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Flourishing systematic reviews, but is evidence keeping pace? A critical evaluation and trend analysis of five orthodontic journals from 2015 to 2024

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ABSTRACT

Introduction: Systematic reviews and meta-analyses (SRMAs) in Orthodontics have increased substantially, but whether this is commensurate with the evidence generated is questionable.
Objective: To evaluate the evidence outcome from SRMAs, the quality of included primary studies, and the proportion of SRMAs to original research in five orthodontic journals from 2015 to 2024.
Methods: SRMAs in Progress in Orthodontics (PO), Angle Orthodontist (AO), European Journal of Orthodontics (EJO), American Journal of Orthodontics and Dentofacial Orthopedics (AJODO), and Journal of the World Federation of Orthodontists (JWFO) published during this period were evaluated for the evidence outcome and Risk of Bias (RoB) of included studies. The proportion of SRMAs to original research was also calculated, and trends were compared across two five-year periods (2015–2019 and 2020–2024).
Results: During this period, 292 SRMAs evaluating 4511 studies for 707 outcomes were published. Of the evaluated outcomes, 16.7 % were fully conclusive, 69.2 % partially conclusive, and 14.1 % inconclusive. Most included studies (n = 3149) showed moderate (37.4 %) or high (32.3 %) RoB. Of all evaluated publications (n = 3904), 7.5 % were SRMAs. Some journals showed an increase in partially conclusive outcomes (AO, JWFO), the proportion of SRMA (EJO), and studies with high RoB, as well as a drop in fully conclusive outcomes (AO, AJODO, PO) in the latter half. However, overall differences remained statistically nonsignificant.
Conclusion: Though maintaining the proportion of SRMA to primary research by most journals is comforting, the SRMAs staying less productive in evidence, and primary research with high RoB are a matter of concern.

1. Introduction

The exponential growth of orthodontic literature and the increasing emphasis on Evidence-Based Medicine have led to a boom in the publication of Systematic Reviews and Meta-Analyses (SRMAs) over the years. Between 1991 and 2014, the increase was a whopping 2728 % for systematic reviews (SRs) and 2635 % for meta-analyses (MAs).[1] The growth rate of SRMAs from 1995 to 2017 was 26 times higher than that of Randomized Controlled Trials (RCTs) in Pediatrics.[2] Though less dramatic, the trend was also evident in Orthodontics, with PubMed-indexed orthodontic SRMAs showing a nine-fold increase in numbers from 2007 to 2017.[3]

Scientifically rigorous SRMAs are essential and instrumental in synthesising available evidence for clinical and research applications, as well as highlighting lacunae.[4] However, there are two growing concerns about the trends in secondary research publications. First is the flooding of poor-quality, redundant, misleading, and conflicting SRMAs.[1] The second, equally important, is the falling proportion of primary research compared to SRMAs.[3] Over 11 years, Papageorgiou and Eliades[3] noted a dip in the proportion of RCT to total orthodontic publications from 4.5 % to 3 %, while the same with SRMA increased from 0.9 % to 4.5 %.

The outcome of SRMA primarily depends on the availability of well-conducted primary studies. It takes little effort to realise that many SRMAs remain inconclusive on the intended outcomes due to insufficient primary data, high risk of bias (RoB) in the included studies, and end up with stereotypical recommendations for more high-quality studies.[5] Twenty-nine percent of orthodontic SRMAs published between January 2000 and 2007 failed to reach conclusions.[6] For SRs published in five major orthodontic journals between January 2000 and June 2014, 79 % had low or very low quality evidence.[7] Also, the

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median number of trials used to calculate the summary estimate was only 4 to 5 in SRMAs between 2000 and 2020.[8]

While inconclusive SRMAs still serve to highlight the lacunae in literature, they fall short of the primary objective of synthesising the sought-after evidence.[4] Therefore, an exponential rise in the SRMA does not necessarily translate to more evidence,[9] a contention that remains under-investigated and unquantified in Orthodontic literature. Hence, the present study was undertaken to analyse and compare the evidence outcomes from SRMAs and the RoB of primary studies in SRMAs in the top five impactful orthodontic journals over a ten-year period, as well as the changing trends. We also assessed whether SRMAs increased at the expense of original research during this period.

