“Researching the Research” in Prostate Cancer: A Comparative Bibliometric Analysis of the Top 100 Cited Articles in the Field of Prostate Cancer

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Key Words

Prostate cancer • Research • Bibliometric analysis • Top100 cited • Citation index • Institutions

impact factor journals, in English medium and content related to PCa research associated with genetics/bio-markers have the highest citation potential.

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Abstract

Background: To perform the first comparative bibliometric analysis of the “Top 100 (T100) cited articles in prostate cancer (PCa)”. **Materials and Methods:** A comprehensive search using the Web of Science Database (v 5.21) covering the Web of Science™ Core Collection, BIOSIS Previews, Central Contents Connect, KCI-Korean Journal Database, MEDLINE, SciELO Index (February 2016) was performed, for all articles relevant to PCa. **Results:** The T100 were cited 582 to 3,387 times, and were published from 1966 to 2012. The top 3 subcategories associated with PCa included: genetics/biomarkers (n = 34), management (n = 25), and physiology (n = 11). T100 contributions from USA (n = 86), were most prominent. If the regional citation was corrected for percentage on research (citation record/percentage gross domestic product on research) a variation in the ranking was noted. **Conclusion:** The first bibliometric analysis in the field of PCa is presented. Regions that predominate the T100, include the United States and Europe. Articles published in higher

Introduction

Prostate cancer (PCa) is among the most prevalent cancers worldwide and is the third most common cause of cancer-associated mortality in men [1]. The recent worldwide PCa incidence of newly diagnosed cases has been estimated at 7.9% of all cancers [2]. Due to its prevalence and the significant burden of diagnosis and treatment, research within PCa has always been a topical and high impact focus region within the contemporary medical literature.

Within medical literature, the number of citations that a published article achieves has been traditionally used to evaluate its intellectual impact it has on research within that topic or specific research focus. Despite the controversies associated with the Citation Index (CI) and the

resulting Journal Impact Factor (IF), it is still a globally recognised parameter in the evaluation of academic research, or intellectual influence within any field [3].

To provide us with an understanding of “prostate cancer” research associated focus areas, the first ever bibliometric analysis in this research topic is performed. Information of the areas of greatest citation potential, regions performing high impact research, centers and authors responsible, journal platforms utilised were thus ascertained. Further, an independent rank of all relevant publications, including a comprehensive literature-wide CI-rating was to be performed within the field of PCa.

Therefore, we aimed to perform the first comprehensive, comparative bibliometric analysis of the “Top 100 most cited articles in the field of PCa” (T100).

Materials and Methods

Search Strategy

To identify the most cited articles in the field of “prostate cancer”, a comprehensive search was performed using the Web of Science Database (v.5.21) (January 1, 1945 to February 2, 2016); covering the Web of Science™ Core Collection, BIOSIS Previews, Central Contents connect, KCI-Korean Journal Database, MEDLINE, SciELO Citation Index, Russian Science Citation and the Chinese Science Citation Database. Search keywords utilized included: prostate/prostatic cancer, prostate/prostatic carcinoma, prostate/prostatic neoplasm/s, and prostate/prostatic adenocarcinoma.

Restriction was not performed to “urology and nephrology” journals only, since other journals may have highly cited research that may fall outside this journal sub-category, but may still be related to PCa research. No language restrictions were applied.

Citation and Publication Data

Following the comprehensive search strategy performed on Web of Science Databases, the resulting outcome was sorted by “Times cited – highest to lowest”. The highest 100 ranked articles were recorded. Data including publication year, journal of publication, authors, affiliated institutions, country of origin and citation data were extracted for analysis.

“Publication year” was determined as per indexing on the Web of Science Database. Journal IF data was obtained from the Journal of Citation Reports [4]. The “primary author” was determined as the first author on the respective publication. In the case of co-authorship, the first listed author was determined as the primary author. “Country of origin” was based on the territory or country of the author affiliation as listed within the publication. “Affiliated institutions” were based on the institutions listed within the publication. In the setting of multi-institutional studies, each institution was counted individually. Ranking of respective institutions were based on the Shanghai Academic Ranking of World Universities (ARWU), Leiden and Quacquarelli Symonds (QS) World Ranking, as ranked on July 25, 2016 [5–7].

Citation data was obtained as calculated by Web of Science Databases. To adjust for the “exposure time” of articles published

prior to 2016, an Adjusted Citation Index (ACI), used in prior bibliometric analysis [8], was also calculated, using the equation: $ACI = \text{Number of citations} / (\text{2016 Year of publication})$.

To adjust for the “expenditure” on research, the ranking was adjusted by percentage of gross domestic product (GDP) on research per country. GDP data was obtained from the World Bank data [9]. To perform this adjustment, the following equation from a previous publication [10], was utilized: $\text{Corrected score for percentage GDP on research} = \text{Citation record} / \text{percentage GDP on research}$.

