Exploring misleading online oral health information: a content analysis

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Abstract

Objective: This study aimed to identify and characterize misleading online oral health information.

Materials and Methods: 410 websites published in English were retrieved by Google Advanced Search and screened by 2 independent investigators, who compiled false messages through content analysis. Afterward, 318 content items were divided in consensus as G1 - informationally-oriented misinformation, G2 - misinformation with interests, G3 - misinformation with interests produced or propagated by dental professionals, and G4 – misinformation with political interests. Their presence on social media and fact-checking agencies was determined using CrowdTangle and Snopes. Data were evaluated by descriptive analysis and Cramer's V test to compare distinct categories.

Results: The main issues associated with misleading content items were gum diseases (12.0%), root canal treatment (11.6%), toothache (10.4%), fluoride (10.4%), and dental caries (9.8%), highlighting recommendations for natural products usage, toxicity concerns, and anti-fluoridation propaganda. Most misinformation (41.9%) was allocated in G3, which exhibited a statistically higher frequency of financial interests than other groups. Besides, falsehoods were considerably identified on Facebook (62.9%) and Instagram (49.4%), especially G3 and G4. Nevertheless, Snopes has already debunked only 5.9% of these content items.

Conclusions: Misleading information was predominantly produced or propagated by dental professionals mainly motivated by financial interests and usually linked to alternative/natural treatments diffusion. Although these items were shared on social media, fact-checking agencies seemed to have insufficient knowledge about their dissemination.

Clinical Relevance: Dental teams need to be conscious of false oral health content to improve the quality of their relationship with patients through adequate communication.

Introduction

The increased production and consumption of misleading online health information is stimulated by self-opinions and autonomous behaviors of digital users that emerged from the phenomenon of hyperconnectivity [1, 2]. The content overload observed in contemporary information ecosystems makes message processing difficult [3], which leads to the development of negative health beliefs that hamper the decision-making process and the self-management of particular conditions, causing adverse consequences to quality of life [4, 5]. It was demonstrated that Internet seekers are usually interested in oral health information on themes as toothache, dental caries, molar incisor hypomineralization, and fluoride [6–9].

The sense of innovation is determinant to the widely spread of falsity online [10, 11]. At the micro-level, people are stimulated to share content by the judgment of their believability through the analysis of information sources, narratives, and context. Conversely, messages are distributed at the macro-level

without in-depth assessments in a cascade pattern [1]. Notably, 80% of users trust the authenticity of online information, which corroborates with more shares of misleading than trustworthy content on social media [11–13].

Hence, the adoption of diverse strategies to manage information disorder is mandatory. The implementation of online oral health education interventions must be emphasized to resolve significant individual and community matters [14]; however, the exclusive adoption of user-centered approaches tend to fail in complex scenarios such as infodemic, the overabundance of accurate or inaccurate information that occurs during an epidemic [15]. Indeed, the development of technologies to the automated detection of misleading health content, as artificial intelligence models, is desirable to prevent the creation and propagation of falsehoods [16]. In both conditions, the establishment of current oral health false content items available in digital environments is essential to enable positive outcomes against frauds and hoaxes available on the Internet [17].

Considering the unfavorable implications of health falsehoods, and the lack of dental research into information disorder, this study aimed to identify and characterize misleading online oral health information. We hypothesized that misinformation with non-informational-related interests and/or published by health professionals presents higher frequencies of spread on social media and detection on fact-checking agencies than informationally-oriented misinformation.

Material And Methods

Study design and ethics

This infodemiological qualitative study aimed to identify and characterize false oral health information found on the Internet. For that, websites published in English were retrieved by Google Advanced Search, and screened by 2 independent investigators, to compile misleading messages through thematic content analysis [18,19]. Based on a conceptual framework, content items were divided in 4 groups: misinformation; misinformation with financial, social and/or psychological interests produced or propagated by laypeople; misinformation with financial, social and/or psychological interests produced or propagated by dental professionals; and misinformation with political interests [5,10,17,19-24]. To determine the spread of content items, social media (Facebook and Instagram) and a fact-checking tool (Snopes) were respectively screened to identify corresponding posts and warnings.

