The 100 most influential skin cancer publications: a citation analysis

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Abstract

Background: As skin cancer is the most common cancer in the U.S., many publications focus on cutaneous malignancies. The objective was to identify and analyze the 100 most-cited articles pertaining to skin cancer to provide clarity on past, and insight for future research.

Methods: Using a two-stage search of Thomson Reuters Web of Science database, the 100 most-cited skin cancer articles between 1945 and 2018 were identified and analyzed.

Results: The articles were cited an average total of 558.49 times (range: 259 to 3429). There were relatively few significant publications until 1988. Linear correlation revealed that journal impact factor was not correlated with average number of citations per year per article (R2=0.06). Molecular pathogenesis and UV exposure were the most common topics. The topics that received the highest average citations per year per article were prevention (50.44 citations per year), diagnosis (47.32 citations per year), and management (41.37 citations per year). Basic science articles accounted for the most publications, followed by narrative literature reviews.

Conclusions: These results may indicate that future publications with similar characteristics are more likely to be cited and thus, more influential.

Keywords: skin cancer, cutaneous malignancy, research, citation analysis, prevention, diagnosis, management

Introduction

Skin cancer is the most common cancer in the United States. Although skin cancer includes basal cell carcinoma, squamous cell carcinoma, melanoma, and other nonepithelial skin tumors, most of the deaths from skin cancer are attributed to melanoma. During 2018 alone, there were 91,270 new cases of melanoma with an estimated 9,320 deaths [1]. Although linked to fewer deaths, there is a much higher incidence of non-melanoma skin cancer, with an estimated 5 million new cases each year [2].

Owing to its impact on the population, many articles about the epidemiology, pathophysiology, diagnosis, and management of skin cancer have been published over the years. In this paper, we used the Thomson Reuters Web of Science database to conduct a citation analysis. Citation analyses are widely utilized to identify the top papers about a particular topic based on the number of times they have been cited. This allows for analysis of their content and characteristics to be performed. By analyzing the influential articles on skin cancer, we hope to provide clarity on relevant topics in the past and insight for future skin cancer research.

Methods

Objective

To identify and analyze the 100 most-cited articles pertaining to skin cancer that were published between 1945 and 2018.

Inclusion criteria

In order to be included, papers had to concentrate mainly on the epidemiology, pathophysiology, diagnosis, management, or treatment specific to skin cancer. Studies that discussed pre-malignant or non-malignant dermatologic diseases were included if more than half of all studied patients were diagnosed with some form of malignant skin cancer.

Articles focusing only, or primarily, on cancers in general were excluded.

Data collection

We queried Thomson Reuters Web of Science database for relevant publications in a two-step manner. During the first phase of data collection, a topic search of the Web of Science database was performed using the term *skin cancer*. The search identified 61,222 articles. These were listed in descending order based on the total number of citations. After thorough review of the titles and abstracts of the first 470 studies, 120 papers on topics related to skin cancer/cutaneous malignancies were identified. All papers were perused to generate a list of keywords to be utilized in the second stage of data collection.

After thorough analysis of the titles and abstracts of the initial 120 articles, 214 key words and key phrases were identified (**Table 1**). A title search of the Web and Science database was performed using these keywords and phrases, yielding 19,744 articles. These articles were then sorted in descending order based on the total number of citations. The 100 articles with the highest number of citations that met the inclusion criteria were identified.

From all 100 articles selected for final inclusion, the title, author(s), journal name, year published, country, year of first citation, year of highest number of citations, total number of times cited, and number of times cited in 2017 were compiled.

Data analysis

The topics and type of manuscript for each article were identified. After all the aforementioned data were collected, the number of years until the first citation, the number of years until the peak citation, and the average number of citations per year were calculated for each article. One-way ANOVAs and linear regression analysis were performed to assess for differences in total citations and average citations per year based on study design, topic, author, country, and journal.

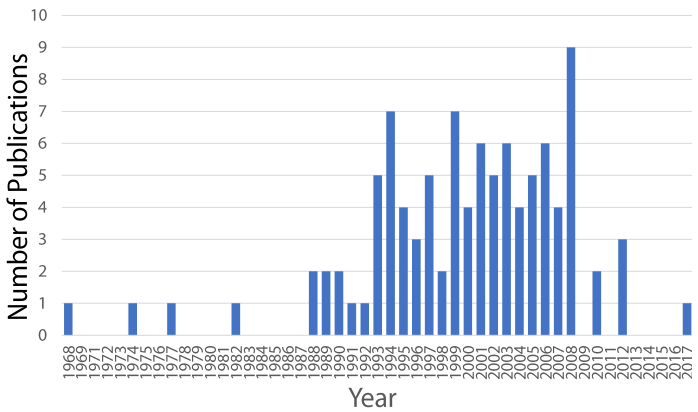

Figure 1. *Years of publication for the top 100 skin cancer articles.*

Results

Gross outcomes

A complete list of the 100 most-cited articles pertaining to skin cancer can be seen in **Table 2**.

The 100 most-cited articles were cited an average of 558.49±513.68 times. The article with the least citations was Moloney et al. [3], which was cited a total of 249 times. The article with the highest number of citations was "Cancer Chemopreventive Activity of Resveratrol, a Natural Product Derived from Grapes," which was published by Jang et al. [4] in 1977. Since then, it has garnered 3,429 total citations with an average of 155.86 citations per year. It reached its peak citations in 2012 and was cited 167 times during 2017. The oldest article was from 1968 by Tseng et al. [5]. The most recent article was from 2017 by Esteva et al. [6].

Figure 1 demonstrates the number of the 100 most-cited skin cancer articles published each year. There were relatively few highly cited publications in the field until the year 1988, which signifies the beginning of a period with an increasing number of influential skin cancer research articles being published. The year with the highest number of influential papers published was 2008, in which 9 of the 100 most-cited skin cancer articles were published [7-14].

The number of times that the 5 most-cited articles were cited each year can be seen in **Figure 2**. The following four articles: Jang et al. [4], Baur et al. [15], Clark et al. [16], and Jarup et al. [17] experienced a relative delay of at least about a decade or more in reaching the peak citation year (**Figure 2**). Conversely, the remaining article by Nestle et al. [18] reached a peak number of citations relatively quickly, with 284 citations within three years of publication.