2. Materials and methods

We analysed the publications from 2015 to 2024 in the five most impactful speciality orthodontic journals selected based on the Journal Impact Factor (IF) for 2024. These included Progress in Orthodontics (PO, IF = 5, https://progressinorthodontics.springeropen.com), Angle Orthodontist (AO, IF = 3.2, https://angle-orthodontist.kglmeridian.com), American Journal of Orthodontics and Dentofacial Orthopedics (AJODO, IF = 3, https://www.ajodo.org), European Journal of Orthodontics (EJO, IF = 2.7, https://academic.oup.com/ejo), and Journal of the World Federation of Orthodontists (JWFO, IF = 3.2, https://www.jwfo.org). All online publications available at the websites of these journals were screened to determine the number of original research studies and systematic reviews in each issue. Subsequently, the full text of each systematic review was examined to extract the key details related to the study.

The preliminary screening of publications for inclusion in the study was conducted independently by two authors (JM and BM), based on the article category, title, and abstract. In cases where these sources provided insufficient information or raised uncertainties, the full text was reviewed for clarification. Only original research studies and SRs (with/without MA) were considered for inclusion. Case reports, case series, clinical pearls, conference proceedings, editorials, letters to the editor, short communications, reprints, bibliometric studies, narrative reviews, umbrella reviews, and scoping reviews were excluded. Also, corrections or errata related to original research or systematic reviews were not considered for the total count.

The full text of each SRMA was thoroughly evaluated to record: (1) The evidence on each evaluated outcome (*Fully conclusive*, *Partly conclusive*, or *Inconclusive);* and (2) Each included study's RoB assessed as very high, high, moderate, low, or very low. When a RoB assessment was not reported, it was recorded as 'Not Available' (NA). The proportion of the SRMA to total research publications was also calculated on a year-by-year basis for all the journals.

The evidence outcome category of the SRMAs was directly decided from the conclusions reported by their authors. SRMAs in which the authors have drawn definitive conclusions, for or against the evaluated outcome, based on adequate evidence, and not limited by heterogeneity or methodological issues, were classified as 'Fully Conclusive'. The SRMAs were considered 'Partly conclusive' when some conclusions were drawn, but with caution regarding the quality of evidence due to the limited number of studies, methodological heterogeneity, or a considerable risk of bias. SRMAs that stated that the evidence was insufficient or absent for drawing any meaningful conclusion were categorised as 'Inconclusive'.

Two investigators independently collected and tabulated the data to improve accuracy and reliability. The data was subsequently cross-checked, and the inconsistencies were resolved by mutual discussion. The process of data collection is summarised in Fig. 1.

