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The Use of Dental Patient-Reported Outcomes Among Comparative Observational Studies in Orthodontics: A Methodological Study

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Xinliang Huang: Methodology, Investigation, Formal analysis, Writing - original draft.

Zhendong Tao: Methodology, Investigation, Formal analysis, Writing - original draft.

Peter Ngan: Methodology, Writing - review & editing.

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ABSTRACT

Objective: To identify and summarize the presence and characteristics of dental patient-reported outcomes (dPROs) and dental patient-reported outcome measures (dPROMs) within comparative observational studies published in 5 leading orthodontic journals.

Methods: Electronic searching was performed to identify intervention (therapeutic or preventive) related comparative observational studies published in selected journals between 2015 and 2021. Two authors extracted the characteristics of each included study independently and in duplicate, and summarized the dPROs and dPROMs used in these studies. All dPROs were classified into 2 general types (oral health-related quality of life [OHRQoL] and others), while dPROMs were divided into 3 categories (single-item questionnaires, generic multiple-item questionnaires, and specific multiple-item questionnaires). In addition, dPROMs were examined if they evaluated the 4 dimensions of OHRQoL (Oral Function, Orofacial Pain, Orofacial Appearance, and Psychosocial Impact).

Results: A total of 683 observational studies were eligible and included, of which 117 (17.1%) used dPROs and dPROMs. Seven different dPROs (OHRQoL, patients' satisfaction with treatment, preferences, concerns, compliance, duration, and unwanted events) and 33 different dPROMs (including 8 single-item questionnaires, 11 generic multiple-item questionnaires, and 14 specific multiple-item questionnaires) were identified in these studies. OHRQoL was the most commonly used dPRO (92/117, 78.6%), while Oral Health Impact Profile 14 (OHIP-14) was the most frequently used dPROM (20/92, 21.7%). In terms of study design, cross-sectional studies had the highest proportion of dPRO usage (62/148, 41.9%), followed by cohort studies (63/505, 12.5%) and case-control studies (1/30, 3.3%).

Conclusions: Only one-sixth of comparative observational studies published in leading orthodontic journals could reflect patients' perspectives. Observational studies in orthodontics need to provide more patient-important information through the use of dPROs and dPROMs.

INTRODUCTION

Patient-reported health status has been employed by the US Food and Drug Administration (FDA) as an efficacy endpoint for therapy approval. Patient-reported outcomes (PROs) are an important component of patient-centered care, which include symptom status, physical function, mental health, social function, and well-being.[1-3] In order to capture PROs, hundreds of standardized measures have been developed during the past three decades. Patient-reported outcome measures (PROMs) are functional instruments to grasp the lived experience of patients,[4] which can be used to evaluate what matters most to patients in clinical trials and to develop tailored treatment in response to the patient's preferences and needs in clinical practice.[5]

Dental patient-reported outcomes (dPROs) are defined as "any report of the status of a patient's oral health condition that comes directly from the patient, without interpretation of the patient's response by clinicians or health professionals", which can be used to measure the impact of diseases or related interventions on oral health.[6,7] Dental patient-reported outcome measures (dPROMs) were developed to measure dPROs by investigating the influence of oral conditions or interventions and expressing it numerically.[8,9]

Previous empirical research has shown that clinical studies in dentistry, including those in orthodontics, paid little attention to patients' perspectives, that is, technical and clinician-centered outcomes are over-emphasized in dental research.[10,11] In orthodontic research, most of the outcomes were related to the morphologic changes of malocclusion, especially changes in cephalometric analyses, which were less relevant to patients' preferences.[12] For instance, Tao et al.[13] found that only 24% of randomized controlled trials (RCTs) in orthodontics used dPROs and dPROMs to reflect patients' perspectives. Outcomes regarding adverse effects, health service resource utilization, and oral health-related quality of life (OHRQoL) have remained under-represented in orthodontic trials.[14] Therefore, the use of dPROs and dPROMs in orthodontic research can reduce the gaps in knowledge and perception between orthodontists and patients, yield evidence that can directly inform shared decision-making, and thereby facilitate evidence-based dental practice.[15,16]

While the highest level of evidence about healthcare interventions comes from RCTs, observational studies still provide extensive data support in both theoretical and

practical dental research.[17,18] According to the Oxford Center for Evidence-Based Medicine 2011 Levels of Evidence and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system,[19,20] the level of evidence of observational studies with dramatic effect could be considered equivalent to RCTs. In the field of orthodontics, researchers typically executed observational studies to evaluate the efficacy and acceptability of orthodontic treatment whenever experimental designs are infeasible, unwarranted or unethical.[21-23] Chen et al.[24] summarized the characteristics of clinical studies published in orthodontic journals between 2015 and 2017, and found that observational studies were the most common type of original studies, accounting for nearly 70% of the studied sample.

However, to our knowledge, the current use of dPROs and dPROMs in orthodontic observational studies has not been investigated. Therefore, the objective of this methodological study was to identify and summarize the presence and characteristics of dPROs and dPROMs within comparative observational studies published in 5 leading orthodontic journals between 2015 and 2021.

MATERIALS AND METHODS

Journal Selection

We selected the top 5 Science Citation Index Expanded (SCIE) indexed orthodontic journals with the highest impact factors (IFs) in the 2021 Journal Citation Report released by Clarivate Analytics: *Progress in Orthodontics* (PIOR, IF = 3.247), *European Journal of Orthodontics* (EJO, 3.131), *American Journal of Orthodontics and Dentofacial Orthopedics* (AJO-DO, 2.711), *Angle Orthodontist* (AO, 2.684), and *Orthodontics & Craniofacial Research* (OCR, 2.563).

Study selection

As determined a *priori*, to ensure the comparability with our previous study investigating RCTs in orthodontics and facilitate interpretation,[13] only comparative observational studies (i.e. cohort studies, case-control studies, and cross-sectional studies) involving clinical interventions published during 2015-2021 were included in this methodological study. However, these study designs were sometimes described using different terminology.[25] For example, the terms ‘follow-up study’ and ‘longitudinal study’ are synonymous with ‘cohort study’, and ‘prevalence study’ is sometimes equivalent to ‘cross-sectional study’. Thus, in the present study, a specific search

strategy for PubMed according to its characteristics and rules was developed (**Table S1**).

Two authors (X.H. and Z.T.) screened the titles and abstracts of all identified records independently and in duplicate. The full texts of all potentially eligible studies were then retrieved for further selection. Possible discrepancies were resolved by discussion with 2 expert investigators (H.H. and F.H.).

Data extraction

All reported outcomes of each observational study were determined in the following order:[26-28]

1. Explicitly reported primary outcome(s) in the full text;
2. Outcome(s) used for the calculation of sample size;
3. Outcome(s) reported in the Results section of full text and in accordance with the primary/main research objective.

Additionally, the following characteristics were extracted from each included study: title of article, name of journal, publication year, type of research, statistician involvement (determined by affiliation information), geographical origin (first author), type of institution, international collaboration, number of affiliations (single or multiple), as well as funding status (funded by industry, funded by other sources, unfunded or unreported). All the extracted data were imported into Microsoft Excel 2020 (Microsoft Corporation, Redmond, Washington) for analysis.

Summary of dPROs and dPROMs

All dPROs were identified from outcomes used in the included observational studies. The proportion of comparative observational studies with dPROs was calculated. The use of dPROs and dPROMs by main characteristics of observational studies (i.e. journal, year, geographical origin, and study design) was summarized.

In addition, all identified dPROs were classified into 2 general types (OHRQoL and others), and all identified dPROMs were classified into 3 categories (single-item questionnaires, generic multiple-item questionnaires and specific multiple-item questionnaires). We also identified whether these dPROMs assessed the 4 dimensions of OHRQoL (i.e. Oral Function, Orofacial Pain, Orofacial Appearance, and

Psychosocial Impact).

RESULTS

A total of 1433 records were initially found. A total of 750 studies were excluded after the screening of full texts. Finally, a total of 683 comparative observational studies which met our eligibility criteria were included in this study (**Figure 1**).

