Title: Vitamin D and Sun Protection: The impact of mixed public health messages in Australia

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Abbreviations: UV, ultraviolet radiation; CATI, computer-assisted telephone interview; MED, Minimal Erythral Dose; OR, odds ratio; CI, confidence interval.

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Balancing the possible benefits and known harms associated with UV exposure represents a challenge not only for health experts but also for the general public. This study shows a shift within the population towards increasing sun exposure for vitamin D. There is an urgent need to re-focus health messages regarding sun exposure and the need for continued sun protection practices particularly in areas with high levels of UV.

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Abstract

Exposure of the skin to sunlight can cause skin cancer and is also necessary for cutaneous vitamin D production. Media reports have highlighted the purported health benefits of vitamin D. Our aim was to examine attitudes and behaviours related to sun protection and vitamin D. A cross-sectional study of 2,001 residents in Queensland, Australia aged 20-70 years was undertaken. Information collected included: skin cancer risk factors; perceptions about levels of sun exposure required to maintain vitamin D; belief that sun protection increases risk of vitamin D deficiency; intention, and actual change in sun protection practices for adults and children. Multivariate models examined predictors of attitudinal and behavioural change. One-third (32%) believed a fair-skinned adult, and 31% thought a child required at least 30 minutes per day in summer sun to maintain vitamin D levels. Reductions in sun protection were reported by 21% of adults and 14% of children. Factors associated with belief that sun protection may result in not obtaining enough vitamin D included aged ≥ 60 years (OR=1.35, 95% CI 1.09-1.66) and having skin that tanned easily (OR=1.96, 95% CI 1.38-2.78). Participants from low income households, and those who frequently used sun protective clothing were more likely to have reduced sun protection practices (OR=1.33, 95% CI 1.10-1.73 and OR=1.73, 95% CI 1.36-2.20, respectively). This study provides evidence of reductions in sun protection practices in a population living in a high UV environment. There is an urgent need to re-focus messages regarding sun exposure and for continued sun protection practices.

Introduction

Vitamin D, commonly referred to as the 'sunshine vitamin' is required for the preservation of calcium and phosphate blood levels and hence the maintenance of bone health.¹ While there are dietary sources of vitamin D, the main source (over 95%) is through exposure of 7-dehydrocholesteral in the skin to ultraviolet radiation (UV) followed by two hydroxylation steps.² It has been estimated that Vitamin D production is maximised following exposure to one-third of a MED (Minimal Erythral Dose).² Increasing the surface of the skin exposed to UV radiation also decreases the amount of time required to synthesize a given amount of vitamin D. It is known that UV induced DNA damage increases linearly with total exposure to sunlight. However the concentration of pre-vitamin D reaches a threshold after less than one MED. Thus increasing exposure of the skin to the sun does not necessarily result in increased vitamin D production.³

Epidemiological studies have suggested that low vitamin D status may be associated with an increased risk of cancer.⁴⁻⁶ Results from a US survey found no association between overall cancer mortality and serum vitamin D levels, but reported an approximate 70% reduction in risk of death from colorectal cancer.⁷ Additionally, other studies have shown small survival benefits for melanoma, lung cancer and Non-Hodgkin lymphoma associated with sun exposure.⁸⁻¹¹ However, as most of these studies have been of an ecological or case-control design, and therefore subject to several biases, their results should be interpreted with caution.

It is well known that UV exposure is the primary cause of the vast majority of non-hereditary skin cancers.¹² For squamous cell carcinoma (SCC) in particular the risk

increases linearly with total sun exposure.¹³⁻¹⁶ In Australia, the lifetime risk of developing melanoma or non-melanoma skin cancer (NMSC) is 1 in 30¹⁷ and 1 in 2¹⁸ respectively, testimony to the mismatch between skin pigmentation and UV exposure.^{19, 20} Therefore weighing up the health benefits and harms associated with UV exposure are challenging and continues to be debated.

