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Scientific impact and bibliometric contextualisation of paediatrics compared to other specialities☆☆,☆

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Abstract
Introduction: The purpose of this paper is twofold. On the one hand, to identify and characterise the indicators of production, citation, impact and collaboration of the *Pediatrics* area of the Journal Citation Reports, and on the other, to place the journal Anales de Pediatría in the context of the Spanish journals of another twenty areas and medical specialties.
Material and Method: The sources of information used to obtain the indicators were Science Citation Index- Expanded, Journal Citation Reports and Scimago Journal & Country Rank. A regression analysis was performed to check the correlation between the citation and other variables.
Results: Pediatrics ranked 8th in scientific production during the period 2009–2018. In citations per journal it ranks 17th and in the average citations per article it approaches 27, occupying in this case the 18th position. Below Pediatrics are Emergency Medicine, Rehabilitation and

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Primary Health Care. 12.47% of the articles were not cited. The average impact factor places the area in 18th place and its h index were 197, reaching 14th position and standing above seven other areas. The percentage of works carried out in international collaboration was 17.71%, above *Primary Health Care* (12.88%), *Oncology* (16.37%) and *Emergency Medicine* (17.03%). Among the Spanish journals, Anales de Pediatría was the fourth most productive journal and occupied an intermediate position in terms of the number of citations.
Conclusions: The indicators of citation and impact of the *Pediatrics* area tend to be above areas such as *Emergency Medicine*, *Primary Health Care*, *Dentistry, Oral Surgery & Medicine* and *Rehabilitation*. Professional practice outside large hospitals, together with poor funding and the low number of clinical trials due to the ethical requirements imposed on studies with children, may be the causes that result in moderate citation and impact indicators.

PALABRAS CLAVE
Bibliometría;
Pediatría;
Colaboración científica;
Citación;
Impacto científico;
Anales de Pediatría

Impacto científico y contextualización bibliométrica de la Pediatría respecto a otras áreas temáticas

Resumen
Introducción: El objetivo de este trabajo es doble. Por una parte, identificar y caracterizar los indicadores de producción, citación, impacto y colaboración del área *Pediatrics* del Journal Citation Reports, y por otra, estudiar a la revista Anales de Pediatría en el contexto de las revistas españolas de otras 20 áreas y especialidades médicas.
Material y método: Las fuentes de información utilizadas para la obtención de los indicadores fueron Science Citation Index-Expanded, Journal Citation Reports y Scimago Journal & Country Rank. Se realizó un análisis de regresión para comprobar la correlación entre la citación y otras variables.
Resultados: Pediatrics ocupó el 8.º lugar en producción científica durante la década 2009–2018. En citas por revista se sitúa en el puesto 17.º y la media de citas por artículo se acerca a las 27, ocupando en este caso el puesto 18.º. Por debajo de *Pediatrics* se sitúan *Emergency Medicine*, *Rehabilitation y Primary Health Care*. El 12,47% de los artículos no fueron citados. El factor de impacto medio la sitúa en el puesto 18.º y su índice h fue 197, alcanzando la posición 14.ª y situándose por encima de otras 7 áreas. El porcentaje de trabajos realizados en colaboración internacional fue del 17,71%, por encima de *Primary Health Care* (12,88%), *Oncology* (16,37%) y *Emergency Medicine* (17,03%). Entre las revistas españolas, Anales de Pediatría fue la cuarta revista más productiva y en número de citas ocupó una posición intermedia.
Conclusiones: Los indicadores de citación e impacto del área *Pediatrics* suelen situarse por encima de áreas como *Emergency Medicine*, *Primary Health Care*, *Dentistry, Oral Surgery & Medicine y Rehabilitation*. El ejercicio profesional fuera de los grandes centros hospitalarios, unido a la deficiente financiación y al escaso número de ensayos clínicos debido a las exigencias éticas impuestas a los estudios con población infantil, pueden ser las causas que provocan unos indicadores de citación e impacto moderados.

Introduction

In the international scientific community, there is broad consensus that the number of citations and other derived indicators (impact indicators) cannot be used to compare subject areas or different specialties for various reasons. On one hand, the size of the field of research influences the number of citations that an article (or journal) may achieve: in a community of 500 researchers, the absolute frequency of citations will be smaller than in a community of 5000 researchers.[1,2] On the other, each field of science exhibits different citation patterns. For example, while articles in the fields of biochemistry or social sciences include approximately 30 references each, articles in engineering tend to have 10 references and articles in mathematics 5, and therefore the probability of being cited in the biochemical literature is 6 times greater than the probability of being cited in the mathematical literature. Similar patterns can be found in the medical specialty literature, especially in fields with a smaller ''research mass'' or in which clinical practice predominates over basic research.[3–5]

Some of the agencies that evaluate bibliometric performance do not take into account the existing variability between specialties and include all of them in the broader umbrella of Medicine, using citation and impact indicators to compare them, which can be seriously and unfairly damaging to researchers in small or medium-size fields that compete at a disadvantage, as the instruments that evaluate their performance are not adjusted to the characteristics of their fields.

