

Research Article

Increase in Early Onset Scoliosis Publications in Major Orthopaedic and Spine Journals: 2005-2020

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Citation: Murphy RF, et al. Increase in Early Onset Scoliosis Publications in Major Orthopaedic and Spine Journals: 2005-2020. J Pediatric Adv Res. 2024;3(1):1-8.

<http://dx.doi.org/10.46889/JPAR.2024.3102>

Received Date: 23-01-2024

Accepted Date: 13-02-2024

Published Date: 20-02-2024



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Abstract

Study Design: Retrospective review

Purpose: To quantify trends in published research in 8 major orthopaedic and spine journals related to Early Onset Scoliosis (EOS) from 2005-2020. We also investigated publication trends in specific subtopics within EOS research.

Methods: The electronic archives of 8 journals (Spine, European Spine Journal, Journal of Children's Orthopaedics, Spine Deformity, Journal of Pediatric Orthopaedics, Journal of Pediatric Orthopaedics B, The Journal of Bone and Joint Surgery-American Volume and The Bone and Joint Journal) were queried for articles published from 2005-2020 containing search terms particular to the following subtopics of EOS research: congenital scoliosis, infantile scoliosis, thoracic insufficiency syndrome, scoliosis casting, Traditional Growing Rod, Vertical Expandable Prosthetic Titanium Rib, Magnetically Controlled Growing Rod and EOS in general. Results were screened to exclude editorials, conference papers and corrections. Included EOS articles were aggregated and analyzed with respect to journal, year of publication and subtopic.

Results: From 2005-2020, a total of 32,000 publications were identified, of which 1,818 (5.7%) were qualified as EOS articles by the presence of at least one search term. The annual number of EOS articles increased from 60 in 2005 to 157 in 2020 and the annual ratio of EOS articles to total publications increased from 4.1% to 7.9%. Congenital spine-related terms matched to the greatest number of articles, while implant-related terms collectively experienced the greatest percentage increase in matching articles per year.

Conclusion: The number of EOS articles published in 8 major orthopaedic and spine journals increased in both absolute and relative terms from 2005-2020. Implant-related subtopics saw

the greatest increase.

Keywords: Early Onset Scoliosis; Traditional Growing Rod; Orthopaedic; Journal

Introduction

Early Onset Scoliosis (EOS) is a condition defined by curvature of the spine greater than 10° before the age of 10 [1,2]. EOS etiology is diverse and includes congenital, neuromuscular, syndromic and idiopathic factors [3]. While the first references to EOS date to the 1950s, treatment at that time was limited and most reports were observational series [4-7]. As surgeon experience with this condition expanded, a deepened understanding of the consequences of early fusion on skeletally immature patients led surgeons to seek novel means of correcting scoliosis without impeding spine and thoracic development. Several iterations of "growth-friendly" constructs were developed to meet this need [8-13]. The 3 most widely adopted today are the Traditional Growing Rod (TGR), the Vertical Expandable Prosthetic Titanium Rib (VEPTR™) and most recently, the Magnetically Controlled Growing Rod (MCGR) [14-16].

Following these developments, an acceleration in EOS-related research efforts has become apparent among clinicians treating children with this condition. Existing bibliometric data on this subject are scarce and no study to date has measured the publication volume of EOS against the broader fields that encompass it (i.e., orthopaedics, pediatric orthopaedics and spine surgery). Quantifying and characterizing these trends may inform future investment in this developing field of research. The purpose of this study was to review the presence and proliferation of EOS-related subtopics in peer-reviewed articles, with attention to various EOS subtopics and specific orthopaedic and spine journals.

We hypothesized that over the period spanning 2005 through 2020, EOS article volume would increase more rapidly than total journal publication volume, thus comprising a greater percentage of the literature in this field over time. Additionally, we hypothesized that literature related to “growth-friendly” implants would experience the greatest increase.

