials. Twenty-eight of the experimental studies used artificial UV as intervention while only nine studies used natural sun exposure as intervention.

Vitamin D and artificial UV

Ten randomized controlled trials were identified that used UV radiation from an artificial source to study its effect on vitamin D levels in humans. The trials were quite considerably heterogeneous in baseline patient demographics, sample size, dose and frequency of UV exposure and amount of skin exposed. Eight of the 10 trials were conducted on adult males and females, whereas 2 studies were in elderly females. The source of UV varied widely among the trials, ranging from narrow-band UVB to broadband UVB to recreational or dermatological sunbeds. The dose of UVB varied from 0.375 SEDs to 3SEDs. Seven

of the 10 studies required the participants to expose their full body to the artificial UV (Bogh et al. 2012a; Bogh et al. 2012b; Carbone et al. 2008; Lagunova et al. 2013; Langdahl et al. 2012; McKenzie et al. 2012; Thieden et al. 2008), while three studies exposed 25% or less skin to UV (Bogh et al. 2011a; Bogh et al. 2011b; Chel et al. 1998).

Vitamin D and sun exposure

Among the studies that were included following the screening, only four were found to have used natural sun exposure as a source of UV radiation. These trials were also heterogeneous in participant characteristics and intervention. One study was conducted on Chinese infants (Ho et al. 1985), one on adolescent Arab girls (Dahifar et al. 2006), one on adult non-western immigrants (Wicherts et al. 2011) and one on elderly residents of an aged care facility (Sambrook et al. 2012). The study period varied from 20 days to 12 months.

Conclusions

A review of the current literature has ascertained the lack of concrete experimental evidence regarding the extent of effect of sunlight exposure on 25(OH)D levels on which public health recommendations may be based. Previous studies on the effect of UV radiation on vitamin D levels in humans have mostly been observational. The current recommendations are based on either ecological studies or mathematical calculations of vitamin D production in response to UV exposure. The few experimental studies that have been used as a basis for recommendation were studies that used artificial UV as the source of radiation to generate 25(OH)D. However, a recent study comparing ultraviolet radiation from natural sunlight and artificial sources, found UV from the artificial source to be 8 times more efficient in generating 25(OH)D . Therefore, there is a need to understand the effect of natural sunlight on 25(OH)D levels.

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