Characteristics of included comparative observational studies

Characteristics of the included comparative observational studies are illustrated in **Table 1**. The vast majority of these observational studies were published in the AJO-DO (31.5%), AO (29.0%), and EJO (21.1%), respectively. Approximately two-thirds of the studies were from Europe (43.3%) and Asia (23.0%). From 2015 to 2021, the number of studies published per year was relatively stable. Besides, the majority of these observational studies were conducted in a university setting (83.0%) and by multiple affiliations (83.6%). The involvement of statisticians as co-authors was seen in only 98 (14.3%) of the included studies. The temporal trend in international collaboration, journal distribution, and geographical distribution are depicted in **Figure 2**, **Table S2** and **Table S3**.

Summary of dPROs

Out of the 683 included comparative observational studies, 117 (17.1%) used dPROs. **Figure 3** shows the number of included observational studies and the corresponding proportion with dPROs by main characteristics.

About one-fourth of comparative observational studies published in AJO-DO used dPROs, which was the highest proportion among the 5 leading orthodontic journals. By contrast, the proportion of published papers using dPROs was relatively low in AO and OCR, which was around 15%. During the period from 2015 to 2021, the proportion of studies using dPROs fluctuated each year with a decrease of 10% during 2015-2017, followed by an increase of 15% during 2017-2021. Among the 3 continents with the highest number of published studies, Asia had the highest proportion of comparative observational studies with dPROs. Cross-sectional studies were the type of observational study which had the highest proportion of dPRO usage (62/148, 41.9 %). Cohort studies, the most common type of comparative observational study (505/683, 73.9%), showed a relatively low percentage of dPRO usage, namely 12.5% (63/505).

Seven different dPROs in total were identified from the included observational studies. The proportion of comparative observational studies that used each of these dPROs is presented in **Figure 4**. Among 117 studies using dPROs, OHRQoL was the most commonly used dPRO (n = 92, 78.6%), followed by patient-reported satisfaction with treatment (n = 18, 15.3%), preferences (n = 6, 5.1%), concerns (n = 6, 5.1%), compliance (n = 5, 4.2%), duration (n = 3, 2.5%), and unwanted events (n = 1, 0.8%).

Summary of dPROMs

The characteristics of dPROMs used in the identified observational studies for the assessment of OHRQoL are depicted in **Table 2**. In view of the absence of reliability and validity, questionnaires designed for specific trial content were excluded. This resulted in a total of 33 different dPROMs[29-53], involving 11 generic multiple-item questionnaires, 14 specific multiple-item questionnaires, and 8 single-item questionnaires. All identified generic multiple-item dPROMs assessed all 4 dimensions of OHRQoL, whereas only 3 (21.4%) of those 14 specific multiple-item dPROMs assessed all 4 dimensions.

Among 92 studies measuring OHRQoL, the Oral Health Impact Profile 14 (OHIP-14) (n = 20, 21.7%), Child Perceptions Questionnaire for 11–14-year-olds (CPQ 11-14) (n = 9, 9.8%), Orthognathic Quality of Life Questionnaire (OQLQ) (n = 8, 8.7%), and Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) (n = 7, 7.6%) were the 4 most frequently used dPROMs.

DISCUSSION

Although observational studies usually have a lower quality of evidence than experimental studies, a variety of research questions cannot be investigated in RCTs due to different ethical and feasibility issues. Published data have demonstrated that observational studies account for a large proportion (80-90%) of publications in medical journals.[54] Well-designed observational studies not only draw causal inferences between exposure and diseases, but are also advantageous for investigating long-term stability and rare adverse effects.[55-58] For instance, observational evidence supported the inference of a causal relationship between smoking and lung cancer.[59] In the field of orthodontics, observational studies generate hypotheses and are often the foundation of future research.

Clinical trials with statisticians as authors tend to have higher reporting quality.[60,61] Statistician involvement was advocated in orthodontic clinical studies.[62] However, the involvement of statisticians as co-authors was seen in only one-seventh of the included observational studies, which may be related to the relatively low proportion of dPRO usage.

The results of this methodological study and our previous one[13] suggested that, although orthodontics was regarded as one of the hot topics in OHRQoL-related research,[63,64] the use of dPROs in both orthodontic RCTs and comparative observational studies was consistently below 30% from 2015 to 2021. In addition, it was found that among RCTs in orthodontics, dPROs did not increase significantly from 2015 to 2021 but remained between 20% and 30%.[13] Nonetheless, it was encouraging to discover that among observational studies in orthodontics, more recent publications paid greater attention to dPROs, but there was still a large room for improvement.

According to the STROBE (strengthening the reporting of observational studies in epidemiology) statement, the 3 main types of observational studies are cohort studies, case-control studies, and cross-sectional studies.[25] Although cohort studies accounted for the largest proportion of included comparative observational studies, the use of dPROs among them was relatively low. The possible reason may be that the majority of cohort studies in orthodontics were retrospective and based on routinely collected clinical data. In addition, numerous included observational studies drew clinically relevant conclusions based on analysis of cone beam computed tomography (CBCT) data, dental casts, and lateral cephalograms. This partially reflects that the orthodontic practice excessively focused on the professional opinions of orthodontists, paying inadequate attention to the values and preferences of patients.[65-67]

dPROs, especially OHRQoL, are of great importance to the decision-making process of orthodontic treatment planning.[68,69] In patient-centered dental practice, orthodontists should focus on the treatment goal that patients desire most. The use of dPROs can depict dentofacial esthetics and function from the perspective of orthodontic patients, thus improving their treatment satisfaction. Moreover, when dPROs are absent in clinical studies, information about treatment efficacy does not yield from patients' perspectives and may not directly inform clinical practice, resulting in avoidable research waste.[70]

The use of dPROMs can strengthen clinical measurements and improve the understanding of treatment outcome, which are often based on data from dental professionals.[71,72] dPROMs were divided into single-item and multiple-item questionnaires in this study. Multiple-item questionnaires were the most widely used dPROMs in orthodontic comparative observational studies, accounting for 76% of all dPROMs. However, among RCTs in orthodontics using dPROs, two-thirds used single-item questionnaires (e.g. pain measured with 10 mm Visual Analogue Scale).[13] This was probably because observational studies are generally more labor- and resource-efficient, and some of them focused on the changes of OHRQoL before and after treatment.[73,74] Therefore, they may prefer to apply multiple-item questionnaires to comprehensively capture the impact of oral diseases and treatment effects on patients.

OHIP-14 is the abbreviated 14-item OHIP with good feasibility in clinical application, which has been used to measure the impact of oral health problems on an individual's life.[75] In the present study, OHIP-14 was the most commonly used dPROM and OHRQoL instrument. This was probably because OHIP is one of the earliest developed OHRQoL instruments and has been translated into many languages with long-term and international influence.[76] The current study summarized 33 dPROMs applied in the included studies and divided them into 3 categories. We found a large variety in the use of dPROMs among orthodontic observational studies, which is partly because a majority of orthodontic patients are children and adolescents. Considering the differences between children, adolescents, and adults in aspects such as cognition, social development, and reading comprehension,[77,78] various questionnaires, have been developed to capture the dPROs of patients of different ages,[79] such as CPQ 11-14[80], CPQ 8-10[81], and OHIP-5 for school-aged children[82]. On the other hand, the large variety in dPROMs caused the heterogeneity of outcomes and difficulty for evidence synthesis.

Furthermore, the wide range of dPROMs makes it challenging for clinicians to select one over another, and questionnaires with a large number of items decrease patients' compliance. These are barriers to the use of dPROs for clinical and research purposes.[83-86] OHIP-5, the shortest OHIP version with only 5 items, is a practical and validated assessment tool of perceived oral health for dental research and practice that can replace longer OHIP versions with good feasibility in all settings across all oral

diseases.[87,88] Thus, to further lessen the burden from dPROM usage and to standardize outcome assessment, it is recommended that future orthodontic observational studies use OHIP-5 to capture patients' perspectives.

