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Optometry research in Spain: Topics of interest, institutions and investigators

Genis Cardona[a,*], **Laura Puigdueta-Carrera**[a], **Nathan Efron**[b]

[a] *Department of Optics and Optometry, Universitat Politècnica de Catalunya, Terrassa, Spain*
[b] *School of Optometry and Vision Science, Queensland University of Technology, Kelvin Grove, Australia*

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Abstract
Purpose: To determine the institutions, journals of choice and topics of investigation of the most prolific and highly cited Spanish optometrist researchers.
Methods: As a primary search strategy, the Scopus database (Elsevier) was queried with the terms (optometr* OR "contact lens*" OR refracti* OR *ocular) and the affiliation country filter "Spain". The list of authors returned by the primary search was used in a secondary manual search based on co-authors and institutions. Authors were included in the analysis if they had an h-index > 10, were of Spanish nationality, were affiliated to Spanish institutions, and possessed an optometry degree. Authors were ranked by h-index, number of publications and number of citations. Topics of research interest and target journals were determined by analyzing the 10 most highly cited papers of each author.
Results: A total of 32 authors with an h-index > 10 were identified, of whom 14 (43.7%) were female. Only one author had an h-index > 40, and 7 (21.9%) authors had an h-index over 20. The Journal of Cataract and Refractive Surgery was the first journal of choice (19.1% of highest cited papers), followed by Optometry and Vision Science (10.3%). The Universidad Complutense de Madrid hosted the largest percentage of authors (18.7%), followed by the Universitat de València (15.6%). Main topics of research interest were topography (6.5% of papers), cornea (6.2%) and contact lens (5.0%).
Conclusion: Optometry in Spain is a fertile field of research, with an increasing number of highly cited authors publishing in high impact journals.

Introduction

Bibliometric analyses provide relevant information to serve as a basis for understanding the evolution and state of the art of a given field of research. Citation metrics, first introduced by Eugene Garfield in 1955,[1] have been used to highlight the

Abbreviations: IF, Impact Factor; Q1, First Quartile; Q2, Second Quartile; ESCI, Emerging Sources Citation Index; JCI, Journal Citation Indicator.

* Corresponding author at: Department of Optics and Optometry, Universitat Politècnica de Catalunya, Violinista Vellsolà, 37, E08222, Terrassa, Spain.
E-mail address: genis.cardona@upc.edu (G. Cardona).

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contribution of investigators, research groups, institutions and countries to each discipline, and to identify the main topics of research interest. Two of the most widespread citation metrics are the impact factor (IF) ,[2] commonly employed to categorize and rank scientific journals, and the h-index.[3] The h-index was developed by Jorge E Hirsch in 2005 to provide a qualitative rather than quantitative appraisal of the research impact of individual investigators, although it may also be applied to institutions, countries or even whole fields of research. The h-index of an author is defined as the maximum value of h, such that the author has published h papers that have each been cited at least h times.[3] Thus, an author with an h-index of 12 has published at least 12 papers which have received 12 cites each or more.

In the discipline of optometry and vision sciences, bibliometric analysis gained momentum with a series of papers by Efron, Brennan and Nichols published between 2011 and 2013,[4-6] followed by papers by Cardona and Sanz in 2014 and 2015, the latter exploring the citation parameters and topics of research in the contact lens field.[7,8] A recent proliferation of publications has evidenced a renewed interest in citation metrics in areas of research such as contact lenses,[9,10] visual therapy,[11] refractive error,[12] vision and sports,[13] meibomian gland and dry eye,[14,15] orthokeratology[16,17] and scleral lenses,[18,19] amongst others.

Of note, in a seminal paper published in 2021, Efron and co-workers identified the top 200 leading optometric researchers worldwide.[20] These authors maintain and curate a version of the Global Optometrist Top 200 Research Ranking (available at https://optomrankings.com/), with live updates every 24 h.[21] As of July 2021, the ranking provided by Efron and co-workers identifies seven Spanish optometrists in the top 200, of whom Robert Montés-Micó has the highest h-index (47, with a global ranking of 16/200) and David Piñero, with 320 papers since 2003, is the most prolific author (h-index 37, global ranking of 52/200). Overall, Spain as a country occupies the fifth position in number of optometrists in the top 200 and country h-index, after countries with a longer and well-established research tradition in optometry and vision sciences such as USA, Australia, UK and Canada.

