Review Article

Dentists' knowledge, attitudes and perceptions of antibiotic prescribing: A systematic review

Olalla Vázquez-Cancela [a,b], Maruxa Zapata-Cachafeiro [a,c,d,*], Maria Teresa Herdeiro [e], Adolfo Figueiras [a,c,d], Almudena Rodríguez-Fernández [a,c,d]

[a] Department of Preventive Medicine and Public Health, University of Santiago de Compostela, 15782 Santiago de Compostela, Spain
[b] Department of Preventive Medicine, Santiago de Compostela University Teaching Hospital, Santiago de Compostela, Spain
[c] Consortium for Biomedical Research in Epidemiology & Public Health (CIBER en Epidemiología y Salud Pública-CIBERESP), Santiago de Compostela, Spain
[d] Institute of Health Research of Santiago de Compostela, Santiago de Compostela, Spain
[e] Department of Medical Sciences, iBiMED-Institute of Biomedicine, University of Aveiro, Aveiro, Portugal

ARTICLE INFO

Keywords:
Antibiotic
Dentist
Prescribing
Knowledge
Attitudes
Perception

ABSTRACT

Objective: This study aims to explore dentists' knowledge, attitudes, and perceptions regarding antibiotic use.
Methods: We conducted a systematic review of dentists' knowledge, attitudes and perceptions regarding antibiotic use, by searching the MEDLINE, EMBASE and Web of Science for all original paper published from January 1990 to July 2023, in accordance with the Preferred Reporting Items for systematic Reviews and Meta-analyses (PRISMA 2020) guidelines.
Results: The review included 37 papers, (7 qualitative and 30 quantitative studies). Modifiable factors (knowledge, attitudes) were reported as being associated with antibiotic prescribing by dentists which were cited in 30 of the 37. These attitudes most frequently identified by dentists were: complacency (22/29); lack of trust (16/29); the need to postpone the dental procedure (17/29); and fear (8/29). Gaps in knowledge were also identified (15/29). Only one of the included articles quantified the influence between the reported modifiable factors and antibiotic prescribing.
Conclusions: The review emphasizes that dentists' antibiotic prescribing is predominantly influenced by modifiable factors. This insight informs the potential for targeted interventions to curtail inappropriate antibiotic use, contributing to global efforts in reducing antibiotic resistance.
The protocol of this systematic review can be found in PROSPERO under registration no. CRD42021253937.

1. Introduction

Antibiotic resistance is one of the most serious threats to public health worldwide, by increasing morbidity and mortality rates, prolonging hospital stays, and raising healthcare costs (Jonas et al., 2017). A recent study estimates that antibiotic resistance was responsible for 1.2 million deaths in 2019. (University of Oxford, 2022) Also, it has been estimated that it could account for as much as $3 trillion of lost gross domestic product by 2050 (Naylor et al., 2018). Excessive and inappropriate antibiotic use is one of the main factors that influences the advance of such resistance (Laxminarayan, 2021), and health professionals play an essential role in correct antibiotic use, not only in terms of prescribing and dispensing, but also in terms of educating patients in responsible use (Sanchez et al., 2019).

Dentists likewise play an important role in antibiotic prescribing, since they are responsible for around 10% of total antibiotics (Johnson

and Hawkes, 2014), twice as much as hospital emergency services (Hicks et al., 2015). Although indications for prescribing antibiotics in dentistry are generally very limited, many studies nonetheless indicate that their use is far more widespread, so much so that for some situations in dentistry, antibiotics may be inappropriately prescribed in as many as 80% of cases, (Cope et al., 2016).

To improve antibiotic prescribing by dentists, it is important to identify the factors that influence overprescribing. A previous systematic review published by Thomson et al. in 2019 identified factors associated with antibiotic prescribing in adults with acute conditions across primary care, including dentists (Thompson et al., 2019). However, there were no systematic reviews conducted on these healthcare professionals that specifically identified modifiable factors, such as knowledge, attitudes and perceptions, responsible for inappropriate or unnecessarily (Ministerio de Sanidad, 2020) antibiotic prescribing by dentists, regardless of the type of clinical activity they perform or the pathology they treat. (Ministerio de Sanidad, 2020). The aim of the study was therefore to identify dentists' knowledge, attitudes and perceptions with regard to antibiotic use in dentistry, and the relationship between these and inappropriate prescribing.

2. Methods

2.1. Search strategy

For review purposes, we conducted a search of the MEDLINE-PubMED scientific database, EMBASE and Web of Science for all original papers published from January 1990 to July 2023.

The search criteria used were as follows: (attitud* or knowledge* or perception* or practice* or determinant* or factor* or barrier* or facilitators*) and (dentist* or odontolog* or dental practicioner or dental practice) and (antibiotic* or antimicrobial* or antibacterial*) was imposed.

The review was performed in accordance with the Preferred Reporting Items for systematic Reviews and Meta-analyses (Page et al., 2021) guidelines (Appendix A). The protocol of this systematic review can be found in PROSPERO under registration no. CRD42021253937.

2.2. Inclusion and exclusion criteria

Original articles were deemed eligible for review if they met the following criteria: (i) the target population had to include dentists. In those cases where the study population included non-dentists (physicians, students of dentistry, etc.), data were solely extracted from dentists, if the results were given as a whole, the article was excluded; (ii) they analysed antibiotic prescribing, and if any other drugs were included, only data on antibiotics were extracted, if the results were given as a whole, the article was excluded; (iii) in terms of outcome measures, studies had to measure knowledge and perceptions and/or attitudes to antibiotic prescribing and/or resistance.

Studies focusing on the prescription of antibiotics for prevention of endocarditis were excluded, since it was felt that the specific characteristics of this group could distort the joint analysis and this disease should therefore be analysed separately. Similarly, studies whose aim was the description of a single clinical report, were also excluded.

2.3. Quality assessment

To evaluate the quality of the studies selected for inclusion, two quality assessment tools were used, i.e., for qualitative studies, the Consolidated criteria for Reporting Qualitative research (COREQ checklist) (Tong et al., 2007), and for quantitative studies, the appraisal tool for cross-sectional studies (AXIS) (Downes et al., 2016). Working separately, two authors (AR and OV) assessed the quality of the studies included: any difference of opinion was resolved by discussion, and where no agreement was reached, a third author (MZ) took the final

decision. The use of these tools brings quality to our review, in that they evaluate whether a given study's published conclusions are credible and reliable on the basis of its stated objectives, methods and results (Appendix B).