The amount of UV exposure required to maintain adequate levels of vitamin D depends on several factors including latitude, ozone depletion, skin colour, sensitivity of skin to UV, and age, and research is ongoing to understand these complex relationships.²¹ While a small study by Kimlin et al found²² 10% of a sample of 127 healthy adults in South-East Queensland had serum 25 (OH) D levels below 25 nmol/l (considered deficient) and a further 32% had levels between 25 nmol/l and 50 nmol/l (considered insufficient), it is not known if this reflects the Queensland population at large. While sunscreen has been suggested to reduce vitamin D synthesis,²³ several studies have failed to show any evidence that regular use of sunscreen results in vitamin D deficiency.²⁴⁻²⁶

In a position statement released in 2007, the Cancer Council Australia in collaboration with leading medical bodies indicated that in summer anywhere in Australia a person with fair skin is able to achieve adequate levels of vitamin D (> 50 nmol/L) by exposing their face, arms and hands to sunlight for only a few minutes either side of the peak UV times on most days of the week. In winter, in areas at higher latitudes where UV is lower, individuals may require two to three hours exposure over a week.

²⁷ It is now recommended that sun protection practices be reduced during winter

months for those living at higher latitudes,²⁸ while no such policy change has as yet been made by health authorities in lower latitude areas such as Queensland.

In 2004, we conducted a population-based survey to assess cancer risk factors and cancer screening behaviours. At that time we obtained information on attitudes towards sun protection and vitamin D and found that 15% agreed, and 39% were unsure, with the statement that ““if I regularly protect my skin from the sun I am in danger of not getting enough vitamin D”.²⁹ Since that survey was conducted a significant amount of media attention has focussed on the issue of vitamin D deficiency, sun protection and cancer. A recent study in Australia examined trends in media coverage about skin cancer prevention, and found a significant increase in coverage of issues surrounding vitamin D. Further, this research highlighted that articles were more likely to report a “negative” effect of sun protection where they referred to vitamin D.³⁰ Given the recent increased media attention on the issue of vitamin D and health, and the level of population uncertainty,³¹⁻³³ we wanted to monitor attitudes and possible changes in sun protection behaviour due to concerns about healthy levels of vitamin D over time.

The aims of this project were to examine whether the prevalence of those who agree that sun protection may result in not getting enough vitamin D has changed since 2004, to assess if in consequence the population has changed their sun protective behaviour, and that of their children, due to concerns about vitamin D and to examine factors associated with these attitudes and behaviours in a high UV environment.

Material and Methods

This cross-sectional study was conducted in the state of Queensland Australia, which spans from approximately 12°S to 27°S latitude and has a population of approximately 4 million with more than 50% living outside its capital city, Brisbane. Queensland residents aged 18 to 70, who spoke English, and who were not cognitively impaired were eligible to participate. Random digit dialling was used to ascertain households at equivalent quotas based on location (50% from Brisbane/metropolitan and 50% from rural and regional areas), sex (50% male and 50% female) and age group (18-49 years and 50-70 years). Based on Australian Bureau of Statistics (ABS) Population Census figures³⁴ we anticipated that approximately 30% of households would contain children under 13 years of age.

Data were obtained using computer-assisted telephone interviews (CATI) utilising a structured questionnaire. We collected information on:

Skin cancer risk factors: hair, eye and skin colour; sensitivity of skin to the sun, ability to tan, previous history of skin cancer.

Knowledge about vitamin D: “have you ever heard about vitamin D (yes, no, don’t know); “Can you tell me what aspects of your health vitamin D is important for?” (unprompted response). Participants were then asked a series of prompted questions to elicit their knowledge about potential health benefits of vitamin D, including healthy bones and prevention of cancer (full list provided in Figure 1). Participants were also asked where they think the body gets vitamin D from, and their source of information (doctor, other health professional, media [print, TV, radio], internet and other sources), and whether they were ever prescribed a vitamin D supplement by their doctor or took over the counter supplements.

Time spent in the sun to maintain healthy vitamin D level: Participants were asked to estimate the amount of time in summer and in winter a fair-skinned person needs to spend in the sun in Queensland during the hours of 10am to 3pm in order to maintain a healthy vitamin D level (none, 5-10 minutes, 15-20 minutes, 30-60 minutes, more than one hour) and what parts of the body need to be exposed.

Attitudes and behaviours: was assessed by asking participants the identical question used in the 2004 survey²⁹: “If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D” (strongly disagree, disagree, unsure, agree, strongly agree). We also examined participants’ intention to change sun protection behaviours and actual change in sun protection behaviours due to concerns about maintaining healthy vitamin D levels.

Current sun protection practices: including the use of protective clothing, hats, sunscreen and sunglasses.

Participants with children under 13 years: we obtained information on the amount of sun exposure required to maintain healthy vitamin D levels, concern about vitamin D levels and current sun protection practices for their children under the age of 13 years.