This study did not require institutional review board approval from the Council of Ethics in Human Research of the *blinded for peer review* because federal regulations do not apply to research using publicly available data that does not involve human subjects.

Conceptual framework

We analyzed current concepts, terminologies, and taxonomies of information disorder to guide the investigations performed in this study. The definitions of terms were synthesized based on the most

accepted theories, as follows: a) misinformation: false information determined based on a grounding of truth and applies only to informationally-oriented content; b) fake news: intentionally misleading and biased representational information for the benefit of the messenger sender, which contains false information, with or without a blend of one or more components of omitted important information, a decontextualized content, misleading headlines or clickbait; c) disinformation: information that is false and deliberately created to harm a person, social group, organization or country; d) mal-information: the sharing of accurate information with the intention to cause harm; and e) conspiracy theories: attempts to explain the ultimate causes of significant social and political events and circumstances with claims of secret plots by two or more powerful actors [10,17,19,22-25]. Moreover, misleading online content can be supported by distinct types of interests.

Regarding the aforementioned concepts, content items were characterized according to 3 criteria:

i. The detection of misleading content (yes or no), including non-evidence-based information as proposed by Swire-Thompson and Lazer [5]. This process regarded the message contexts to identify possible misinterpretation or imprecise use of information;
ii. The identification of interests (yes or no) behind the content, authors, and websites. The interests were classified as informational (warnings against deceitful content and beliefs), financial (profiting from information disorder through advertising), political (attempts to influence public opinion in relation to political positions), social (connecting with groups online or off), and/or psychological (seeking prestige or reinforcement), as stated by Wardle and Derakhshan [10];
iii. The definition of the scientific background of the producer(s) or propagator(s) of content (dentists/oral health companies or others), aligned to the technical knowledge that enable specialists to the identification of misleading oral health information, concerning the professional responsibility of promoting those subjects on digital environments.

Figure 1 depicts the decision tree used to divide oral health misleading content items according to groups with distinct characteristics of interest and authorship, as follows: G1 – misinformation (informationally-oriented content); G2 – misinformation with financial, social and/or psychological interests produced or propagated by laypeople; G3 – misinformation with financial, social and/or psychological interests produced or propagated by dental professionals; and G4 – misinformation with political interests. This structure considered the objective contextual analysis that could be associated with the intentional production or propagation of false information, since the determination of intentionality is founded on subjective factors, making difficult the standardization of analysis. According to Poe's law, the clues left by newsmakers are often inadequate to differentiate the honest and dishonest mistakes [3,26].

Data collection

Between February 4 and 23, 2021, websites published in English were retrieved using Google Advanced Search, the search engine market leader in English-speaking countries [27]. The systematization of data collection is summarized in Figure 2. Initially, an exploratory analysis about the main dental fields was

made through predetermined search strategies using Boolean operators. The queries were created by the intersection of a “specific field” AND (“fake news” OR disinformation). Previously, the browser was defaulted by idiom in a Microsoft Edge at Windows 10 system, with all cookies and history cleared to minimize the influence of personal preferences on data collection. The first 10 websites (front page) were accessed for each search strategy, replacing repetitions and sponsored advertisements. It is noteworthy that 95% of users who search for health information on Google only follow links on the first page [28]. All links selected were registered in Archive Today to ensure that websites remain unchanged and saved in a public repository for further analysis [29,30].

Ten main dental fields (general dentistry, cariology, oral medicine, restorative dentistry, endodontics, prosthodontics, orthodontics, pediatric dentistry, periodontics, and surgery) were applied in the first stage. Only the queries with general dentistry and cariology did not retrieve websites. Thus, between March 1 and April 22, 2021, 2 independent investigators (ML and OSJ) manually analyzed the first 80 websites through thematic content analysis to identify misleading information. For that, the investigators coded each sentence of webpages as 0 (information) or 1 (misleading content) [18,19]. Each misleading content item and its respective authors’ contextualization were tabulated in association with a particular dental field. Then, these findings were gathered in a single table to eliminate possible repetitions.