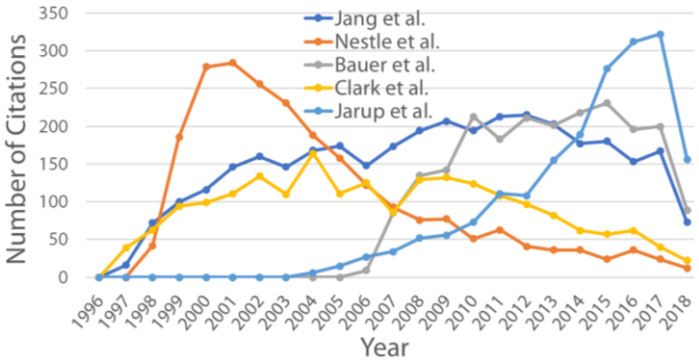

Figure 2. *The number of citations per year for the top 5 skin cancer publications.*

Journal

Table 3 displays the journals that published articles in the list of 100 most-cited articles. They are listed in the order from the highest to the lowest number of total publications. There were 48 journals represented, ranging in impact factors from 1.541 (*International Journal of Dermatology*) to 79.258 (*New England Journal of Medicine*). The journals with the largest number of articles on the list were the *Journal of the American Academy of Dermatology* and *Proceedings of the National Academy of Sciences of the United States of America*, each of which published 8 of the 100 articles. In the *Journal of the American Academy of Dermatology*, the 8 articles were published between 1993 and 2008 and had an average of 23.48 citations per year per article [8,19-25]. In the *Proceedings of the National Academy of Sciences of the United States of America*, the 8 articles were published between 1974 and 2006 and had an average of 22.74 citations per year per article [26-33]. The *New England Journal of Medicine* was the journal with the highest impact factor [34-39]. It ranked second based on the number of articles on the list of 100, accounting for 6 of the 100 most-cited articles. *Nature Reviews Drug Discovery* had the highest average citations per year per article with the one article published in this journal averaging 164.62 citations per year [15].

Figure 3 demonstrates the relationship between journal impact factor and the average number of citations per year that published articles in each particular journal received. A linear correlation was performed to evaluate the correlation between these two variables, and the following equation was obtained: y=-0.4116x+39.333 with a coefficient of determination (R^2) of 0.062. These results show that journal impact factor was not significantly related to the average number of citations per year that each of these publications received.

One-way ANOVAs revealed that there was no statistically significant difference when comparing average citations per year per article (P=0.208) or when comparing average total citations (P=0.667) between articles of different journals.

Author and country

Seven authors had more than one first-author publication on the list of 100 most cited articles (**Table 4**). Each of these authors either had two or three first-author publications. The most productive authors were Dr. Robert S. Stern and Dr. Frank de Gruijl, who both had three first-author articles and were included as an author on four studies in the 100 most-cited articles. Dr. Stern's four publications in the 100 most-cited articles received an average 14.12 citations per year per article and an average of 326.5 total citations [37,40-42]. Dr. de Gruijl's four publications in the 100 most-cited articles received an average 13.87 citations per year per article and an average of 304 total citations [43-46]. Dr. Joseph A. Baur published the article that received the most citations per year with 164.615 citations per year and 2,140 total citations [15]. ANOVAs revealed no statistically significant difference between each of

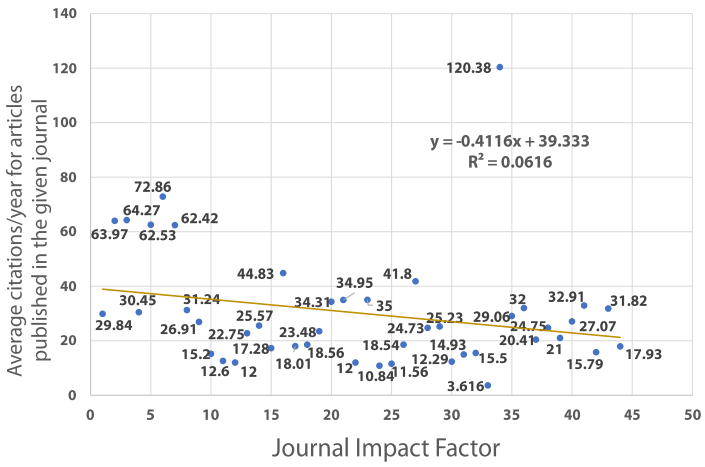

Figure 3. *Scatterplot displaying the relationship between journal impact factor and average citations/year. The line of best fit is shown.*

Table 4. *Most frequently published first authors and citation analysis.*

Author	First-Author Publications	Total Publications	Total Times Cited	Average Citations/ Article	Average Citations/Year/ /Article
Stern, RS	3	4	1306	326.5	14.12
de Gruijl, FR	3	4	1216	304.0	13.87
Green, A	2	2	794	397.0	24.25
Kraemer, KH	2	2	686	343.0	12.87
Masutani, C	2	2	1279	639.5	30.43
Tseng, WP	2	2	1145	527.5	12.28
Ziegler, A	2	2	1170	855.0	33.75

the 7 authors' publications when comparing average citations per year per article (P=0.139), as well as average total citations (P=0.086).

Analysis of the countries where the research was conducted revealed that researchers from the United States contributed the most articles, accounting for 50% of the publications followed by the Netherlands, England, Australia, Germany, France, and Japan (**Figure 4**). Other countries, which contributed fewer publications include Norway, Sweden, Switzerland, Taiwan, Austria, Canada, Denmark, Ireland, Italy, New Zealand, and Scotland.

Topic

In **Table 5**, the topics that were covered in the articles are listed in descending order based on the number of articles that discussed each topic. This is displayed graphically in **Figure 5**. Many of the publications discussed more than one topic, as is reflected in **Table 5**. The most common topic was molecular pathogenesis, which was the focus of 47 publications. Articles related to molecular pathogenesis had an average of 34.98 citations per year per article. Most of these articles were published in the 2000s. The topic that received the highest average citations per year per article was prevention with an average of 50.44 citations per year per article. This was followed by diagnosis with 47.32 citations per year per article and management with 41.37 citations per year per article. All three of these topics peaked in the 2000s. For all of the topics, the majority of articles were published in either 1990s or 2000s. The only exception was management, which had an equivalent number of publications in the 2000s and 2010s.