2.4. Data-extraction and analysis

All data were drawn from original studies. Two of the authors (AR, OV), acting separately, screened the titles and abstracts of the retrieved studies to assess their eligibility. Following this initial screening, they independently reviewed the full texts to ensure the studies met the eligibility criteria and extracted the relevant data from those selected. Any disagreements between the two reviewers during the full-text screening or data extraction were resolved through consensus by two additional reviewers (MZC and AF). Data extraction from the relevant research studies was conducted independently, applying the following process:

For every study included in the review, the following parameters and characteristics were recorded: author; year of publication; country; study population; year of data-collection; sample size; and data-collection and quality assessment methods. Two data-extraction sheets were completed by applying the following process:

1. Socio-demographic characteristics: age, gender, and years of experience. In papers that furnished quantitative results, we summarised the socio-demographic factors that indicated a statistically significant relationship (p-value <0.05) with antibiotic prescribing (direct, indirect, or no-relationship but tested).
2. Knowledge: data on dentists' knowledge about antibiotics was summarised and classified as follows: (i) 1st choice of prescription drug; (ii) data-sources used for updating; and, (iii) disorders, conditions, field of knowledge and the percentage of cases in which antibiotics were indicated by dentists.
3. Attitudes and perceptions: data were collected on situations and factors acknowledged by dentists as having an influence on their antibiotic prescribing behaviour. Attitudes and perceptions: data were collected on situations and factors acknowledged by dentists as having an influence on their antibiotic prescribing behaviour. To enable correct classification, Table 1 was previously drawn up with pre-defined ideas based on other published systematic reviews, (Lopez-Vazquez et al., 2012; Servia-Dopazo and Figueiras, 2018) to which additional ideas not initially included were subsequently added by consensus among all authors.
4. Patterns of clinical practice: data were collected for main disorders for which dentists prescribed antibiotics.

Any discrepancy or non-defined attitudes identified when extracting the data were evaluated by a panel of experts (clinical pharmacologists, psychologists, dentists, public health experts, pharmaco-epidemiologists) with experience in studies on attitudes and knowledge about antibiotics.

3. Results

3.1. Search results

The search strategy identified 10,531 papers. After elimination of duplicates, 7687 papers remained in the MEDLINE-PubMed scientific database, EMBASE and Web of Science, which were screened by title and abstract. Of this initial number, 73 papers were subjected to an in-depth reading of the full text, and of these, a total of 37 were finally included for systematic review purposes (Fig. 1). (Agossa et al., 2021; Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Khatib and Almohammad, 2022; Al-Sebaei and Jan, 2016; Alzouri et al., 2020; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Battellino and Bennun, 1993; Baudet et al., 2020; Böhmer et al., 2021; Cope et al.,

Table 1
Attitudes and perceptions that may influence antibiotic prescription in dentistry.

Attitudes	Situation	Definition
Complacency	PE: Patient expectations	Prescription of antibiotics to fulfil patient expectations
Confidence	RF: Risk factors	Prescription of antibiotics due to the risk/comorbidities or social background factors presented by the patient
	UD: Uncertain diagnosis	Prescription of antibiotics due to ignorance/doubts about the patient's treatments
Need to delay treatment[a]	DT: Delay treatmetn	Prescription of antibiotics due to the need to delay treatment because of: Time pressure/schedule Patient (time to accept intervention, vacations)
Fear	F: Fear	Prescription of antibiotics due to fear of: Complications in the patient's pathology Poor internet reviews Medico-legal complication
Economic benefit	EB: Economic benefit	Prescription of antibiotics with a view to economic benefit (pleasing the patient, avoiding conflict)
Responsibility of others	ER: External responsibility	Consider other professionals as responsible for the problem, or not a sufficiently high amount of prescriptions to be regarded as a problem of their own.
	N: New antimicrobial development	Solution in the development of new drugs

Perception	Situation	Definition
Interested	GC: Global concern	Consider the advance of resistance as a global concern
	IR: Important role	Consider that dentists play an important role in the development of resistance
	IU: Interested in updates	Interest in updates

[a] Not pre-defined attitudes.

2014; Coric et al., 2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Dormoy et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Mainjot et al., 2009; Mansour et al., 2018; Mauffrey et al., 2016; Mazzaglia et al., 2002; Oliveira and Guerreiro, 2017; Palmer et al., 2001; Patait et al., 2015; Pisarnturakit et al., 2020; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023; Salako et al., 2004; Sivaraman et al., 2013; Sturrock et al., 2018; Tanwir et al., 2013,Teoh et al., 2019; Thompson et al., 2020; Vessal et al., 2011; Zhuo et al., 2018)

3.2. Quality assessment

Table 2 shows the items which each paper does not fulfilled on the AXIS checklist (Downes et al., 2016) and COREQ (Tong et al., 2007), depending on the tool used in accordance with the methodology of the paper.

All the quantitative studies were considered suitable for study purposes, since they complied with most of the AXIS questions: only 6 of the 30 papers failed to meet more than half of the proposed criteria (Al-Huwayrini et al., 2013; Battellino and Bennun, 1993; Demirbas et al., 2006; Jones and Cope, 2018; Mazzaglia et al., 2002; Patait et al., 2015). AXIS scale points numbers 3 (justification of sample size), 6 (representative selection of participants), 7 (measures to address non-responders), 13 (bias in response rate) and 14 (information about non-responders) were the least represented, being absent in 17/30, 20/30, 25/30, 25/30 and 29/30 papers respectively (Table Appendix B).

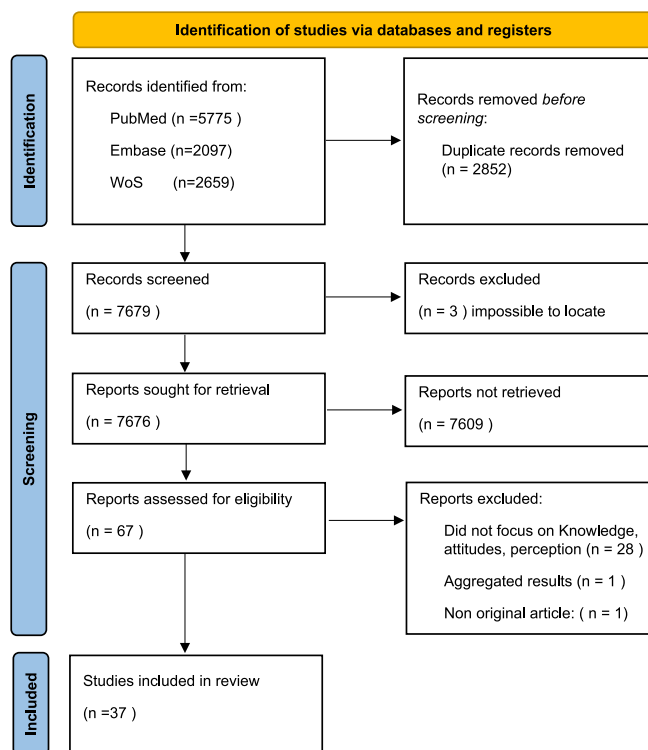The qualitative studies (Böhmer et al., 2021; Cope et al., 2014;

Fig. 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only.

