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Assessment of SPIN in abstracts of Endodontic meta-analyses published in the last decade

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Πρόγραμμα Μεταπτυχιακών Σπουδών

«Παθολογία και Θεραπευτική Οδοντικών και Περιοδοντικών Ιστών»

Ειδίκευση: Ενδοδοντία

Τίτλος Μεταπτυχιακής Διπλωματικής Εργασίας

Αξιολόγηση του SPIN στις περιλήψεις των δημοσιευμένων μετα-αναλύσεων της τελευταίας δεκαετίας στην Ενδοδοντική βιβλιογραφία

Δημήτριος Γιαννακούλας

Αθήνα 2023

Τριμελής Εξεταστική Επιτροπή

Τζανετάκης Γεώργιος, Αναπληρωτής Καθηγητής, Επιβλέπων

Γεωργοπούλου Μαρία, Καθηγήτρια, Μέλος

Κερεζούδης Νικόλαος, Καθηγητής, Μέλος

Πρόλογος

Η παρούσα διπλωματική εργασία αποτελεί και την τελευταία πράξη της φοίτησης μου ως μεταπτυχιακός φοιτητής της Ενδοδοντίας, στην Οδοντιατρική Σχολή του Εθνικού και Καποδιστριακού Πανεπιστημίου Αθηνών. Είναι αποτέλεσμα μιας κοπιώδους προσπάθειας διάρκειας περισσότερης από ενάμιση χρόνο κατά τον οποίο, υπό τη συνεχή καθοδήγηση και προσωπική ενασχόληση του επιβλέποντα Επίκουρου Καθηγητή κ. Τζανετάκη Γιώργου και της κ. Κωλέτση Δέσποινας καταφέραμε να φτάσουμε στο παρόν αποτέλεσμα.

Τα τριάμισι χρόνια της μεταπτυχιακής μου πορείας, ήταν γεμάτα δύσκολες αλλά και όμορφες στιγμές. Στιγματίστηκαν από μία πανδημία που δυσκόλεψε τη διδακτική διαδικασία χωρίς όμως να μας αφήσει αδρανείς. Έστω και από μακριά για ένα διάστημα, «συναντηθήκαμε», μελετήσαμε και μάθαμε. Επιστρέψαμε πιο δυνατοί και με μεγαλύτερη όρεξη για δουλειά.

Επ’ αφορμής λοιπόν αυτής της τελευταίας πράξης, θα ήθελα να ευχαριστήσω τους ανθρώπους με τους οποίους συμπορευτήκαμε όλα αυτά τα χρόνια στον συναρπαστικό χώρο της Ενδοδοντίας.

Ξεκινώ με ένα μεγάλο ευχαριστώ στον κύριο επιβλέποντα μου για την εκπόνηση της διπλωματικής μου εργασίας τον κ. Τζανετάκη. Αποτέλεσε και αποτελεί για μένα πρότυπο και μέντορα τόσο για την κλινική όσο και για την θεωρητική μου ενασχόληση με το αντικείμενο της Ενδοδοντίας. Η γνωριμία μας άλλωστε πριν την εισαγωγή μου στο Μεταπτυχιακό Πρόγραμμα έπαιξε πολύ σημαντικό ρόλο για την αγάπη μου προς αυτήν.

Ένα ξεχωριστό και μεγάλο ευχαριστώ στον Καθηγητή κ. Κοντακιώτη Ευάγγελο, ο οποίος αποτελεί ίσως το σημαντικότερο άτομο που επηρέασε την πορεία μου και με

εισήγαγε στο δρόμο της Ενδοδοντίας. Μου έδωσε όλα εκείνα το ερεθίσματα αλλά και την ώθηση από το τέταρτο έτος των προπτυχιακών μου σπουδών που με έπεισαν πως αυτό ήταν ακριβώς που ήθελα να κάνω στο μέλλον μου. Θα κατέχει πάντα μια ξεχωριστή θέση μέσα μου για όσα έχω επιτύχει και όσα ευελπιστώ να πετύχω ακόμη στον τομέα της Ενδοδοντίας.

Ένα μεγάλο ευχαριστώ στη Δασκάλα μας, την Καθηγήτρια κ. Γεωργοπούλου Μαρία. Μέσα από διαφωνίες, εντάσεις αλλά και πολύ όμορφες στιγμές, μέσα από επιστημονικές αλλά και κοινωνικές συζητήσεις θεωρώ πως με έκανε καλύτερο γιατρό, που ίσως είναι και το σημαντικότερο. Οφείλω να αναφέρω ότι η οργάνωση και λειτουργία της μεταπτυχιακής κλινικής μας επί των ημερών της υπήρξε υποδειγματική.

Ιδιαιτέρως θα ήθελα να ευχαριστήσω τον Καθηγητή κ. Κερεζούδη Νικόλαο που με έφερε για πρώτη φορά σε επαφή με το αντικείμενο της Ενδοδοντίας στο 3^{ο} έτος των προπτυχιακών σπουδών μου, αλλά και για τη μετέπειτα διαχρονικά άριστη συνεργασία μας.

Ευχαριστώ πολύ την Επίκουρη Καθηγήτρια κ. Αγραφιώτη Αναστασία για την ουσιαστική βοήθεια και καθοδήγηση που μου παρείχε για την τέλεση και συγγραφή ερευνητικών εργασιών.

Θα ήθελα να ευχαριστήσω όλα τα μέλη ΔΕΠ και τους συνεργάτες της κλινικής του τομέα μας για τις δεξιότητες και γνώσεις που μου μετέδωσαν. Συγκεκριμένα, τον Καθηγητή κ. Πανόπουλο Παναγιώτη που τελούσε ακόμη διευθυντής τα πρώτα χρόνια των μεταπτυχιακών σπουδών μου. Τέλος ευχαριστώ τους Επίκουρους Καθηγητές κ. Φαρμάκη Ελευθέριο και την κ. Μαυρίδου Αθηνά.

Ένα ξεχωριστό και μεγάλο ευχαριστώ στην κ. Κωλέτση για τη καθοριστική συνδρομή της στην περάτωση αυτής της εργασίας. Η συνεργασία μας, εκτός από εξαιρετική μου απέφερε και πολλές γνώσεις στον τομέα της έρευνας.

Όσον αφορά στους συμφοιτητές μου, η σχέση μας που διαμορφώθηκε μέσα από εντάσεις, γέλια, ανταγωνισμό αλλά και συναγωνισμό έφτασε στο καλύτερο σημείο της τώρα που φτάσαμε στο τέλος. Εύχομαι να μη χαθούμε και να κρατήσουμε αυτή τη σχέση αναλλοίωτη στο χρόνο.

Τέλος, θέλω να ευχαριστήσω όλους εκείνους τους ανθρώπους εκτός σχολής, των οποίων η προσφορά και συναναστροφή συνέβαλε στην ψυχική μου ισορροπία αυτά τα όμορφα αλλά και πολύ πιεστικά χρόνια. Συγκεκριμένα, οι γονείς μου, η Κωνσταντίνα, οι φίλοι μου -τόσο αυτοί που βρίσκονται κοντά, όσο και όσοι βρίσκονται μακριά- με βοηθούσαν καθημερινά με την παρουσία και τη στάση τους να ξεπερνώ δυσκολίες, άγχη και ευθύνες, να βρίσκω διεξόδους και εν τέλει να είμαι ισορροπημένος και ολοκληρωμένος ως άνθρωπος.

Το ερευνητικό μέρος της παρούσας διπλωματικής εργασίας έχει δημοσιευθεί στο *International Endodontic Journal* και μπορεί να βρεθεί στον παρακάτω σύνδεσμο : https://onlinelibrary.wiley.com/doi/abs/10.1111/iej.13832

Contents

General part

A. The rational of Systematic reviews and meta-analyses

In clinical practice of medicine and dentistry, there is a general need to eliminate existing gaps between research and practice. That is the reason why an evidence-based approach has been adopted in the last years, by aiming to assist in treatment planning and justify and decision-making process (Forrest 2009). Evidence-based medicine has been defined as, ‘‘the integration of best research evidence with clinical expertise and patient values” (Sackett 1997). The aforementioned concept has been adopted by International Dental Associations such as the American Dental Association promoting the judicious assessment of scientific evidence and its correlation with clinical practice (Forrest 2009).

Based on the concept described above, each decision treatment plan made by a clinician in every-day clinical practice should be based on existing evidence coming from sound scientific research. As far as of evidence is concerned, a hierarchy exists that facilitates decision making process, considering that the higher the levels of evidence of a study the lower the risk of bias is (Phillips 2001). Regarding the levels of evidence in scientific literature, a Pyramid of Evidence is valid. The higher we look at that pyramid the higher the levels of evidence are. Laboratory and animal studies, together with editorials and expert opinions are located at the bottom of the pyramid, after that case reports, case control studies, and cohort studies are considered as with moderate quality of evidence whereas properly designed randomized controlled trials (RCTs) and furthermore systematic reviews (SRs) and meta-analyses (MAs) of Randomized Controlled Trials (RCTs) are the studies with the higher quality of evidence (Forrest 2009) (**Figure 1**).

