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ARTICLE

Multidimensional indicators of scholarly impact in the skin oncology literature: is there a correlation between bibliometric and altmetric profiles?

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ABSTRACT

Introduction: Bibliometric and altmetric analyses are used to identify landmark publications in their respective research field. We hypothesised that highly cited skin oncology articles correlate positively with the Oxford Evidence Based Medicine scoring level, altmetric score (AS) and rank within the top 100 manuscripts.

Methods: Thomson Reuter's Web of Science citation indexing database was searched to identify all English-language skin oncology full-text articles in the last 75 years. The top 100 articles with the highest citation count were analysed by subject matter, publishing journal, author, year, institution, individual and five-year impact factor, AS and Oxford EBM level.

Results: 180,132 articles were identified. The most cited article (Hodi et al.) demonstrated improved survival with ipilimumab in patients with metastatic melanoma (7894 citations). The article with the highest AS was Esteva et al. (AS = 576.7, 'dermatologist-level classification of skin cancer with deep neural networks'). No difference was found between evidence level and citation count ($r = -0.1239$, $p = 0.2291$), but a significant difference was seen for AS ($r = -0.3024$, $p = 0.0028$). AS scores increased over time, whereas bibliometrics did not.

Conclusion: This work highlights the most influential work in the skin oncology field in the last 75 years. We have identified a differential relationship between commonly used metrics and evidence level in the field of skin oncology. As the digitalisation of research output and consumption increases, both bibliometric and altmetric analyses need to be considered when an article's impact is being assessed.

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Introduction

Bibliometric analysis is the traditional method by which statistical evaluation of research quality is undertaken. The term was first defined in 1969 by Pritchard et al. [1] and includes key measures such as journal impact factor and citation scores. It was developed at a time when published research was solely in written form, however the last two decades have seen a paradigm shift as bibliometrics have been adapted to age of the internet and vast online databases such as Web of Science, Scopus and PubMed etc. Contemporary bibliometric analyses have been used widely across multiple medical and surgical specialities to establish the influence of scholarly impact in the research community [2–9]. Conventional wisdom is now being questioned due to growing recognition that bibliometric analysis may not, in isolation, be the best method to establish the academic value of a paper [10]. Bibliometrics such as the citation score and number of citations take time to build and thus is thought to favour established papers and researchers [11].

The term altmetrics was first described in 2010 [12] and differs from bibliometrics in that it includes much greater article level data and incorporates citations, downloads, links and social media posts [13]. The altmetric score (AS) is primarily calculated from social media and research networks and is emerging as an additional resource alongside traditional bibliometric analysis that may better represent how research is viewed and consumed in the modern era. As such, altmetrics provide a complementary view, alongside bibliometrics, as to the value of a research article. This is exemplified by a bibliometric and altmetric analysis of the top 100 most citied papers across the whole of surgery, which showed AS's were significantly correlated with citation rate and number [14].

The National Institute for Health and Care Excellence (NICE) approval of systemic adjuvant immunotherapy for malignant melanoma, signal transduction inhibitors for BRAF V600 mutation-positive malignant melanoma, cemiplimab for treating metastatic and locally advanced cutaneous squamous cell carcinoma and avelumab for metastatic merkel cell carcinoma, representing a paradigm shift in the management of these conditions [15]. A previous solely bibliometric analysis of the malignant melanoma literature in 2014 highlighted many important scientific breakthroughs in this area of skin oncology research [16]. Since this article was published, the landscape of medical therapy in the treatment of both melanoma and non-melanomatous skin cancer has rapidly evolved. Since the advent of immunotherapy, no studies have assessed the most influential articles in the field of skin oncology and compared citation count or AS with level of evidence. The aim of this study was to investigate the relationship between these metrics and provide a contemporary overview of the studies of greatest clinical influence that have augmented our knowledge regarding the modern management of skin cancer.