Results

ACI

The T100 are listed in table 1. These articles were cited 582 to 3,387 times, with a median citation rate of 853. Articles featuring in the T100 were all published from 1966 to 2012.

Recalculation using the ACI resulted in a drastic change of the overall ranking, with the previously seventh ranked most cited paper [11], ranking highest (table 1). Further, the initially ranked sixty-ninth paper [12], after applying the ACI, was ranked last of the T100 at 100.

Journals

General medical or oncology journals dominated the top positions within this category (table 2). *The New England Journal of Medicine* had published most of the T100 publications ($n = 21$). It also had the highest IF from the list of Journals assessed. Among the “nephrology and urology” journal category, *The Journal of Urology* had the most publications ($n = 5$), followed by *European Urology* ($n = 2$).

Country of Origin versus GDP% on Research, Adjusted Score, and Adjusted Rank

When reviewing the geographic origin of the T100, contributions from USA ($n = 86$), Canada ($n = 16$) and United Kingdom ($n = 15$) were most prominent. The corresponding record count is tabulated in table 3 (countries where 2 or more papers of the T100 originated), and the corresponding figure 1.

In ranking various countries research output, the correcting formula for percentage spent on GDP was utilised [10]. Despite this adjustment, USA still featured most prominently in the T100.

Article Category and Type

A further breakdown of the T100, into the research associated categories based on the “Main content” category and the listed “Web of Science category” was as-