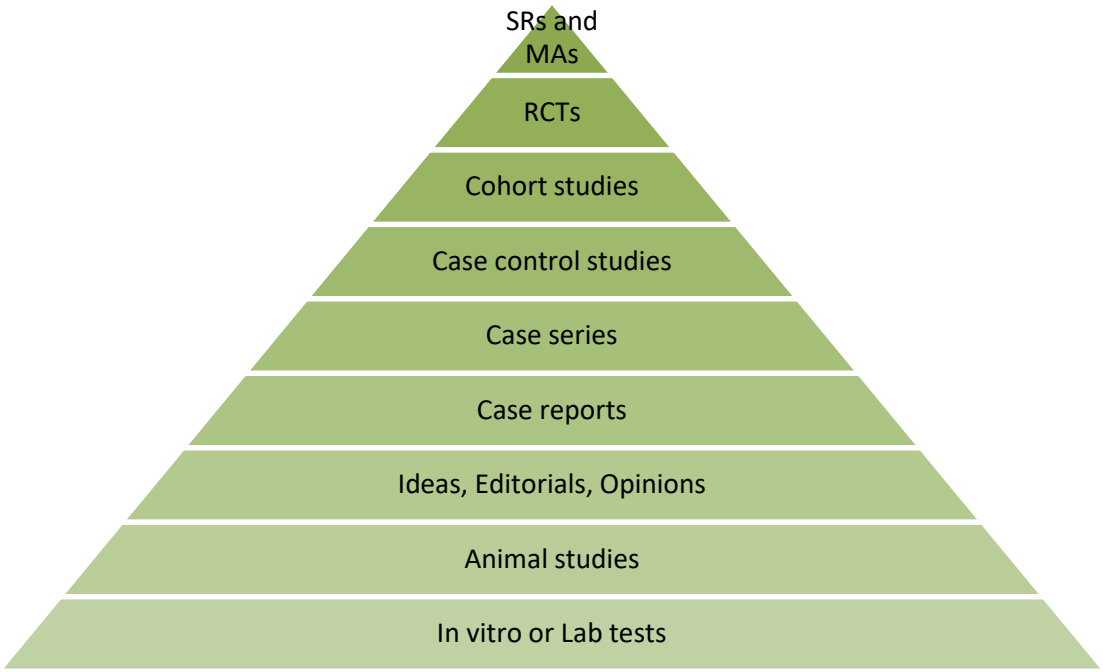

Figure 1. The pyramid of evidence-based medicine

Properly designed systematic reviews (SRs) are studies with well-defined methodology which their sample consists of original research studies on the topic of interest. SRs include potentially all the original studies regarding the topic under interest through a well-conducted and thorough search of the literature. This search is performed exploring electronic databases such as Pubmed, Scopus and others, or searching gray literature whereas hand searching through the references of previously included studies is also necessary (Cook et al. 1997, Nagendrababu et al. 2018). When all the appropriate data have been collected from all eligible studies, these are synthesized in such way to eliminate publication bias and random errors. If the data from the original studies can be statistically synthesized, then the SR is considered quantitative and can be described as meta-analysis (Cook et al. 1997). It is worth mentioning that the statistical analysis of data from different studies is usually not feasible, as the eligible studies have to be reasonably similar. This is the main reason

why in many SRs only a small number of studies may be included in the meta-analysis if it is possible. The results and conclusions of such studies ought to be interpreted with caution as their validity depends mostly on their methodological integrity (Nagendrababu et al. 2018).

At this point, the differences between a systematic review and a narrative review should be highlighted mainly regarding the study design and the potential benefits for the clinician. On the one hand, SRs are designed to answer a specific clinical question on a more general subject. There are four elements that should be answered when conducting a research question for a systematic review. The acronym PICO is consisted of those four factors which are Patient, Intervention, Comparison and Outcome (Santos et al. 2007). Answering a PICO question is what makes systematic reviews so focused on specific parameters. An example of such a question is "In adult patients undergoing root canal therapy (P), does occlusal reduction (I) compared to placebo (C) achieve greater pain relief (O) based on randomized clinical trials (RCTs)?" (Shamszadeh et al., 2020). Based on the results of such studies, clinicians can decide whether occlusal reduction could be beneficial for the patient. On the other hand, a narrative review provides a broader overview of the issues regarding a topic without being so critical. A similar example could be "Post-operative pain in endodontically treated teeth". Such a type of review could give general information to clinicians regarding several factors that could affect post-operative pain without giving any specific answers based on quantitative data.

In the last years, there seems to be an exponential increase regarding all type of publications in several fields of medicine and dentistry including endodontics (Spångberg 2007). The same tendency seems to be present in systematic reviews that

try to collect and summarize the increasing number of published papers in each topic. Although SRs and meta-analyses are considered to be at the highest level of evidence, their quality has been recently challenged (Nagendrababu et al. 2018, Sharif et al. 2013, Spångberg 2007).

The quality of a SR with or without meta-analysis has been described as their ability to provide unbiased results (Moher et al. 1995). Proper methodological design is necessary to conduct a meta-analysis and to interpret the results appropriately. Respectively, accurate extrapolation of the findings in clinical practice is essential to lead the readership to appropriate treatment planning decisions. However, several concerns are developed when contradictory results are provided between a randomized clinical trial and a systematic review with meta-analysis concerning the same clinical question (Cochrane Injuries Group Albumin Reviewers 1998, Cook et al. 1996). Those kinds of problems can be overcome when authors conduct studies of high quality or when clinicians rely solely on such studies.

Several tools have been developed in the literature to objectively assess the quality of SRs. The Overview Quality Assessment Questionnaire has been used in several fields of medical literature to assess the quality of review articles (Oxman et al. 1991, Suebnukarn et al. 2010). The “A Measurement Tool to Assess Systematic Reviews (AMSTAR)” is a combination of Overview Quality Assessment Questionnaire, another checklist (Sacks et al. 1987) and an expert’s opinion , which is a newer tool with proven validity and credibility (Shea et al. 2007, Suebnukarn et al. 2010). The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) checklist (Liberati et al. 2009), is another tool of great importance to validate the

quality of SRs. A checklist of 27 required items is used to assess the content of SRs with or without meta-analysis (Liberati et al. 2009, Page et al. 2021).

PRISMA checklist is divided to seven sections that contain several items. Each section corresponds to a certain part of the text, such as Title, Abstract, Introduction, Methods, Results, Discussion and Funding (Liberati et al. 2009). Regarding the title, the authors of the PRISMA checklist propose that it should state clearly whether the report is a SR, a meta-analysis or both, whereas the abstract should be well-structured. The introduction should contain information about the rationale and the aim of the SR. The whole structure of the materials and methods section is indicated by 12 items of the checklist and 7 more items also describe the necessary results that the study should state. Finally, a summary of the results, the limitations of the study and its conclusions are expected to be presented in the discussion section (Liberati et al. 2009). The PRISMA checklist represents an important guideline for the authors of systematic reviews which can lead to well- designed studies.

In endodontic literature, several publications have been made assessing the quality of SRs and meta-analyses. In 2010, Suebnukarn et al. published an article in which they systematically evaluated the meta-analyses of Endodontic literature published between 2001-2009 (Suebnukarn et al. 2010). The tool which they used was the AMSTAR, concluding that the overall quality of meta-analyses included in their study rated as good. The only drawback they found was a lack in assessment of the possible existence of publication bias. However, it should be stated that only 16 studies were included in the aforementioned study concerning a period when the publication rate of such studies was low compared to respective of recent similar ones. A similar study was published by Kattan et al. in 2018 (Kattan et al. 2018) using

the same methodology and covering the period between 2009-2016. In their results, it was evident that although the number of published SRs had increased in the field of endodontics, their reporting and methodological quality had been decreased. In particular, it is stated that a major problem of the included studies, namely ‘‘the provision of an a priori design’’ was missing and they propose that the authors of a SR should initially register their protocol to an open-access platform such as PROSPERO (Booth et al., 2011), to avoid reporting bias in their study.

In 2018, Nagendrababu et al. published the “methodological and reporting quality of Systematic Reviews and Meta-analyses in Endodontics”. AMSTAR and PRISMA checklist were used as tools to assess the methodological and reporting quality for the period between 2000-2017. According to their results, a significant correlation was found between AMSTAR tool and PRISMA checklist. As far as the quality of SRs and meta-analyses is concerned, it was characterized as moderate, in accordance with the results of Kattan et al. (2018). However, performing a comparison between their results to those of Suebnukarn et al., regarding 6 common included studies, they stated that their evaluation concerning the quality score of these studies differed significantly from the respective score of Suebnukarn et al., an issue of major concern for clinical readership.

From a general perspective, Systematic Reviews are a valuable tool for the progress of medicine both in the scientific and the clinical field. They guide clinicians into taking the right decisions in every-day clinical practice and underline the gaps in scientific knowledge. However, despite that publication rates seem to be vastly increasing, their quality often fails to follow that increase. Thus, it is of great importance that certain rules have to be established by scientific journals to guarantee

a minimum of quality for the studies that reach the clinician. SRs should stick to strict methodological designs with a well-stated PICO question and following the PRISMA or AMSTAR guidelines and checklists. Moreover, they should include well conducted clinical studies for their conclusions to be of clinical importance.

Finally, in the field of Endodontics, the published SRs and meta-analyses have some limitations which are mainly related to the lack of well-designed and executed randomized clinical trials. This issue makes even more difficult to conduct a proper SR with a meta-analysis. Knowing however the limitations of the literature of each medical and dental field, researchers could create and give right directions for future scientific studies.

B. *SPIN*: Definition and its role in medical literature

Origins of *spin*

The word *spin* in the context that concerns this study and not the physics term, is related to storytelling, as in "spinning a yarn." The first documented example of that phrase comes from 1812, as a sailor's expression for telling a story while performing some task like yarn-spinning (*What Is Spin (PR, Marketing)?*, n.d.).

The term "*spin*" has its origins to public relations, politics, and journalism. It is used to describe the selling of a position that is heavily biased in favor of or against a certain argument (*Political Spin | Politics | Britannica*, n.d.). *Spin* is usually related to the use of the media in appropriate ways to present the biased position and has often been implied that manipulation or deception are being used. The aforementioned

characteristics of *spin* have made it to be considered even as a form of propaganda (Safire, 1996).

In politics, *spin* has been related to press conferences where the political figure talking, usually the press secretary of a government, presents a point or a decision as being the most favorable one, neglecting alternatives or non-desirable outcomes. Some of the most common techniques of expressing *spin* include a carefully chosen time when a message is delivered, presentation of certain facts in a selective way or the use of certain words or "catch-phrases" that are expected to influence the audience in desirable ways. Skillful practitioners of *spin* are sometimes pejoratively referred to as "spin doctors," or "spinmeisters" (*Political Spin | Politics | Britannica*, n.d.).

As far as the journalism is concerned, it has been stated that *spin* promotes both lazy and distorted journalism (Grattan M 1998). Lazy journalism is described as the one that relies on government or opposition biased sources and reproduces that kind of information instead of conducting thorough research on a subject before publishing the information. Distorted journalism is met when certain positions on various subjects are uncritically accepted, and become orthodoxies, or when a well-based position that might be an alternative is discredited due to strong bias led by spin (Grattan M, 1998) .