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Methods

A search strategy was designed to capture all full-text articles relating to skin oncology (Table 1). The Thomson Reuters Web of Science citation indexing database was searched from 1945 to April 2020. Two independent researchers (SRA and RS) conducted the search simultaneously in order to ensure all eligible articles meeting the inclusion criteria were captured for analysis. Results were filtered to include full-text English language manuscripts only. Results were sorted by citation count as described previously by Paladugu et al. [17]. Studies were excluded if they did not specifically focus on skin cancer related research or were non-English. The 100 most cited skin cancer related articles were identified and reviewed by two authors (SRA and RS) who extracted data pertaining to: topic, author list, year of publication, country of origin and publishing journal. Every included journal had its individual and five-year impact factor recorded. We recognised that historical manuscripts would have the potential to accrue citations over a longer time period time in comparison to newer, more influential publications [18]. In an attempt to overcome this cofounding factor we calculated the citation rate index by dividing the number of citations by the number of years since publication [14,19]. The quality of evidence contained within the articles was assessed according to the Oxford Evidence Based Medicine (EBM) scoring system [20]. Altmetric scores were generated from altmetric.com (https://www.altmetric.com/products/free-tools/bookmarklet/). The correlation between citation count, citation rate index, altmetric score and Oxford EBM level was assessed using Spearman's correlation coefficient as a non-parametric measure of correlation. Statistical analysis was performed using GraphPad Prism 8.0 (La Jolla, California, United States of America). $p < 0.05$ was taken as significant.

Table 1. Search strategy.

	Source criteria	Results
1.	((TS="skin cancer*")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	19312
2.	((TS="skin neoplas*")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	1059
3.	((TS="basal cell carcinoma*")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	10127
4.	((TS= "basal cell epithelioma*")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	228
5.	((TS = basalioma*)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	57
6.	((TS=(melanoma OR nonmelanoma OR nonmelanoma OR melanocyt* OR nonmelanocyt* OR nonmelanocyt* OR keratinocyte*))) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	157830
7.	((TS = nmsc)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	967
8.	#7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1	172061
9.	(TS= (skin OR epiderm* OR cutaneous)) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	623132
10.	(TS= "squamous cell carcinoma*") AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)	91524
11.	#10 AND #9	15264
12.	#11 OR #8	180132

Date range used (5 years, 10 years): No date range.
Limits used (gender, article/study type, etc.): Top 150 citations, English language.

Results

Bibliometric analysis

A total of 180,132 full-length, English language papers were identified from the Thomson Reuters Web of Science database. Table 2 illustrates the 100 most cited skin cancer articles [21–120]. The vast majority of articles pertained to malignant melanoma ($n = 90$), followed by basal cell carcinoma ($n = 4$), pan-skin oncology ($n = 4$) and squamous cell carcinoma ($n = 2$). A wide range of citation counts were noted, ranging from 7894 by Hodi et al. [66] ('Improved Survival with Ipilimumab in Patients with Metastatic Melanoma') to 839 by Villanueva et al. [115] ('Acquired Resistance to BRAF Inhibitors Mediated by a RAF Kinase Switch in Melanoma Can Be Overcome by Cotargeting MEK and IGF-1R/PI3K'). The median citation count was 1548 [interquartile range (IQR) 960.75–1723], which was not normally distributed. Wolchok et al. [61] published the latest manuscript ('Overall Survival with Combined Nivolumab and Ipilimumab in Advanced Melanoma').

Table 2. The 100 most cited skin cancer articles.