Table 1. The T100 cited articles in PCa

Rank	Cites	Journal article title	Adjusted CI	Adjusted rank
1	3,387	Li J, et al: PTEN, a putative protein tyrosine phosphatase gene mutated in human brain, breast, and prostate cancer. <i>Science</i> 1997;275:1943–1947.	178.26	7
2	2,638	Tannock IF, et al: Docetaxel plus prednisone or mitoxantrone plus prednisone for advanced prostate cancer. <i>N Engl J Med</i> 2004;351:1502–1512.	219.83	5
3	1,967	Petrylak DP, et al: Docetaxel and estramustine compared with mitoxantrone and prednisone for advanced refractory prostate cancer. <i>N Engl J Med</i> 2004;351:1513–1520.	163.92	8
4	1,910	Schroeder FH, et al: Screening and prostate cancer mortality in a randomized European study. <i>N Engl J Med</i> 2009;360:1320–1328.	272.86	2
5	1,828	D'Amico AV, et al: Biochemical outcome after radical prostatectomy, external beam radiation therapy, or interstitial radiation therapy for clinically localized prostate cancer. <i>JAMA</i> 1998;280:969–974.	101.56	19
6	1,801	Tomkins SA, et al: Recurrent fusion of TMPRSS2 and ETS transcription factor genes in prostate cancer. <i>Science</i> 2005;310:644–648.	163.73	9
7	1,726	Kantoff PW, et al: Sipuleucel-T immunotherapy for castration-resistant prostate cancer. <i>N Engl J Med</i> 2010;363:411–422.	287.67	1
8	1,697	Stamey TA, et al: Prostate-specific antigen as a serum marker for adenocarcinoma of the prostate. <i>N Engl J Med</i> 1987;317:909–916.	58.52	48
9	1,585	Collins AT, et al: Prospective identification of tumorigenic prostate cancer stem cells. <i>Cancer Res</i> 2005;65:10946–10951.	144.09	13
10	1,492	Catalona WJ, et al: Measurement of prostatic-specific antigen in serum as a screening test for prostate cancer. <i>N Engl J Med</i> 1991;324:1156–1161.	59.68	45
11	1,480	Chan JM, et al: Plasma insulin-like growth factor I and prostate cancer risk: a prospective study. <i>Science</i> 1998;279:563–566.	82.22	30
12	1,450	Thompson IM, et al: The influence of finasteride on the development of prostate cancer. <i>N Engl J Med</i> 2003;349:215–224.	111.54	18
13	1,407	Andriole GL, et al: Mortality results from a randomized prostate cancer screening trial. <i>N Engl J Med</i> 2009;360:1310–1319.	201	6
14	1,405	Gleason DF, et al: Prediction of prognosis for prostatic adenocarcinoma by combined histological grading and clinical staging. <i>J Urol</i> 1974;111:58–64.	33.45	86
15	1,361	Horoszewicz JS, et al: LNCaP model of human prostatic carcinoma. <i>Cancer Res</i> 1983;43:1809–1818.	41.24	73
16	1,352	Kaighn ME, et al: Establishment and characterization of a human prostatic carcinoma cell line (PC-3). <i>Invest Urol</i> 1979;17:16–23.	36.54	80
17	1,327	Feldman BJ, et al: The development of androgen-independent prostate cancer. <i>Nat Rev Cancer</i> 2001;1:34–45.	88.47	27
18	1,310	Varambally S, et al: The polycomb group protein EZH2 is involved in progression of prostate cancer. <i>Nature</i> 2002;419:624–629.	93.57	22
19	1,300	Weidner N, et al: Tumor angiogenesis correlates with metastasis in invasive prostate carcinoma. <i>Am J Pathol</i> 1993;143:401–409.	56.52	52
20	1,282	Partin AW, et al: Combination of prostate-specific antigen, clinical stage, and gleason score to predict pathological stage of localized prostate cancer – A multi-institutional update. <i>JAMA</i> 1997;277:1445–1451.	67.47	37
21	1,240	Singh D, et al: Gene expression correlates of clinical prostate cancer behaviour. <i>Cancer Cell</i> 2002;1:203–209.	88.57	26
22	1,183	Thompson IM, et al: Prevalence of prostate cancer among men with a prostate-specific antigen level <= 4.0 ng per milliliter. <i>N Engl J Med</i> 2004;350:2239–2246.	98.58	21
23	1,178	De Bono JS, et al: Abiraterone and increased survival in metastatic prostate cancer. <i>N Engl J Med</i> 2011;364:1995–2005.	235.6	3
24	1,169	Dhanasekaran SM, et al: Delineation of prognostic biomarkers in prostate cancer. <i>Nature</i> 2001;412:822–826.	77.93	32
25	1,162	Crawford ED, et al: A controlled trial of leuprolide with and without flutamide in prostatic carcinoma. <i>N Engl J Med</i> 1989;321:419–424.	43.04	66
26	1,097	Harisinghani MG, et al: Noninvasive detection of clinically occult lymph-node metastases in prostate cancer. <i>N Engl J Med</i> 2003;348:2491–2495.	84.38	29
27	1,093	Epstein JI, et al: Pathological and clinical findings to predict tumor extent of nonpalpable (stage T1c) prostate cancer. <i>JAMA</i> 1994;271:368–374.	49.68	58
28	1,083	Bolla M, et al: Long-term results with immediate androgen suppression and external irradiation in patients with locally advanced prostate cancer (an EORTC study): a phase III randomised trial. <i>Lancet</i> 2002;360:103–108.	77.36	34
29	1,082	Tannock IF, et al: Chemotherapy with mitoxantrone plus prednisone or prednisone alone for symptomatic hormone-resistant prostate cancer: a Canadian randomized trial with palliative end points. <i>J Clin Oncol</i> 1996;14:1756–1764.	54.1	55
30	1,068	Bolla M, et al: Improved survival in patients with locally advanced prostate cancer treated with radiotherapy and goserelin. <i>N Engl J Med</i> 1997;337:295–300.	56.21	53
31	1,045	Zhong H, et al: Modulation of hypoxia-inducible factor 1 alpha expression by the epidermal growth factor/phosphatidylinositol 3-kinase/PTEN/AKT/FRAP pathway in human prostate cancer cells: Implications for tumor angiogenesis and therapeutics. <i>Cancer Res</i> 2000;60:1541–1545.	65.31	38
32	1,030	Oesterling JE: Prostate specific antigen: a critical assessment of the most useful tumor markers for adenocarcinoma of the prostate. <i>J Urol</i> 1991;145:907–923.	41.2	74
33	978	McDonnell TJ, et al: Expression of the protooncogene bcl-2 in the prostate and its association with emergence of androgen-independent prostate cancer. <i>Cancer Res</i> 1992;52:6940–6944.	40.75	75
34	960	Taylor BS, et al: Integrative genomic profiling of human prostate cancer. <i>Cancer Cell</i> 2010;18:11–22.	160	10
35	959	Epstein JI, et al: The 2005 International Society of Urological Pathology (ISUP) consensus conference on Gleason grading of prostatic carcinoma. <i>Am J Surg Pathol</i> 2005;29:1228–1242.	87.18	28
36	954	Catalona WJ, et al: Comparison of digital rectal examination and serum prostate specific antigen in the early detection of prostate cancer: results of a multicenter clinical trial of 6,630 men. <i>J Urol</i> 1994;151:1283–1290.	43.36	64
37	925	Sanda MG, et al: Quality of life and satisfaction with outcome among prostate-cancer survivors. <i>N Engl J Med</i> 2008;358:1250–1261.	115.63	17
38	921	de Bono JS, et al: Prednisone plus cabazitaxel or mitoxantrone for metastatic castration-resistant prostate cancer progressing after docetaxel treatment: a randomised open-label trial. <i>Lancet</i> 2010;376:1147–1154.	153.5	11
39	918	Roach M, et al: Defining biochemical failure following radiotherapy with or without hormonal therapy in men with clinically localized prostate cancer: Recommendations of the RTOG-ASTRO Phoenix Consensus Conference. <i>Int J Radiat Oncol Biol Phys</i> 2006;65:965–974.	91.8	25
40	903	Sreekumar A, et al: Metabolomic profiles delineate potential role for sarcosine in prostate cancer progression. <i>Nature</i> 2009;457:910–914.	129	14
41	901	Giovannucci E, et al: Intake of carotenoids and retinol in relation to risk of prostate cancer. <i>J Natl Cancer Inst</i> 1995;87:1767–1776.	42.9	69
42	899	Saad F, et al: A randomized, placebo-controlled trial of zoledronic acid in patients with hormone-refractory metastatic prostate carcinoma. <i>J Natl Cancer Inst</i> 2002;94:1458–1468.	64.21	40
43	891	Lippman SM, et al: Effect of selenium and vitamin E on risk of prostate cancer and other cancers: the Selenium and Vitamin E Cancer Prevention Trial (SELECT). <i>JAMA</i> 2009;301:39–51.	127.29	15
44	880	Scher HI, et al: Increased survival with enzalutamide in prostate cancer after chemotherapy. <i>N Engl J Med</i> 2012;367:1187–1197.	220	4
45	877	Olumi AF, et al: Carcinoma-associated fibroblasts direct tumor progression of initiated human prostatic epithelium. <i>Cancer Res</i> 1999;59:5002–5011.	51.59	56
46	868	Visakorpi T, et al: In vivo amplification of the androgen receptor gene and progression of human prostate cancer. <i>Nat Genet</i> 1995;9:401–406.	41.33	72

