DEMOGRAPHIC CHARACTERISTICS OF SYSTEMATIC REVIEWS, META-ANALYSES AND RANDOMIZED CONTROLLED TRIALS IN NON-ORTHODONTIC JOURNALS WITH IMPACT FACTOR

Ahlam Rashid Alqaydi

BDS, University of Sharjah, 2010

Presented to the Hamdan Bin Mohammed College of Dental Medicine of
Mohammed Bin Rashid University of Medicine and Health Sciences
in Partial Fulfilment of the Requirements for the Degree of
Master of Science in Orthodontics
2017

ABSTRACT

Demographic characteristics of Systematic Reviews, Meta-Analyses and Randomized Controlled Trials in non-orthodontic journals with impact factor

Ahlam Rashid Alqaydi, BDS

Professor Athanasios E. Athanasiou

Assistant Professor Georgios Kanavakis, former Associate Professor Shazia Naser-ud-Din

Aim:

The purpose of this study was to identify authorship characteristics of all orthodontic systematic reviews (SRs), meta-analyses (MAs) and randomized controlled trials (RCTs) published in non-orthodontic journals with Impact Factor (IF). The outcomes of this investigation will reveal authorship trends in high impact orthodontic articles published in non-orthodontic journals.

Materials and methods:

This study identified all SRs, MAs and RCTs published in non-orthodontic journals with IF, until December 2015.

Detailed search strategies were developed for every database searched which was based on the strategy developed for MEDLINE but revised appropriately for each database to take account of the differences in controlled vocabulary and syntax rules. The following electronic databases were searched: MEDLINE via PubMed, Scopus, Web of Science™ Core Collection, Google Scholar, and Ovid database. Each database was searched individually and included all the articles published until December 2015. No restrictions were applied during the electronic search regarding language or publication status. However, articles without an abstract in English were excluded. A total of 4524 articles were found. After deleting duplicated results, letters, comments, books, and articles published in orthodontic journals 1860 articles remained. After reviewing each article we ended up with 274 articles in total (SRs: 152; MAs: 36; RCTs: 86).

Results:

In general, most of the articles published were SRs (55.5%) followed by RCTs (31.4%) and MAs (13.1%). North America (52.2%), European Union countries (56.7%), non-European Union countries (64.3%), and Central and South America (53.6%), all are concentrating in publishing SRs mostly followed by RCTs (North America 32.6%; European Union countries 34.6%; non-European Union countries21.4%; and Central and South America 32.1%). On the other hand, authors in Asia concentrated more on SRs (56.9%) and published RCTs (21.6%) and MAs (21.6%) to almost the same extent. Similar trends applied to authors in Africa (SRs: 60%; MAs: 20%; RCTs: 20%). Oceania presented only publications of RCTs.

All three kinds of articles were mostly published during the period of 2006-2015 and most of the regions presented an increase in publications in this period. It was shown that in both periods most of the articles were published in non-orthodontic dental journals (before 2006: 65.8%; during 2006-2015:64.8%).

Regarding the number of authors, RCTs had mostly four or more authors (23.3%), SRs had mostly five authors (21.1%) and MAs had three authors (30.6%). It was noticed that in both periods the majority of studies had four authors (21.1% and 20.8%, respectively).

Conclusions:

Orthodontic literature of a high level published in non-orthodontic journals has significantly increased during the last decade (2006-2015) and has been concentrated mostly in dental journals characterized mainly by an increase in publishing SRs. During the period 2006-2015 there was a significant increase in published articles originating from Asia compared to similar contributions by European Union countries, whose output exhibited a slight decline over the period.

DEDICATION

I would like to dedicate this thesis to my parents and husband.

DECLARATION

I declare that all the content of the thesis is my own work. There is no conflict of interest with any other entity or organization.

Name: Ahlam Rashid Alqaydi

Signature:

ACKNOWLEDGEMENTS

I would like to express my special thanks and indebtedness to my supervisor, mentor, Dean, Professor and Program Director in Orthodontics Athanasios E. Athanasiou, who continually and convincingly conveyed a spirit of adventure in regards to orthodontics and research, and provided me with vast and invaluable support and guidance during my years as an orthodontic resident.

I would like also to express my deepest appreciation to my co-supervisors, Assistant Professor Georgios Kanavakis and former Associate Professor ShaziaNaser-ud-Din; without their guidance and support this dissertation would not have been possible.

LIST OF TABLES

LIST OF FIGURES:

TABLE OF CONTENTS

1. INTRODUCTION

Scientific journals constitute the crucial tool for the advancement and development of science. The purpose of scientific periodicals is to introduce, publish and disseminate new knowledge and information produced by imaginative thinking supported by vigorous and systematic research together with careful and critical observations linked with conceptual innovations (Eliades and Athanasiou 2001). With the current emphasis on evidence-based practice in orthodontics, it is important that scientific journals attract and publish high quality scientific articles. "We need less research, better research, and research done for the right reasons" (Altman, 1994). High level scientific evidence is provided by systematic reviews (SRs), meta-analysis (MAs), and randomized controlled trials (RCTs) (The Cochrane Collaboration, 2014).

Scientific journals are most commonly ranked and evaluated according to their impact factor (IF), which measures the frequency that an average article published in a specific journal has been cited during a certain time frame. This is calculated by dividing the number of citations of a journal (including self-citations) in a 1- or 2-year period by the number of articles published in that journal during the same period. The scientific association between the IF of a journal and circulation has attracted much interest in the relevant literature (Kanavakis et al., 2006). Hence, the greater the number of citations, the higher (and better) the IF of a journal (Luther, 2000). The term IF was first used by Garfield and Sher (1963) with the Institute for Scientific Information. However, IF in its current form was introduced during the 1970's (Kanavakis et al., 2006). IF ratings are released yearly, are scientific-industry specific, and cannot be compared between different scientific fields (Eliades andAthanasiou 2001). IF rankings exist for almost 8000 journals citing 12 million references per year (Garfield, 1976).

Recent advances in orthodontics and the applications of techniques and procedures used in the broader area of biomedical research have resulted in a notable increase in orthodontic research (Kanavakis et al., 2006). The quantity of orthodontic literature has also significantly increased within the last decades. The total number of orthodontic articles published approximately tripled between 1981 and 2000 (Mavropoulos and Kiliaridis 2001). Previous investigations have evaluated orthodontic literature by identifying types of publications and authorship characteristics within a certain time period. Kanavakis et al. (2006) compared the authorship characteristics of three orthodontic journals between 1993-1997 and 1998-2002. In a very recent study Kanavakis et al. (2015) explored the demographic characteristics of SRs, MAs and RCTs published in the seven orthodontic journals with an IF. However, orthodontic articles are often published in non-orthodontic journals. To the best of our knowledge, there are no contemporary reports of the authorship characteristics of orthodontic articles providing high levels of evidence and published in non-orthodontic journals. Therefore, it would be very useful to study the characteristics of such publications (Mavropoulos and Kiliaridis 2003).

2. REVIEW OF THE LITERATURE

Scientific journals are the key tools for the improvement, development and progress of science. This is because the purpose of scientific publications is to introduce, publish and disseminate new knowledge and information produced by creative thinking supported by dynamic and systematic research in conjunction with critical and careful observations and theoretical innovation (Eliades and Athanasiou, 2001).

2.1. Evidence-based orthodontics

Orthodontic journals worldwide have been continuously growing in number, indicating a strong motivation among publishers/owners and editors of the different journals to participate in contributing scientifically to our specialty in different ways (i. e. continuing education, promotion of research, stimulation of thinking, publication of scientific activities) (Eliades and Athanasiou, 2001).

In recent years, the pace of orthodontic research has increased due to the advances in applications, techniques, and procedures. The most important purpose of scientific articles in orthodontics is to assess interventions and reach valid decisions about the different treatment options.

In the current climate of evidence-based care, it is important that clinical decisions are supported, as far as possible, by scientifically justified evidence; a principle which also applies to the practice of orthodontics.

Evidence-based clinical practice is an approach to decision making where the clinician uses the best available current evidence, in consultation with the patient, to decide which treatment is best suited to the patient's case (Gray, 1997).

Rosenberg and Donald (1995) described as "evidence-based practice" the one that involves systematically finding, assessing and using this contemporary research as a base for clinical decision making.

It has been emphasized that evidence-based practice should include both individual clinical expertise and the best available external evidence, because either alone is not enough (Sackett et al., 1996).

Evidence-based health care is the careful use of the best presently available evidence in making decisions about the care of specific patients or the delivery of health services. The current best evidence is the latest information from related, valid research about the impact of different forms of health care, the potential for harm from exposure to specific agents, the accuracy of diagnostic tests, and the predictive power of prognostic factors (Cochrane, 1972).

2.2. Hierarchy of evidence

Evidence hierarchy concerns the relative importance, impact and authority of various types of biomedical research. Although there is no consensus regarding a universally accepted hierarchy of evidence, there is wide agreement about the relative strengths of the principal types of research or epidemiological studies. RCTs rank above observational studies, while expert opinion and anecdotal experience have a lesser status. Some evidence hierarchies rank SRs and MAs above RCTs, since these two often combine data from multiple RCTs, and possibly from other types of studies as well.

Greenhalgh (1997) has suggested that "the relative weight carried by the different types of primary studies when making decisions about clinical interventions (the "hierarchy of evidence") places them in the following ranking:

1) SRs and MAs of "RCTs with definitive results".
2) RCTs with definitive results (confidence intervals that do not overlap with the threshold for clinically significant effect).
3) RCTs with non-definitive results (a point estimate that suggests a clinically significant effect but with confidence intervals overlapping the threshold for this effect).
4) Cohort studies.
5) Case control studies.
6) Cross-sectional surveys.
7) Case reports.

More recently, Gibson and Harrison (2011) have suggested a slightly modified hierarchy of strength of evidence concerning efficacy of treatment (Figure 1).

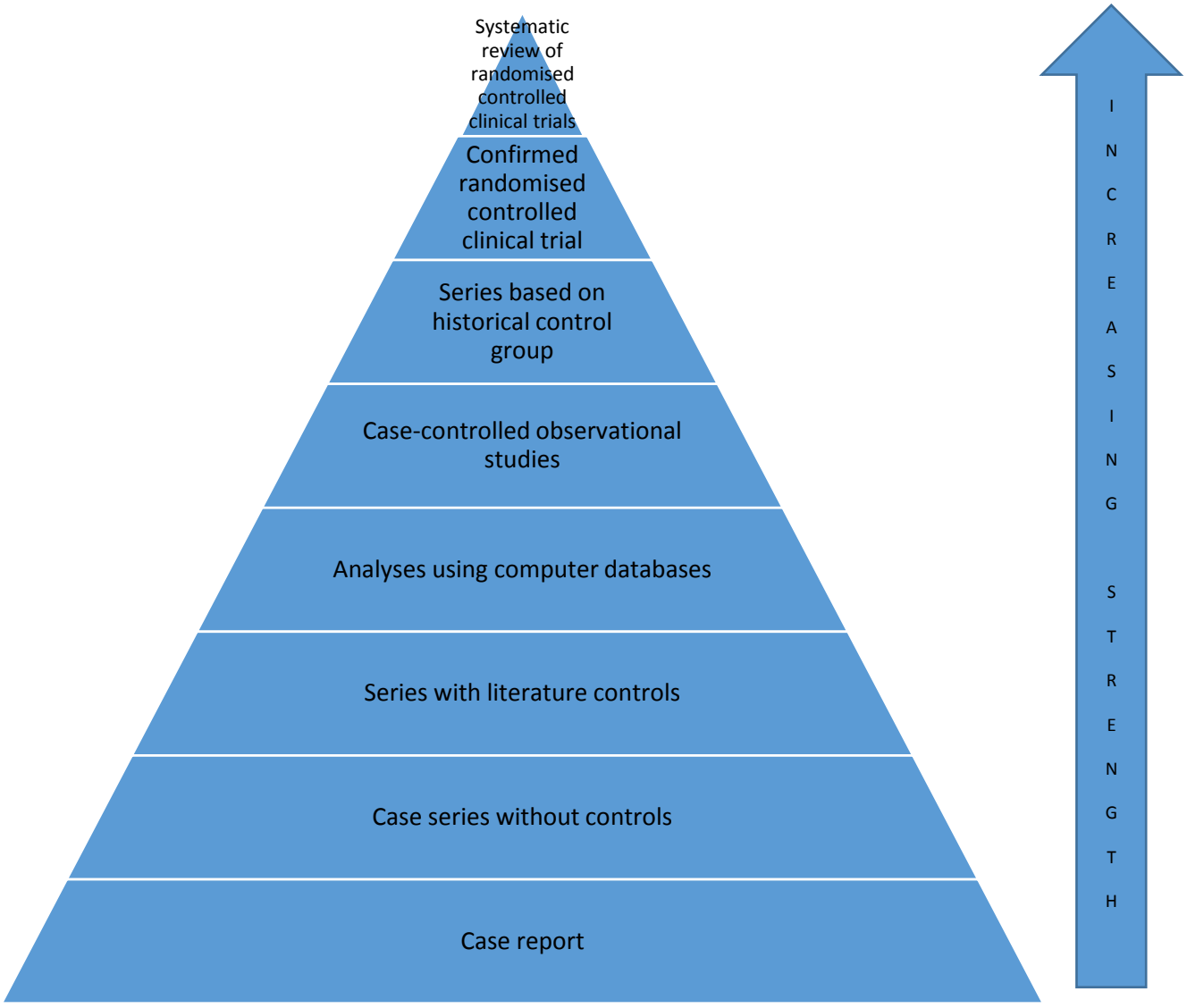

Figure 1. Hierarchy of strength of evidence regarding efficacy of treatment (Gibson and Harrison, 2011).