Rank	Citation count	First author	Rank	Citation count	First author
1	7894	F. S. Hodi	51	1179	C. Robert
2	6601	H. Davies	52	1168	A. Ziegler
3	4804	P. B. Chapman	53	1168	E. A. Clark
4	3408	J. Larkin	54	1162	G. Q. Phan
5	2923	C. M. Balch	55	1151	M. E. Dudley
6	2717	P. Vanderbruggen	56	1123	P. M. Pollock
7	2695	C. Robert	57	1117	M. Hahne
8	2647	A. Kamb	58	1115	G. Bollag
9	2596	C. Robert	59	1106	M. A. Postow
10	2480	J. D. Wolchok	60	1090	C. Robert
11	2472	C. Robert	61	1084	C. J. Hussussian
12	2458	F. O. Nestle	62	1083	B. Rubinfeld
13	2442	K. T. Flaherty	63	1075	R. Straussman
14	2378	P. C. Tumeh	64	1069	S. A. Rosenberg
15	2205	K. T. Flaherty	65	1041	B. K. Armstrong
16	2119	O. Hamid	66	1022	L. M. Coussens
17	1980	P. Agostinis	67	1016	R. Akbani
18	1941	M. E. Dudley	68	1015	J. A. Curtin
19	1886	C. M. Balch	69	1000	B. Thurner
20	1880	A. Snyder	70	999	S. A. Rosenberg
21	1833	J. D. Wolchok	71	998	T. Schatton
22	1831	A. Breslow	72	981	C. M. Johannessen
23	1828	W. H. Clark	73	967	D. Fang
24	1804	A. Hauschild	74	963	L. A. Garraway
25	1730	A. Esteva	75	961	Y. Kawakami
26	1716	H. C. Feng	76	960	J. W. Xie
27	1671	S. A. Rosenberg	77	952	C. Twyman-Saint Victor
28	1659	H. Peinado	78	952	M. A. Curran
29	1657	J. A. Curtin	79	945	J. D. Wolchok
30	1657	R. A. Morgan	80	940	J. M. Zaretsky
31	1648	C. M. Balch	81	935	D. Schadendorf
32	1569	J. DeRisi	82	929	R. B. Setlow
33	1541	D. E. Brash	83	926	F. W. Huang
34	1512	J. M. Kirkwood	84	918	S. Horn
35	1489	S. A. Rosenberg	85	907	E. M. Van Allen
36	1478	M. Bittner	86	903	V. Brichard
37	1469	M. A. Postow	87	899	J. Tsai
38	1449	J. A. Sosman	88	894	C. Yee
39	1423	H. Hahn	89	894	J. E. Gershenwald
40	1404	C. Michaloglou	90	888	P. I. Poulikakos
41	1385	R. Nazarian	91	886	M. E. Dudley
42	1371	R. L. Johnson	92	877	M. R. Middleton
43	1332	E. Hodis	93	876	P. P. Lee
44	1303	J. S. Weber	94	875	W. H. Clark
45	1280	S. L. Topalian	95	866	G. J. Nabel
46	1264	M. B. Atkins	96	860	A. C. Allen
47	1235	D. L. Morton	97	858	A. E. Chang
48	1235	E. Quintana	98	853	G. V. Long
49	1207	J. M. Taube	99	845	R. H. I. Andtbacka
50	1202	A. J. Maniotis	100	839	J. Villanueva

Table 3. Journals with the top 100 cited skin cancer articles.

Journal	Impact factor 2018/19	5-year impact factor	Number of manuscripts in the top 100	Cumulative citation count
New England Journal of Medicine	70.67	70.331	22	48498
Nature	43.07	45.819	17	26479
Journal of Clinical Oncology	28.349	22.565	13	17116
Science	41.063	43.655	11	17000
Proceedings of the National Academy of Sciences of the United States of America	9.58	10.6	8	8204
Nature Medicine	30.641	34.848	4	6482
Cell	36.216	36.43	4	4793
Nature Genetics	25.455	31.077	3	3776
Clinical Cancer Research	8.911	9.174	2	2902
Lancet	59.102	54.664	2	2894

The oldest published manuscript in the top 100 was published in 1953 by Allen et al. [116] ('Malignant melanoma; a clinicopathological analysis of the criteria for diagnosis and prognosis'). The year with the most publications was 2015 ($n = 11$).

The top 100 articles were published across 21 journals (Table 3) with each journal publishing a range between 1 and 22 articles. The New England Journal of Medicine published the most articles ($n = 22$), resulting in a cumulative citation rate of 48,498, making it the journal with the highest overall cumulative citation rate. The journal with the highest individual impact factor and five-year impact factor was CA: A Cancer Journal for Clinicians (223.679 and 177.323 respectively). The median impact factor of journals was 40.515 (IQR 27.626–51.086). Journals with a very high impact factor (>30) included 62% of all published manuscripts within this bibliometric analysis. Only 4 articles were published in journals with an impact factor less than 5.