Spin in medical scientific literature

As it is already stated the term "spin" has its origins in the ways adopted by politicians to "turn" (or "spin") thoughts or public opinions around in order to match to their

goals. However, during the last years, *spin* has made its appearance in the medical literature rising various concerns about the clinical-related information that is being published and how this could affect every day clinical practice. A lot of effort is being made through letters to editors of peer reviewing journals that aim to highlight distorted presentation or interpretation studies' results or methodological errors that could lead to misleading reporting (Boutron et al., 2010). Randomized Clinical Trials and SRs are commonly criticized in such ways as they are the most influential scientific studies for establishing clinical protocols.

The first systematic attempt to identify *spin* and to report and classify *spin* strategies in medical literature was made by Boutron et al. in 2010 (Boutron et al., 2010). In their study, they made a definition of the term *spin* in medicine as the "use of specific reporting strategies, from whatever motive, to highlight that the experimental treatment is beneficial, despite a statistically nonsignificant difference for the primary outcome, or to distract the reader from statistically nonsignificant results" (Boutron et al., 2010). Similarly another definition given for spin in scientific writing, is "a specific reporting which can distort the interpretation of results of a certain study and as a consequence, mislead the readers" (Fletcher & Black, 2007).

Boutron et al. used trials of parallel-group RCTs with statistically nonsignificant results for the primary outcome as their sample. As it is stated, such results are more likely to be affected by biased interpretation resulting in several sorts of *spin*. As a result, a Classification Scheme was presented by the authors regarding the *spin* strategies that were identified. Those were presented for each section of a scientific paper beginning from the Title to Conclusions. It is important to note that abstract *spin* and main text *spin* were evaluated separately. Some characteristic spin strategies

that were found in the Classification Scheme are: focus on statistically significant secondary outcome, focus on statistically significant subgroup analyses, acknowledge statistically nonsignificant results for the primary outcome but emphasize the beneficial effect of treatment, acknowledge statistically nonsignificant results for the primary outcome but emphasize other statistically significant results, recommendation to use a treatment provided etc (Boutron et al., 2010).

A number of concerns arise from some of the results of the aforementioned study. For example, more than half of the studies' conclusions were found to have some kind of *spin*. Moreover, *spin* was more prevalent in the abstract of the studies than in the main text. This is a major issue if we consider that many readers falsely base their interpretation of a certain study reading only the abstract section. Also, in many cases of subscription fee journals the full text of an article is not available so readers gain the information solely from the abstract (Hopewell et al. 2008). However, a certain limitation of a given study that that try to assess *spin* in other studies is the subjectivity that exists when someone interprets certain results. Bourton et al. trying to resolve the issue of subjectivity stated that having two reviewers working on the data independently and reaching a consensus, if there are any disagreements, can significantly decrease it or limit it to a certain point.

In a recent similar study by Ferrell et al. (2021), *spin* was evaluated in the abstracts of systematic reviews and meta-analyses of emergency medicine studies, published between 2015 to 2020 (Ferrell et al., 2021). The authors justify the choice of evaluating the abstracts, stating that an Emergency Medicine physician needs access to evidence- based reliable information in a timely manner, something that could be achieved by reading the abstract of a systematic review. However, as

mentioned before, abstracts are more prone to *spin* (Boutron et al., 2010), so the choice of authors to evaluate the presence of *spin* in the abstract texts was even further justified. In this case, the criteria that were used for *spin* evaluation were the same ones described by Yavchitz et al. (Yavchitz et al., 2016). Ferrel et al. found that from 200 eligible SRs, 69 of them presented at least one type of *spin* which corresponds to a percentage of 34.5%. However, this rate seems considerably low when it is compared to respective rates up to 80% of other similar studies (Nascimento et al., 2020). In their final proposal, Ferrell et al. considered that the use of PRISMA guidelines for abstracts could effectively minimize the prevalence of spin in SRs. Moreover, a thorough education of the phenomenon of *spin* through scientific conferences and journals is encouraged (Ferrell et al., 2021).

Since 2010, several studies have been published evaluating the prevalence of *spin* in various medical domains (Austin et al., 2019; Cooper et al., 2019; Khan et al., 2019; Wayant et al., 2019). In 2017, a systematic review of all meta-research studies was published reporting that the median prevalence of spin in medical literature was 67% with a range of 10-84% as far as the abstracts were concerned (Chiu et al., 2017). The factor that was only found to be statistically related to the presence of *spin* was the non-statistically significant results (Chiu et al., 2017). According to Boutron, the assessment of *spin* should not be a "black- and- white situation" (Boutron, 2020). In most of the studies, the prevalence of *spin* is reported as a dichotomous value, however, the essence of its presence varies from study to study both in amount and type. Particularly, several spin methods could be present throughout a study. However, types of spin like selective reporting of outcomes could be more misleading than linguistic spin for example.(Boutron, 2020).

In the aforementioned editorial, four suggestions were made aiming to minimize *spin* in published scientific papers. Firstly, *spin* should be acknowledged as a potentially harmful practice for scientific writing. Thus, the presentation of the findings of a scientific study should be conducted objectively. Secondly, everyone involved in publishing a scientific study should be aware of spin and its different types. More specifically, appropriate training and specific guidelines for authors, reviewers and editors could effectively minimize the presence of spin in disseminated research. Third, a proposition is made regarding the interpretation and reporting process of the results of each study. More specifically, the findings of a study should be presented after a consensus between authors, peer reviewers, and journal editors is made regarding their interpretation. Finally, the current model of "scientific success" is criticized. As it is stated, the pressure put on researchers to increase their publication rates makes them prone to adopt *spin* strategies for their studies to be more appealing for scientific journals. (Boutron, 2020).

All in all, the awareness of *spin*'s existence in scientific literature is of great value for everyone involved in the biomedical community. Journal editors, reviewers, authors and readers should be all familiar with the presence of *spin* and take precautions to minimize its influence.

Spin in Dental literature

The concept of *spin* in biomedical literature can be considered as novel, although *spin* existed in publications before being assessed. As discussed in a previous paragraph of the current thesis, *spin* was firstly assessed in 2010 (Boutron et al., 2010). As far as the dental literature is concerned, assessment of the prevalence of spin was conducted

even more recently and in particular in 2019 (Roszhart et al., 2019). Before that, an editorial was published in Journal of American Dental Association which raised awareness regarding the use of practices in scientific writing that could be deceptive for readership. Among others, *spin* was one of those practices introduced as a term in the dental literature for the first time (Glick & Carrasco-Labra, 2019). Since then, few studies have been published concerning the presence *of spin* in papers of several domains of dental specialties (Fang et al. 2020, Guo et al. 2021, Makou et al. 2021, Wu et al. 2020).

In a relevant study, Roszhart et al. included 75 RCTs with non-significant primary outcomes that were retrieved from 9 major journals of dental literature and evaluated the prevalence of *spin* in their abstract. According to the results, almost 1/3 (30.7%) of the included studies, presented with some type of *spin*. Although that percentage seems considerably high, this finding is in agreement with the results of other similar studies in biomedical literature. On the other hand, in a similar study published one year later by Eleftheriadi et al., the results seem worse. In this study, both the prevalence of spin in the abstract and the main text of RCTs of dental literature were assessed. Eleftheriadi et al. (2020) conducted a more thorough electronic search via PubMed and established more strict inclusion criteria, leading to the inclusion of 47 trials. More than 60% out of them presented at least one type of *spin* in the abstract section and over 78% in the main text (Eleftheriadi et al. 2020).

A cross-sectional analysis in the specialties of periodontology and oral implantology was published in 2020 assessing the presence of *spin* in the abstracts of RCTs (Wu et al., 2020). The authors also investigated the scientific influence of *spin* by recording inappropriate citations of articles that had been found with *spin*. it was

found that almost 70% of the included studies contained *spin* in their abstract section. The two types of spin that were present more often were focusing on secondary outcomes, including within- and between- group comparisons in the results section or on within-group assessment in the conclusion section. Concerning the inappropriate citations of studies with *spin*, the showed a low percentage with a trend of increase overtime (Wu et al., 2020). In a similar study of orthodontic literature, the results were consistent with the aforementioned. In particular, 62.2% abstracts of RCTs were found with at least one type of *spin* (Guo et al., 2021).

In Endodontology, one study has been published investigating the presence of *spin* in the abstracts of RCTs published from 2017 to 2018 (Fang et al., 2020). Spin was prevalent in 34 out of 40 trials (85%) investigated. Claiming equivalence of statistically nonsignificant primary outcomes in the conclusion section was the most common *spin* strategy. Those results highlight the urgent need for better reporting and interpretation of the results of RCTs in Endodontic literature.

Besides studies investigating *spin* in RCTs of dental literature, there have been published a couple of studies that investigate its prevalence in systematic reviews and meta-analyses. A relevant study on implantology showed low percentage of reporting, interpretation, and extrapolation issues in both the abstract and main text of SRs with meta-analysis (de Lucena Alves et al., 2022). The authors included only SRs with at least one meta-analysis and time-to-event outcomes such as survival, success, or failure rates of implants. They also adapted an already proposed 9-item checklist to evaluate *spin* in SRs and meta-analyses (Yavchitz et al., 2016). The most common type of *spin* that was found to be the “failure to mention adverse events of interventions”

with a prevalence of 51,1% in the abstract and 26.7% in the full text (de Lucena Alves et al., 2022).

Another similar orthodontic study (Makou et al., 2021) evaluating the presence of *spin* in SRs and meta-analyses of five leading orthodontic journals as well as the Cochrane Database of Systematic Reviews showed that *spin* was present in 48,6% of the meta-analyses. The authors report that SRs of observational studies were more prone to present *spin* whereas more than half of the studies with *spin*, presented more than one types of *spin*. The most prevalent types of *spin* were "failure to report number of studies/patients actually contributing to meta-analysis for main outcomes", "conclusions claiming beneficial effect despite high risk of bias in primary studies" and "conclusions claiming beneficial effect despite high heterogeneity".

In the specialty of Endodontology, no study has been published so far to assess reporting, interpretation, and extrapolation issues in the SRs with meta-analyses. The information of such a study can be beneficial for the endodontic community as it could raise awareness regarding the accurate evaluation of the content of such type of published articles.