Numerous studies have been published that analyse the current situation, evolution and trends of paediatric research worldwide[6–8] and in Spain,[9] some of which have focused on paediatric subspecialties and others on specific journals.[9–14] A search we did on the subject in the PubMed database in October 2019 with the terms (P̈ediatrics[Mesh]) AND B̈ibliometrics[Mesh]) retrieved 181 articles. However, we did not find studies comparing bibliometric indices in paediatrics with those of other medical specialties, a crucial aspect that we believe should be analysed and discussed, always taking into account the particular characteristics of each field.

The aim of our study was two-fold: on one hand, we aimed to identify and characterize indicators for the output, citation, impact and collaboration in the Journal Citation Reports *Pediatrics* category, and on the other, to characterize the position of the journal *Anales de Pediatría* in the context of the Spanish journals in the other 20 medical specialties/categories.

Materials and methods

The source we used to obtain indicators were: the Science Citation Index-Expanded (SCI) database of the Web of Science (WoS) for output indicators, the Journal Citation Reports (JCR) for impact indicators, and the Scimago Journal & Country Rank (SJR) (sites that offer information on scientific indicators of journals indexed in the SCI and Scopus databases, respectively) for collaboration indicators. The period we selected to present the indicators in annual or cumulative distributions was the 2009–2018 decade, and we restricted the sample to original articles.

We selected the subject categories related to Paediatrics from the website of the Asociación Española de Pediatría (Spanish Association of Paediatrics [AEP], https://www.aeped.es/especialidades), choosing medical fields associated to any of the 24 paediatric specialty associations affiliated to the AEP. In the end, our study included the subject of *Pediatrics* and the 20 subject categories listed in Table 1.

We structured the study in 2 parts. The first part consisted in the analysis of the Paediatrics subject category in the context of the other 20 medical specialties. In the second part, we analysed *Anales de Pediatría* in comparison with the other Spanish journals indexed in the SCI.

We classified indicators into:

1 Output indicators: number of documents, number of journals per subject and number of documents per journal.
2 Citation indicators: number of citations, average number of citations per journal, average number of citations per article and number of uncited articles.
3 Impact indicators: mean impact factor, aggregate impact factor and h-index. We calculated the mean impact factor by dividing the impact factor of all journals in a given category in one year by the number of journals in the category. We calculated the aggregate impact factor in the same way, but using the number of citations and the number of articles in the journals in the category.
4 Indicators of the most frequently cited articles by subject category.
5 Indicators of international collaboration. To calculate these indicators, we selected the 5 journals with the highest impact factors (IFs) in 2018 in each JCR Science Edition subject category for the year, and obtained the percentage of international collaboration for each journal from the SJR, which reflects the proportion of documents signed by authors from more than 1 country. We then calculated the mean values for each journal, taking into account the years for which data was available, either for the full 2009–2018 decade or the years following indexation of the journal in the database. Lastly, we calculated the mean of the 5 journals to obtain the indicator for each subject category. We also calculated the interquartile range between the journals with the highest and lowest percentages of international collaboration.

Table 1 Specialties and subject categories under study.

Specialty	Journal Citation Reports subject category
Allergy	Allergy
Cardiology	Cardiac & Cardiovascular System
Intensive Care	Critical Care Medicine
Paediatric odontology	Dentistry, Oral Surgery & Medicine
Emergency Medicine	Emergency Medicine
Endocrinology	Endocrinology & Metabolism
Gastroenterology	Gastroenterology & Hepatology
Genetics	Genetics & Heredity
Haematology	Hematology
Immunology	Immunology
Infectious Diseases	Infectious Diseases
Neurology	Neurosciences
Oncology	Oncology
Primary Care	Primary Care Health
Diagnostic Imaging	Radiology, Nuclear Medicine & Medical Imaging
Rehabilitation	Rehabilitation
Pulmonology	Respiratory System
Rheumatology	Rheumatology
Surgery	Surgery
Nephrology	Urology & Nephrology

We included Spanish journals based on the hits obtained in a search of the JCR database in 2018 of the 21 subject categories (*Pediatrics* and the 20 categories listed in Table 1). The search yielded 24 journals, and we obtained indicators similar to those obtained for the subject categories and the number of funded articles. We conducted the searches on

September 16, 2019 using computer terminals of the Universitat de València.

We performed the statistical analysis with the software Statgraphics Centurion XVI, calculating the correlations between variables. We also performed logarithmic transformation to normalize the data and obtain regression curves as needed.

Results

The *Paediatrics* subject category in the context of the other 20 medical specialties

Scientific output: number of articles, number of journals per subject category and number of articles per journal

Table 2 presents the distribution of output, citation and impact indicators by subject category, listed in alphabetical order based on the name of the category in the JCR database. The categories corresponding to the greatest number of documents published were *Surgery* (391 696), followed by *Oncology* (339 256) and *Clinical Neurology* (227 585), and the categories with the least documents published were *Primary Health Care* (13 391), *Allergy* (19 002) and *Cardiac & Cardiovascular System* (24 173), while *Pediatrics*, with 140 555 documents, ranked 8th.