To our knowledge, this methodological study is the first to focus specifically on the use of dPROs and dPROMs among comparative observational studies in orthodontics. However, a few limitations exist in our study. First, observational studies not related to clinical interventions were excluded in this study, such as epidemiological surveys of oral diseases, which may lead to a loss of some information from a broader perspective of all clinical research. However, this was done in order to ensure comparability with the results of other similar studies. Second, only comparative observational studies published in 5 leading orthodontic journals were included. Therefore, the results of this study may not be representative of all comparative observational studies in orthodontics. Third, the assessment of study quality was not conducted, which is beyond the scope of this study. Further research is required to investigate the relationship between study quality and dPRO usage in orthodontic studies.

CONCLUSIONS

Only about one-sixth of comparative observational studies published in leading orthodontic journals could reflect patients' perspectives. OHRQoL was the most commonly used dPRO in these studies, while OHIP-14 was the most frequently used dPROM. Observational studies in orthodontics need to provide more patient-important information through wide and standardized use of dPROs and dPROMs.

REFERENCES

1. Nelson EC, Eftimovska E, Lind C, Hager A, Wasson JH, Lindblad S. Patient reported outcome measures in practice. BMJ 2015, 350: g7818. doi:10.1136/bmj.g7818.
2. Chang SS, Movsas B. How vital are patient-reported outcomes? J Natl Cancer Inst 2022, 114(3): 347-348. doi:10.1093/jnci/djab178.
3. Kirby JS. Patient-reported outcomes in dermatology. JAMA Dermatol 2022, 158(1): 97-98. doi:10.1001/jamadermatol.2021.1559.
4. Pattinson RL, Trialonis-Suthakharan N, Gupta S, Henry AL, Lavallée JF, Otten M*, et al.* Patient-reported outcome measures in dermatology: A systematic review. Acta Derm Venereol 2021, 101(9): adv00559. doi:10.2340/00015555-3884.
5. Yoon J, Homsi HA, Barbieri JS. Analysis of content and phrasing of health-related quality-of-life patient-reported outcome measures used in patients with acne. JAMA Dermatol 2022, 158(9): 1072-1073. doi:10.1001/jamadermatol.2022.2293.
6. John MT. Health outcomes reported by dental patients. J Evid Based Dent Pract 2018, 18(4): 332-335. doi:10.1016/j.jebdp.2018.09.001.
7. Qin D, Hua F, John M. Glossary for dental patient-centered outcomes research. J Evid Based Dent Pract (in press).
8. Shayestehpour S, Sharma K, Mosor E, Omara M, Ritschl V, Shayestehpour S*, et al.* Patient-reported outcome measures for pediatric dental patients: A methodological review and mapping exercise. J Evid Based Dent Pract 2022, 22(1s): 101661. doi:10.1016/j.jebdp.2021.101661.
9. Reissmann DR. Dental patient-reported outcome measures are essential for evidence-based prosthetic dentistry. J Evid Based Dent Pract 2019, 19(1): 1-6. doi:10.1016/j.jebdp.2019.01.003.
10. Fleming PS, Koletsi D, O'Brien K, Tsichlaki A, Pandis N. Are dental researchers asking patient-important questions? A scoping review. J Dent 2016, 49: 9-13. doi:10.1016/j.jdent.2016.04.002.
11. Fagundes NCF, Minervini G, Furio Alonso B, Nucci L, Grassia V, d'Apuzzo F*, et al.* Patient-reported outcomes while managing obstructive sleep apnea with oral appliances: A scoping review. J Evid Based Dent Pract 2023, 23(1s): 101786. doi:10.1016/j.jebdp.2022.101786.
12. Hua F. Increasing the value of orthodontic research through the use of dental patient-reported outcomes. J Evid Based Dent Pract 2019, 19(2): 99-105. doi:10.1016/j.jebdp.2019.04.005.
13. Tao Z, Zhao T, Ngan P, Qin D, Hua F, He H. The use of dental patient-reported outcomes among randomized controlled trials in orthodontics: A methodological study. J Evid Based Dent Pract 2023, 23(1s): 101795. doi:10.1016/j.jebdp.2022.101795.
14. Tsichlaki A, O'Brien K. Do orthodontic research outcomes reflect patient values? A systematic review of randomized controlled trials involving children. Am J Orthod Dentofacial Orthop 2014, 146(3): 279-285. doi:10.1016/j.ajodo.2014.05.022.
15. Barry MJ, Edgman-Levitan S. Shared decision making--pinnacle of patient-centered care. N Engl J Med 2012, 366(9): 780-781. doi:10.1056/NEJMp1109283.
16. Mittal H, John MT, Sekulić S, Theis-Mahon N, Rener-Sitar K. Patient-reported outcome measures for adult dental patients: A systematic review. J Evid Based Dent Pract 2019,

19(1): 53-70. doi:10.1016/j.jebdp.2018.10.005.
17. Glasziou P, Vandenbroucke JP, Chalmers I. Assessing the quality of research. Bmj 2004, 328(7430): 39-41. doi:10.1136/bmj.328.7430.39.
18. Song JW, Chung KC. Observational studies: Cohort and case-control studies. Plast Reconstr Surg 2010, 126(6): 2234-2242. doi:10.1097/PRS.0b013e3181f44abc.
19. Guyatt GH, Oxman AD, Sultan S, Glasziou P, Akl EA, Alonso-Coello P*, et al.* GRADE guidelines: 9. Rating up the quality of evidence. J Clin Epidemiol 2011, 64(12): 1311-1316. doi:10.1016/j.jclinepi.2011.06.004.
20. Howick J CJLLI, Glasziou P, et al. OCEBM Levels of Evidence Working Group*. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine. http://www.cebm.net/index.aspx?o=5653.
21. Turner DP, Houle TT. Observational study designs. Headache 2019, 59(7): 981-987. doi:10.1111/head.13572.
22. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007, 370(9596): 1453-1457. doi:10.1016/s0140-6736(07)61602-x.
23. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ*, et al.* Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Int J Surg 2014, 12(12): 1500-1524. doi:10.1016/j.ijsu.2014.07.014.
24. Chen Y, Hua F, Mei Y, Thiruvenkatachari B, Riley P, He H. The characteristics and level of evidence of clinical studies published in 5 leading orthodontic journals. J Evid Based Dent Pract 2019, 19(3): 273-282. doi:10.1016/j.jebdp.2019.03.001.
25. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ*, et al.* Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. PLoS Med 2007, 4(10): e297. doi:10.1371/journal.pmed.0040297.
26. Guo F, Fang X, Li C, Qin D, Hua F, He H. The presence and characteristics of 'spin' among randomized controlled trial abstracts in orthodontics. Eur J Orthod 2021, 43(5): 576-582. doi:10.1093/ejo/cjab044.
27. Wu X, Yan Q, Fang X, Hua F, Shi B, Tu Y-K. Spin in the abstracts of randomized controlled trials in periodontology and oral implantology: A cross-sectional analysis. J Clin Periodontol 2020: 1079-1086. doi:10.1111/jcpe.13340.
28. Fang X, Wu X, Levey C, Chen Z, Hua F, Zhang L. Spin in the abstracts of randomized controlled trials in operative dentistry: A cross-sectional analysis. Oper Dent 2022, 47(3): 287-300. doi:10.2341/21-025-lit.
29. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997, 25(4): 284-290. doi:10.1111/j.1600-0528.1997.tb00941.x.
30. Locker D, Jokovic A, Tompson B. Health-related quality of life of children aged 11 to 14 years with orofacial conditions. The Cleft Palate-craniofacial Journal 2005, 42(3): 260-266. doi:10.1597/03-077.1.
31. Cunningham SJ, Garratt AM, Hunt NP. Development of a condition-specific quality of

life measure for patients with dentofacial deformity: I. Reliability of the instrument. Community Dent Oral Epidemiol 2000, 28(3): 195-201. doi:10.1034/j.1600-0528.2000.280305.x.

