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Conflict of interest and funding in health communication on social media: a systematic survey

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ABSTRACT

Objectives: To synthesize the available evidence on the reporting of conflicts of interest (COI) by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media.

Data Sources: Medline(OVID) (2005-March 2022), Embase (2005-March 2022) and Google Scholar (2005-August 2022), supplemented with a review of reference lists and forward citation tracking.

Design: Reviewers selected eligible studies and abstracted data in duplicate and independently. We appraised the quality of the included studies using the Mixed Methods Appraisal Tool. We summarized the results in both narrative and tabular formats. We followed the PRISMA 2020 checklist for reporting our study.

Results: Of a total of 16,645 retrieved citations, we included 17 eligible studies. The frequency of reporting of conflicts of interest varied between 0% and 60%, but it was mostly low. In addition, a significant proportion, ranging between 15-80%, of healthcare professionals using social media have financial relationships with industry. However, three studies assessed the proportion of conflicts of interest of physicians identified through Open Payment Database (OPD) but not reported by the authors. It was found that 98.7-100% of these relationships with industry are not reported when communicating health-related information. Also, two studies showed that there is evidence of a potential association between COI and the content of posting. No data was found on the reporting of funding sources of studies cited in health messages on social media.

Conclusions: While a significant proportion of healthcare professionals using social media have financial relationships with industry, lack of reporting on COI and undisclosed COI are common. We did not find studies on the reporting of funding sources of studies cited in health messages on social media.

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ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first systematic survey on the subject of reporting of conflicts of interest in social media.
- The study applied standard methodology for conducting systematic reviews (including a comprehensive search, duplicate screening, and data abstraction).
- We found a relatively limited number of eligible studies.
- Meta-analysis was not conducted due to heterogeneity of the included studies.

INTRODUCTION

The traditional internet has expanded to a more dynamic and interactive entity referred to as "Web 2.0" [1]. Web 2.0 allows its users to create and share content as well as communicate and interact with other users [1]. It differs from Web 1.0 in that content and applications of the web are no longer necessarily created by specific individuals but by all internet users, and constantly modified by them [2]. It includes various social media platforms such as blogs, Twitter, Facebook, Instagram, and YouTube [1].

Many individuals rely on the internet to answer their medical questions. While 90% of health care professionals use social media platforms for personal purposes, 65% use them for professional reasons such as promotion of health behaviors, discussions of health care policy, communicating with colleagues, and education of patients, peers, and students [3]. Within recent years, the use of social media by health care professionals has increased significantly with some estimates reporting increases from 42% in 2010 to as high as 90% in 2011 [4].

However, professionals may have conflicts of interest (COI) that may bias their postings on their platforms [4]. In general, conflicts of interest can be either individual or institutional, financial or non-financial.[5] While financial COI entail receiving grants, personal fees, trips, honoraria or stock ownership, non-financial COI include career advancement, political or ideological beliefs, strong scientific opinions, fame, and social interests.

Reporting COIs allow their acknowledgment and incorporation in the public's interpretation of information posted on social media [4]. That in turn should enhance public trust in the medical profession. Many medical associations have developed guidelines on physicians' use of social media, including reporting of COI [6-8]. However, there are many challenges to reporting COI on social media. Social media posts are often brief with character limitation [4]. Also, a layperson may interpret COI statements differently than other professional users such as physicians and scientists [4].

Very limited research has been done on the topic of conflicts of interest and funding in social media. Previous studies considered COI reporting as part of measures of online professionalism [9], or as an indicator to assess credibility and quality of online information [10-13]. McCarthy et al discussed the urgent need for "more research examining the prevalence, impact of physicians' COI on social media content, and appropriate management strategies" [4].

The objective of this study is to synthesize the available evidence on the reporting of conflicts of interest by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media.

METHODS

Design overview and definitions

We conducted a systematic survey of the published peer reviewed literature. We referred to the following definition of COI: "a COI exists when a past, current, or expected interest creates a significant risk of inappropriately influencing an individual's judgment, decision, or action when carrying out a specific duty" [5]. We considered COI a concept relevant to a social media account of an individual or an organization (which would include the funding by a specific organization). We considered funding a concept relevant to a research study or project.

Table 1 shows the terms used for different scenarios that vary by whether COI exists or not, and whether a COI reporting statement is available.

Table 1 Problems associated with scenarios varying by whether COI exists or not, and whether a COI reporting statement is available.

	No COI exists	COI exists
No statement reporting on COI	Lack of reporting but no undisclosed COI	Lack of reporting with undisclosed COI
Statement reporting no COI	No problem	Undisclosed COI
Statement reporting COI	Over-reporting of COI	No problem

We used the following definition of social media: "a group of applications which is based on ideological and technological foundations of Web 2.0 that allows the creation and exchange of user-generated content" [1].

We developed and published a detailed protocol for this review on protocols.io [14], (included in *supplementary file 1*. We followed the PRISMA 2020 checklist to report our study [15].

Eligibility criteria

We included articles that meet the following eligibility criteria:

- Topic: conflict of interest on social media or funding;
- Type of social media: all platforms that fit the Web 2.0 definition, including blogs, Facebook, Instagram, Twitter, LinkedIn, and YouTube;

- Field: health field, including clinical, health systems and policy, public health and biomedical sciences;
- Study design: any primary study including surveys, research letters, and qualitative studies. We excluded editorials, abstracts, letters to the editor, reviews, and opinion pieces;
- Date of publication: 2005 to current (2005 being the year of the rise of Web 2.0);
- Language: any language.

Search strategy

We searched Medline(OVID) (2005-March 2022), Embase (2005-March 2022) and Google Scholar (2005-August 2022). The search strategies included both keywords and medical subject headings (MeSH terms) relevant to the concepts of conflict of interest, funding, and social media. We developed the search strategies with the help of an experienced librarian and included them in the supplementary file *(supplementary file 2*). We conducted our search in the databases with no restrictions on the language. We restricted the search by year (2005 and beyond). In addition, we screened the reference lists of included studies and forward searched for publications citing these included studies via Google Scholar.

Study selection

Teams of two reviewers screened in duplicate and independently the titles and abstracts of citations identified by the search using Rayyan screening tool. We retrieved the full texts of citations judged as potentially eligible by at least one reviewer. Reviewers subsequently screened the full texts in duplicate and independently. They resolved any disagreement by discussion or with the help of a third reviewer when consensus could not be reached. We used standardized and pilot-tested screening tools. We recorded the reasons for exclusion and summarized the results of the selection process using the 2020 PRISMA flow diagram [15]. The reviewers conducted calibration exercises before the screening process.

Data collection process

We developed a standardized and pilot-tested data extraction form with detailed instructions. Two teams of two reviewers abstracted the data from eligible studies independently and in duplicate using a standardized pilot tested form. The reviewers completed calibration exercises before starting the data collection process. They resolved any disagreements by discussion between the two reviewers or with the help of the principal investigator.

We extracted the following variables into a Word document:

1. General characteristics of the study:

- Type of healthcare professionals: physicians, nurses, or other;
- Year of conduct;
- Study design;
- Funding of the study;
- COI of study authors;
- Country of study authors

2. Social media:
   - Type: e.g., Facebook, twitter, Instagram, YouTube, LinkedIn;
   - Number of posts, videos, or blogs assessed;
   - Language of posts, videos, or blogs;
   - Country of the subjects of study;
   - Topic focus of the study, if any.

3. Conflicts of interest:
   - Type of conflict of interest;
   - Subject of conflict of interest;
   - Source of conflict of interest;
   - Tools used to assess the presence of financial relationships;
   - Prevalence of conflict of interest, verified or suspected;
   - Frequency of reporting of conflict of interest;
   - Proportion of undisclosed conflict of interest;
   - Proportion of organizations reporting undisclosed conflict of interest;
   - Association between conflict of interest and post content.

4. Funding:
   - Source of funding;
   - Amount of funding;
   - Role of funder.

Quality assessment and data synthesis

A team of two reviewers assessed independently the risk of bias of included studies using the Mixed Methods Appraisal Tool. This tool is designed for the appraisal stage of systematic reviews that include qualitative, quantitative, or mixed methods studies [16]. Due to the nature of the data, we report the results in narrative and tabular formats.

Patient and public involvement

We did not involve patients or the public in the design, conduct, reporting, or dissemination plans of our research.

RESULTS

Study selection

The PRISMA flowchart (*supplementary file 3*) depicts the study selection process. We excluded 198 studies at the full text screening stage for the following reasons: not about conflicts of interest or funding (n=116), not about social media (n=33), and not the study design of interest (n=66) (*supplementary file 4*). We judged 17 studies to be eligible.

General characteristics

All of 17 included studies were cross-sectional and reported quantitative data. Table 2 shows the remaining general characteristics of these studies. The majority of studies were survey of social media posts (88%), had the United States or Canada as the country of the study subjects (53%), focused on posts in English language (88%), and focused on a specific health specialty (71%). The median year of posts upload date was 2018.The social media most assessed were Twitter (29%), YouTube videos (29%), and blogs (29%).

Table 2 *General characteristics of included studies (N=17)*

	n (%)
Study design	
Survey of posts	13 (76%)
Median sample size (IQR)	159 (879)
Survey of individuals or accounts	4 (24%)
Median sample size (IQR)	117 (205)
Funding of the study	
Funded	4 (24%)
Not funded	6 (35%)

Not reported	7 (41%)
Conflict of interest of study authors	
Conflict of interest reported	5 (29%)
No conflict of interest	11 (65%)
Not reported	1 (6%)
Study focused on a specific health specialty	12 (71%)
Type of social media	
Twitter	5 (29%)
Blogs	5 (29%)
YouTube	5 (29%)
Not specified	2 (12%)
Language of posts§	
English	15 (88%)
Other languages	4 (24%)
No language restriction	1 (6%)
Time period covered	
≤1 year	4 (24%)
11-12 years	4 (24%)
Not specified	9 (53%)
Median year of post date (IQR)	2018 (3)
Country of the subjects of study§	
United States of America	7 (41%)
Canada	2 (12%)
Europe	2 (12%)
Asia	2 (12%)

United Kingdom	1 (6%)
Australia	2 (12%)
Not reported	6 (35%)
No restrictions to countries	1 (6%)
Outcome§	
Prevalence of COI	5 (29%)
Frequency of reporting of COI	8 (47%)
Proportion of undisclosed COI	3 (18%)
Proportion of organizations reporting undisclosed COI	2 (12%)
Association between COI and post content	2 (12%)

§ Some studies included more than one language, country, or outcome

Table 3 shows the characteristics of COI in health communication on social media in the included studies. The majority of the studies had physicians as their study population (76%), specified industry as the source of COI (65%), and did not specify the types of COI studied (59%).

Table 3 *Characteristics of COI in health communication on social media assessed in the included studies (N= 17)*

	n (%)
Subjects of COI	
Physicians	13 (76%)
Medical students	1 (6%)
University	4 (24%)
Healthcare entity (hospital, clinic)	4 (24%)
Others◊	9 (53%)
Source of COI	

Industry	11 (65%)
Others[δ]	2 (12%)
Not specified	6 (35%)
Types of COI	
Financial	7 (41%)
Not specified	10 (59%)

[◊]Others: non-physician health professionals (nurses, dietitians, nutritionists, pharmacists, chiropractors, acupuncturists), patients, societies/organizations (foundations, governmental institutions, academic journals), industry, news media, and bloggers.

[δ] Others: Volunteer donation, foundation, insurer, not-for-profit, webhost, or corporation entity.