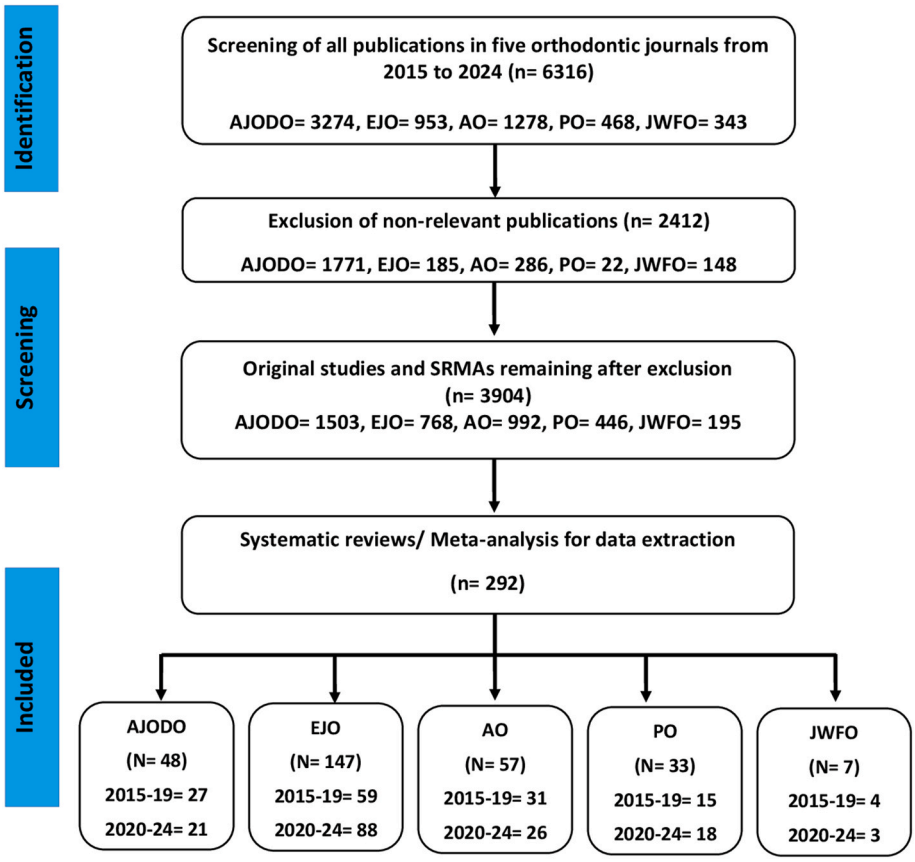

Fig. 1. Flowchart of the data collection process.

Table 1
Comparison of the evidence outcome from SRMAs published from 2015 to 2024.

Category	EJO % (n)	AO % (n)	AJODO % (n)	PO % (n)	JWFO % (n)	p value	Total % (n)
Full	24 (68)$_a$	16.1 (26)$_a$	15.6 (20)$_a$	1.7 (2)$_b$	10 (2)$_{a,\ b}$	<0.001#	16.7 (118)
Partial	62.9 (178)$_a$	66.5 (107)$_a$	70.3 (90)$_a$	91.3 (105)$_b$	45 (9)$_a$		69.2 (489)
Inconclusive	13.1 (37)$_a$	17.4 (28)$_a$	14.1 (18)$_a$	7 (8)$_a$	45 (9)$_b$		14.1 (100)
Total	100 (283)	100 (161)	100 (128)	100 (115)	100 (20)		100 (707)

Each subscript letter denotes a subset of Journal categories whose column proportions do not differ significantly from each other at the Bonferroni adjusted 0.05 level in Z -Test.
EJO - European Journal of Orthodontics, AO - Angle Orthodontist, AJODO - American Journal of Orthodontics and Dentofacial Orthopedics, PO - Progress in Orthodontics, JWFO - Journal of the World Federation of Orthodontists.
Chi-square test.

Table 2
Comparison of the evidence outcome from SRMAs between the two evaluation periods.

