

Knowledge and Attitudes about Vitamin D and Impact on Sun Protection Practices among Urban Office Workers in Brisbane, Australia

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Abstract

Background: Sun exposure is the main source of vitamin D. Increasing scientific and media attention to the potential health benefits of sun exposure may lead to changes in sun exposure behaviors.

Methods: To provide data that might help frame public health messages, we conducted an online survey among office workers in Brisbane, Australia, to determine knowledge and attitudes about vitamin D and associations of these with sun protection practices. Of the 4,709 people invited to participate, 2,867 (61%) completed the questionnaire. This analysis included 1,971 (69%) participants who indicated that they had heard about vitamin D.

Results: Lack of knowledge about vitamin D was apparent. Eighteen percent of people were unaware of the bone benefits of vitamin D but 40% listed currently unconfirmed benefits. Over half of the participants indicated that more than 10 minutes in the sun was needed to attain enough vitamin D in summer, and 28% indicated more than 20 minutes in winter. This was significantly associated with increased time outdoors and decreased sunscreen use. People believing sun protection might cause vitamin D deficiency (11%) were less likely to be frequent sunscreen users (summer odds ratio, 0.63; 95% confidence interval, 0.52-0.75).

Conclusions: Our findings suggest that there is some confusion about sun exposure and vitamin D, and that this may result in reduced sun-protective behavior.

Impact: More information is needed about vitamin D production in the skin. In the interim, education campaigns need to specifically address the vitamin D issue to ensure that skin cancer incidence does not increase. *Cancer Epidemiol Biomarkers Prev*; 19(7); 1784-9. ©2010 AACR.

Introduction

Skin cancer is a significant problem particularly among Caucasian populations in many Western countries (1). The primary cause of most skin cancers is exposure to solar UV radiation, and for several decades, public health education campaigns have promoted sun-protective behaviors. There is evidence that adoption of these practices is beginning to reduce the incidence of skin cancers in Australia (2).

In contrast to its harmful effects, solar UV radiation also results in the production of vitamin D (3). Adequate vitamin D levels are essential for maintenance of bone health (4), but there has been increasing research in the

past decade into its other possible health benefits (5). There has been growing media attention to these potential benefits (6), and there is concern that this might lead to reduced sun-protective behaviors, with consequent increases in the risk of skin cancer (7-9).

The Cancer Council Australia (10) has released a position statement that attempts to balance the benefits and harms of sun exposure. It suggests that most fair-skinned people only need a few minutes of sun exposure per day on either side of the peak UV period to generate sufficient vitamin D in summer. Although sun protection may not be required in some regions in winter, in areas where the ambient UV remains high, consistent use of sun-protective measures is warranted throughout the year (10).

To develop effective public education campaigns, better understanding about knowledge and attitudes of populations toward vitamin D and the effect that these may have on sun exposure behavior is necessary. There have been previous surveys in Queensland which suggest that a high proportion of the population is unaware of the current recommendations (7, 11). However, these surveys have had relatively low response rates and have not targeted a specific population. We therefore undertook a survey in a population of office workers in Brisbane, Australia, recruiting employees of

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Table 1. Knowledge and attitudes about vitamin D among 1,971 participants who had ever heard/learnt about vitamin D, Brisbane, 2009

	<i>n</i> (%)
<i>Knowledge about vitamin D</i>	
<i>Benefits of vitamin D</i>	
Don't know the benefits of vitamin D*	617 (31)
Know about the benefits of vitamin D (<i>n</i> = 1,354)	1,354 (69)
Healthy bone	1,027 (76)
Prevention of rickets	457 (34)
Prevention of general weakness	471 (35)
Prevention of chronic diseases [†]	418 (31)
Healthy pregnancy	227 (17)
Other benefits	107 (8)
Grouped by bone versus other benefits (<i>n</i> = 1,354)	
Only benefits to bone (healthy bone, prevent rickets)	531 (39)
Both benefits to bone and other benefits	585 (43)
Only other benefits	238 (18)
<i>Sources of vitamin D</i> (<i>n</i> = 1,742; 1,094 females and 648 males)	
Don't know about the sources of vitamin D*	229 (12)
Know the sources of vitamin D (<i>n</i> = 1,742)	1,742 (88)
Correct food sources (fatty fish, cod liver oil, eggs)	568 (33)
Sun exposure	1,443 (83)
Vitamin D supplements	1,205 (69)
Others [‡]	581 (33)
<i>Time per day needed outdoors in summer between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D</i>	
<10 min	870 (44)
10 to <20 min	780 (40)
20+ min	321 (16)
<i>Time per day needed outdoors in winter between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D</i> (missing = 1)	
<10 min	623 (32)
10 to <20 min	779 (40)
20+ min	558 (28)
<i>Attitudes about vitamin D</i>	
If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D (missing = 5)	
Disagree/strongly disagree	1,349 (69)
Unsure	395 (20)
Agree or strongly agree	222 (11)
I am concerned that my current vitamin D levels might be too low	
Disagree/strongly disagree	986 (50)
Neither agree nor disagree	807 (41)
Agree or strongly agree	178 (9)