Afterwards, in the second stage, 7 themes known related to general dentistry and cariology (dental caries, floss, fluoride, mouthwash, toothache, toothbrushing, and toothpaste) and 3 themes usually observed among fields without the identification of misleading content (oral cancer, root canal, and teeth whitening) were explored to retrieve more 100 websites. Additionally, 20 new themes that appeared in the first and second stages of analysis led to the collection of more 200 websites (third stage). After that, 3 other new themes emerged from the third stage, requiring the retrieval of additional 30 websites (fourth stage), when it was achieved the saturation of themes. The screening resulted in 410 websites with the identification of 369 non-repeated potentially misleading content items.

Identification and characterization of false oral health information

Between April 27 and July 5, 2021, other 2 independent investigators (ML and TC) manually analyzed potentially misleading content items, considering their context on websites. The items divergently qualified by examiners were re-assessed until consensus. Fifty-one items were excluded from the analysis because they were related to supportive results of systematic reviews, clinical trials, or cohort studies published in international journals indexed in databases Cochrane, Embase Search, Clinical Trials, Ovid, PubMed, Scopus, and/or Web of Science. Then, each one of 318 misleading content items was allocated in a group, as previously described (Table 1).

The publication of misleading content on Instagram and Facebook was verified using the CrowdTangle [31], taking into account the popularity of posting social media worldwide [32]. This platform permits data analysis of public accounts and pages. Also, the Snopes fact-checking tool was accessed to determine whether false oral health information had already been debunked previously [33]. The main words of each misleading content item were applied to search posts and warnings using Boolean

operators in both platforms. For example, the item described as *"fluoride may cause cancer"* was synthesized as fluoride AND cancer.

For more details, please consult the public data repository [30].

Data analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (v. 21.0; SPSS; Chicago, IL, USA). Thematic nodes and subnodes that emerged from the content analysis were represented by a conceptual map. Also, data were evaluated by descriptive analysis and Cramer's V test to compare distinct categories of misleading content items according to the frequencies of types of interest (informational, financial, social, psychological, and political), detection on social media (Facebook and Instagram), and fact-checking agency (Snopes). For all analyses, p values <0.05 were considered significant.

Results

The misleading oral health information is summarized in Table 1. Most items were allocated in G3 (41.9%), followed by G2 (24.8%), G1 (24.2%), and G4 (9.1%). The main interests detected were social and psychological ones, with more than 54.2% of items related to 5 themes: gum diseases (12.0%), root canal treatment (11.6%), toothache (10.4%), fluoride (10.4%), and dental caries (9.8%). Substantial proportions of items were identified in Facebook (62.9%) and Instagram (49.4%). In contrast, Snopes debunked only 5.9% of content items. Notably, all misinformation with political interests were focused on fluoride-related information, supporting anti-fluoridation propaganda (supplemental material).

Table 2 depicts the distribution of types of interests, presence in social media, and fact-checking detection according to the categories of misleading content. The financial interest was statistically higher among G3 in comparison to other groups. Misinformation of groups G3 and G4 were detected more significantly on Instagram than G1. Similar percentages of all categories of misleading content were checked and publicized by Snopes.