2.3. Systematic Reviews

SRs are considered as high-level overviews of primary research. According to the Cochrane handbook, a SR contains a clearly formulated question and obvious methods to identify, select, and critically evaluate relevant research.

SRs gather and investigate collective data from the studies that they include. They are recognized as efficient resources of summarizing current evidence regarding a certain question and are becoming very increasingly relied on (Patsopoulos et al., 2005).

SRs were added to the hierarchy of evidence strength levels as suggested by Green and Byar (1984), based on their strength and the degree to which they are not susceptible to bias (Harrison, 2002).

Both Cochrane and non-Cochrane SRs are very important in guiding future medical research, changing clinical practice and implementing health policy (Harrison et al., 2007).

According to Papageorgiou et al (2011), 110 orthodontic SRs were found in the literature up until January 2011. Almost half of them (46.4%) were published in orthodontic journals, with the rest being published in non-orthodontic journals. Of these SRs, around 27.3% were of low quality, 57.3% of medium quality, and 15.5% of high quality. An electronic search of the literature between January 2000 and June 2014 revealed that most of the SRs published in the orthodontic journals were about Class II treatment (Koletsi et al., 2015).

Between 2000 and 2011, most of the SRs were published in the American Journal of Orthodontics and Dentofacial Orthopedics (AJODO) (31.2%), in the Angle Orthodontist (29.4%), and in the Cochrane Database of Systematic Reviews (CDSR) (23.9%). The quality of these SRs according to PRISMA score appeared to be slightly better in the AJODO (62.1%) and the Angle Orthodontist (61.9%) than in the other orthodontic journals (Fleming et al., 2013). On

the other hand, it has been noticed that SRs published in higher impact journals were undertaken more rigorously (Fleming et al., 2014).

Although the number of published orthodontic SRs has increased in the last decade, their quality characteristics can only be characterized as moderate (Papageorgiou et al., 2011). The reporting of these SRs in leading orthodontic journals has been found to be deficient in some areas, especially with regard to the prospective registration of review protocols, reporting of sources of funding, assessment of reports of risk of bias across studies, definition of summary measures, and detailed explanation of the methods of analysis and eligibility criteria (Fleming et al., 2013).

2.4. Meta-analyses

MAs statistically combine results of clinical trials included in SRs using a variety of different techniques, which integrate the studies involved (Higgins et al., 2009). Similarly, articles summarizing evidence by means of MAs should always fulfill the requirements for SRs.

Kolestiand and co-workers (2015) found that MAs were present in approximately 27.4% of the SRs in the orthodontic literature between January 2000 and June 2014. The highest proportion of SRs that included an MA were found in Orthodontic and Craniofacial Research (46.1%), followed by the CDSR (36.4%) and the AJODO (34.1%).

Furthermore, Papageorgiou et al (2014) used the AMSTAR tool (Shea et al., 2007) to evaluate 80 MAs from a search in the literature up until 2011, and reported that 27.3% of them were of low quality, 46.3% of medium quality, and 22.5% of high quality (Papageorgiou et al., 2014).

The number of orthodontic MAs published in the literature is constantly increasing, while their overall quality is considered to be low to medium. Although the number of medium and high

level MAs is rising, several other aspects need improvement to increase their overall level of quality (Papageorgiou et al., 2014).

2.5. Randomized controlled trials

Clinical research is now focused more on RCTs since they are considered the keystones of clinical research because randomization ensures compatibility of patients at baseline, so all final differences can be attributed to the intervention. In order to be able to rely on the conclusions from individual trials it is necessary to evaluate their internal validity; something based on the quality of the research design. Research conducted with the appropriate methodology usually has a significant impact on clinical practice (Moher et al, 2010; Juni et al, 2001).

Carefully designed and well conducted RCTs also provide the most reliable evidence on the effectiveness of healthcare interventions. On the other hand, trials employing poor methodologies tend to introduce bias, and usually overestimate treatment effects (Schulz et al., 1995; Moher, 1998; Kjaergard et al., 1999; Juni et al., 2001). Such trials, can potentially have an impact on decision making in healthcare at all levels, from formulating individual treatment plans to implementing national public health policies. One of the most important guidelines developed to specifically guide researchers about reporting, and indirectly on conducting of RCTs are the CONSORT (Consolidated Standards of Reporting Trials) guidelines. These guidelines contain 25 items that cover key features of clinical trials and set standards on the reporting of the design, conduct, and analysis of such studies (Moher et al, 2010). The CONSORT guidelines are well known in the dental literature and have been endorsed by the editors of orthodontic journals (Turpin, 2005).

The pyramid of evidence levels has been criticized in the past for putting too much emphasis on RCTs. The truth is that not all research questions can be answered definitively by RCTs, primarily due to practical and/or ethical issues. Moreover, even when evidence is available from high-quality RCTs, evidence from other study types may still be relevant. Deeks and co-workers (2003) addressed the issue of relying on non-randomized studies to assess the effectiveness of healthcare interventions. They concluded that non-randomized studies should only be started when randomized controlled trials are not feasible or are unethical; because non randomized studies may be misleading, even when good prognostic data are available. It has been underlined that "the whole of medicine depends on the transparent reporting of clinical trials" (Rennie, 2001).

2.6. Impact factor

In 1955 the idea of IF was first proposed (Garfield, 1955), with Garfield and Sher publishing first reports regarding an independent ranking in 1963, with the Institute for Scientific Information (ISI®) (Garfield, 1976). Later during the 70's, the IF in its presently known form was introduced. IF rankings used to exist for around 8000 journals quoting 12 million references each year (Garfield, 1976).

It was known that a core group of frequently cited large journals needed to be covered in the Science Citation Index. On the other hand, it was also observed that small but important review journals would not be selected if they only depended on simple publication or citation counts (Brodman, 1960). Therefore a simple method for comparing journals regardless of their size was needed, and the journal IF was introduced. The use of the term IF has progressively expanded, especially in Europe, to include both journal and author impact.

Two basic elements contribute to the IF of a journal: one of them is the numerator; the number of citations in the present year of any items published in a journal in the past two years; and the other element is the denominator, which is the number of applicable articles (source items) published in the same two year period (Garfield, 1999). The IF could be simply based on the previous year's articles alone, which would give greater weight to rapidly changing fields (Garfield, 1999).

However, experience has shown that in each specialty the best journals might be those in which it is most difficult to have an article accepted, and these are generally those with the highest IF. As a measure of popularity the use of IF is common because it fits well with the opinion that prevails in each field of the best journals in our specialty.

There is a belief that the scope of the scientific community served by a journal affects the impact of that journal. However, this overlooks the fact that the greater the author and article pool for quoting from, the greater the number of published articles likely to share those quotations. Numerous articles in large fields are not well cited, while those in more restricted fields may have an unusual impact. Thus, the key elements in impact are the mean number of citations per article (density) and the half-life or proximity of citations to a specified journal rather than the number of authors or articles in the field. This difference was discussed many years ago in an essay on "Garfield's constant" (Garfield, 1976).

There are also other factors that may affect the IF, such as the time required to review manuscripts. If revision and publication are delayed, references to articles that are no longer present may not be included in the impact calculation. Even the appearance of articles on the same subject in the same issue of a journal may have an effect (Garfield, 1999).

In addition to helping libraries decide which journals to subscribe to, journal impact factors are also used by authors to decide where to submit their articles. It is well known that the journals

with high IF attract more prestige. Nevertheless, some librarians claim that the numerator in the IF calculation is in itself even more applicable.

Of the many contradictory opinions about impact factors, Hoeffel (1998) expressed the situation concisely: “Impact Factor is not a perfect tool to measure the quality of articles but there is nothing better and it has the advantage of already being in existence and is, therefore, a good technique for scientific evaluation.”

2.7. Bibliometric research in orthodontic journals with and without Impact Factor

Across disciplines and study areas, approximately 70% of articles are frequently found in 30% of journals in any specified area of study (Potter, 1988). This supports Bradford’s Law of Scattering for journal subsets, which states that the important articles on any topic will be concentrated in a small subset of journals, with exponential drop-off in numbers of relevant articles across journal titles (Potter, 1988).

“Bibliometrics is not a new discipline, and it would perhaps be wrong to understand it simply as a means of scientific control. It has many creative possibilities and can help in mapping the intellectual growth of a discipline and paving the way to a more sophisticated approach to evidence-based medicine” (Mavropoulos and Kiliaridis, 2003). To evaluate the accessibility of medical literature in numerous medical disciplines various proposals using different methods have already been made (Sun et al., 2000; Yang et al., 2001; Glazier et al., 2001; Garcia-Rio et al., 2001; Stevens, 2000; Kim et al., 2001).

The total number of orthodontic articles published constantly increased between 1981 and 2012 (Mavropoulos and Kiliaridis, 2003; Baumgartner et al., 2014). The number of orthodontic journals with an IF has grown from three to seven within the last decade, suggesting that well

cited orthodontic articles appear in a much wider range of periodicals from different regions of the world, according to comparative data from the ISI Web of Knowledge (2014). Although the most frequently used measure to assess scientific journals by counting their popularity within their field of focus is the IF, it does not necessarily directly relate to the quality of their publications (Eliades and Athanasiou, 2001; Garfield, 1996).

Around 16000 articles with orthodontic concerns were published from 1981 to 2000, and the number of articles published each year in English has almost always increased year by year over these two decades (from about 300 in 1981 to about 900 in 2000). There is a massive flow of information the value of which has not always been validated. Almost half (45%) of these were published in non-orthodontic journals, some of which have high IFs. A significant number of high-quality studies of orthodontic interest were not published in the purely orthodontic journals. The articles published in the orthodontic journals concentrate more on treatment assessment and diagnosis as the requirement for high-quality evidence becomes increasingly obvious (Mavropoulos and Kiliaridis, 2003). On the other hand, other topics such as those related to new techniques and materials, have been losing ground (Mavropoulos and Kiliaridis, 2003). Other topics such as biology and genetics are mostly found in the non-orthodontic journals, where they have already become a significant proportion of the total number of articles with orthodontic content, along with studies related to diagnosis. Not all articles with orthodontic content contain 'orthodontic', or its derivatives, in their titles, abstracts, or affiliations, but, on the other hand, not all articles embracing this term are really of orthodontic interest. Even so, and despite some other differences, MEDLINE is a powerful and fairly accurate tool in retrieving orthodontic literature and using it in bibliometric studies.

The present orthodontic literature has also been influenced by research in other scientific fields such as in engineering, biology, mathematics, etc. As a result, methodological approaches have

improved and orthodontic-related research articles nowadays often appear in high impact non-orthodontic journals. Numerous studies have reported that IF of a journal is the strongest predictor of the likely citation counts of an article (Allareddy et al., 2010; Filion and Pless, 2008; Callaham et al., 2002).

In the past, clinical research in the field of orthodontics included many study designs that were rather weak concerning the hierarchy of evidence (Rinchuse et al., 2008), specifically, they were of low power and reliability (Tulloch et al., 1989).

The number of orthodontic journals is increasing. This indicates the growing interest in orthodontic research; the characteristics of the publications may reveal emerging trends such as: authorship demographics, constituent components of affiliation, origin, basic or applied research, and other variables (Eliades and Athanasiou, 2001). From another perspective, due to the increasing interest in evidence-based orthodontics, the availability of high-quality evidence is an important factor (Haynes et al., 1996; Muir Gray et al., 1997).

Harrison and co-workers (1996) revealed that there were significant differences between the contents of the British Journal of Orthodontics (now called the Journal of Orthodontics) and the European Journal of Orthodontics with regard to type, context, and subject of the articles published. This supports the idea that different journals may be better reference points for different aspects of the specialty. An understanding of the publication trends in different journals may provide clinicians with the resources for the recognizing journals which are more suitable for meeting their individual requirements.

In general, the understanding of sequenced events along with the phenomena such as craniofacial growth and adaptation, tooth movements, and materials performance in the intraoral environment has improved during the past two decades; something reflecting the advanced level of research. A study analyzing 3000 papers published in three major orthodontic journals over

two 5-year intervals suggested that research papers, as well as author affiliations from non-orthodontic sources, were encountered more often in the second more recent interval. These results show that the collaborations between departments had increased in the most recent interval (Kanavakis et al., 2006). It can be seen that the number of author affiliations has increased over time, this may be related the cross-appointed faculty who may serve in associated disciplines such as sciences and engineering. This is indicative of the increased collaboration among orthodontic departments, or between orthodontics and other sciences in response to the demands of the present research environment which requires the interactions of the different disciplines to successfully respond to research challenges (Eliades, 2013).