Rank	Cites	Journal article title	Adjusted CI	Adjusted rank
47	862	Stone KR, et al: Isolation of a human prostate carcinoma cell line (DU 145). <i>Int J Cancer</i> 1978;21:274–281.	22.68	98
48	861	Pollack A, et al: Prostate cancer radiation dose response: results of the M.D. Anderson phase III randomized trial. <i>Int J Radiat Oncol Biol Phys</i> 2002;53:1097–1105.	61.5	43
49	855	Stenman UH, et al: A complex between prostate-specific antigen and alpha 1-antichymotrypsin is the major form of prostate-specific antigen in serum of patients with prostatic cancer: assay of the complex improves clinical sensitivity for cancer. <i>Cancer Res</i> 1991;51:222–226.	34.2	85
50	853	Greenberg NM, et al: Prostate cancer in a transgenic mouse. <i>Proc Natl Acad Sci USA</i> 1995;92:3439–3443.	40.62	76
51	853	Partin AW, et al: The use of prostate specific antigen, clinical stage and Gleason score to predict pathological stage in men with localized prostate cancer. <i>J Urol</i> 1993;150:110–114.	37.09	78
52	822	Bill-Axelsson A, et al: Radical prostatectomy versus watchful waiting in early prostate cancer. <i>N Engl J Med</i> 2005;352:1977–1984.	74.73	36
53	793	Messing EM, et al: Immediate hormonal therapy compared with observation after radical prostatectomy and pelvic lymphadenectomy in men with node-positive prostate cancer. <i>N Engl J Med</i> 1999;341:1781–1788.	46.65	63
54	791	Taplin ME, et al: Mutation of the androgen-receptor gene in metastatic androgen-independent prostate cancer. <i>N Engl J Med</i> 1995;332:1393–1398.	37.67	77
55	774	Kattan MW, et al: A preoperative nomogram for disease recurrence following radical prostatectomy for prostate cancer. <i>J Natl Cancer Inst</i> 1998;90:766–771.	43	67
56	759	Adam BL, et al: Serum protein fingerprinting coupled with a pattern-matching algorithm distinguishes prostate cancer from benign prostate hyperplasia and healthy men. <i>Cancer Res</i> 2002;62:3609–3614.	54.21	54
57	746	Catalona WJ, et al: Detection of organ-confined prostate cancer is increased through prostate-specific antigen-based screening. <i>JAMA</i> 1993;270:948–954.	32.43	88
58	745	Scher HI, et al: Design and end points of clinical trials for patients with progressive prostate cancer and castrate levels of testosterone: Recommendations of the prostate cancer clinical trials working group. <i>J Clin Oncol</i> 2008;26:1148–1159.	93.13	23
59	740	Yeager M, et al: Genome-wide association study of prostate cancer identifies a second risk locus at 8q24. <i>Nat Genet</i> 2007;39:645–649.	82.22	31
60	738	Litwin MS, et al: Quality-of-life outcomes in men treated for localized prostate cancer. <i>JAMA</i> 1995;273:129–135.	35.14	83
61	736	Bubley GJ, et al: Eligibility and response guidelines for phase II clinical trials in androgen-independent prostate cancer: Recommendations from the prostate-specific antigen working group. <i>J Clin Oncol</i> 1999;17:3461–3467.	43.29	65
62	735	Heidenreich A, et al: EAU guidelines on prostate cancer. <i>Eur Urol</i> 2008;53:68–80.	91.88	24
63	734	Dong JT, et al: KAI1, a metastasis suppressor gene for prostate cancer on human chromosome 11p11.2. <i>Science</i> 1995;268:884–886.	34.95	84
64	726	Heinlein CA, et al: Androgen receptor in prostate cancer. <i>Endocr Rev</i> 2004;25:276–308.	60.5	44
65	725	Heidenreich A, et al: EAU guidelines on prostate cancer. Part 1: screening, diagnosis, and treatment of clinically localised disease. <i>Eur Urol</i> 2011;59:61–71.	145	12
66	710	Craft N, et al: A mechanism for hormone-independent prostate cancer through modulation of androgen receptor signaling by the HER-2/neu tyrosine kinase. <i>Nat Med</i> 1999;5:280–285.	41.76	70
67	707	Lapointe J, et al: Gene expression profiling identifies clinically relevant subtypes of prostate cancer. <i>Proc Natl Acad Sci USA</i> 2004;101:811–816.	58.92	47
68	699	Tran C, et al: Development of a second generation antiandrogen for treatment of advanced prostate cancer. <i>Science</i> 2009;324:787–790.	99.86	20
69	698	Gleason DF: Classification of prostatic carcinomas. <i>Cancer Chemother Rep</i> 1966;50:125–128.	13.96	100
70	692	McNeal JE, et al: Zonal distribution of prostatic adenocarcinoma. Correlation with histologic pattern and direction of spread. <i>Am J Surg Pathol</i> 1988;12:897–906.	24.71	96
71	691	Chodak GW, et al: Results of conservative management of clinically localized prostate cancer. <i>N Engl J Med</i> 1994;330:242–248.	31.41	91
72	678	Zietman AL, et al: Comparison of conventional-dose vs high-dose conformal radiation therapy in clinically localized adenocarcinoma of the prostate: a randomized controlled trial. <i>JAMA</i> 2005;294:1233–1239.	61.64	42
73	667	Zelevsky MJ, et al: Dose escalation with three-dimensional conformal radiation therapy affects the outcome in prostate cancer. <i>Int J Radiat Oncol Biol Phys</i> 1998;41:491–500.	37.06	79
74	663	Stanford JL, et al: Urinary and sexual function after radical prostatectomy for clinically localized prostate cancer: the prostate cancer outcomes study. <i>JAMA</i> 2000;283:354–360.	41.44	71
75	657	Catalona WJ, et al: Use of the percentage of free prostate-specific antigen to enhance differentiation of prostate cancer from benign prostatic disease: a prospective multicenter clinical trial. <i>JAMA</i> 1998;279:1542–1547.	36.5	81
76	656	Nelson WG, et al: Mechanisms of disease: prostate cancer. <i>N Engl J Med</i> 2003;349:366–381.	50.46	57
77	656	Taichman RS, et al: Use of the stromal cell-derived factor-1/CXCR4 pathway in prostate cancer metastasis to bone. <i>Cancer Res</i> 2002;62:1832–1837.	46.86	62
78	655	Albertsen PC, et al: 20-year outcomes following conservative management of clinically localized prostate cancer. <i>JAMA</i> 2005;293:2095–2101.	59.55	46
79	651	Graff JR, et al: E-cadherin expression is silenced by DNA hypermethylation in human breast and prostate carcinomas. <i>Cancer Res</i> 1995;55:5195–5199.	31	92
80	644	Partin AW, et al: Contemporary update of prostate cancer staging nomograms (Partin Tables) for the new millennium. <i>Urology</i> 2001;58:843–848.	42.93	68
81	642	Keating NL, et al: Diabetes and cardiovascular disease during androgen deprivation therapy for prostate cancer. <i>J Clin Oncol</i> 2006;24:4448–4456.	64.2	41
82	639	Shahinian VB, et al: Risk of fracture after androgen deprivation for prostate cancer. <i>N Engl J Med</i> 2005;352:154–164.	58.09	50
83	634	Freedland SJ, et al: Risk of prostate cancer-specific mortality following biochemical recurrence after radical prostatectomy. <i>JAMA</i> 2005;294:433–439.	57.64	51
84	633	Bookstein R, et al: Suppression of tumorigenicity of human prostate carcinoma cells by replacing a mutated RB gene. <i>Science</i> 1990;247:712–715.	24.35	97
85	625	Gleason DF: Histologic grading of prostate cancer: a perspective. <i>Hum Pathol</i> 1992;23:273–279.	26.04	94
86	623	de Bono JS, et al: Circulating tumor cells predict survival benefit from treatment in metastatic castration-resistant prostate cancer. <i>Clin Cancer Res</i> 2008;14:6302–6309.	77.88	33
87	623	Draisma G, et al: Lead times and overdiagnosis due to prostate-specific antigen screening: estimates from the European randomized study of screening for prostate cancer. <i>J Natl Cancer Inst</i> 2003;95:868–878.	47.92	60
88	615	Gronberg H: Prostate cancer epidemiology. <i>Lancet</i> 2003;361:859–864.	47.31	61
89	611	Fizazi K, et al: Denosumab versus zoledronic acid for treatment of bone metastases in men with castration-resistant prostate cancer: a randomised, double-blind study. <i>Lancet</i> 2011;377:813–822.	122.2	16
90	611	Kantoff PW, et al: Hydrocortisone with or without mitoxantrone in men with hormone-refractory prostate cancer: results of the cancer and leukemia group B 9182 study. <i>J Clin Oncol</i> 1999;17:2506–2513.	35.94	82
91	609	Giovannucci E, et al: The CAG repeat within the androgen receptor gene and its relationship to prostate cancer. <i>Proc Natl Acad Sci USA</i> 1997;94:3320–3323.	32.05	89