32. Klages U, Claus N, Wehrbein H, Zentner A. Development of a questionnaire for assessment of the psychosocial impact of dental aesthetics in young adults. Eur J Orthod 2006, 28(2): 103-111. doi:10.1093/ejo/cji083.
33. Martins MT, Ferreira FM, Oliveira AC, Paiva SM, Vale MP, Allison PJ*, et al.* Preliminary validation of the Brazilian version of the Child Perceptions Questionnaire 8-10. Eur J Paediatr Dent 2009, 10(3): 135-140.
34. Jokovic A, Locker D, Stephens M, Kenny D, Tompson B, Guyatt G. Measuring parental perceptions of child oral health-related quality of life. J Public Health Dent 2003, 63(2): 67-72. doi:10.1111/j.1752-7325.2003.tb03477.x.
35. Leao A, Sheiham A. Relation between clinical dental status and subjective impacts on daily living. J Dent Res 1995, 74(7): 1408-1413. doi:10.1177/00220345950740071301.
36. Adulyanon S, Vourapukjaru J, Sheiham A. Oral impacts affecting daily performance in a low dental disease Thai population. Community Dent Oral Epidemiol 1996, 24(6): 385-389. doi:10.1111/j.1600-0528.1996.tb00884.x.
37. Broder HL, McGrath C, Cisneros GJ. Questionnaire development: face validity and item impact testing of the Child Oral Health Impact Profile. Community Dent Oral Epidemiol 2007, 35 Suppl 1. doi:10.1111/j.1600-0528.2007.00401.x.
38. Broder HL, Wilson-Genderson M, Sischo L. Reliability and validity testing for the Child Oral Health Impact Profile-Reduced (COHIP-SF 19). J Public Health Dent 2012, 72(4): 302-312. doi:10.1111/j.1752-7325.2012.00338.x.
39. Jeong SH, Kang SM, Ryu JH, Kwon HK, Kim BI. Subjective food intake ability in relation to the Mixing Ability Index in Korean adults. J Oral Rehabil 2010, 37(4): 242-247. doi:10.1111/j.1365-2842.2009.02050.x.
40. Oosterink FMD, de Jongh A, Hoogstraten J, Aartman IHA. The Level of Exposure-Dental Experiences Questionnaire (LOE-DEQ): A measure of severity of exposure to distressing dental events. Eur J Oral Sci 2008, 116(4): 353-361. doi:10.1111/j.1600-0722.2008.00542.x.
41. Mandall NA, McCord JF, Blinkhorn AS, Worthington HV, O'Brien KD. Perceived aesthetic impact of malocclusion and oral self-perceptions in 14-15-year-old Asian and Caucasian children in greater Manchester. Eur J Orthod 2000, 22(2): 175-183. doi:10.1093/ejo/22.2.175.
42. Benson PE, Cunningham SJ, Shah N, Gilchrist F, Baker SR, Hodges SJ*, et al.* Development of the Malocclusion Impact Questionnaire (MIQ) to measure the oral health-related quality of life of young people with malocclusion: part 2 - cross-sectional validation. J Orthod 2016, 43(1): 14-23. doi:10.1080/14653125.2015.1114223.
43. Kerns RD, Turk DC, Rudy TE. The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). Pain 1985, 23(4): 345-356. doi:10.1016/0304-3959(85)90004-1.
44. Stouthard ME, Hoogstraten J, Mellenbergh GJ. A study on the convergent and discriminant validity of the Dental Anxiety Inventory. Behav Res Ther 1995, 33(5): 589-595. doi:10.1016/0005-7967(94)00096-3.
45. Stewart MG, Witsell DL, Smith TL, Weaver EM, Yueh B, Hannley MT. Development

and validation of the Nasal Obstruction Symptom Evaluation (NOSE) scale. Otolaryngol Head Neck Surg 2004, 130(2): 157-163. doi:10.1016/j.otohns.2003.09.016.

46. Piombino P, Ruggiero F, Dell'Aversana Orabona G, Scopelliti D, Bianchi A, De Simone F*, et al.* Development and validation of the quality-of-life adolescent cleft questionnaire in patients with cleft lip and palate. J Craniofac Surg 2014, 25(5): 1757-1761. doi:10.1097/SCS.0000000000001033.
47. Turner SR, Thomas PW, Dowell T, Rumsey N, Sandy JR. Psychological outcomes amongst cleft patients and their families. Br J Plast Surg 1997, 50(1): 1-9. doi:10.1016/s0007-1226(97)91275-3.
48. Conti A, Freitas M, Conti P, Henriques J, Janson G. Relationship between signs and symptoms of temporomandibular disorders and orthodontic treatment: A cross-sectional study. The Angle Orthodontist 2003, 73(4): 411-417. doi:10.1043/0003-3219(2003)073<0411:RBSASO>2.0.CO;2.
49. Bowman AC, Saltaji H, Flores-Mir C, Preston B, Tabbaa S. Patient experiences with the Forsus Fatigue Resistant Device. The Angle Orthodontist 2013, 83(3): 437-446. doi:10.2319/081112-647.1.
50. Feldmann I, List T, John MT, Bondemark L. Reliability of a questionnaire assessing experiences of adolescents in orthodontic treatment. The Angle Orthodontist 2007, 77(2): 311-317. doi:10.2319/0003-3219(2007)077[0311:ROAQAE]2.0.CO;2.
51. Czochrowska EM, Stenvik A, Bjercke B, Zachrisson BU. Outcome of tooth transplantation: Survival and success rates 17-41 years posttreatment. Am J Orthod Dentofacial Orthop 2002, 121(2). doi:10.1067/mod.2002.119979.
52. Taghavi Bayat J, Huggare J, Mohlin B, Akrami N. Determinants of orthodontic treatment need and demand: A cross-sectional path model study. Eur J Orthod 2017, 39(1): 85-91. doi:10.1093/ejo/cjw020.
53. Arqub SA, Voldman R, Ahmida A, Kuo C-L, Godoy LDC, Nasrawi Y*, et al.* Patients' perceptions of orthodontic treatment experiences during COVID-19: A cross-sectional study. Prog Orthod 2021, 22(1): 17. doi:10.1186/s40510-021-00363-7.
54. Scales CD, Jr., Norris RD, Peterson BL, Preminger GM, Dahm P. Clinical research and statistical methods in the urology literature. J Urol 2005, 174(4 Pt 1): 1374-1379. doi:10.1097/01.ju.0000173640.91654.b5.
55. Dai S, Zhou X, Xu H, Li B, Zhang J. Evaluation of the reporting quality of observational studies in master of public health dissertations in China. BMC Med Res Methodol 2020, 20(1): 230. doi:10.1186/s12874-020-01116-6.
56. Inoue T, Maeda K, Nagano A, Shimizu A, Ueshima J, Murotani K*, et al.* Related factors and clinical outcomes of osteosarcopenia: A narrative review. Nutrients 2021, 13(2). doi:10.3390/nu13020291.
57. Auvin S, Walker L, Gallentine W, Jozwiak S, Tombini M, Sills GJ. Prospective clinical trials to investigate clinical and molecular biomarkers. Epilepsia 2017, 58 Suppl 3: 20-26. doi:10.1111/epi.13782.
58. Gianicolo EAL, Eichler M, Muensterer O, Strauch K, Blettner M. Methods for evaluating causality in observational studies. Dtsch Arztebl Int 2020, 116(7): 101-107. doi:10.3238/arztebl.2020.0101.
59. Cornfield J, Haenszel W, Hammond EC, Lilienfeld AM, Shimkin MB, Wynder EL.

Smoking and lung cancer: Recent evidence and a discussion of some questions. 1959. Int J Epidemiol 2009, 38(5): 1175-1191. doi:10.1093/ije/dyp289.