3. AIM

3.1. Aim

The purpose of this study is to identify the authorship characteristics of all orthodontic SRs, MAs and RCTs that have been published in non-orthodontic journals with IF. The outcomes of this investigation will provide a profile of orthodontic papers in high quality non-orthodontic scientific journals and reveal trends in authorship.

3.2. Objectives

a. To study the authorship characteristics of all orthodontic SRs, MAs, and RCTs that have been published in non-orthodontic journals with IF and compare the results regarding:

   a. Article type (SR, MA, or RCT) and region of origin (North America, Europe EU (European Union), Europe non-EU, Central and South America, Asia, Oceania, or Africa).
   b. Article type (SR, MA, or RCT) and the periods 2006-2015 or before 2006 during which they were published.
   c. Article type (SR, MA, or RCT) and type of journal (dental or non-dental) in which they were published.
   d. Article type (SR, MA, and RCT) and number of authors contributing to the article.
   e. Periods of 2006-2015 or before 2006, and type of journals (dental or non-dental).

f. Periods of 2006-2015 or before 2006, and region of origin (North America, Europe EU, Europe non-EU, Central and South America, Asia, Oceania, or Africa).

g. Periods of 2006-2015 or before 2006, and the number of authors.

h. Region of origin (North America, Europe EU, Europe non-EU, Central and South America, Asia, Oceania, or Africa) and the number of authors.

i. Region of origin (North America, Europe EU, Europe non-EU, Central and South America, Asia, Oceania, or Africa) and type of journal (dental, or non-dental).

4. MATERIALS AND METHODS

4.1. Selection criteria applied for the review

The selection criteria for the domains of study design, authorship and affiliation data, intervention characteristics and principal outcome measures applied for the present review were as follows:

4.1.1. Types of studies included

Studies included in the present thesis had to be SRs, MAs and RCTs with orthodontic-related topics that were published in non-orthodontic journals with IF up until December 2015.

4.2. Search strategy for identification of studies

Detailed search strategies were developed for each database searched. These were based on the strategy developed for MEDLINE but revised appropriately for each database to take account of the differences in controlled vocabulary and syntax rules. The following electronic databases were searched (Table 1): MEDLINE via PubMed (http://www.ncbi.nlm.nih.gov/pubmed), Scopus (http://www.scopus.com), Web of Science™ Core Collection (http://apps.webofknowledge.com/), Google Scholar (https://scholar.google.com), Ovid database (http://ovidsp.tx.ovid.com.ezproxy.library.tufts.edu). Each database was searched individually, and included all the articles published up until December 2015. The results were exported into Endnote (X7.2.1 version: Thomson Roeuters ™, USA) in order to eliminate all duplicates. No restrictions were applied during the electronic search regarding language or publication status.

However, articles without an abstract in English were excluded. Portable Document Format (PDF) files (Adobe Systems Incorporated, Mountain View, California, USA) of all articles were downloaded, saved, and arranged according to journal and type of article in an external hard drive (Figure 2).

Table 1. Strategy for database search.

Database	Search strategy	Hits
General Sources		
MEDLINE via PubMed http://www.ncbi.nlm.nih.gov/pubmed	("orthodont*" AND "meta-analysis") and ("orthodont*" AND "systematic review") and ("orthodont*" AND "randomised control trial") and ("orthodont*" AND "randomized control trail") **Timespan:** All years until December 2015. All field.	**1556**
Scopus https://www.scopus.com/	("orthodont*" AND "meta-analysis") and ((orthodont*) AND systematic review) and ("orthodont*" AND "randomised control trial") and ("orthodont*" AND "randomized control trail") Timespan: All years until December 2015.	**415**
Web of Science™ Core Collection http://apps.webofknowledge.com	**TOPIC:** ("orthodont*" AND "meta-analysis") and ("orthodont*" AND "systematic review") and ("orthodont*" AND "randomised control trial") and ("orthodont*" AND "randomized control trail") **Timespan:** All years until December 2015. Search language=Auto	**545**
Ovid database http://ovidsp.tx.ovid.com.ezproxy.library.tufts.edu	**Keyword:** ("orthodont*" AND "meta-analysis") and ("orthodont*" AND "systematic review") and ("orthodont*" AND "randomised control trial") and ("orthodont*" AND "randomized control trail") **Timespan:** All years until December 2015.	**1258**
Grey literature sources		
Google Scholar https://scholar.google.com	("orthodont*" AND "meta-analysis") and ("orthodont*" AND "systematic review") and ("orthodont*" AND "randomised control trial") and ("orthodont*" AND "randomized control trail") **Timespan:** All years until December 2015.	**774**

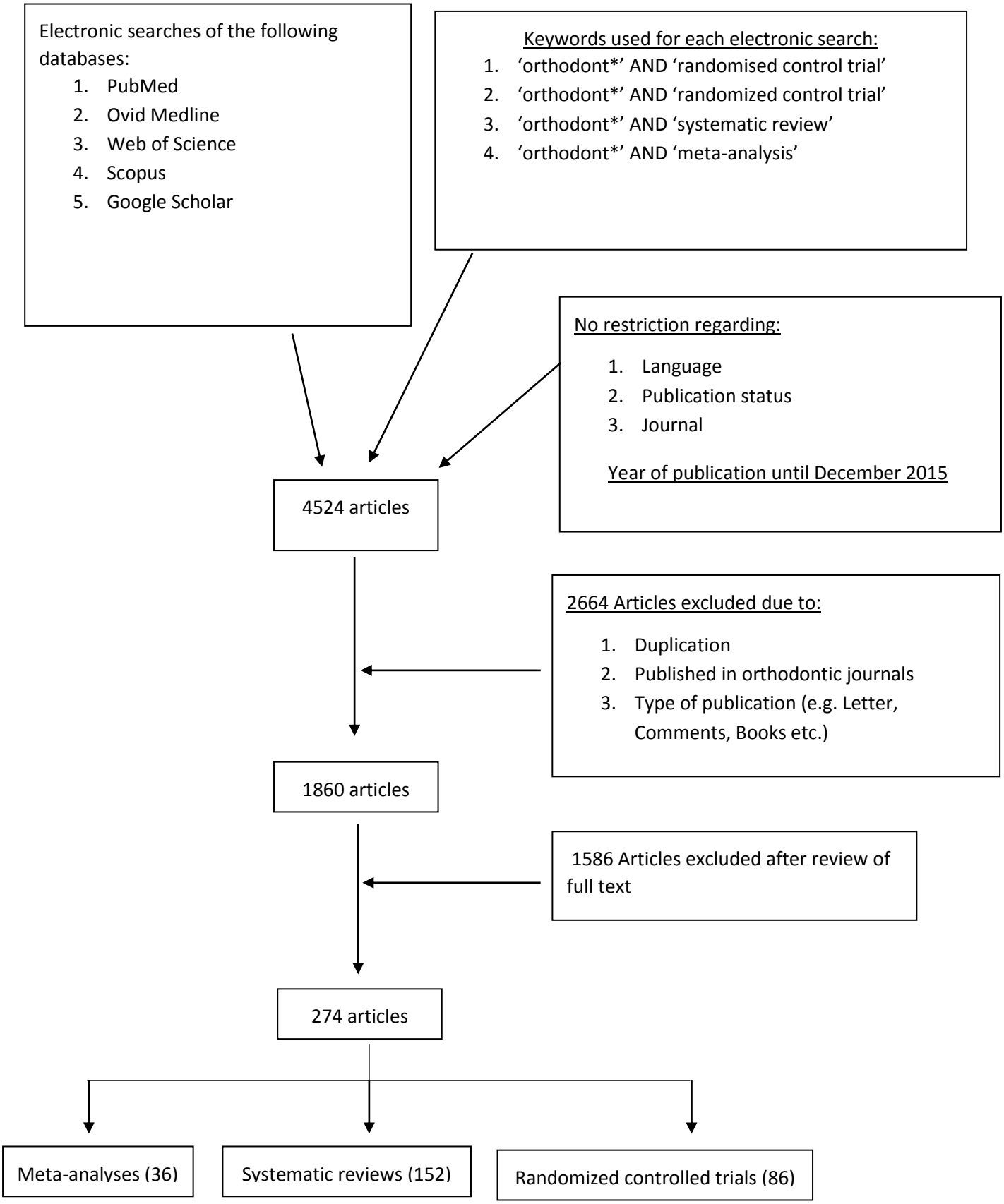

Figure 2. Search strategy.

4.3. Selection of studies and data extraction

The author performed the search and retrieved the articles. The author and her co-supervisor obtained and assessed, independently, the full report of records to meet the inclusion criteria. Disagreements were resolved by discussion or consultation with the thesis supervisor. The comprehensive review resulted in 274 articles, all of which met the inclusion criteria. All these articles were published in non-orthodontic journals with IF (Table 2). A record of all decisions on study identification was kept.

Data collection forms were used to record the desired information by the author:

- **a.** The journal in which the article was published in.
- **b.** Type of journal (dental or non-dental).
- **c.** Year of publication.
- **d.** The period during which the article was published in (2006-2015 or before 2006).
- **e.** Article type (SRs, MAs or RCTs).
- **f.** Number of authors.
- **g.** Country name (based on the first author).
- **h.** Region of origin (North America, Europe EU, Europe non-EU, Central and South America, Asia, Oceania, Africa) shown in Table 3.

Chi-Square Test and Fisher's Exact Test was preformed after collecting the data.

Table 2. Non-orthodontic journals and their IF from the identified studies.

Journal	IF
American Journal of Respiratory and Critical Care Medicine (Am J Respir Crit Care Med)	13.118
Cochrane Database of Systematic Reviews (Cochrane Database Syst Rev)	6.103
Contact Dermatitis (Contact Derm)	5.692
International Journal of Cardiology (Int J Cardiol)	4.638
Journal of Dental Research (J Dent Res)	4.602
American Journal of Public Health (Am J Public Health)	4.138
Journal of Clinical Periodontology (J Clin Periodontol)	3.915
Clinical Oral Implants Research (Clin Oral Implants Res)	3.464
Journal of Dentistry (J Dent)	3.109
Journal of Sleep Research (J Sleep Res)	3.093
Plastic and Reconstructive Surgery (Plast Reconstr Surg)	3.087
PLOS ONE	3.057
Journal of Endodontics (J Endod)	2.904
Journal of Orofacial Pain (J Orofac Pain)	2.824
Journal of Clinical Sleep Medicine (J Clin Sleep Med)	2.710
International Journal of Oral Science (Int J Oral Sci)	2.595
Lasers in Medical Science (Lasers Med Sci)	2.461
Sleep and Breathing (Sleep Breath)	2.332
European Journal of Oral Implantology (Eur J Oral Implantol)	2.328
Caries Research (Caries Res)	2.278

Table 2. (Continued)

Journal	IF
Community Dentistry and Oral Epidemiology (Community Dent Oral Epidemiol)	2.233
Journal of Behavioral Medicine (J Behav Med)	2.227
Clinical Oral Investigations (Clin Oral Investig)	2.207
BioMed Research International (Biomed Res Int)	2.134
International Journal of Environmental Research and Public Health (Int J Environ Res Public Health)	2.035
Journal of Oral Rehabilitation (J Oral Rehabil)	1.926
Respiratory Care (Respir Care)	1.922
International Journal of Oral and Maxillofacial Implants (Int J Oral Maxillofac Implants)	1.859
Trials	1.859
Biological Trace Element Research (Bio Trace Elem Res)	1.798
Journal of the American Dental Association (J Am Dent Assoc)	1.767
Archives of Oral Biology (Arch Oral Biol)	1.733
BMC Musculoskeletal Disorders (BMC Musculo skelet Disord)	1.684
Journal of Oral and Maxillofacial Surgery (J Oral Maxillo fac Surg)	1.631
Photomedicine and Laser Surgery (Photomed Laser Surg)	1.631
European Journal of Oral Sciences (Eur J Oral Sci)	1.607
Journal of Cranio-Maxillo-Facial Surgery (J Cranio maxillo fac Surg)	1.592
Journal of Craniofacial Surgery (J Cranio fa cSurg)	1.592
Journal of Otolaryngology Head and Neck Surgery (J Otolaryngol Head Neck Surg)	1.585

Table 2. (Continued)

Journal	IF
International Journal of Oral and Maxillofacial Surgery (Int J Oral Maxillo fac Surg)	1.563
Journal of Prosthetic Dentistry (J Prosthet Dent)	1.515
International Journal of Prosthodontics (Int J Prostho dont)	1.487
Toxicology Mechanisms and Methods (Toxicol Mech Meth)	1.476
Evidence-based Dentistry (Evid Based Dent)	1.474
Medical Science Monitor (Med Sci Monit)	1.405
Dental Traumatology (Dent Traumatol)	1.327
International Journal of Pediatric Dentistry (Int J Paediatr Dent.)	1.303
Journal of Communication Disorders (J Commun Disord)	1.278
Australian Dental Journal (Aust Dent J)	1.272
Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics (Oral Surg Oral Med Oral Pathol Oral Radiol Endo)	1.262
British Journal of Oral and Maxillofacial Surgery (Br J Oral Maxillo fac Surg)	1.237
Journal of Esthetic and Restorative Dentistry (J Esthet Restor Dent)	1.231
BioMed Central Oral health (BMC Oral Health)	1.21
ActaOdontologicaScandinavica (Acta Odontol Scand)	1.171
International Journal of Computerized Dentistry (Int J Comput Dent)	1.154
Acta Oto-Laryngologica (Acta Otolaryngol)	1.127
Journal of Applied Oral Science (J Appl Oral Sci)	1.117
Medicina Oral, Patologia Oral y CirugiaBucal (Med Oral Patol Oral Cir Bucal)	1.087