Articles within the 100 most cited list were geographically distributed over nine countries (Figure 1). The United States of America was the country that produced the highest number of papers that featured within the 100 most cited skin cancer manuscripts ($n = 79$), followed by France ($n = 5$) and Germany ($n = 4$). The National Institute of Health, Maryland, United States of America had the greatest number of published manuscripts ($n = 14$) followed by Howard Hughes Medical Institute, Maryland, United States of America ($n = 11$) (Table 4). One author (C. Robert) had five first author publications within the 100 most cited articles and one author had four first name publications (S. A. Rosenberg). One author (S. A. Rosenberg) was the senior author on seven publications within the 100 most cited articles and one author (A. Ribas) was the senior author on five publications.

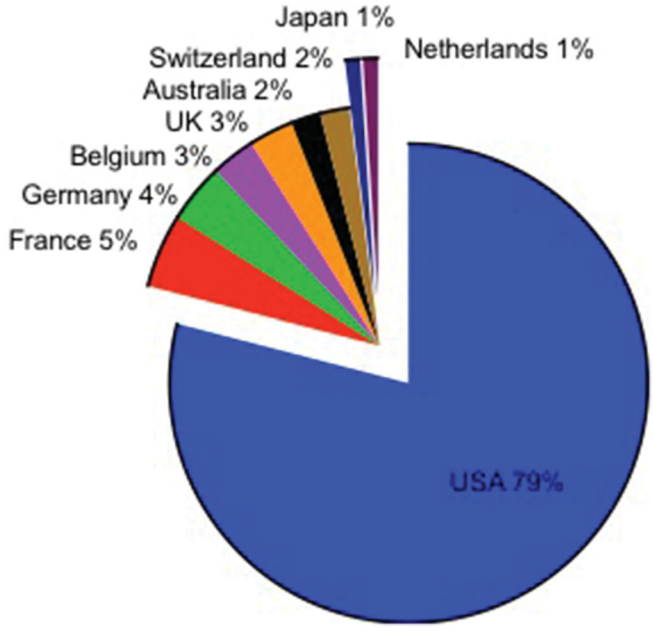

Figure 1. Geographical distribution of the 100 most cited skin cancer articles.

Citation rate index

The top 10 highest citation rate indices ranged from 789.4 by Hodi et al. [66] ('Improved Survival with Ipilimumab in Patients with Metastatic Melanoma') to 315.0 by Larkin et al. [61] ('Overall Survival with Combined Nivolumab and Ipilimumab in Advanced Melanoma') (Table 5).

Subject matter

Of the 100 most cited skin cancer articles, management ($n = 37$) was the most frequently discussed topic followed by pathophysiology ($n = 25$) and genetics ($n = 18$) (Table 6). Of management related articles, 12 discussed immunotherapy with check point inhibitors in malignant melanoma and six discussed signal transduction inhibitors in malignant melanoma. Articles published pre-1999 reported on: genetics ($n = 8$), management ($n = 8$) and pathophysiology ($n = 6$) of skin cancer. Whereas articles published post-2000, mostly discussed management ($n = 29$) of skin cancer.

Evidence levels and citation count

Twenty-one articles presented level 1 evidence, 4 level 2 evidence, zero level 3 evidence, 17 level 4 evidence, 54 level 5 evidence, and 4 were not scored as they were guidelines or consensus statements. There was no significant correlation between citation count and the Oxford EBM level ($r = -0.1239$, $p = 0.2291$). To investigate the impact of year on AS score and Oxford EBM level post-hoc multiple regression analysis was performed. Including both year and Oxford EBM level as independent variables gave the regression equation: citation count $= -8535 + 5.31$*year $-$ 149.69*Oxford EBM level. Year was not statistically significant ($p = 0.583$) but Oxford EBM level was ($p = 0.025$). The correlation of citation count with Oxford EBM level after adjusting for year was 0.245 ($p = 0.056$).