C. Classification of *spin* in systematic reviews and meta-analyses

As it has already been mentioned, systematic reviews and meta-analyses are an extremely useful tool for the clinicians, regarding the evaluation of different therapeutic managements, as they summarize the best available evidence concerning certain medical interventions. Appropriate reporting and interpretation of the results

of SRs is of outmost importance for their applicability in clinical practice. Because misleading reporting and distorted interpretation of findings has already been reported to lead to bias (Ezzo et al., 2001; Lau et al., 2006), a need for classification of *spin* in SRs is apparent with a clear definition of its different types so that readership, authors and editors would be able to clearly identify it. Yavchitz et al. recognized this necessity developing through a detailed approach, a classification of different types of *spin* that may be observed into the main texts and abstracts of systematic reviews. In addition, he classified various types of *spin* that could occur in abstracts according to their perceived severity (Yavchitz et al., 2016). This classification which is illustrated in Table A is of utmost importance for future research in all biomedical fields as it helps researchers conducting their study through a standardized approach.

Yavchitz et al. initially tried to give a definition of *spin* which was "a specific way of reporting, intentional or not, to highlight that the beneficial effect of the experimental treatment in terms of efficacy or safety is greater than that shown by the results (i.e., overstate efficacy and/or understate harm)". After that, a four-phase consensus of the study was followed. The first phase consisted of a thorough literature search about methodological work on *spin* and different *spin* strategies in systematic reviews. Further search was conducted to identify letters and editorials related to interpretation of systematic reviews' results and articles about systematic reviews' and meta-analyses' interpretation in general. In the second phase, two of the authors proposed a classification of potential types of *spin* coming of as a result of phase 1. In the third phase, all the authors discussed the results of the previous two phases reaching a consensus and finally a classification scheme of *spin* for systematic reviews

and meta-analyses concerning therapeutic interventions was developed (Yavchitz et al., 2016).

The second part of the study included an online survey aiming to rank *spin* types in the abstract section according to their perceived severity. The participants that took part in this online survey were members of the Cochrane Collaboration with expertise in the domain of SRs and meta-analyses (Yavchitz et al., 2016).

Finally, a table including the classification of different types of *spin* was presented. In total, 39 types of *spin* were identified of which, 28 corresponded to the main text and 21 to the abstract and title. Three major categories of *spin* were proposed to be considered by the authors as follows:

1. Misleading reporting,

2. Misleading interpretation, and

3. Inappropriate extrapolation.

In addition, exact definitions for each one of them were given. Misleading reporting was defined as "inadequate reporting of the methods, study analysis, study results, or any important information that could be misleading to the reader" containing 8 different types of *spin* for the abstract section. Misleading interpretation was defined as "interpretation of study's results which could mislead the reader". It contained 10 items for the abstract section. Finally, inappropriate extrapolation was defined as "a generalization of the results of a study in an inappropriate manner". This category contained 3 spin types regarding the abstract (Yavchitz et al., 2016). The types of spin in the abstract of an SR as described above are analytically presented in

Table 1. which is similar to the one existing in the original article of Yavchitz et al/ (Yavchitz et al., 2016).

Misleading reporting	**Misleading interpretation**	**Inappropriate extrapolation**
1) and 2) Selective reporting of or overemphasis on efficacy/ harm outcomes favoring the beneficial effect/ safety of the experimental intervention 3) Negligence to state a wide CI 4) Failure to report any conflict of interest 5) Focus on the results of primary studies favoring the beneficial effect of the experimental intervention instead of the meta-analysis' results 6) Focus selectively on statistically significant outcome 7) Failure to report the number of studies/patients actually contributing to the analysis 8) Failure to specify the direction of the effect if it	9) Title claims or suggests beneficial effect not supported by the findings 10) Reliance solely on P-value instead of magnitude of the effect estimates 11) Focus on relative effect when the absolute is small 12) Conclusion claiming equivalence for non-significant results with wide CI 13) Conclusion providing clinical recommendations not supported by the findings 14) Conclusion claiming safety based on non-significant results with wide CI 15) Conclusion asserting beneficial effect of the treatment disregarding high RoB in	19) Conclusion extrapolating the review's findings to a different population 20) Conclusion extrapolating the review's findings to a different intervention 21) Conclusion extrapolating the review's findings from a surrogate marker or a specific outcome to the global improvement of the disease

favors the control	primary studies 16) Conclusion asserting beneficial effect of the experimental treatment desregarding reporting bias 17) Conclusion asserting beneficial effect of the treatment desregarding high heterogeneity 18) Ignoring the inclusion of different study designs (e.g., controlled trial or observational studies)	

Table 1. Overview of spin classification in abstracts of SRs and meta-analyses (Yavchitz et al., 2016). CI: confidence intervals, RoB: Risk of Bias.

In general, the *spin* types shown in the table above are descriptive and comprehensible for the reader, however, some terms could be further explained for better understanding.

The first category contains mostly *spin* strategies that omit to present certain information, such as efficacy or safety outcomes, wide confidence intervals, the numbers of patients or/and studies that contributed to the analysis of the main outcomes or overemphasizing on others such as the results of primary studies. A common issue is when authors disregard the actual number of studies that have contributed to the analysis of each outcome in the abstract of a study. In particular,

the amount of the included studies may be presented without explaining how many of these were used for the analysis of the outcomes (Makou et al. 2021).

As far as the second category is concerned, the reader should be familiar with certain terms that are related to SRs and meta-analyses. P-value and effect estimates are commonly presented in the scientific literature. A p-value is the probability of the results being due to chance or, to state it in a different way, the probability that the null hypothesis is incorrectly rejected (Kalinowski & Fidler 2010). P-value defines the existence of statistical significance without providing information about the effect size or clinical significance. Moreover p-value is dependent to the sample size (Berben et al., 2012). On the other hand, effect size estimates are not dependent to sample size and give information about the extent of a treatment effect or the association between variables. There is a variety of effect size statistics being reported in studies depending on the nature of the results, such as, mean differences, odds ratios, relative risk differences etc (Berben et al. 2012). Confidence intervals (CIs) are also important when calculating effect size estimates. They reflect the precision of the calculated effect size (Kalinowski & Fidler, 2010). Being familiar with the aforementioned terms it is clear that omitting to state the effect size estimates and presenting solely the p-values in the abstract of a meta-analysis potentially leads to misleading interpretation of the results as presented in **Table 1**.

All kinds of bias can negatively impact the conduction of medical research. This is the reason why methodological measures should be taken to limit its presence within studies (Furuya-Kanamori et al. 2021). The assessment of the risk of bias (RoB) of studies included in a systematic review is of outmost importance for interpreting and summarizing its results (Institute of Medicine (US) Committee on Standards for

Systematic Reviews of Comparative Effectiveness Research 2011). RoB assessment refers to the flaws in the methodology, conduct, and analysis of a study that can affect its results (Banzi et al. 2018). It is a crucial part of the study playing an important role in the final assessment of the strength of the evidence and it should be noted that there are systematic reviews that even exclude studies with high RoB (Viswanathan et al. 2018). It is understandable that SRs and meta-analyses that either have not calculated the RoB or have included studies with high RoB, without reporting it, can lead to misleading interpretation of their results.

Assessment of heterogeneity is another important task. Heterogeneity refers to the variation in methodology and clinical parameters (participants, interventions, outcomes) among studies included in systematic reviews and meta-analyses (Song et al. 2001). Several sources of heterogeneity have been reported such as variability in the sample, the types of outcome measurements and intervention characteristics, the so-called "clinical heterogeneity". "Methodological heterogeneity", on the other hand, consists of , variability in the trial design and quality(*Cochrane Handbook for Systematic Reviews of Interventions*, n.d.). Statistical heterogeneity also exists when true effects being evaluated differ between studies (Higgins & Thompson 2002). Both clinical and methodological heterogeneity contribute to the presence of "statistical heterogeneity" (*Cochrane Handbook for Systematic Reviews of Interventions*, n.d.). There are statistical tools available to quantify heterogeneity in the process of conducting a systematic review and a subsequent meta-analysis (Higgins & Thompson, 2002). The presence of heterogeneity in SRs can generate inaccurate conclusions and misleading decision-making if not taken properly into account (Gagnier et al. 2012).

Therefore, whenever heterogeneity is present in a considerable extent, that should be highlighted to avoid misleading interpretation of the study's results.

It would be of paramount importance if the scientific community was adequately aware of the types of spins presented by Yavchitz et al. (Yavchitz et al. 2016) as well as the meaning of certain terms included in order to understand its content. It is an essential tool for the detection of *spin*, avoiding mainly the overinterpretation of the results of systematic reviews with the application of their recommendations in every day clinical practice.

Research Part

Περίληψη

Σκοπός: Ο όρος *spin* αναφέρεται στην εκούσια προτίμηση της επιλεκτικής αναφοράς συνήθως μόνο των στατιστικά σημαντικών ευρημάτων καθώς και της προσπάθειας υπερ-ερμηνείας (over-intrepretation) αλλά και μη πρέπουσας αναγωγής των αποτελεσμάτων μιας μελέτης στην κλινική πράξη. Ο σκοπός της παρούσας μελέτης ήταν η διερεύνηση και η πιθανή αναγνώριση της ύπαρξης *spin* στις περιλήψεις (abstracts) των συστηματικών ανασκοπήσεων (ΣΑ) με μετα-ανάλυση σε σχέση με τα αναφερόμενα στο κυρίως κείμενο (main text) της εργασίας στο γνωστικό αντικείμενο της Ενδοδοντίας.