Dormoy et al., 2021; Mauffrey et al., 2016; Oliveira and Guerreiro, 2017) included in this review also displayed quality, in that they complied with most of the COREQ items (Appendix B).

3.3. Characteristics of selected studies

The general characteristics of the selected studies are summarised in Table 2. As will be seen, the number of papers published on antibiotic prescribing factors in dentistry has risen over time, with a growing interest in knowledge, attitudes and perceptions in recent years.

The studies were drawn from five different continents, though mainly from Europe (Agossa et al., 2021; Baudet et al., 2020; Böhmer et al., 2021; Cope et al., 2014; Coric et al., 2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Dormoy et al., 2021; Jones and Cope, 2018; Mainjot et al., 2009; Mauffrey et al., 2016; Mazzaglia et al., 2002; Oliveira and Guerreiro, 2017; Palmer et al., 2001; Köhler et al., 2013; Rodríguez-Fernández et al., 2023; Sturrock et al., 2018; Thompson et al., 2020) ($n = 18/37$) and Asia (Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Khatib and Almohammad, 2022; Al-Sebaei and Jan, 2016; Alzouri et al., 2020; Baskaradoss et al., 2018; Halboub et al., 2016; Mansour et al., 2018; Patait et al., 2015; Pisarnturakit et al., 2020; Salako et al., 2004; Tanwir et al., 2013; Vessal et al., 2011) ($n = 13/37$), with three having been conducted in America (del Angarita-Díaz et al., 2021; Battellino and Bennun, 1993; Sivaraman et al., 2013) and two in Oceania (Teoh et al., 2019; Zhuo et al., 2018), and one in Africa (Ramandan et al., 2019).

Seven studies were qualitative (Böhmer et al., 2021; Cope et al., 2014; Dormoy et al., 2021; Mauffrey et al., 2016; Oliveira and Guerreiro, 2017; Teoh et al., 2019; Thompson et al., 2020) and relied on the semi-structured interview technique. The remaining 30 studies used quantitative methodology by means of the distribution of questionnaires, (Agossa et al., 2021; Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Khatib and Almohammad, 2022; Al-Sebaei and Jan, 2016; Alzouri et al., 2020; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Battellino and Bennun, 1993; Baudet et al., 2020; Coric et al.,

Table 2
Methodological and quality characteristics of the paper selected.

Author (year)	Country	Study population	Year data collected	Sample size	% response rate	Data collection	Lack of points by appraisal tool: Axis; *CoreQqualitative (Total points[a])
Rodríguez-Fernández et al. (2023)	Spain	Dentist	2021	1191*	3.1	Online questionnaire	7,13,14 (17)
D'Ambrosio et al. (2022)	Italy	Dentist	2021	665	58.3	Online questionnaire	6,7,13,14 (16)
Al-Khatib and Almohammad (2022)	Jordan	Dentist	2020-2021	345	–	Online questionnaire	3, 7,13,14 (16)
Böhmer et al. (2021)	Germany	Dentist	–	18	–	Qualitative (open-ended in depth interviews and focus group discussion)	*2,4,13,18,23,28 (26)
Dormoy et al. (2021)	France	Dentist	2019-2020	40	50.0	Qualitative face-to-face interview	*2,3,4,13,18,23,28 (25)
Agossa et al. (2021)	France	Dentist (GDP[b] and "specialize/oriented in periodontology")	2019/2020	272	15.5	Questionnaire (hand out/online)	6,7,13,14 (16)
Baudet et al. (2020)	France	Dentist	2016-2018	455	1.1	Online questionnaire	3,5,6,7,9,10,14 (13)
Alzouri et al. (2020)	Saudi Arabia	Dentist	–	185	57.3	Self-administrated questionnaire and online	3,6,7,13,14,18 (14)
Coric et al. (2020)	Bosnia and Herzegovina and Croatia	Dental specialists, residents and GDP	2017	115	97.5	Online questionnaire	3,5,6,7,13,14,18 (13)
Thompson et al. (2020)	England	Dentists	2017-2018	10-11	–	Ethnographic observations and telephone interview	*4,13,15,23,28 (27)
Pisarnturakit et al. (2020)	Thailand	Dentist	2018	588	5.8	Online questionnaire	7,10,13,14,18 (15)
del Angarita-Díaz et al. (2021)	Colombia	Dentist	2018-2019	700	–	Questionnaire(visit)	6,7,10,13,14,15 (14)
Ramandan et al. (2019)	Sudan	Dentist	2011	100	74.1	Self-administrated questionnaire (convenience sample)	6,7,11,12,13,14,16 (13)
Teoh et al. (2019)	Australia	Dentist	2018	15	79.0	Qualitative semi-structured interview	*20,23,25,27 (28)
Baskaradoss et al. (2018)	Saudi Arabia	Dentist	2017	282	79.3	Questionnaire (distributed by hand)	13,14,18 (17)
Jones and Cope (2018)	Wales	Dentist (recient graduate)	2016	71	78.9	Questionnaire (upon request)	3,6,7,13,14,18 (6)
Mansour et al. (2018)	Lebanon	Dentist	2017	322	21.0	Telephone questionnaire	10,13 (18)
Zhuo et al. (2018)	Australia	Dentist	2016	380	2.3	Online questionnaire	3,5,6,7,14 (15)
Sturrock et al. (2018)	England and Portugal	Dentist	2016	275	11.9	Audit-tool of prescriptions and questionnaire	3,4,6,7,10,11,13,14 (12)
Oliveira and Guerreiro (2017)	Portugal	Dentist	–	14	–	Qualitative (semi-structured interview)	*1,13,20,23,25,28 (26)
Al-Sebaei and Jan (2016)	Saudi Arabia	Dentist (GDP[b] and DS[c])	2014	150	50.0	Questionnaire (distributed by hand)	3,6,7,13,14 (15)
Halboub et al. (2016)	Saudi Arabia	Dentist	2015	373	9.4	Online questionnaire	3,6,7,13,14 (15)
Mauffrey et al. (2016)	France	Dentist	2015.	6	20.0	Qualitative (semi-structured interview)	* 9,20,23 (29)
Patait et al. (2015)	–	Faculty members	–	42	99.0	Questionnaire	2,3,4,5,6,7,9,10,11,12,13,14,16,17,18,20 (4)
Cope et al. (2014)	Wales	Dentist	2013	19	–	Qualitative (semi-structured interview by telephone)	*6,7,10,13,14 (27)
Al-Huwayrini et al. (2013)	Saudi Arabia	Dentist (GDP and DS[c])	2010	303	79.7	Questionnaire (visit)	3,5,6,7,10,11,12,13,14,16 (10)
Sivaraman et al. (2013)	USA	Pediatric dentist	–	987	21.0	Online questionnaire	3,6,7,10,11,13,14,16,20 (11)
Tanwir et al. (2013)	Pakistan	Dentist of the outpatient department	2013	85	–	Questionnaire (visit)	2,3,7,8,9,13,14,16 (12)
Köhler et al. (2013)	Switzerland	Dentist	2008-2009	800	20.1	Questionnaire (mail)	3,5,6,7,9,10,11,13,14 (11)