Table 2
Distribution of interest, social media, and fact-checking according to the categories of misleading information. Distinct superscript lowercase letters indicate significant statistical differences between categories

	Misleading information					
	G1 n = 77	G2 n = 79	G3 n = 133	G4 n = 29	φ	*P*
Interest						
Informational	77 (100%)[a]	0 (0%)[b]	0 (0%)[b]	0 (0%)[b]	1.000	< 0.001
Financial	0 (0%)[a]	33 (41.8%)[b]	78 (58.6%)[c]	3 (10.3%)[d]	0.509	< 0.001
Social	0 (0%)[a]	79 (100%)[b]	133 (100%)[b]	29 (100%)[b]	1.000	< 0.001
Political	0 (0%)[a]	0 (%)[a]	0 (0%)[a]	29 (100%)[b]	1.000	< 0.001
Psychological	0 (0%)[a]	79 (100%)[b]	133 (100%)[b]	29 (100%)[b]	1.000	< 0.001
Social media						
Facebook	41 (53.2%)[a]	49 (62.0%)[a,b]	88 (66.2%)[a,b]	22 (75.9%)[b]	0.135	0.122
Instagram	26 (33.7%)[a]	38 (48.1%)[a,b]	75 (56.4%)[b]	18 (62.1%)[b]	0.195	0.007
Fact-checking						
Snopes	6 (7.8%)[a]	2 (2.5%)[a]	9 (6.8%)[a]	2 (6.9%)[a]	0.085	0.510

Figure 3 presents a conceptual map of misleading oral health information emerged from content analysis. It demonstrates the relationship of 9 nodes (fields), 18 first-level subnodes (themes), and 50 second-level subnodes (context). The most commonly identified contexts were recommendations of home remedies and natural products usage (32.1%), toxicity concerns (16.3%), anti-fluoridation propaganda (9.1%), and alternative medicine (6.6%).

Discussion

To our knowledge, this is the first study that identified and characterized misleading oral health content in Dentistry. These findings indicate that items were predominantly produced or propagated by dental professionals with a statistically higher frequency of financial interests than other groups. Most items were linked to gum diseases, root canal treatment, toothache, fluoride, and dental caries, highlighting recommendations of home remedies and natural products usage, toxicity concerns, anti-fluoridation propaganda, and alternative medicine. All misinformation with political interests were related to fluoride.

Content items of groups G3 and G4 were significantly more detected on Instagram than G1. Even with the diffusion of content on social media, items were rarely debunked by Snopes.

These outcomes confirmed that messages with interests and dental authorship were more usually found on social media than informationally-oriented misinformation. In this sense, public health measures and policies, such as water fluoridation, were systematically depreciated due to political interests [34], e.g., *"the water fluoridation is a communist plot to control minds,"* and *"the water fluoridation is designed to boost the sugar lobby."* These outcomes are in agreement with the behavior of Twitter users who were mostly interested in content that emphasized the negative health aspects of fluoride measures [8]. It can be explained by the concurrence of multiple factors, as the sense of innovation of falsehoods, information overload, and weak tie relationships on social networks, which are inflated by predisposing personal characteristics of users in the form of preexisting beliefs, ideological motivations, and political polarization [1, 13, 35].

The higher frequency of financial interests detected in group G3 demonstrates a lack of commitment of several dental professionals and companies to the truth. In this sense, a high percentage of those misleading content items discouraged the use of traditional oral care products, e.g., *"glycerin present in toothpastes can make teeth yellow," "triclosan present in toothpastes affects heart function,"* and *"use of dental floss may cause Alzheimer's disease,"* or offered miraculous homemade self-management of conditions, e.g., *"oil pulling reduces the bacteria in the mouth and helps to dental caries prevention," "applying pepper paste can provide relief in case of a toothache,"* and *"neem has been shown to help to prevent oral cancers."* Probably, these arguments aimed to supply a demand for few accessible dental care services, exploring a current preference for natural products. Notwithstanding, it is relevant to consider a possible falsification of content's authorship because this aspect is difficult to verify online; however, if this hypothesis is confirmed, fabricated messages must be regarded as disinformation. Thus, our model was proven effective for characterizing misleading content because it demonstrated a proportional increase of the availability of items on social media in parallel to the presence of interests and dental authorship (53.2–75.9% in Facebook, and 33.7–62.1% in Instagram). In theory, dental professionals or companies are more able to avoid and recognize the falsehood in technical texts and posts than laypeople, i.e., they have a considerable responsibility to promote oral health information as social authorities.