Media reports: the interview also obtained information regarding perceptions of media messages about vitamin D and if the messages impacted on sun protection behaviours.

Statistical Analysis

Descriptive statistical analyses were used to summarise participants’ characteristics and proportions were compared using Chi-Square tests. For questions asking participants’ level of agreement or disagreement with certain statements, we collapsed five categories into three due to small numbers in some categories. Multivariate

logistic regression models were fitted to examine predictors of 1) attitudes and 2) predictors of sun protection behaviour change. All variables with significant ($p < 0.05$) bivariate associations as well as variables of a-priori interest (age, sex, skin colouring) were entered into the multivariate models. All analyses were weighted by age, gender and geographic location so that the actual results reflected the Queensland population 20 to 70 years. As there were no significant differences between rural and urban participants for any variables of interest, results are not reported further. All data were analysed using SAS version 9.1.³⁵

Ultraviolet radiation exposures, presented as MED were extracted from data collected via an outdoor UV detector based at the Queensland University of Technology in Brisbane, Queensland. Total irradiances were calculated from this data for 10, 20 and 60 minute exposure times at 9am, 12pm and 3pm respectively. Figures 2 and 3 plot the exposure times participants estimated (y-axes on the left hand side) and also presents the associated measured UV exposure levels in Queensland (Brisbane) for summer and winter which a person with type 2 skin would be exposed to if they were to remain in the sun for 10, 20 or 60 minutes at 10am, 12pm and 3 pm (y-axes on the right hand side).

Ethics approval for this study was obtained from the Behavioural and Social Sciences Ethics Review Committee of University of Queensland. Informed consent was obtained at the time of interview.

Results

Of a total of 4,468 eligible households, 2,001 completed the survey (response rate=45%). Table 1 provides a description of the study group. Mean age was 45 years (similar for men and women). Approximately one-third had children under the age of 13 years and 25% had obtained a university degree. In relation to skin cancer risk factors nearly two-thirds (60%) had fair skin and around one-quarter (24%) indicated their skin tended to burn and not tan after exposure to the sun (Table 1).

Knowledge about vitamin D

The majority of participants (84%) had heard about vitamin D. Women, and those over the age of 60 years were significantly more likely to have heard about vitamin D (χ^2 57.9, $p < 0.001$ and χ^2 9.8, $p = 0.04$, respectively). The most frequently cited sources for obtaining information about vitamin D included the media (48%), doctors (12%) or pharmacists (8%).

In unprompted responses, participants indicated that vitamin D was beneficial for general health (22%), protecting the skin (20%), good for the bones (14%), good for eyesight (4%). When prompted, there were significant differences in knowledge about known or purported health benefits of vitamin D between men and women. Over half of women (59%) identified that vitamin D is beneficial for healthy bones compared to 40% of men (χ^2 114.3, $p < 0.001$). Compared to men, women were also significantly more likely to identify that vitamin D is beneficial for the prevention of rickets (χ^2 184.1, $p < 0.001$). However compared to women, more men indicated they thought vitamin D helped prevent skin cancer (χ^2 27.1, $p < 0.001$) (Figure 1).

Approximately one-third of the group identified fatty fish as a source of vitamin D. More women than men identified milk as a source of vitamin D (36% and 28%

respectively) (χ^2 21.3, $p < 0.001$). The majority of participants (82% of men and 90% of women) identified that vitamin D can be obtained by exposing the skin to the sun.

How much sun (UV exposure) do you need to maintain a healthy vitamin D level?

Nearly one-third of participants (32%) thought a fair-skinned person needed at least 30 minutes in the sun per day between the hours of 10am and 3pm in summer to maintain a healthy vitamin D level and for winter, 47% indicated 30 minutes or more was required on a daily basis (Figures 2 and 3).

Attitudes and behaviors

When asked “If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D” 32% agreed or strongly agreed and 16% were unsure.

Approximately 16% of participants intended to, and 21% indicated they already had, reduced their sun protective behaviours due to concerns about vitamin D levels. No significant differences were observed between men and women, or according to age. Of those who indicated they had changed their sun protective behaviours, approximately 20% did so on the advice of a health professional, and this was significantly more common for men (χ^2 9.5, $p=0.002$), and for those 60 years or older (χ^2 6.0, $p=0.05$) (Table 2).

Who is concerned about Vitamin D?