Table 1. Knowledge and attitudes about vitamin D among 1,971 participants who had ever heard/learnt about vitamin D, Brisbane, 2009 (Cont'd)

	<i>n</i> (%)
<i>Where have you heard/learnt about vitamin D?</i> (<i>n</i> = 1,959; missing = 12)	
Professional sources (doctors, other health staff, school/university) only	403 (21)
Media (newspaper, TV, magazine, radio, internet) only	869 (44)
Both professional and media sources	459 (23)
Friend/relative (not citing any sources mentioned above)	207 (11)
Others (not citing any sources mentioned above)	23 (1)

*Percentages calculated of 1,971 participants.

[†]Those who selected at least one of the chronic diseases listed in the survey including cancer, kidney disease, Alzheimer's disease, diabetes, multiple sclerosis, seizures, heart disease, and schizophrenia.

[‡]Those who selected at least one of the other sources as listed in the survey including white fish, yogurt, vegemite, chicken, red meat, milk, and olive oil. We did not ask about fortified foods.

Suncorp, a large banking and insurance organization with employees from a broad range of backgrounds. Suncorp runs a community education program, Sunwise, aiming to provide education to the general public, and was thus able to facilitate this project as part of its research support program. This study aimed to (a) understand knowledge and attitudes toward vitamin D, and determinants of these, and (b) explore associations between knowledge and attitudes and sun protection behaviors.

Materials and Methods

In March 2009, we conducted an online survey among Suncorp employees based in Brisbane, a city situated at 27 degrees south in Queensland, Australia. Ethical approval for this study was obtained from the Queensland Institute of Medical Research Human Research Ethics Committee.

The survey collected information about sociodemographic factors, skin cancer risk factors, and self-reported past history of skin cancers. To ascertain knowledge about vitamin D, we asked about the sources of vitamin D and the amount of time required in the sun in winter and summer for a fair-skinned person to obtain enough vitamin D (see Supplementary Data for the wording of the questions). Attitudes were assessed by asking the participants about their level of agreement with two

statements that were similar to those used in previous surveys (7, 11). These were (a) "If I regularly protect myself from the sun, I am in danger of not getting enough vitamin D"; (b) "I am concerned that my vitamin D levels might be too low." Responses were measured using a five-level Likert scale.

We asked participants about the amount of time spent outdoors on typical nonwork days and about their sunscreen use (see Supplementary Data). The sun exposure variables were dichotomized into "less than 2 hours" versus "2 hours or more" and the sunscreen use variables

into "never, rarely, or sometimes" versus "usually or always/almost always" for the analysis of associations with knowledge and attitudes.

We analyzed data using PASW Statistics version 17.0. Analyses were largely restricted to those people who said that they had heard or learnt about vitamin D and therefore completed the vitamin D section of the questionnaire ($n = 1,971$). Differences between this subgroup and those who had not heard about vitamin D were assessed using χ^2 statistics. We used logistic regression to estimate associations with vitamin D knowledge and attitudes and then

Table 2. Factors associated with attitudes about vitamin D among those who said they ever heard/learnt about vitamin D, Brisbane, 2009 ($n = 1,971$)