Table 2 (*continued*)

Author (year)	Country	Study population	Year data collected	Sample size	% response rate	Data collection	Lack of points by appraisal tool: Axis; *CoreQqualitative (Total points[a])
Vessal et al. (2011)	Iran	Dentist	2006	219 (400)	48.6	Questionnaire (postal mail)	4,6,7,14,20 (15)
Demirbas et al. (2006)	Norway	Dentist	2004	313	66.5	Questionnaire (mail)	3,5,6,7,9,10,11,14,16,18,20 (9)
Mainjot et al. (2009)	Belgium	Dentist (accredited by the Belgian social security office)	2004	268	89.3	Questionnaire (record information about antibiotic prescriptions for 2 weeks)	3,7,9,10,13,14 (14)
Al-Haroni and Skaug (2006)	Yemen	Dentist	2004	181 (150)	64.6	Questionnaire (distributed by hand)	3,5,6,7,10,13,14,20 (12)
Salako et al. (2004)	Kuwait	Dentist	–	168	84.0	Questionnaire (postal mail)	3,5,6,7,11,13,14,18,20 (11)
Mazzaglia et al. (2002)	Italy	Dentist	1998-99	33	37.9	Questionnaire (postal mail)	3,4,5,6,7,9,13,14,18,20 (10)
Palmer et al. (2001)	England. Scotland	Dentist	–	2216	60.4	Questionnaire (postal mail)	3,7,11,13,14,16,20 (13)
Battellino and Bennun (1993)	Argentine	Dentist	1990	285	100.0	Questionnaire	5,6,7,8,9,10,12,13,14,16,18,20 (8)

[a] Total of net points in Axis or CoreQ (positive points minus negative points) maximum achievable points: Axis (21), COREq. (23).

[b] General dental practitioner; [c] Dental surgery.

2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Halboub et al., 2016; Jones and Cope, 2018; Köhler et al., 2013; Mainjot et al., 2009; Mansour et al., 2018; Mazzaglia et al., 2002; Palmer et al., 2001; Patait et al., 2015; Pisarnturakit et al., 2020; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023; Salako et al., 2004; Sivaraman et al., 2013; Sturrock et al., 2018; Tanwir et al., 2013; Vessal et al., 2011; Zhuo et al., 2018) which ranged from online questionnaires in nine (Al-Khatib and Almohammad, 2022; Baudet et al., 2020; Coric et al., 2020; D'Ambrosio et al., 2022; Halboub et al., 2016; Pisarnturakit et al., 2020; Rodríguez-Fernández et al., 2023; Sivaraman et al., 2013; Zhuo et al., 2018), to postal questionnaires in six (Demirbas et al., 2006; Köhler et al., 2013; Mazzaglia et al., 2002; Palmer et al., 2001; Salako et al., 2004; Vessal et al., 2011), manually-distributed questionnaires in six, (Tanwir et al., 2013; Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Sebaei and Jan, 2016; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018) a telephone questionnaire in one (Mansour et al., 2018) and a combination of manually-distributed and online questionnaires in another two (Agossa et al., 2021; Alzouri et al., 2020). In the remaining six articles, information on the type of questionnaire was not provided or was incomplete (Battellino and Bennun, 1993; Jones and Cope, 2018; Mainjot et al., 2009; Patait et al., 2015; Ramandan et al., 2019; Sturrock et al., 2018).

Sample sizes ranged from 33 to 2216 dentists in the quantitative studies (Mazzaglia et al., 2002; Palmer et al., 2001) to 6-40 dentists in the qualitative studies. (Cope et al., 2014; Dormoy et al., 2021) The response rate also varied widely: while some studies did not furnish these data, (Battellino and Bennun, 1993; Oliveira and Guerreiro, 2017; Pisarnturakit et al., 2020) others reported percentages ranging from 1.1% to 100% (Battellino and Bennun, 1993; Baudet et al., 2020).

The study population consisted of general and specialist dentists drawn from both the private and public health systems. Questionnaires were exclusively applied to pediatric dentists in one study (Sivaraman et al., 2013) and to dental faculty members in another (Patait et al., 2015).

3.4. Socio-demographic characteristics

As shown in Table 3, a total of fourteen studies used questionnaire-based scores (Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Demirbas et al., 2006; Halboub et al., 2016; Mansour et al., 2018; Palmer et al., 2001; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023; Salako et al.,

2004; Tanwir et al., 2013; Vessal et al., 2011) to analyse whether socio-demographic factors (age, sex and experience) had an influence on knowledge/quality in antibiotic prescribing. Only three studies observed statistically significant differences by sex, with two reporting better scores in women (Baskaradoss et al., 2018; Halboub et al., 2016) and one reporting a better score in men. (Al-Haroni and Skaug, 2006) When analysed by age, three studies reported better scores in older dentists (Alzouri et al., 2020; Palmer et al., 2001; Salako et al., 2004). One study reported better scores among dentists who attended Continuing Professional Development courses (Palmer et al., 2001). One article analysed the influence between socio-demographic factors and the quality of antibiotic prescribing with better results in dentist with <30 years of experience (Rodríguez-Fernández et al., 2023).