60. Guo F, Fang X, Li C, Qin D, Hua F, He H. The presence and characteristics of 'spin' among randomized controlled trial abstracts in orthodontics. Eur J Orthod 2021, 43(5): 576-582. doi:10.1093/ejo/cjab044.
61. Delgado-Rodriguez M, Ruiz-Canela M, De Irala-Estevez J, Llorca J, Martinez-Gonzalez A. Participation of epidemiologists and/or biostatisticians and methodological quality of published controlled clinical trials. J Epidemiol Community Health 2001, 55(8): 569-572. doi:10.1136/jech.55.8.569.
62. Spanou A, Koletsi D, Fleming PS, Polychronopoulou A, Pandis N. Statistical analysis in orthodontic journals: Are we ignoring confounding? Eur J Orthod 2016, 38(1): 32-38. doi:10.1093/ejo/cjv004.
63. Yu X, Chen Y, Li Y, Hong J, Hua F. A bibliometric mapping study of the literature on oral health-related quality of life. J Evid Based Dent Pract 2023, 23(1s): 101780. doi:10.1016/j.jebdp.2022.101780.
64. Mitus-Kenig M, Derwich M, Czochrowska E, Pawlowska E. Quality of life in orthodontic cancer survivor patients-A prospective case-control study. Int J Environ Res Public Health 2020, 17(16). doi:10.3390/ijerph17165824.
65. Demir O, Arici N. Dose-related effects of extracorporeal shock waves on orthodontic tooth movement in rabbits. Sci Rep 2021, 11(1): 3405. doi:10.1038/s41598-021-82997-5.
66. Baseer MA, Almayah NA, Alqahtani KM, Alshaye MI, Aldhahri MM. Oral impacts experienced by orthodontic patients undergoing fixed or removable appliances therapy in saudi arabia: A cross-sectional study. Patient Prefer Adherence 2021, 15: 2683-2691. doi:10.2147/ppa.S343084.
67. Xu X, Ji Q, Shen M. Patient preferences and values in decision making for migraines: A systematic literature review. Pain Res Manag 2021, 2021: 9919773. doi:10.1155/2021/9919773.
68. Hua F. Dental patient-reported outcomes update 2022. J Evid Based Dent Pract 2023, 23(1s): 101802. doi:10.1016/j.jebdp.2022.101802.
69. Hua F. Dental patient-reported outcomes update 2021. J Evid Based Dent Pract 2022, 22(1s): 101663. doi:10.1016/j.jebdp.2021.101663.
70. Reuter-Selbach MJ, Su N, Faggion CM, Jr. Assessment of the frequency of reporting Dental Patient-reported Outcomes (dPROs) in a sample of randomized controlled trials on root coverage procedures. J Evid Based Dent Pract 2023, 23(1s): 101793. doi:10.1016/j.jebdp.2022.101793.
71. Nagendrababu V, Vinothkumar TS, El-Karim I, Rossi-Fedele G, Doğramaci EJ, Dummer PMH*, et al.* Dental patient-reported outcomes in endodontics - A narrative review. J Evid Based Dent Pract 2023, 23(1): 101805. doi:10.1016/j.jebdp.2022.101805.
72. Karimbux N, John MT, Stern A, Mazanec MT, D'Amour A, Courtemanche J*, et al.* Measuring patient experience of oral health care: A call to action. J Evid Based Dent Pract 2023, 23(1s): 101788. doi:10.1016/j.jebdp.2022.101788.
73. Chabrier S, Ozanne A, Naggara O, Boulouis G, Husson B, Kossorotoff M. Hyperacute

recanalization strategies and childhood stroke in the evidence age. Stroke 2021, 52(1): 381-384. doi:10.1161/strokeaha.120.031133.

74. Jaeken K, Cadenas de Llano-Pérula M, Lemiere J, Verdonck A, Fieuws S, Willems G. Reported changes in oral health-related quality of life in children and adolescents before, during, and after orthodontic treatment: A longitudinal study. Eur J Orthod 2019, 41(2): 125-132. doi:10.1093/ejo/cjy035.
75. Campos LA, Peltomäki T, Marôco J, Campos J. Use of Oral Health Impact Profile-14 (OHIP-14) in different contexts. What is being measured? Int J Environ Res Public Health 2021, 18(24). doi:10.3390/ijerph182413412.
76. Ingleshwar A, John MT. Cross-cultural adaptations of the oral health impact profile - An assessment of global availability of 4-dimensional oral health impact characterization. J Evid Based Dent Pract 2023, 23(1s): 101787. doi:10.1016/j.jebdp.2022.101787.
77. Kronenburg A, Deckers PT, van den Berg E, van Schooneveld MM, Vonken EJ, van der Zwan A*, et al.* The profile of cognitive impairment and hemodynamic compromise in moyamoya: A single-center prospective cohort study. J Neurosurg 2023, 138(1): 173-184. doi:10.3171/2022.3.Jns212844.
78. Gonçalves F, Reis A, Inácio F, Morais IS, Faísca L. Reading Comprehension Predictors in European Portuguese Adults. Front Psychol 2021, 12: 789413. doi:10.3389/fpsyg.2021.789413.
79. Nitschke I, Slashcheva L, Jockusch J. Dental Patient-Reported Outcomes in Geriatric Dentistry. J Evid Based Dent Pract (in press).
80. Foster Page LA, Thomson WM, Jokovic A, Locker D. Validation of the Child Perceptions Questionnaire (CPQ 11-14). J Dent Res 2005, 84(7): 649-652. doi:10.1177/154405910508400713.
81. Boy-Lefèvre ML, Razanamihaja N, Azogui-Lévy S, Vigneron A, Jordan L, Berdal A*, et al.* Translation and validation of the French version of the Child Perceptions Questionnaire for children aged from 8 to 10 years old (CPQ 8-10). Health Qual Life Outcomes 2018, 16(1): 86. doi:10.1186/s12955-018-0907-x.
82. Solanke C, John M, Ebel M, Altner S, Bekes K. OHIP-5 for school-aged children. J Evid Based Dent Pract (in press).
83. Wang Y, Qin D, Guo F, Levey C, Huang G, Ngan P*, et al.* Outcomes used in trials regarding the prevention and treatment of orthodontically induced white spot lesions: A scoping review. Am J Orthod Dentofacial Orthop 2021, 160(5): 659-670.e657. doi:10.1016/j.ajodo.2021.04.018.
84. Qin D, Wang Y, Levey C, Ngan P, He H, Hua F. Protocol for the development of a Core Outcome Set for trials on the prevention and treatment of Orthodontically induced enamel White Spot Lesions (COS-OWSL). Trials 2021, 22(1): 507. doi:10.1186/s13063-021-05371-w.
85. Tsichlaki A, O'Brien K, Benson PE, Marshman Z, Johal A, Colonio-Salazar FB*, et al.* Development of a core outcome set for use in routine orthodontic clinical trials. Am J Orthod Dentofacial Orthop 2020, 158(5): 650-660. doi:10.1016/j.ajodo.2020.05.010.
86. Lamont TJ, Clarkson JE. Core outcome sets and dental patient reported outcomes. J Evid Based Dent Pract 2022, 22(1s): 101659. doi:10.1016/j.jebdp.2021.101659.
87. John MT, Omara M, Su N, List T, Sekulic S, Häggman-Henrikson B*, et al.*

Recommendations for use and scoring of Oral Health Impact Profile versions. J Evid Based Dent Pract 2022, 22(1): 101619. doi:10.1016/j.jebdp.2021.101619.

88. John MT. Standardization of dental patient-reported outcomes measurement using OHIP-5 - validation of "Recommendations for use and scoring of Oral Health Impact Profile versions". J Evid Based Dent Pract 2022, 22(1s): 101645. doi:10.1016/j.jebdp.2021.101645.

Table 1. Characteristics of included observational studies (n = 683).