Journal	Category	2015–2019 % (n)	2020–2024 % (n)	p value	Total % (n)
EJO	Full	23.9 (21)$_a$	24.1 (47)$_a$	0.39#	24 (68)
	Partial	67 (59)$_a$	61 (119)$_a$		62.9 (178)
	Inconclusive	9.1 (8)$_a$	14.9 (29)$_a$		13.1 (37)
AO	Full	23.5 (19)$_a$	8.8 (7)$_b$	0.026#	16.1 (26)
	Partial	58 (47)$_a$	75 (60)$_b$		66.5 (107)
	Inconclusive	18.5 (15)$_a$	16.3 (13)$_a$		17.4 (28)
AJODO	Full	22.1 (15)$_a$	8.3 (5)$_b$	0.10#	15.6 (20)
	Partial	66.2 (45)$_a$	75 (45)$_a$		70.3 (90)
	Inconclusive	11.8 (8)$_a$	16.7 (10)$_a$		14.1 (18)
PO	Full	4.9 (2)$_a$	0 (0)$_a$	0.009*	1.7 (2)
	Partial	95.1 (39)$_a$	89.2 (66)$_a$		91.3 (105)
	Inconclusive	0 (0)$_a$	10.8 (8)$_b$		7 (8)
JWFO	Full	7.7 (1)$_a$	14.3 (1)$_a$	0.009*	10 (2)
	Partial	23.1 (3)$_a$	85.7 (6)$_b$		45 (9)
	Inconclusive	69.2 (9)$_a$	0 (0)$_b$		45 (9)
Overall	Full	19.9 (58)$_a$	14.4 (60)$_a$	0.16#	16.7 (118)
	Partial	66.3 (193)$_a$	71.2 (296)$_a$		69.2 (489)
	Inconclusive	13.7 (40)$_a$	14.4 (60)$_a$		14.1 (100)
	Total	100 (291)	100 (416)		100 (707)

Each subscript letter denotes a subset of Journal categories whose column proportions do not differ significantly from each other at the Bonferroni adjusted 0.05 level in Z -Test.
EJO - European Journal of Orthodontics, AO - Angle Orthodontist, AJODO - American Journal of Orthodontics and Dentofacial Orthopedics, PO - Progress in Orthodontics, JWFO - Journal of the World Federation of Orthodontists.
Chi-square test.
* Fisher-Freeman-Halton Exact Test.

2.1. Data analysis

The data were tabulated and analysed in IBM SPSS Statistics 23 for Windows (IBM, Armonk, NY, USA). Descriptive statistics (frequency and proportion) were calculated for all the outcome variables, including the conclusiveness of SRMA, RoB categories of studies included in SRMA, and the proportion of SRMA to original research publications. To assess the changing trends in these variables, the entire evaluation period was divided into two five-year periods: 2015–2019 and 2020–2024. The differences between and within the journals were evaluated with a Chi-square or Fisher-Freeman-Halton exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Table 3
Risk of Bias in studies included in SRMAs between the two evaluation periods.

Category of RoB	2015–2019 % (n)	2020–2024 % (n)	p value	Total % (n)
Very High	0.2 (4)$_a$	0.5 (11)$_a$	<0.001#	0.3 (15)
High	28.1 (618)$_a$	36.4 (841)$_b$		32.3 (1459)
Moderate	37.3 (823)$_a$	37.5 (867)$_a$		37.4 (1690)
Low	15.1 (333)$_a$	19.5 (449)$_b$		17.3 (782)
Very Low	0.1 (3)$_a$	0 (0)$_a$		0.1 (3)
Not Available	19.2 (422)$_a$	6.1 (140)$_b$		12.6 (562)
Total	100 (2203)	100 (2308)		100 (4511)

Each subscript letter denotes a subset of Journal categories whose column proportions do not differ significantly from each other at the Bonferroni adjusted 0.05 level in Z -Test.
Chi-square test.

3. Results

Two hundred and ninety-two SRMAs, evaluating 707 outcomes from 4511 primary studies, were published in these journals from 2015 to 2024.

3.1. Evidence outcome from SRMA

The SRMAs published in the evaluated journals were fully conclusive for 16.7 % of the evaluated outcomes, partly conclusive for 69.2 %, and inconclusive for 14.1 % (Table 1). There was a statistically significant difference between the journals in the overall distribution of the outcome categories ($p < .001$). Pair-wise comparisons of journals for each evidence category revealed that PO had lesser proportion of fully conclusive outcomes (1.7 %) than EJO (24 %), AO (16.1 %) and AJODO (15.6 %) and the differences were statistically significant at $p < .05$. Also, it had the higher proportion of outcomes with partial conclusions than the other four journals (91.3 %, $p < .05$). The proportion of Inconclusive outcomes in JWFO was higher as compared to the other journals (45 %, $p < .05$).