	If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D			I am concerned that my current vitamin D levels might be too low		
	Disagree, <i>n</i> (%)	Agree, <i>n</i> (%)	OR* (95% CI)	Disagree, <i>n</i> (%)	Agree, <i>n</i> (%)	OR† (95% CI)
Total	1,744 (89)	222 (11)		1,793 (91)	178 (9)	
Sex						
Male	659 (89)	78 (11)	1	702 (95)	37 (5)	1
Female	1,085 (88)	144 (12)	1.14 (0.85-1.53)	1,092 (89)	141 (11)	2.43 (1.67-3.54)
Age (y)						
<30	383 (91)	39 (9)	1	374 (88)	50 (12)	1
30-49	1,086 (89)	140 (11)	1.28 (0.88-1.86)	1,133 (92)	96 (8)	0.68 (0.47-0.97)
50+	275 (86)	43 (14)	1.57 (0.98-2.47)	287 (90)	32 (10)	0.90 (0.56-1.44)
Education						
≤Junior high school	148 (85)	27 (15)	1	158 (90)	17 (10)	1
Senior high school	455 (89)	56 (11)	0.75 (0.45-1.25)	453 (88)	60 (12)	1.34 (0.74-2.40)
Trade/technical certificate/diploma	360 (90)	40 (10)	0.67 (0.39-1.15)	364 (91)	38 (9)	1.11 (0.60-2.06)
University/college	781 (89)	96 (11)	0.77 (0.47-1.25)	816 (93)	63 (7)	0.85 (0.47-1.52)
History of nonmelanoma skin cancer						
No	1,340 (89)	166 (11)	1	1,376 (91)	133 (9)	1
Yes	404 (88)	56 (12)	1.02 (0.73-1.43)	418 (90)	45 (10)	1.21 (0.83-1.76)
History of melanoma						
No/unsure	1,699 (89)	214 (11)	1	1,747 (91)	172 (9)	1
Yes	45 (85)	8 (15)	1.29 (0.60-2.79)	47 (89)	6 (11)	1.40 (0.58-3.36)
Hair type						
Red/fair/blond	327 (90)	38 (10)	1	338 (92)	28 (8)	1
Light brown	671 (91)	70 (9)	0.90 (0.59-1.37)	669 (90)	74 (10)	1.35 (0.85-2.12)
Dark brown/black	746 (87)	114 (13)	1.36 (0.92-2.02)	787 (91)	76 (9)	1.29 (0.82-2.03)
Skin type						
Fair	1,004 (90)	106 (10)	1	1,007 (91)	105 (9)	1
Medium	534 (88)	75 (12)	1.32 (0.97-1.81)	564 (92)	47 (8)	0.84 (0.59-1.21)
Olive or brown	206 (83)	41 (17)	1.91 (1.29-2.82)	233 (90)	26 (10)	1.14 (0.72-1.80)
Skin sensitivity						
Burn and not tan	426 (91)	44 (9)	1	420 (89)	50 (11)	1
Burn then tan	974 (89)	121 (11)	1.22 (0.84-1.75)	1,007 (92)	93 (8)	0.82 (0.57-1.19)
Tan without burn	344 (86)	57 (14)	1.65 (1.08-2.51)	367 (91)	35 (9)	0.84 (0.53-1.32)

*OR for agree (including agree and strongly agree) versus disagree (including disagree, strongly disagree, and unsure), adjusted for sex and age.

†OR for agree (including agree and strongly agree) versus disagree (including disagree, strongly disagree, and neither agree nor disagree), adjusted for sex and age.

Table 3. Associations between vitamin D knowledge and attitudes and number of hours spent outdoors on a typical nonwork day among 1,971 participants who ever heard/learnt about vitamin D, Brisbane, 2009

	Sun exposure in summer			Sun exposure in winter		
	<2 h, n (%)	2+ h, n (%)	OR* (95% CI)	<2 h, n (%)	2+ h, n (%)	OR* (95% CI)
Knowledge about vitamin D benefits						
Confirmed bone benefits only	376 (71)	155 (29)	1	329 (62)	202 (38)	1
Others +/- confirmed bone benefits	530 (67)	263 (33)	1.16 (0.91-1.48)	456 (57)	337 (43)	1.20 (0.95-1.50)
Knowledge of sun exposure as a source of vitamin D						
Yes	982 (68)	461 (32)	1	869 (60)	574 (40)	1
No	334 (63)	194 (37)	1.22 (0.99-1.51)	305 (58)	233 (42)	1.10 (0.90-1.35)
Sun exposure required a day in summer between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D						
<10 min	636 (73)	234 (27)	1			
10 to <20 min	516 (66)	264 (34)	1.33 (1.08-1.65)			
20+ min	164 (51)	157 (49)	2.45 (1.88-3.21)			
Sun exposure required a day in winter between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D						
<10 min				416 (67)	207 (33)	1
10 to <20 min				471 (60)	308 (40)	1.26 (1.01-1.57)
20+ min				278 (50)	280 (50)	1.88 (1.48-2.39)
If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D						
Disagree/unsure	1,165 (67)	579 (33)	1	1,041 (60)	703 (40)	1
Agree	148 (67)	74 (33)	1.03 (0.76-1.39)	130 (59)	92 (41)	1.05 (0.79-1.40)
I am concerned that my current vitamin D levels might be too low						
Disagree/unsure	1,178 (66)	615 (34)	1	1,051 (59)	742 (41)	1
Agree	138 (77)	40 (23)	0.61 (0.42-0.88)	123 (69)	55 (31)	0.69 (0.49-0.97)

*OR for 2+ h versus <2 h, adjusted for age and sex.

between knowledge/attitudes and sun exposure/sunscreen use.