Table 2. (Continued)

Journal	IF
Cleft Palate Craniofacial Journal (Cleft Palate Craniofac J)	1.05
International Journal of Periodontics and Restorative Dentistry (Int J Periodontics Restorative Dent)	1.039
Implant Dentistry (Implant Dent)	1.023
British Dental Journal (Br Dent J)	0.997
International Journal of Dentistry (Int J Dent)	0.967
Head and Face Medicine (Head Face Med)	0.916
Brazilian Oral Research (Braz Oral Res)	0.859
Journal of Dental Education (J Dent Educ)	0.83
Quintessence International (Quintessence Int)	0.821
Pediatric Dentistry (Pediatr Dent)	0.8
International Journal of Dental Hygiene (Int J Dent Hyg)	0.791
Community Dental Health (Community Dent Health)	0.767
Genetics and Molecular Research (Genet Mol Res)	0.764
The Journal of Craniomandibular Practice (Cranio)	0.738
Oral Health and Preventive Dentistry (Oral Health Prev Dent)	0.69
African Health Sciences (Afr Health Sci)	0.642
Saudi Medical Journal (Saudi Med J)	0.562
Journal of Clinical Pediatric Dentistry (J Clin Pediatr Dent)	0.562
International Journal of Osteopathic Medicine (Int J Osteopath Med)	0.509
European Journal of Paediatric Dentistry (Eur J Paediatr Dent)	0.421
Bioscience Journal (Biosci. J)	0.218

Table 3. Geographic origin of countries:1: North America; 2: Europe EU; 3: Europe non-EU; 4: Central and South America; 5: Asia; 6: Oceania; and 7: Africa

Country	Code
Australia	6
Bahrain	5
Belgium	2
Brazil	4
Canada	1
China	5
Colombia	4
Czech Republic	2
Denmark	2
Egypt	7
Finland	2
Germany	2
Greece	2
India	5
Iran	5
Ireland	2
Italy	2
Japan	5
Jordan	5
Kuwait	5

Table 3. (Continued)

Country	Code
Malaysia	5
Malta	2
Netherlands	2
Nigeria	7
Pakistan	5
Poland	2
Saudi Arabia	5
Serbia	3
South Africa	7
Spain	2
Sweden	2
Switzerland	3
Syria	5
Turkey	3
Uganda	7
UK	2
USA	1
Yemen	5

5. RESULTS

A total of 4524 articles were found. After deleting duplicated results, letters, comments, books, and articles published in orthodontic journals 1860 articles remained.

5.1. Comparison between articles' types

Tables 4 and 5 present frequency distributions of all orthodontic articles published in non-orthodontic journals and with respect to all variables studied.

Table 4: Frequency distributions of all orthodontic articles over the entire observation period in relation to their geographic region of origin, article type, journal type and number of authors.

		Number (N) / Percentage (%) of articles between regions of origin Total number (%within article type, journal type, number of authors) (%within region of origin)							
	Total N (% of total)	**North America**	**Europe-EU**	**Europe-non-EU**	**Central & South America**	**Asia**	**Oceania**	**Africa**	p-value
Article type									
RCTs	86 (31.4)	15 (17.4) (32.6)	44 (51.2) (34.6)	3 (3.5) (21.4)	9 (10.5) (32.1)	11 (12.8) (21.6)	3 (3.5) (100.0)	1 (1.2) (20.0)	0.278*
SRs	152 (55.5)	24 (15.8) (52.2)	72 (47.4) (56.7)	9 (5.9) (64.3)	15 (9.9) (53.6)	29 (19.1) (56.9)	0 (0.0) (0.0)	3 (2.0) (60.0)	
MAs	36 (13.1)	7 (19.4) (15.2)	11 (30.6) (8.7)	2 (5.6) (14.3)	4 (11.1) (14.3)	11 (30.6) (21.6)	0 (0.0) (0.0)	1 (2.8) (20.0)	

Table 4: (Continued)

		Number (N) / Percentage (%) of articles between regions of origin Total number (%within article type, journal type, number of authors) (%within region of origin)							
Journal type	Total N (% of total)	**North America**	**Europe-EU**	**Europe-non-EU**	**Central & South America**	**Asia**	**Oceania**	**Africa**	p-value
Dental	178 (65.0)	40 (22.5) (87.0)	73 (41.0) (57.5)	13 (7.3) (92.9)	15 (8.4) (53.6)	32 (18.0) (62.7)	2 (1.1) (66.7)	3 (1.7) (60.0)	0.001*
Non-Dental	96 (35.0)	6 (6.3) (13.0)	54 (56.3) (42.5)	1 (1.0) (7.1)	13 (13.5) (46.4)	19 (19.8) (37.3)	1 (1.0) (33.3)	2 (2.1) (40.0)	
Number of authors									
One	18 (6.6)	5 (27.8) (10.9)	9 (50.0) (7.1)	0 (0.0) (0.0)	0 (0.0) (0.0)	4 (22.2) (7.8)	0 (0.0) (0.0)	0 (0.0) (0.0)	0.111*
Two	33 (12.0)	8 (24.2) (17.4)	13 (39.4) (10.2)	4 (12.1) (28.6)	1 (3.0) (3.6)	5 (15.2) (9.8)	0 (0.0) (0.0)	2 (6.1) (40.0)	
Three	43 (15.7)	8 (18.6) (17.4)	20 (46.5) (15.7)	1 (2.3) (7.1)	2 (4.7) (7.1)	9 (20.9) (17.6)	1 (2.3) (33.3)	2 (4.7) (40.0)	
Four	57 (20.8)	5 (8.8) (10.9)	31 (54.4) (24.4)	6 (10.5) (42.9)	6 (10.5) (21.4)	8 (14.0) (15.7)	1 (1.8) (33.3)	0 (0.0) (0.0)	
Five	51 (18.6)	8 (15.7) (17.4)	26 (51.0) (20.5)	3 (5.9) (21.4)	7 (13.7) (25.0)	6 (11.8) (11.8)	0 (0.0) (0.0)	1 (2.0) (20.0)	
Six	38 (13.9)	7 (18.4) (15.2)	17 (44.7) (13.4)	0 (0.0) (0.0)	6 (15.8) (21.4)	8 (21.1) (15.7)	0 (0.0) (0.0)	0 (0.0) (0.0)	
More than six	34 (12.4)	5 (14.7) (10.9)	11 (32.4) (8.7)	0 (0.0) (0.0)	6 (17.6) (21.4)	11 (32.4) (21.6)	1 (2.9) (33.3)	0 (0.0) (0.0)	

*: P-values calculated with the Fisher exact test.

The level of statistical significance was adjusted to p= (0.0167) after a Bonferroni correction.

Table 5: Frequency distributions of all orthodontic articles for the two periods in association to article type, journal type, region of origin and number of authors.

		Number (N) / Percentage (%) per time interval Total number (%within article type, journal type, region of origin, number of authors) (%within interval)		
	Total N (% of total)	**<2006**	**2006-2015**	p-value
Article type				
RCTs	86 (31.4)	25 (29.1) (65.8)	61 (70.9) (25.8)	0.000*
SRs	152 (55.5)	10 (6.6) (26.3)	142 (93.4) (60.2)	
MAs	36 (13.1)	3 (8.3) (7.9)	33 (91.7) (14.0)	
Journal type				
Dental	178 (65.0)	25 (14.0) (65.8)	153 (86.0) (64.8)	0.908
Non-Dental	96 (35.0)	13 (13.5) (34.2)	83 (86.5) (35.2)	

Table 5: (Continued)

		Number (N) / Percentage (%) per time interval Total number (%within article type, journal type, region of origin, number of authors) (%within interval)		
Region of origin	Total N (% of total)	**<2006**	**2006-2015**	p-value
North America	46 (16.8)	8 (17.4) (21.1)	38 (82.6) (16.1)	0.000*
Europe – EU	127 (46.4)	26 (20.5) (68.4)	101 (79.5) (42.8)	
Europe - Non-EU	14 (5.1)	0 (0.0) (0.0)	14 (100.0) (5.9)	
Central & South America	28 (10.2)	0 (0.0) (0.0)	28 (100.0) (11.9)	
Asia	51 (18.6)	1 (2.0) (2.6)	50 (98.0) (21.2)	
Oceania	3 (1.1)	2 (66.7) (5.3)	1 (33.3) (0.4)	
Africa	5 (1.8)	1 (20.0) (2.6)	4 (80.0) (1.7)	

Table 5: (Continued)

		Number (N) / Percentage (%) per time interval Total number (%within article type, journal type, region of origin, number of authors) (%within interval)		
Number of authors	Total N (% of total)	**<2006**	**2006-2015**	p-value
One	18 (6.6)	2 (11.1) (5.3)	16 (88.9) (6.8)	0.995*
Two	33 (12.0)	6 (18.2) (15.8)	27 (81.8) (11.4)	
Three	43 (15.7)	6 (14.0) (15.8)	37 (86.0) (15.7)	
Four	57 (20.8)	8 (14.0) (21.1)	49 (86.0) (20.8)	
Five	51 (18.6)	7 (13.7) (18.4)	44 (86.3) (18.6)	
Six	38 (13.9)	5 (13.2) (13.2)	33 (86.8) (14.0)	
More than six	34 (12.4)	4 (11.8) (10.5)	30 (88.2) (12.7)	

*: P-value calculated with Fisher's exact test

The level of statistical significance was adjusted to p= (0.0125) after a Bonferroni correction.

5.1.1.Article type and region of origin

Article types and their distribution among the region of origin are displayed in table 4 and Figure 3.

In general, most of the articles published were SRs (55.5%) followed by RCTs (31.4%) and MAs (13.1%).

Most of the systematic reviews originated from European Union countries (47.4%) followed by Asia (19.1%), and North America (15.8%). A similar pattern characterizes RCTs, most of which originated from European Union countries (51.2%), followed by North America (17.4%), and Asia (12.8%). On the other hand, MAs mostly originated from both Asia (30.6%) and European Union countries (30.6%) followed by North America (19.4%).

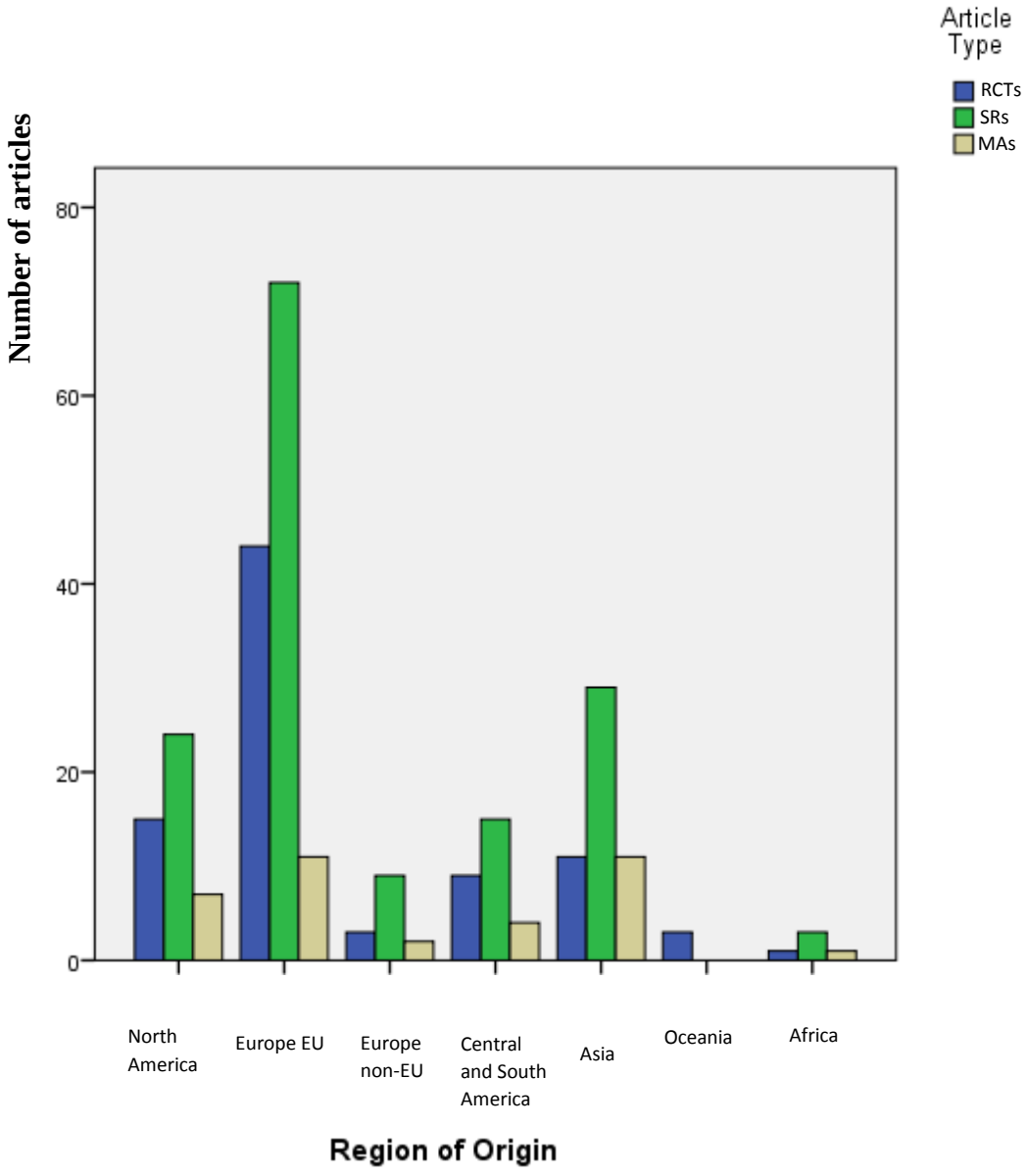

Figure 3. Distribution of region of origin per article type.