3.5. Knowledge and sources of information regarding antibiotic use and resistance

In all articles the knowledge of dentists was explored through at least one or several clinical situations or scenarios, except for 3 cases: in one case only knowledge of pharmacology was investigated (Battellino and Bennun, 1993). In other two articles besides practical questions, issues on pharmacology (Al-Huwayrini et al., 2013) and on microbiology (Al-Sebaei and Jan, 2016) were included.

The percentage of correct replies to questions on knowledge in the questionnaires varied across studies, ranging from correct replies in only 13.1% (Baudet et al., 2020) to correct replies in 94% of those surveyed (Pisarnturakit et al., 2020). Only seven studies reported a percentage of correct replies higher than 75% for some of the questions (Agossa et al., 2021; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Baudet et al., 2020; Pisarnturakit et al., 2020; Rodríguez-Fernández et al., 2023; Salako et al., 2004), while in five studies the percentage of correct replies was below 30% (Table 3) (Al-Haroni and Skaug, 2006; Baskaradoss et al., 2018; Baudet et al., 2020; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023).

Table 3 also shows the sources of antibiotic data and updates identified by dentists as being the most used: ten papers cited Continuing Professional Development courses as the most popular choice (Al-Sebaei and Jan, 2016; Baskaradoss et al., 2018; Baudet et al., 2020; Cope et al., 2014; D'Ambrosio et al., 2022; Halboub et al., 2016; Jones and Cope, 2018; Köhler et al., 2013; Mainjot et al., 2009; Sivaraman et al., 2013), eight studies cited National Guidelines, (Baudet et al., 2020; Coric et al., 2020; D'Ambrosio et al., 2022; Jones and Cope, 2018; Oliveira and

Table 3

Factors identified as influencing of antibiotic prescription in dentistry.

Author (year)	Sociodemographic characteristics	Correct answer %	Field of knowledge	Information	Knowledge autoperception	Attitudes	Perceptions	Antibiotics first choice
Rodríguez-Fernández et al. (2023)	=G, E↓	28.1-93.3	Clinical situation	–	–	PE, F(cp), DT(s), ER, EB	GC, IR	–
D'Ambrosio et al. (2022)	–	–		NG, CPD, SC, JA, IG, co	–	PE, RF, DT (pa), F (ml)	GC, IR	–
Al-Khatib and Almohammad (2022)	–	–		–	KA	PE	–	Amoxicilin
Böhmer et al. (2021)	–	–		–	KI	DT (s, pa, em), F (ml)	–	–
Dormoy et al. (2021)	–	–		–	–	PE, DT (pa, em), F (or, ml), ER	GC	Amoxicilin
Agossa et al. (2021)	–	77.2	Clinical situation	–	–	-	–	Amoxicilin
Baudet et al. (2020)	–	13.1-89.3	Clinical situation	NG, CPD, SC	KI	PE, RF	GC, IR, IU	Amoxicilin/ clindamycin
Alzouri et al. (2020)	=G, E↑	–		UG, JA	–	PE, UD	IU	Amoxicilin
Coric et al. (2020)	–	–		IG, NG	KA	ER, N	GC, IU	–
Thompson et al. (2020)	–	–		–	–	PE, UD, DT (s, pa, em), F (Cp, or, ml), ER, EB	GC, IR	–
Pisarnturakit et al. (2020)	–	50.0-94.0	Clinical situation	NG	KI	–	GC, IR, IU	–
del Angarita-Díaz et al. (2021)	–	91.7	Clinical situation	UG, IG, co	–	PE, DT (s)	GC	Amoxicilin
Ramandan et al. (2019)	=A, =G, =E	–		IG, NG	KA	PE	–	Metronidazole
Teoh et al. (2019)	–	–		NG	KI	PE, RF, F (or, ml), UD, DT (pa, s, e), ER	–	Amoxicilin/ clindamycin
Baskaradoss et al. (2018)	=A, ↑GF, =E	33.5-85.5	Clinical situation	CPD	-	PE, RF, DT (pa, s), UD	–	Amoxicilin/ clindamycin
Jones and Cope (2018)	–	–		NG, UG, CPD	KA	PE, RF, DT (pa, s), UD	GC, IR	–
Mansour et al. (2018)	=A, =G, =E	18.8	Clinical situation	–	–	PE, RF	GC, IR	Penicilin/ Spiramicin and metronidazole
Zhuo et al. (2018)	–	–		–	–	F (Cp), DT (pa, s)	IR	–
Sturrock et al. (2018)	–	–		–	–	PE, RF DT (pa, s),	–	Amoxicilin
Oliveira and Guerreiro (2017)	–	–		NG, co	–	PE, F(Cp), EB, ER	IR	–
Al-Sebaei and Jan (2016)	–	65.9 63.0	Clinical situation microbiology	CPD	–	RF	IR	Amoxicilin+ clavulanic acid
Halboub et al. (2016)	↑gf	69.0	Clinical situation	CPD	–	PE, RF, DT (pa, s), UD	–	Amoxicilin+ clavulanic acid
Mauffrey et al. (2016)	–	–		–	–	F(Cp)	–	-
Patait et al. (2015)	–	–		–	–		–	Amoxicilin+ clavulanic acid
Cope et al. (2014)	–	–		CPD, UG, JA	–	PE, DT (pa), ER, N	–	–
Al-Huwayrini et al. (2013)	=E	89.4* 67.7*	Clinical situation pharmacology	–	–	RF	–	–
Sivaraman et al. (2013)	–	–		JA, CPD, co	–	–	GC	Amoxicilin
Tanwir et al. (2013)	=A, =G, E↓	39.0	Clinical situation		–	–	GC	–
Köhler et al. (2013)	–	–		CPD, SC, IG, JA, I, co	–	PE, UD, DT(em)	IU	–
Vessal et al. (2011)	=G, =CPD	65.0	Clinical situation		–	PE	–	Amoxicilin/ erythromycin
Demirbas et al. (2006)	–	–			–	RF	–	Amoxicilin/ clindamycin
Mainjot et al. (2009)	–	–		Co, CPD	KA	PE	IR	Amoxicilin/ macrolides
Al-Haroni and Skaug (2006)	=A, ↑GM	34.0-65.0	Clinical situation	–	–	PE, RF, DT (pa, s), UD	–	Penicillin
Salako et al. (2004)	=A, =G, E ↑	77.0	Clinical situation	–	–	PE, RF, DT (pa, s), UD	–	Amoxicilin/ erythromycin

(continued on next page)

Table 3 (*continued*)