Results

Of 4,709 eligible staff, 70% logged onto the online survey. Of these, 2,867 people (61% of 4,709) completed the questionnaire with full information on sociodemographic characteristics. Sixty-nine percent (1,971) of those who completed the questionnaire affirmed that they had some knowledge of vitamin D. These were more likely to be female, somewhat older, and to have a university education than those who had not heard about vitamin D (see Supplementary Table). There were no differences in phenotypic skin cancer risk factors between these two groups, but participants who did not know about vitamin D seemed more likely to spend more time outdoors in summer and less likely to use sunscreen than those who did know about it.

Knowledge about vitamin D

The majority of the participants (67%) indicated that they had obtained information about vitamin D from the media (television, newspaper, and magazine; Table 1). Nearly one third indicated that they had no knowledge of the benefits of vitamin D (Table 1), and this was more common in men than in women [odds ratio (OR), 1.63; 95% confidence interval (95% CI), 1.35-1.97 (age adjust-

ed)]. Among those who indicated some knowledge of the benefits of vitamin D, 18% did not indicate any of the confirmed benefits to bone health (Table 1).

Approximately one third of respondents who said they knew the sources of vitamin D indicated an incorrect food source and 17% did not select exposure of the skin to the sun.

Over half of the participants indicated that more than 10 minutes in the sun was needed to attain enough vitamin D in summer, and 28% selected more than 20 minutes in winter. This belief was significantly more common in men than in women.

Attitudes toward vitamin D

The majority of participants (69%) disagreed with the statement "If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D," whereas 11% agreed (Table 1). Study participants over 50 and those with olive skin were more likely than younger and fair-skinned participants to feel that sun protection would cause vitamin D deficiency (Table 2). Those who were unsure about this statement were more likely to be male (42% versus 36%, P 0.02) and less likely to use sunscreen frequently in summer (51% versus 61%, P < 0.001) and in winter (14% versus 23%, P < 0.001) than those who either agreed or disagreed.

Fifty percent of people disagreed with the statement "I am concerned that my current vitamin D level might

be too low" and 9% of people agreed. Women were more concerned about their vitamin D levels than men (OR, 2.43; 95% CI, 1.67-3.54). Compared with those who agreed or disagreed with this statement, people who were unsure tended to have lower education levels (40% versus 48% with a degree, $P < 0.001$) and to be less likely to use sunscreen in summer (57% versus 61% usually or always, $P 0.08$) and in winter (18% versus 24% usually or always, $P 0.002$).

Association between vitamin D knowledge and attitudes and sun exposure/protection

Approximately one third of the population reported spending 2 or more hours outside on weekends in summer and 41% in winter. Fifty-nine percent of people used sunscreen frequently in summer compared with 21% in winter (Supplementary Table).

We found significant positive associations between the amount of time spent outdoors and the time thought necessary to ensure vitamin D sufficiency (Table 3). People who believed that high levels of sun exposure are required to generate vitamin D were less likely to be frequent sunscreen users (Table 4). Compared with those identifying only the benefits to bone, participants identifying other benefits reported spending more than 2 hours in the sun and using less sunscreen during the last year.

Participants who believed that sun protection might cause vitamin D deficiency reported a significantly lower frequency of sunscreen use (Table 4). Those who expressed concern about their own vitamin D levels were significantly less likely to have spent more than 2 hours in the sun last summer and winter and were less likely to have used sunscreen often last summer.

Discussion

We assessed knowledge and attitudes about vitamin D of office workers in Brisbane and the influence of these on sun exposure and sunscreen use. There was clear evidence of a knowledge deficit in this population. A high proportion of participants did not know that vitamin D is vital for bone health, but a majority indicated that vitamin D has a range of other health benefits, which has frequently been the subject of media attention (8). Lack of knowledge about vitamin D is further illustrated by the high proportion of people who incorrectly identified foods as sources of vitamin D or were unaware that sun exposure leads to formation of vitamin D. Approximately 30% of participants reported that they had no knowledge of vitamin D at all, and were therefore asked no further questions. We can assume that the knowledge of this group of people would be poor.

