Review

UV Radiation and Cancer Prevention: What is the Evidence?

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Abstract. *The health benefits of sunlight and the risk of skin cancer from UV exposure are still controversial. The literature was analyzed in terms of reviews, controlled and epidemiological studies for the relationships between sunshine exposure and overall cancer mortality, as well as mortality from cancer of the prostate, colon and breast. The residential and/or occupational sun exposure rate seemed to be positively correlated with a lower risk of overall morality due to organ cancer. A normal vitamin D status appeared to be an important precondition, via the local and autocrine synthesis of 1,25(OH)$_2$D$_3$ in the target tissues. The vitamin D hormone system is necessary for cell proliferation and differentiation; different types of vitamin D receptor gene polymorphism seemed to be associated with cancer cell growth. The health benefits of sunlight appear to outweigh the risk of skin cancer. However, the optimal UV exposure, the target level of circulating vitamin D, and whether vitamin D is the only pathway are still undetermined.*

The risks and benefits of ultraviolet radiation through exposure to sunlight have been controversially discussed in recent decades. Ultraviolet (UV) radiation activates the vitamin D cascade. The vitamin D hormone system is essential, *e.g.*, for bone health, muscle power, cardiovascular regulation, as well as for cell proliferation and differentiation. However, UV radiation can also cause skin damage and skin cancer.

Recently, research has indicated that vitamin D may also be important for the prevention of some organ cancers.

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Key Words: Sunlight exposure, vitamin D, organ cancer, review – meta-analysis.

The aim of this review was to analyze the published evidence, with special emphasis on vitamin D and cancer of the prostate, colon, and breast.

Materials and Methods

Literature search. Mainly using the PubMed system, the following key words were entered: prostate, colon and breast cancer, respectively, combined with ultraviolet radiation, sunlight, sunburn, sunbeds, latitude, environment and season. The search resulted in 2,210 publications (Table I).

The 1,387 papers concerning breast cancer dated back to 1950, the 392 papers on colon cancer to 1982, and the 315 publications on prostate cancer back to 1970.

Upon adding the key word "vitamin D", the number of publications was reduced to 18 papers for prostate cancer, 16 for colon cancer and 14 for breast cancer.

Selecting only reviews, cohort and observational/ epidemiological studies, the list was finally reduced to eight papers for prostate cancer, four papers for colon/rectal cancer and five papers for breast cancer; three papers presented reviews focusing on UV irradiation and overall cancer mortality.

Measure for meta-analysis. Using a scoring system adapted to the rules of the International Society of Biometrics, the finally selected publications were score-evaluated for: study design quality (except reviews), recruitment quality (=inclusion and exclusion criteria) and power of the statistical measurement interpretation regarding the quality of the design.

For each of the four categories there was a maximum of five points, making the highest possible score 20 points.

Results

Sunlight exposure and prostate cancer. For the final selection of papers (n=8) see Table II.

There was a significantly higher rate of prostate cancer mortality in the North-East than in the South-West of the USA (1). The risk of prostate cancer was inversely correlated with sun exposure: the higher the exposure, the lower the risk (Odd's ratio [OR] 3.21 for cancer risk in the quartile with

Table I. *Literature search: Cancer and environment / latitude / sun / UV and vitamin D.*

Literature search:								
Breast cancer +		Colon cancer +		Prostate cancer +	
environment	1032	environment	245	environment	322
environmental exposure	246	environmental exposure	39	environmental exposure	41
latitude	12	latitude	2	latitude	2
seasons	64	seasons	2	seasons	5
solarium	0	solarium	0	solarium	0
sunbeds	0	sunbeds	0	sunbeds	0
sunburn	2	sunburn	0	sunburn	2
sunlight	107	sunlight	27	sunlight	37
tanning	0	tanning	0	tanning	1
ultraviolet	126	ultraviolet	30	ultraviolet	42
ultraviolet rays	57	ultraviolet rays	13	ultraviolet rays	26
UV	118	UV	29	UV	30
	1764		387		508
total after duplicates removed	1387	total after duplicates removed	315	total after duplicates removed	392
since 2000	633	since 2000	136	since 2000	242
from the 1387 above **vitamin D	14	from the 315 above **vitamin D	16	from the 392 above **vitamin D	18
since 2000	4	since 2000	8	since 2000	10

Table II. *Meta-analysis: Sunlight / UV and prostate cancer.*

Ref. no.	First author	Year	Journal	Design [score]	Statistics [score]	Recruitment and interpretation score	Total score
1	Hanchette MA	1992	Cancer	Epidemiological study (1970-1979) [–]	5	–/3	8
2	Luscombe CJ	2001	The Lancet	Epidemiological case-control study (1999-2000) [5]	5	5/5	20
3	Luscombe CJ	2001	Cancer	Case-control study (1999-2000) [2]	4	1/3	10
4	Bodiwala D	2003	Cancer Lett	Confirmatory case-control study (2001-2002) [3]	5	2/2	12
5	Bodiwala D	2003	Cancer Lett	Confirmatory case-control studies (1999-2000 and 2001-2002) [3]	5+	2/2	12+
6	Bodiwala D	2004	Environment Molec Mutagenesis	Case-control study (1999-2002) [2]	5	1/3	11
7	Grant WB	2004	Int J Cancer	Epidemiological studies (1970-1994 and 1950-1969) [–]	5	–/5	10
8	Grant WB	2004	Eur Urol	Multicountry ecological study (late 1990s) [–]	5	–/3	8