Comparison of the overall distribution within each journal for the evaluation periods 2015–2019 and 2020–2024 (Table 2) revealed statistically significant differences only for AO ($p = .026$), PO($p = .009$) and JWFO($p = .009$). For pair-wise comparisons in each outcome category, AO showed a drop in the proportion of outcomes with full conclusions (23.5 % vs. 8.8 %, $p < .05$) and a corresponding increase in outcomes with partial conclusions (58 % vs. 75 %, $p < .05$). In PO, the proportion of inconclusive outcomes increased from nil to 10.8 ($p < .05$), and the proportion of fully conclusive outcomes dropped from 4.9 % to 0 % ($p < .05$). JWFO exhibited an increase in the proportion of outcomes with partial conclusions (23.1 %–85.7 %), and a fall in inconclusive outcomes (69.2 %–0 %, $p < .05$) during the same period.

3.2. RoB in included studies

Of the 4511 studies included in the SRMAs, a majority had either moderate (37.4 %) or high (32.3 %) RoB (Table 3). Compared to 2015–2019, there was an 8.3 % increase in studies with high RoB and a 4.4 % increase in those with low RoB in the next five years. There was also a statistically significant 13.1 % drop in the number of studies with unreported RoB.

Table 4
Distribution of Original Research publications and SRMAs in the evaluated journals.

Type	EJO % (n)	AO % (n)	AJODO % (n)	PO % (n)	JWFO % (n)	p value
Original	80.9 $(621)_a$	94.3 $(935)_b$	96.8 $(1455)_c$	92.6 $(413)_b$	96.4 $(188)_{b,\ c}$	$<0.001^{\#}$
SRMA	19.1 $(147)_a$	5.7 $(57)_b$	3.2 $(48)_c$	7.4 $(33)_b$	3.6 $(7)_{b,\ c}$	
Total	100 (768)	100 (992)	100 (1503)	100 (446)	100 (195)	

Each subscript letter denotes a subset of Journal categories whose column proportions do not differ significantly from each other at the Bonferroni adjusted 0.05 level in Z -Test.
EJO - European Journal of Orthodontics, AO - Angle Orthodontist, AJODO - American Journal of Orthodontics and Dentofacial Orthopedics, PO - Progress in Orthodontics, JWFO - Journal of the World Federation of Orthodontists.
Chi-square test.

Table 5
Comparison of the distribution of Original Research publications and Systematic Reviews and Meta-analyses between the two evaluation periods.

Journal	Type of study	2015–2019 % (n)	2020–2024 % (n)	p value	Total % (n)
EJO	Original	84.8 (328)	76.9 (293)	$0.006^{\#}$	80.9 (621)
	SRMA	15.2 (59)	23.1 (88)		19.1 (147)
AO	Original	94.6 (543)	93.8 (392)	$0.58^{\#}$	94.3 (935)
	SRMA	5.4 (31)	6.2 (26)		5.7 (57)
AJODO	Original	96.1 (661)	97.4 (794)	$0.14^{\#}$	96.8 (1455)
	SRMA	3.9 (27)	2.6 (21)		3.2 (48)
PO	Original	92.9 (197)	92.3 (216)	$0.80^{\#}$	92.6 (413)
	SRMA	7.1 (15)	7.7 (18)		7.4 (33)
JWFO	Original	95.6 (86)	97.1 (102)	$0.55^{\#}$	96.4 (188)
	SRMA	4.4 (4)	2.9 (3)		3.6 (7)
Total	Original	93.0 (1815)	92.0 (1797)	$0.23^{\#}$	92.5 (3612)
	SRMA	7.0 (136)	8.0 (156)		7.5 (292)

EJO - European Journal of Orthodontics, AO - Angle Orthodontist, AJODO - American Journal of Orthodontics and Dentofacial Orthopedics, PO - Progress in Orthodontics, JWFO - Journal of the World Federation of Orthodontists.
Chi-square test.