Rank	Cites	Journal article title	Adjusted CI	Adjusted rank
92	603	Thomas G, et al: Multiple loci identified in a genome-wide association study of prostate cancer. Nat Genet 2008;40:310–315.	75.38	35
93	601	Haldar S, et al: Taxol induces bcl-2 phosphorylation and death of prostate cancer cells. Cancer Res 1996;56:1253–1255.	30.05	93
94	598	Harries LW, et al: Identification of genetic polymorphisms at the glutathione S-transferase Pi locus and association with susceptibility to bladder, testicular and prostate cancer. Carcinogenesis 1997;18:641–644.	31.47	90
95	596	Colombel M, et al: Detection of the apoptosis-suppressing oncoprotein bcl-2 in hormone-refractory human prostate cancers. Am J Pathol 1993;143:390–400.	25.91	95
96	589	Heinonen OP, et al: Prostate cancer and supplementation with alpha-tocopherol and beta-carotene: incidence and mortality in a controlled trial. J Natl Cancer Inst 1998;90:440–446.	32.72	87
97	588	Saad F, et al: Long-term efficacy of zoledronic acid for the prevention of skeletal complications in patients with metastatic hormone-refractory prostate cancer. J Natl Cancer Inst 2004;96:879–882.	49	59
98	585	Small EJ, et al: Placebo-controlled phase III trial of immunologic therapy with sipuleucel-T (APC8015) in patients with metastatic, asymptomatic hormone refractory prostate cancer. J Clin Oncol 2006;24:3089–3094.	58.5	49
99	585	Cooner WH, et al: Prostate cancer detection in a clinical urological practice by ultrasonography, digital rectal examination and prostate specific antigen. J Urol 1990;143:1146–1154.	22.5	99
100	582	Gudmundsson J, et al: Genome-wide association study identifies a second prostate cancer susceptibility variant at 8q24. Nat Genet 2007;39:631–637.	64.67	39