Μεθοδολογία: Η στρατηγική αναζήτησης έλαβε χώρα στη βιβλιογραφική βάση του PubMed με λέξεις-κλειδιά για τον εντοπισμό ΣΑ με μετα-ανάλυση στο γνωστικό αντικείμενο της Ενδοδοντίας, η οποία συμπληρώθηκε από αντίστοιχη ηλεκτρονική αναζήτηση σε 3 μεγάλα εξειδικευμένα ενδοδοντικά περιοδικά και συγκεκριμένα στο International Endodontic Journal, στο Journal of Endodontics και στο Australian Endodontic Journal, καλύπτοντας την περίοδο από την 1η Ιανουαρίου 2010 έως τις 16 Απριλίου 2022. Διερευνήθηκε και καταγράφηκε η ύπαρξη και η έκταση του *spin* με βάση τους διάφορους τύπους κάτω από τους οποίους ανιχνεύθηκε και συγκεκριμένα εάν σχετίζονταν με επιλεκτική αναφορά, υπερ-ερμηνεία και ακατάλληλη αναγωγή των αποτελεσμάτων των υπό διερεύνηση μετα-αναλύσεων. Τέλος, διερευνήθηκε η ύπαρξη συσχέτισης του *spin* με διάφορα χαρακτηριστικά των υπό διερεύνηση μελετών όπως το έτος δημοσίευσης, ο τύπος περιοδικού (ενδοδοντικό ή μη), ο αριθμός των συγγραφέων, η περιοχή ή χώρα προέλευσης του πρώτου συγγραφέα, η πιθανή ύπαρξη χρηματοδότησης, ο τύπος των μελετών που συμπεριέλαβε στην ανάλυσή της κάθε συστηματική ανασκόπηση (π.χ.

τυχαιοποιημένες κλινικές μελέτες, κοορτικές μελέτες) και τέλος η πιθανότητα στατιστικής ή μη, σημαντικότητας των αποτελέσματος των.

Αποτελέσματα: Συνολικά εκατόν ογδόντα έξι (186) συστηματικές ανασκοπήσεις με μετα-ανάλυση βρέθηκαν κατά το χρονικό διάστημα της αναζήτησης. *Spin* εντοπίστηκε σε 125 περιλήψεις εξ΄ αυτών (67,2%). Στην πλειοψηφία των περιλήψεων εντοπίστηκαν περισσότεροι από έναν τύπους *spin* (91/125, 72,8%). Στις περιλήψεις των μετα-αναλύσεων με μη στατιστικά σημαντικά αποτελέσματα ανιχνευθηκαν 60% χαμηλότερες πιθανότητες για ύπαρξη *spin* (λόγος πιθανοτήτων, OR: 0,40; 95%CI: 0,19, 0,83; p= 0,04), μετά από προσαρμογή για το έτος, το είδος του περιοδικού και τον αριθμό των συγγραφέων.

Συμπεράσματα: Η επιλεκτική αναφορά συνήθως μόνο των στατιστικά σημαντικών αποτελεσμάτων, η υπερ-ερμηνεία και η μη πρέπουσα αναγωγή των ευρημάτων στην κλινική πράξη σε περιλήψεις μετα-αναλύσεων είναι εμφανείς στην ενδοδοντική βιβλιογραφία. Θα πρέπει να υπάρξει προσπάθεια ευαισθητοποίησης της επιστημονικής και ακαδημαϊκής κοινότητας προς περισσότερο διαφανή παρουσίαση και κατάλληλη ερμηνεία των αποτελεσμάτων των συστηματικών μελετών που βρίσκονται στο ανώτερο επίπεδο της τεκμηρίωσης.

Abstract

Aim: *Spin* refers to reporting, interpretation and extrapolation related distortion or manipulation of the findings of a study. The aim of this report was to identify the prevalence and extent of *spin* in the abstracts of systematic reviews (SRs) including meta-analyses in the scientific field of Endodontics.

Methodology: A sensitive and inclusive search strategy in PubMed was developed to identify eligible SRs with meta-analyses in Endodontics, supplemented by an electronic search within 3 major specialty journals, from January 1, 2010 to April 16, 2022. Inclusion and extent of *spin* was recorded, per domain and following issues related to misleading reporting, interpretation and inappropriate extrapolation of meta-analyses' findings. Association of *spin* with publication characteristics such as year, journal type, number of authors, continent of authorship, funding, primary study design and significance of the outcome was explored.

Results: A hundred and eighty-six SRs with meta-analyses were retrieved, and inclusion of *spin* was detected in 125 abstracts (67.2%), for one or more domains. The majority of abstracts were affected by more than one types of *spin* (91/125; 72.8%). There was evidence that abstracts of meta-analyses of non-significant findings had 60% lower odds for inclusion of *spin* (Odds ratio, OR: 0.40; 95%CI: 0.19, 0.83; p= 0.04), after adjusting for year, journal type and number of authors.

Conclusions: Misleading reporting and misinterpretation of findings in abstracts of meta-analyses is evident in endodontic research. Efforts should be reinforced to increase awareness within the scientific and academic community to improve adherence to transparent reporting and interpretation.

Introduction

Systematic reviews (SRs) are considered the backbone of decision-making process in everyday clinical practice. When also accompanied by a meta-analysis of primary studies, offering a pooled estimate of a treatment effect, they qualify for a more straightforward quantification of the effectiveness or safety of an intervention. As such, and especially when following transparent conduct and reporting guidelines, systematic reviews are top-rank in terms of evidence perspectives (Cook et al., 1997; Fleming et al., 2014; Mulrow et al., 1997).

As the importance of high-quality SRs is profound and the abundance of evidence available to the readership is more than ever accessible, the clear focus should be placed on reporting and transparency strategies, as well as on the certainty of the evidence stemming from disseminated published research. Apparently, this is vital and possesses a central role in guiding researchers and clinicians towards efficient decision making.

In Endodontology, specialty journals have made a great effort to improve the content, structure and quality of published SRs. Particularly, they have introduced special requirements for reporting of structured abstracts and PROSPERO registration for SRs (Nagendrababu et al., 2019), following concurrent international perspectives (Page et al., 2021). However, based on a very recent evaluation, endodontic meta-analyses have been reported to present deficiencies with regard to their quality (Nagendrababu et al., 2018). On this basis, it has been concluded that several reporting, interpretation and extrapolation issues have been identified in published research including SRs (Boutron et al., 2010; Yavchitz et al., 2016). This distortion of

presentation of published research findings has been represented by the inclusive term "*spin*". In other words, *spin* has been characterized by the intentional or unintentional presentation, distortion or manipulation of findings with an ultimate negative effect on the guidance of the readership, thus impacting on the overall application of knowledge to the translation to clinical practice (Boutron et al., 2010; Horton, 1995; Yavchitz et al., 2016).

Abstracts of research studies have long been identified as sources of *spin* within the biomedical literature, with reporting and interpretation of flawed or distorted findings being identified as impacting more than half of the published RCTs in medical journals (Boutron et al., 2010; Cooper et al., 2019; Fang et al., 2020; Kinder et al., 2019). The lack of available time or the inaccessibility of the full text of articles may often leads clinicians, health care consumers and scientists to read solely the abstract of the relevant manuscript, as an informative and concise element of knowledge (PMC, 2006), and this is pertinent also for the SRs and meta- analyses. As such, if an abstract constitutes a distorted picture of the findings related to a research question and is also the sole source of information provided to an individual reader, then implications for its usefulness and effectiveness in promoting credibility and unbiased perspectives for clinical decision making should be considered (Pitkin et al., 1999).

During the past few years, a number of articles have been published in biomedical literature evaluating the existence and extent of *spin* in either RCTs or SRs. In Endodontics, Fang *et al.* (2020) reported the existence and characteristics of *spin* in abstracts of RCTs (Fang et al., 2020). So far, no study has assessed *spin* in endodontic meta-analyses. Therefore, the aim of the present study was two-fold: a) to identify

and record the prevalence of *spin* and b) to assess publication factors associated with this flaw in abstracts of endodontic meta-analyses.

Materials and Methods

Search strategy and selection process

A comprehensive search was conducted in PubMed to identify SRs and meta- analyses related to Endodontics, between January 1, 2010 and April 16, 2022. The formulation of the search query was based on the search strategy followed by Fang et al. (2020) (Fang et al. 2020) and was formed as follows:

("endodontal"[All Fields] OR "endodontic"[All Fields] OR "endodontical"[All Fields] OR "endodontically"[All Fields] OR "endodontics"[MeSH Terms] OR "endodontics"[All Fields] OR "endodont"[Title/Abstract] OR "pulp*"[Title/Abstract] OR "root canal"[All Fields] OR "apexification"[MeSH Terms] OR "apexification"[All Fields] OR "apexifications"[All Fields] OR "periradicular lesions"[All Fields] OR "periapical disease"[All Fields] OR "gutta percha"[All Fields] OR "retrograde obturation"[All Fields] OR "retrograde filling"[All Fields] OR "apicoectomy"[MeSH Terms] OR "apicoectomy"[All Fields] OR "apicoectomies"[All Fields] OR "root end surgery"[All Fields] OR "tooth replantation"[All Fields] OR "tooth autotransplantation"[All Fields] OR "intentional replantation"[All Fields] OR "apical abscess"[All Fields] OR "apical periodontitis"[All Fields]) AND ((meta-analysis[Filter] OR systematic review[Filter]) AND (2010:2022[pdat])).*

Moreover, this was supplemented by an electronic search within the archives of the three leading specialty journals in Endodontics, namely the International Endodontic Journal, the Journal of Endodontics, and the Australian Endodontic Journal, in the same publication period, so as to include any missing, but eligible

articles. The selection process involved identification of the term ‘systematic review’ in the titles or abstracts of the identified study entries. Full texts for all potentially relevant reviews were obtained and examined to conclude whether a systematic methodology as well as a quantitative synthesis (meta-analysis) of data was performed, so as to qualify as eligible for inclusion. SRs without quantitative synthesis of data were excluded. Inclusion criteria involved meta-analyses of studies on humans, both interventional and observational (epidemiological) in design. More sophisticated designs such as network or Bayesian meta-analyses were excluded. Diagnostic SRs, SRs involving animal or in vitro studies were also excluded, as these follow different methodological perspectives. Moreover, studies with a content not relevant to Endodontics and studies related to primary dentition were not included for further evaluation. Screening was done independently by one author and confirmed by a second and any disagreements were settled until consensus was reached, or with the assistance of a third investigator.

Data extraction

As a second step and after standardization of the ultimately included studies based on the a priori set eligibility criteria, data extraction was performed by two reviewers after initial calibration. In particular:

Characteristics of the meta-analyses were recorded including journal of publication, publication year, continent of authorship based on the first author’s affiliation details provided in the article, number of authors, type (design) of the meta-

analysis (interventional, observational), funding, significance or not of the primary outcome and the endodontic thematic domain of the study.