Difficulties may arise when comparing the scientific outcome of different countries, given the particular characteristics of each country in terms of number and antiquity of research institutions, types of research and tenure-track career paths, public and private research funding, degree of co-operation and relationship between ocular health and vision care specialists, overall social consideration and implementation of optometry as a health profession, or even main language used for scientific communication. It was therefore the aim of the present study to conduct a bibliometric analysis of the optometry and vision sciences related publications authored by optometrist researchers from Spain in order to identify the most prolific authors, the institutions where they pertain, their topics of research interest and their preferred target journals.

Material and methods

The Scopus search engine (Elsevier, www.scopus.com) was employed for this analysis. The study was conducted between the months of May and July 2021 and aimed at identifying authors with a Scopus h-index $>$ 10. To generate an initial list of authors, the Scopus search engine was queried with the following search terms:

TITLE-ABS-KEY(optometr* OR "contact lens*" OR refracti* OR *ocular) AND (LIMIT-TO (SRCTYPE,"j")) AND (LIMIT-TO (AFFILCOUNTRY,"Spain")) AND (LIMIT-TO (SUBJAREA,"MEDI") OR LIMIT-TO (SUBJAREA,"HEAL"))

This search strategy returned a total of 8621 documents. In order to identify researchers with an h-index $>$ 10, the author list of these documents was retrieved, and authors with a number of publications of 20 or more were selected (159 authors). Although this number was arbitrarily chosen, it was considered that with less than 20 articles it was highly improbable for an author to reach an h-index $>$ 10. Next, the author profile provided by Scopus of each of the selected researchers was accessed to manually collect the following information: h-index, number of published articles, number of citations, number of different co-authors, affiliation and ORCID identity (if available). In this regard, Scopus links institutions to authors according to the information provided by their most recent publication.

As the aim of this study was to identify Spanish optometrist researchers working in Spanish institutions, secondary internet searches based on author names discovered during the primary search were conducted to exclude authors not working in Spain, not of Spanish nationality and not optometrists. Authors with multiple degrees (e.g., optometrist and physicist; optometrist and biologist; optometrist and ophthalmologist; optometrist and pharmacologist) were not excluded from the analysis as long as their main body of publications were related to the visual sciences.

In addition, to discover potential authors missed by the primary Scopus search, the list of the top contributing co-authors of each investigator was manually reviewed. Similarly, once the most relevant institutions were identified by the outcome of the primary search, the online directory provided by the website of each institution was consulted, whereupon all investigators not included in the primary search outcome were submitted to a further Scopus analysis to determine their h-index and scientific outcome. Finally, authors with h-index $>$ 10 were ranked in descending order of h-index values and, when necessary, ties were broken by referring to the total number of published papers and number of citations.

After the list of optometrists with an h-index $>$ 10 was completed and refined, the top 10 most highly cited articles of each author were retrieved. Each article was then accessed to collect the name of the journal where it was published and the key word list provided by the author of that article. In those articles not containing specific key word information, the title and abstract were reviewed to determine the main topic or topics of research. The resulting compilation of target journals and key words was employed to determine the top 10 journals of choice for Spanish optometrist researchers and the 10 topics reflecting the highest research interest.

Results

The primary and secondary search strategies revealed a total of 32 authors with an h-index $>$ 10 (**Table 1**). The author with the highest h-index was Robert Montés-Micó,

Table 1 Spanish optometrist investigators with h-index > 10, with indication of latest associated institution, number of articles, year of first publication, citation number, number of different co-authors, most contributed topics of 2016–2020, and ORCID Identity.