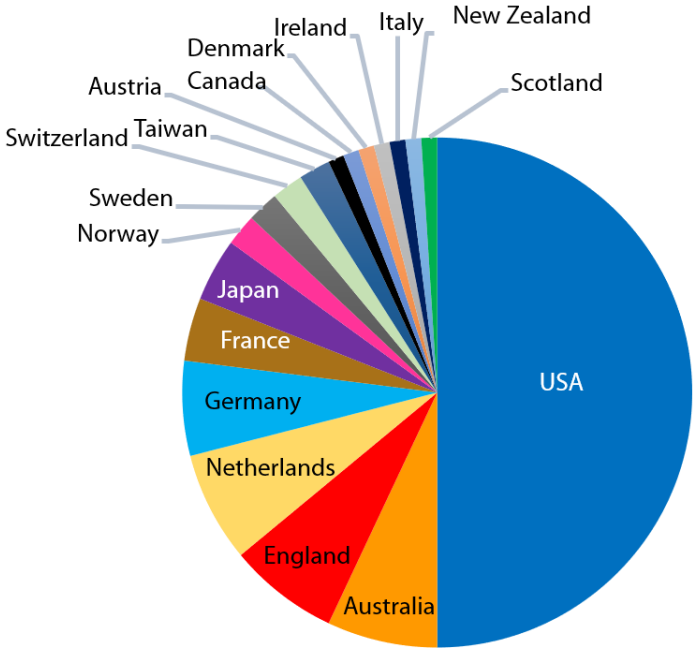

Figure 4. *Top 100 skin cancer articles by country.*

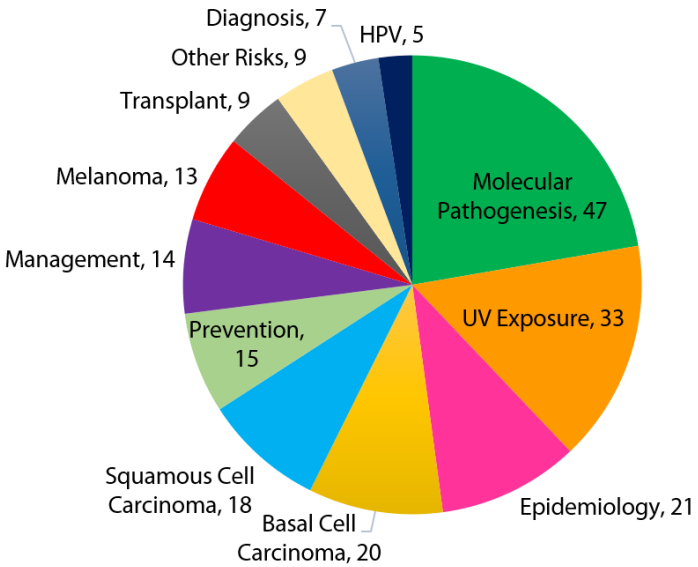

Figure 5. *Number of articles discussing each topic.*

Table 5. *Analysis by topic.*

Topic	Number of publications	Average citations/ year/article	Decade(s) with most publication
Molecular Pathogenesis	47	34.98	2000s
UV Exposure	33	23.14	1990s
Epidemiology	21	29.63	2000s
Basal Cell Carcinoma	20	26.39	1990s
Squamous Cell Carcinoma	18	33.13	1990s
Prevention	15	50.44	2000s
Management	14	41.37	2000s/2010s
Melanoma	13	34.97	2000s
Transplant	9	23.79	2000s
Other Risks	9	30.68	2000s
Diagnosis	7	47.32	2000s
HPV	5	26.54	1990s/2000s

Table 6. *Analysis by study design.*

Study Type	Number of publications	Average citations/ year/article	Decade(s) with most publication
Basic science	32	33.25	1990s
Narrative literature review	24	39.20	2000s
Cohort study	13	19.58	2000s
Controlled study	8	42.33	1990s
Incidence study	6	20.81	2000s
Systematic literature review	6	37.21	2000s
Case-control study	3	13.38	1990s
Clinical trial	3	44.00	1990s
Cross-sectional	2	41.40	1960s/2010s
Cost analysis	1	17.94	2000s
Guidelines	1	29.18	2000s
Theoretical analysis	1	19.84	1970s

Although many of the publications investigated skin cancer in general, some of the articles focused on one or two specific types of skin cancer. Thirteen articles studied melanoma, 20 articles studied squamous cell carcinoma, and 18 articles studied basal cell carcinoma. Additionally, many of the articles that discussed squamous cell carcinoma were the same articles that covered basal cell carcinoma. One-way ANOVAs showed no statistically significant difference when comparing the average total citations (P=0.520) or when comparing the average citations per year per article (P=0.163) between articles of different topics.

Study design

Table 6 lists the study designs of the articles in descending order. **Figure 6** displays this data graphically. The most common study design was basic science, with 32 articles in this category. The basic science articles had an average of 33.25 citations per year per article. There were 24 narrative literature reviews, making it the second most-common article type. The narrative literature reviews

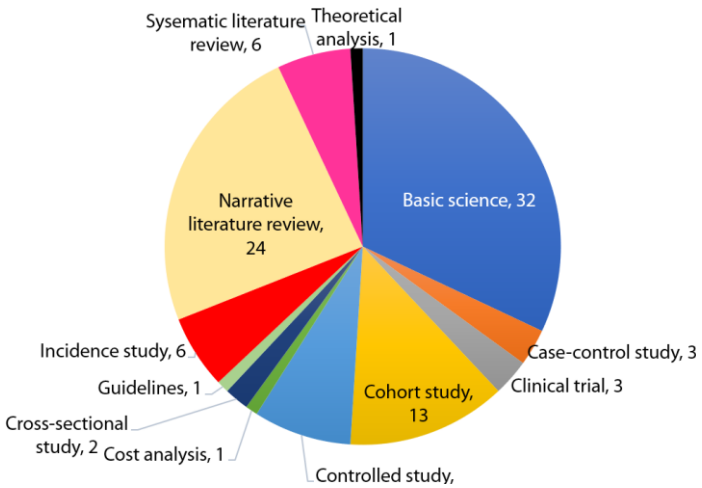

Figure 6. *Number of articles of each study type.*

had an average of 39.20 citations per year per article. Clinical trials had an average of 44.00 citations per year per article, which was the highest number of average citations. This was followed closely by controlled studies, which had an average of 42.33 citations per year per article. One-way ANOVA did not reveal statistically significant differences when comparing average total citations (P=0.833) or when comparing average citations per year per article (P=0.804) between articles of different study designs.

Figure 7 illustrates the distribution of article types published in each decade since the 1960s. Overall, the number of highly cited articles increased over time, peaking in the 2000s. Basic science articles, controlled studies, case-control studies, and clinical trials rose significantly in the 1990s. Narrative literature reviews, systematic literature reviews, incidence studies, and cohort studies rose significantly in the 2000s.

Discussion

Citation analysis is a well-established method for studying research trends in a particular area. Citation analyses have been performed on many subjects in a wide variety of medical and surgical fields, including oncology, neurosurgery, general surgery, and gastroenterology [47-50]. Dermatologic citation analyses in the past have been performed on psoriatic arthritis, toxic epidermal necrolysis and Stevens-Johnson syndrome, and melanoma [51-53]. However, to the best of our knowledge, no citation analysis has been performed for all skin cancers or cutaneous malignancies. We employed a two-stage selection process to ensure we captured all possible skin cancer-related topics in the study. We chose to analyze author, journal, topic, study design, and country of publication to provide a comprehensive analysis of article characteristics. This study was performed in hopes to provide insights on both past trends in skin cancer, as well as future directions for research.