Assessment of spin was performed after careful reading of the abstract and the main text of each eligible article. Types of spin were assessed according to the latest classification for abstracts of SRs and meta-analyses, developed by Yavchitz et al. (2016).

- **A. misleading reporting:** concerns selective reporting and overstatement outcomes for the intervention group, failure to report direction of the effect, a (wide) confidence interval or the number of contributing studies/patients to the analysis and reporting of conclusions with a selective focus on the statistically significant outcome.
- **B. Misleading interpretation:** comprises inadequate focus on P-values instead of the magnitude of effect estimates and uncertainty bounds, formulation of recommendations for practice not supported by the findings, and conclusions claiming the beneficial effect of the treatment, while disregarding risk of bias, heterogeneity, primary study design, and reporting bias.
- **C. Inappropriate extrapolation:** spin in extrapolation concerns distorted generalizability strategies and extrapolation of findings to different populations or interventions.

Statistical analysis

The association between spin inclusion in abstracts and study characteristics was presented through descriptive statistics and the use of cross tabulations and pearson chi-square test as appropriate. The types and extent of spin (no spin, one, or more types) were also investigated.

Univariable and multivariable logistic regression models were structured to assess the effect of study characteristics including year (2010 to 2016 and 2017 to 2022), journal of publication (either specialty or general audience), continent of authorship, number of authors, funding, study design, and statistical significance of outcomes, on overall spin detection. Potential predictors were inserted sequentially, one at a time in the model (forward stepwise variable selection). Along with the coefficient of determination for goodness of fit, and to balance model fitness and its complexity, two information criteria were assessed to structure and select the multivariable regression model, first the Akaike Information Criterion (AIC), and also the Bayesian Information Criterion (BIC). The model which minimized the considered information criteria was selected. Model post-estimation diagnostics were checked through Hosmer-Lemeshow goodness of fit test. As indicated above, year was dichotomized in terms of analysis, based on the reference year of 2016, when the landmark study of Yavchitz et al. 2016 was published (Yavchitz et al. 2016). Interaction between year and journal was studied, through likelihood ratio test. The unweighted kappa statistic was used to assess inter-rater agreement for inclusion of spin overall, in 15 of the included records. Level of statistical significance was set at $p<0.05$. All statistical analyses were conducted with Stata version 15.1 software (Stata Corporation, College Station, Tx, USA).

Results

A total of 1076 articles were the results of the electronic PubMed search. After application of eligibility criteria, electronic search within the specialty journals as well as duplicate removal, a total of 186 SRs with meta-analyses related to endodontics were left for inclusion and formulated the sample for this study (**Figure 2**).

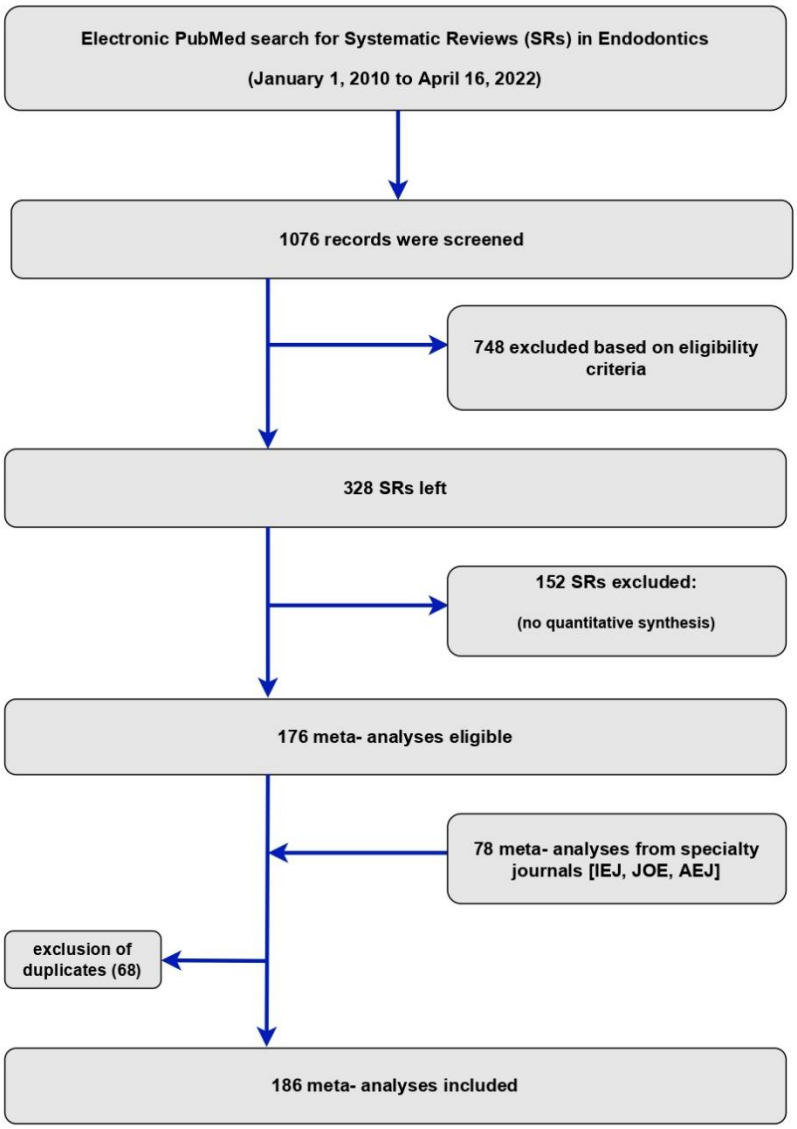

Figure 2. Flowchart of study selection process.

Inter-rater agreement was high, and the unweighted kappa statistic was 0.86 (95% Confidence Interval, 95%CI: 0.59, 1.00). The largest part of our sample constituted SRs

with meta-analyses published within the last 5 years (2017-2022: 141/186, 75.8%; (**Figure 3**), and within specialty journals (78/ 186; 41.9%). The majority originated from America (67/186; 36.0%) and Asia/other (68/186; 36.6), were co-authored by six or more researchers (82/186; 44.1%) and had not received any financial support (138/186; 74.2%). Reviews concerning interventional studies were more prevalent (106/186; 57.0%), while most claimed statistical significance of the outcome of interest (111/186; 59.7%) (**Table 2**).

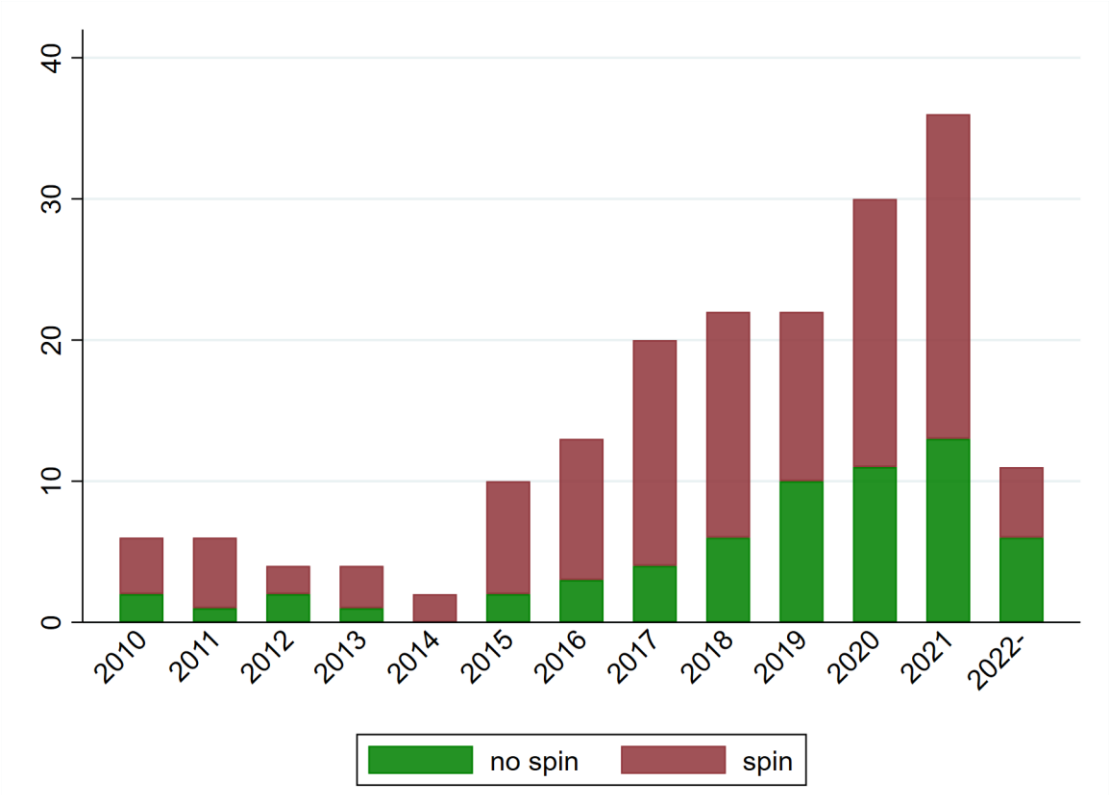

Figure 3. Bar graph showing frequency distribution of SRs with meta-analyses published in the period 2010- 2022, divided by presence of *spin*.

	Presence of *spin* in abstracts of endodontic meta-analyses			p-value
	No N (%)	**Yes N (%)**	**Total N (100.0%)**	
Year of publication				0.17*
2010- 2016	11 (24.4)	34 (75.6)	45	
2017- 2021	50 (35.5)	91 (64.5)	141	
Journal				0.15*
General Dental journals	40 (37.0)	68 (63.0)	108	
Endodontic journals	21 (26.9)	57 (73.1)	78	
Continent				0.35*
America	18 (26.9)	49 (73.1)	67	
Europe	20 (39.2)	31 (60.8)	51	
Asia/other	23 (33.8)	45 (66.2)	68	
No. authors				0.01*
1- 3	18 (46.2)	21 (53.8)	39	
4- 5	26 (40.0)	39 (60.0)	65	
≥ 6	17 (20.7)	65 (79.3)	82	
Funding				0.79*
No	46 (33.3)	92 (66.7)	138	
Yes	15 (31.3)	33 (68.7)	48	
Type of Study				0.70*
Interventional	36 (34.0)	70 (66.0)	106	
Epidemiological	25 (31.3)	55 (68.7)	80	
Significance				0.02*
No	24 (49.0)	25 (51.0)	49	
Yes	30 (27.0)	81 (73.0)	111	
Non- applicable	7 (26.9)	19 (73.1)	26	
Total	**61 (32.8)**	**125 (67.2)**	**186**	

*pearson chi- square

Table 2. Frequency distribution for the presence of *spin* or otherwise, by article characteristic (n=186).