Table 4. Associations between vitamin D knowledge and attitudes and sunscreen use among 1,971 participants who ever heard/learnt about vitamin D, Brisbane, 2009

	Sunscreen use in summer			Sunscreen use in winter		
	N/R/S, n (%)	U/A, n (%)	OR* (95% CI)	N/R/S, n (%)	U/A, n (%)	OR* (95% CI)
Knowledge about vitamin D benefits						
Confirmed bone benefits only	206 (39)	325 (61)	1	396 (75)	135 (25)	1
Others +/- confirmed bone benefits	326 (41)	467 (59)	0.91 (0.73-1.15)	630 (79)	163 (21)	0.78 (0.60-1.02)
Knowledge of sun exposure as a source of vitamin D						
Yes	567 (39)	876 (61)	1	1,113 (77)	330 (23)	1
No	237 (45)	291 (55)	0.80 (0.65-0.98)	431 (82)	97 (18)	0.77 (0.60-0.99)
Sun exposure required a day in summer between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D						
<10 min	325 (37)	545 (63)	1			
10 to <20 min	312 (40)	468 (60)	0.94 (0.77-1.15)			
20+ min	167 (52)	154 (48)	0.59 (0.45-0.76)			
Sun exposure required a day in winter between 9 a.m. and 3 p.m. for a fair-skinned person to get enough vitamin D						
<10 min				440 (71)	183 (29)	1
10 to <20 min				629 (81)	150 (19)	0.60 (0.46-0.76)
20+ min				469 (84)	89 (16)	0.49 (0.37-0.66)
If I regularly protect my skin from the sun, I am in danger of not getting enough vitamin D						
Disagree/unsure	683 (39)	1,061 (61)	1	1,357 (78)	387 (22)	1
Agree	117 (53)	105 (47)	0.63 (0.52-0.75)	183 (82)	39 (18)	0.73 (0.51-1.06)
I am concerned that my current vitamin D levels might be too low						
Disagree/unsure	718 (40)	1,075 (60)	1	1,402 (78)	391 (22)	1
Agree	86 (48)	92 (52)	0.65 (0.47-0.88)	142 (80)	36 (20)	0.83 (0.56-1.22)

Abbreviations: N/R/S, never/rarely/sometimes; U/A, usually/almost always or always.

*OR for U/A versus N/R/S, adjusted for age and sex.

It has been suggested that in an environment with high UV levels such as in Brisbane, 2 to 6 minutes of sun exposure per day during peak UV hours in summer and 4 to 17 minutes in winter would be sufficient for vitamin D production in a fair-skinned person, and that sun protection practices should be maintained all year (12). A high proportion of our sample was unaware of these recommendations and believed that substantially greater time is needed for vitamin D production. This lack of knowledge was associated with increased time outdoors and reduced sunscreen use. Due to the cross-sectional study design, we could not determine whether lack of knowledge about vitamin D resulted in reduced sun protection practices or whether people justified reduced sun protection behavior on the basis of perceived vitamin D requirements. However, these findings are consistent with the results of a recent survey in Queensland (11), suggesting that increasing knowledge may lead to improved sun protection practices.

Sunscreen use does not seem to affect vitamin D production in a population setting (5). However, 11% of our sample believed that sun protection might lead to a lack of vitamin D. This is lower than the 32% reported by Youl and colleagues (11) and might be due to the difference in sampling frame. Nevertheless, as in the previous study, we also found that this attitude was more common among people with a lower frequency of sunscreen use. A relatively high proportion of people were uncertain about whether or not sunscreen use diminishes vitamin D production, further emphasizing the need for public education about this issue.

Our study focused specifically on a population of office workers in whom we were able to include a large sample size with a relatively high response rate. The participants in this study were recruited from an organization that actively promotes sun protection to the public. Messages about vitamin D have not formed a core part of the promotional materials, and there is no fact sheet or clear position statement about vitamin D on the Suncorp Sun-

wise website (13). However, it is possible that this population has greater knowledge about vitamin D than the general community. If so, there would be even greater cause for concern about the possible effects of mixed messages about sun exposure than indicated here. Additional research in other populations in different areas, possibly with a prospective study design to gauge change in attitudes, would lead to a better understanding of public perception of this issue.

In conclusion, current knowledge about the health effects of low vitamin D and on how much sun exposure is needed to make vitamin D in different circumstances makes it very difficult to balance the need to adopt a precautionary approach about the possible benefits of sun-induced vitamin D against the known harms of overexposure to the sun. Substantial research is needed to address these issues. In the interim, evidence from this and other studies indicates that the public are confused and concerned and that public health messages need to specifically target the vitamin D issue to ensure that skin cancer rates do not increase in coming years.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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