Material and Methods

Data Collection

The electronic archives of 8 orthopaedic and spine journals were queried for publications during a 16-year study period from Jan 1, 2005, through Dec 31, 2020. The included journals were Spine, European Spine Journal (ESJ), Journal of Children’s Orthopaedics (JCO), Spine Deformity (SDEF), Journal of Pediatric Orthopaedics (JPO), Journal of Pediatric Orthopaedics B (JPO-B), The Journal of Bone and Joint Surgery-American Volume (JBJS) and The Bone and Joint Journal (BJJ) (formerly The Journal of Bone and Joint Surgery-British Volume). The annual number of total publications was determined for each journal by querying content type and year only; these results were not screened.

There were 23 search terms divided between the 8 EOS subtopics (Table 1). To reduce the number of duplicates produced by articles matching multiple terms within a single subtopic, queries were performed using Boolean search strings with straight quotation marks, following a standardized format that was tested for compatibility with each journal’s archive search function.

Archive queries were performed independently by 3 authors, each assigned to a subset of the included journals. A search restriction for content type (articles) and publication year 2005-2020 was used in all queries (Table 1). Queries for all-fields/full-text were performed separately for each search string to allow for stratification by subtopic. For each record, the full title (including subtitle), publishing journal, year of publication and matching subtopics were recorded. Duplicates were removed prior to screening (Fig. 1).

Screening

Screening of EOS records was conducted by one author 3 times on 3 separate occasions. Record titles and publication dates were individually inspected for eligibility. Records were included if they were published in one of 8 included journals from 2005-2020, were indexed as “articles” in the journal’s archives, matched to one or more EOS search terms (as determined by archive query methods) and were peer-reviewed original or review articles (as determined by inspection of full title and subtitle). Records were excluded if their titles designated them as conference abstracts, papers or proceedings, editorial content (including correspondence) or corrections (Fig. 1). Ambiguity regarding eligibility was resolved by inspection of the associated source document.

Analysis

The data were aggregated and descriptive analysis was performed with Microsoft Excel. For each year of the study period, the number of EOS articles and total publications in each journal were tabulated, along with the number of EOS articles matching to each subtopic. The annual ratio of EOS articles to total publications was then calculated for each journal.