In the multivariate model (Table 3) factors associated with an increased likelihood of believing sun protection may result in not getting enough vitamin D included aged 60 years or older (OR=1.35, 95% CI 1.09-1.68) and having children under the age of 13 years (OR=1.38, 95% CI 1.15-1.56). Other factors positively associated included having skin that

tanned easily, belief that high levels of sun exposure are required to maintain healthy vitamin D levels, and participants who tried to tan in the past 12 months. Factors associated with a decreased likelihood of believing that sun protection may result in not getting enough vitamin D, included a high gross household income (OR=0.57, 95% CI 0.43-0.76), a history of skin cancer (OR=0.72, 95% CI 0.59-0.88), and frequent use of sunscreen (OR=0.79, 95% CI 0.63-0.98) (Table 3).

Who has changed their sun protection behaviour due to Vitamin D concerns?

Participants showing an increased likelihood of reducing their sun protection behaviours included those with a gross annual household income of less than \$60,000 (OR=1.33, 95% CI 1.09-1.73), and a tendency to tan and not burn (OR=1.34, 95% CI 1.09-2.01).

Participants indicating they covered up outdoors some of the time were nearly 80% more likely to have changed their sun protection behaviours. There were no variables within the fully adjusted model associated with a decreased likelihood of reduced sun protective behaviours (Table 4).

Vitamin D, sun (UV) exposure and sun protection for children

Approximately one third (31%) of parents said they thought their child needed at least 30 minutes a day in the sun in summer, and 43% indicated they required at least 30 minutes in winter (Figures 2 and 3). Over three-quarters (77%) thought their child was maintaining a healthy level of vitamin D. However, 12% were concerned their child was not maintaining a healthy vitamin D level, and nearly 14% had actually changed the sun protection behaviours for their child (Table 2).

In a logistic regression analysis factors associated with an increased likelihood of having reduced the sun protective behaviours for their children included parents with a high school

education and low income households (OR=1.65, 95% CI 1.12-2.41, and OR=1.56, 95% CI 1.10-2.27 respectively), parents with dark or olive skin (OR=2.04, 95% CI 1.31-2.99), and parents who indicated they thought their child required at least 30 minutes of exposure to the sun in summer to maintain a healthy vitamin D level (OR=2.13, 95% CI 1.46-3.09).

Discussion

Within the past 4 years, since our last cross-sectional survey²⁹ in the Queensland population, the percentage of people agreeing with the statement that sun protection could lead to not having enough vitamin D has increased by about 15 percentage points or 100% to a current figure of 32%. While both surveys were cross-sectional and did not interview the same people at both time periods, the surveys were conducted in the same population. The percentage changes are consistent with what we could expect under a dissemination of innovations model. In 2004, we may have observed the early adopters changing their sun protection attitudes based on scientific and subsequent media reports about beneficial effects of sun exposure for vitamin D, while now the early majority is following their lead.³⁶ The attitudinal effect is occurring at a faster rate than the actual behavioural change, where 21% of our participants reported a reduction in their own, and 14% a reduction in their children's (≤ 12 years), sun protection behaviour out of concern about vitamin D levels.

After adjustment for age, sex, skin colour and skin type, participants who usually undertook some sun protective behaviours, such as covering up when outdoors and using sunscreen, represented the group most likely to have changed their sun protective behaviours with respect to vitamin D. This finding may indicate that those who have earlier followed sun protection messages are now so concerned about their vitamin D levels they

are electing to reduce their sun protection practices, again consistent with dissemination theory.

Recent work by Samanek et al ³⁷ indicated the times of UV exposure required to produce current recommended intakes of Vitamin D. For Brisbane, they suggested that in summer 2 to 6 minutes of solar UV exposure was required whilst in winter 4 to 17 minutes of exposure was required. This data varies significantly from the UV exposure times that the general public reported in this work. Data obtained in this study provides strong evidence that the public is confused about how much sun exposure is required to maintain healthy levels of vitamin D. A large proportion of the population estimated long time-periods of 15 minutes or more per day. Some reports in the US have recommended exposing hands, face & arms to a third to one half an MED in summer is required to maintain adequate levels of vitamin D, equivalent to about 5 minutes for those with type 2 skin. ^{38, 39} In Australia, current recommendations have been designed to reduce the confusion surrounding sun exposure and vitamin D (as outlined in the introduction). ²⁷ However the results from this current study indicate that this strategy does not seem to have been successful. If a significant proportion of the Queensland population were to follow their current belief and expose themselves for up to 30 minutes or longer, this may result in them receiving high levels of UV radiation (as shown in Figures 2 and 3), a well established risk factor for skin cancer.