Table 2. The most frequently cited journals featured in the T100

Journal	Papers within T100	Latest journal IF 2014	Cumulative number of citations
N Engl J Med	21	55.873	26,172
JAMA	11	35.289	9,865
Cancer Res	10	9.329	9,368
J Clin Oncol	6	18.443	4,401
J Natl Cancer Inst	6	12.583	4,374
Science	6	33.611	8,734
J Urol	5	4.36	4,827
Lancet	4	45.217	3,230
Nat Genet	4	29.352	2,793
Int J Radiat Oncol Biol Phys	3	4.258	2,446
Nature	3	41.456	3,382
Proc Natl Acad Sci USA	3	9.674	2,169
Am J Pathol	2	5.145	1,896
Am J Surg Pathol	2	5.145	1,651
Cancer Cell	2	23.3	2,200
Eur Urol	2	13.938	1,460

Fig. 1. World map of the centers of origin of the T100 (Due to international collaboration during certain publications, more than 100 centres were represented in total).

sessed. Of these categories; genetics and biomarkers (n = 34), management of PCa (n = 25), physiology/biology/pathophysiology (n = 11) and content related to classification/grading/staging/nomograms (n = 11) were most prominent (fig. 2). If the prepopulated “Web of Science” category within the T100 is further analysed, then PCa research ranked under medicine general internal (n = 36), oncology (n = 31), multidisciplinary sciences (n = 12), urology nephrology (n = 9) is most featured (fig. 3). Of the T100 articles, article types included original articles (n = 93), reviews (n = 4), notes (n = 2) and proceedings paper (n = 1).

Performance within T100 over Time-Frames [5 Year Intervals]

Allocating number of articles within 5 year intervals from 1990, revealed the most “intellectually productive” time frame being from 1995 to 1999. With the most prolific year being the year 2005, when 8 papers within the T100 were published within that year (fig. 4).

Center of Origin (University or Center) versus International Rank (ARWU, QS, Leidin Ranking System)

Research centers or universities with at least 5 papers within the T100 were tabulated (table 4). Harvard University was the institution that had the most T100 contributions (n = 20) within this review. The center responsible for the most T100, was observed to be within the top 2 of all the University rankings assessed.

Centers or universities with at least 5 citations within the T100 have been listed. Three research centers (non-university centers) were also observed within this list; National Cancer Institute, Memorial Sloan Kettering Cancer Center and the Brigham and Women’s Hospital.