The attention of fact-checking agencies is provoked by the main interests of digital users [22]. The detection of low frequencies of debunked content on Snopes may denote the absence of criticism and awareness of oral health information seekers, either by limitations related to their eHealth and media literacy or by ignoring the possible negative effects of misleading items. Additionally, there is still a lack of consciousness of academics and authorities on the prominence of these communication anomalies, culminating with the deficiency of policies and online surveillance systems to promote the identification of false information [36, 37].

This study contributes to the development of further investigation and technologies in a multifaceted way, in reference to (a) the definition of the scope of misleading online oral health information over time, (b) the characterization of misleading information to define correct inputs to artificial intelligence-based detection systems, (c) the construction of models and methodologies to assess the propagation of false information on social media, and (d) the evidence on how misleading content might influence the decision-making process in clinical situations to elucidate overcoming schemes. Also, the results have the potential to support fact-checking agencies and dental associations to disclose warnings about deceitful messages to their audience immediately. In this context, dental professional teams need to be conscious of false content to improve the quality of their relationship with patients through adequate communication. They also need to establish significant education about the harmful effects of misleading health information, such as the damaging consequences of natural treatments for the progression of oral cancer and dental caries. Moreover, these outcomes foment public debate toward the prevention of the genesis and propagation of falsities. Thus, the legislators may create guidelines and laws to control the spread of misleading oral health information. Finally, enlarging access to dental treatment and high-quality information may be a powerful tool to avoid consuming deceptive subjects because most themes are linked to populations' preeminent and basic needs.

These findings should be interpreted with caution. First, it is not possible to affirm that this methodological approach was able to identify all existent and currently available misleading online oral health information because these outcomes were dependent on choices of systematization; however, a large volume of web content was retrieved until the saturation of themes was achieved. Second, Google algorithms retrieve links that consider the personal preferences of seekers, which might influence the results of data collection. All history and cookies of the browser were cleared before proceeding with searches to minimize this aspect. Third, digital users are not necessarily consuming the evaluated content. In contrast, we focused our analyses on identifying the maximum amount of materials linked to information disorder, which justifies our search strategies and the large volume of recovered content. Fourth, these interpretations were based only on content published in English. Although it is the most spoken language worldwide, cultural aspects probably influenced the detection of false information.

In conclusion, misleading online oral health information was predominantly produced or propagated by dental professionals mainly motivated by financial interests. Overall items were usually linked to the diffusion of alternative and natural treatments. It is noteworthy that the presence of interests and involvement of dental professionals with misinformation increased its spread on social media, although fact-checking agencies seemed to have little knowledge about its existence, dissemination, and negative influence on populations. Therefore, our hypothesis was partially confirmed. We expect these outcomes to be relevant to further studies to develop innovative tools and policies to combat oral health misinformation.

Declarations

Author's contributions

ML: Conceptualization, Methodology, Formal Analysis, Investigation, Visualization, and Writing – Original Draft.

OSJ: Formal Analysis, Investigation, and Writing – Review & Editing

MAAMM: Writing – Review & Editing

TC: Conceptualization, Methodology, Formal Analysis, Investigation, Visualization, Writing – Review & Editing, Supervision, and Project Administration.

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Conflict of Interest

The authors declare no potential conflict of interest with respect to the research, authorship and/or publication of this article.