5.1.2.Article type and period

Article types and their distribution among both periods (before 2006, or 2006-2015) are shown in Table 5 and Figure 4.

All three kinds of articles were published mostly during the period of 2006-2015. RCTs were published more (70.9%) between 2006-2015, compared to those published before 2006 (29.1%). SRs were published more during the period of 2006-2015 (93.4%) compared to the years before 2006 (6.6%). Almost the same pattern could be observed with MAs: the great majority were published during 2006-2015 (91.7%) compared to the years before 2006 (8.3%).

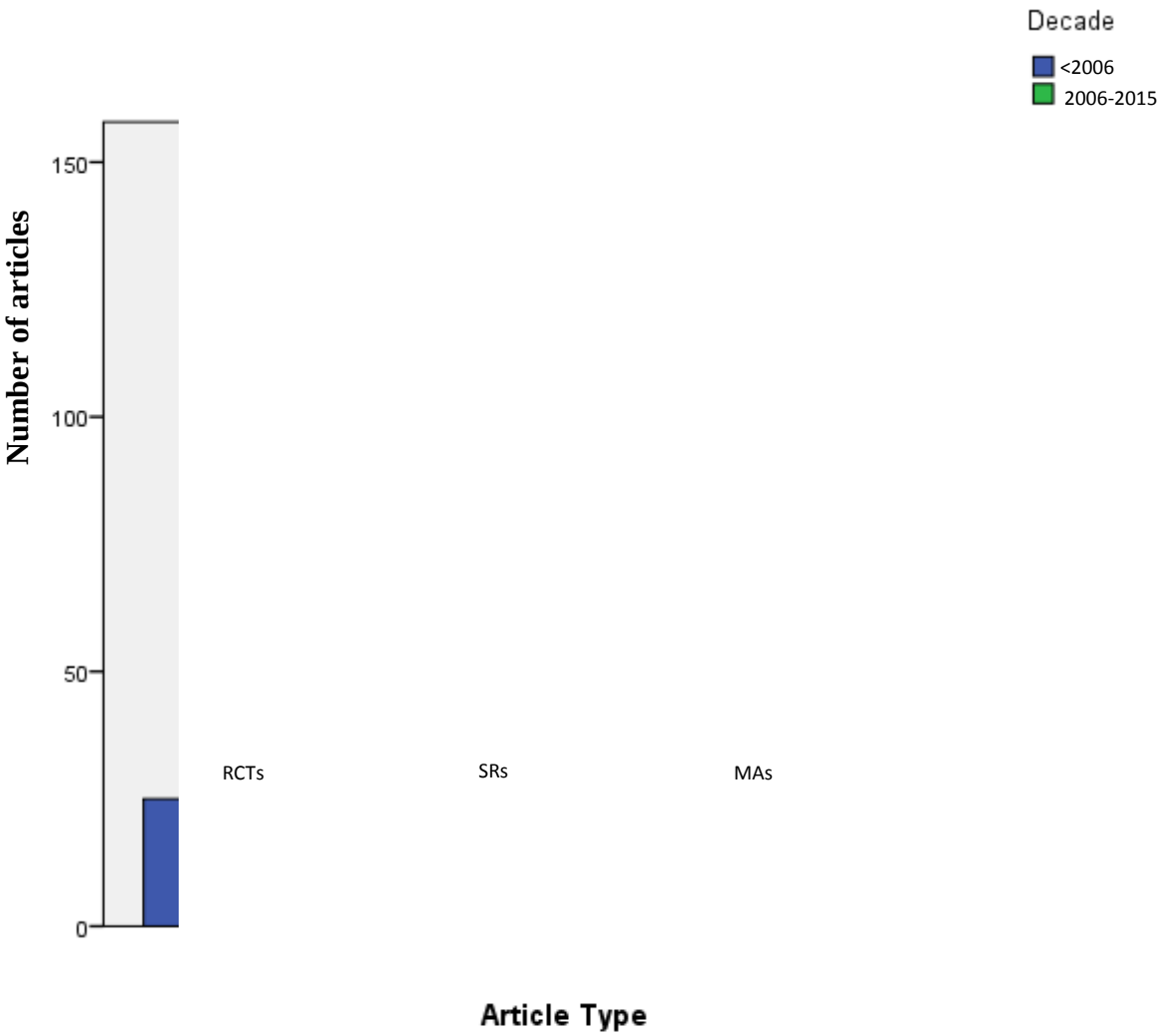

Figure 4. Distribution of different type of articles between two different decades.

5.1.3.Article type and type of journal

The distribution of articles regarding their publication in dental or non-dental journals is shown in Table 6 and Figure 5.

RCTs were mostly found in dental journals (74.4%) compared to non-dental journals (25.6%). MAs were found to be published mostly in dental journals (66.7%) compared to non-dental journals (33.3%). On the other hand, SRs are almost equally distributed between dental journals (59.2%) and non-dental journals (40.8%).

Table 6. Frequency distribution of all three kinds of articles type and the association regarding dental and non-dental journals.

		Type of Journal		
		Total number (%within article type) (%within type of journal)		
Article Type	Total N (% of total)	**Dental**	**Non-Dental**	P-value
RCTs	86 (31.4)	64 (74.4) (36.0)	22 (25.6) (22.9)	0.60
SRs	152 (55.5)	90 (59.2) (50.6)	62 (40.8) (64.6)	
MAs	36 (13.1)	24 (66.7) (13.5)	12 (33.3) (12.5)	

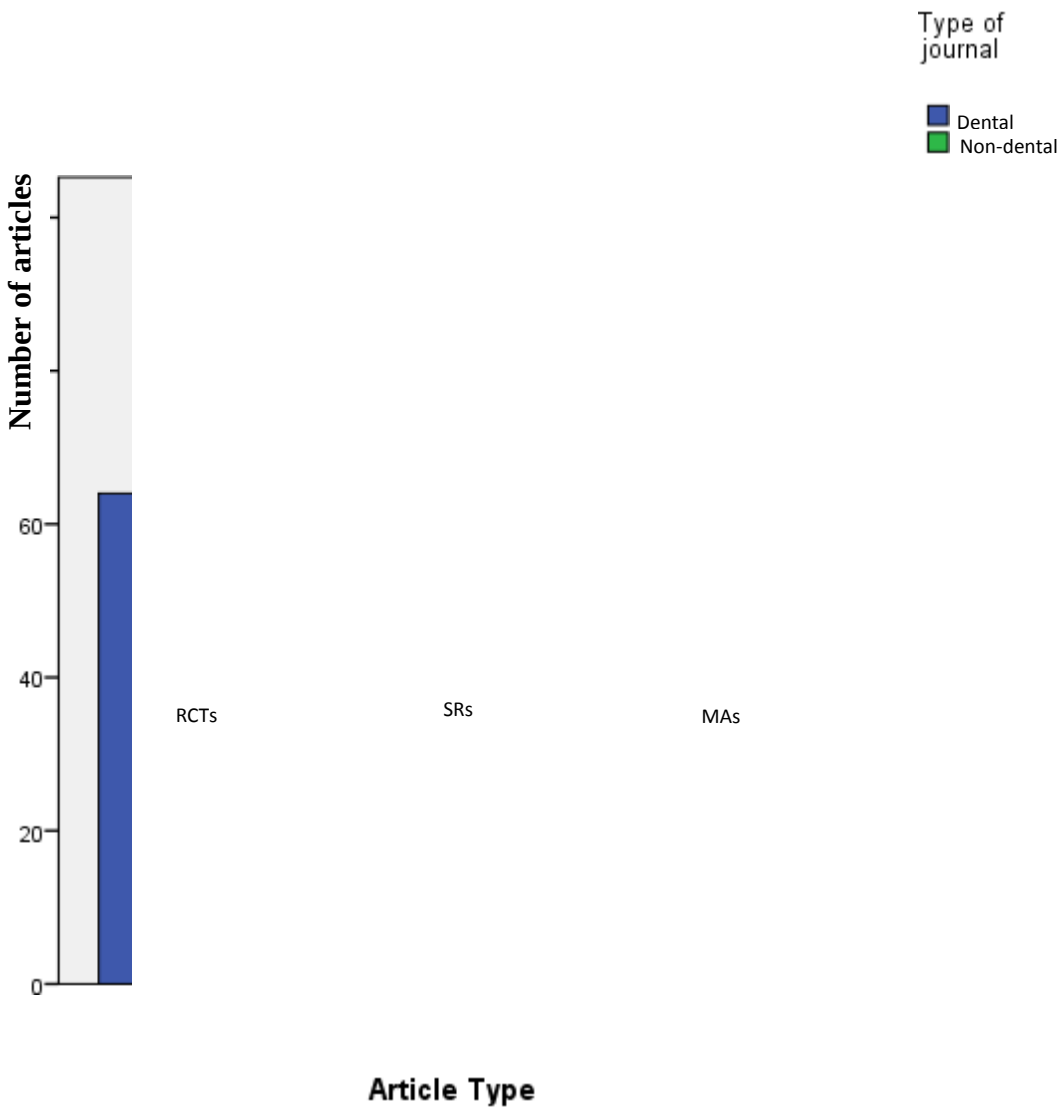

Figure 5. Distribution of different types of articles between dental and non-dental journals.

5.1.4.Article type and number of authors

The number of authors participating in each type of article is shown in Table 7 and Figure 6. RCTs mostly had four or more authors (23.3%), SRs mostly had five authors (21.1%) and MAs had three authors (30.6%).

Table 7. Distribution of article types and the association of number of authors.

		Number of Authors							
		Total number (%within number of authors) (%within article type)							
Article Type	Total	**1**	**2**	**3**	**4**	**5**	**6**	**7**	P-value
RCTs	86 (31.4)	3 (16.7) (3.5)	6 (18.2) (7.0)	11 (25.6) (12.8)	20 (35.1) (23.3)	17 (33.3) (19.8)	12 (31.6) (14.0)	17 (50.0) (19.8)	0.037*
SRs	152 (55.5)	13 (72.2) (8.6)	24 (72.7) (15.8)	21 (48.8) (13.8)	28 (49.1) (18.4)	32 (62.7) (21.1)	21 (55.3) (13.8)	13 (38.2) (8.6)	
MAs	36 (13.1)	2 (11.1) (5.6)	3 (9.1) (8.3)	11 (25.6) (30.6)	9 (15.8) (25.0)	2 (3.9) (5.6)	5 (13.2) (13.9)	4 (11.8) (11.1)	