When it came to the mean number of journals per subject, we found the highest value in *Oncology* (204), followed by *Surgery* (196) and *Clinical Neurology* (191), while the lowest values corresponded to *Primary Health Care* (18), *Allergy* (24) and *Emergency Medicine* (24). *Pediatrics* had a mean of 117, which once again placed this subject in an intermediate position (9th) relative to the other subjects considered in the analysis.

Lastly, when we obtained the mean number of articles, we found that the leading journal was *Oncology* (1768.29), followed by *Surgery* (1666.47) and *Critical Care Medicine* (1604.37) while those with the least articles were *Primary Health Care* (675.94), *Rehabilitation* (820.39) and *Allergy* (964.17). *Pediatrics* ranked 15th with 1290.46 documents.

Citations: number of citations, mean number of citations per journal, mean citations per article and number of uncited articles

Five subject categories neared or exceeded 10 million citations (*Oncology, Immunology, Clinical Neurology, Genetics & Heredity* and *Surgery*), while four categories did not reach or barely exceeded 1 million citations (*Primary Health Care, Emergency Medicine, Allergy* y *Rehabilitation*). The total number of citations corresponding to documents in the subject of *Pediatrics* exceeded 4 million (4 053 493), placing this category in the 12th position.

The mean number of citations per journal in the subject of *Pediatrics* was 34 734.30, placing it in the 17th position, above *Primary Health Care, Rehabilitation, Emergency Medicine* and *Dentistry, Oral Surgery & Medicine*. The mean number of citations per article neared 27, and the subject ranked 18th on this factor; *Hematology, Genetics & Heredity, Critical Care Medicine, Immunology* and *Endocrinology & Metabolism* neared or exceeded 50 citations per article. The categories that ranked below *Pediatrics* again included *Emergency Medicine, Rehabilitation* and *Primary Health Care*. Fig. 1 presents a comparison of the scientific output and mean number of citations per article for each subject category.

We identified 17 528 uncited articles in the category of *Pediatrics*, amounting to 12.47% of the total articles. This percentage was only lower compared to *Emergency Medicine* (16.73%) and *Primary Health Care* (12.81%). The percentages were lower in the other categories that we analysed, with percentages of around 6% in 7 of them (*Immunology, Endocrinology & Metabolism, Hematology, Critical Care Medicine, Gastroenterology & Hepatology, Infectious Diseases* and *Rheumatology*).

Impact: mean and aggregate impact factors and h-index

The mean impact factor of journals in the subject category of *Pediatrics* (1505) placed this category in the 18th position, and the aggregate impact factor (1989) in the 17th position. Again, the subject categories that ranked below *Pediatrics were Emergency Medicine, Dentistry, Oral Surgery & Medicine* and *Rehabilitation* when it came to the mean impact factor, and the same in addition to *Primary Health Care* when it came to the aggregate impact factor.

The relative ranking of *Pediatrics* improved if the h-index was considered instead (197), achieving the 14th position, above another 7 categories.

Characteristics of the most cited articles

The most cited articles (Table 3) corresponded to the categories of *Genetics & Heredity* (40 891 citations), *Oncology* (24 184) and *Endocrinology & Metabolism* (8716). The most cited article in *Pediatrics* was cited 1965 times. We found very small differences in the distribution by subject category when we took into account the number of years elapsed since the publication of the articles. The 3 categories with the most cited articles were also the categories with the highest number of articles cited more than 1000 times, led by 85 articles in *Oncology* and 68 in *Genetics & Heredity*, compared to only 4 articles in *Pediatrics*. The categories with the most articles cited more than 500 times were, again, *Oncology* (335) and *Genetics & Heredity* (223), followed by *Immunology* (126). We found 23 such articles in the subject category of *Pediatrics*. Table S1 in the supplemental materials lists the 10 most-cited articles in each subject category.

Collaboration

The highest percentage of articles fruit of international collaboration (Table 4) corresponded to *Genetics & Heredity* (40.34%), followed by *Dentistry, Oral Surgery & Medicine* (39.53%) and *Infectious Diseases* (34.37%), while the lowest percentages corresponded to *Primary Health Care* (12.88%), *Oncology* (16.37), *Emergency Medicine* (17.03) and *Pediatrics* (17.71). Table S2 in the supplemental materials presents detailed information on how these indicators were calculated.

When we performed a simple regression analysis to assess the association between the percentage of international collaboration and the mean number of citations per article, we found a correlation coefficient (r) of 0.559649 with a *p*-value of 0.0083. Thus, the analysis revealed a significant, positive linear correlation between these variables and that

Table 2 Output, citation and impact indicators by subject category.