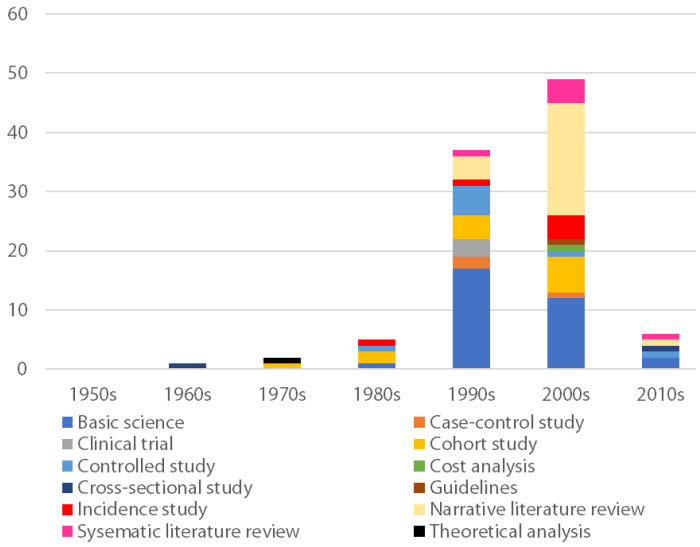

Figure 7. *The distribution of articles of each study type by decade.*

The focus and timing of these articles can be correlated with changes in awareness of skin cancer and clinical trends in prevention and management. Prior to 1988, there were a sparse number of highly cited publications on skin cancer. After this time, there was an increase in the number of highly cited articles. This correlates with the timing of increased public awareness about skin cancer, sun protection, and other preventative measures, that occurred in the 1980s and 1990s [54-56]. It is unclear whether the increased public awareness led to more influential research being performed or if the groundbreaking research led to the increased public awareness. However, there does seem to be a correlation between the trends. The increases in research and public awareness are also likely related to initiatives by dermatologists to raise awareness of skin cancer beginning in the 1980s [56]. When analyzing the 100 articles by topic, most topics had the majority of their publications in the 1990s and 2000s, as this was the time period where influential research about these topics was being performed. Management articles peaked later in the 2000s and 2010s. This likely reflects the incorporation of new therapeutic techniques more recently (e.g. immunotherapy) and increases in the number of skin cancer procedures being performed during this period [57,58].

The oldest article, titled "Prevalence of Skin Cancer in an Endemic Area of Chronic Arsenicism in Taiwan," was published in 1968 by Tseng et al. [5]. This study, performed in Taiwan, analyzed the prevalence of skin cancer and its relationship to arsenic exposure. They found that there was a dose-dependent relationship between arsenic exposure and

development of skin cancer. There have been many subsequent studies done on arsenic's relationship to skin cancer development and it is now a known risk factor for non-melanoma skin cancers [59].

The most recent article was "Dermatologist-Level Classification of Skin Cancer with Deep Neural Networks" by Esteva et al., which was published in *Nature* in 2017 [6]. Deep convolutional neural networks (CNNs) have the potential to be utilized as computer-based dermatologic diagnostic programs. In this study, a CNN was used to differentiate keratinocyte carcinomas from seborrheic keratoses and malignant melanomas from benign nevi. The performance and accuracy of the CNN was compared to board-certified dermatologists' classification of these images. They found that the CNN was equally effective as dermatologists in identifying the diagnoses. This study demonstrated a technological system that was effective at differentiating dermatologic conditions and has the potential to revolutionize diagnosis in dermatology. This innovative article was able to garner 298 citations in just one year.

The most-cited article in the area of skin cancer was "Cancer Chemopreventive Activity of Resveratrol, a Natural Product Derived from Grapes," which was published by Jang et al. in 1997 [4]. This article discusses a study in which resveratrol prevented tumorigenesis in a mouse skin cancer model. Resveratrol is used as a chemopreventive agent for various cancers. This was the first study which evaluated resveratrol's effect in skin cancer. This link prompted many further studies on the use of resveratrol in preventing skin cancer, including two other articles in the list of 100 most-cited articles, "Therapeutic Potential of Resveratrol: The In Vivo Evidence" and "Resveratrol: A Review of Preclinical Studies for Human Cancer Prevention" [15,60]. Based on many studies on resveratrol's mechanism and therapeutic potential, resveratrol has been incorporated as a topical skin cancer prevention agent.

The two journals with the highest number of articles of the 100 most-cited publications were *Journal of the American Academy of Dermatology* (*JAAD*) and *Proceedings of the National Academy of Sciences of the United States of America*, which both contributed 8 of the 100 most-cited articles. Impact factors ranged from 1.541 (*International Journal of Dermatology*) to 79.258 (*New England Journal of Medicine*). Interestingly, linear regression showed no relationship between journal impact factor and average citations per year for each article. This analysis indicates that although authors heavily consider the impact factor of the journal when choosing where to submit their research article, it may not have a significant influence on the impact of the publication as generally believed. Additionally, there may be merit in creating a dermatology journal-specific impact factor system. This would allow for better comparison of journals focusing on dermatology, as non-dermatology journals may have higher impact factors but may be less likely read or cited by dermatologists.

The two authors with the most publications were Dr. Robert S. Stern and Dr. Frank de Gruijl. They each had a total of four publications, three of which were first-author publications. Dr. Stern's four papers were published from 1988 to 2000. His most highly cited paper, titled "Malignant Melanoma in Patients Treated for Psoriasis with Methoxsalen (Psoralen) and Ultraviolet A Radiation (PUVA)," was published in 1997 [37]. Dr. de Gruijl's four articles were published from 1993 to 2001 and all studied ultraviolet radiation. His most highly cited publication was "Wavelength Dependence of Skin-Cancer Induction by Ultraviolet-Irradiation of Albino Hairless Mice," which was published in 1993 [43]. Dr. de Gruijl was from the Netherlands and Dr. Stern was from the United States. In general, the United States had the most publications, with 50% of the articles being from the U.S. Other major contributing countries included the Netherlands, England, Australia, and Germany.

The most common topic covered was molecular pathogenesis, with 47 of the 100 articles discussing this topic. Other common topics were related to increased susceptibility to skin cancer, including UV exposure, transplantation, HPV, epidemiology, and other risk factors. When looking at the average citations per year per article by topic, prevention had the highest average citations per year per article,

followed by diagnosis, and then management. The three most common types of skin cancer are basal cell carcinoma, squamous cell carcinoma, and melanoma. Although some of the articles discussed skin cancer in general, others focused on one or two specific types of skin cancer. There were more articles focusing on squamous cell and/or basal cell carcinoma than those focusing specifically on melanoma.