Evidence levels and altmetric score

There was a negative relationship between altmetric score and Oxford EBM level ($r = -0.3024$, $p = 0.0028$). Including both year and Oxford EBM level as independent variables gave the regression

Table 4. Institutions with the highest numbers of papers in the top 100.

Institution	Number of manuscripts in the top 100	Cumulative citation count
National Institute of Health, Maryland, USA	14	21620
Howard Hughes Medical Institute, Maryland, USA	11	8037
Memorial Sloan-Kettering Cancer Center, New York City, USA	7	15988
University of California, California, USA	7	9364
Harvard Medical School, Massachusetts, USA	6	7996
Gustave Roussy, Paris, France	4	7337
Johns Hopkins Medical Institution, Mayland, USA	4	7664
Dana-Farber Cancer Institute, Massachusetts, USA	3	9764
University of Pittsburgh, Pittsburgh, USA	2	3228
Ludwig Institute for Cancer Research, Oxford, UK	2	2783
Yale University School of Medicine, Connecticut, USA	2	2709
Plexxikon Incorporated, California, USA	2	2014
University of Pennsylvania, Pennsylvania, USA	2	1806

Table 5. The top 10 highest citation rate index skin cancer articles.

Rank	Citation rate index	First author	Senior author	Title	Institution
1	789.4	F. S. Hodi	W. J. Urba	Improved Survival with Ipilimumab in Patients with Metastatic Melanoma	Dana-Farber Cancer Institute, Massachusetts, USA
2	681.6	J. Larkin	J. D. Wolchok	Combined Nivolumab and Ipilimumab or Monotherapy in Untreated Melanoma	Memorial Sloan-Kettering Cancer Center, New York City, USA
3	576.7	A. Esteva	S. Thrun	Dermatologist-level classification of skin cancer with deep neural networks	Stanford University, California, USA
4	533.8	P. B. Chapman	B.-S. Grp	Improved Survival with Vemurafenib in Melanoma with BRAF V600E Mutation	Memorial Sloan-Kettering Cancer Center, New York City, USA
5	519.2	C. Robert	P. A. Ascierto	Nivolumab in Previously Untreated Melanoma without BRAF Mutation	Gustave Roussy, Paris, France
6	494.4	C. Robert	A. Ribas	Pembrolizumab versus Ipilimumab in Advanced Melanoma	Gustave Roussy, Paris, France
7	396.3	P. C. Tumeh	A. Ribas	PD-1 blockade induces responses by inhibiting adaptive immune resistance	University of California Los Angeles, California, USA
8	366.7	H. Davies	P. A. Futreal	Mutations of the BRAF gene in human cancer	The Wellcome Trust Sanger Institute, Hinxton, UK
9	354.3	J. D. Wolchok	M. Sznol	Nivolumab plus Ipilimumab in Advanced Melanoma	Memorial Sloan-Kettering Cancer Center, New York City, USA
10	315	J. D. Wolchok	J. Larkin	Overall Survival with Combined Nivolumab and Ipilimumab in Advanced Melanoma	Royal Marsden NHS Foundation Trust, London, UK and Swansea University, Swansea, UK

Table 6. Most referenced topics within the 100 most cited skin cancer articles*.

Classification	Count
Management	37
Pathophysiology	25
Genetics	18
Basic Science	8
Prognosis	7
Aetiology	1
Diagnosis	1
Epidemiology	1
Histology	1
Pathology	1

*Numerous manuscripts covered multiple topics therefore the cumulative total does not add up to 100.

equation: altmetric score $= -13668 + 6.95^{*}$year $- 39.16^{*}$ Oxford EBM level. Both coefficients were statistically significant ($p = 0.010$ and $p = 0.033$, respectively). The correlation of AS with Oxford EBM level after adjusting for year was 0.356 ($p = 0.002$). AS was weakly associated with journal impact factor but this was not significant ($r = 0.1297$, $p = 0.1983$). The median citation count received for each Oxford EBM level was: level 1 was 2064 (IQR 945–2509), level