Characteristics	Category	n (%)
Journals	EJO	144 (21.1%)
	PIOR	57 (8.3%)
	AJO-DO	215 (31.5%)
	AO	198 (29.0%)
	OCR	69 (10.1%)
Publication year	2015	126 (18.4%)
	2016	78 (11.4%)
	2017	104 (15.2%)
	2018	93 (13.6%)
	2019	92 (13.5%)
	2020	89 (13.0%)
	2021	101 (14.8%)
Type of research	Cohort study	505 (73.9%)
	Case control study	30 (4.4%)
	Cross-sectional study	148(21.7%)
Statistician involvement	No	585 (85.7%)
	Yes	98 (14.3%)
Type of institution	University	567 (83.0%)
	Private practice	57 (8.3%)
	Others	59 (8.6%)
Geographical origin	Europe	296 (43.3%)
	Asia	157 (23.0%)
	North America	121 (17.7%)
	South America	81 (11.9%)
	Africa	5 (0.7%)
	Oceania	23 (3.4%)
Multiple affiliations	No	112 (16.4%)
	Yes	571 (83.6%)
Funding status	Industry	13 (1.9%)
	Funded by other sources	194 (28.4%)
	Unfunded or unreported	476 (69.7%)
International collaboration	No	462 (67.6%)
	Yes	221 (32.4%)
Overall	-	683 (100%)

EJO: European Journal of Orthodontics; AJO-DO: American Journal of Orthodontics and Dentofacial Orthopedics; PIOR: Progress in Orthodontics; AO: Angle Orthodontist; OCR: Orthodontics & Craniofacial Research.

Table 2. Characteristics of dental patient-reported outcome measures (dPROMs) used in the identified observational studies for assessment of oral health-related quality of life (OHRQoL) (n = 92).

No.	dPROM	Category	Oral Function	Orofacial Pain	Orofacial Appearance	Psychosocial Impact	n (%)
1	Oral Health Impact Profile 14 [OHIP-14][29]	Generic multiple-item	√	√	√	√	20 (21.7%)
2	Child Perceptions Questionnaire for 11–14-year-olds [CPQ 11-14][30]	Generic multiple-item	√	√	√	√	9 (9.8%)
3	Orthognathic Quality of Life Questionnaire [OQLQ-22][31]	Specific multiple-item	√	√	√	√	8 (8.7%)
4	Psychosocial Impact of Dental Aesthetics Questionnaire [PIDAQ][32]	Specific multiple-item			√	√	7 (7.6%)
5	Pain measured with VAS	Single-item		√			7 (7.6%)
6	Analgesic consumption measure with “yes or no”	Single-item		√			4 (4.3%)
7	Child Perceptions Questionnaire for 8–10-year-olds [CPQ 8-10][33]	Generic multiple-item	√	√	√	√	2 (2.2%)
8	Parental-Caregiver Perceptions Questionnaire [P-CPQ][34]	Generic multiple-item	√	√	√	√	2 (2.2%)
9	Dental Impact on Daily Living [DIDL][35]	Generic multiple-item	√	√	√	√	2 (2.2%)
10	Oral Impacts on Daily Performances [OIDP][36]	Generic multiple-item	√			√	2 (2.2%)
11	Children’s Oral Health Impact Profile [COHIP][37]	Generic multiple-item	√	√	√	√	2 (2.2%)
12	Child Oral Health Impact Profile Short Form-19 [COHIP-SF 19][38]	Generic multiple-item	√	√	√	√	2 (2.2%)

13	Food Intake Ability (FIA) test[39]	Generic multiple-item	√				2 (2.2%)
14	Discomfort measured with VAS	Single-item		√			2 (2.2%)
15	Esthetics measured with VAS	Single-item			√		2 (2.2%)
16	Level of Exposure-Dental Experiences Questionnaire [LOE-DEQ][40]	Generic multiple-item		√		√	1 (1.1%)
17	Oral Aesthetic Subjective Impact Score [OASIS][41]	Specific multiple-item			√	√	1 (1.1%)
18	Malocclusion Impact Questionnaire [MIQ][42]	Specific multiple-item	√		√	√	1 (1.1%)
19	Multidimensional Pain Inventory [MPI-Orthodontic][43]	Specific multiple-item		√		√	1 (1.1%)
20	Short Dental Anxiety Inventory [S-DAI][44]	Generic multiple-item				√	1 (1.1%)
21	Nasal Obstruction and Septoplasty Effectiveness Scale [NOSE][45]	Specific multiple-item	√				1 (1.1%)
22	Quality-of-Life Adolescents Cleft Questionnaire [QoLAdoCleft][46]	Specific multiple-item	√	√	√	√	1 (1.1%)
23	Royal College of Surgeons' Questionnaire [RCS][47]	Specific multiple-item				√	1 (1.1%)
24	Modified Helkimo's Anamnestic Index[48]	Specific multiple-item	√	√			1 (1.1%)
25	Bowman's Questionnaire (2013)[49]	Specific multiple-item	√	√	√	√	1 (1.1%)

26	Feldmann's Questionnaire (2007)[50]	Specific multiple-item	√	√			1 (1.1%)
27	Czochrowska's Questionnaire (2002)[51]	Specific multiple-item		√			1 (1.1%)
28	Bayat's Questionnaire (2016)[52]	Specific multiple-item	√			√	1 (1.1%)
29	Arqub's Questionnaire (2021)[53]	Specific multiple-item		√			1 (1.1%)
30	Masticatory ability measured with VAS	Single-item	√				1 (1.1%)
31	Oral burning measured with VAS	Single-item			√		1 (1.1%)
32	Esthetics measured with LS	Single-item			√		1 (1.1%)
33	Comfort measured with LS	Single-item		√			1 (1.1%)

VAS, Visual Analogue Scale; LS, Likert Scale.

Figure Legends

Figure 1. The flow chart of study selection.

Footnote: RCT: randomized controlled trial; dPROs: dental patient-reported outcomes; dPROMs: dental patient-reported outcome measures.

Figure 2. Temporal trend among the included observational studies in international collaboration (A), journal distribution (B) and geographical distribution (C).

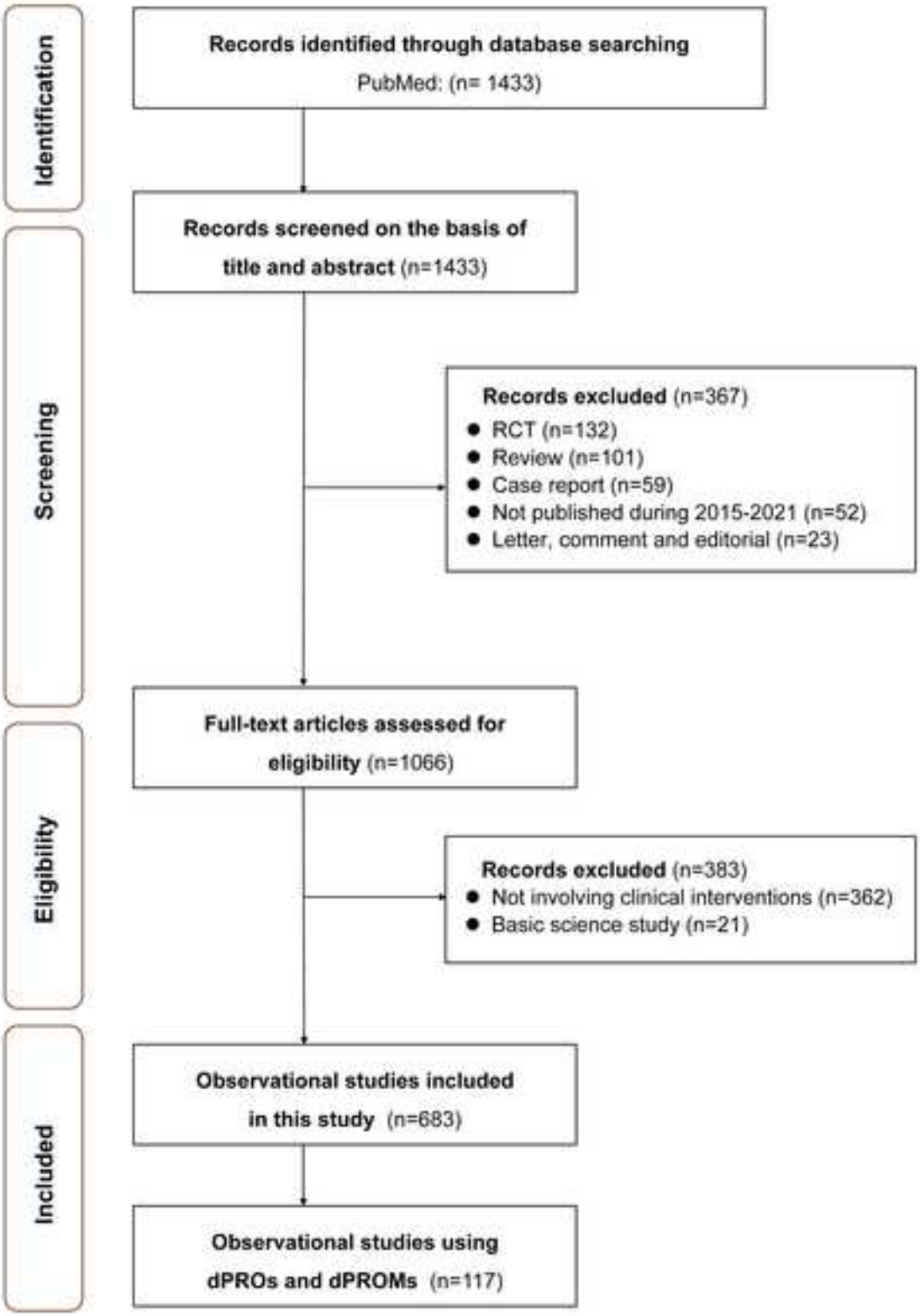
Footnote: EJO, European Journal of Orthodontics; PIOR, Progress in Orthodontics; AJO-DO, American Journal of Orthodontics and Dentofacial Orthopedics; AO, Angle Orthodontist; OCR, Orthodontics & Craniofacial Research.