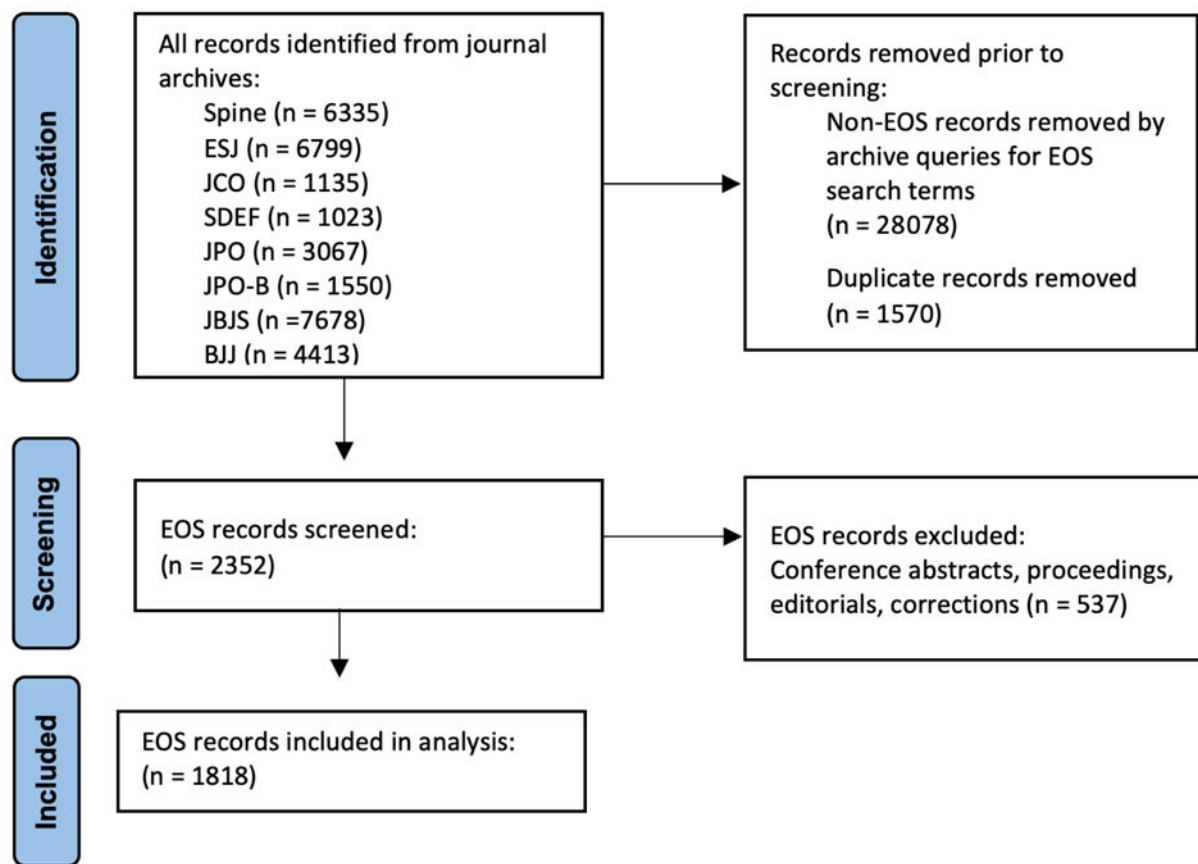


Figure 1: PRISMA flow diagram showing record selection process [27].

Results

Our review of the archives of 8 orthopaedic journals identified 32,000 total publications over a 16-year study period from 2005-2020. Over that span, there was a considerable increase in total publication volume across all 8 journals. In 2005, the 6 actively publishing journals combined for 1,475 publications. In 2020, those same 6 journals combined for 1,870 publications, representing an increase of 26.8%. JCO and SDEF were not actively publishing until 2007 and 2012, respectively. JCO accounted for 65 publications in its inaugural year, 2007 and 86 in 2020, representing an increase of 32%. SDEF exhibited the most rapid growth in publishing volume, increasing from 20 publications in 2012 to 176 in 2020 or 780% in 8 years.

Of 32,000 total publications, 1,818 (5.7%) were identified as EOS articles (Table 2). Variability was observed among the journals concerning the extent of their EOS focus, with 32.7% of SDEF publications being EOS articles, compared to 0.6% of those in BJJ. Additional journals with a high percentage of EOS articles were the other spine-focused journals, ESJ (9.6%) and Spine (7.7%), followed by the pediatric orthopaedics-focused journals, JPO (5.5%), JCO (3.5%) and JPO-B (2.7%). The less-specialized journals, like JBJS (0.8%) and BJJ, had the lowest percentage of EOS content.

There was an increase in the annual number of EOS articles published by the journals over the study period (Fig. 2). In 2005, the 6 actively publishing journals published 60 EOS articles and in 2020, they published 101, representing a 68.3% increase (Table 2). SDEF saw the greatest increase in EOS articles during the study period, from 9 articles in 2012, to 52 articles in 2020, an increase of 477.7%. We also observed an increase in the ratio of EOS articles to total publications. In 2005, there were 60 EOS articles out of 1475 total publications and in 2020, there were 157 EOS articles out of 2132 publications, representing an increase from 4.1% to 7.4% EOS content.

With 2624 total matches to EOS subtopics, each EOS article matched to 1.4 subtopics on average (Table 3). The subtopics with the greatest number of matching articles were congenital scoliosis (485, 29.9%), TGR (347, 13.2%) and other EOS (337, 12.8%). The subtopics with the fewest matching articles were TIS (176, 6.7%), scoliosis casting (173, 6.6%) and MCGR (150, 5.7%).