The breakdown of research topics is presented in **Table 3**, revealing a total of 14 thematic domains. Regenerative endodontic procedures (33/186; 17.7%), postoperative pain (33/186; 17.7%) and systemic health & endodontics (20/186; 10.8%) were the most prevalent domains (**Figure 4**).

	Presence of *spin* in abstracts of endodontic MAs		
MA Topics	**No** **N (%)**	**Yes** **N (%)**	**Total** **N (100%)**
Regenerative endodontic procedures	10 (30.3)	23 (69.7)	33
Postoperative pain	11 (33.3)	22 (66.7)	33
Systemic health and Endodontics	8 (40.0)	12 (60.0)	20
Surgical Endodontics	5 (27.8)	13 (72.2)	18
Single visit vs multiple visit outcome	3 (50.0)	3 (50.0)	6
Endodontic Microbiology	3 (21.4)	11 (78.6)	14
Root canal Obturation/ irrigation	3 (42.9)	4 (57.1)	7
Root canal anatomy	3 (37.5)	5 (62.5)	8
Dental Trauma/ fractures (Crown-VRF)	3 (37.5)	5 (62.5)	8
Anaesthetic efficacy	7 (38.9)	11 (61.1)	18
Procedural iatrogenic events	2 (28.6)	5 (71.4)	7

Prevalence of apical periodontitis	1 (16.7)	5 (83.3)	6
Lasers/ photodynamic therapy	2 (50.0)	2 (50.0)	4
Conventional endodontic treatment outcome	0 (0.0)	4 (100.0)	4
Total	**61**	**125**	**186**

Table 3. Prevalence of *spin* across endodontic meta-analysis (MA) topic domain.

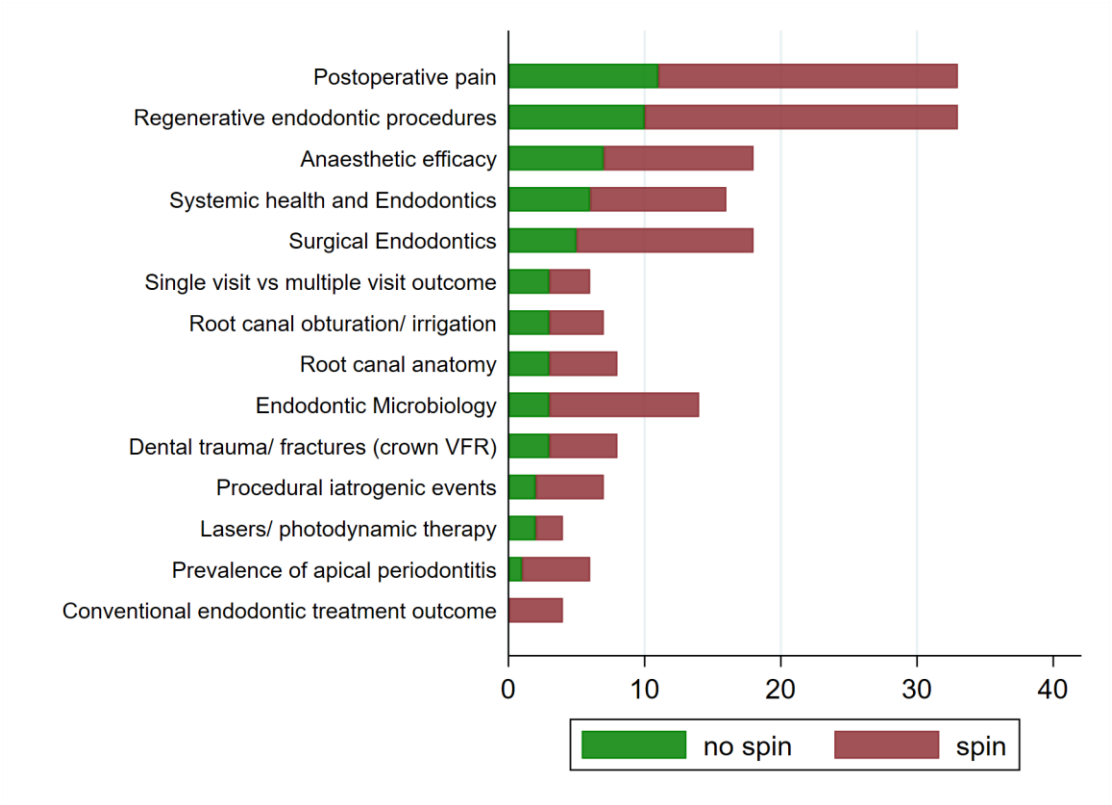

Figure 4. Horizontal bar graph on frequency distribution of endodontic SRs with meta-analyses, across thematic discipline, by presence of *spin.*

A hundred and twenty- five SRs including meta-analyses (67.2%) included some type of spin in their abstracts related to reporting, interpretation or extrapolation issues in the presentation of their findings. Those with statistically significant outcomes (p=0.02), and those co- authored by six or more authors (p=0.01) were more likely to include spin overall (**Table 2**). The vast majority of abstracts that included spin was affected by more than one types (91/125; 72.8%). Considering spin domains, failure to report the number of patients/ teeth/ studies contributing to meta-analyses was present in 80 of 125 abstracts with spin (64.0%). Likewise, considering interpretation issues, most concluded positively for a beneficial effect, disregarding heterogeneity across primary studies (68/125; 54.4%), or demonstrated focus on p- values rather than the magnitude of the effect estimates (45/125; 36.0%) (**Table 4**). Representative examples of spin, following the most prevalent types are included in **Table 5**.

	Reporting (100) N (%)	**Interpretation (101) N (%)**	**Extrapolation (4) N (%)**
Selective reporting/ overemphasis on efficacy outcomes favoring intervention	5 (6.3)		
Selective reporting/ overemphasis on safety outcomes favoring intervention	1 (1.0)		
Failure to report wide confidence interval of estimate or at all	51 (51.0)		
Inadequate focus on results of primary studies instead of those from meta-analyses	1 (1.0)		
Conclusion focusing selectively on statistically significant outcome	4 (4.0)		
Failure to report number of studies/ patients actually contributing to meta-analysis for main outcomes	80 (80.0)		

Failure to specify the direction of the effect when favoring the control	1 (1.0)		
Inadequate focus on p- value instead of magnitude of effect estimates		45 (44.6)	
Conclusion claiming equivalence or comparable effectiveness for non-statistically significant results with a wide confidence interval		3 (3.0)	
Conclusion formulating recommendations for clinical practice not supported by the findings		5 (5.0)	
Conclusions claiming beneficial effect despite high RoB in primary studies		38 (37.6)	
Conclusions claiming beneficial effect despite reporting bias		1 (1.0)	
Conclusions claiming beneficial effect despite high heterogeneity		68 (67.3)	
Ignoring that the review included different study design		6 (5.9)	
Conclusion extrapolating review findings to different population			3 (75.0)
Conclusion extrapolating the review's findings to a different intervention			1 (25.0)

Table 4. Type and extent of spin across affected SRs with meta-analyses.

Type of spin	**Example**
Failure to report wide confidence interval of estimate or at all	"*Meta-analysis showed that ibuprofen 600 mg is more effective than placebo at 6 hours postoperatively (ES = 10.50, P = .037), and ibuprofen 600 mg + acetaminophen 1000 mg combination is more effective than placebo (ES = 34.89,P = .000) but not significantly different than ibuprofen (ES = 13.94, P = .317)*". The results of the meta-analysis are presented without mentioning the CIs at all. However in the main text wide CIs are found.
Failure to report number of studies/ patients actually contributing to meta-analysis for main outcomes	"*Quality assessment highlighted four non-randomised studies to be of fair and five of poor-quality. Four randomised trials showed high risk of bias. The pooled success rate differed based on material and follow-up. Calcium hydroxide success rate was 74% at 6-months, 65% at 1-year, 59% at 2-3 years and 56% at 4-5 years. Mineral trioxide aggregate (MTA) success was 91%, 86%, 84% and 81% at the same time points. Biodentine success was 96% at 6-months, 86% at 1 year and 86% at 2-3 years. Meta-analysis revealed different MTA had better success than calcium hydroxide at 1-year (OR 2.66, 95% CI; 1.46- 4.84, p=0.001) and 2-3 years follow-up (OR 2.21, 95% CI; 1.42 - 3.44, p=0.0004). There was no difference between MTA and Biodentine*". The results are presented but there is no report of how many studies or patients contributed to each result.
Inadequate focus on p- value instead of magnitude of effect estimates	"*All meta-analyses revealed a global effect (P < .05, P < .05, and P < .05), which means that 4 mg dexamethasone helps relieve pain, sometimes for up to 8, 12, and 24 hours*"
Conclusions claiming beneficial effect despite high heterogeneity	"*… it can be concluded that RET yielded high survival and healing rates with a good root development rate*". This is the conclusion despite high heterogeneity is found in the main text.

Table 5. The most prevalent types of spin in endodontic meta-analyses, by example.

Multivariable logistic regression revealed evidence of association between spin inclusion on abstracts of meta-analyses and statistical significance of the outcomes. In essence, non-significant findings presented 60% lower odds for inclusion of spin compared to significant (Odds ratio, OR: 0.40; 95%CI: 0.19, 0.83; Wald- test, p= 0.04), conditional on year, journal type, number of authors (**Table 6**). In addition, SRs including meta-analyses co- authored by six or more investigators were more likely to present some sort of spin in their abstracts compared to a maximum of three authors in the author list (OR: 3.67; 95% CI: 1.49, 9.06; Wald test, p=0.01), adjusted for year, journal type and statistical significance of the outcome. Test for interaction between year and journal type was non- significant (likelihood ratio test, p=0.23).