Subject categories	Science Citation Index- Expanded 2009–2018				Journal Citation Reports - Science Edition 2009–2018							
	Scientific output	Uncited documents	% uncited documents	H-index	Mean journals	Articles	Total Cites	Mean articles/ journal	Mean cites/ journal	Mean cites/ article	Mean IF. 10 years	Aggregate IF. 10 years
Allergy	19 002	1638	8.62%	172	24	23 140	1 018 622	964.17	42 442.58	44.02	2.602	4.233
Cardiac & Cardiovascular System	24 173	1738	7.19%	134	121	177 259	7 913 852	1462.53	65 295.81	44.65	2.161	4.016
Clinical Neurology	227 585	19 767	8.69%	303	191	253 133	10 227 791	1328.08	53 661.02	40.40	2.279	3.196
Critical Care Medicine	43 801	2807	6.41%	226	28	45 564	2 401 421	1604.37	84 557.08	52.70	2.491	4.196
Dentistry. Oral Surgery & Medicine	82 779	8680	10.49%	143	84	85 457	2 634 051	1019.77	31 432.59	30.82	1.362	1.851
Emergency Medicine	30 872	5166	16.73%	110	24	32 726	695 403	1346.75	28 617.41	21.25	1.122	1.810
Endocrinology & Metabolism	146 663	8951	6.10%	282	128	161 003	8 043 674	1262.77	63 087.64	49.96	2.820	4.070
Gastroenterology & Hepatology	100 873	6544	6.49%	296	76	112 059	5 074 134	1476.40	66 852.89	45.28	2.544	4.086
Genetics & Heredity	182 766	14 067	7.70%	388	163	187 215	10 190 921	1147.85	62 482.65	54.43	2.546	4.281
Hematology	90 372	5593	6.19%	265	68	103 678	5 742 366	1520.21	84 198.91	55.39	2.592	4.683
Immunology	190 608	11 089	5.82%	338	145	214 758	10 974 588	1486.21	75 948.71	51.10	2.923	4.320
Infectious Diseases	123 950	8288	6.69%	237	75	119 279	4 453 823	1592.51	59 463.59	37.34	2.559	3.611
Oncology	339 256	24 253	7.15%	443	204	360 731	15 234 288	1768.29	74 677.88	42.23	2.769	4.444
Pediatrics	140 555	17 528	12.47%	197	117	150 597	4 053 493	1290.46	34 734.30	26.92	1.505	1.989
Primary Health Care	13 391	1715	12.81%	83	18	12 242	314 834	675.94	17 383.47	25.72	1.534	1.674
Radiology. Nuclear Medicine & Medical Imaging	178 817	16 116	9.01%	269	121	184 272	6 325 448	1524.17	52 319.67	34.33	1.830	2.849
Rehabilitation	49 525	5454	11.01%	127	59	48 403	1 228 965	820.39	20 829.92	25.39	1.448	1.814
Respiratory System	77 285	6127	7.93%	239	54	79 942	3 505 982	1483.15	65 046.05	43.86	2.461	3.718
Rheumatology	40 825	2809	6.88%	193	30	46 131	1 892 521	1548.02	63 507.42	41.02	2.583	3.845
Surgery	391 696	43 925	11.21%	256	196	325 795	9 910 563	1666.47	50 693.42	30.42	1.517	2.257
Urology & Nephrology	89 967	8959	9.96%	213	74	99 522	3 600 483	1339.46	48 458.72	36.18	1.878	3.032