When analyzing study design, most articles fell into the category of basic science, followed by narrative literature reviews. The number of articles of each type of study design changed based on the decade of publication. This is most evident when comparing the types of studies in the 1990s and 2000s. The majority of publications in the 1990s were basic science, followed by controlled studies. In the 2000s, narrative reviews became the most predominant type of study design, followed by basic science articles. As many significant articles were published in the 1990s and earlier, there was more information to write narrative literature reviews about in the 2000s.

In addition to linear regression, one-way ANOVAs were performed to test differences in average citations per year per article and total number of citations based on journal, author, topic, and study design. No significant differences were found with the ANOVAs.

Although citation analysis is a commonly used research method, there are a few possible limitations. Although it is possible that articles that are most-cited have been most influential on the field, this may not be the case. There may be biased citations including self-citations, negative citations, incorrect citations, or failure to cite an influential work [61]. Despite these potential limitations, citation analysis is still an effective method to analyze previous research on a particular subject. Another limitation is the classification by topic, particularly the use of the term "Molecular Pathogenesis" as this term has changed its meaning over time and may be interpreted differently depending on the person.

Through this study, we found that historically, basic science and narrative literature reviews were the most-cited study designs, with common topics including molecular pathogenesis, UV exposure, and risk factors for skin cancer development. Prevention, diagnosis, and management were also frequently covered topics and each had a high number of average citations per year per article. Presumably, based on these findings, future skin cancer research articles with these characteristics will likely be highly cited and, thus, influential to skin cancer management in the field of dermatology.

Conclusion

To the best of our knowledge, this is the first citation analysis for skin cancer. Through this study, we hope to provide a greater understanding of previous skin cancer research trends and provide directions for future research.

Potential conflicts of interest

The authors declare no conflicts of interest.

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35. Alam M, Ratner D. Cutaneous squamous-cell carcinoma. *N Engl J Med.* 2001;344:975-983. [PMID: 11274625].
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59. Mayer JE, Goldman RH. Arsenic and skin cancer in the USA: the current evidence regarding arsenic-contaminated drinking water. *Int J Dermatol.* 2016;55:e585-e591. [PMID: 27420023].
60. Athar M, Back JH, Tang X, et al. Resveratrol: a review of preclinical studies for human cancer prevention. *Toxicol Appl Pharmacol.* 2007;224:274-283. [PMID: 17306316].
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Table 1. *Search terms used for second stage of literature search.*

Problem	Diagnosis	Management	Outcome	Natural History	Pathophysiology	Epidemiology
Melanoma	Sequence analysis	Melanoma vaccination	Response	Development	MEK inhibition	Incidence
Basal cell carcinoma	Digital transcriptome subtraction	Selenium supplementation	Regression	Risk	BRAF-mutated melanoma	Exposure
Squamous cell carcinoma	Skin tissues	Treatment	Survival	Stage IV	V600K BRAF	Occupation
Skin cancer	Gene expression profiling	BRAF inhibitor	Outcome	Unresectable	V600E BRAF	Epidemiology
Merkel cell carcinoma	Transcript analysis	Chemotherapy	Mortality	Stage III	Sunlight	Occupational
Cutaneous melanoma	Partial sequences	Trametinib	Metastasis	Invasive	UV	Endemic
Malignant melanoma	Gene analysis	Decarbazine	Cancer	Advanced stage	Mutations	Epidemic
Non-melanoma skin cancer	Genomic hybridization	Paclitaxel	Toxicity	Genetic change	Carcinogen	Rising
Uveal melanoma		Dabrafenib	Malignancy	Malignancy	p53	Trend
Lip SCC		Vaccination	Safety	Promotion stage	Double-base change	
Cutaneous SCC		Mage-3A peptide	Efficacy	Clonal expansion	Dypirimidine sites	
Langerhans cell histiocytosis		Imatinib	Adverse event	Papilloma	Substitutions	
		Sun protection	Metastatic lesions	Solar keratosis	Oncogenic	
		Photodynamic therapy	Intraepithelial neoplasias	Actinic keratosis	Polyoma	
		5-ala	Morbidity	Natural history	Infection	
		Surgical resection	Free of progression		Pathogenesis	
		Targeted drug therapy	Metastatic disease		MCV	
		MEK inhibition	Chemoresistance		DNA double-strand breaks	
		Combination therapy	Remission		Sunburn	
		Sunscreen application	Progression		Radiation	
		Beta-carotene supplementation	Recurrence		DNA damage	
		Prevention	Lethality		FAS (Apo-1/CD95 ligand)	
		Sorafenib	Death		T cell	
		Antioxidants			Apoptosis	
		Polyphenols			Viral genome	
		Vitamin C			HPV 16	

		Vitamin E			HPV 18	
		Methyl aminolevulinate			Light-exposed	
		EFGR inhibitor			Virus	
		ZD1839 therapy			Dendritic cells	
		Isotretinoin			Wavelengths	
		13-cis-retinoic acid			KIT	
		Interferon alpha 2A			Sun-induced damage	
		Nanoparticles			NRAS	
					MAP kinase	
					Solar radiation	
					Smoothened mutation	
					Patched gene	
					Arsenic	
					Mast cells	
					TNF alpha	
					Cancer associated fibroblasts	
					NF-kappa B	
					Xeroderma pigmentosum	
					DNA polymerase	
					UV damage	
					GNAQ mutation	
					GNA11 mutation	
					Trisomy	
					Loss of heterozygosity	
					Senescence	
					IGFBP7	
					RAC1 mutation	
					UV signature	
					Nucleotide excision repair	
					Sunlight sensitivity	
					Tanning	
					Immunosuppression	
					Photoproducts	
					Photocarcinogenesis	
					Kidney transplant	
					Azathioprine	

					Prednisolone	
					Environmental carcinogens	
					Hereditary defect	
					KRAS	
					Ozone depletion	
					TGF beta 1	
					Carcinogenesis	
					Tumor suppressor	
					UVB	
					Reactive oxygen species	
					DNA repair	
					RAS	
					UV-apoptosis	
					Sonic hedgehog	
					Gli1	
					Kidney-allograft recipient	
					Cyclosporine	
					Sun exposure	
					Beta-catenin	
					Renal transplant	
					H-RAS	
					Psoralen	
					PUVA	
					COX-2	
					PREX2 mutation	
					Cyclobutamine pyrimidine dimers	
					Akt3	
					PTEN	
					c-MYC	
					Lymphocytes	
					T control	
					Melanin	
					Collagenase	
					Integrin alpha V	
					Lymphangiogenesis	
					Chromium	
					HLA-G	

					Pigmentary factors	
					ERCC2	
					Pi class glutathione S-transferases	
					Hedgehog-gli signaling	