The annual number of articles matching each subtopic broadly increased over the study period. All subtopics experienced an increase in article matches from 2005 to 2020. The subtopics related to implants, i.e., TGR, MCGR and VEPTR—along with the non-specific “other EOS” subtopic—experienced the most growth in this regard, rising by 41, 35, 25 and 31 articles, respectively (Fig. 3). While congenital scoliosis was by far the most frequently matched subtopic, its annual number of matching articles increased by just 10 between 2005 and 2020.

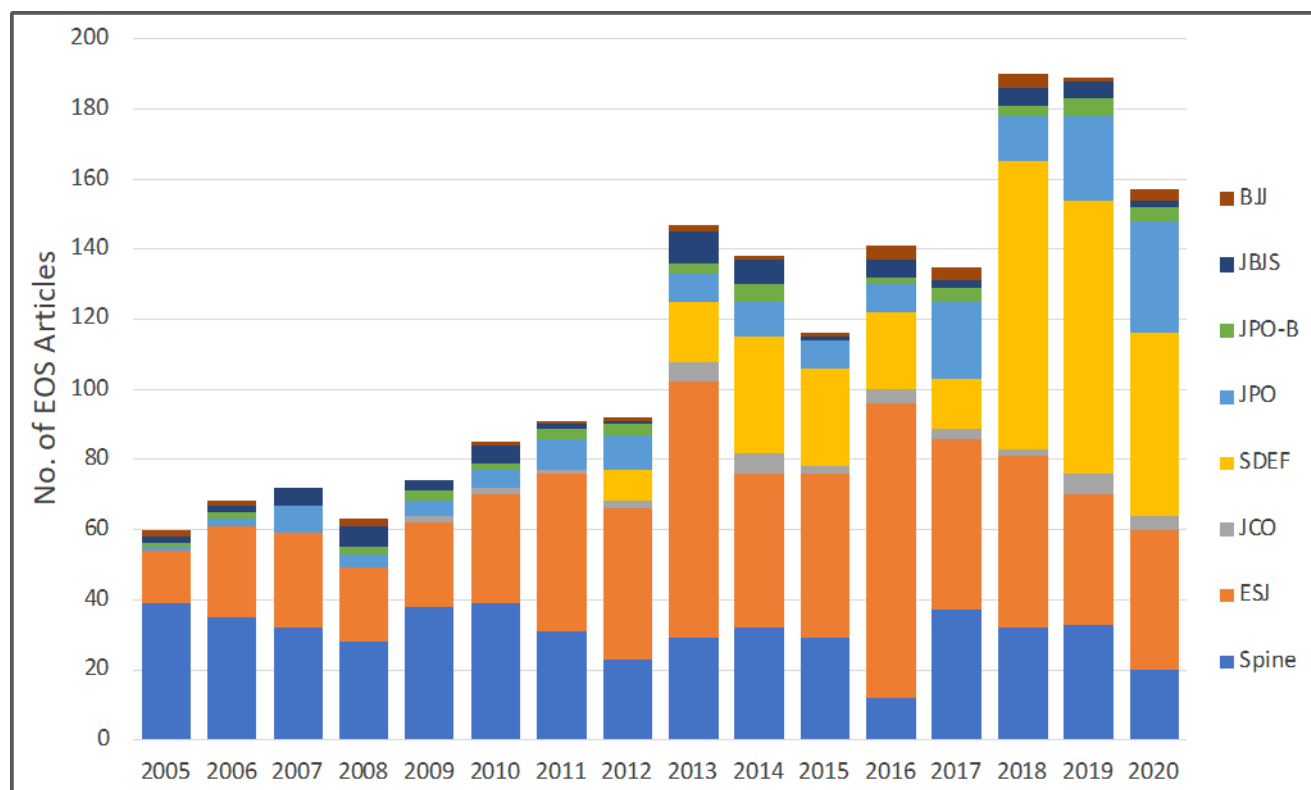


Figure 2: Annual number of EOS articles published in 8 orthopaedic and spine journals. Spine = Spine, ESJ = European Spine Journal, JCO = Journal of Children’s Orthopaedics, SDEF = Spine Deformity, JPO = Journal of Pediatric Orthopaedics, JPO-B = Journal of Pediatric Orthopaedics B, JBJS = The Journal of Bone and Joint Surgery-American Volume, BJJ = The Bone and Joint Journal.