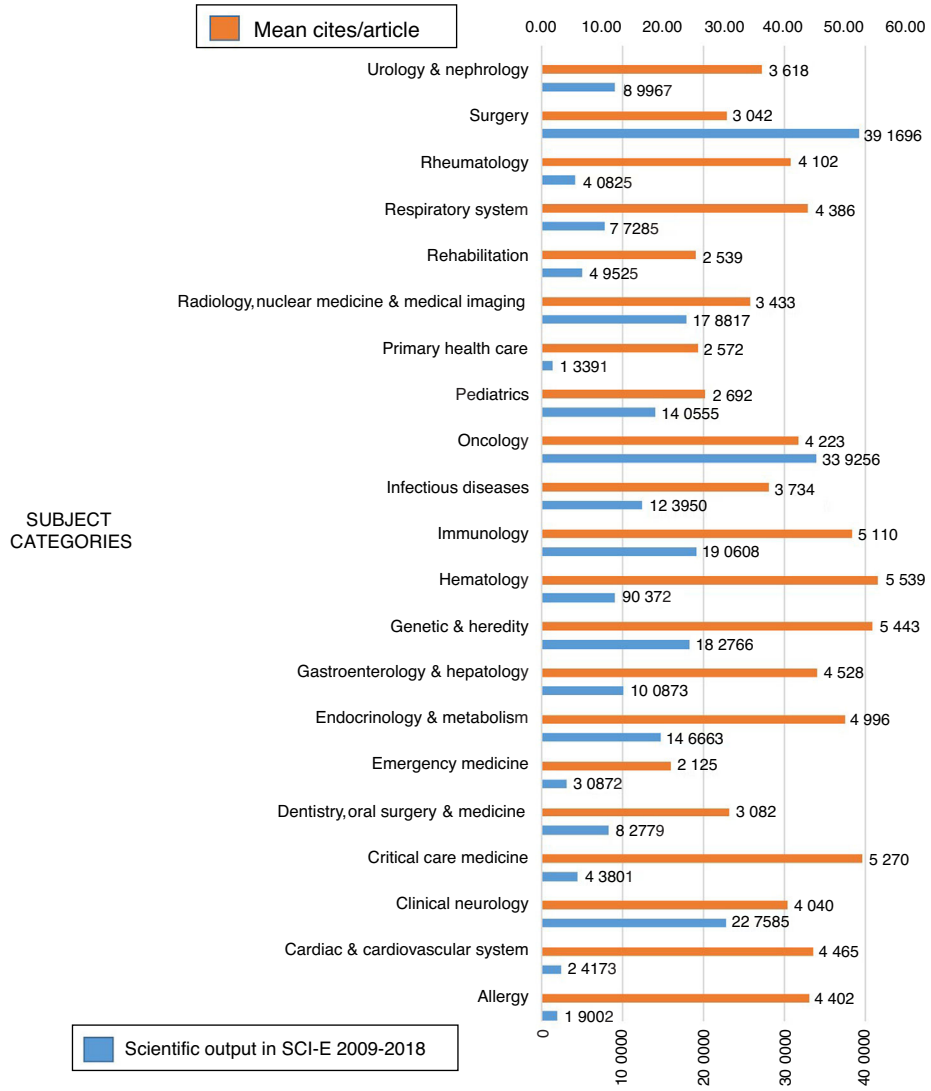

Fig. 1 Scientific output and mean number of citations per article by subject category.

31% of the variability in the percentage of collaboration was explained by the variability in the mean number of citations per article. The regression model showed that when the collaboration increased by 1 percentage point, the mean number of citations per article increased by nearly 0.79.

Anales de Pediatría in the context of the other Spanish journals included in the JCR

Table 5 presents several indicators for the 24 Spanish journals included in the JCR under the subject categories analysed in our study. *Anales de Pediatría* ranked 4th in terms of output (933 articles), outperformed solely by *Revista de Neurología* (1375), *Clinical & Translational Oncology* (1299) and *Medicina Oral Patología Oral y Cirugía Bucal* (1206). When it came to the number of citations, it ranked somewhere in the middle (12th, with 2945 citations). The most cited article was published in 2009, with 37 citations. The percentage of uncited articles was of 21.76%, below the journals in 6 other subject categories, including *Urology & Nephrology, Endocrinology & Metabolism, Clinical Neurology, Radiology* and *Primary Health Care*. It ranked 18th based on the h-index, and 21st based on the mean number of citations per article, once again *Urology & Nephrology, Endocrinology & Metabolism* and *Clinical Neurology*. The percentage of funded articles did not reach 1%, which was similar to the percentages in other journals such as *Neurocirugía*, *Revista de Neurología* or *Archivos Españoles de Urología*.

Fig. 2 presents a graphical comparison of the scientific output and mean number of citations per article of the Spanish journals.

When we analysed the percentage of funded articles relative to the percentage of uncited articles, we found a correlation coefficient of −0.5632, which was negative, of intermediate value and significant, and suggested that the greater the percentage of funded articles, the lower the percentage of uncited articles. In the case of *Anales de Pediatría*, despite a low percentage of funded articles, the percentage of uncited articles was lower than would be expected based on the regression model.

Table 3 Citation-related indicators of the most cited article in each subject area.

Subject category	Cites of most cited article, *n*	Years elapsed	Mean cites/year	Articles with >1000 cites, *n*	Articles with >500 cites, *n*
Allergy	1186	9	132	1	7
Cardiac & Cardiovascular System	2983	5	597	3	14
Clinical Neurology	4754	8	594	20	90
Critical Care Medicine	4467	6	745	13	49
Dentistry, Oral Surgery & Medicine	751	7	107	0	6
Emergency Medicine	736	9	82	0	3
Endocrinology & Metabolism	8716	5	1743	20	82
Gastroenterology & Hepatology	2162	7	309	8	79
Genetics & Heredity	40 891	8	5111	68	223
Hematology	2824	6	471	6	44
Immunology	2824	6	471	15	126
Infectious Diseases	2928	7	418	13	51
Oncology	24 184	8	3023	85	335
Pediatrics	1965	9	218	4	23
Primary Health Care	555	10	56	0	2
Radiology, Nuclear Medicine & Medical Imaging	4042	4	1011	13	76
Rehabilitation	506	10	51	0	1
Respiratory System	3181	8	398	16	56
Rheumatology	2802	9	311	8	27
Surgery	2983	5	597	5	51
Urology & Nephrology	2907	10	291	8	35

Table 4 International collaboration of the 5 journals with the highest impact by subject category.