Findings

We did not find evidence on the reporting of funding sources of studies cited in health messages on social media. With regards to COI reporting, the included studies assessed one or more of the following 5 outcomes: (1) prevalence of COI, verified or suspected (n=5); (2) frequency of reporting of COI (n=8); (3) proportion of undisclosed COI (n=3); (4) proportion of organizations reporting undisclosed COI (n=2); and (5) association between COI and post content (n=2). We provide the full details in supplementary file 5 and summarize them narratively in the following paragraphs. Supplementary file 6 includes the results of the risk of bias assessment of the included studies. No major concerns were noted.

Prevalence of COI, verified or suspected

Table 4 presents the results from five studies on the prevalence of COI. The prevalence of verified COI (using Open Payment Database) ranged between 15% and 80%. The prevalence of suspected COI (based on authors' judgement) ranged between 0% and 80%.

Table 4 *Results from five studies on the prevalence of COI*

Study	Social Media	Health condition	Prevalence of COI (n of authors with COI / N total authors)
Verified			

Niforatos 2019 [17]	Blogs	Emergency medicine	**15.4%** (45/292) of U.S-based healthcare providers
Tao 2017 [18]	Twitter	Hematology-oncology	**79.5%** (504/634) of U.S-based hematologist-oncologists
Walradt 2021 [19]	Twitter	Gastrointestinal endoscopy	**37%** (7/19) of tweets that mentioned the name of a medical device were posted by a U.S physician who had received a payment
Suspected			
Toth 2019 [12]	Blogs	Detox diets industry	**80%** (4/5) of nutritionist blog posts had a 'potential' COI **None** of registered dietitians blog posts had a 'potential' COI
Chretien 2011 [20]	Twitter	General	**0.2%** (12/5156) of tweets involved 'possible' conflicts of interest

Frequency of reporting COI

Table 5 presents the results of eight studies on the frequency of COI reporting. The frequency ranged from 0% to 60%. It was not clear from any of the studies whether the percentage referred to the number of COI statements (whether reporting the existing or not of COI) or to the number of statements reporting a COI.

Table 5 *Results from eight studies on the frequency of reporting COI*

Study	Social Media	Health condition	Frequency (n of posts reporting COI / N total posts)
Betschart 2020 [21]	YouTube	Treatment options for lower urinary tract symptoms with benign prostatic hyperplasia	**2%** (2/159) (COI reporting)
Lagu 2008 [22]	Blogs	General	**0%** (0/271) (COI reporting)
Nishizaki 2021 [23]	Japanese YouTube videos	Pediatrics: nocturnal enuresis	**0%** (0/72) (COI reporting)
Pratsinis 2021 [24]	YouTube	Treatment options of urinary stones	**9%** (9/100) (COI reporting)
Pratsinis, 2021 [25]	YouTube	Benign prostatic hyperplasia, prostate cancer, and urinary stone disease	"Majority" did not have COI disclosure Estimated: 46/240 (COI reporting)
Vu 2021 [26]	YouTube	Treatment of prostate cancer: surgical therapy versus radiotherapy	**10%** (surgery) and **5%** (radiotherapy) (COI reporting)
Miller 2011 [11]	Blogs	General	**15.6%** (148/951) of health blogs reported sponsorship
Shrank 2011 [27]	Social networking sites (93% featured blogs)	Diabetes information	1. Industry sponsorship: - Pharmaceutical manufacturers: **53.3%** (8/15) - Diabetes device manufacturers: **60%** (9/15)

			- Webhost Sponsorship: **13.3%** (2/15) 2. Foundation sponsorship: **20%** (3/15) 3. Voluntary donations: **26.7%** (4/15) 4. No industry sponsorship: **20%** (3/15) 5. Insurers: **20%** (3/15) 6. Not-for-profit: **26.7%** (4/15)

Proportion of undisclosed COI

We identified three studies reporting on the proportion of undisclosed COI. The proportion values were 99%, 100%, and 100% [17, 19, 28]. All three studies assessed the proportion of COI identified through Open Payment Database but not reported by the authors. It was not clear from any of the studies whether the proportion referred to those who reported no COI or those who had no COI statement.

Proportion of organizations reporting undisclosed COI

We identified two studies on the proportion of organizations reporting undisclosed COI. Chretien et al. [29] surveyed 130 deans of student affairs from institutions in the Association of American Medical Colleges. Out of the 78 deans who responded, 3% (2/78) reported unprofessional incidents related to product endorsement without reporting COI.

Greysen et al. [9] surveyed 48 executive directors of state medical boards about US-based physicians' violations of online professionalism. An estimated percentage of 56% indicated that they received reports of violations related to "failure to reveal conflicts of interest online".

Association between COI and content of posting

We identified two studies on the association between COI and the content of posting. Kaestner et al.[28] analyzed tweets of 156 US-based hematologist-oncologists on oncology drugs; they also verified the physicians' financial conflicts of interest using Open Payments Database. The

authors found that tweets were more likely to be positive (p=0.02) when they related to drugs from a company for which they had a financial COI compared with drugs from a company for which they did not have a financial COI.

Hessari et al.[30] assessed 1156 tweets of alcohol industry-funded organizations and 1649 tweets of non- alcohol industry-funded charities, with all entities aiming to raise alcohol awareness. While 10.1% (n=166/1649) of the non- alcohol industry-funded organizations tweets mentioned alcohol marketing, advertising, sponsorship, issues related to alcohol pricing and physical health harms, none (n=0/1156) of the alcohol industry -funded organizations tweets mentioned those topics.

DISCUSSION

Summary of evidence

We systematically surveyed the literature for the reporting of COI by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media. The frequency of reporting of COI varied across studies but was mostly low (less than 15%). A significant proportion of healthcare professionals using social media have financial relationships with industry (up to 80%). However, most of these relationships are not reported when communicating health-related information. Also, there is evidence of a potential association between COI and the content of posting. We did not find studies on the reporting of funding sources of studies cited in health messages on social media.

These findings are of high importance with the increasing reliance of patients and the public on social media as a source of information and medical advice. Furthermore, there is evidence that the use of social media increases significantly during natural hazard and crises. [31]. This is particularly relevant to the COVID-19 information shared with the public on novel therapeutic agents which may have harmful side effects [32].

Strengths and limitations

To the best of our knowledge, this is the first systematic survey about conflicts of interest and funding in social media. We have applied standard methodology based on the principles of conducting systematic surveys (including a comprehensive search, duplicate screening, data abstraction and quality appraisal).

Unfortunately, a limited number of studies have addressed the topic of reporting of conflicts of interest in social media, and none has explored the reporting of funding of studies cited in health messages on social media. In addition, the included studies were heterogeneous in terms of study designs and outcomes reported, which prevented us from conducting a more advanced synthesis.

Two of the included studies found an association between COI and the content of social media posting. However, it is not clear whether the relationship is causal, i.e., having it is the COI that leads to a specific point of view.

Implications for practice and research

Reporting conflict of interest and funding on social media is a basic requirement for the responsible use of social media during, particularly during crises associated with "infodemics", such as the COVID-19 pandemic [33]. Clear guidance and policies are needed for the reporting of COI and funding by health care professionals when using social media. In addition, improving media literacy is essential to ensure the public is aware of the potential role of COI and funding, and the importance of their reporting in the context of social media.

Future research should explore the impact of COI in social media on the perceptions, beliefs, and behaviors of their users. Despite the extent of misinformation, and disinformation on social media during the COVID-19 pandemic [34], no study has assessed the prevalence of COI in that context. Interestingly, one study found a correlation between the amounts received by academic infectious diseases physicians from Gilead Sciences, producer of remdesivir, and their public opposition to the use of hydroxychloroquine [35]. Therefore, it would be important to explore the prevalence of COI in that context and the relationship between COI, misinformation, and disinformation. From a methodological point of view, future studies should clearly distinguish between the absence of a COI statement and a statement of absence of COI.

DECLERATIONS

Authors Contributions

EAA conceived and designed the study. VH and FM coordinated various parts of the study. EAA had full access to all the data in the study and takes responsibility for the integrity and accuracy of the data analysis. LH, VH and FM designed the search strategy. FM and RAK ran the search and VH later updated it. VH, FM, JK, HN, AM, RAK, DAO, and RH contributed to the study selection process. VH, FM, AM, HN, and JK extracted the data. VH and FM analyzed the data. VH, FM, JK, and EAA interpreted the data. FM wrote the first draft of the manuscript with EAA; VH worked on subsequent drafts with JK and EAA. All authors critically revised the manuscript and approved the final manuscript.

Ethics and dissemination

This systematic survey did not involve human research participants, and therefore does not require ethical approval.

Patient Consent

Patient consent is not applicable.

Transparency

EAA affirms that this manuscript is an honest, accurate, and transparent account of the study being reported, that no important aspects of the study have been omitted and that any discrepancies from the planned study have been explained.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest

EAA and JK have conducted studies on the topics of conflicts of interest and funding.

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information.

SUPPLEMENTARY MATERIAL

Supplementary file 1: Systemic survey protocol.

Supplementary file 2: Search strategies used in Medline(OVID), Embase and Google Scholar.

Supplementary file 3: PRISMA flow diagram for systematic reviews.

Supplementary file 4: Excluded studies in full-text screening with their corresponding reasons of exclusion.

Supplementary file 5: Characteristics of the 17 included studies.

Supplementary file 6: Appraisal of the 17 included studies using Mixed Methods Appraisal Tool.

ABBREVIATIONS

COI: conflicts of interest

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

COVID-19: Corona Virus Disease 2019

OPD: Open Payment Database

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Supplemental file 1: Systematic survey protocol

Title: Conflict of interest and funding in health communication on social media: a systematic survey

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Keywords: conflict of interest, funding, social media, health, systematic review

Ethical approval: The study involves no human subjects and requires no ethical approval.

BACKGROUND

Social media has reshaped the dissemination of information and medical education. The patient-physician relationship has been transformed with the introduction of social media especially during the COVID-19 pandemic when quarantine and restrictions were applied. Many users rely on the internet to find answers to their medical questions. Health professionals can communicate and share their health-related opinions using posts, videos, or blogs.

Within recent years, the use of social media by physicians and health care professionals has increased significantly with some estimates reporting increases from 42% in 2010 to as high as 90% in 2011 [1]. While 90% of health care professionals use social media platforms for personal purposes, 65% use them for professional reasons such as promotion of health behaviors, discussions of health care policy, communicating with colleagues, and education of patients, peers, and students [2]. However, professionals may have conflicts of interest (COI) that may bias their shared health-related recommendations on their platforms [1].

STUDY OBJECTIVES

The objective of this study was to synthesize the available evidence on the disclosure of conflicts of interests by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media,

METHODS

Design overview and definitions

We will conduct a systematic review to identify studies that addressed reporting of conflict of interest and funding in social media health communications. We will use the following definitions:

- Conflict of interests: “a COI exists when a past, current, or expected interest creates a significant risk of inappropriately influencing an individual’s judgment, decision, or action when carrying out a specific duty” [3].
- Declaration statement: any statement reporting a COI of a named individual, whether indicating the absence of COI or presence of a specific COI and describing it.

Eligibility criteria

We will include articles that meet the following eligibility criteria:

- Topic: conflict of interest on social media or funding;
- Type of social media: we will include all social media platforms that fit the Web 2.0 definition. This includes blogs, and social media applications such as Facebook, Instagram, Twitter, LinkedIn, and YouTube. We will exclude studies that involved traditional media channels (Web 1.0) such as newspapers, radio, TV, emails, and websites;
- Field: health field, including clinical, health systems and policy, public health and biomedical sciences;
- Study design: any primary study including surveys, research letters, and qualitative studies. We will exclude editorials, abstracts, letters to the editor, reviews and opinion pieces;
- Date of publication: 2005 to current, with 2005 being the year of the rise of Web 2.0;
- Language: any language.