Table 2. *Top 100 skin cancer articles.*

Rank	Publication	Most Cited Year	Average Citations/Year since Publication	Number of citations in 2017	Total Number of Citations
1	Jang M, Cai L, Udeani GO, et al. Cancer chemopreventive activity of resveratrol, a natural product derived from grapes. *Science.* 1997;275:218-20. [PMID: 8985016].	2012	155.86	167	3429
2	Nestle FO, Alijagic S, Gilliet M, et al. Vaccination of melanoma patients with peptide- or tumor lysate-pulsed dendritic cells. *Nat Med.* 1998;4:328-32. [PMID: 9500607].	2001	110.76	24	2326
3	Baur JA, Sinclair DA. Therapeutic potential of resveratrol: the in vivo evidence. *Nat Rev Drug Discov.* 2006;5:493-506. [PMID: 16732220].	2015	164.62	200	2140
4	Clark LC, Combs GF, Jr., Turnbull BW, et al. Effects of selenium supplementation for cancer prevention in patients with carcinoma of the skin. A randomized controlled trial. Nutritional Prevention of Cancer Study Group. *JAMA.* 1996;276:1957-63. [PMID: 8971064].	2009	90.48	40	2081
5	Jarup L. Hazards of heavy metal contamination. *Br Med Bull.* 2003;68:167-82. [PMID: 14757716].	2017	120.38	322	1926
6	Brash DE, Rudolph JA, Simon JA, et al. A role for sunlight in skin cancer: UV-induced p53 mutations in squamous cell carcinoma. *Proc Natl Acad Sci U S A.* 1991;88:10124-8. [PMID: 1946433].	1996	52.32	28	1465
7	Feng H, Shuda M, Chang Y, Moore PS. Clonal integration of a polyomavirus in human Merkel cell carcinoma. *Science.* 2008;319:1096-100. [PMID: 18202256].	2013	132.55	124	1458
8	Ziegler A, Jonason AS, Leffell DJ, et al. Sunburn and p53 in the onset of skin cancer. *Nature.* 1994;372:773-6. [PMID: 7997263].	1997	45.04	20	1126
9	Hahne M, Rimoldi D, Schroter M, et al. Melanoma cell expression of Fas(Apo-1/CD95) ligand: implications for tumor immune escape. *Science.* 1996;274:1363-6. [PMID: 8910274].	1998	47.70	10	1097
10	zur Hausen H. Papillomavirus infections--a major cause of human cancers. *Biochim Biophys Acta.* 1996;1288:F55-78. [PMID: 8876633].	1999	44.83	20	1031
11	Masutani C, Kusumoto R, Yamada A, et al. The XPV (xeroderma pigmentosum variant) gene encodes human DNA polymerase eta. *Nature.* 1999;399:700-4. [PMID: 10385124].	2001	48.45	31	969
12	Setlow RB. The wavelengths in sunlight effective in producing skin cancer: a theoretical analysis. *Proc Natl Acad Sci U S A.* 1974;71:3363-6. [PMID: 4530308].	2000	19.84	12	893
13	Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. *J Photochem Photobiol B.* 2001;63:8-18. [PMID: 11684447].	2012	48.83	56	879
14	Euvrard S, Kanitakis J, Claudy A. Skin cancers after organ transplantation. *N Engl J Med.* 2003;348:1681-91. [PMID: 12711744].	2010	51.13	63	818
15	Peng Q, Warloe T, Berg K, et al. 5-Aminolevulinic acid-based photodynamic therapy. Clinical research and future challenges. *Cancer.* 1997;79:2282-308. [PMID: 9191516].	2006	34.95	21	769
16	Miller DL, Weinstock MA. Nonmelanoma skin cancer in the United States: incidence. *J Am Acad Dermatol.* 1994;30:774-8. [PMID: 8176018].	2005	29.16	24	729
17	Tseng WP, Chu HM, How SW, et al. Prevalence of skin cancer in an endemic area of chronic arsenicism in Taiwan. *J Natl Cancer Inst.* 1968;40:453-63. [PMID: 5644201].	2003	12.57	10	641
18	Rogers HW, Weinstock MA, Harris AR, et al. Incidence estimate of nonmelanoma skin cancer in the United States, 2006. *Arch Dermatol.* 2010;146:283-7. [PMID: 20231499].	2015	70.22	66	632
19	Diepgen TL, Mahler V. The epidemiology of skin cancer. *Br J Dermatol.* 2002;146 Suppl 61:1-6. [PMID: 11966724].	2013/ 2016	35.82	46	609

20	Johnson RE, Kondratick CM, Prakash S, Prakash L. hRAD30 mutations in the variant form of xeroderma pigmentosum. *Science*. 1999;285:263-5. [PMID: 10398605].	1999	29.40	17	588
21	Ziegler A, Leffell DJ, Kunala S, et al. Mutation hotspots due to sunlight in the p53 gene of nonmelanoma skin cancers. *Proc Natl Acad Sci U S A*. 1993;90:4216-20. [PMID: 8483937].	1997	22.46	3	584
22	Alam M, Ratner D. Cutaneous squamous-cell carcinoma. *N Engl J Med*. 2001;344:975-83. [PMID: 11274625].	2013/ 2016	31.94	47	575
23	Vajdic CM, McDonald SP, McCredie MR, et al. Cancer incidence before and after kidney transplantation. *JAMA*. 2006;296:2823-31. [PMID: 17179459].	2016	43.31	59	563
24	Soengas MS, Lowe SW. Apoptosis and melanoma chemoresistance. *Oncogene*. 2003;22:3138-51. [PMID: 12789290].	2011	34.31	26	549
25	Goodman MF. Error-prone repair DNA polymerases in prokaryotes and eukaryotes. *Annu Rev Biochem*. 2002;71:17-50. [PMID: 12045089].	2004	31.24	14	531
26	Green A, Williams G, Neale R, et al. Daily sunscreen application and betacarotene supplementation in prevention of basal-cell and squamous-cell carcinomas of the skin: a randomised controlled trial. *Lancet*. 1999;354:723-9. [PMID: 10475183].	2011/ 2012	26.50	18	530
27	Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. *Br J Dermatol*. 2012;166:1069-80. [PMID: 22251204].	2017	73.00	120	511
28	Krauthammer M, Kong Y, Ha BH, et al. Exome sequencing identifies recurrent somatic RAC1 mutations in melanoma. *Nat Genet*. 2012;44:1006-14. [PMID: 22842228].	2016	72.86	90	510
29	Matsumura Y, Ananthaswamy HN. Toxic effects of ultraviolet radiation on the skin. *Toxicol Appl Pharmacol*. 2004;195:298-308. [PMID: 15020192].	2015	33.60	40	504
30	Tseng WP. Effects and dose--response relationships of skin cancer and blackfoot disease with arsenic. *Environ Health Perspect*. 1977;19:109-19. [PMID: 908285].	2014	12.00	65	504
31	Jensen P, Hansen S, Moller B, et al. Skin cancer in kidney and heart transplant recipients and different long-term immunosuppressive therapy regimens. *J Am Acad Dermatol*. 1999;40:177-86. [PMID: 10025742].	2015	24.40	18	488
32	Friedberg EC. How nucleotide excision repair protects against cancer. *Nat Rev Cancer*. 2001;1:22-33. [PMID: 11900249].	2014	26.78	11	482
33	Thompson SC, Jolley D, Marks R. Reduction of solar keratoses by regular sunscreen use. *N Engl J Med*. 1993;329:1147-51. [PMID: 8377777].	1999	18.08	17	470
34	Ichihashi M, Ueda M, Budiyanto A, et al. UV-induced skin damage. *Toxicology*. 2003;189:21-39. [PMID: 12821280].	2016	29.06	39	465
35	Elwood JM, Jopson J. Melanoma and sun exposure: an overview of published studies. *Int J Cancer*. 1997;73:198-203. [PMID: 9335442].	2005/ 2011	20.18	8	444
36	Tsai JH, Donaher JL, Murphy DA, et al. Spatiotemporal regulation of epithelial-mesenchymal transition is essential for squamous cell carcinoma metastasis. *Cancer Cell*. 2012;22:725-36. [PMID: 23201165].	2015	62.43	90	437
37	Hartevelt MM, Bavinck JN, Kootte AM, et al. Incidence of skin cancer after renal transplantation in The Netherlands. *Transplantation*. 1990;49:506-9. [PMID: 2316011].	2010	14.93	16	433
38	Athar M, Back JH, Tang X, et al. Resveratrol: a review of preclinical studies for human cancer prevention. *Toxicol Appl Pharmacol*. 2007;224:274-83. [PMID: 17306316].	2015	35.67	28	428
39	Braathen LR, Szeimies RM, Basset-Seguin N, et al. Guidelines on the use of photodynamic therapy for nonmelanoma skin cancer: an	2009	35.17	25	422