Subject categories	Int. collab. of top 5 journals in Q1 – 2009–2018	Interquartile range
Allergy	27.77	18.26–42.58
Cardiac & Cardiovascular System	27.96	12.25–45.20
Clinical Neurology	31.64	21.63–47.59
Critical Care Medicine	30.59	18.71–61.49
Dentistry, Oral Surgery & Medicine	39.53	2.18–60.43
Emergency Medicine	17.03	3.29–36.46
Endocrinology & Metabolism	27.58	7.82–38.32
Gastroenterology & Hepatology	26.69	11.65–35.90
Genetics & Heredity	40.34	13.36–55.58
Hematology	32.03	26.91–42.32
Immunology	29.18	13.45–39.76
Infectious Diseases	34.37	27.71–39.76
Oncology	16.37	10.55–23·81
Pediatrics	17.71	12.63–23.83
Primary Health Care	12.88	1.65–41.20
Radiology, Nuclear Medicine & Medical Imaging	29.36	21.03–43.01
Rehabilitation	23.98	12.43–32.56
Respiratory System	27.17	19.76–40.80
Rheumatology	27.38	12.14–44.04
Surgery	18.49	7.26–30.51
Urology & Nephrology	24.60	12.83–37.05

Discussion

This study allowed us to establish the ranking of global and Spanish paediatrics publications in absolute terms and in relation to other subjects based on a selected set of output, citation, impact and collaboration indicators. The sources used for the purpose were the WoS SCI and JCR databases, supplemented with information from the SJR. We obtained some of the indicators directly from these sources and calculated the rest. To make comparisons with other fields, we chose the 20 subjects covered by the ''specialty associations'' affiliated to the

Table 5 Indicators for Spanish journals in the 21 subjects included in the analysis.

Journal	Subject categories	2018 IF	Output in SCI-E 2009–2018	Cites 2009–2018	Cites in most cited article	Uncited docs	% uncited docs	H-index	Mean cites/doc	Unfunded docs	Funded docs	% funded docs
Journal of Investigational Allergology and Clinical Immunology	Allergy / Immunology	3.802	520	6511	178 (2011)	32	6.15%	33	12.52	281	239	45.96%
Allergologia et Immunopathologia	Allergy / Immunology	1.640	577	3487	208 (2013)	63	10.92%	20	6.04	379	198	34.32%
Revista Española de Cardiología	Cardiac & Cardiovascular System	5.126	890	10 802	128 (2011)	42	4.72%	39	12.14	638	252	28.31%
Neurología	Clinical Neurology	2.038	478	2430	40 (2011)	69	14.44%	19	5.08	5	473	98.95%
Neurocirugía	Clinical Neurology / Surgery	0.519	336	1055	59 (2009)	90	26.79%	13	3.14	333	3	0.89%
Revista de Neurología	Clinical Neurology	0.485	1 375	4687	57 (2011)	360	26.18%	19	3.41	1361	14	1.02%
Medicina Intensiva	Critical Care Medicine	1.982	501	2761	50 (2013)	43	8.58%	19	5.51	466	35	6.99%
Medicina Oral Patología Oral y Cirugía Bucal	Dentistry, Oral Surgery & Medicine	1.284	1 206	10 939	102 (2009)	101	8.37%	36	9.07	930	276	22.89%
Emergencias	Emergency Medicine	3.350	454	2796	89 (2010)	93	20.48%	25	6.16	SD	SD	SD
Endocrinología y Nutrición	Endocrinology & Metabolism	1.649	170	802	37 (2014)	21	12.35%	13	4.72	136	34	20.00%
Endocrinología Diabetes y Nutrición	Endocrinology & Metabolism	0.934	113	143	8 (2017)	45	39.82%	5	1.27	95	18	15.93%

Table 5 (*Continued*)

Journal	Subject categories	2018 IF	Output in SCI-E 2009–2018	Cites 2009–2018	Cites in most cited article	Uncited docs	% uncited docs	H-index	Mean cites/doc	Unfunded docs	Funded docs	% funded docs
Revista Española de Enfermedades Digestivas	Gastroenterology & Hepatology	1.858	766	4470	61 (2013)	141	18.41%	24	5.84	682	84	10.97%
Gastroenterología y Hepatología	Gastroenterology & Hepatology	1.126	528	1809	31 (2012)	109	20.64%	15	3.43	502	26	4.92%
Aids Reviews	Immunology / Infectious Diseases	2.357	69	1032	108 (2011)	4	5.80%	18	14.96	33	36	52.17%
Enfermedades Infecciosas y Microbiología Clínica	Infectious Diseases	1.685	821	4486	58 (2011)	112	13.64%	23	5.46	692	129	15.71%
Clinical & Translational Oncology	Oncology	2.441	1 299	11 207	174 (2010)	94	7.24%	35	8.63	762	537	41.34%
Anales de Pediatría	Pediatrics	1.166	933	2945	37 (2009)	203	21.76%	15	3.16	926	7	0.75%
Atención Primaria	Primary Health Care	1.346	677	2610	49 (2010)	150	22.16%	18	3.86	662	15	2.22%
Revista Española de Medicina Nuclear e Imagen Molecular	Radiology, Nuclear Medicine & Medical Imaging	0.928	363	1193	26 (2012)	90	24.79%	12	3.29	343	20	5.51%
Archivos de Bronconeumología	Respiratory System	4.214	622	5869	168 (2012)	52	8.36%	29	9.44	610	12	1.93%
Cirugía Española	Surgery	0.835	642	2689	60 (2014)	121	18.85%	18	4.19	SD	SD	SD
Nefrología	Urology & Nephrology	1.439	655	3580	154 (2010)	100	15.27%	21	5.47	615	40	6.11%
Actas Urológicas Españolas	Urology & Nephrology	1.136	851	3611	68 (2011)	140	16.45%	19	4.24	848	3	0.35%
Archivos Españoles de Urología	Urology & Nephrology	0.335	680	817	25 (2014)	337	49.56%	9	1.20	672	8	1.18%