Search strategy

We developed a search strategy, using the help of a librarian, for MEDLINE, EMBASE and Google Scholar electronic databases from 2005 to present. The search combined various keywords and medical subject headings (MeSH) terms relevant to concepts of conflict of interest, funding, and social media. We did not restrict the search to specific languages. We will also screen the reference lists of included studies as well as other relevant papers.

Article selection

Teams of two reviewers will assess in duplicate and independently the titles and abstracts of citations identified by the search for potential eligibility using Rayyan screening tool. We will retrieve the full texts of citations judged as potentially eligible by at least one reviewer. Reviewers subsequently will screen in duplicate and independently the full texts using Rayyan screening tool. They will resolve any disagreements by discussion or with the help of a third reviewer when consensus cannot be reached. We will use standardized and pilot-tested screening tools. We will record the reasons for exclusion and summarize the results of the

selection process using the 2020 PRISMA flow diagram. The reviewers will conduct calibration exercises before the screening process.

Data abstraction

The reviewers will abstract data from eligible studies in duplicate and independently. We will use a standardized and pilot-tested data abstraction form. Disagreements will be resolved through discussion or with the help of a third reviewer (EAA). We will conduct a calibration exercise to enhance the validity of the process. Study authors will be contacted for any clarification.

We will abstract the following variables from each included study:

1. General characteristics of the study:
    - Population (e.g., type of healthcare professionals: physicians, nurses, or other);
    - Year of conduct;
    - Study design;
    - Funding of the study;
    - COI of study authors
    - Country of study authors

2. Social media:
    - Type of social media (e.g., Facebook, twitter, Instagram, YouTube, LinkedIn …);
    - Number of posts, videos or blogs assessed;
    - Language of posts, videos or blogs
    - Country of the subjects of study
    - Topic focus of the study, if any.

3. Conflict of interest:
    - Type of conflict of interest
    - Subject of conflict of interest
    - Source of conflict of interest
    - Tools used to assess the presence of financial relationships
    - Prevalence of conflict of interest
    - Frequency of reporting of conflict of interest

- Proportion of undisclosed conflict of interest
- Unprofessional incidents involving conflict of interest

4. Funding:
   - Type of funding
   - Source of funding
   - Frequency of reporting of funding

Quality assessment

A team of two reviewers will assess independently the risk of bias of included studies using Mixed Methods Appraisal Tool (MMAT). This tool is designed for the appraisal stage of systematic reviews that include qualitative, quantitative or mixed methods studies [4]. We expect most of the studies to be cross-sectional and these will be assessed using the relevant part of the tool.

Data synthesis

Due to the nature of the data, we will report the results in narrative and tabular formats.

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Supplementary file 2: Search strategies used in Medline(OVID), Embase and Google Scholar

Medline Search Strategy

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to February 15, 2019>
Search Strategy:
---

1 "Conflict of Interest"/ (9255)
2 ((competing or conflict*) adj3 (interest? or influence? or relationship?)).mp. (18489)
3 financial support/ or research support as topic/ (25591)
4 (((financ* or monetary or industr* or pharmaceutical*) adj3 (fund* or pay* or paid or support or contributi* or compensat* or sponsor* or backing or (kick adj back*) or incentive? or re?imburse* or subsidi* or award* or endow* or tie? or link* or associat* or affiliation? or relation* or grant*)) or disclos*).mp. (120953)
5 Disclosure/ (12719)
6 Gift Giving/ (1521)
7 ((financ* or gift? or gift-giving) adj3 (disclos* or report* or declar* or reveal* or receiv* or giv* or gave or accept* or award* or admit*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (7487)
8 or/1-7 (158539)
9 exp Mass Media/ (44039)
10 (mass adj2 (media? or medium or communication?)).mp. (16758)
11 (columnist? or reporter? or correspondent? or commentator? or reviewer?).mp. (145928)
12 Social Media/ (5474)
13 (((social or digital) adj2 (medium or media* or network* or net-work* or bookmark* or book-mark* or application? or debate* or channel* or communication? or collaborat*)) or (institution* adj repositor*)).mp. (35361)
14 Blogging/ (903)
15 (blog* or microblog* or micro-blog* or weblog*).mp. (2308)
16 (tout or wordpress or yammer or citeulike or zotero or evernote or delicious or Digg or picasa or youtube or Vimeo or reddit or snapchat or mendeley).mp. (3525)
17 exp Social Networking/ (2487)
18 (facebook or twitter or tweet* or LinkedIn or pinterest).mp. (5334)
19 ((Google adj plus) or google?+).mp. (15664)
20 (Tumblr or Instagram or myspace or researchgate or academia or figshare or mendeley).mp. (7153)
21 Webcasts as Topic/ (301)
22 (podcast* or pod-cast* or webcast* or web-cast*).mp. (1687)
23 (rss adj2 feed*).mp. (49)
24 (weibo or flickr).mp. (171)
25 ((virtual or video* or content? or project? or audio or digital or online or forum? or web) adj2 (world? or reality or place? or communit* or communicat* or collaborat* or shar*)).mp. (23762)
26 (web adj2 application*).mp. (2856)
27 ((user adj generated) or usergenerated).mp. (359)

28 (wikipedia or wiki* or "web 2.0").mp. (1786)
29 ((knowledge or internet or (electronic adj mail) or email or e-mail or health or listserv*) adj2 (share* or communicat* or sharing? or collaborat*)).mp. (15600)
30 or/9-29 (296669)
31 8 and 30 (4486)
32 limit 31 to yr="2005 -Current" (3436)

****

EMBASE Search Strategy

#33 #32 AND (2005:py OR 2006:py OR 2007:py OR 2008:py OR 2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py OR 2019:py OR 2020:py OR 2021:py OR 2022:py) **5551**

#32 #31

#31 #9 AND #30 **6193**

#30 #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 **334472**

#29 (knowledge OR internet OR electronic) NEAR/2 (mail OR email OR 'e mail' OR health OR listserv*) NEAR/2 (share* OR communicat* OR sharing* OR collaborat*) **2485**

#28 wikipedia OR wiki* OR 'web 2.0' **2900**

#27 (user NEXT/1 generated) OR usergenerated **407**

#26 web NEAR/2 application* **3670**

#25 (virtual OR video* OR content* OR project* OR audio OR digital OR online OR forum* OR web) NEAR/2 (world* OR reality OR place* OR communit* OR communicat* OR collaborat* OR shar*) **44943**

#24 weibo OR flickr **1657**

#23 rss NEAR/2 feed* **72**

#22 podcast* OR 'pod cast*' OR webcast* OR 'web cast*' **1687**

#21 'webcast'/de **310**

#20 tumblr OR instagram OR myspace OR researchgate OR academia OR figshare OR Mendeley **41870**

#19 (google NEXT/1 plus) OR google?+ **63**

#18 facebook OR twitter OR tweet* OR linkedin OR pinterest **7561**

#17 'social network'/exp **13447**

#16 tout OR wordpress OR yammer OR citeulike OR zotero OR evernote OR delicious OR digg OR picasa OR youtube OR vimeo OR reddit OR snapchat **4608**

#15 blog* OR microblog* OR 'micro blog*' OR weblog* **3710**

#14 'blogging'/de **260**

#13 ((social OR digital) NEAR/2 (medium OR media* OR network* OR 'net work*' OR bookmark* OR 'book mark*' OR application? OR debate* OR channel* OR communication? OR collaborat*)) OR (institution* NEAR/2 repositor*) **44828**

#12 'social media'/de **13939**

#11 columnist* OR reporter* OR correspondent* OR commentator* OR reviewer* **172962**

#10 'mass medium'/exp **17396**

#9 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 **224956**

#8 (financ* OR gift* OR 'gift giving') NEAR/3 (disclos* OR report* OR declar* OR reveal* OR receiv* OR giv* OR gave OR accept* OR award* OR admit*) **10745**

#7 'gift giving'/de **1086**

#6 disclos* **89957**

#5 (financ* OR monetary OR industr* OR pharmaceutical*) NEAR/3 (fund* OR pay* OR paid OR support OR contributi* OR compensat* OR sponsor* OR backing OR 'kick back' OR incentive* OR re*imburse* OR subsidi* OR award* OR endow* OR disclos* OR tie OR ties OR link* OR associat* OR affiliat* OR relation* OR grant*) **80180**

#4 research NEAR/1 support **6650**

#3 'funding'/de **37321**

#2 (competing OR conlict*) NEAR/3 (interest* OR influence* OR relationship*) **22710**

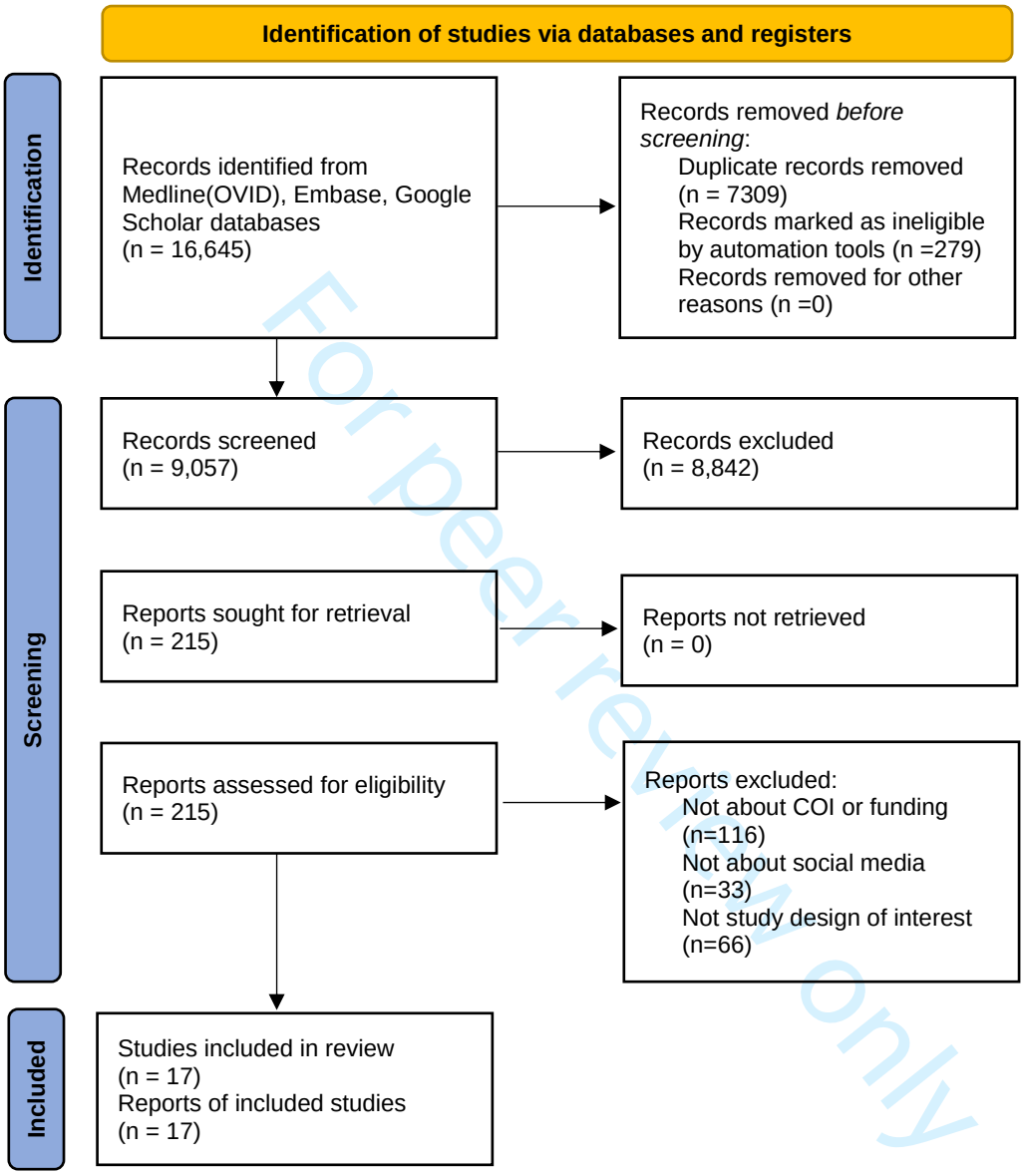
#1 'conflict of interest'/exp **11111**

……..