Due to the complexity of the vitamin D issue and the variety of factors people need to take into account when calculating sun exposure, such as their skin type, occupation, location of residence, cloud coverage and so on, a more individualised approach of information provision must be taken. This is not uncommon in health. For example, a similarly

complicated picture of potential benefits and risks exists with regards to information provision around screening for prostate cancer using prostate specific antigen (PSA). The current recommendation in Australia is to provide men with decision aids to make an informed choice.⁴⁰ In this study we found that approximately half those surveyed had heard about vitamin D through the media and only a minority through a doctor or other health professional. Thus given the complexity of this issue it maybe necessary for health professionals to take a more active educative role.

Around one-third of those surveyed thought that vitamin D helped prevent cancer. A number of studies have reported inverse relationships between vitamin D and incidence or mortality for some cancers (primarily prostate, colorectal and breast cancer),^{5, 6, 41-43} and these studies have tended to feature prominently in the popular press. It should be noted however that a number of these studies have examined the effect of vitamin D supplementation in their intervention and not increased sun exposure. Other studies failing to find a relationship between vitamin D levels and the prevention of cancers⁴⁴⁻⁴⁸ have received less press. The conflicting results of these studies highlight the uncertainty surrounding the possible cancer preventive benefits of vitamin D. Meanwhile evidence that excessive sun exposure is the main cause of skin cancer has been available for decades.^{13, 49-52} Skin cancer is associated with significant morbidity, and associated health care costs.^{53, 54} Additionally, it is estimated that melanoma will account for 8,420 deaths in the USA in 2008 and has accounted for over 1,200 deaths in Australia in 2003.^{17, 55} Some evidence now suggests a stabilisation in the incidence of melanoma in younger cohorts, which has been attributed to two decades of public health messages.⁵⁶ Recent media reports could be responsible for our observation of an attitude and behaviour change with regards to sun protection.

In this study participants who agreed that they may be in danger of not obtaining enough vitamin D if they regularly protect their skin displayed a tendency towards increased levels of sun exposure, e.g. believed that a suntanned person looked healthier and thought that more than 10 minutes of daily sun exposure were required for a healthy vitamin D level. It is therefore possible that those who usually display less sun protective behaviours now feel they can “legitimately” go unprotected. There has been strong evidence to suggest that those who purposely attempt to tan are likely to be young adults and teenagers who have sun sensitive skin.⁵⁷ However this is also the group who is least likely to have low levels of vitamin D.³ It would be beneficial therefore for media reports to also feature the potential harms associated with increasing sun exposure or reducing sun protection.

Strengths of this study are its large sample size and population-based design. Limitations include the response rate of approximately 45%. While this could be considered low, it is in line with many studies where ascertainment is by random digit dialling. Some recent methodological studies have failed to show associations between response rates and bias.^{58,}
⁵⁹ We compared our study sample to ABS Population Census figures and found it broadly representative of the Queensland population with the exception that our participants were slightly more educated, married, and in full-time work.³⁴ An additional limitation is that the cross-sectional nature of the survey prohibits the establishment of causality.

This study has provided evidence regarding the level of population uncertainty and concern about vitamin D and sun exposure, leading to reduced sun protection practices in up to 20% of the population. This is of great concern, as this part of Australia has the highest rates of skin cancer in the world, with high levels of year round UV radiation. There is also

evidence that the current tailoring of public health messages regarding sun exposure and vitamin D, are causing confusion in the population. There is an urgent need to re-focus health messages regarding sun exposure and the need for continued sun protection practices. If not potentially we may witness an increase in rates of skin cancer in the future.