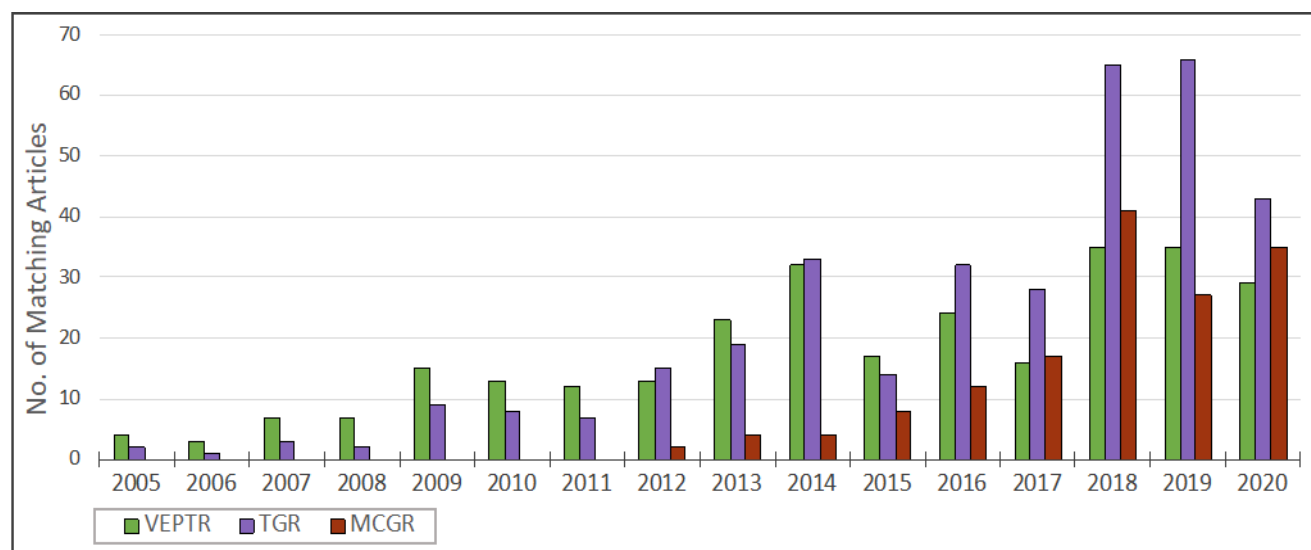


Figure 3: Annual EOS articles matching implant-related EOS subtopics. VEPT = Vertical Expandable Prosthetic Titanium Rib, TGR = Traditional Growing Rod, MCGR = Magnetically Controlled Growing Rod.

EOS Subtopic	Search String
Congenital	"Congenital scoliosis" OR "congenital spine" OR "congenital kyphosis"
TGR	"TGR" OR "traditional growing rod" OR "single growing rod" OR "dual growing rod"
Other EOS	"Early onset scoliosis" OR "growing spine"
VEPTR	"VEPTR" OR "vertical expandable prosthetic titanium rib"
Infantile Scoliosis	"Infantile scoliosis" OR "infantile idiopathic scoliosis"
TIS	"TIS" OR "thoracic insufficiency syndrome"
Scoliosis Casting	"Scoliosis casting" OR "Risser casting" OR "Mehta casting" OR "elongation-derotation-flexion casting" OR "EDF casting"
MCGR	"MCGR" OR "MAGEC" OR "magnetically controlled growing rod"

Table 1: EOS subtopics and corresponding Boolean search strings.