3.3. Original studies versus SRMA

The changes in the ratio of SRMAs to original articles over the ten-

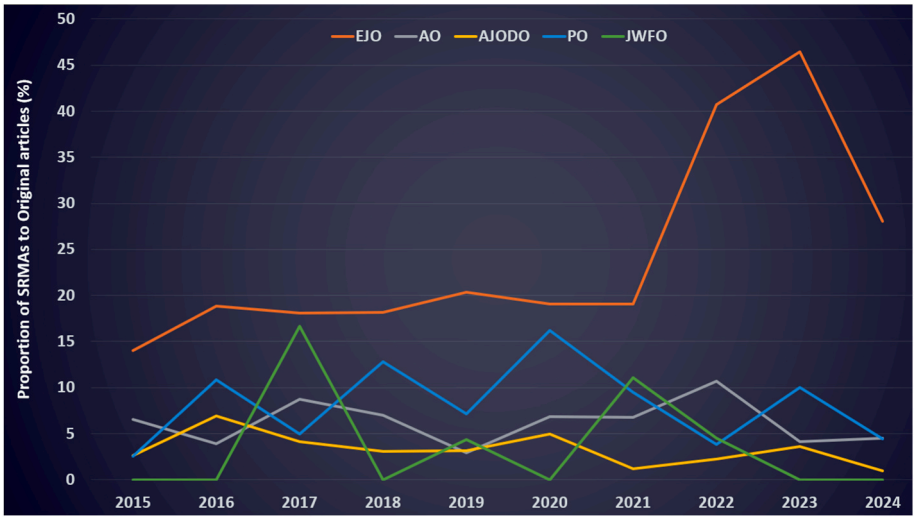

Fig. 2. Changes in the proportions of SRMAs to original articles published in the evaluated journals from 2015 to 2024. (PO - Progress in Orthodontics, AO - Angle Orthodontist, AJODO - American Journal of Orthodontics and Dentofacial Orthopedics, EJO - European Journal of Orthodontics, JWFO - Journal of the World Federation of Orthodontists).

year study period for the evaluated journals are presented in Fig. 2.

There was a statistically significant difference between the journals in the overall distribution of the SRMAs and original articles published in ten years ($p < .001$). For pair-wise comparisons of journals (Table 4), EJO had a higher proportion of SRMA (19.1 %) than the other four journals ($p < .05$). AJODO had the lowest proportion of SRMA among all five evaluated journals (3.2 %), but only the differences with AO (5.7 %) and PO (7.4 %) were statistically significant ($p < .05$).

Comparison of changes within the journal between 2015–2019 and 2020–2024 (Table 5) showed an increase in the proportion of SRMA (5.2 %, versus 23.1 %, $p = .006$) and a corresponding decrease in the proportion of original articles in EJO. The differences noted for the other journals were not statistically significant. Overall, the SRMA accounted for 7 % of all research publications in these journals from 2015 to 2019 and had increased only marginally (8 %) in the subsequent five years. There was a corresponding 1 % decrease in the proportion of original studies from 93 % to 92 %. These differences were not statistically significant ($p = .23$).

4. Discussion

The present study aimed to evaluate the conclusiveness and quality of evidence generated from SRMAs published over the past decade, as well as whether primary research publications are keeping pace with the increasing number of SRMAs.