	international consensus. International Society for Photodynamic Therapy in Dermatology, 2005. *J Am Acad Dermatol.* 2007;56:125-43. [PMID: 17190630].				
40	Stern RS, Nichols KT, Vakeva LH. Malignant melanoma in patients treated for psoriasis with methoxsalen (psoralen) and ultraviolet A radiation (PUVA). The PUVA Follow-Up Study. *N Engl J Med.* 1997;336:1041-5. [PMID: 9091799].	1999	18.95	9	417
41	Kraemer KH, DiGiovanna JJ, Moshell AN, et al. Prevention of skin cancer in xeroderma pigmentosum with the use of oral isotretinoin. *N Engl J Med.* 1988;318:1633-7. [PMID: 3287161].	1993/ 1994/ 1997	13.32	7	413
42	Buckman SY, Gresham A, Hale P, et al. COX-2 expression is induced by UVB exposure in human skin: implications for the development of skin cancer. *Carcinogenesis.* 1998;19:723-9. [PMID: 9635856].	2001/ 2004	18.33	13	385
43	Berg D, Otley CC. Skin cancer in organ transplant recipients: Epidemiology, pathogenesis, and management. *J Am Acad Dermatol.* 2002;47:1-17; quiz 8-20. [PMID: 12077575].	2010	22.35	22	380
44	Pfeifer GP, You YH, Besaratinia A. Mutations induced by ultraviolet light. *Mutat Res.* 2005;571:19-31. [PMID: 15748635].	2014	27.07	31	379
45	Stahl JM, Sharma A, Cheung M, et al. Deregulated Akt3 activity promotes development of malignant melanoma. *Cancer Res.* 2004;64:7002-10. [PMID: 15466193].	2012	24.93	16	374
46	Epstein EH. Basal cell carcinomas: attack of the hedgehog. *Nat Rev Cancer.* 2008;8:743-54. [PMID: 18813320].	2015	32.91	33	362
47	Brenner M, Hearing VJ. The protective role of melanin against UV damage in human skin. *Photochem Photobiol.* 2008;84:539-49. [PMID: 18435612].	2017	32.91	85	362
48	Rubin AI, Chen EH, Ratner D. Basal-cell carcinoma. *N Engl J Med.* 2005;353:2262-9. [PMID: 16306523].	2017	25.86	46	362
49	de Gruijl FR, Sterenborg HJ, Forbes PD, et al. Wavelength dependence of skin cancer induction by ultraviolet irradiation of albino hairless mice. *Cancer Res.* 1993;53:53-60. [PMID: 8416751].	1999	13.88	3	361
50	Yoshikawa T, Rae V, Bruins-Slot W, et al. Susceptibility to effects of UVB radiation on induction of contact hypersensitivity as a risk factor for skin cancer in humans. *J Invest Dermatol.* 1990;95:530-6. [PMID: 2230216].	1995	12.45	11	361
51	Fisher MS, Kripke ML. Suppressor T lymphocytes control the development of primary skin cancers in ultraviolet-irradiated mice. *Science.* 1982;216:1133-4. [PMID: 6210958].	1985	9.70	3	359
52	Patton EE, Widlund HR, Kutok JL, et al. BRAF mutations are sufficient to promote nevi formation and cooperate with p53 in the genesis of melanoma. *Curr Biol.* 2005;15:249-54. [PMID: 15694309].	2010/ 2011/ 2012	25.57	28	358
53	Lunn RM, Helzlsouer KJ, Parshad R, et al. XPD polymorphisms: effects on DNA repair proficiency. *Carcinogenesis.* 2000;21:551-5. [PMID: 10753184].	2005/ 2007	18.74	11	356
54	Pyke C, Ralfkiaer E, Huhtala P, et al. Localization of messenger RNA for Mr 72,000 and 92,000 type IV collagenases in human skin cancers by in situ hybridization. *Cancer Res.* 1992;52:1336-41. [PMID: 1310643].	1994	13.04	1	352
55	Glass AG, Hoover RN. The emerging epidemic of melanoma and squamous cell skin cancer. *JAMA.* 1989;262:2097-100. [PMID: 2795783].	1995/ 1996	11.73	3	352
56	Leiter U, Garbe C. Epidemiology of melanoma and nonmelanoma skin cancer--the role of sunlight. *Adv Exp Med Biol.* 2008;624:89-103. [PMID: 18348450].	2011	31.82	36	350
57	Woodward RM, Cole BE, Wallace VP, et al. Terahertz pulse imaging in reflection geometry of human skin cancer and skin tissue. *Phys Med Biol.* 2002;47:3853-63. [PMID: 12452577].	2011	20.41	37	347