Year	Journal ^a																	
	Spine		ESJ		JCO		SDEF		JPO		JPO-B		JBJS		BJJ		All Journals	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
2005	39	17.0	15	8.4	^b		^b		1	0.6	1	1.4	2	0.4	2	0.6	60	4.1
2006	35	14.6	26	8.0					2	1.3	2	2	2	0.4	1	0	68	4.1
2007	32	13.7	27	8.2	0	0			8	4.6	0	0	5	1.0	0	0	72	4.2
2008	28	11.5	21	6.6	0	0			4	2.6	2	3	6	1.2	2	0.7	63	3.8
2009	38	12.0	24	7.5	2	2.7			4	2.5	3	3.7	3	0.5	0	0	74	4.1
2010	39	9.9	31	8.7	2	2.4			5	2.8	2	1.9	5	1.0	1	0.3	85	4.4
2011	31	7.0	45	10.8	1	1.4			9	4.5	3	3.7	1	0	1	0.3	91	4.5
2012	23	5.4	43	8.7	2	2.5	9	45.0	10	5.2	3	2.9	1	0.2	1	0.4	92	4.4
2013	29	5.8	73	13.2	6	6.7	17	23.3	8	4.4	3	3	9	1.8	2	0.7	147	6.4
2014	32	5.7	44	8.8	6	7.9	33	44.0	10	6.3	5	4.5	7	1.4	1	0	138	6.1
2015	29	4.9	47	8.7	2	2.6	28	30.4	8	4.3	0	0	1	0.3	1	0	116	5.3
2016	12	2.0	84	13.4	4	4.3	22	19.8	8	4.4	2	1.8	5	1.3	4	2	141	6.0
2017	37	8.0	49	9.6	3	3.6	14	12.3	22	9.4	4	3	2	0.5	4	2	135	6.2
2018	32	7.9	49	9.4	2	2.1	82	46.1	13	6.5	3	3.1	5	1.2	4	2	190	8.9
2019	33	9.4	37	9.4	6	7.1	78	42.4	24	9.8	5	5.1	5	1.0	1	0	189	8.9
2020	20	5.8	40	9.4	4	4.7	52	29.5	32	11.6	4	4.1	2	0.4	3	1	157	7.4
All	489	7.7	655	9.6	40	3.5	335	32.7	168	5.5	42	2.7	61	0.8	28	0.6	1818	5.7

Table 2: Annual number and percentage of EOS-related articles included for each journal.

EOS Subtopic ^a	Article Matches	
	No.	%
Congenital	960	36.6
TGR	347	13.2
Other EOS	337 ^b	12.8
VEPTR	285	10.9
Infantile scoliosis	196	7.5
TIS	176	6.7
Scoliosis casting	173	6.6
MCGR	150	5.7

Total	2624 c	100
A: Congenital = congenital scoliosis, TGR = Traditional Growing Rod, Other EOS = EOS in general, VEPTR = Vertical Expandable Prosthetic Titanium Rib, TIS = thoracic insufficiency syndrome, MCGR = Magnetically Controlled Growing Rod. B: 'Other EOS' excludes articles that matched to additional subtopics. C: Many articles matched to multiple		

Table 3: Article matches for each EOS subtopic.

Discussion

EOS is a complex condition with varied etiology that presents unique challenges to both patients and surgeons. It may result in substantial morbidity and potentially mortality due to devastating consequences on thoracic growth [1,6,17,18]. Treatment of EOS is highly complex, prone to complications and often requires multiple operations. Each of the various etiologies brings its own set of challenges, which adds to the heterogeneity of the patient population [6,19].

Some have raised concerns that the rate of technological advancement is exceeding the specialty's capacity to develop best-practice guidelines, leading to a lack of consensus regarding treatment standards [20,21]. There has also been inconsistency in the reporting of surgical outcome measures that are important to the study of EOS, such as spine growth, which has hindered the ability of researchers to conduct systematic reviews [22].

The rarity of EOS has historically made it difficult to study and the true incidence and prevalence of EOS are unknown. With patients few and far between, compiling data sets conducive to high statistical power at any single institution can be challenging. To confront this challenge, patient registries were established to pool data across multiple institutions [23]. This development has provided larger and more diverse patient populations, which in turn has resulted in studies with higher levels of evidence [24,25]. In the context of these rapid developments, pediatric spine deformity surgeons have perceived an increase in EOS research efforts.