*: P-value calculated with Fisher's exact test

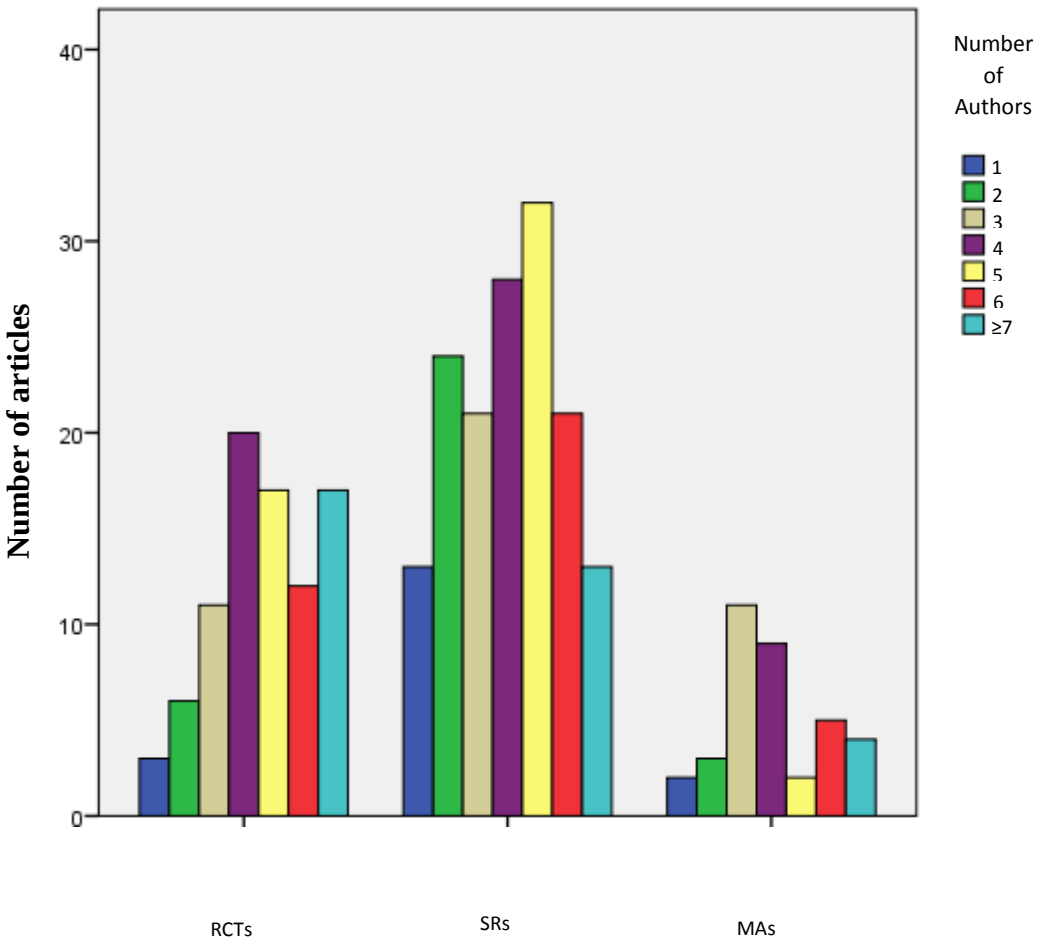

Figure 6. Distribution of different types of articles per number of authors.

5.2.Comparison between periods

5.2.1.Period and the type of journals

The distribution of articles regarding the period and the type of journal is shown in Table5 and Figure 7.

It appears that in both periods most of the articles were published in dental journals (before 2006: 65.8%; during 2006-2015:64.8%).

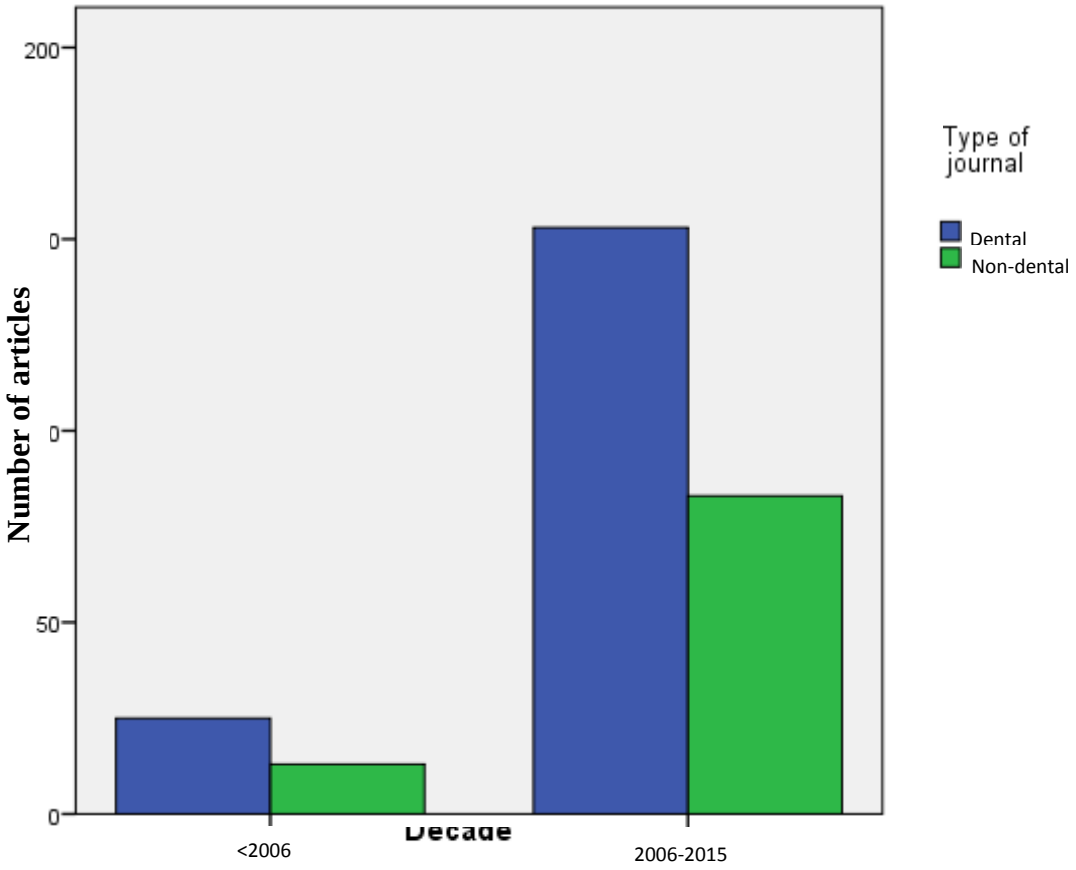

Figure 7. Distribution of two different decades per dental and non-dental journals.

5.2.2.Period and article type

The distribution of articles regarding the period when they were published and the type of article, is shown in Table 5 and Figure 4.

It can be seen that before 2006 most of the published articles were RCTs (65.8%), followed by SRs (26.3%), and MAs (7.9%). On the other hand, during the period of 2006-2015, there was a great increase in the number of SRs (60.2%), an increase in the MAs (14%) and a decrease in the RCTs (25.8%).

5.2.3.Period and region of origin

The comparison of both periods regarding the region of origin of the articles is shown in Table 5 and Figure 8.

Before 2006 most of the publications were from the Europe Union countries (68.4%), followed by North America (21.1%). European Union countries still remained the most prolific publishers during 2006-2015 (42.8%). However, Asia exhibited a significant increase in this decade and reached a publication percentage of 21.2%, followed by North America (16.1%).

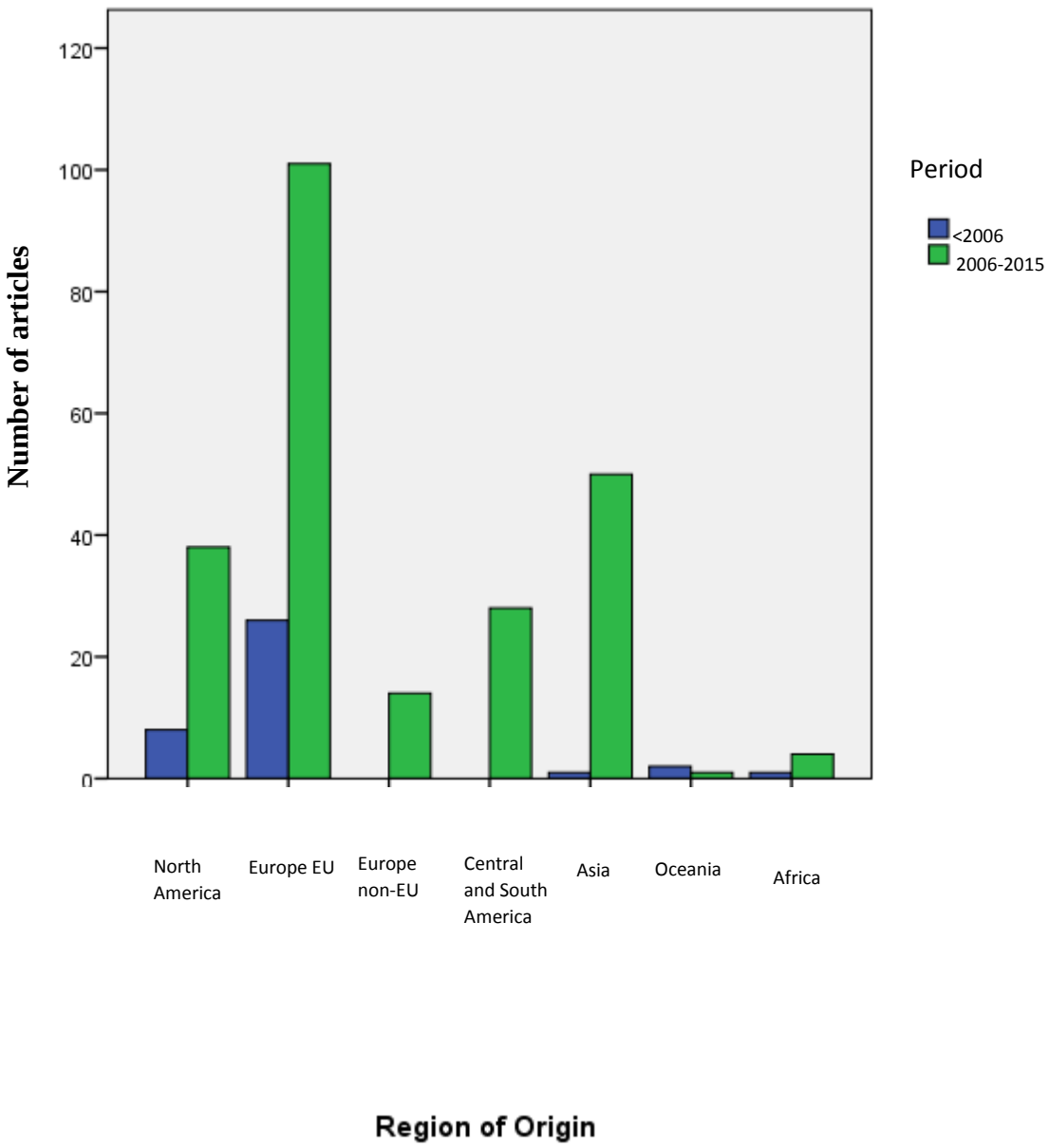

Figure 8. Distribution of region of origin between two different decades.

5.2.4.Period and number of authors

The distribution of published orthodontic articles in each period and number of authors contributing to the article is shown in Table 5 and Figure 9.

It can be seen that in both periods most of the studies had four authors (21.1% and 20.8%, respectively).

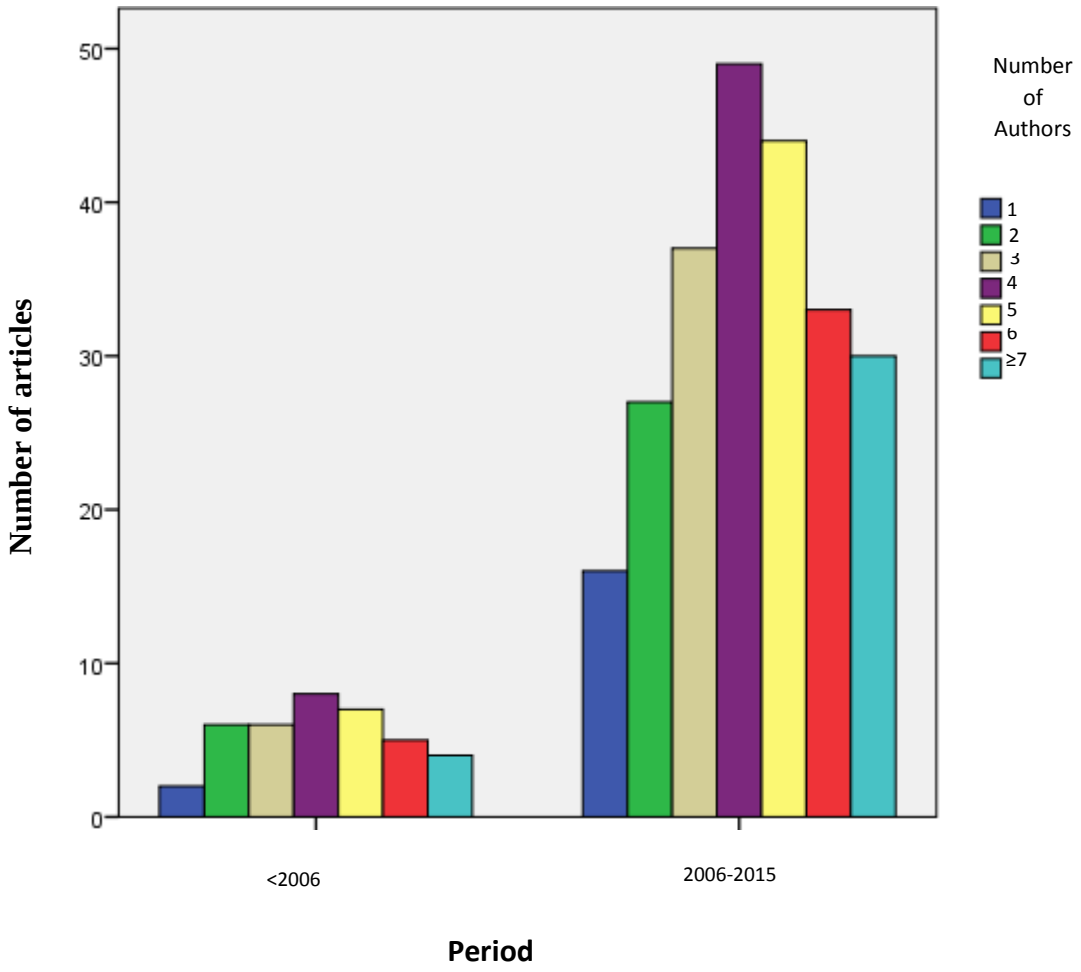

Figure 9. Distribution of two different decades per number of authors for each publication.