58	Wei Q, Matanoski GM, Farmer ER, et al. DNA repair and aging in basal cell carcinoma: a molecular epidemiology study. *Proc Natl Acad Sci U S A.* 1993;90:1614-8. [PMID: 8434025].	1995	13.00	8	338
59	Heath M, Jaimes N, Lemos B, et al. Clinical characteristics of Merkel cell carcinoma at diagnosis in 195 patients: the AEIOU features. *J Am Acad Dermatol.* 2008;58:375-81. [PMID: 18280333].	2017	30.64	38	337
60	Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma: III. Family history, actinic damage and phenotypic factors. *Eur J Cancer.* 2005;41:2040-59. [PMID: 16125929].	2014	24.07	30	337
61	Brantsch KD, Meisner C, Schonfisch B, et al. Analysis of risk factors determining prognosis of cutaneous squamous-cell carcinoma: a prospective study. *Lancet Oncol.* 2008;9:713-20. [PMID: 18617440].	2017	30.45	50	335
62	Mouret S, Baudouin C, Charveron M, et al. Cyclobutane pyrimidine dimers are predominant DNA lesions in whole human skin exposed to UVA radiation. *Proc Natl Acad Sci U S A.* 2006;103:13765-70. [PMID: 16954188].	2015	25.38	23	330
63	Staples MP, Elwood M, Burton RC, et al. Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985. *Med J Aust.* 2006;184:6-10. [PMID: 16398622].	2010	25.23	28	328
64	Lindelof B, Sigurgeirsson B, Gabel H, Stern RS. Incidence of skin cancer in 5356 patients following organ transplantation. *Br J Dermatol.* 2000;143:513-9. [PMID: 10971322].	2010	17.11	21	325
65	Agar NS, Halliday GM, Barnetson RS, et al. The basal layer in human squamous tumors harbors more UVA than UVB fingerprint mutations: a role for UVA in human skin carcinogenesis. *Proc Natl Acad Sci U S A.* 2004;101:4954-9. [PMID: 15041750].	2008	21.53	16	323
66	Telfer NR, Colver GB, Morton CA, British Association of D. Guidelines for the management of basal cell carcinoma. *Br J Dermatol.* 2008;159:35-48. [PMID: 18593385].	2016	29.18	37	321
67	Jemal A, Devesa SS, Hartge P, Tucker MA. Recent trends in cutaneous melanoma incidence among whites in the United States. *J Natl Cancer Inst.* 2001;93:678-83. [PMID: 11333289].	2010	17.83	8	321
68	de Vries A, van Oostrom CT, Hofhuis FM, et al. Increased susceptibility to ultraviolet-B and carcinogens of mice lacking the DNA excision repair gene XPA. *Nature.* 1995;377:169-73. [PMID: 7675086].	1997	13.38	6	321
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97	de Gruijl FR. Skin cancer and solar UV radiation. *Eur J Cancer*. 1999;35:2003-9. [PMID: 10711242].	2015	13.05	15	261
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99	Barr BB, Benton EC, McLaren K, et al. Human papilloma virus infection and skin cancer in renal allograft recipients. *Lancet*. 1989;1:124-9. [PMID: 2563048].	1997	8.67	3	260
100	Moloney FJ, Comber H, O'Lorcain P, et al. A population-based study of skin cancer incidence and prevalence in renal transplant recipients. *Br J Dermatol*. 2006;154:498-504. [PMID: 16445782].	2010	19.92	25	259

Table 3. *Journal Statistics.*

Journal	Impact Factor	Number of Articles	Average citations/ year/article	Year of first publication	Year of most recent publication
Journal of the American Academy of Dermatology	6.898	8	23.48	1993	2008
Proceedings of the National Academy of Science	9.504	8	22.74	1974	2006
New England Journal of Medicine	79.258	6	26.55	1988	2005
Science	41.058	6	64.27	1982	2008
British Journal of Dermatology	6.129	5	35.01	2000	2012
JAMA	47.661	4	41.63	1989	2006
Lancet	53.254	4	21.54	1989	2010
Nature	41.577	4	63.97	1994	2017
Cancer Research	9.130	3	17.29	1992	2004
International Journal of Cancer	7.360	3	18.09	1995	2007
Journal of Investigative Dermatology	6.448	3	11.99	1988	2001
Archives of Dermatology	4.789	2	41.80	1995	2010
Cancer	6.537	2	23.26	1994	1997
Carcinogenesis	5.072	2	18.54	1998	2000
Embo Journal	10.557	2	12.60	1994	1994
European Journal of Cancer	7.191	2	18.56	1999	2005
Journal of Photochemistry and Photobiology B-Biology	3.165	2	32.00	2001	2001
Journal of the National Cancer Institute	13.757	2	15.20	1968	2001
Nature Medicine	32.621	2	62.53	1998	1999
Nature Reviews Cancer	42.784	2	29.84	2001	2008
Toxicology and Applied Pharmacology	3.616	2	34.63	2004	2007
Annual Review of Biochemistry	20.154	1	31.24	2002	2002
Biochemical and Biophysical Research Communications	2.559	1	21.00	2006	2006
Biochimica et Biophysica Acta-Reviews on Cancer	8.220	1	44.83	1996	1996
British Journal of Cancer	5.922	1	10.84	1994	1994
British Medical Bulletin	3.356	1	120.38	2003	2003
Cancer Cell	22.844	1	62.43	2012	2012
Cell Research	15.393	1	26.91	2008	2008
Current Biology	9.251	1	25.57	2005	2005
Environmental Health Perspectives	9.780	1	12.00	1977	1977
International Journal of Dermatology	1.541	1	17.93	2004	2004
Journal of Clinical Microbiology	4.054	1	12.29	1995	1995
Journal of Medical Virology	1.988	1	15.79	2000	2000
Lancet Oncology	36.418	1	30.45	2008	2008
Medical Journal of Australia	4.227	1	25.23	2006	2006
Molecular Carcinogenesis	3.851	1	15.50	1999	1999
Mutation Research-Fundamental and Molecular Mechanisms of Mutagenesis	2.398	1	27.07	2005	2005
Nature Genetics	27.125	1	72.85	2012	2012
Nature Reviews Drug Discovery	50.167	1	164.61	2006	2006
Oncogene	6.854	1	34.31	2003	2003
Photochemistry and Photobiology	2.214	1	32.91	2008	2008
Physics in Medicine and Biology	2.665	1	20.41	2002	2002
Plasma Chemistry and Plasma Processing	2.658	1	24.75	2007	2007
RNA	4.490	1	24.73	2008	2008
Sunlight, Vitamin D and Skin Cancer	1.760	1	31.81	2008	2008