Rank	Researcher	h-index	Institution	Number of articles	Year of first publication	Number of citations	Number of different co-authors	Most contributed topics (2016–2020)	ORCID ID
1	Montés-Micó, Robert	48	Univ. València	304	1997	7717	214	Accommodation, multifocal intraocular lenses, presbyopia	0000–0001–6179–8261
2	Piñero, David P	37	Univ. Alacant	311	2003	4765	416	Keratoconus, multifocal intraocular lenses, refractive surgery	0000–0002–1546–4807
3	Ferrer-Blasco, Teresa	28	Univ. València	146	2000	2758	88	Refractive surgery, presbyopia, multifocal intraocular lenses	
4	Villa-Collar, César	26	Univ. Europea Madrid	108	2003	1787	242	Keratometry, myopia, refractive errors	0000–0002–6743–8264
5	Cerviño, Alejandro	23	Univ. València	94	2000	1761	108	Presbyopia, contact lenses, dry eye syndrome	0000–0001–8014–3279
6	Madrid-Costa, David	22	Univ. Complutense Madrid	96	2008	1386	93	Keratoconus, refractive errors, dry eye syndrome	0000–0003–3927–2858
7	Peral, Assumpta	21	Univ. Complutense Madrid	39	1998	1118	55	Endophthalmitis, melatonin receptors, contact lenses	0000–0002–7495–3088
8	Yebra-Pimentel, Eva	19	Univ. Santiago Compostela	82	1993	1167	91	Dry eye syndrome, hyperaemia, Meibomian glands	0000–0002–4012–4636
9	García-Lázaro, Santiago	18	Univ. València	84	2010	947	64	Dry eye syndrome, presbyopia, multifocal intraocular lenses	0000–0001–5837–2892
10	Albarrán-Diego, César	17	Clínica Baviera, Madrid	68	1997	952	57	Multifocal intraocular lenses, contact lenses, refractive surgery	0000–0001–8972–1784
11	Anera, Rosario G.	17	Univ. Granada	61	2000	820	43	Glare, cataracts, contrast sensitivity	0000–0003–3614–2142
12	González-García, María J.	17	Univ. Valladolid	50	2001	774	76	Dry eye syndrome, ocular surface, contact lenses	0000–0003–3673–0585
13	García-Ayuso, Diego	17	Univ. Murcia	36	2010	800	90	Glaucoma, retinal degeneration, visual pigments	0000–0002–7639–5366
14	Sobrado-Calvo, Paloma	17	Univ. Murcia	27	1998	1310	68	Glaucoma, retinal ganglion cell, ocular hypertension	0000–0001–8871–9404
15	Vilaseca, Meritxell	16	Univ. Politècnica Catalunya	91	2002	1006	120	Glare, cataracts, contrast sensitivity	0000–0001–8166–1617
16	López-Miquel, Alberto	15	Univ. Valladolid	53	2009	622	90	Dry eye syndrome, artificial tears, keratoconus	0000–0001–9429–1571
17	Martín, Raúl	14	Univ. Valladolid	69	2001	726	92	Keratoconus, corneal pachymetry, contact lenses	0000–0001–7156–619X
18	Carracedo, Gonzalo	14	Univ. Complutense Madrid	69	2002	648	96	Myopia, contact lenses, keratoconus	0000–0003–0054–1731
19	Giráldez-Fernández, María J.	14	Univ. Santiago Compostela	53	1995	535	61	Dry eye syndrome, artificial tears, Meibomian glands	0000–0001–9595–7486
20	Puell, María Cinta	13	Univ. Complutense Madrid	31	1997	447	36	Nerve fibres, glaucoma, macular degeneration	0000–0002–9227–4927
21	Jiménez, Raimundo	12	Univ. Granada	71	2003	516	64	Glaucoma, intraocular pressure, ocular motility disorders	0000–0002–8036–2532
22	Biarnés, Marc	12	Barcelona Macula Foundation	41	2009	612	298	Macular degeneration, geographical atrophy, glaucoma	0000–0003–2584–4894
23	de Juan, Victoria	12	Hosp. Ramón y Cajal, Madrid	39	2007	314	45	Optic disk, keratoconus, optical coherence tomography	0000–0001–5187–8778
24	Cardona Pérez, Juan de la Cruz	12	Univ. Granada	32	2006	526	65	Corneal epithelium, contact lenses, composite resins	0000–0003–2867–9708
25	Rodríguez, Guadalupe	12	Univ. Valladolid	26	2004	321	40	Keratoconus, corneal pachymetry, contact lenses	0000–0002–9943–2051
26	Cardona, Genís	11	Univ. Politècnica Catalunya	63	1996	582	111	Keratoconus, multifocal intraocular lenses, contact lenses	0000–0002–4770–8992
27	Esteve-Taboada, José J.	11	Univ. València	56	2015	383	44	Accommodation, presbyopia, refractive surgery	0000–0001–8663–6373
28	Pérez-Cambrodí, Rafael J.	11	Univ. València	54	2011	475	61	Keratoconus, low vision, macular degeneration	0000–0002–7387–3035
29	García-Resúa, Carlos	11	Univ. Santiago Compostela	47	2004	359	38	Dry eye, artificial tears, Meibomian glands	0000–0002–6804–4478
30	Caballero, María Teresa	11	Univ. Alacant	39	2001	382	29	Keratoconus, corneal pachymetry, multifocal intraocular lenses	0000–0002–2745–4761
31	Antona, Beatriz	11	Univ. Complutense Madrid	21	2003	283	26	Asthenopia, computer vision, ocular motility disorders	0000–0001–5219–8643
32	Martín-Gil, Alba	11	Univ. Complutense Madrid	21	2009	278	47	Contact lenses, keratoconus, artificial tears	0000–0001–8641–2169