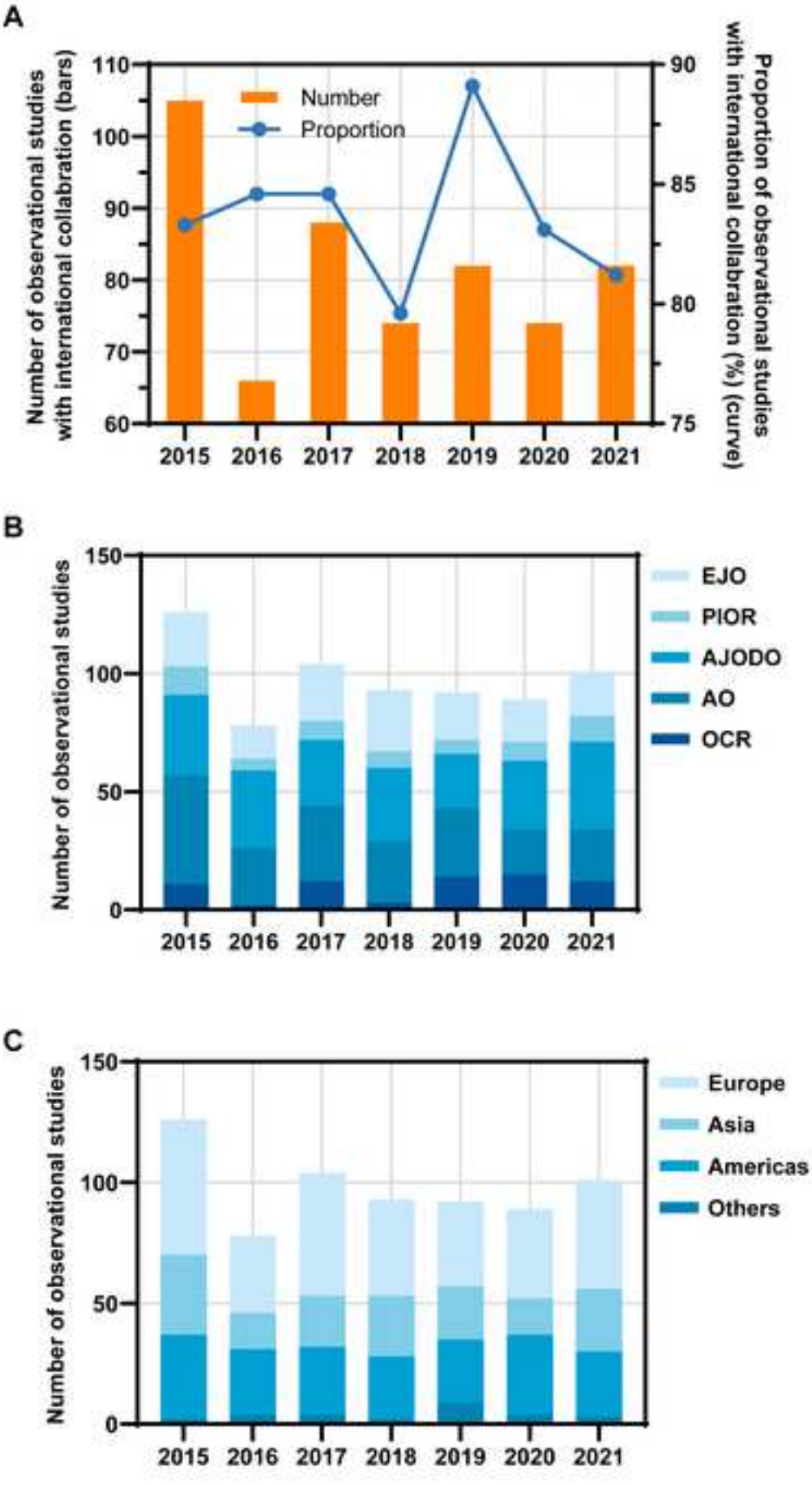
Figure 3. The number of included observational studies and the corresponding proportion with dental patient-reported outcomes (dPROs) by journal (A), publication year (B), geographical origin (C), and type of research (D).

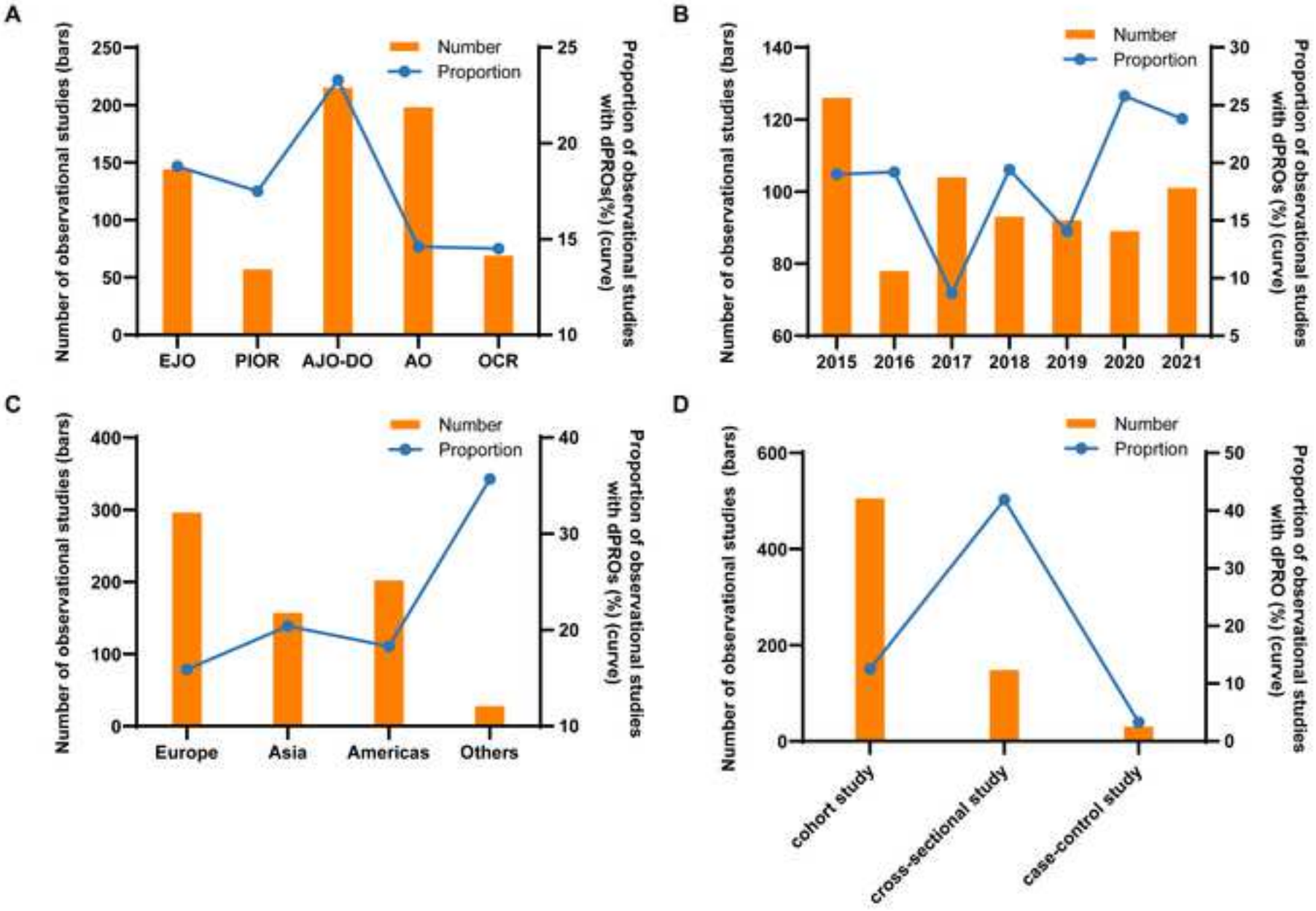
Footnote: EJO, European Journal of Orthodontics; PIOR, Progress in Orthodontics; AJO-DO, American Journal of Orthodontics and Dentofacial Orthopedics; AO, Angle Orthodontist; OCR, Orthodontics & Craniofacial Research.