Author (year)	Sociodemographic characteristics	Correct answer %	Field of knowledge	Information	Knowledge autoperception	Attitudes	Perceptions	Antibiotics first choice
Mazzaglia et al. (2002)	–	–		–	–	–	–	Amoxicilin/ clarithromycin
Palmer et al. (2001)	=G, ↑ CPD, A ↑ <61 year	66.7	Clinical situation	–	–	–	–	-
Battellino and Bennun (1993)	-	58.5-70.5	Pharmacology	–	–	–	–	Ampicilin/ erythromycin

Sociodemografic characteristics: Statistical significance (only quantitative studies); = factor was not statistically significant; ↑ factor leads to a statistically significant better Knowledge score, ↓ factor leads to a statistically significant worst Knowledge score/Quality prescription // A: Age, G:gender- F: Female, M: Male, E: Experience, CPD: Attend Continuing Professional Development; Correct answer %: Percentage of correct answers in a knowledge questionnaire;* Percentage of dentist with an acceptable level of knowledge; Information: NG: National Guidelines, CPD: Continuing Professional Development, SC: Scientific Societies, IG: International Guidelines, UG: Undergraduate, Co: Colleagues, JA: Journal article; Knowledge autoperception: KI: Knowledge Inadequate KA: Knowledge Adequate; Attitudes: RF: Risk Factors, PE: Patient Expectation, F: Fear (or: poor online reviews, ml: medico-legal complications, Cp: Complications in the patient's pathology), UD: Uncertain Diagnosis, DT: Delay Treatment (s: schedule, pa: time to accept intervention, em: emergency), ER: External Responsibility, N: New antimicrobial development, EB: Economical Benefit, Perceptions: GC: Global Concern, IR: Important Role, IU: Interested in Updates; Antibiotic First Choice: antibiotic of choice in patients allergic to penicillin and non-allergic patients.

Guerreiro, 2017; Pisarnturakit et al., 2020; Ramandan et al., 2019; Teoh et al., 2019) six studies cited professional colleagues (del Angarita-Díaz et al., 2021; D'Ambrosio et al., 2022; Köhler et al., 2013; Mainjot et al., 2009; Oliveira and Guerreiro, 2017; Sivaraman et al., 2013), and only five studies cited scientific journal articles as a source of updates (Alzouri et al., 2020; D'Ambrosio et al., 2022; Jones and Cope, 2018; Tanwir et al., 2013; Sivaraman et al., 2013).

Nine papers explored dentists' auto-perceptions about their own knowledge: dentists identified their knowledge as inadequate in four (Baudet et al., 2020; Böhmer et al., 2021; Pisarnturakit et al., 2020; Teoh et al., 2019) and as adequate or satisfactory in the other five (Al-Khatib and Almohammad, 2022; Coric et al., 2020; Jones and Cope, 2018; Mainjot et al., 2009; Ramandan et al., 2019).

3.6. Attitudes and perceptions regarding antibiotic use and resistance

Table 3 shows which attitudes and perceptions are reflected in each article. In addition, in supplementary material. The attitude most frequently cited by dentists as influencing their prescribing was complacency towards patients' expectations of receiving antibiotics, which was identified in twenty-two studies (Al-Haroni and Skaug, 2006; Al-Khatib and Almohammad, 2022; Alzouri et al., 2020; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Baudet et al., 2020; Cope et al., 2014; D'Ambrosio et al., 2022; Dormoy et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Mainjot et al., 2009; Mansour et al., 2018; Oliveira and Guerreiro, 2017; Tanwir et al., 2013.; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019; Thompson et al., 2020; Vessal et al., 2011).

This was followed by the need to delay treatment, which was repeated in seventeen studies (Al-Haroni and Skaug, 2006; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Böhmer et al., 2021; Cope et al., 2014; D'Ambrosio et al., 2022; Dormoy et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Rodríguez-Fernández et al., 2023; Salako et al., 2004; Sturrock et al., 2018; Tanwir et al., 2013; Teoh et al., 2019; Thompson et al., 2020; Zhuo et al., 2018). This category covers situations in which treatment must be postponed, whether due to a lack of time on the health professional's side (Al-Haroni and Skaug, 2006; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Böhmer et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Rodríguez-Fernández et al., 2023; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019; Thompson et al., 2020; Zhuo et al., 2018) to a decision taken by the patient (Al-Haroni and Skaug, 2006; Baskaradoss et al., 2018; Böhmer et al., 2021; A L Cope et al., 2014; D'Ambrosio et al., 2022; Dormoy et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019; Thompson et al., 2020; Zhuo

et al., 2018) or due to an emergency (Böhmer et al., 2021; Dormoy et al., 2021; Tanwir et al., 2013; Teoh et al., 2019; Thompson et al., 2020).

The **lack of confidence** in the face of the patient's risk factors is a decisive factor in antibiotic prescribing and was reported in sixteen studies (Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Sebaei and Jan, 2016; Alzouri et al., 2020; Baskaradoss et al., 2018; Baudet et al., 2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Halboub et al., 2016; Jones and Cope, 2018; Mansour et al., 2018; Köhler et al., 2013; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019; Thompson et al., 2020) and was associated with doubts about or difficulties in the patient's diagnosis. This latter category encompasses both dentists who prescribe in accordance with the risk factors presented by their patients (Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Sebaei and Jan, 2016; Baskaradoss et al., 2018; Baudet et al., 2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Halboub et al., 2016; Jones and Cope, 2018; Mansour et al., 2018; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019) and prescriptions that are issued due to ignorance of or lack of access to patients' clinical history (Al-Haroni and Skaug, 2006; Alzouri et al., 2020; Baskaradoss et al., 2018; Halboub et al., 2016; Jones and Cope, 2018; Köhler et al., 2013.; Salako et al., 2004; Teoh et al., 2019; Thompson et al., 2020).

Only three papers described antibiotic prescribing as being directly influenced by economic benefit (Oliveira and Guerreiro, 2017; Rodríguez-Fernández et al., 2023; Thompson et al., 2020). Seven studies pointed to responsibility of others, contending that dentists do not prescribe in sufficient numbers to warrant them being seen as implicated in the problem, (Cope et al., 2014; Coric et al., 2020; Dormoy et al., 2021; Oliveira and Guerreiro, 2017; Rodríguez-Fernández et al., 2023; Teoh et al., 2019; Thompson et al., 2020) and that the solution to the problem of resistance lies rather in the development of new drugs (Cope et al., 2014; Coric et al., 2020).