from the Universitat de València, with an h-index of 47 (year of first publication 1997), followed by David Piñero, from the Universitat d'Alacant, with an h-index of 33 (year of first publication 2003) and by Teresa Ferrer-Blasco, from the Universitat de València, with an h-index of 28 (year of first publication 2000). These same investigators, but in a different order, were the most prolific authors, with 311 publications authored by David Piñero (attracting 4765 citations), 304 by Robert Montés-Micó (7717 citations) and 146 by Teresa Ferrer-Blasco (2758 citations). David Piñero had shared his publications with the largest number of different, unique co-authors (416), followed by Marc Biarnés (298) and César Villa-Collar (242). Overall, 5 (15.6%) authors had an h-index between 20 and 29 and 2 authors (6.2%) had an h-index $\geq$ 30. Almost all authors were registered to ORCID.

A total of 14 (43.7%) investigators with an h-index $>$ 10 were female. The highest-ranking female on the list was Teresa Ferrer-Blasco, from the Universitat de València, followed by Assumpta Peral, from the Universidad Complutense de Madrid, with an h-index of 21 (39 papers, 1118 citations, 55 co-authors) and Eva Yebra-Pimentel, from the Universidad de Santiago de Compostela, with an h-index of 19 (82 papers, 1167 citations, 91 co-authors).

The top 10 most frequently selected key words, as determined by their occurrence in the 10 most highly cited documents of each author, are summarized in Table 2. The main topics of interest of Spanish researchers were topography (6.5%), cornea (6.2%) and contact lens (5.0%), followed by contrast sensitivity (4.8%) and myopia (4.7%). The most highly cited articles and the most recent articles of the top 10 Spanish optometrist researchers are listed in Table 3.

The top 10 target journals for the most highly cited papers are shown in Table 4, which also provides information on their IF and website, as well as the number of top 10 highest cited articles published there. The Journal of Cataract and Refractive Surgery (IF 2020 = 3.351; 18/62 in the category of Ophthalmology of the Journal Citation Reports, Science Citation Index Expanded) was the journal of choice for 61 (19.1%) of the top 10 highest cited papers of Spanish optometrist researchers with h-index $>$ 10, followed by Optometry and Vision Science (IF 2020 = 1.973; 44/62), with 33 (10.3%) articles, and Journal of Refractive Surgery (IF 2020 = 3.573; 15/62), with 31 articles (9.7%). The journal with the highest IF was American Journal of Ophthalmology (IF 2020 = 5.258; 6/62), which published 10 articles (3.1%) of the top 10 most highly cited papers of all authors under consideration. Overall, 82 articles (25.6%) were published in journals located at the first quartile (Q1) of the Ophthalmology category of the Journal Citation Reports and 154 articles (48.1%) in journals located at the second quartile (Q2). Only 3 (0.9%) of the top 10 highest cited papers of all authors were published in Journal of Optometry, which in 2021 was first included in the Emerging Sources Citation Index (ESCI) of the Journal Citation Reports, within the category Ophthalmology, with a Journal Citation Indicator (JCI) of 0.77 and with a total of 566 citations.