5.3.Comparison between region of origin of the articles (North America, Europe EU, Europe non-EU, Central and South America, Asia, Oceania, Africa):

5.3.1.Region of origin and article type

The regions of origin of the published articles compared to their type (SRs, MAs, and RCTs) are shown in Table 4 and Figure 3.

North America (52.2%), European Union countries (56.7%), non-European Union countries (64.3%), and Central and South America (53.6%), all concentrated on predominately publishing SRs followed by RCTs (North America 32.6%, European Union countries 34.6%, non-EuropeanUnion countries21.4%, and Central and South America 32.1%). On the other hand, Asia focused more on SRs (56.9%) and published RCTs (21.6%) and MAs (21.6%) in equal numbers. Similarly with Africa, (SRs: 60%; MAs: 20%; RCTs: 20%). Oceania presented only publications of RCTs.

5.3.2.Region of origin and number of authors

Region of origin of the articles, with a comparison of the number of authors is shown in Table 4 and Figure 10.

North America had equal distribution of number of authors for the articles (17.4% for each 2, 3 or 5 authors). European Union countries mostly had 4 or 5 authors (24.4%; 20.5%, respectively). Non-European Union countries mostly had 4 or 2 authors (42.9%; 28.6%, respectively). Central and South America, 5 authors (25%), and Asia mostly presented 7 or more authors (21.6%).

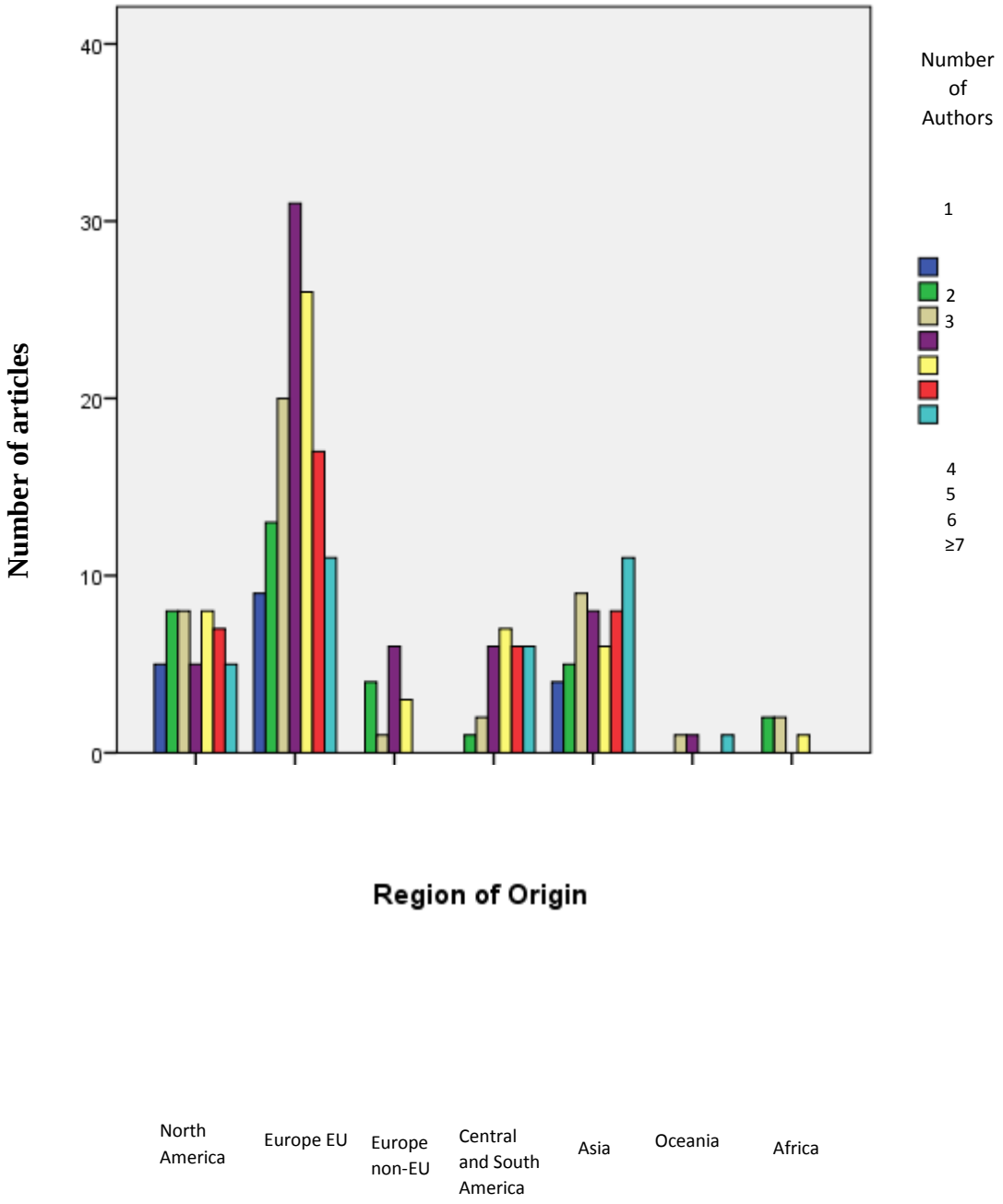

Figure 10. Distribution of region of origin per number of authors.

5.3.3.Region of origin and periods

The distribution of region of origin of the articles between both periods is shown in Table 5 and Figure 8.

Most of the regions presented an increase in the number of publications in the years between 2006 and 2015. North America produced 82.6% of its publications in this decade, European Union countries 79.5%, Asia 98% and Africa 80%. Non-European Union countries Central and South America had all their publications in this decade. Only Oceania had most of the publication (66.7%) published before 2006.

5.3.4.Region of origin and the type of journal

Region of origin of the articles and the type of journals where they were published are shown in Table 4 and Figure 11.

All of the regions exhibited a larger number of publications in dental journals. North America had 87% of its publications in dental journals, non-European Union countries 92.9%, Asia 62.7%, Oceania 66.7%, and Africa 60%. On the other hand, European Union countries had 57.5% in dental and 42.5% in non-dental journals. A similar pattern characterized Central and South America, where 53.6% or the articles were published in dental journals and 46.4% in non-dental journals.

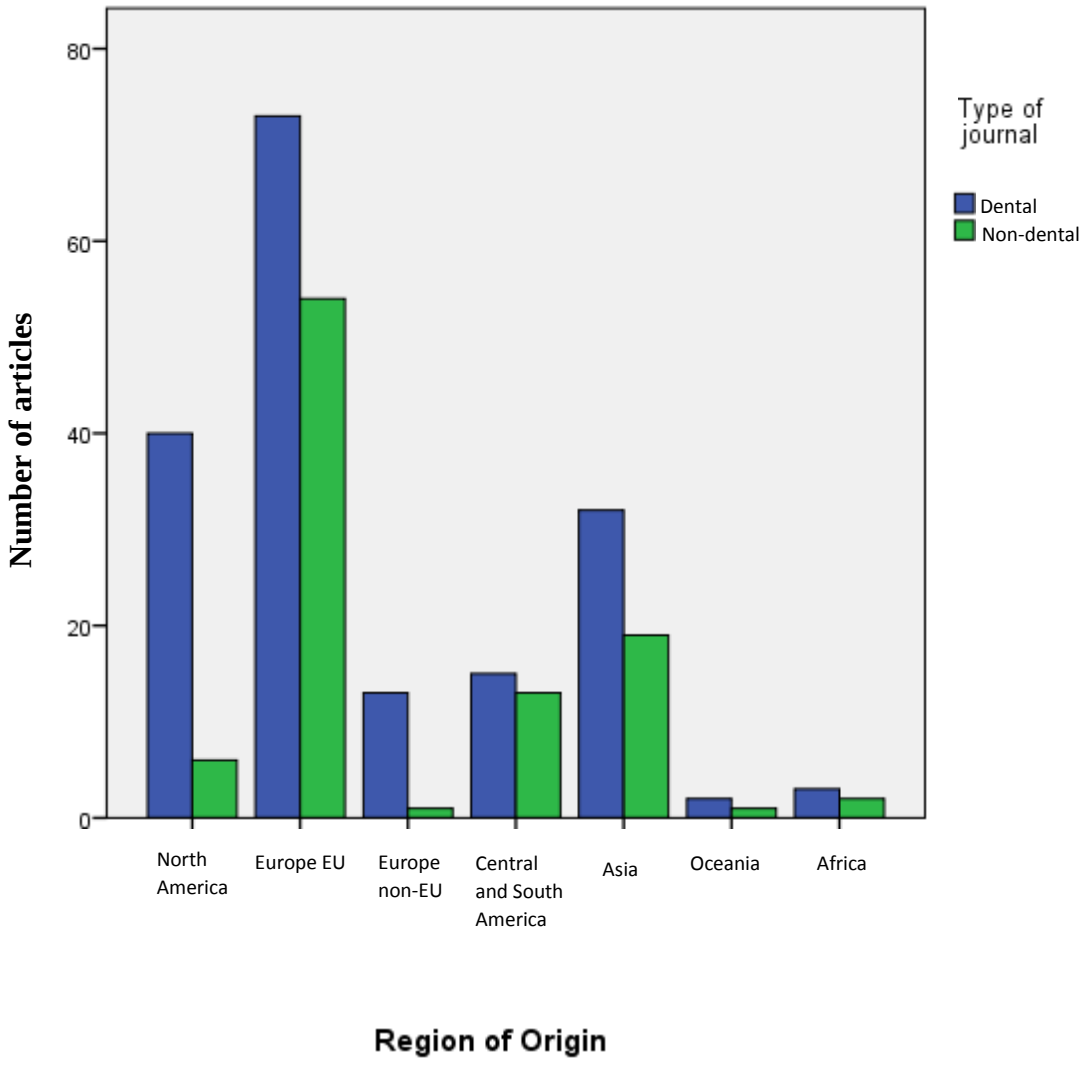

Figure 11. Distribution of region of origin between dental and non-dental journals.

6. Discussion

Since there is no data extant regarding the bibliometric characteristics of orthodontic articles published in non-orthodontic journals with IF, this study was conducted to explore the demographic characteristics of RCTs, SRs, and MAs. The results showed that the volume of high quality orthodontic literature has significantly increased during the last decade (2006-2015), characterized by a significant increase in SRs, MAs, and RCTs. This remarkable increase is most probably associated with the increased emphasis given to evidence-based dentistry, particularly in orthodontics (Kokich, 2013; Gianelly, 2006).

The article 'The scandal of poor medical research' by Altman (1994) emphasized that compromised and low quality research was often published in the medical literature due to the absence of strict criteria in the peer review process. It also pointed to the fact that the scientific community must increase its emphasis on the quality of published articles rather than just on their quantity. Journal editors and editorial boards have recently applied stricter guidelines for the submission of research manuscripts, and the peer review procedure has become more demanding.

Evidently, the academic environment has become more competitive; researchers are trying to produce and publish high quality research to improve their academic standing. Previous articles have shown an increase in the MAs, SRs and RCTs in the previous years (2004-2013) (Kanavakis et al., 2015). This is in agreement with the results of the present study, which showed an increase in all three high hierarchical status types of article during the period of 2006-2015.

It was confirmed that biomedical literature from Asia and South America has shown a dramatic increase in published research, in contrast to a relative decline in the USA and Europe

(Cappelland Davis, 2008; Rahman and Fukui, 2003). This report has identified a significant increase during 2006-2015 in published articles originating from Asia, from 2.6% before 2006 to 21.2% of the total published articles in each time period. Relevant contributions by European Union countries exhibited a slight decrease from 68.4% before 2006 to 42.8% between 2006 and 2015.

The present investigation was limited to articles that were published in non-orthodontic journals with IFs, according to the 2015 listing. Therefore, articles that may be of great scientific value and were published in non-orthodontic journals without IF were not considered. It is a well-established trend that researchers prefer to submit their work to journals with IF since these kinds of publication play a greater role in affecting the publicity and citation of an article (Allareddy et al., 2010).

It has been previously reported that around 45% of orthodontic articles until 2003 were published in non-orthodontic journals (Mavropoulos and Kiliaridis, 2003), and this is confirmed by our study in which 274 articles were published in non-orthodontic journals with IF. The fact that the IF value in orthodontic journals is relatively low compared to other scientific dental publications could have influenced authors' decisions to submit their work to higher IF journals in other fields of dentistry or even in other medico-biological or material sciences fields.