In contrast, in terms of **interest** shown in the problem of the advance of resistance, eighteen papers noted the presence of concern in the dental community, with twelve stating that dentists consider the advance of resistance to be a global problem (del Angarita-Díaz et al., 2021; Baudet et al., 2020; Coric et al., 2020; D'Ambrosio et al., 2022; Dormoy et al., 2021; Jones and Cope, 2018; Mansour et al., 2018; Pisarnturakit et al., 2020; Rodríguez-Fernández et al., 2023; Sivaraman et al., 2013; Tanwir et al., 2013; Thompson et al., 2020), eleven considering that dentists play an important role in the advance of resistance (Al-Sebaei and Jan, 2016; Baudet et al., 2020; D'Ambrosio et al., 2022; Jones and Cope, 2018; Mainjot et al., 2009; Mansour et al., 2018; Oliveira and Guerreiro, 2017; Pisarnturakit et al., 2020; Rodríguez-Fernández et al., 2023; Thompson et al., 2020; Zhuo et al., 2018) and five reporting that dentists express interest in updates on the issue. (Alzouri et al., 2020; Baudet et al., 2020; Coric et al., 2020; Pisarnturakit

et al., 2020; Köhler et al., 2013).

3.7. Patterns of clinical practice regarding antibiotic use

Most dentists identified amoxicillin as the antibiotic most used in their dental practice, as was seen in fifteen of the twenty-two studies in which this question was posed (Agossa et al., 2021; Al-Khatib and Almohammad, 2022; Alzouri et al., 2020; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Baudet et al., 2020; Demirbas et al., 2006; Dormoy et al., 2021; Mainjot et al., 2009; Mazzaglia et al., 2002; Salako et al., 2004; Sivaraman et al., 2013; Sturrock et al., 2018; Teoh et al., 2019; Vessal et al., 2011). In the case of allergies, a macrolide or clindamycin was the alternative choice in eight out of ten studies (Baskaradoss et al., 2018; Baudet et al., 2020; Mainjot et al., 2009; Mazzaglia et al., 2002; Salako et al., 2004; Sivaraman et al., 2013; Teoh et al., 2019; Vessal et al., 2011). In three papers, however, the first-choice antibiotic was amoxicillin/clavulanic acid (Al-Sebaei and Jan, 2016; Halboub et al., 2016; Patait et al., 2015), and in another four (Al-Haroni and Skaug, 2006; Battellino and Bennun, 1993; Mansour et al., 2018; Ramandan et al., 2019) the most popular antibiotics were penicillin, ampicillin and metronidazole (Table 3).

Table Appendix C in supplementary material summarises the main disorders for which dentists prescribed antibiotics and in what percentage. Periapical abscesses were the conditions with highest prescription rates, displaying percentages that ranged from approximately 37,9% to as a high as 88,7% (del Angarita-Díaz et al., 2021; Pisarnturakit et al., 2020). Other situations showed greater variation among dentists, with percentage prescription rates ranging from 3.8% to 77.0%, as in the case of dental extractions(Al-Sebaei and Jan, 2016; Alzouri et al., 2020) or odontogenic pain, with percentages of 1.0% to 65.0% (Alzouri et al., 2020; Demirbas et al., 2006).

4. Discussion

The results of this systematic review suggest that, among dentists, antibiotic prescribing is associated with potentially modifiable factors, while non-modifiable factors, such as socio-demographic factors, exert less influence. Complacency, lack of confidence, fear, and the need to delay dental procedures are modifiable factors identified as influencing prescribing in this group. Our results also reveal gaps in dentists' knowledge about antibiotics. These findings may be relevant for the design of interventions targeted at improving the quality of antibiotic prescribing in this group of health professionals.

4.1. Discussion of methods

Almost all the studies that make up this review are qualitative or quantitative descriptive in nature. In the quantitative studies, gaps were detected in methodological aspects, such as a lack of justification of sample size and fully validated questionnaires (López-Vázquez et al., 2016). What is most noteworthy, however, is the fact we were able to find only one analytical study which had attempted to quantify the influence of knowledge and attitudes on dentists' prescribing habits by means of statistical hypothesis testing (Rodríguez-Fernández et al., 2023).

4.2. Discussion of results

Our review identifies **complacency** as one of the factors most frequently identified by dentists as influencing their prescribing (Al-Haroni and Skaug, 2006; Al-Khatib and Almohammad, 2022; Alzouri et al., 2020; del Angarita-Díaz et al., 2021; Baskaradoss et al., 2018; Baudet et al., 2020; Cope et al., 2014; D'Ambrosio et al., 2022; Dormoy et al., 2021; Halboub et al., 2016; Jones and Cope, 2018; Mainjot et al., 2009; Mansour et al., 2018; Oliveira and Guerreiro, 2017; Ramandan et al., 2019; Rodríguez-Fernández et al., 2023; Salako et al., 2004;

Sturrock et al., 2018; Teoh et al., 2019; Thompson et al., 2020; Vessal et al., 2011), a finding that is in line with those published to date on other groups, such as physicians(Lopez-Vazquez et al., 2012) and pharmacists (Servia-Dopazo and Figueiras, 2018). Thomson et al. identified in a systematic review, conducted in adults with acute condition across primary care (including dentistry), that the patient's expectation to receive antibiotics is one of the main factors influencing dentists to prescribe antibiotics (Thompson et al., 2019). In addition to the fact that dentists' income may depend on the number of patients attended, complacency can also mean patient loyalty (Thompson et al., 2020). Part of the **economic benefit** of a dental practice, bearing in mind that it is largely a private activity in most healthcare systems, could well be linked to patient satisfaction with the treatment received. In contrast to what is observed among pharmacists, in dentists the economic factor has only been directly detected in three studies (Oliveira and Guerreiro, 2017; Rodríguez-Fernández et al., 2023; Thompson et al., 2020). The explanation for this might lie in the fact that it might prove complicated for dentists to admit that there is financial motivation (Welie, 2004).

Another attitude identified is lack of confidence when it comes to prescribing antibiotics, due to the risk factors presented by patients, doubts in diagnosis, or lack of access to the patient's clinical history(Al-Haroni and Skaug, 2006; Al-Huwayrini et al., 2013; Al-Sebaei and Jan, 2016; Alzouri et al., 2020; Baskaradoss et al., 2018; Baudet et al., 2020; D'Ambrosio et al., 2022; Demirbas et al., 2006; Halboub et al., 2016; Jones and Cope, 2018; Mansour et al., 2018; Salako et al., 2004; Sturrock et al., 2018; Teoh et al., 2019; Wendy Thompson et al., 2020).