Table 3. Individual countries record of articles within the T100 cited articles versus their percentage expenditure of research (Due to collaboration within many publications, the cumulative total exceeds 100).

Country	Record number of articles within the T100	Percentage GDP spent on research and development	Most recent year listed	Corrected for percentage on research (Citation record/%GDP on research)	Adjusted rank
USA	86	2.81	2012	40.60	1
Canada	16	1.62	2013	9.87	2
France	13	2.23	2013	5.82	5
United Kingdom	15	1.63	2013	9.20	3
(England + Scotland + Wales)	(10 + 3 + 2)				
Netherlands	9	1.98	2013	4.54	6
Italy	8	1.26	2013	6.34	4
Sweden	8	3.30	2013	2.42	10
Finland	7	3.31	2013	2.11	13
Belgium	6	2.28	2013	2.63	8
Australia	5	2.25	2011	2.22	12
Switzerland	5	2.96	2012	1.68	15
Germany	4	2.85	2013	1.43	16
Spain	4	1.24	2013	3.22	7
Brazil	3	1.15	2012	2.60	9
Israel	3	4.21	2013	0.71	18
Hungary	2	1.41	2013	1.41	17
Poland	2	0.87	2013	2.29	11
Russia	2	1.13	2013	1.76	14

Table 4. The top 15 most prominent universities or centers within the T100

Organization	Citations within the T100	International University Ranking as per		
		ARWU – Shanghai Ranking (2015) [5]	Leiden Ranking (2015) [6]	QS rating (2015) [7]
Harvard Univ	20	1	2	2
Univ Michigan	12	22	48	30
Johns Hopkins Univ	11	16	36	16
NCI	11	–	–	–
Univ California San Francisco	11	18	8	–
Washington Univ	11	32	29	110
MSKCC	10	–	–	–
Univ Colorado	9	201–300	22	175
Univ Washington	9	15	27	65
UCLA	8	12	20	27
Univ Texas	8	37	14	77
Baylor Coll Med	6	101–150	81	–
Brigham and Women's Hospital	6	–	–	–
Duke Univ	6	31	31	29
Columbia Univ	5	8	19	22

Univ = university; NCI = National Cancer Institute; MSKCC = Memorial Sloan Kettering Cancer Center; UCLA=University of California, Los Angeles.

Authorship (Total, First, Co-Author)

Authors with at least 4 publications within the T100 were tabulated (table 5). The author Catalona W. J., is responsible for the most (n = 4) T100 articles as a first author in the observed history of PCa research. The authors Crawford E. D. and Walsh P. C., have both contributed

to the most (n = 7) T100 articles as author and co-author combined. The list of the top ranked author list within T100 (number of publications listed as first and co-author) is tabulated (table 6). The top ranked combined first and co-author was Crawford E. D. and Walsh P. C. with 7 cumulative publications within the T100.

Fig. 2. Actual “content-related” categories associated with PCa.

Fig. 3. Web of Science associated categories associated with PCa.

Table 5. The top ranked first authors within the T100

Rank of citations	Author	Number of T100 articles as first author
1	Catalona W. J.	4
2	De Bono J. S.	3
3	Gleason D. F.	3
4	Partin A. W.	3
5	Bolla M.	2
6	Epstein J. I.	2
7	Giovannucci E.	2
8	Heidenreich A.	2
9	Kantoff P. W.	2
10	Saad F.	2

Table 6. Top ranked author list within T100 (number of publications listed as first/co-author)

Rank of citations	Author	Number of T100 articles		
		Author	First author	Co-author
1	Crawford E. D.	7	1	6
2	Walsh P. C.	7	—	7
3	Partin A. W.	6	3	3
4	Scher H. I.	6	2	4
5	Catalona W. J.	5	4	1
6	Giovannucci E.	5	2	3
7	Pienta K. J.	5	—	5
8	Scardino P. T.	5	—	5
9	Small E. J.	5	1	4
10	Varambally S.	4	1	3

Languages of Publication

All papers included within the T100, were published in the English language.

Discussion

PCa represents a rapidly evolving field and accounts for a considerable proportion of urological publications within the contemporary medical literature. To better understand this dynamic research focus area, we performed a comparative bibliometric analysis in PCa research. The findings of the current study demonstrate that North American and European institutions dominate the T100 PCa publications. Further, our findings demonstrate that articles pertaining to PCa genetics and biomarkers represent the highest citation potential.