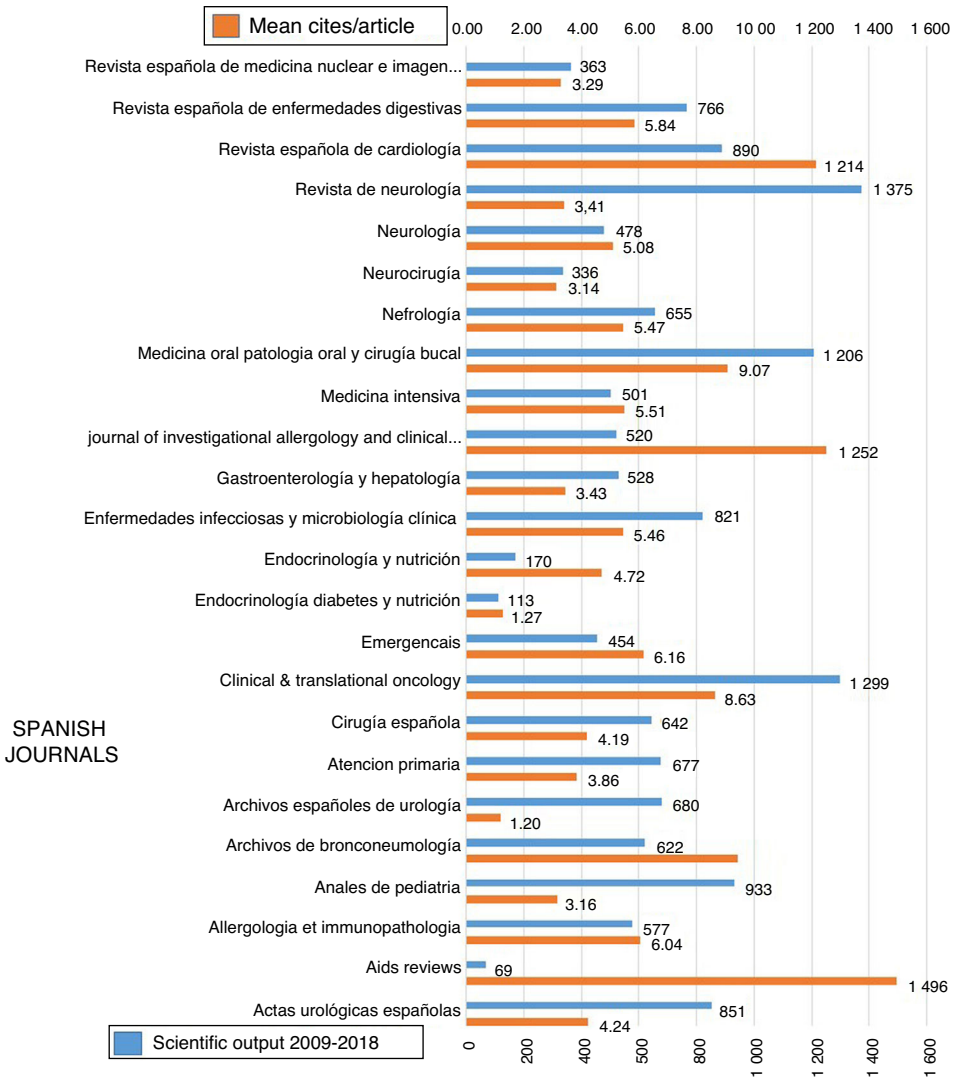

Fig. 2 Scientific output and mean number of citations per article of the Spanish journals.

Asociación Española de Pediatría (https://www.aeped.es/especialidades).

As we previously discussed, in absolute terms the subject category of *Pediatrics* held an intermediate position in relation to the other categories, both in the mean number of journals and in its output (ranking 9th in both) and in terms of citations (ranking 12th). However, taking into account other relative indicators, such as the mean number of citations per journal or the percentage of uncited articles, it ranks 17th and 19th, respectively. We found a similar trend in the mean and aggregate impact factors, which placed *Pediatrics* in the 18th and 17th positions, respectively.

In most citation-related indicators, the *Pediatrics* category usually ranked higher than 2 other categories (*Emergency Medicine* and *Primary Health Care*), and it also outperformed another 2 categories in other indicators (*Dentistry, Oral Surgery & Medicine* and *Rehabilitation*). The analysis of the most cited documents yielded a perspective that was similar to the perspective obtained with other citation-based indicators, placing *Pediatrics* above the same specialties.