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Tables

Table 1 is available in the Supplementary Files section

Figures

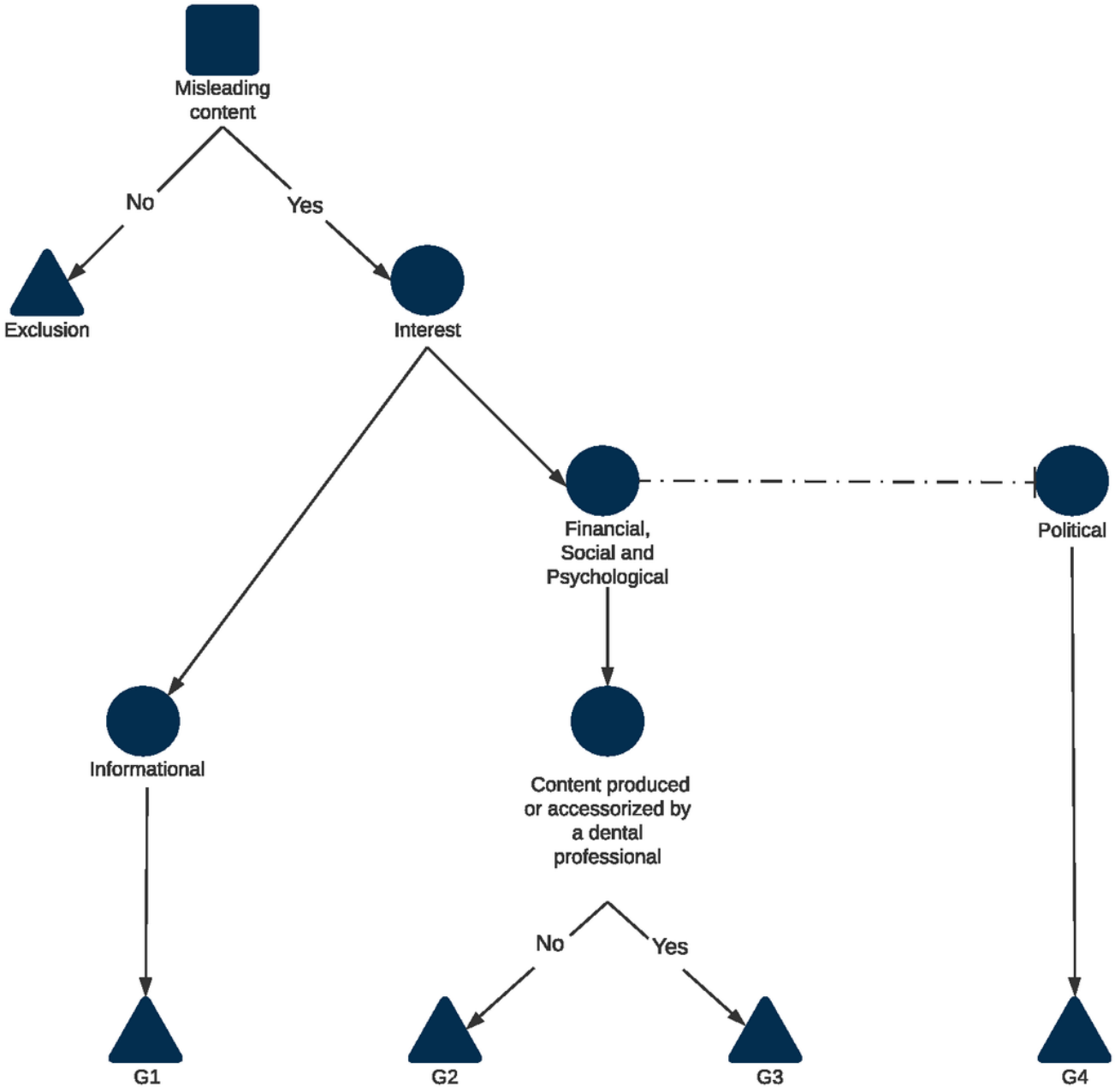

Figure 1

Decision tree to categorize misleading online oral health information. Note that G1 represents misinformation with informationally-oriented content, while G2 is misinformation with financial, social, and/or psychological interests produced or propagated by laypeople, G3 is misinformation with financial, social, and/or psychological interests produced or propagated by dental professionals, and G4 is misinformation with political interests