Table III. *Meta-analysis: Sunlight / UV and colon cancer.*

Ref. no.	First author	Year	Journal	Design [score]	Statistics [score]	Recruitment and interpretation score	Total score
9	Garland C	1985	The Lancet	Long-term prospective, epidemiologic study (1954-1973) [2]	3	2/4	11
10	Kampman E	2000	Cancer Causes Control	Case-control study [5]	5	2/5	17
11	Tangpricha V	2001	The Lancet	Case-control study [–]	–	–/–	–
12	Slattery ML	2004	Int J Cancer	Case-control study [5]	2	5/4	16

lowest sun exposure *vs.* OR 0.998 in the highest quartile). The role of vitamin D in cell differentiation and regulation seemed to be an important factor (2, 3, 7, 8). Additionally, vitamin D receptor (VDR) polymorphism seemed to influence the risk; the presence of the FOK 1 genotype was associated with increased risk. Moreover, the skin type was another factor that could influence the risk (4-6).

Sunlight exposure and colon cancer. For the final selection of papers (n=4) see Table III.

There was evidence of an inverse relationship between geographic latitude and colon cancer mortality. This appeared to be dependent on the body store of vitamin D (9,10). Malignant colon tissue has a higher concentration of 1-alpha-hydroxylase; it therefore needs a high concentration of 25-hydroxy-vitamin D_3 to optimize local production of the growth-regulating hormone (11). Again, there seemed to be an association with VDR polymorphism; people with the genotype PolyASS or BsmIBB, respectively, had a reduced risk of rectal cancer (in connection with a low calcium diet). On the other hand, controversially, a high intake of calcium was reported to be inversely correlated with the risk of colon cancer (in connection with vitamin D) (12).

Sunlight exposure and breast cancer. For a final selection of publications (n=5) see Table IV.

There was also evidence for an inverse correlation between the geographic latitude and breast cancer mortality rate (13). In northern latitudes a deficiency of vitamin D is common. Therefore, it can be postulated that sunlight exposure in southern latitudes could reduce the risk of breast cancer *via* the body's store of vitamin D (14, 15). Additionally, living in urban areas seems to be connected with a higher risk as compared to a rural environment. Moreover, the hormonal status of a woman can raise or lower the environmental risk factors for breast cancer (16, 17).

Sunlight exposure and overall cancer mortality. For a final selection of papers (n=3) see Table V.

The extent of residential and occupational sun exposure was negatively correlated with organ cancer. The strategy for individual sun exposure should depend on the environmental situation, the season and the latitude of residence (18-20). High levels of vitamin D seemed to be an important protecting factor (18, 20).

On the other hand, there was a positive correlation with lifetime cumulative sun exposure and non-melanoma skin cancer. However, when an individually adapted strategy was employed, the benefits of sunlight exposure seemed to outweigh the risk of skin cancer (18,19).

Discussion

1. Is vitamin D the only or the main pathway for organ cancer prevention?
2. What are the target levels of circulating vitamin D (25-hydroxy vitamin D_3) to obtain the discussed beneficial and systemic effects?
3. Is sunlight (UV) exposure superior to oral vitamin D supplementation for protection against organ cancer and/or organ health?

Table IV. *Sunlight / UV and breast cancer.*

Ref. no.	First author	Year	Journal	Design [score]	Statistics [score]	Recruitment and interpretation score	Total score
13	Garland CG	1990	Prevent Med	Ecological Study [5]	multiple regression analysis [5]	5/5	20
14	John ME	1999	Cancer Epidem Biomark Prevent	Epidemiological follow-up studies (1971-74 and 1992) [5]	Cox proportional hazard regression (RR) [5]	5/5	20
15	Lipkin M	1999	Am Coll Nutrit	Review [–]	–	–/–	–
16	Blot WJ	1995	Nat Cancer Inst	Review of a epidemiological study (1987), geographic comparison of estimated risk factors [–]	–	–/–	–
17	Coyle YM	2004	Breast Cancer Res Treat	Review [–]	–	–/–	–

Table V. *Sunlight / UV and overall cancer mortality.*

Ref. no.	First author	Year	Journal	Design [score]	Statistics [score]	Recruitment and interpretation score	Total score
18	Ainsleigh HG	1993	Prevent Med	Review [–]	–	–/–	–
19	Freedman DM	2002	Occup Environ Med	Death certificate-based case-control study [5]	3	5/2	15
20	Grant WB	2003	Rec Results Cancer Res	Review of ecological studies [–]	–	–/–	–

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