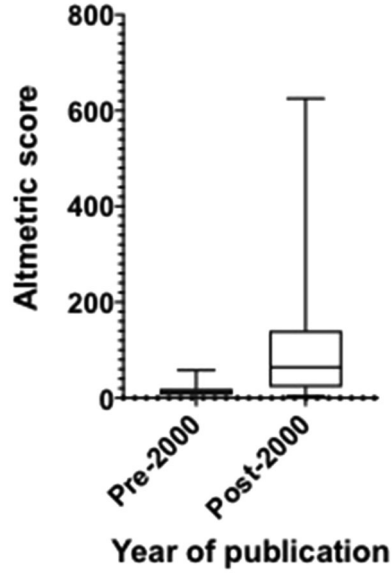

Figure 2. The distribution of altmetric scores in articles published pre- and post-2000. $p < 0.0001$, Mann–Whitney Test. The manuscript by Esteva et al. [78] was an outlier with an altmetric score of 2861. This was removed for graphical representation to make the distribution of altmetric scores clearer.

2 was 1243 (IQR 885–1191.5), level 4 was 1393 (IQR 1000–1504.5) and level 5 was 1314 (IQR 961–1465) (Figure 2).

Altmetric analysis

Altmetric scores ranged from 0 to 2861 (median 104.65) with 97 articles scoring ≥1.0. Esteva et al. was the article with the highest AS (Table 7). The United States of America had the most articles in the top 10 AS ($n = 8$), followed by France and the United Kingdom ($n = 1$). Management ($n = 8$) was the commonest topic in the top 10 AS, followed by diagnosis ($n = 1$) and genetics ($n = 1$). Articles published from the year 2000 onwards had a significantly higher AS ($p < 0.0001$) with a median of 67 (IQR 24–139), compared with a median of 13 (IQR 6.75–19) in articles published before 2000 (Figure 2). AS correlated with citation rate index ($r = 0.8195$, $p < 0.0001$) and total number of

Table 7. Top 10 articles with the highest altmetric score.

Rank	Altmetric score	First author	Senior author	Title	Institution
1	2861	A. Esteva	S. Thrun	Dermatologist-level classification of skin cancer with deep neural networks	Stanford University, California, USA
2	625	J. D. Wolchok	J. Larkin	Overall Survival with Combined Nivolumab and Ipilimumab in Advanced Melanoma	Royal Marsden NHS Foundation Trust, London, UK and Swansea University, Swansea, UK
3	503	R. H. I. Andtbacka	R. S. Coffin	Talimogene Laherparepvec Improves Durable Response Rate in Patients With Advanced Melanoma	Huntsman Cancer Institute, University of Utah, Utah, USA
4	355	J. M. Zaretsky	A. Ribas	Mutations Associated with Acquired Resistance to PD-1 Blockade in Melanoma	University of California, California, USA
5	325	J. D. Wolchok	M. Sznol	Nivolumab plus Ipilimumab in Advanced Melanoma	Memorial Sloan-Kettering Cancer Center, New York City, USA
6	300	O. Hamid	A. Ribas	Safety and Tumor Responses with Lambrolizumab (Anti-PD-1) in Melanoma	Angeles Clinic and Research Institute, California, USA
7	281	F. S. Hodi	W. J. Urba	Improved Survival with Ipilimumab in Patients with Metastatic Melanoma	Dana-Farber Cancer Institute, Massachusetts, USA
8	272	C. Robert	A. Ribas	Pembrolizumab versus Ipilimumab in Advanced Melanoma	Gustave Roussy, Paris, France
9	245	M. A. Postow	F. S. Hodi	Nivolumab and Ipilimumab versus Ipilimumab in Untreated Melanoma	Memorial Sloan-Kettering Cancer Center, New York City, USA
10	208	J. A. Sosman	A. Ribas	Survival in BRAF V600-Mutant Advanced Melanoma Treated with Vemurafenib	Vanderbilt-Ingram Cancer Center, Tennessee, USA