Google Scholar

("Conflict of Interest" OR "Conflict of Interests" OR "Competing Interest" OR "Competing Interests" OR "financial support" OR "financial declaration") AND (Facebook OR Instagram OR twitter OR tweet OR Pinterest OR LinkedIn OR fig share OR Mendeley OR Snapchat OR "social media")
Picked: 200 articles

Supplementary file 3: PRISMA 2020 flow diagram for systematic reviews



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Supplementary File 4: Excluded studies in full-text screening with their corresponding reason of exclusion.

Author/Journal, year	Reason of exclusion
Aase 2010 [1]	Not study design of interest
Abdel-Wahab 2019 [2]	Not about COI
Aboujaoude 2019 [3]	Not about COI
Addiction 2011 [4]	Not about social media
Ahc 2019 [5]	Not about social media
AIDS alert 2011 [6]	Not about social media
Aiken 2012 [7]	Not about COI
Al-Balushi 2020 [8]	Not study design of interest
Alshaikh 2019 [9]	Not about social media
Anderson 2010 [10]	Not about COI
Anderson 2010 [10]	Not study design of interest
Anderson 2013 [11]	Not about COI
Apperson 2019 [12]	Not about COI
Au 2021 [13]	Not study design of interest
Azizi 2013 [14]	Not about COI
Back letter 2008 [15]	Not about social media
Back letter 2008 [16]	Not about social media
Baier 2019 [17]	Not about COI
Bamat 2018 [18]	Not study design of interest
Barber 2020 [19]	Not about social media
Barreda 2015 [20]	Not about COI
Baxter 2009 [21]	Not study design of interest
Bayne 2017 [22]	Not about COI
Bechini 2021 [23]	Not about social media
Becker 2015 [24]	Not about social media
Bertholf 2021 [25]	Not study design of interest
Bhat 2019 [26]	Not study design of interest
Bibault 2017 [27]	Not study design of interest
Blastl 2020 [28]	Not study design of interest
Bosslet 2011 [29]	Not about COI
Braccia 2009 [30]	Not about COI
Braillon 2018 [31]	Not study design of interest
Braunstein 2012 [32]	Not about COI
Bredenoord 2017 [33]	Not about COI
Bukhari 2021 [34]	Not about social media
Bullock 2014 [35]	Not about COI
Cain 2010 [36]	Not about COI
Capel 2019 [37]	Not about COI
Carson 2018 [38]	Not about COI
Casigliani 2020 [39]	Not study design of interest
Casswell 2018 [40]	Not about social media

Chan 2012 [41]	Not study design of interest
Chretien 2013 [42]	Not study design of interest
Coutts 2018 [43]	Not about social media
Cunningham 2014 [44]	Not about COI
Dainton 2009 [45]	Not about COI
De Ambrogi 2019 [46]	Not study design of interest
DeCamp 2012 [47]	Not study design of interest
DeCamp 2013 [48]	Not study design of interest
DeCamp 2013 [49]	Not study design of interest
DeChello 2012 [50]	Not study design of interest
Denecke 2014 [51]	Not study design of interest
Dolgin 2019 [52]	Not about social media
Douglas 2020 [53]	Not study design of interest
Drone 2015 [54]	Not about COI
Dugdale 2021 [55]	Not study design of interest
ED management 2005 [56]	Not about COI
Englund 2012 [57]	Not about COI
Essary 2011 [58]	Not about COI
Failli 2021 [59]	Not about social media
Faloon 2006 [60]	Not about COI
Farrelly 2014 [61]	Not about COI
Fattore 2019 [62]	Not about COI
Fontanarosa 2019 [63]	Not about social media
For the Record 2011 [64]	Not study design of interest
For the record 2013 [65]	Not study design of interest
Frankish 2012 [66]	Not about COI
Galbraith 2014 [67]	Not about COI
Gifford 2021 [68]	Not study design of interest
Gilligan 2019 [69]	Not study design of interest
Gordon 2010 [70]	Not about COI
Gottlieb 2020 [71]	Not study design of interest
Grace 2021 [72]	Not about COI
Grummer-Strawn 2019 [73]	Not about social media
Guo 2020 [74]	Not study design of interest
Gupta 2020 [75]	Not study design of interest
Haddas 2021 [76]	Not study design of interest
Haldar 2010 [77]	Not about COI
Hampton 2005 [78]	Not about social media
Hanley 2012 [79]	Not about COI
Harris 2012 [80]	Not about COI
Henderson 2014 [81]	Not about COI
Henderson 2020 [82]	Not about COI
Henry 2014 [83]	Not about COI
Hernandez-Aguado 2020 [84]	Not about COI

Hessari 2019 [85]	Not study design of interest
Hetzler 2020 [86]	Not about COI
Holden 2017 [87]	Not about COI
Huby 2016 [88]	Not about COI
Hwang 2016 [89]	Not health field
Hwong 2014 [90]	Not study design of interest
Islam 2019 [91]	Not study design of interest
Jiang 2017 [92]	Not about COI
Jones 2021 [93]	Not about COI
Joshi 2020 [94]	Not study design of interest
Journal of Instructional Psychology 2012 [95]	Not about COI
Journal of Korean medical science 2015 [96]	Not about COI
Katz 2014 [97]	Not about COI
Kh 2009 [98]	Not about social media
Kirschner 2013 [99]	Not study design of interest
Kleebauer 2014 [100]	Not about COI
Knoepfler 2016 [101]	Not about COI
Knopf 2018 [102]	Not about COI
Korman 2021 [103]	Not about social media
Kullgren 2014 [104]	Not about COI
Kunze 2020 [105]	Not about COI
Lachman 2013 [106]	Not about COI
Lackner 2012 [107]	Not about social media
Lagu 2011 [108]	Not about COI
Layng 2012 [109]	Not about COI
Lazard 2020 [110]	Not about COI
Lee 2016 [111]	Not health field
Lee 2020 [112]	Not about COI
Lerner 2013 [113]	Not about COI
Lin 2016 [114]	Not about COI
Lusis 2009 [115]	Not about COI
Macauley 2021 [116]	Not study design of interest
MacWilliam 2006 [117]	Not study design of interest
Mansfield 2011 [118]	Not about COI
Margaret 2019 [119]	Not about COI
Mayes 2018 [120]	Not about social media
McCarthy 2018 [121]	Not study design of interest
McComas 2008 [122]	Not about COI
McCullough 2010 [123]	Not about COI
Medical marketing 2016 [124]	Not study design of interest
Militello 2021 [125]	Not study design of interest
Milton 2014 [126]	Not about COI
Milton 2016 [127]	Not about COI
Milton 2018 [128]	Not about COI
Minhas 2006 [129]	Not study design of interest

Modern Healthcare 2017 [130]	Not about COI
Moodley 2013 [131]	Not about COI
Moses 2014 [132]	Not about COI
Moukarzel 2021 [133]	Not study design of interest
Murakami 2019 [134]	Not about COI
Muzumdar 2021 [135]	Not study design of interest
Naeem 2021 [136]	Not about COI
Nau 2017 [137]	Not about COI
Neuer 2019 [138]	Not about social media
Neville 2015 [139]	Not about COI
Neville 2016 [140]	Not about COI
Nursing ethics 2015 [141]	Not study design of interest
Nursing standard 2016 [142]	Not study design of interest
Nursing times 2011 [143]	Not study design of interest
O'Glasser 2020 [144]	Not study design of interest
O'Hanlon 2011 [145]	Not about COI
O'Keeffe 2019 [146]	Not study design of interest
O'Rourke 2015 [147]	Not about COI
Oncology 2012 [148]	Not about COI
Ong 2021 [149]	Not study design of interest
OR Manager 2009 [150]	Not about COI
Oransky 2006 [151]	Not study design of interest
Ornstein 2011 [152]	Not about social media
Padeiro 2021 [153]	Not about COI
Pagoto 2019 [154]	Not about COI
Parasidis 2019 [155]	Not about COI
Paterson 2019 [156]	Not study design of interest
Peltier 2012 [157]	Not about social media
Pelton 2012 [158]	Not about COI
Pierce 2019 [159]	Not about COI
Prasad 2018 [160]	Not study design of interest
Prateek 2018 [161]	Not about COI
Ragan 2012 [162]	Not about COI
Ranpariya 2020 [163]	Not study design of interest
Ravn 2020 [164]	Not about COI
Rechenberg 2013 [165]	Not about social media
Redick 2022 [166]	Not about social media
Research Practitioner 2011 [167]	Not about social media
Roucka 2014 [168]	Not about COI
Roupret 2014 [169]	Not about COI
Samsa 2019 [170]	Not about social media
Santillan-Doherty 2020 [171]	Not about COI
Santoro 2015 [172]	Not about COI
Santoro 2022 [173]	Not study design of interest
Sartor 2019 [174]	Not about social media

Scruth 2015 [175]	Not about COI
Seppey 2017 [176]	Not about social media
Sh 2019 [177]	Not about COI
Sharma 2020 [178]	Not about COI
Shore 2011 [179]	Not about COI
Silva 2018 [180]	Not about COI
Sissung 2021 [181]	Not study design of interest
Slagle 2011 [182]	Not about social media
Smyth 2005 [183]	Not study design of interest
Snyder 2011 [184]	Not about COI
Studenic 2019 [185]	Not about COI
Swartz 2016 [186]	Not about COI
Tanchuco 2020 [187]	Not about COI
Technology 2021 [188]	Not about COI
Terrasse 2019 [189]	Not study design of interest
The American nurse 2015 [190]	Not study design of interest
Tulloch 2011 [191]	Not about COI
Van Cauwenberghe 2012 [192]	Not about COI
Van Eperen 2010 [193]	Not about COI
Varghese 2019 [194]	Not study design of interest
Varghese 2019 [195]	Not study design of interest
Vogel 2020 [196]	Not about COI
Wagner 2012 [197]	Not study design of interest
Wallen 2013 [198]	Not about COI
Wang 2019 [199]	Not about COI
Wayant 2018 [200]	Not about social media
Weijs 2017 [201]	Not about COI
Weijs 2019 [202]	Not about COI
Weinstein 2011 [203]	Not about COI
Wheelock 2021 [204]	Not study design of interest
White 2007 [205]	Not about COI
Wilkinson 2018 [206]	Not about COI
Williams 2011 [207]	Not about COI
Wisniewski 2017 [208]	Not about COI
Yan 2020 [209]	Not study design of interest
Yeh 2018 [210]	Not about COI
Yeo 2020 [211]	Not about COI
Zember 2015 [212]	Not about COI
Zenone 2021 [213]	Not study design of interest
Zhitomirsky 2016 [214]	Not study design of interest
Zhou 2018 [215]	Not study design of interest

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Supplementary file 5: Characteristics of the 17 included studies related to conflicts of interest.