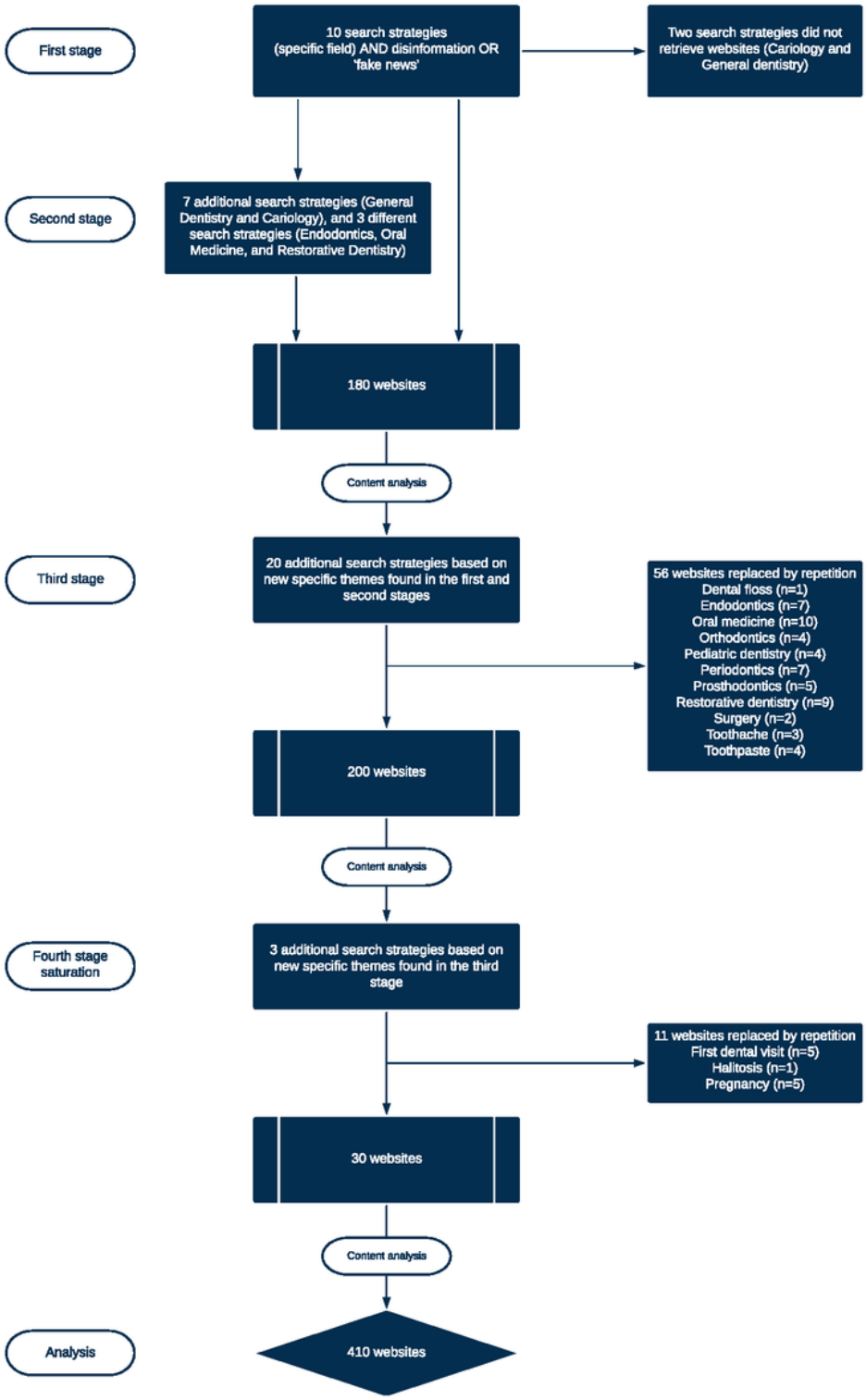

Figure 2

Flowchart of the search strategy.