High level evidence articles are not problem-free. As noticed during the search process in this study, the results of the electronic search were reviewed by three assessors to exclude articles that did not meet the inclusion criteria. It is obvious that there is a significant inconsistency in reporting quality among articles of the same type (MAs, SRs, and RCTs). The same issue was raised by previous studies evaluating the reporting characteristics of RCTs (Harrison, 2003; Fleming et al., 2012), MAs (Papageorgiou et al., 2014a; 2014b), and SRs (Papageorgiou et al.,

2011) in the orthodontic literature. They all concluded that the quality of the high level evidence orthodontic articles ranges between low and moderate and is suboptimal in some cases.

Funding is needed for RCTs due to their high operational costs (Allareddy et al., 2014). On the other hand, SRs are the most published type of articles because they head the hierarchy of evidence and do not require operational and administrative costs. Readers, particularly clinicians, appreciate SRs since they provide critical information with clinical implications (Turpin, 2009)

Our study was limited to high level evidence articles that were published in non-orthodontic journals with IF; consequently, MAs, SRs, and RCTs that appeared in orthodontic or non-orthodontic journals without an IF were not included. However, it has to be said that good quality publications regarding these kinds of journals can be found (Gibson and Harrison, 2011; Harrison, 2003; Flint and Harrison, 2010; Kanavakiset al., 2015) that were excluded from the present study. Recommendations for future studies can be suggested that focus more on a comprehensive evaluation of the entire body of high level evidence orthodontic articles and a qualitative assessment of their research design and characteristics.

7. CONCLUSIONS

Orthodontic literature with a high level of scientific status published in non-orthodontic journals has significantly increased during the last decade (2006-2015) and has been concentrated mostly in dental journals. It has been mainly characterized by an increase in SRs. During the period 2006-2015 there has been a significant increase in published articles originating from Asia

compared to the relevant contributions by European Union countries, which exhibited a slight decrease in this period.

REFERENCES

Allareddy V, Rampa S, Masoud MI, Lee MK, Nalliah R, Allareddy V. Overview of registered studies in orthodontics: Evaluation of the ClinicalTrials.gov registry. Am J OrthodDentofacialOrthop 2014;146(5):587-93.

Allareddy V, Shah A, Lin C, Elangovan S, Lee M, Chung K, Vasudavan S, Karimbux N. Randomized trials published in the journal of dental research are cited more often compared with those in other top-tier non-specialty-specific dental journals. J Evid Based Dent Pract 2010;10:71–7.

Altman DG. The scandal of poor medical research. BMJ 1994;308:283-4.

Baumgartner S, Pandis N, Eliades T. Exploring the publications in three major orthodontic journals a comparative analysis of two 5-year periods. Angle Orthod 2014;84:397-403.

Brodman E. Choosing physiology journals. Med LibrAssoc Bull 1960;32:479.

Callaham M, Wears R, Weber E. Journal prestige, publication bias, and other characteristics associated with citation of published studies in peer-reviewed journals. JAMA 2002;287:2847–50.

Cappell MS, Davis M. A significant decline in the American domination of research in gastroenterology with increasing globalization from 1980 to 2005: an analysis of American authorship among 8,251 articles. Am J Gastroenterol. 2008;103:1065-74.

Chattopadhyay A. How useful is journal impact factor? Indian J Dent Res 2009;20:246-8.

Cochrane AL. Effectiveness and Efficiency : Random Reflections on Health Services. London: Nuffield Provincial Hospitals Trust, 1972. Reprinted in 1989 in association with the BMJ. Reprinted in 1999 for Nuffield Trust by the Royal Society of Medicine Press, London, ISBN 1-85315-394-X.

Deeks J, Dinnes J, D'Amico R, Sowden AJ, Sakarovitch C, Song F, Petticrew M, Altman DG. Evaluating non-randomised intervention studies. Health Technol Assess 2003; 7:1–173.

Eliades T. Research Methods in Orthodontics. Heidelbergi: Springer, 2013:xiii.

Eliades T, Athanasiou AE. Impact Factor: a review with specific relevance to orthodontic journals. J OrofacOrthop 2001;62:74-83.

Filion K, Pless I. Factors related to the frequency of citation of epidemiologic publications.EpidemiolPerspectInnov 2008;5:3.

Fleming PS, Buckley N, Seehra J, Polychronopoulou A, Pandis N. Reporting quality of abstracts of randomized controlled trials published in leading orthodontic journals from 2006 to 2011. Am J OrthodDentofacialOrthop 2012;142:451-8.

Fleming PS, Koletsi D, Seehra J, Pandis N. Systematic reviews published in higher impact clinical journals were of higher quality. Journal of clinical epidemiology 2014; 67:754-9.

Fleming PS, Seehra J, Polychronopoulou A, Fedorowicz Z, Pandis N. A PRISMA assessment of the reporting quality of systematic reviews in orthodontics. Angle Orthod 2013;83:158-63.

Flint HE, Harrison JE. How well do reports of clinical trials in the orthodontic literature comply with the CONSORT statement? J Orthod 2010;37:250-61.

Garcia-Rio F, Serrano S, Dorgham A, Alvarez-Sala R, Ruiz Penõ A, Pino J. A bibliometric evaluation of European Union research of the respiratory system from 1987 to 1998. EurRespir J 2001;17:1175-80.

Garfield E. Citation indexes to science: a new dimension in documentation through association of ideas. Science 1955;122:108-11.

Garfield E. Current comments: is the ratio between number of citations and publications cited a true constant? Curr Contents 1976;6:5-7.

Garfield E. How can impact factors be improved? BMJ 1996;313:411–13.

Garfield E. Is the ratio between number of citations and publications cited a true constant? Current Contents 1976;6. Reprinted in Essays of an Information Scientist. Vol 2, 1974-76. p. 419-21. Available: http://garfield.library.upenn.edu /essays/v2p419y1974-76.pdf

Garfield E. Journal impact factor: a brief review. CMAJ 1999;161:979-80.

Gianelly A. Evidence-based therapy: an orthodontic dilemma. Am J OrthodDentofacialOrthop 2006;129:596-8.

Gibson R, Harrison JE. What are we reading now? An update on the papers published in the orthodontic literature (1999-2008). J Orthod 2011;38:196-207.

Gibson R, Harrison JE. What are we reading? An analysis of the orthodontic literature 1999 to 2008. Am J OrthodDentofacialOrthop 2011;139:e471-e484.

Glazier R, Fry J, Badley E. Arthritis and rheumatism are neglected health priorities: a bibliometric study. J Rheumatol 2001;28:706-11.

Green S, Byar D. Using observational data from registries to compare treatments: the fallacy of omnimetrics. Stat Med 1984;3:361–73.

Greenhalgh T. How to read a paper. Getting your bearings (deciding what the paper is about). BMJ 1997;315:243-6.

Harrison JE, Ashby D, Lennon M. An analysis of articles published in the British and European Journals of Orthodontics. Br J Orthod 1996;23:203–9.

Harrison JE. Clinical trials in orthodontics II: assessment of the quality of reporting of clinical trials published in three orthodontic journals between 1989 and 1998. J Orthod 2003;30:309–15.

Harrison JE. Evidence based orthodontics: the way forward or an unrealistic dream? Liverpool: Department of Orthodontics, University of Liverpool, 2002.

Haynes RB, Sackett DL, Gray JM, Cook DJ, Guyatt GH. Transferring evidence from research into practice: 1. The role of clinical care research evidence in clinical decisions. ACP J Club 1996;125:A14–6.

Higgins J, Green S. Cochrane Handbook for Systematic Reviews of Interventions. Cochrane Database Syst Rev 2009; 5.0.2 www.cochrane-handbook.org

Hoeffel C. Journal impact factors [letter]. Allergy 1998;53:1225.

http://en.wikipedia.org/wiki/Systematic_review#cite_note-CEBM_about-0

http://garfield.library.upenn.edu/essays/v6p468y1983.pdf

ISI Web of Knowledge. http://thomsonreuters.com/journal-citationreports/

Jüni P, Altman DG, Egger M. Systematic reviews in health care: assessing the quality of controlled clinical trials. Br Med J 2001;323:42-6.

Kanavakis G, Dombroski M, Malouf D, Athanasiou AE. Demographic charactaristics of systematic reviews, meta-analysis, and randomized controlled trials in orthodontic journals with impact factor. Eur J Orthod 2015;12:1-9.

Kanavakis G, Spinos P, Polychronopoulou A, Eliades T, Papadopoulos M, Athanasiou AE. Orthodontic journals with impact factors in perspective: trends in the types of articles and authorship characteristics. Am J OrthodDentofacialOrthop 2006;130:516-22.

Kim M, Lin J, White R, Niederman R. Benchmarking the endodontic literature on MEDLINE. J Endod 2001;27:470-3.

Kjaergard LL, Villumsen J, Gluud C. Quality of randomised clinical trials affects estimates of intervention efficacy. Rome: 7th Cochrane Colloquium; 1999.

KokishVG. Do you have an evidence-based practice? Am J OrthodDentofacialOrthop 2013;143,1.

Koletsi D, Fleming PS, Eliades T, Pandis N. The evidence from systematic reviews and meta-analyses published in orthodontic literature. Where do we stand? Eur J Orthod 2015;37:603-9.

Mavropoulos A,Kiliaridis S. Orthodontic literature: an overview of the last 2 decades. Am J OrthodDentofacialOrthop 2003;124:30–40.

Moher D, Hopewell S, Schulz K, Montori V, Gotzsche P, Devereaux P, Elbourne D, Egger M, Altman D. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. Int J Surg 2012;10:28-55.

Moher D, Hopewell S, Schulz KF, Montori V, Gotzsche PC, Devereaux PJ, Elbourne D, Egger M, Altman DG. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. BMJ 2010;340:c869.

Moher D. CONSORT: an evolving tool to help improve the quality of reports of randomized controlled trials. Consolidated Standards of Reporting Trials. J Am Med Assoc 1998;279:1489-91.

Muir Gray JA, Haynes RB, Sackett DL, Cook DJ, Guyatt GH. Transferring evidence from research into practice: 3. Developing evidence-based clinical policy. ACP J Club 1997;126:A14–16.

Muir Gray JA. Evidence-based Healthcare: How to Make Health Care Policy and Management Decisions. London: Churchill Livingstone, 1997.

Papageorgiou SN, Papadopoulos MA,Athanasiou AE. Assessing small study effects and publication bias in orthodontic meta-analyses: a meta-epidemiological study. Clin Oral Investig. 2014a;18:1031–44.

Papageorgiou SN, Papadopoulos MA, Athanasiou AE. Evaluation of methodology and quality characteristics of systematic reviews in orthodontics. OrthodCraniofac Res 2011;14:116-37.

Papageorgiou SN, Papadopoulos MA, Athanasiou AE. Reporting characteristics of meta-analyses in orthodontics: methodological assessment and statistical recommendations. Eur J Orthod 2014b;36:74-85.

Patsopoulos N, Analatos A, Ioannidis J. Relative citation impact of various study designs in the health sciences. JAMA 2005;293:2362–6.

Potter WG. Of making many books there is no end: bibliometrics and libraries. J Acad Librarianship 1988;14:238a-238c.

Rahman M, Fukui T. Biomedical publication-global profile and trend. Public Health 2003;117:274–280.

Rennie D. CONSORT revised-improving the reporting of randomized trials. J Am Med Assoc 2001;285:2006-7.

Rinchuse D, Rinchuse D, Kandasamy S, Ackerman M. Deconstructing evidence in orthodontics: making sense of systematic reviews, randomized clinical trials, and meta-analyses. World J Orthod 2008;9:167–76.

Rosenberg W, Donald A. Evidence based medicine: an approach to clinical problem-solving. BMJ 1995;310:1122–6.

Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ 1996;312:71-2.

Schulz KF, Chalmers I, Hayes RJ, Altman DG. Empirical evidence of bias. Dimensions of methodological quality associated with estimates of treatment effects in controlled trials. J Am Med Assoc 1995;273:408-12.

Shea BJ, Grimshaw JM, Wells GA, Boers M, Andersson N, Hamel C, Porter AC, Tugwell P, Moher D, Bouter LM. Development of AMSTAR: a measurement too to assess the methodological quality of systematic reviews. BMC 2007;7:10.

Stevens S. Mapping the literature of cytotechnology. Bull Med LibrAssoc 2000;88:172-7.

Sun R, Conway S, Zawaideh S, Niederman D. Benchmarking the clinical orthodontic evidence on Medline. Angle Orthod 2000;70:464-70.

Tulloch J, Antczak-Bouckoms A, Tuncay O. A review of clinical research in orthodontics. Am J OrthodDentofacialOrthop 1989;95:499–504.

Turpin DL. CONSORT and QUOROM guidelines for reporting randomize clinical trials and systematic reviews. Am J OrthodDentofacialOrthop 2005;128:681-5.

Turpin DL. Looking for the highest level of evidence. Am J OrthodDentofacialOrthop 2009;135(6):687.

Yang S, Needleman H, Niederman R. A bibliometric analysis of the pediatric dental literature in MEDLINE. Pediatr Dent 2001;23:415-8.