Finally, the top 5 institutions to which the identified authors were affiliated are summarized in Table 5. With only 3 exceptions, all authors were affiliated to universities. The Universidad Complutense de Madrid hosted the largest number of authors (6, 18.7%), followed by the Universitat de València (5, 15.6%) and the Universidad de Valladolid (4, 12.5%).

Table 2 Topics of research interest of Spanish optometrists determined by key word occurrence in their top 10 most highly cited articles.

Key word	Occurrence (%)
Topography	6.5
Cornea	6.2
Contact lens	5.0
Contrast sensitivity	4.8
Myopia	4.7
Dry eye	3.6
Intraocular lens	3.4
Intraocular pressure	2.8
Keratoconus	2.7
LASIK	2.5

Discussion

A bibliometric analysis of publications authored by Spanish optometrist researchers provided evidence to support the notion that Spain is rapidly becoming a country of reference in the field of research in optometry and vision sciences, in the tradition of countries with more established optometric research profiles such as USA, Canada, UK and Australia.

Primary and secondary search strategies identified 32 Spanish optometrists with an h-index $>$ 10, mostly affiliated to public universities. Of these authors, 7 had an h-index $\geq$ 20, representing a 3.5% of the top 200 researchers worldwide, headlined by the Australian researcher Konrad Pesudovs, with an h-index of 70.

Topics of research interest of Spanish optometrists were widespread and revealed common over-arching themes similar to those described by Efron and co-authors,[20] thus suggesting that optometry research in Spain is fully integrated within the international community of investigators. Indeed, many Spanish researchers have an extensive network of co-authors from international institutions: for instance, Marc Biarnés, from the Barcelona Macula Foundation, has 298 co-authors, of whom more than half are not Spanish.

It must be acknowledged that differences between Scopus and other search engines such as Web of Science (Clarivate) or Google Scholar (Google) may yield slightly different values of h-index and thus, may introduce changes to the list of authors, both in their overall rank and in their actual inclusion in the list of top authors, particularly in the lower tiers. For example, one of the main reasons for choosing Scopus was that this search engine defines Optometry as a stand-alone category, whereas Web of Science only contemplates the category Ophthalmology, also implementing a more limiting criterion for journal inclusion, based on IF, than Scopus, which includes a wider range of Optometry journals, probably providing a more accurate representation of the output of optometrist researchers. Similarly, to determine h-index, Google Scholar also considers citations on sources different from journals, including books, doctoral theses, and even some websites. In addition, a different primary search equation may have retrieved other authors,

Table 3 Most highly cited article (with number of citations) and most recent article of the top 10 Spanish optometrist researchers.