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Table I: SOCIO-DEMOGRAPHIC AND SKIN CANCER RISK CHARACTERISTICS OF 2,001 STUDY PARTICIPANTS

	No. ¹	% ²
Sex		
Male	1001	50
Female	1000	50
Age group		
20 – 29 years	252	7
30 – 39 years	430	18
40 – 49 years	526	27
50 – 59 years	513	30
60+ years	280	18
Location		
Brisbane/Metropolitan region	1000	34
Outer regional / rural	1001	66
Marital status		
Married/living together	1,444	74
Divorced/separated/widowed	243	13
Never married	310	13
Education		
Primary/no formal schooling	26	2
Some high school	541	31
Completed high school	526	25
Trade/technical certificate	373	18
University/college	526	25
Employment		
Full-time	1113	54
Part-time/casual	417	22
Home duties/home carer	145	7
Unemployed	55	2
Retired	188	11
Other	79	4
Gross annual household income		
Less than \$20,000	154	9
\$20,000 to less than \$60,000	689	35
\$60,000 to less than \$100,000	513	24
≥ \$100,000	352	17
Unwilling to answer	173	9
Don't know	120	6
Private health insurance		
Yes	1147	59
No	844	41
Households with children ≤ 12 years		
None	1340	71
One child	250	11
Two or more	411	18
Skin colour		
Fair	1191	60
Medium	502	25
Olive/brown/black	307	15
Skin sensitivity ³		
Burn and not tan afterwards	467	24
Burn then tan	936	47
Tan slightly without burning	456	23
Tan a lot without burning	131	6
History of any type of skin cancer		
Yes	429	24
No	1563	76

¹ total may vary due to missing values, ² Percentages weighted to the Queensland population, ³ Skin sensitivity assessed by asking “If you were exposed to strong sun for 30 minutes at the beginning of summer, would your skin...”

Table II: ATTITUDES AND BEHAVIORS ABOUT SUN PROTECTION AND VITAMIN D LEVELS

	No.	% ¹
Do you think you are maintaining a healthy vitamin D level?		
Yes	1190	59
No	142	7
Don't know	669	34
Are you concerned about not maintaining a health vitamin D level?		
Yes	235	12
No	1623	81
Don't know	143	7
Intend to change sun protective behaviours because of vitamin D levels		
Yes	320	16
No	1577	81
Don't know	81	4
Changed sun protective behaviours due to concern about vitamin D levels		
Yes	412	21
No	1542	77
Don't know	47	2
Believe that sun protection may result in not getting enough vitamin D		
Strongly disagree/disagree	1059	52
Agree/strongly agree	647	32
Unsure	295	16
Do you think your child/children are maintaining a healthy vitamin D level? ²		
Yes	507	77
No	16	2
Don't know	138	21
Are you concerned your child/children are not maintaining a healthy vitamin D level?		
Yes	75	12
No	552	83
Don't know	34	5
Changed sun protective behaviours for child/children due to concern about vitamin D levels		
Yes	98	14
No	527	80
Don't know	36	6

¹ percentages weighted to the Queensland population, ² figures based on 661 participants who indicated they had children under the age of 13 years

Table III: FACTORS ASSOCIATED WITH BELIEF THAT IF YOU REGULARLY PROTECT SKIN FROM THE SUN YOU ARE IN DANGER OF VITAMIN D DEFICIENCY: AGREE/STRONGLY AGREE VERSUS DISAGREE/STRONGLY DISAGREE/UNSURE

	If I regularly protect my skin from the sun I am in danger of not getting enough vitamin D			χ^2 , p value	Adjusted ¹ Odds Ratio (95% CI)	
	32% Agree	16% Unsure	52% Disagree		Agree versus unsure or disagree	
Sex				32.3, < 0.001		
Female	31	13	56		1.00	
Male	33	18	49		1.10	0.93-1.30
Age				30.9, < 0.001		
20 – 39 years	32	14	54		1.00	
40 – 59 years	31	15	54		1.05	0.86-1.27
60 – 75 years	37	20	43		1.35	1.09-1.66
Education				58.7, < 0.001		
Primary/junior high	34	19	47		1.00	
Completed high school	37	14	49		1.35	1.12-1.62
Trade/technical/diploma	33	14	53		1.02	0.82-1.26
University	26	13	61		0.96	0.78-1.19
Gross household income				36.7, < 0.001		
Less than \$20,000	39	18	43		1.00	
\$20,000 - \$59,999	35	15	50		0.83	0.64-1.08
\$60,000 – 79,999	31	13	56		0.75	0.55-1.02
\$80,000+	27	16	57		0.57	0.43-0.76
Children under the age of 13 yrs				3.1, 0.21		
No	31	16	53		1.00	
Yes	34	16	50		1.38	1.15-1.67
Skin colour				32.3, < 0.001		
Fair	29	16	55		1.00	
Medium	35	14	51		1.13	0.93-1.37
Olive/dark	40	15	45		1.37	1.08-1.74
Tendency to burn after 30 mins of unprotected sun exposure				25.6, 0.003		
Burn and not tan afterwards	29	15	56		1.00	
Burn then tan	31	15	54		1.07	0.87-1.31
Tan slightly without burning	35	17	48		1.15	0.90-1.48
Tan a lot without burning	42	15	43		1.96	1.38-2.78
History of skin cancer				22.6, < 0.001		
No	34	16	50		1.00	
Yes	26	15	59		0.72	0.59-0.89
Believe suntanned person looks healthy				58.9, < 0.001		
Strongly disagree/disagree	28	16	56		1.00	
Agree/strongly agree	39	14	47		1.77	1.51-2.07
Sun exposure required to maintain vitamin D level ²				356.2, < 0.001		
Nil to less than 10 minutes	27	10	63		1.00	
15 to 20 minutes	35	10	55		1.59	1.27-1.98
30 minutes or more	39	12	49		1.58	1.29-1.93
Don't know	27	39	34		1.01	0.78-1.31
Use sunscreen when outdoors in the sun				51.6, < 0.001		
Never/little of the time	38	17	45		1.00	
Some of the time	30	12	58		0.78	0.63-0.98
Most of the time/always	29	16	55		0.88	0.73-1.06