Within medical literature, there is an absence of a universally-accepted absolute bibliometric comparator [13]. As such, CI may represent a useful objective measure of intellectual influence to a particular field. Previous citation bibliometric analyses have been reported in the fields of psoriasis [14], pediatric neuro-surgery [8], spine-related research [15], cardiovascular research [16], dentistry [17], and within adult and pediatric urology [18-21]. These bibliometric evaluations provided a clearer “snapshot” of articles and associated research focus areas which have generated the most “intellectual influence” within the particular research focus area analysed. Despite this, there are inherent limitations in using citation data as a marker of intellectual influence that should be noted. A recent review observed that the CI alone was also not a good marker when reviewing the prescribed or suggested reading or study material when

Fig. 4. A 5-year interval bar graph depicting the timeline distribution of the T100 (covering the last 25 years).

preparing for the Fellow of the Royal College of Surgeons Urology Examination [22]. Furthermore, certain strategies are well known to increase the CI. These include using consistent name and affiliations, publishing in high IF journals, using an international collaborative authorship approach or publishing across fields [23].

Our study highlights the predominance of publications originating from institutions located in USA or Europe. Specifically, of the affiliated countries, USA accounted for the largest total (86/203). Further, we identified that medical and oncological journals represented a significant proportion of publications within in the T100, while *The Journal of Urology* was the highest ranked journal in the “urology and nephrology” category. Our results have corroborated with a previous bibliometric review of the T100 cited articles in “general” urology [19]. Nason et al. [19] observed a majority of the articles originated from USA (77/100), most in the field of oncology (54/100). Further, this group identified that *The Journal of Urology* published these articles most frequently (16/100) within the journals within the “urology and nephrology” category. These sentiments were further echoed by an earlier review of 1,239 “citation classics” [20], in urology, where a “citation classic” was defined as a paper with a CI of more than 100. In their review, the articles originated from USA accounted for the majority

(774/1,239) of papers assessed. Similar to Nason et al. [19] the category of “prostate cancer and PSA” was the most prevalent (33.5%) category. Furthermore, amongst the journals assessed, *The Journal of Urology* had listed the most cites within the “urology and nephrology” category. Controversy exists in the geographical region of distribution of the T100 and the fact that the preferential citation biases from the USA, by other American authors and may lead to an over-estimated CI [10].

An attempt at adjusting for PCa research per country by factoring the percentage of GDP given for research was also explored in this study, and this change is reflected in table 3. Despite adjusting for this variable within our study, the USA is still top ranked. This finding had been previously observed in a review of the “geographical origin” of publications within the urological literature, where adjusting the ranking using the percentage spent on research per GDP, did have an impact on the overall rank [10]. This may be explained by the previously noted “preferential citation biases” from the USA, by other American authors, which in turn may lead to an over-estimated CI [10].

Certain content relevant to PCa research may be highly citable and may not be contained in the “urology and nephrology” journal category, so we opted not to include a limitation to the journal category searched. This

allowance proved to be significant, since the top ranked article in the T100 [24], was published in a category outside the “urology and nephrology” journal category.

There are several limitations to the current study. Firstly, as previously discussed, there are inherent limitations in using citation data in bibliometric analyses. Secondly, our study utilized only the Web of Science Database. A number of alternate databases that calculate citation metrics are available including Google Scholar, Science Direct and EMBASE. The Web of Science was selected as it includes “older” publications, although the Scopus database is more extensive in more recent literature records. Nevertheless, Web of Science database was utilized as the duration of publication has a greater impact on citation [25]. Thirdly, this study did not review actual book chapters or book content, and unpublished Ph.D. and masters dissertations were also not assessed. These were excluded in the search term as the book databases are less encompassing and thus citation records would prove challenging to review.

Furthermore, there may well be research content that may have had an influence but has not been cited or not cited correctly. Also, publication bias or un-blinded peer-review, may also play a role in the publication process, where more prominent authors or institutions have preference over others. Further, the citation score may not always reflect the inherent quality of a particular finding, research paper. The topic of “prostate cancer” is indeed a multifaceted, so isolating a certain subset within this field may have been more accurate in the assessment process. Self or over citation of author’s publications may also weigh heavily on the CI, sometimes without appropriate merit. Finally, a hallmark paper by Huggins and Hodges (1941) [26], was excluded due to our study search date limitation (1945–2016). Their article was the first translational research study in hormonal therapy and PCa and earned the first author Charles Brenton Huggins, a Nobel prize in the category of physiology or medicine in the year 1966 [27]. A citation search on the Web of Science performed for their article returned 2,578 citations, which would have placed this third on the overall CI ranking in the T100.

In conclusion, despite the controversies involved in the CI of published research, it has remained a recording measure of academic, peer-reviewed research. We present the first comparative, bibliometric study to review the CI and citation metrics in the field of PCa research. Geographic regions that pre-dominate the literature amongst the T100 include North America and Europe. Publications originating from higher IF journals, English

language medium of publication, original article format and multi-center collaborative research was observed to be more prominent amongst the T100. Areas within PCa research that are related to the content category of genetics and biomarkers have the highest citation potential. Amongst the journal category “urology and nephrology”, most T100 were published in *The Journal of Urology*. When assessing within all journal categories, *The New England Journal of Medicine* leads the list. All these above mentioned factors may have an implication on future citation potential in PCa research, the funding and choice of associated research focus that academic urologists take in the future.

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