Researcher	Most highly cited article	Most recent article
Montés-Micó, Robert	Ferrer-Blasco T, Montés-Micó R, Peixoto-de-Matos SC, González-Méijome JM, Cerviño A. Prevalence of corneal astigmatism before cataract surgery. J Cataract Refract Surg. 2009;35(1):70—5. https://doi.org/10.1016/j.jcrs.2008.09.027 (cited 257)	Montés-Micó R, Pastor-Pascual F, Ruiz-Mesa R, Tañá-Rivero P. Ocular biometry with swept-source optical coherence tomography. J Cataract Refract Surg. 2021;47(6):802—4. https://doi.org/10.1097/j.jcrs.0000000000000551
Piñero, David P	Ortiz D, Piñero D, Shabayek MH, Arnalich-Montiel F, Alió JL. Corneal biomechanical properties in normal, post-laser in situ keratomileusis, and keratoconic eyes. J Cataract Refract Surg. 2007;33(8):1371—5. https://doi.org/10.1016/j.jcrs.2007.04.021 (cited 316)	Shneor E, Piñero DP, Doron R. Contrast sensitivity and higher-order aberrations in keratoconus subjects. Sci Rep. 2021;11(1):12,971. https://doi.org/10.1038/s41598-021-92396-5
Ferrer-Blasco, Teresa	Ferrer-Blasco T, Montés-Micó R, Peixoto-de-Matos SC, González-Méijome JM, Cerviño A. Prevalence of corneal astigmatism before cataract surgery. J Cataract Refract Surg. 2009;35(1):70—5. https://doi.org/10.1016/j.jcrs.2008.09.027 (cited 257)	Monsálvez-Romín D, Domínguez-Vicent A, Esteve-Taboada JJ, Montés-Micó R, Ferrer-Blasco T. Multisectorial changes in the ciliary muscle during accommodation measured with high-resolution optical coherence tomography. Arq Bras Oftalmol. 2019;82(3):207—13. https://doi.org/10.5935/0004-2749.20190041
Villa-Collar, César	Santodomingo-Rubido J, Villa-Collar C, Gilmartin B, Gutiérrez-Ortega R. Myopia control with orthokeratology contact lenses in Spain: refractive and biometric changes. Invest Ophthalmol Vis Sci. 2012;53(8):5060—5. https://doi.org/10.1167/iovs.11-8005 (cited 188)	Lopes-Ferreira D, Ruiz-Pomeda A, Peréz-Sanchéz B, Queirós A, Villa-Collar C. Ocular and corneal aberrations changes in controlled randomized clinical trial MiSight® Assessment Study Spain (MASS). BMC Ophthalmol. 2021;21(1):112. https://doi.org/10.1186/s12886-021-01865-y
Cerviño, Alejandro	Ferrer-Blasco T, Montés-Micó R, Peixoto-de-Matos SC, González-Méijome JM, Cerviño A. Prevalence of corneal astigmatism before cataract surgery. J Cataract Refract Surg. 2009;35(1):70—5. https://doi.org/10.1016/j.jcrs.2008.09.027 (cited 257)	García-Marqués JV, Martínez-Albert N, Talens-Estarelles C, García-Lázaro S, Cerviño A. Repeatability of Non-invasive Keratograph Break-Up Time measurements obtained using Oculus Keratograph 5 M. Int Ophthalmol. 2021;41(7):2473—83. https://doi.org/10.1007/s10792-021-01802-4
Madrid-Costa, David	Fernandes P, González-Méijome JM, Madrid-Costa D, Ferrer-Blasco T, Jorge J, Montés-Micó R. Implantable collamer posterior chamber intraocular lenses: a review of potential complications. J Refract Surg. 2011;27(10):765—76. https://doi.org/10.3928/1081597x-20110617-01 (cited 135)	Alfonso JF, Torquetti L, Fernández-Vega-Cueto L, Allan B, Poo-López A, Alfonso-Bartolozzi B, de la Cruz J, Monteiro T, Madrid-Costa D. Visual and tomographic outcomes of a 300° arc-length ICRS implantation in moderate to advanced central keratoconus. J Refract Surg. 2021;37(4):249—55. https://doi.org/10.3928/1081597x-20210115-01
Peral, Assumpta	Pintor J, Martin L, Pelaez T, Hoyle CH, Peral A. Involvement of melatonin MT(3) receptors in the regulation of intraocular pressure in rabbits. Eur J Pharmacol. 2001;416(3):251—4. https://doi.org/10.1016/s0014-2999(01)00864-0 (cited 115)	Peral A, Martinez-Aguila A, Pastrana C, Huete-Toral F, Carpena-Torres C, Carracedo G. Contact lenses as drug delivery system for glaucoma: a review. Applied Sciences. 2020;10(15):5151. https://doi.org/10.3390/app10155151
Yebra-Pimentel, Eva	González-Méijome JM, Cerviño A, Yebra-Pimentel E, Parafita MA. Central and peripheral corneal thickness measurement with Orbscan II and topographical ultrasound pachymetry. J Cataract Refract Surg. 2003;29(1):125—32. https://doi.org/10.1016/s0886-3350(02)01815-1 (cited 131)	Garcia-Queiruga J, Pena-Verdeal H, Giraldez MJ, Garcia-Resua C, Yebra-Pimentel E. Inter-week variation of meibometry and tear break-up time in healthy subjects. Clin Exp Optom. 2021. https://doi.org/10.1080/08164622.2021.1878815
García-Lázaro, Santiago	Montés-Micó R, Cerviño A, Ferrer-Blasco T, García-Lázaro S, Madrid-Costa D. The tear film and the optical quality of the eye. Ocul Surf. 2010;8(4):185—92. https://doi.org/10.1016/s1542-0124(12)70233-1 (cited 68)	García-Marqués JV, Martínez-Albert N, Talens-Estarelles C, García-Lázaro S, Cerviño A. Repeatability of Non-invasive Keratograph Break-Up Time measurements obtained using Oculus Keratograph 5 M. Int Ophthalmol.