For SRs in clinical dentistry, published in MEDLINE from 1966 to 2002, Badar and Ismail[4] noted that 67 % could not answer the key question or answered it with reservations about the strength of the evidence. In Orthodontics, the proportion of inconclusive SRs was 29 % for those published between 2000 and 2007.[6] The SRMAs evaluated in this study from 2015 to 2024 were inconclusive for 14.1 % and only partially conclusive for 69.2 % of the evaluated outcomes. The changing trends in these journals between the two five-year periods were generally not positive, as evidenced by a drop in the proportion of fully conclusive outcomes (AO and AJODO), an increase in the number of partially conclusive outcomes (AO and JWFO), and an increase in the number of inconclusive outcomes (PO). The paucity of high-quality primary data, resulting from heterogeneity in study designs and outcome measures, high risk of bias, poor reporting standards, and insufficient power in primary studies, may be the principal reason for these observations.[10–12] However, the contributions from overlapping and duplicate SRMAs across journals that rely on the same primary data and yield similar results may also have contributed.[13] Overall, a majority of SRMAs appear to have been more resourceful in highlighting the insufficiency of quality data than synthesising evidence for clinical practice.

The quality of primary studies included in SRMAs is vital for reliable evidence synthesis. Unfortunately, 36.4 % of the original studies included in SRMAs during the 2020–2024 period had a high RoB, a 12.1 % increase compared to 2015–2019. This decline in the quality of evidence in primary research with high RoB, despite recommended advancements in research methodology and emphasis on protocol registration and reporting standards, is a matter of concern. The increasing number of SRs, especially on emerging topics with limited high-quality data, may be a possible reason. Simply put, conducting an evidence synthesis a bit too early opens up the possibility of including poor-quality data. Alternatively, this change may reflect a welcome trend of more stringent and transparent evaluation and reporting of RoB over the years. Either way, they underscore the need for higher-quality primary research studies.

The evidence from SRMA is only as good as the included studies, and an increase in the number of SRMAs without a concomitant rise in high-quality primary data would add no further value. Primary research studies, especially trials involving human participants, are more demanding in terms of human, financial, and temporal resources, and they also involve ethical concerns.[14,15] SRMAs are often less resource-intensive and more rewarding alternatives, especially as a publication exercise or citation metrics builder.[16,17] There is a concern that the number of SRMAs is increasing at the expense of original research. Hoffmann et al.[18] reported that nearly 80 PubMed-indexed SRs were published per day in 2019, which was more than a 20-fold increase over the preceding two decades. From 2007 to 2017, Papageorgiou and Eliades[3] noted a progressive increase in the proportion of SRMAs in orthodontics from 0.9 to 4 %, while that of RCTs dropped from 4 to 3.5 %. However, this study offers reassurance that it may not apply to primary research in toto when all study designs are considered. There was no statistically significant change, either overall or for four out of five journals. This pattern could also be attributed to the editorial policies of the selected journals, which limit the number of SRMAs accepted for publication. EJO was the only exception, showing a 7.9 % drop in original articles and an equal rise in SRMAs.

The findings of this study reiterate the need to improve the quality of primary research in orthodontics. Authors owe the responsibility for a robust study design, registration of trials and SRs prior to initiation, proper execution, and comprehensive and transparent reporting. Journal editors and reviewers can play a significant role by ensuring adherence to standardised methodological frameworks and critical appraisal tools. The orthodontic research community must recognise that an increase in SRs alone does not equate to more or stronger evidence, unless they are based on sound primary data and provide definite conclusions. An unchecked increase in the publication of SRs also runs the risk of research redundancy or scientific waste. Equally critical are overlapping reviews that use the same low-quality primary data, thereby falsely inflating the evidence for or against the outcome of interest. Researchers should consult registries like PROSPERO to mitigate these issues. Live SRs are another promising avenue to explore in this regard.[19]

5. Conclusions

The present analysis revealed that while the number of SRMAs published in high-impact orthodontic journals over the past decade remains high, their ability to generate conclusive evidence remains limited. Primary research studies with a high or moderate risk of bias continue to be a concern. The stable proportion of SRMAs to original research publications in four out of five evaluated journals is a positive trend. These observations highlight the need for more stringent SRMAs and high-quality primary research to improve evidence synthesis.

Patient's/guardian's consent

Not applicable.

Ethical clearance

Not required.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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