Category	Univariable			Multivariable		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Year			0.17			0.10
2010-2016	Reference			Reference		
2017-2022	0.59	0.27, 1.26		0.49	0.21, 1.13	
Journal			0.15			0.12
Endodontic Journals	Reference			Reference		
General Dental	0.63	0.33, 1.18		0.57	0.29, 1.14	
Continent			0.36*			
America	Reference					
Europe	0.57	0.26, 1.24				
Asia/ Other	0.72	0.34, 1.50				
No. Authors			0.01*			0.01*
1-3	Reference			Reference		
4-5	1.29	0.58, 2.87		1.30	0.55, 3.11	
≥ 6	3.28	1.44, 7.48		3.67	1.49, 9.06	
Funding			0.79			
No	Reference					
Yes	1.10	0.54, 2.23				
Study Category			0.70			
Interventional	Reference					
Observational	1.13	0.61, 2.10				
Significance			0.02*			0.04*
Yes	Reference			Reference		
No	0.39	0.19, 0.78		0.40	0.19, 0.83	
Not applicable	1.01	0.38, 2.63		0.79	0.29, 2.17	

*wald test for overall association

Table 6. Univariable and multivariable logistic regression with Odds Ratios (OR) and associated 95% CIs for the effect of article characteristics on inclusion of *spin* in abstracts of endodontic SRs with meta-analyses (n=186).

Discussion

Dissemination of research is of paramount importance to guide clinical decision making, what is more, through published research articles and diffusion to a wide readership audience. The substantiation of confidence in the disseminated research findings is normally conditional on the quality of reporting and transparent interpretation of the results, this being reflected in a fairly valuable amount within systematic reviews and meta- analyses.

The present study is one of the very few across dentistry domains, focusing on potentially misleading reporting, interpretation and extrapolation of findings from meta-analyses. Thus, the importance of identification of spin being included in the topmost representatives of the pyramid of evidence may be easily assumed, even more when it reflects the most straightforward part of a study, the abstract, which summarizes the state of the art of a given medical condition and treatment effect. A considerably high level of spin was detected in our sample, covering a wide range of publication years, as well as diverse journals, both specialty as well as general audience, always related to endodontic research. Importantly, nearly two thirds of SRs with meta-analyses included some type of spin, irrespective of the type of journal published, while studies with non- significant outcomes were less likely to present spin. It is of note that most reporting problems identified in the abstracts were failure to report on the number of studies or patients/teeth truly contributing to the estimates formulated by the meta-analyses, or failure to report on the confidence bounds for this estimate. In addition, interpretation inconsistencies were related to conclusions claiming beneficial effects, while disregarding primary study limitations

such as the risk of bias and heterogeneity issues; or otherwise, specific focus on p-values rather than the magnitude of an effect. Such findings are in keeping with previously identified shortcomings in the Endodontic literature, irrespective of the nature of the disseminated research. Over-reliance on p-values rather than on an uncertainty estimator has been diffusing publications in the field for years (Tzanetakis & Koletsi 2021b), thus making it impossible to assess confidence on any disseminated effect estimates for a given intervention. Moreover, intense efforts should be set in place in order to educate students and clinicians to interpret the quantitative findings of SRs in the context of the limitations of the contributing studies, with specific focus on the risk of bias, heterogeneity and overall sample sizes.

As already mentioned, few studies have investigated the prevalence of *spin* in published SRs. Initiatives have been identified in the biomedical literature since at least 2016 (Yavchitz et al. 2016) in a more thorough and specific format, but also earlier (Boutron et al. 2010). A previous report in orthodontics has elucidated for the first time the condition with misleading reporting, interpretation and extrapolation of research findings emerging form quantitative syntheses of SRs, exclusively published in orthodontic specialty journals. It was clear that spin was rather prevalent in orthodontic meta-analyses as well, detected in half of the sample, while more than half presented at least 2 types of spin. Contrary to our findings, the study of Makou et al. (2021) identified study design-oriented spin, with observational type SRs being mostly affected, while again a trend was observed for non-significant meta-analyses to be less affected by this flaw (Makou et al. 2021). The former effect has been demonstrated in other types of methodological flaws of original studies as well, since observational and non-randomized studies have been considered of lower quality

overall in terms of evidence perspectives (Gratsia et al. 2019, Koletsi et al. 2015, Tzanetakis & Koletsi, 2021a, 2021c). Regarding the latter, one might consider this is related to the overall nature of the identified spin domains, with authors of most SRs being more prone to overstress the conceivably significant findings, disregarding the limitations of the contributing primary studies, or overstating a statistically significant p-value result (Koletsi et al. 2009). In line with the latest empirical report on spin in orthodontics, the present study confirmed more prevalent inclusion of spin upon co-authoring of the SRs from a large number of investigators (ie, more than 6). Interestingly, if one considers the methodological perspectives and stages involved in a SR with quantitative synthesis (search strategy, data extraction, risk of bias assessment, mathematical synthesis), a maximum of 4-5 authors in collaboration might be considered adequate in dental research, this being confirmed by previous research in the field (Alqaydi et al. 2018). However, exceptions do exist especially when large- scale comprehensive reviews with more sophisticated analyses of data take place. Otherwise, speculations might exist regarding justification or non-justification of research work, not excluding honorary authorship, lacking accountability and thus not necessarily well- educated to conduct and report a SR. In terms of identification and detection of spin in other study designs, it has been indicated that there is a wide but always high prevalence of this discrepancy across biomedicine, including percentages from 35 to 60 percent (Boutron et al., 2010; Chiu et al., 2017; Lazarus et al., 2015). Up to now and prior to the study of Makou et al. (2021), there have been only sporadic empirical reports in dentistry, on the prevalence and extent of spin included in randomized clinical trials (RCTs) (Roszhart et al., 2019). A recent report on RCTs in dentistry has indicated that spin might be included in

almost 62% of abstracts by the study authors, being mostly represented by selective overstating of the significant findings, irrespective of the study aims and objectives (Eleftheriadi et al., 2020); however, this report included a relatively small sample size and pertained solely to a short time-span, thus appearing potentially not fully representative. Moreover, other specialty specific reports have also identified noteworthy elements of spin. A very recent study in orthodontic RCTs, following abstract assessment, has revealed that 62.2% of those suffered by this flaw, with conclusion section spin being identified in more than half (Guo et al., 2021). In this report, international collaborations as well as trial registration accounted for improved reporting and interpretation, contrary to spin practices. The latter has also been acknowledged universally as a backbone practice for providing transparency and credibility in disseminated research findings (Fleming et al., 2015; Koufatzidou et al., 2019; Tzanetakis & Koletsi, 2021a, 2021c). Similarly, abstracts of RCTs in periodontology and implantology have been reported to present spin in almost 70% of their reports (Wu et al., 2020). Likewise, most incorporated spin in their conclusions, with a wide range across their sub-specific thematic domains.

Apparently, the presence of spin in abstracts of endodontic meta-analyses has been identified collectively and was recorded in high prevalence in almost all disciplines of endodontic research. More specifically, when evaluating the thematic domains including a considerable number of studies (ie., over 10), it seems that contemporary and modern endodontic techniques, namely regenerative procedures, as well as more standard thematology disciplines, such as endodontic microbiology or postoperative pain are invariably affected. This renders the call for increasing

awareness of the scientific community, including authors, clinicians, editors, reviewers and academia in general highly anticipated.

The relation of spin and methodological quality of systematic reviews and meta-analyses has additionally been examined in specific domains in biomedicine. A recent study on abstracts of SRs on cannabis use disorder has revealed only a weak positive correlation between the presence of spin and AMSTAR-2 score. This might be anticipated to an extent, since aspects related to AMSTAR-2 and methodological quality of SRs have focused on mainly on stiff reporting dynamics within the SR, while presence of spin, uncovers a wrongful and manipulative interplay between the presentation of findings and their interpretation (Shea et al. 2017).

This meta-epidemiologic study was not free of limitations. First, it is apparent that we have not included all endodontic related SRs with quantitative syntheses; however, we have applied a database search supplemented by hand searching of the most rigorous endodontic journals and as such it is anticipated that our sample has been representative, what is more since we included SRs both from specialty as well as from general audience journals. Current searching methodologies in the literature follow either only the first or solely the second approach, most of them including a limited time-span, thus, we consider our approach a clear advantage of our study towards transparency and completeness (Eleftheriadi et al. 2020, Makou et al. 2021). Second, the focus was on SRs with meta-analyses, extracted from a larger pool of quantitative and qualitative SRs, thus reducing the number of ultimately eligible studies. This was a priori designed to incorporate any aspects of spin related to pooled data from primary studies, and interpretation in the context of effect size and estimates, confidence bounds, heterogeneity, risk of bias, and p-values. In any case,

the sample was larger than previous efforts in the field (Makou et al. 2021). Third, only the abstracts of the included studies have been evaluated for spin detection and one might argue that the results of our study might have been reversed if the full text of the studies were assessed. Current evidence suggests that abstracts largely reflect the main text of the respective studies and general similarities in the patterns of spin are anticipated, although exceptions do exist (Chiu et al. 2017, Kaptchuk 2003). In this respect, word count limitations in abstracts might also exist in some journals, however, this may not be considered a reason for information non-inclusion, distortion, or inadequate reporting. Evidently, abstracts have been considered of the most vital elements of a study, since these constitute the first line disseminated information and bear a considerable impact on clinical decisions by end-users and clinicians, allied also to accessibility practices of journals. As such, the accuracy and transparency of abstract texts and structure, especially for systematic reviews, has been set highly in place by the latest reporting guidelines (Page et al. 2021).

Conclusions

1. Interpretation, reporting and extrapolation shortcomings, identified as *spin,* have been detected in high prevalence in abstracts of endodontic meta-analyses over the last decade.
2. In this respect, and in the light of the swiftly increasing number of SRs and meta-analyses in published endodontic research, presentation of the studies' findings should be considered carefully, following also contemporary reporting guidelines.

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