Table 3 (*Continued*)

Researcher	Most highly cited article	Most recent article
		2021;41(7):2473–83. https://doi.org/10.1007/s10792-021-01802-4
Albarrán-Diego, César	Muñoz G, Albarrán-Diego C, Montés-Micó R, Rodríguez-Galietero A, Alió JL. Spherical aberration and contrast sensitivity after cataract surgery with the Tecnis Z9000 intraocular lens. J Cataract Refract Surg. 2006;32(8):1320–7. https://doi.org/10.1016/j.jcrs.2006.02.055 (cited 99)	Javaloy J, Druchkiv V, Beltrán J, Moya J, Albarrán-Diego C, Montalbán R, Muñoz G. Retinal detachment after phacoemulsification in refractive surgery clinics: a large series analysis with variable follow-up during 16 years. Graefes Arch Clin Exp Ophthalmol. 2021;259(6):1555–67. https://doi.org/10.1007/s00417-021-05160-w

although it may be assumed that the combination of primary and secondary search strategies would have identified similar investigators to those listed in the present study. Also, it must be noted that Scopus only considers citations accrued from 1970 onwards, although this limitation may be safely ignored in this study.

The results of this citation analysis revealed many young researchers with h-index values of or near 10, who at the time of publication may have already achieved an h-index of 11. Given the progressive difficulty to reach high h-index values, established authors are probably more stable in their rank than those in the lower tiers. The aim of this study was to portray the state of the art at the time of writing (July 2021), and results would benefit from a periodically updating system such as that offered in www.optomrankings.com[21]. Besides, although particular care was taken to complement the primary search outcome with a manual secondary search based on co-authors and institutions, the authors of this analysis would like to apologize for any unwanted omission and error in their results.

Another aspect to consider is affiliation. Scopus determines affiliation according to the information provided by authors in their last publication. It may be the case of recent changes in institution in which undue credit is given to the new host institution in detriment of the one where the author had conducted his or her main body of research. A similar concern may arise about the non-inclusion of Spanish authors currently working abroad who, until now, had undertaken their research in Spanish institutions.

It is interesting to note that of the top 10 journals of choice for Spanish investigators, 4 of them are optometry or contact lens journals: Optometry and Vision Science (American Academy of Optometry), Ophthalmic & Physiological Optics (British College of Optometrists), Contact Lens and Anterior Eye (British Contact Lens Association) and Clinical Experimental Optometry (Optometry Australia, the New

Table 4 Main target journals of Spanish optometrist researchers with indication of journal impact factor (IF) 2020, rank and quartile within the category Ophthalmology of the Journal Citation Reports (Science Citation Index Expanded), website and number and percentage of published articles from the top 10 most highly cited articles of all investigators.