A finding worth highlighting is that the h-index for *Pediatrics* ranked this category above not only the 4 specialties we already mentioned, but also above others such as *Cardiac & Cardiovascular System*, *Allergy* and *Rheumatology*. However, this indicator is not the most suitable to compare different research fields, as it does not take into account the differences in the patterns of publication and citation between fields. The h-index is high in subjects with a long research tradition.[15,16]

Collaboration is a key factor in research. The multidisciplinary, technical and complex nature of biomedical research requires teamwork, and its maximum expression is the formation of international teams for the development of collaborative international projects such as multicentre trials.[17–19] In the category of *Pediatrics*, international collaboration occurred in nearly 18% of the articles, a percentage that once again outperformed *Emergency Medicine* and *Primary Health Care*, and, in this case, also *Oncology*. There is evidence that clinical trials conducted through collaborative networks give rise to articles with high numbers of citations and published in high-impact journals.[20,21] The

regression analysis showed that international collaboration was associated with a higher mean number of citations per article.

Compared to other Spanish journals indexed in SCI, *Anales de Pediatría* is one of the most productive journals and occupies an intermediate position based on the number of citations. The mean number of citations per article is not high, but it is above the mean for specialties such as *Urology & Nephrology, Endocrinology & Metabolism* and *Clinical Neurology*.

One of the possible explanations of the position of *Pediatrics* relative to other subject categories is the dearth of published paediatric randomised controlled trials. Clinical trials in children are affected by numerous methodological, ethical and economic barriers in meeting quality standards, which hinders their performance. On the other hand, the marketing authorisation of drugs distributed in Europe included evidence from paediatric clinical trials in only 30% of drugs.[22] Initiatives such as the Global Research in Paediatric (GRiP) project, aimed at the research and development of safe and effective drugs for children and launched under the Seventh Framework Programme of the European Commission, may contribute to improving this situation. In this context, Salim et al. found that, following the trend observed in other medical specialties, there has been a significant increase in recent years in the publication of systematic reviews in paediatric surgery, although their quality has been poor.[23]

Paediatric diseases are often rare and may only affect a small number of patients, and therefore it may be necessary to develop research networks and perform multicentre studies to obtain significant results. In this regard, there has been a substantial increase in collaborative projects and in the development of paediatrics research networks in recent years, but it is still too soon to evaluate the results and necessary to continue to develop these initiatives.

On the other hand, a high percentage of paediatricians carry out their work at the outpatient level outside hospitals with scarce resources and far from larger health care facilities that are better equipped, which means they produce less research, as their circumstances are less advantageous compared to medical professionals in other fields that are mainly hospital-based or involve basic research.

To improve the quality of paediatrics research and with it citation and impact indicators, it would be worth promoting training in research methods to provide these specialists with the skills required to design and participate in paediatric clinical trials.[24–26] Holland et al. found that each additional year of training in research methods in a national child health institute in the United States was associated with a 15% increase in the h-index.[27] A key point in this process is to facilitate the collaboration and pooling of resources between academics, health care providers, regulatory agencies and industry at both the national and international levels. At the same time, governments and educational institutions should provide an appropriate framework to reward companies that invest in paediatric research.

There is no question that since this is a multifactorial problem, it is challenging to identify every necessary improvement strategy in order to improve the standing of the field of *Pediatrics* relative to other subjects. Years ago, we performed a strengths, weaknesses, opportunities, and threats (SWOT) analysis of the Spanish paediatric research publication output (based on a study of science output metrics for the 2006–2010 period conducted by the Asociación Española de Pediatría),[9,28,29] and some of their conclusions as to the strengths, weaknesses, opportunities, and threats can apply to our current discussion.

One of the limitations of this study is that some of the indicators that we used, especially the impact factor, have drawbacks when used as tools for assessing research that have been extensively debated in the literature. Some of the most relevant drawbacks, as discussed above, is that these indicators exhibit significant variability depending on the field of research, that they may be manipulated by editors and the lack of transparency as regards the data used for their calculation.[30–32] In this regard, the San Francisco Declaration on Research Assessment recommends against using journal-based metrics, such as the impact factor, as a measure of the quality of individual research articles, to assess the contribution of an individual researcher or to guide funding, appointment, and promotion decisions.[33]

Conclusions

The citation and impact indicators in *Pediatrics* tended to be lower compared to other subject categories, with the exception of *Emergency Medicine*, *Primary Health Care*, *Dentistry, Oral Surgery & Medicine* and *Rehabilitation*. The various factors mentioned above may contribute to this situation.

Whatever the reason, the final conclusion is clear and was one of the aims of this study: if the agencies that evaluate scientific output do not take this inter-specialty variability into account and place all of these journals in the broader subject of Medicine, the category of *Pediatrics* (and, therefore, paediatricians) is at a disadvantage when it comes to applying for grants and competing for national and international funding, which constitutes a vicious cycle that will be difficult to overcome.

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