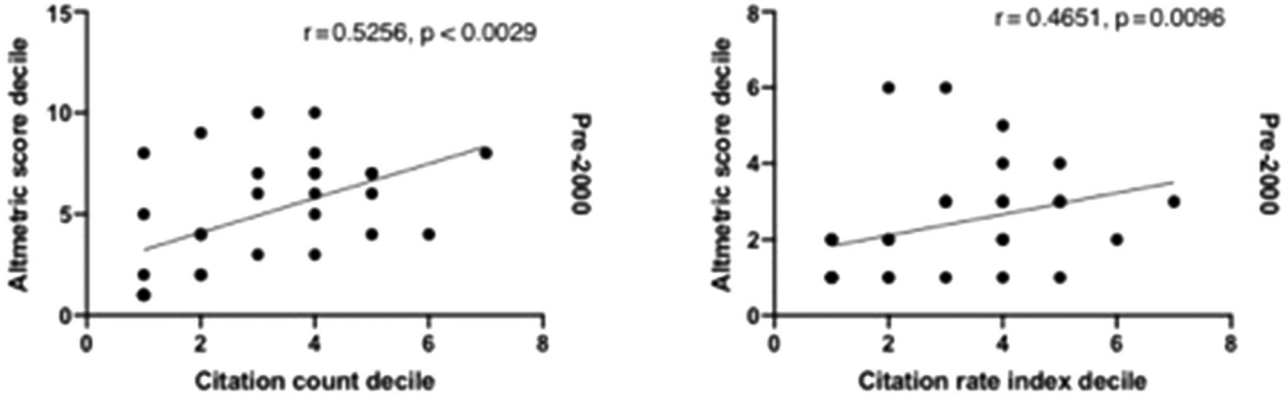

Figure 3. The relationship between altmetric score, number of citations and citation rate index post-2000 publication.

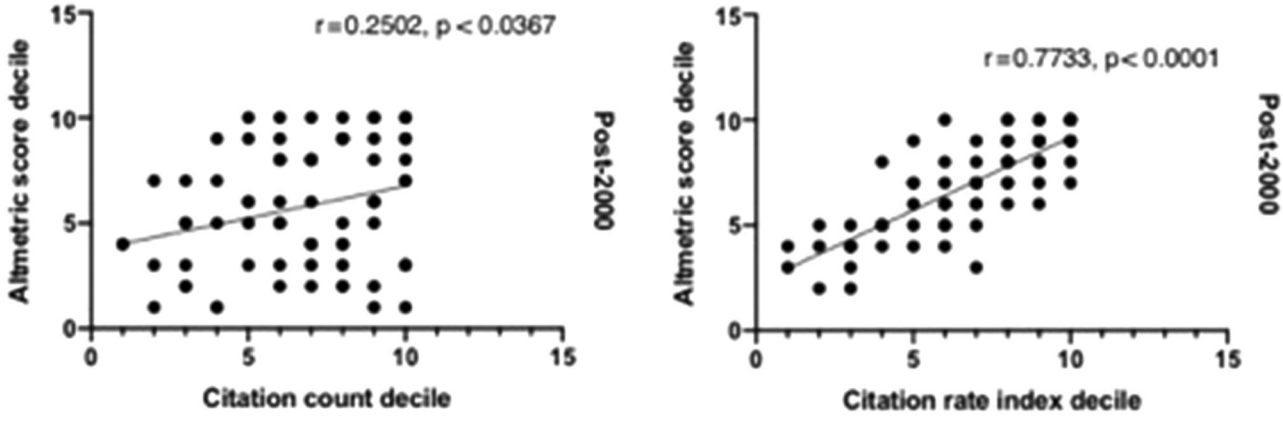

Figure 4. The relationship between altmetric score, number of citations and citation rate index pre-2000 publication.

citations ($r = 0.3248$, $p = 0.0010$). In articles published after 2000 (Figure 3) AS was associated with number of citations ($r = 0.2502$, $p < 0.0367$), and citation rate index ($r = 0.7733$, $p < 0.0001$). This correlation was also evident in articles published before 2000 (Figure 4) for number of citations ($r = 0.5256$, $p < 0.0029$) and for citation rate index ($r = 0.4651$, $p = 0.0096$). Twenty articles appeared in both the top 40 for citations and AS.