Author, Year	Date of search/data collection	Start Upload Date	End Upload Date	Period of coverage	Population	Study outcomes	Funding of the study	COI of study authors	Country of study authors	Country of the subjects of study	Type of social media	Focus	Language of posts	Subject of COI	Type of COI	Sources of COI	Tools to assess the presence of COI	**Results**
Betschart 2020 [21]	May 2019	July 2007	May 2019	12 years	Cross-sectional: Survey of 159 YouTube videos addressing treatment options for lower urinary tract symptoms with benign prostatic hyperplasia	Frequency of reporting of COI	Not reported	None	Switzerland Germany	Not reported	YouTube	Urology: lower urinary tract symptoms associated with benign prostatic hyperplasia.	English	Physicians, clinic, hospital, or university Others: Industry, news media, societies/organizations	Not specified	Not specified	None	▪ **1.3%** (2/159) videos included a disclosure of conflicts of interest ▪ 83.6% (133/159) of the videos were subject to commercial bias (defined as information presented in a manner that attempts to sway participants' opinions in favor of a particular commercial product for the express purpose of furthering a commercial entity's business, meaning a deliberate intent to mislead).
Chretien 2009 [29]	March/April 2009	N/A	N/A	N/A	Cross-sectional: Electronic survey of 78 deans of student affairs, their representatives, or counterparts from US medical schools in the Association of American Medical Colleges	Unprofessional incidents involving COI	Not reported	None	United States	United States	Web 2.0: not specified otherwise	General	English[1]	Medical students	Not specified	Industry	None	▪ **4%** (2/46) of all reported unprofessional incidents involved conflicts of interest (e.g., product endorsement without a COI disclosure)
Chretien 2011 [20]	May 2010	May 1, 2010	May 31, 2010	1 month	Cross-sectional:	Unprofessional	Not reported	None	United States	United States,	Twitter	General: surgery,	English	Physicians	Not specified	Industry	None	▪ **8.3%** (12/144) of unprofessional tweets

					Survey of 5156 tweets of 260 self-identified physicians with >500 followers	tweets involving 'possible' COI				Europe, Canada, Asia, Australia, not specified		internal medicine, family medicine, pediatrics, psychiatry, emergency medicine, obstetrics/gynecology, and not specified						involved 'possible' conflicts of interest (i.e., making unsupported claims about a product being sold on the physician's website or repeatedly promoting specific health products)
Greysen 2012 [9]	N/A	N/A	N/A	N/A	Cross-sectional: Survey of 48 executive directors of all medical and osteopathic boards in the US	Unprofessional incidents involving COI	Funded by the Robert Wood Johnson Foundation and the Department of Veterans Affairs	1/5 reported serving as a scientific advisory board member for Fair Health Inc and receiving funding as a collaborator on the Yale University Open Data Access project	United States	United States	Not specified	General	English[1]	Physicians	Not specified	Not specified	None	▪ **56%** of state medical boards indicated that they received reports of violations related to "failure to reveal conflicts of interest online" (estimated percentage from the figure)
Hessari 2019 [30]	December 2016	January 2016	December 2016	1 year	Cross-sectional: Survey of a total of 2805 tweets of Alcohol industry (AI)-	Association between COI and content of posting	None	None	United Kingdom	United Kingdom, Ireland, Australia	Twitter	Social aspects/public relations organizations related to alcohol	English[1]	Alcohol industry (AI)-funded organizations and non-AI-funded charities	Sponsorship by alcohol industry	Alcohol industries	None	▪ **None** (0/1156) of alcohol-industry funded organizations tweets mentioned alcohol marketing, advertising, and sponsorship; issues related to alcohol pricing; physical health harms, including cancers, heart disease,

					funded organizations (1156 tweets) and non-AI-funded charities (1649 tweets)							awareness						dementia and diabetes; and fertility and pregnancy ▪ **10.1% (**166/1649) of non-industry-funded organizations tweets mentioned alcohol marketing, advertising, and sponsorship; issues related to alcohol pricing; physical health harms, including cancers, heart disease, dementia and diabetes; and fertility and pregnancy
Kaestner 2017 [28]	Jan 7-25, 2017	N/A	N/A	N/A	Cross-sectional: Survey of twitter accounts of 156 hematologist-oncologists in the US with a FCOI (at least US$1000 in 2014), and frequent tweets (at least 100 total Tweets); physicians with private accounts were excluded	Proportion of undisclosed COI Association between COI and content of posting	Not reported	1/4 reported receiving payments for his book "Ending Medical Reversal".	United States	United States	Twitter	Hematology-oncology	English	Hematology-oncology physicians	Financial COI: payment	Biopharmaceutical industry	Open Payments database	▪ **1.3%** (2/156 physicians) of U.S-based hematologist-oncologists, who had financial conflicts of interest according to OPD, included disclosures of their payments, and these were in their 5-line twitter biography. ▪ **81%** (126/156) of physicians mentioned at least one drug from a company for which they had a FCOI ▪ Of 4358 total drug mentions, 52% (2252/4358) regarded conflicted drugs. ▪ Association between COI and coding of tweets (positive, neutral, or negative): conflicted tweets were more likely to be positive (p=0.02), similarly likely to be neutral (p=0.45), and less likely to be negative (p=0.008) ▪ General payment FCOI: Median $13,668 (IQR, $4,292-$33,213) Range $1,031-$444,055

																		More than half of drug mentions refer to a median of six companies that pay these physicians
Lagu 2008 [22]	December 14, 2006	January 1, 2006	December 14, 2006	1 year	Cross-sectional: Survey of 271 health-related blogs by doctors or nurses	Frequency of reporting of COI	Partially funded by The Robert Wood Johnson Foundation Clinical Scholars program	None	United States	Not reported	Blogs (Medlogs, Yahoo Health and Medicine Blogs and The Medical Blog Network)	General	English[1]	Physicians and nurses	Not specified	Industry	None	▪ **None** (0/31) of the blogs that explicitly promoted a specific healthcare product (i.e., providing product images, descriptions, or advocacy) disclosed conflicts of interest.
Miller 2011 [11]	June 2007 and May 2008	N/A	N/A	N/A	Cross-sectional: Survey of 951 health blogs	Frequency of reporting of COI	Not reported	Not reported	United States	Not reported	Blogs	General	English	Physicians Others: other non-physician health professionals, patient, individual, consumer, caregiver	Funding/sponsorship	Corporation, Web site, medical group, foundation, or other entity	None	▪ **15.6%** (148/951) of health blogs reported sponsorship Sponsorship stratified by occupation (p=0.053): ▪ 14.9% (29/194) of physicians reported sponsorship in their blogs ▪ 19.7% (50/254) of other health professionals reported sponsorship in their blogs ▪ 12.9% (58/451) of non-health-related occupations reported sponsorship in their blogs
Niforatos 2019 [17]	N/A	June 1, 2017	June 1, 2018	1 year	Cross-sectional: Survey of 31 FOAMed blogs and websites	Prevalence of COI Proportion of undisclosed COI	Not reported	None	United States	United States	Blog posts and website entries	Emergency medicine	English[1]	Emergency medicine physicians	Financial: 1) compensation for services other than consulting, including serving as faculty or as a speaker at a venue	Industry	Open Payments database	▪ **15.4%** (45/292) of U.S-based healthcare providers had FCOI in the 2017 Open Payments database. ▪ Of the 12 bloggers who had 'significant' FCOI (defined as general or research payments>$5,000 from a single company over a 12-month period): **0%**

															other than a continuing education program; 2) consulting fee; 3) travel and lodging; 4) honoraria; 5) food and beverage; and (6) education.			(0/12) disclosed FCOI in their FOAMed content. ▪ General payment FCOI: Median $191 (IQR, $94.1–$829) Range $38,132 ▪ Research payment FCOI: Median $15,703 (IQR, $10,262–$72,916) Range $127,261 ▪ Type of FCOI: Food and beverages (85.8%), Travel and lodging (8.6%), Other services (1.9%), Honoraria (1.9%), consulting (1.2%), and education (0.6%).
Nishizaki 2021 [23]	August 2021	N/A	N/A	N/A	Cross-sectional: Survey of 72 YouTube videos reporting on pediatrics nocturnal enuresis	Frequency of reporting of COI	Not reported	None	Japan	Japan	YouTube	Pediatrics: nocturnal enuresis	Japanese	1. Physicians, nurses 2. non-health personnel: (1) academic (authors/uploaders affiliated with research groups or universities/colleges); (2) non-physician health personnel (pharmacists/chiropractors/acupuncturists); (4) independent user (nursery	Not specified	Not specified	None	▪ **0%** (0/72) of videos had a conflicts of interest declaration by the uploader ▪ 0% (0/72) videos were judged to have a commercial bias

														schoolteachers/schoolteachers), and (5) patient and family				
Pratsinis, 2021 [24]	October 2019	December 2006	December 2018	12 years	Cross-sectional: 100 YouTube videos addressing treatment options of urinary stones	Frequency of reporting of COI	None	None	Switzerland, Germany	Not reported	YouTube	Urology: surgical treatment of urinary stones	English	Physicians, clinic, hospital or university Industry, consumer/patient, medical societies/organizations and news media	Not specified	Not specified	None	▪ **9%** (9/100) of YouTube videos had a declaration of COI ▪ 72% of all videos were issued by healthcare providers or medical industry
Pratsinis 2021 [25]	October 2020	January 2008	June 2020	12 years	Cross-sectional: Survey of 240 YouTube videos reporting on benign prostatic hyperplasia, prostate cancer, and urinary stone disease. The 20 most viewed videos for each urological condition and language were included in the analysis.	Frequency of reporting of COI	None	None	Switzerland	Not reported	YouTube	Urology: benign prostatic hyperplasia, prostate cancer, and urinary stone disease	English, French, German, and Italian	Physicians, clinic, hospital or university Industry, consumer/patient, medical societies/organizations and news media	Not specified	Not specified	None	▪ "Majority" of all videos did not have declaration of conflicts of interest ▪ Estimated percentage of COI declaration: across 12 categories, proportion of videos reporting on COI ranges from 4.4%-35%, with a median of 19%; the total percentage of reporting of COI in the 240 videos is 19% ▪ No differences in reported COI for the different languages assessed

Shrank 2011 [27]	November 17, 2010.	N/A	N/A	N/A	Cross-sectional: Survey of 15 social networking sites (93% featured blogging)	Frequency of reporting of COI	Funded (by a research grant from CVS Caremark and a career development award from the National Heart, Lung, and Blood Institute)	None	United States	All countries	Social network websites	Diabetes	All languages	Health bloggers	Financial	Volunteer donation, foundation, pharmaceutical manufacturer, device manufacturer, insurer, not-for-profit, webhost	None	1. Industry sponsorship: Pharmaceutical manufacturers: **53.3%** (8/15) Diabetes device manufacturers: **60%** (9/15) Webhost Sponsorship: **13.3%** (2/15) 2. Foundation sponsorship: **20%** (3/15) 3. Voluntary donations: **26.7%** (4/15) 4. No industry sponsorship: **20%** (3/15) 5. Insurers: **20%** (3/15) 6. Not-for-profit: ▪ **26.7%** (4/15)
Tao 2017 [18]	June 1 - August 1, 2016	N/A	N/A	N/A	Cross-sectional: Survey of Twitter accounts of 634 hematologist-oncologists in the US	Prevalence of COI	Funded by Laura and John Arnold Foundation	1/4 reported receiving payments for contributions to Medscape	United States	United States	Twitter	Hematology-oncology	English[1]	Hematology-oncology physicians	Financial (general payments and research payments)	Industry	Open Payments database	▪ **79.5%** (504/634) of U.S-based hematologist-oncologists were reported on the Open Payment Database for having at least 1 FCOI ▪ Type of COI: General and research payments: 41% (262/634) of hematologist-oncologists Receiving general payment: 72.4% (459/634) of hematologist-oncologists Prevalence research payment: 48.4% (307/634) of hematologist-oncologists ▪ General payment FCOI: Median $1,644 (IQR, $129-$13,744) ▪ Research payment FCOI:

																		Median $11,064 (IQR, $0-$175164) General payments seemed consistent regardless of the extent of Twitter use, while research payments appeared greatest among those who use Twitter the least
Toth 2019 [12]	November 2017	N/A	N/A	N/A	Cross-sectional: Survey of 10 blog posts of nutritionists and registered dieticians in Ontario	Prevalence of 'potential' COI	None	1/5 reported being the chair of the Professional Titles for Dietitians in Ontario Advocacy Group and 5/5 of authors are Ontario registered dietitians	Canada	Canada	Blogs	Detoxification diets	English	Nutritionists and registered dietitians in Ontario	Not specified	Detox diets industry	None	▪ **80%** (4/5) of nutritionist blog posts had a 'potential' COI (i.e., selling a product or service related to detox diets, including selling books, meal plan guides, and products such as juices) ▪ **None** of registered dietitians blog posts had a 'potential' COI
Vu 2021 [26]	March 2021	February 2008 (surgery) November 2008 (radiotherapy)	September 2019	11 years	Cross-sectional: Survey of 80 YouTube videos on optimal treatment of prostate cancer: surgical therapy versus radiotherapy	Frequency of reporting of COI	None	None	Switzerland	Not reported	YouTube	Urology oncology: surgical therapy or radiotherapy of prostate cancer	English	Physicians, clinic, hospital or university Others: patients, societies (foundations, governmental institutions, academic journals), industry, and news media	Not specified	Not specified	None	▪ **10%** (surgery) and **5%** (radiotherapy) of the providers included a disclosure of their conflicts of interest ▪ Commercial bias: 15% (surgery videos) and 23% (radiotherapy videos) of the videos contained commercial bias

Walradt 2021 [19]	April 2020	No limit	April 2020	N/A	Cross-sectional: Survey of 956 tweets by gastroenterologists and surgeons, sharing gastrointestinal (GI) endoscopy videos/images. Selected after identifying those followed by at least 1 major US gastroenterology society and had > 500 followers	Prevalence of COI Proportion of undisclosed COI	None	Potential competing interests: Dr. Berzin is a consultant for Wision AI, Boston Scientific, and Medtronic. All other authors disclosed no financial relationships relevant to this publication.	United States	United States	Twitter	Gastroenterology	English	Gastroenterologists and surgeons	Financial	Industry	Open Payments database	▪ **37%** (7/19) of tweets that mentioned the name of a medical device were posted by a U.S physician who had received a payment (according to OPD) from the manufacturer of the device mentioned. ▪ **None** of the physicians who had received a payment from the manufacturer of the device mentioned disclosed any financial relationships.

[1]Language was assumed based on the country of the individuals posting

ABBREVIATIONS:

COI: conflict of interest

FCOI: financial conflict of interest

OPD: Open Payment Database

FOAMed: Free Open Access Medical Education

N/A: Not available

Supplementary file 6: Appraisal of the 17 included studies using Mixed Methods Appraisal Tool.

Mixed Methods Appraisal Tool (MMAT)

		SCREENING QUESTIONS		4. QUANTITATIVE DESCRIPTIVE STUDIES				
First author	Year	S1. Are there clear research questions?	S2. Do the collected data allow to address the research questions?	4.1. Is the sampling strategy relevant to address the research question?	4.2. Is the sample representative of the target population?	4.3. Are the measurements appropriate?	4.4. Is the risk of nonresponse bias low?	4.5. Is the statistical analysis appropriate to answer the research question?
Betschart [21]	2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chretien [29]	2009	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chretien [20]	2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Greysen [9]	2012	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hessari [30]	2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kaestner [28]	2017	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes
Lagu [22]	2008	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Miller [11]	2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Niforatos [17]	2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nishizaki [23]	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pratsinis [24]	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pratsinis [25]	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shrank [27]	2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tao [18]	2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Toth [12]	2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vu [26]	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Walradt [19]	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Check PRISMA for abstracts checklist
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Pages 5-6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary file 2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Pages 6-7
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Pages 5 and 7
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Pages 6-7
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 7
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Pages 6-7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Not applicable
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Pages 6-7
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Pages 6-7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Not applicable
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not applicable

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Not applicable
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Not applicable
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 8
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary file 4
Study characteristics	17	Cite each included study and present its characteristics.	Supplementary file 5
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary file 6
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Pages 8-15
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pages 8-15
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pages 8-15
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Not applicable
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not applicable
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not applicable
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Not applicable
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 15
	23b	Discuss any limitations of the evidence included in the review.	Pages 15-16
	23c	Discuss any limitations of the review processes used.	Pages 15-16
	23d	Discuss implications of the results for practice, policy, and future research.	Page 16
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 5
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 17
Competing interests	26	Declare any competing interests of review authors.	Page 17

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 17

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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PRISMA 2020 for Abstracts Checklist

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	Yes
Registration	12	Provide the register name and registration number.	Yes

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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Conflict of interest and funding in health communication on social media: a systematic review

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ABSTRACT

Objectives: To synthesize the available evidence on the reporting of conflicts of interest (COI) by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media.

Data Sources: Medline (OVID) (2005-March 2022), Embase (2005-March 2022) and Google Scholar (2005-August 2022), supplemented with a review of reference lists and forward citation tracking.

Design: Reviewers selected eligible studies and abstracted data in duplicate and independently. We appraised the quality of the included studies using the Mixed Methods Appraisal Tool. We summarized the results in both narrative and tabular formats. We followed the PRISMA 2020 checklist for reporting our study.

Results: Of a total of 16,645 retrieved citations, we included 17 eligible studies. The frequency of reporting of conflicts of interest varied between 0% and 60%, but it was mostly low. In addition, a significant proportion, ranging between 15-80%, of healthcare professionals using social media have financial relationships with industry. However, three studies assessed the proportion of conflicts of interest of physicians identified through Open Payment Database (OPD) but not reported by the authors. It was found that 98.7-100% of these relationships with industry are not reported when communicating health-related information. Also, two studies showed that there is evidence of a potential association between COI and the content of posting. No data was found on the reporting of funding sources of studies cited in health messages on social media.

Conclusions: While a significant proportion of healthcare professionals using social media have financial relationships with industry, lack of reporting on COI and undisclosed COI are common. We did not find studies on the reporting of funding sources of studies cited in health messages on social media.

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ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first systematic review on the subject of reporting of conflicts of interest in social media.
- The study applied standard methodology for conducting systematic reviews (including a comprehensive search, duplicate screening, and data abstraction).
- We found a relatively limited number of eligible studies.
- Meta-analysis was not conducted due to heterogeneity of the included studies.

INTRODUCTION

The traditional internet has expanded to a more dynamic and interactive entity referred to as "Web 2.0" [1]. Web 2.0 allows its users to create and share content as well as communicate and interact with other users [1]. It differs from Web 1.0 in that content and applications of the web are no longer necessarily created by specific individuals but by all internet users, and constantly modified by them [2]. It includes various social media platforms such as blogs, Twitter, Facebook, Instagram, and YouTube [1].

Many individuals rely on the internet to answer their medical questions. While 90% of health care professionals use social media platforms for personal purposes, 65% use them for professional reasons such as promotion of health behaviors, discussions of health care policy, communicating with colleagues, and education of patients, peers, and students [3]. Within recent years, the use of social media by health care professionals has increased significantly with some estimates reporting increases from 42% in 2010 to as high as 90% in 2011 [4].

However, professionals may have conflicts of interest (COI) that may bias their postings on their platforms [4]. In general, conflicts of interest can be either individual or institutional, financial or non-financial.[5] While financial COI entail receiving grants, personal fees, trips, honoraria or stock ownership, non-financial COI include career advancement, political or ideological beliefs, strong scientific opinions, fame, and social interests.

Reporting COIs allow their acknowledgment and incorporation in the public's interpretation of information posted on social media [4]. That in turn should enhance public trust in the medical profession. Many medical associations have developed guidelines on physicians' use of social media, including reporting of COI [6-9]. However, there are many unique challenges to reporting and managing COI on social media. These challenges arise from the characteristics of social media, such as the rapid spread of information, user-generated content, and character limitation [4]. Users may share products or services with which they may have financial or non-financial interest, without disclosing their conflicts. This blurring of boundaries between personal opinions, professional advice, and undisclosed relationships can mislead the public and compromise the credibility of health communication.

Very limited research has been done on the topic of conflicts of interest and funding in social media. Previous studies considered COI reporting as part of measures of online professionalism [10], or as an indicator to assess credibility and quality of online information [11-14]. McCarthy et al discussed the urgent need for "more research examining the prevalence, impact of physicians' COI on social media content, and appropriate management strategies" [4].

The objective of this study is to synthesize the available evidence on the reporting of conflicts of interest by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media.

METHODS

Design overview and definitions

We conducted a systematic review of the published peer reviewed literature. We have followed Akl et al. framework for defining, categorizing, and assessing conflicts of interest in health research [5]. We referred to the following definition of COI: "a COI exists when a past, current, or expected interest creates a significant risk of inappropriately influencing an individual's judgment, decision, or action when carrying out a specific duty" [5].

We considered COI as a concept relevant to a social media account of an individual or an organization (which would include the funding by a specific organization). We considered funding as a concept relevant to a research study or project.

Table 1 shows the terms used for different scenarios that vary by whether COI exists or not, and whether a COI reporting statement is available.

Table 1 Problems associated with scenarios varying by whether COI exists or not, and whether a COI reporting statement is available.

	No COI exists	COI exists
No statement reporting on COI	Lack of reporting but no undisclosed COI	Lack of reporting with undisclosed COI
Statement reporting no COI	No problem	Undisclosed COI
Statement reporting COI	Over-reporting of COI	No problem

We used the following definition of social media: "a group of applications which is based on ideological and technological foundations of Web 2.0 that allows the creation and exchange of user-generated content" [1].

We developed and published a detailed protocol for this review on protocols.io [15], (included in *supplementary file 1*. We followed the PRISMA 2020 checklist to report our study [16].

Eligibility criteria

We included articles that meet the following eligibility criteria:

- Topic: conflict of interest on social media or funding;

- Type of social media: all platforms that fit the Web 2.0 definition, including blogs, Facebook, Instagram, Twitter, LinkedIn, and YouTube;
- Field: health field, including clinical, health systems and policy, public health and biomedical sciences;
- Study design: any primary study including surveys, research letters, and qualitative studies. We excluded editorials, abstracts, letters to the editor, reviews, and opinion pieces;
- Date of publication: 2005 to current (2005 being the year of the rise of Web 2.0);
- Language: any language.

Search strategy

We searched Medline(OVID) (2005-March 2022), Embase (2005-March 2022) and Google Scholar (2005-August 2022). The search strategies included both keywords and medical subject headings (MeSH terms) relevant to the concepts of conflict of interest, funding, and social media. We developed the search strategies with the help of an experienced librarian and included them in the supplementary file *(supplementary file 2*). We conducted our search in the databases with no restrictions on the language. We restricted the search by year (2005 and beyond). In addition, we screened the reference lists of included studies and forward searched for publications citing these included studies via Google Scholar.

Study selection

Teams of two reviewers screened in duplicate and independently the titles and abstracts of citations identified by the search using Rayyan screening tool. We retrieved the full texts of citations judged as potentially eligible by at least one reviewer. Reviewers subsequently screened the full texts in duplicate and independently. They resolved any disagreement by discussion or with the help of a third reviewer when consensus could not be reached. We used standardized and pilot-tested screening tools. We recorded the reasons for exclusion and summarized the results of the selection process using the 2020 PRISMA flow diagram [16]. The reviewers conducted calibration exercises before the screening process.