Dentists do not always have access to patients' clinical records and may thus have doubts about self-reported clinical histories. This attitude, which has also been identified among physicians (Lopez-Vazquez et al., 2012), could be resolved by boosting the use of applications that provide direct access to electronic health records or diagnostic support systems (Muhiyaddin et al., 2020), as well as by empowering patients to access their own disorders or conditions using mobile clinical history applications (Sanchez et al., 2019).

Fear of clinical complications, medico-legal consequences, and poor online reviews are situations described by dentists as motivating the prescription of antibiotics, even in cases where these are not indicated (Al-Sebaei and Jan, 2016; Oliveira and Guerreiro, 2017; Zhuo et al., 2018). Fear is indirectly related with attitudes previously identified in this review, such as complacency towards the patient, lack of confidence, and economic benefit. Improving the health professional-patient relationship through purpose-designed courses and facilitating shared decision making about patients' treatment might help lessen health professionals' fear and thereby reduce unnecessary prescribing (Muhiyaddin et al., 2020).

Another factor that emerges from the results of our review is the need to provide antibiotic prescriptions in cases where a proposed dental treatment (e.g., extraction) is postponed,(Al-Haroni and Skaug, 2006; Baskaradoss et al., 2018; A L Cope et al., 2014; Halboub et al., 2016; Jones and Cope, 2018; Salako et al., 2004; Teoh et al., 2019; Zhuo et al., 2018) either because of a **lack of time** on the dentist's part or because the patient needs time to decide whether or not to go through with the intervention. Clinical time pressures were identified in other research as predictive of antibiotic prescribing in the absence of infection (Cope et al., 2016). This is a factor specific to this group, as Thomson et al. identified in their review (Thompson et al., 2019). This has been described elsewhere as a way of balancing the 'competing demands', and it could have important implications when it comes to proposing effective strategies to reduce antibiotic prescribing by dentists. Additionally, it would be interesting to consider the implementation of antibiotic prescription audits with feedback. This approach could not only provide valuable data on current practices but also serve as an educational tool for dentists, helping them identify areas for improvement and adopt better evidence-based practices(Löffler and Böhmer, 2017).

Fifteen studies report results on dentists' knowledge of antibiotics. Dentists' self-perceived knowledge is examined in nine papers (Al-Khatib and Almohammad, 2022; Baudet et al., 2020; Böhmer et al., 2021; Coric et al., 2020; Jones and Cope, 2018; Mainjot et al., 2009; Pisarnturakit et al., 2020; Ramandan et al., 2019; Teoh et al., 2019), with dentists admitting that it is inadequate in almost half of these. Nonetheless, our results point to an overestimation of the need to prescribe antibiotics for many conditions and disorders. An explanation for this might lie in the fact that: (i) a proportion of dentists do not follow the guideline recommendations; or (ii) the guidelines which they do follow have not been updated; or (iii) they rely on one or more of the many other data-sources available. Having updated and accessible clinical practice guidelines is essential for providing dentists with up-to-date, evidence-based information to make informed clinical decisions. This standardizes practices, promotes evidence-based approaches, and enhances the quality of dental care (Lockhart et al., 2019).

A greater degree of agreement apparently surrounds the perceived role played by dentists themselves in the advance of antibiotic resistance (Al-Sebaei and Jan, 2016; Baudet et al., 2020; Coric et al., 2020; D'Ambrosio et al., 2022; Jones and Cope, 2018; Mainjot et al., 2009; Mansour et al., 2018; Oliveira and Guerreiro, 2017; Pisarnturakit et al., 2020; Rodríguez-Fernández et al., 2023; Sivaraman et al., 2013; Wendy Thompson et al., 2020; Zhuo et al., 2018). In most of the papers, dentists acknowledge being involved in the problem and being interested in updates on the topic, something that might be taken to indicate that campaigns and strategies targeted at this group would be well received. However, these campaigns often fail to emphasize the crucial role that dental professionals play in antibiotic management, similar to their established role in oral health education (Watt et al., 2019). For instance, nudge interventions specifically designed for dentists, incorporating scenarios relevant to oral pathology, could motivate them to become active drivers of change in antibiotic culture (Thompson et al., 2021). In a systematic review on the effectiveness of nudge interventions in reducing antibiotic prescribing in primary care, it was found that 78.3% of the evaluated studies reported a reduction in antibiotic prescriptions following the implementation of various nudge strategies (Raban et al., 2023). In this sense, these appropriately selected nudge interventions along with actions aimed at improving the dentist-patient relationship could help dentists combat practices related to the attitudes identified in this review such as complacency and lack of confidence.

4.3. Strengths and limitations

To our knowledge, this is the first systematic review to be conducted on knowledge, attitudes and perceptions on antibiotic prescribing, regardless of the type of clinical activity they are carrying out or the pathology they treat and, as such, therefore furnishes interesting results when it comes to designing specific interventions.

The main limitation of the study is the heterogeneity of the studies selected, in terms both of methodology and of the variables recorded, as there is no fully validated questionnaire to measure attitudes. Therefore, we couldn't perform a meta-analysis on the subject. A further limitation lies in the difficulty of classifying items and fitting them into previous attitudes and knowledge, in that other authors could have classified them in a different way. Even so, the research team has wide-ranging experience in these types of reviews, and we feel that this factor would in no way change the final message of the review.

5. Conclusions

In the context of the current worldwide resistance emergency, it is necessary to intervene in the case of any and all actors who may share responsibility for the problem. Insofar as they are responsible for 10% of all antibiotic prescribing, dentists should thus also be included in any antibiotic stewardship efforts (Suda et al., 2019). Our results suggest that the main factors associated with prescribing are potentially

modifiable (lack of knowledge, inappropriate attitudes) and, as such, should be the target of future interventions. However, more studies are needed to relate prescribing antibiotics practices to knowledge, attitudes, and perceptions in dentists. Such interventions could have major benefits in terms of reduction of antibiotic resistance worldwide.

Funding

Registration

The protocol of this systematic review can be found in PROSPERO under registration no. CRD42021253937, published on Jun 08, 2021. (crd.york.ac.uk/prospero/display_record.php?ID=CRD42021253937.

CRediT authorship contribution statement

Olalla Vázquez-Cancela: Writing – original draft, Formal analysis, Data curation. **Maruxa Zapata-Cachafeiro:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Maria Teresa Herdeiro:** Supervision. **Adolfo Figueiras:** Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Almudena Rodríguez-Fernández:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no competing interests.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2024.108043.

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