¹ Model is fully adjusted for all factors in the table; ² “Between the hours of 10am and 3pm in Queensland in summer approximately how much time do you think a fair skinned person needs in the sun per day to maintain a healthy Vitamin D level?”

**TABLE IV: FACTORS ASSOCIATED WITH A REDUCTION IN SUN PROTECTION BEHAVIOR
DUE TO CONCERN ABOUT NOT MAINTAINING HEALTHY LEVELS OF VITAMIN D –
RESULTS OF FULLY ADJUSTED MODEL**

RESULTS OF FULLY ADJUSTED MODEL			
		Adjusted ¹ Odds Ratio (95% CI)	
Sex			
Female		1.00	
Male		0.96	0.80-1.16
Age			
20 – 39 years		1.00	
40 – 59 years		0.94	0.76-1.16
60 – 75 years		1.13	0.84-1.51
Education			
Primary school/junior high		1.00	
Completed high school		0.95	0.77-1.18
Trade/technical/diploma		1.13	0.89-1.42
University		0.91	0.72-1.15
Gross household income			
Less than \$20,000		1.00	
\$20,000 - \$59,999		1.33	1.10-1.73
\$60,000 - \$79,000		1.21	0.84-1.74
\$80,000+		1.06	0.76-1.50
Skin colour			
Fair		1.00	
Medium		1.07	0.86-1.32
Olive/dark		1.24	1.00-1.45
History of skin cancer			
No		1.00	
Yes		1.26	1.02-1.56
Sun exposure required to maintain vitamin D level ²			
Nil to less than 10 minutes		1.00	
15 to 20 minutes		1.05	0.81-1.34
30 minutes or more		1.25	1.05-1.56
Don't know		0.84	0.62-1.13
Cover up when outdoors in the sun			
Never/little of the time		1.00	
Some of the time		1.73	1.36-2.20
Most of the time/always		1.55	1.24-1.93
Use sunscreen when outdoors in the sun			
Never/little of the time		1.00	
Some of the time		1.00	0.78-1.29
Most of the time/always		1.32	1.06-1.63

¹ Model is fully adjusted for all above factors, ² Between the hours of 10am and 3pm in Queensland in summer approximately how much time do you think a fair skinned person needs in the sun per day to maintain a healthy Vitamin D level?"

Figure 1: Percentage reporting knowledge about purported health benefits of vitamin D

Figure 2 - Study participants' reported amount of time they thought a fair-skinned person needs to spend in the sun in summer to maintain a healthy vitamin D level. The y-axis represents the amount of erythemally weighted UV radiation causing erythema 8 to 24 hours post UV exposure in Queensland (Brisbane) in summer for a person with type II skin who remains in the sun for 10, 20 or 60 minutes at 10am, 12pm and 3 pm.

Figure 3 - Study participants' reported amount of time they thought a fair-skinned person needs to spend in the sun in winter to maintain a healthy vitamin D level. The y-axis represents the amount of erythemally weighted UV radiation causing erythema 8 to 24 hours post UV exposure in Queensland (Brisbane) in winter for a person with type II skin who remains in the sun for 10, 20 or 60 minutes at 10am, 12pm and 3 pm.