Data collection process

We developed a standardized and pilot-tested data extraction form with detailed instructions. Two teams of two reviewers abstracted the data from eligible studies independently and in duplicate using a standardized pilot tested form. The reviewers completed calibration exercises before starting the data collection process. They resolved any disagreements by discussion between the two reviewers or with the help of the principal investigator.

We extracted the following variables into a Word document:

1. General characteristics of the study:
   - Type of healthcare professionals: physicians, nurses, or other;
   - Year of conduct;
   - Study design;
   - Funding of the study;
   - COI of study authors;
   - Country of study authors

2. Social media:
   - Type: e.g., Facebook, twitter, Instagram, YouTube, LinkedIn;
   - Number of posts, videos, or blogs assessed;
   - Language of posts, videos, or blogs;
   - Country of the subjects of study;
   - Topic focus of the study, if any.

3. Conflicts of interest:
   - Type of conflict of interest;
   - Subject of conflict of interest;
   - Source of conflict of interest;
   - Tools used to assess the presence of financial relationships;
   - Prevalence of conflict of interest, verified or suspected;
   - Frequency of reporting of conflict of interest;
   - Proportion of undisclosed conflict of interest;
   - Proportion of organizations reporting undisclosed conflict of interest;
   - Association between conflict of interest and post content.

4. Funding:
   - Source of funding;
   - Amount of funding;
   - Role of funder.

Quality assessment and data synthesis

A team of two reviewers assessed independently the quality assessment of included studies using the Mixed Methods Appraisal Tool. This tool is designed for the appraisal stage of systematic

reviews that include qualitative, quantitative, or mixed methods studies [17]. Due to the nature of the data, we report the results in narrative and tabular formats.

Patient and public involvement

We did not involve patients or the public in the design, conduct, reporting, or dissemination plans of our research.

RESULTS

Study selection

The PRISMA flowchart (*supplementary file 3*) depicts the study selection process. We excluded 198 studies at the full text screening stage for the following reasons: not about conflicts of interest or funding (n=116), not about social media (n=33), and not the study design of interest (n=66) (*supplementary file 4*). We judged 17 studies to be eligible.

General characteristics

All of 17 included studies were cross-sectional and reported quantitative data. Table 2 shows the remaining general characteristics of these studies. The majority of studies were survey of social media posts (88%), had the United States or Canada as the country of the study subjects (53%), focused on posts in English language (88%), and focused on a specific health specialty (71%). The median year of posts upload date was 2018.The social media most assessed were Twitter (29%), YouTube videos (29%), and blogs (29%).

Table 2 *General characteristics of included studies (N=17)*

	n (%)
Study design	
Survey of posts	13 (76%)
Median sample size (IQR)	159 (879)
Survey of individuals or accounts	4 (24%)
Median sample size (IQR)	117 (205)
Funding of the study	

Funded	4 (24%)
Not funded	6 (35%)
Not reported	7 (41%)
Conflict of interest of study authors	
Conflict of interest reported	5 (29%)
No conflict of interest	11 (65%)
Not reported	1 (6%)
Study focused on a specific health specialty	12 (71%)
Type of social media	
Twitter	5 (29%)
Blogs	5 (29%)
YouTube	5 (29%)
Not specified	2 (12%)
Language of posts[§]	
English	15 (88%)
Other languages	4 (24%)
No language restriction	1 (6%)
Time period covered	
≤1 year	4 (24%)
11-12 years	4 (24%)
Not specified	9 (53%)
Median year of post date (IQR)	2018 (3)
Country of the subjects of study[§]	
United States of America	7 (41%)
Canada	2 (12%)

Europe	2 (12%)
Asia	2 (12%)
United Kingdom	1 (6%)
Australia	2 (12%)
Not reported	6 (35%)
No restrictions to countries	1 (6%)
Outcome§	
Prevalence of COI	5 (29%)
Frequency of reporting of COI	8 (47%)
Proportion of undisclosed COI	3 (18%)
Proportion of organizations reporting undisclosed COI	2 (12%)
Association between COI and post content	2 (12%)

§ Some studies included more than one language, country, or outcome

Table 3 shows the characteristics of COI in health communication on social media in the included studies. The majority of the studies had physicians as their study population (76%), specified industry as the source of COI (65%), and did not specify the type (whether financial or non-financial) of COI studied (59%).

Table 3 *Characteristics of COI in health communication on social media assessed in the included studies (N= 17)*

	n (%)
Subjects of COI	
Physicians	13 (76%)
Medical students	1 (6%)
University	4 (24%)
Healthcare entity (hospital, clinic)	4 (24%)

Others[◊]	9 (53%)
Source of COI	
Industry	11 (65%)
Others[δ]	2 (12%)
Not specified	6 (35%)
Types of COI	
Financial	7 (41%)
Not specified	10 (59%)

[◊]Others: non-physician health professionals (nurses, dietitians, nutritionists, pharmacists, chiropractors, acupuncturists), patients, societies/organizations (foundations, governmental institutions, academic journals), industry, news media, and bloggers.

[δ] Others: Volunteer donation, foundation, insurer, not-for-profit, webhost, or corporation entity.

Findings

We did not find evidence on the reporting of funding sources of studies cited in health messages on social media. With regards to COI reporting, the included studies assessed one or more of the following 5 outcomes: (1) prevalence of COI, verified or suspected (n=5); (2) frequency of reporting of COI (n=8); (3) proportion of undisclosed COI (n=3); (4) proportion of organizations reporting undisclosed COI (n=2); and (5) association between COI and post content (n=2). We provide the full details in supplementary file 5 and summarize them narratively in the following paragraphs. Supplementary file 6 includes the results of the quality assessment of the included studies. No major concerns were noted, except unclear appropriate measurements for 11 out of the 17 included studies.

Prevalence of COI, verified or suspected

Table 4 presents the results from five studies on the prevalence of COI. The prevalence of verified COI (using Open Payment Database) ranged between 15% and 80%. The prevalence of suspected COI (based on authors' judgement) ranged between 0% and 80%.

Table 4 *Results from five studies on the prevalence of COI*

Study	Social Media	Health condition	Prevalence of COI (n of authors with COI / N total authors)
Verified			
Niforatos 2019 [18]	Blogs	Emergency medicine	**15.4%** (45/292) of U.S-based healthcare providers
Tao 2017 [19]	Twitter	Hematology-oncology	**79.5%** (504/634) of U.S-based hematologist-oncologists
Walradt 2021 [20]	Twitter	Gastrointestinal endoscopy	**37%** (7/19) of tweets that mentioned the name of a medical device were posted by a U.S physician who had received a payment
Suspected			
Toth 2019 [13]	Blogs	Detox diets industry	**80%** (4/5) of nutritionist blog posts had a 'potential' COI **None** of registered dietitians blog posts had a 'potential' COI
Chretien 2011 [21]	Twitter	General	**0.2%** (12/5156) of tweets involved 'possible' conflicts of interest

Frequency of reporting COI

Table 5 presents the results of eight studies on the frequency of COI reporting. The frequency ranged from 0% to 60%. It was not clear from any of the studies whether the percentage referred

to the number of COI statements (whether reporting the existing or not of COI) or to the number of statements reporting a COI.

Table 5 *Results from eight studies on the frequency of reporting COI*

Study	Social Media	Health condition	Frequency (n of posts reporting COI / N total posts)
Betschart 2020 [22]	YouTube	Treatment options for lower urinary tract symptoms with benign prostatic hyperplasia	**2%** (2/159) (COI reporting)
Lagu 2008 [23]	Blogs	General	**0%** (0/271) (COI reporting)
Nishizaki 2021 [24]	Japanese YouTube videos	Pediatrics: nocturnal enuresis	**0%** (0/72) (COI reporting)
Pratsinis 2021 [25]	YouTube	Treatment options of urinary stones	**9%** (9/100) (COI reporting)
Pratsinis, 2021 [26]	YouTube	Benign prostatic hyperplasia, prostate cancer, and urinary stone disease	"Majority" did not have COI disclosure Estimated: 46/240 (COI reporting)
Vu 2021 [27]	YouTube	Treatment of prostate cancer: surgical therapy versus radiotherapy	**10%** (surgery) and **5%** (radiotherapy) (COI reporting)
Miller 2011 [12]	Blogs	General	**15.6%** (148/951) of health blogs reported sponsorship
Shrank 2011 [28]	Social networking sites (93% featured blogs)	Diabetes information	1. Industry sponsorship: - Pharmaceutical manufacturers: **53.3%** (8/15)

			- Diabetes device manufacturers: **60%** (9/15) - Webhost Sponsorship: **13.3%** (2/15) 2. Foundation sponsorship: **20%** (3/15) 3. Voluntary donations: **26.7%** (4/15) 4. No industry sponsorship: **20%** (3/15) 5. Insurers: **20%** (3/15) 6. Not-for-profit: **26.7%** (4/15)

Proportion of undisclosed COI

We identified three studies reporting on the proportion of undisclosed COI. The proportion values were 99%, 100%, and 100% [18, 20, 29]. All three studies assessed the proportion of COI identified through Open Payment Database but not reported by the authors. It was not clear from any of the studies whether the proportion referred to those who reported no COI or those who had no COI statement.

Proportion of organizations reporting undisclosed COI

We identified two studies on the proportion of organizations reporting undisclosed COI. Chretien et al. [30] surveyed 130 deans of student affairs from institutions in the Association of American Medical Colleges. Out of the 78 deans who responded, 3% (2/78) reported unprofessional incidents related to product endorsement without reporting COI.

Greysen et al. [10] surveyed 48 executive directors of state medical boards about US-based physicians' violations of online professionalism. An estimated percentage of 56% indicated that they received reports of violations related to "failure to reveal conflicts of interest online".

Association between COI and content of posting

We identified two studies on the association between COI and the content of posting. Kaestner et al.[29] analyzed tweets of 156 US-based hematologist-oncologists on oncology drugs; they also verified the physicians' financial conflicts of interest using Open Payments Database. The authors found that tweets were more likely to be positive (p=0.02) when they related to drugs from a company for which they had a financial COI compared with drugs from a company for which they did not have a financial COI.

Hessari et al.[31] assessed 1156 tweets of alcohol industry-funded organizations and 1649 tweets of non- alcohol industry-funded charities, with all entities aiming to raise alcohol awareness. While 10.1% (n=166/1649) of the non- alcohol industry-funded organizations tweets mentioned alcohol marketing, advertising, sponsorship, issues related to alcohol pricing and physical health harms, none (n=0/1156) of the alcohol industry -funded organizations tweets mentioned those topics.

DISCUSSION

Summary of evidence

We systematically reviewed the literature for the reporting of COI by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media. The frequency of reporting of COI varied across studies but was mostly low (less than 15%). A significant proportion of healthcare professionals using social media have financial relationships with industry (up to 80%). However, most of these relationships are not reported when communicating health-related information. Also, there is evidence of a potential association between COI and the content of posting. We did not find studies on the reporting of funding sources of studies cited in health messages on social media.

Strengths and limitations

To the best of our knowledge, this is the first systematic review about conflicts of interest and funding in social media. We have applied standard methodology based on the principles of conducting systematic reviews (including a comprehensive search, duplicate screening, data abstraction and quality appraisal).

Unfortunately, a limited number of studies have addressed the topic of reporting of conflicts of interest in social media, and none has explored the reporting of funding of studies cited in health messages on social media. In addition, the included studies were heterogeneous in terms of study designs and outcomes reported, which prevented us from conducting a more advanced synthesis.

Two of the included studies found an association between COI and the content of social media posting. However, it is not clear whether the relationship is causal, i.e., having it is the COI that leads to a specific point of view.