Discussion

This study identifies the 100 most influential manuscripts in skin oncology in the last 75 years. As expected, malignant melanoma was the most commonly cited tumour. Over time we have shown how research activity has shifted from genetics and pathophysiology to management as we have learned more about cancer biology and have seen the treatment options broaden. Translation of research with the addition of immunotherapy and signal transduction inhibitors to clinical practise in the last decade has revolutionised the management of malignant melanoma. This is reflected in this analysis with 2015 being the year of greatest citations, corresponding to the advent and clinical introduction of adjuvant treatment. Despite surgery remaining the primary treatment modality in non-metastatic malignant melanoma and a number of trials investigating the greatly debated topic of appropriate surgical margins [121,122], it is of interest that no papers concerning this made it into our top 100 analysis.

Bibliometrics were unrelated to evidence level on correlation analysis. Conversely, altmetrics correlated negatively with the level of evidence. Altmetric scores increased over time but bibliometrics did not. A change in research consumption with the rising popularity of altmetrics since the term was first proposed in 2010, is the likely explanation for this [12]. Social media usage within the dermatological research community has risen in recent years. A 2012 study of 102 dermatology journals listed on SCImago Journal and Country Rank portal showed that 12.7% were present on Facebook and 13.7% on Twitter [123]. The authors repeated this survey in 2018 and demonstrated an increase in usage with 17.7% of dermatology journals active on Facebook and 16.9% on Twitter [124]. 3.8 billion people worldwide are social media users and as mainstream social media platforms continue to rise in popularity, so do academic social networking sites for scientists and researchers [125]. With a reported 15 million users, ResearchGate is the largest academic social network and has been described as the 'Facebook for science'. Traditional metrics may therefore no longer represent true viewing figures and impact of research articles. While citation rates, journal rankings and views are not in themselves a complete marker of a good quality study they do provide a considerable indication to such. Social media not only has a vast reach, but platforms like Twitter are specifically designed to facilitate easy information sharing through the application of 'hashtags' and 'follow recommendations'. As a result, research posted on social media will have a broader circulation than traditional journals and will also be incredibly easy to discover and access for anyone with an interest in the field. In the field of digital marketing, professionals are wary to place too much importance on traditional 'engagement metrics' such as likes, comments and shares in-platform (often referred to as vanity metrics) as these can vary due to factors such as seasonality, time of day, post length, external events, post format, regularity of posting and of course subjective preferences of the user [126]. More importantly, engagement rates do not reliably correlate to return on investment so astute media professionals are realistic when analysing social media engagement data [127]. If this applies to the digital marketing world then the same principle could be attributed to altmetrics when taking into account their impact versus traditional metrics. For researchers and clinicians, it is important to understand and be aware of the landmark studies, both to ensure that patients are receiving the best and most up to date care, as well as to identify areas of weakness requiring further or more detailed research. While the traditional 'big' journals will continue to play an important role, open access is becoming more important in the dissemination of information. In their study of the scientific impact of open access versus subscription journals, Björk et al. [128] report the proportion of open access versus subscription journals in Web of Science and Scopus data as 8% and 12% respectively.

Limitations of any bibliometric analysis include institutional, language, self-citation and powerful person bias. We recognise that older articles will by their nature have a higher citation count and the citation rate index was designed to address this potential confounder in the design of this study. Only the first and last authors were analysed and this has likely underestimated author contribution. Similarly, only the institution of the first author was noted in the author analysis.

Conclusion

This is the first study of its kind to provide a bibliometric and altmetric analysis of the skin oncology literature. We demonstrate what it takes for an article to make the greatest impact in the modern management of skin cancer and highlight the differential relationship bibliometric and altmetric analyses have with evidence level. The most cited malignancy was malignant melanoma with the two most cited topics being management and pathophysiology. This study serves as a point of reference to the most influential manuscripts in the skin cancer literature and demonstrates the differential impact between bibliometrics and the emerging field of almetrics in this field.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Authors' contributions

All listed authors contributed to; 1) conception and design, acquisition of data, analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; 3) final approval of the version to be published; 4) agreement to be accountable for all aspects of the work.

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