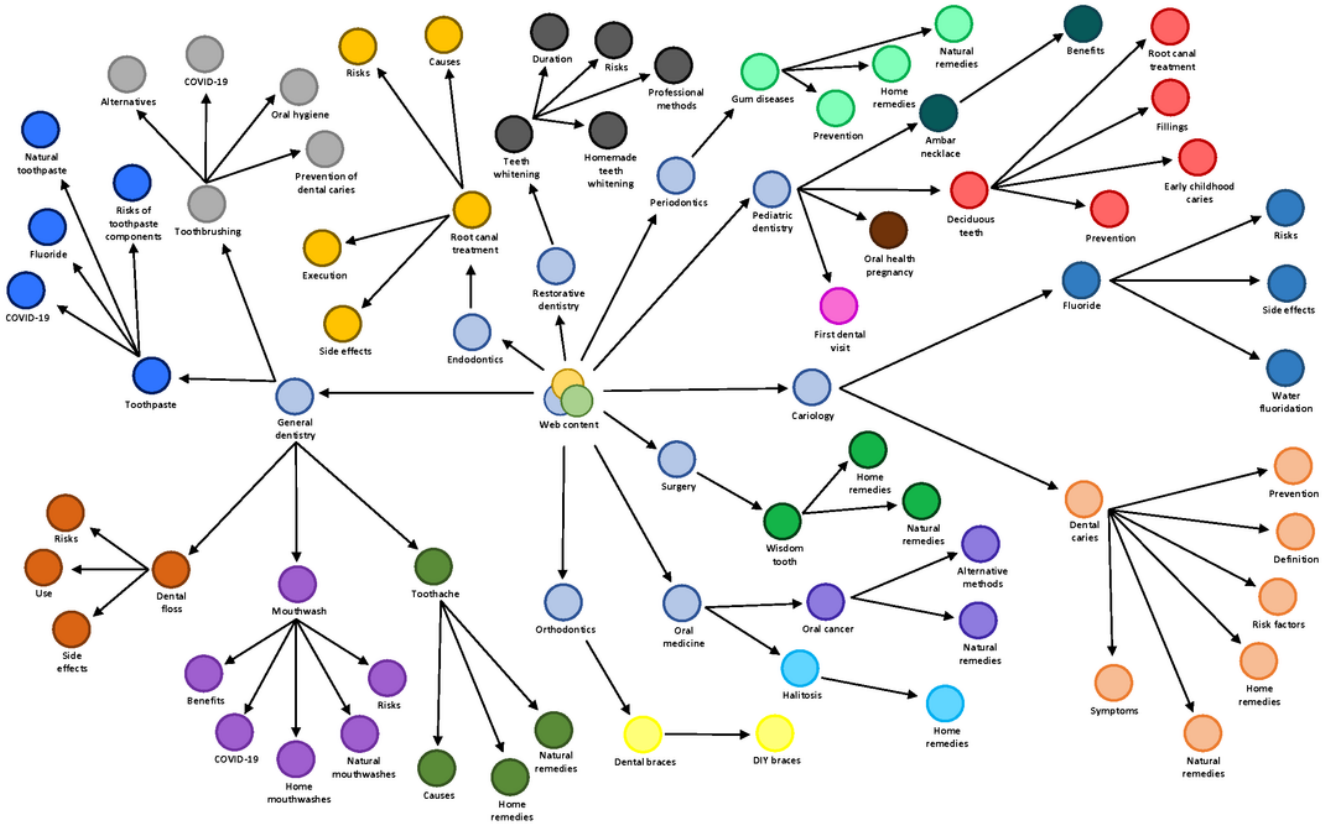

Figure 3

Conceptual map demonstrating the relationship of fields, themes, and context of misleading online oral health information identified in websites. Note that blue balls indicate only misleading information detected in web content.

Supplementary Files

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- Supplementalmaterial3.docx
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- Table1CLOI.docx