Journal	IF 2020	Number (%) of articles	Website
Journal of Cataract and Refractive Surgery	3.351 (Q2; 18/62)	61 (19.1%)	https://journals.lww.com/jcrs/pages/default.aspx
Optometry and Vision Science	1.973 (Q3; 44/62)	33 (10.3%)	https://journals.lww.com/optvissci/pages/default.aspx
Journal of Refractive Surgery	3.573 (Q1; 15/62)	31 (9.7%)	https://journals.healio.com/journal/jrs
Investigative Ophthalmology & Visual Science	4.779 (Q1; 8/62)	30 (9.3%)	https://iovs.arvojournals.org/
Graefe's Archive for Clinical and Experimental Ophthalmology	3.117 (Q2; 23/62)	20 (6.2%)	https://www.springer.com/journal/417
Ophthalmic & Physiological Optics	3.117 (Q2; 24/62)	14 (4.4%)	https://onlinelibrary.wiley.com/journal/14751313
Contact Lens and Anterior eye	3.077 (Q2; 25/62)	10 (3.1%)	https://www.journals.elsevier.com/contact-lens-and-anterior-eye
American Journal of Ophthalmology	5.258 (Q1; 6/62)	10 (3.1%)	https://www.ajo.com/
Current Eye Research	2.424 (Q3; 36/62)	10 (3.1%)	https://www.tandfonline.com/toc/icey20/current
Clinical and Experimental Optometry	2.472 (Q2; 30/62)	8 (2.5%)	https://www.tandfonline.com/toc/tceo20/current

Table 5 Top 5 institutions associated with Spanish optometrist researchers with indication of number and percentage of h-index > 10 investigators pertaining to each institution and website.

Institution	Number (%) of investigators	Website
Universidad Complutense de Madrid	6 (18.7%)	http://optica.ucm.es/
Universitat de València	5 (15.6%)	http://www.uv.es/uvweb/grado-optica-optometria/es/grado-optica-optometria-1285917919322.html
Universidad de Valladolid	4 (12.5%)	https://www.uva.es/export/sites/uva/2.docencia/2.01.grados/2.01.02.ofertaformativagrados/detalle/Grado-en-Optica-y-Optometria/
Universidad de Granada	3 (9.4%)	https://grados.ugr.es/optica/
Universidad de Santiago de Compostela	3 (9.4%)	https://www.usc.gal/es/centros/opto/

Zealand Association of Optometrists, and the Hong Kong Society of Professional Optometrists). None of these are currently located in the first quartile of the Journal Citation Reports, which is an important consideration when deciding target journals, as journal rank of authored publications has direct implications in the selection processes and tenure track progress of investigators. It may be that the topic of research outweighs journal rank when selecting target journals for those studies more closely related to optometry, contact lenses and vision. Although only 3 of the 320 most highly cited papers were published in Journal of Optometry, the recent inclusion of this open access journal in the Emerging Sources Citation Index (ESCI) of the Journal Citation Reports will probably encourage more top researchers to submit their work to this journal.

The h-index was selected for this analysis. Although this index has been described as superior to other citation metrics to assess the publication output of individual investigators, it is nevertheless not free of limitations. Some of these limitations were highlighted by Efron and co-workers in their investigation.[20] For instance, the h-index may favor authors with a longer career, as longer careers may result in more publications and more time for these publications to reach the required number of citations. Similarly, a large number of co-authors from different institutions may lead to increased citation and h-index inflation, an overestimation that has led some authors to suggest the fractional allocation of citations amongst co-authors (h-frac) .[22]

Also, different subdisciplines may have different scope and impact: a recent bibliometric analysis of different fields of research within the ophthalmic literature demonstrated that dry eye, contact lens and refractive error publications have different metrics in terms of subdiscipline h-index, time span of publication, citations and even percentage of uncited papers.[23] Finally, even though optometrists with more than one degree were only included in the analysis if their main body of research was in the optometry field, working on multiple fields may expand the network of co-authors and research interests to other areas with superior metrics, probably leading to an overestimation of the actual contribution of these investigators to optometry research.

In conclusion, the citation analysis of the research production of Spanish optometrists has demonstrated the excellent health of optometry research conducted in Spanish institutions, with a growing number of prolific authors publishing in high impact journals and making important contributions to the field. Although citation metric parameters are not without limitations, this type of analysis is useful to determine the impact and scope of a field of research and may be of interest to new and experienced researchers, librarians, advisory bodies, optometry associations and general public.

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Declaration of Competing Interest

None.

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