Whereas a single prior study has described an absolute increase in EOS publications over time, the present study sought to demonstrate that between 2005 and 2020, the field of EOS research has taken on a larger role relative to the broader fields of orthopaedic and spine research [26]. To achieve this, we tabulated the annual ratio of EOS articles to total publications for 8 orthopaedic and spine journals. While EOS articles were individually screened, total publications were not. The goal was to measure the number EOS articles that were peer-reviewed original or review articles and compare to the total output of the included journals.

The present study identified increases in the volume of both total publications and EOS articles from 2005-2020 (Fig. 2). Importantly, the ratio of EOS articles to total publications increased as well. This demonstrates that, while the annual volume of total publication grew considerably, the annual volume of EOS publications experienced an even greater increase. This supports our hypothesis that an increase in EOS articles would outpace a broader increase in total publications within the included journals. The observed increase in total publications highlights the importance of correcting for background publication volume.

Articles corresponding to implant-related and other/general EOS search terms saw the greatest increase in articles per year from 2005-2020, which supports one of our hypotheses. We believe that considering the historical frustrations associated with treating patients with EOS, the expanding availability of novel and growth friendly implants led to the observed increase in research efforts, as surgeons and investigators were eager to publish their experiences.

Our findings have several limitations. While all efforts were made to identify all publications, as well as to exclude inappropriate findings, there could always be error in accuracy of the data. Additionally, the inception of 2 new journals during the study period contributed to the increase in all literature in addition to the EOS literature. Specifically, SDEF had the highest proportion of EOS publications and began publishing in 2012, well into the study period. However, the establishment of new EOS-focused journals during this period indicates growing research interest in this field and should not necessarily be excluded from analysis. The query method utilized relied on articles matching to at least one EOS search term and some matching articles likely contained little EOS content. However, even if some articles were only tangentially related to EOS, the sustained upward trend relative to total publications demonstrates the expansion of EOS research topics in the literature.

Conclusion

In conclusion, the period spanning 2005 through 2020 saw an increase in the number of EOS articles published in the 8 orthopaedic and spine journals examined. Importantly, the ratio of EOS articles to all publications increased steadily over the same period. The specific subtopics of EOS research which experienced the greatest increase were those related to growth-friendly implant systems (i.e., TGR, MCGR and VEPTR), possibly owing to rapid technical advances in EOS treatment occurring over the study period.

Conflict of Interest

The authors have no conflict of interest to declare.

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Appendix

Journal ^a	Date Last Searched (M/D/Y)	Date-Restriction	Export File Format	URL
Spine	11/5/2022	manual	manual	https://journals.lww.com/spinejournal/pages/default.aspx
ESJ	11/5/2022	native	.CSV	https://link.springer.com/search?query=&search-within=Journal&facet-journal-id=586
JCO	11/6/2022	native	manual	https://journals.sagepub.com/home/CHO
SDEF	11/6/2022	native	.CSV	https://link.springer.com/search?query=&search-within=Journal&facet-journal-id=43390
JPO	11/4/2022	manual	manual	https://journals.lww.com/pedorthopaedics/pages/default.aspx
JPO-B	11/4/2022	manual	manual	https://journals.lww.com/jpo-b/pages/default.aspx
JBJS	11/4/2022	native	manual	https://www.jbjs.org/journal.php?j=jbjs
BJJ	11/4/2022	native	manual	https://online.boneandjoint.org.uk/journal/bjj
a: Spine = Spine, ESJ = European Spine Journal, JCO = Journal of Children's Orthopaedics, SDEF = Spine Deformity, JPO = Journal of Pediatric Orthopaedics, JPO-B = Journal of Pediatric Orthopaedics B, JBJS = The Journal of Bone and Joint Surgery-American Volume, BJJ = The Bone and Joint Journal.				

Appendix Table 1: Digital journal archive sources and metadata.

Journal of Pediatric Advance Research



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