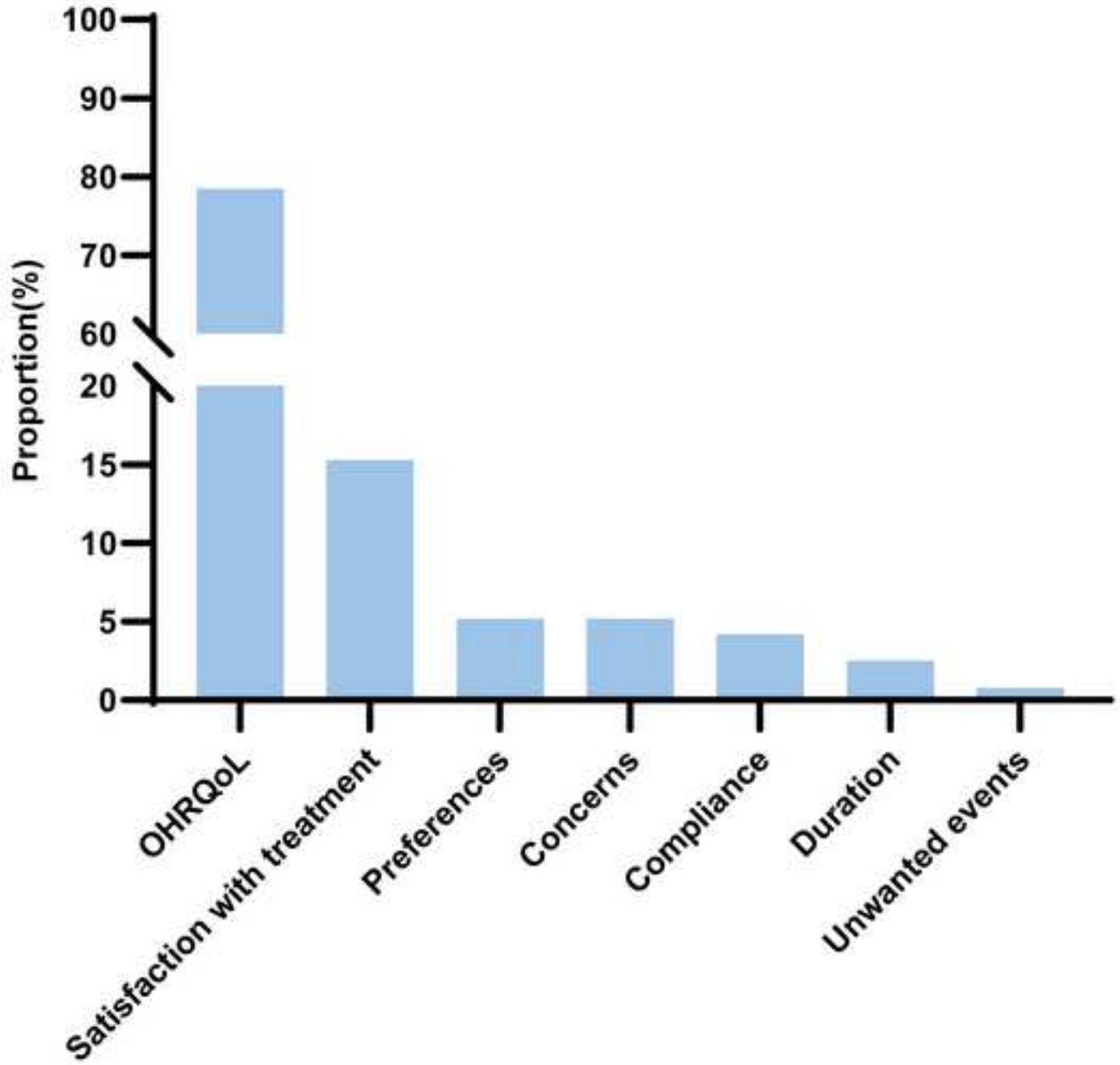
Figure 4. Proportion of identified dental patient-reported outcomes (dPROs).

Footnote : OHRQoL, oral health-related quality of life.


Identification
Records identified through database searching
PubMed: (n= 1433)
Screening
Records screened on the basis of title and abstract (n=1433)
Records excluded (n=367)
RCT (n=132)
Review (n=101)
Case report (n=59)
Not published during 2015-2021 (n=52)
Letter, comment and editorial (n=23)
Eligibility
Full-text articles assessed for eligibility (n=1066)
Records excluded (n=383)
Not involving clinical interventions (n=362)
Basic science study (n=21)
Included
Observational studies included in this study (n=683)
Observational studies using dPROs and dPROMs (n=117)


A
Number of observational studies with international collabration (bars)
Proportion of observational studies with international collabration (%) (curve)
Number
Proportion
110
100
90
80
70
60
90
85
80
75
2015
2016
2017
2018
2019
2020
2021
B
Number of observational studies
150
100
50
0
EJO
PIOR
AJODO
AO
OCR
2015
2016
2017
2018
2019
2020
2021
C
Number of observational studies
150
100
50
0
Europe
Asia
Americas
Others
2015
2016
2017
2018
2019
2020
2021


A
Number of observational studies (bars)
Proportion of observational studies with dPROs(%) (curve)
Number
Proportion
250
200
150
100
50
0
25
20
15
10
EJO
PIOR
AJO-DO
AO
OCR
B
Number of observational studies (bars)
Proportion of observational studies with dPROs (%) (curve)
Number
Proportion
140
120
100
80
60
30
25
20
15
10
5
2015
2016
2017
2018
2019
2020
2021
C
Number of observational studies (bars)
Proportion of observational studies with dPROs (%) (curve)
Number
Proportion
400
300
200
100
0
40
30
20
10
Europe
Asia
Americas
Others
D
Number of observational studies (bars)
Proportion of observational studies with dPRO (%) (curve)
Number
Proprtion
600
400
200
0
50
40
30
20
10
0
cohort study
cross-sectional study
case-control study


100
90
80
70
60
20
15
10
5
0
Proportion(%)
OHRQoL
Satisfaction with treatment
Preferences
Concerns
Compliance
Duration
Unwanted events