Implications for practice and research

Our findings are of high importance with the increasing reliance of patients and the public on social media as a source of information and medical advice. Furthermore, there is evidence that the use of social media increases significantly during natural hazard and crises. [32]. This is particularly relevant to the COVID-19 information shared with the public on novel therapeutic agents which may have harmful side effects [33].

This is particularly important, considering our definition of COI. Indeed, the specific duty for individuals posting on social media (particularly professional figures with high number of followers) is to provide accurate and reliable information. This is extremely important given the potential impact on both clinical and public health decisions. Having conflicts of interests, whether financial or non-financial, poses a significant risk of biasing the opinions of individuals sharing their opinions on social medial, leading to either misinformation or disinformation.

Given the above, reporting conflict of interest and funding on social media is a basic requirement for the responsible use of social media, particularly during crises (such as the COVID-19 pandemic) associated with infodemics, misinformation and disinformation [34].

Healthcare professionals should be encouraged to disclose their conflicts of interest when sharing health-related content by referring to existing guidelines on physicians' use of social media [6-9]. When using social media platforms with character limits such as Twitter, it is recommended to include a disclosure of interests by incorporating an electronic hyperlink to a standardized disclosure form, such as the one provided by the International Committee of Medical Journal Editors (https://www.icmje.org/disclosure-of-interest/). Alternatively, healthcare professionals can include a link to public reporting tools such as Center for Medicare and Medicaid Open Payments [4].

In addition, clear guidance and policies are needed for the reporting of COI and funding by health care professionals when using social media. Such policies can be developed through a collaboration between regulatory entities, professional organizations, and social media platforms. Healthcare providers can refer to published guidance on the reporting of funding [35]. In addition, improving public media literacy is essential to help users identify potential conflicts in health information and make informed decisions.

Future research should explore the impact of COI in social media on the perceptions, beliefs, and behaviors of their users. Despite the extent of misinformation, and disinformation on social media during the COVID-19 pandemic [36], no study has assessed the prevalence of COI in that context. Interestingly, one study found a correlation between the amounts received by academic infectious diseases physicians from Gilead Sciences, producer of remdesivir, and their public opposition to the use of hydroxychloroquine [37]. Therefore, it would be important to explore the prevalence of COI in that context and the relationship between COI, misinformation, and disinformation. From

a methodological point of view, future studies should clearly distinguish between the absence of a COI statement and a statement of absence of COI.

Two crucial aspects that were outside the scope of this study, but deserve further consideration are the reporting of funding by the media and scientific journals and the declaration of interests by their editors [38]. Funding by, and financial relationships with pharmaceutical companies and other for-profit entities, have the potential to bias the information shared through media and journals publications. Indeed, a recent survey found that an extremely low percentage of peer reviewers and journals editors addressed study funding and authors' COI [39]. Also, the study found that peer reviewers and journal editors rarely declared their COI, or commented on their own or on each other's COI.

DECLARATIONS

Authors Contributions

EAA conceived and designed the study. VH and FM coordinated various parts of the study. EAA had full access to all the data in the study and takes responsibility for the integrity and accuracy of the data analysis. LH, VH and FM designed the search strategy. FM and RAK ran the search and VH later updated it. VH, FM, JK, HN, AM, RAK, DAO, and RH contributed to the study selection process. VH, FM, AM, HN, and JK extracted the data. VH and FM analyzed the data. VH, FM, JK, and EAA interpreted the data. FM wrote the first draft of the manuscript with EAA; VH worked on subsequent drafts with JK and EAA. All authors critically revised the manuscript and approved the final manuscript.

Ethics and dissemination

This systematic review did not involve human research participants, and therefore does not require ethical approval.

Patient Consent

Patient consent is not applicable.

Transparency

EAA affirms that this manuscript is an honest, accurate, and transparent account of the study being reported, that no important aspects of the study have been omitted and that any discrepancies from the planned study have been explained.

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Conflict of interest

EAA and JK have conducted studies on the topics of conflicts of interest and funding.

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information.

SUPPLEMENTARY MATERIAL

Supplementary file 1: Systematic review protocol.

Supplementary file 2: Search strategies used in Medline(OVID), Embase and Google Scholar.

Supplementary file 3: PRISMA flow diagram for systematic reviews.

Supplementary file 4: Excluded studies in full-text screening with their corresponding reasons of exclusion.

Supplementary file 5: Characteristics of the 17 included studies.

Supplementary file 6: Appraisal of the 17 included studies using Mixed Methods Appraisal Tool.

ABBREVIATIONS

COI: conflicts of interest

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

COVID-19: Corona Virus Disease 2019

OPD: Open Payment Database

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Supplementary file 1: Systematic review protocol

Title: Conflict of interest and funding in health communication on social media: a systematic review

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Keywords: conflict of interest, funding, social media, health, systematic review

Ethical approval: The study involves no human subjects and requires no ethical approval.

BACKGROUND

Social media has reshaped the dissemination of information and medical education. The patient-physician relationship has been transformed with the introduction of social media especially during the COVID-19 pandemic when quarantine and restrictions were applied. Many users rely on the internet to find answers to their medical questions. Health professionals can communicate and share their health-related opinions using posts, videos, or blogs.

Within recent years, the use of social media by physicians and health care professionals has increased significantly with some estimates reporting increases from 42% in 2010 to as high as 90% in 2011 [1]. While 90% of health care professionals use social media platforms for personal purposes, 65% use them for professional reasons such as promotion of health behaviors, discussions of health care policy, communicating with colleagues, and education of patients, peers, and students [2]. However, professionals may have conflicts of interest (COI) that may bias their shared health-related recommendations on their platforms [1].

STUDY OBJECTIVES

The objective of this study was to synthesize the available evidence on the disclosure of conflicts of interests by individuals posting health messages on social media, and on the reporting of funding sources of studies cited in health messages on social media,

METHODS

Design overview and definitions

We will conduct a systematic review to identify studies that addressed reporting of conflict of interest and funding in social media health communications. We will use the following definitions:

- Conflict of interests: “a COI exists when a past, current, or expected interest creates a significant risk of inappropriately influencing an individual’s judgment, decision, or action when carrying out a specific duty” [3].
- Declaration statement: any statement reporting a COI of a named individual, whether indicating the absence of COI or presence of a specific COI and describing it.

Eligibility criteria

We will include articles that meet the following eligibility criteria:

- Topic: conflict of interest on social media or funding;
- Type of social media: we will include all social media platforms that fit the Web 2.0 definition. This includes blogs, and social media applications such as Facebook, Instagram, Twitter, LinkedIn, and YouTube. We will exclude studies that involved traditional media channels (Web 1.0) such as newspapers, radio, TV, emails, and websites;
- Field: health field, including clinical, health systems and policy, public health and biomedical sciences;
- Study design: any primary study including surveys, research letters, and qualitative studies. We will exclude editorials, abstracts, letters to the editor, reviews and opinion pieces;
- Date of publication: 2005 to current, with 2005 being the year of the rise of Web 2.0;
- Language: any language.

Search strategy

We developed a search strategy, using the help of a librarian, for MEDLINE, EMBASE and Google Scholar electronic databases from 2005 to present. The search combined various keywords and medical subject headings (MeSH) terms relevant to concepts of conflict of interest, funding, and social media. We did not restrict the search to specific languages. We will also screen the reference lists of included studies as well as other relevant papers.

Article selection

Teams of two reviewers will assess in duplicate and independently the titles and abstracts of citations identified by the search for potential eligibility using Rayyan screening tool. We will retrieve the full texts of citations judged as potentially eligible by at least one reviewer. Reviewers subsequently will screen in duplicate and independently the full texts using Rayyan screening tool. They will resolve any disagreements by discussion or with the help of a third reviewer when consensus cannot be reached. We will use standardized and pilot-tested screening tools. We will record the reasons for exclusion and summarize the results of the

selection process using the 2020 PRISMA flow diagram. The reviewers will conduct calibration exercises before the screening process.

Data abstraction

The reviewers will abstract data from eligible studies in duplicate and independently. We will use a standardized and pilot-tested data abstraction form. Disagreements will be resolved through discussion or with the help of a third reviewer (EAA). We will conduct a calibration exercise to enhance the validity of the process. Study authors will be contacted for any clarification.

We will abstract the following variables from each included study:

1. General characteristics of the study:
    - Population (e.g., type of healthcare professionals: physicians, nurses, or other);
    - Year of conduct;
    - Study design;
    - Funding of the study;
    - COI of study authors
    - Country of study authors

2. Social media:
    - Type of social media (e.g., Facebook, twitter, Instagram, YouTube, LinkedIn …);
    - Number of posts, videos or blogs assessed;
    - Language of posts, videos or blogs
    - Country of the subjects of study
    - Topic focus of the study, if any.

3. Conflict of interest:
    - Type of conflict of interest
    - Subject of conflict of interest
    - Source of conflict of interest
    - Tools used to assess the presence of financial relationships
    - Prevalence of conflict of interest
    - Frequency of reporting of conflict of interest

- Proportion of undisclosed conflict of interest
- Unprofessional incidents involving conflict of interest

4. Funding:
   - Type of funding
   - Source of funding
   - Frequency of reporting of funding

Quality assessment

A team of two reviewers will assess independently the risk of bias of included studies using Mixed Methods Appraisal Tool (MMAT). This tool is designed for the appraisal stage of systematic reviews that include qualitative, quantitative or mixed methods studies [4]. We expect most of the studies to be cross-sectional and these will be assessed using the relevant part of the tool.

Data synthesis

Due to the nature of the data, we will report the results in narrative and tabular formats.

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Supplementary file 2: Search strategies used in Medline(OVID), Embase and Google Scholar

Medline Search Strategy

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily <1946 to February 15, 2019>
Search Strategy:
---

1 "Conflict of Interest"/ (9255)
2 ((competing or conflict*) adj3 (interest? or influence? or relationship?)).mp. (18489)
3 financial support/ or research support as topic/ (25591)
4 (((financ* or monetary or industr* or pharmaceutical*) adj3 (fund* or pay* or paid or support or contributi* or compensat* or sponsor* or backing or (kick adj back*) or incentive? or re?imburse* or subsidi* or award* or endow* or tie? or link* or associat* or affiliation? or relation* or grant*)) or disclos*).mp. (120953)
5 Disclosure/ (12719)
6 Gift Giving/ (1521)
7 ((financ* or gift? or gift-giving) adj3 (disclos* or report* or declar* or reveal* or receiv* or giv* or gave or accept* or award* or admit*)).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] (7487)
8 or/1-7 (158539)
9 exp Mass Media/ (44039)
10 (mass adj2 (media? or medium or communication?)).mp. (16758)
11 (columnist? or reporter? or correspondent? or commentator? or reviewer?).mp. (145928)
12 Social Media/ (5474)
13 (((social or digital) adj2 (medium or media* or network* or net-work* or bookmark* or book-mark* or application? or debate* or channel* or communication? or collaborat*)) or (institution* adj repositor*)).mp. (35361)
14 Blogging/ (903)
15 (blog* or microblog* or micro-blog* or weblog*).mp. (2308)
16 (tout or wordpress or yammer or citeulike or zotero or evernote or delicious or Digg or picasa or youtube or Vimeo or reddit or snapchat or mendeley).mp. (3525)
17 exp Social Networking/ (2487)
18 (facebook or twitter or tweet* or LinkedIn or pinterest).mp. (5334)
19 ((Google adj plus) or google?+).mp. (15664)
20 (Tumblr or Instagram or myspace or researchgate or academia or figshare or mendeley).mp. (7153)
21 Webcasts as Topic/ (301)
22 (podcast* or pod-cast* or webcast* or web-cast*).mp. (1687)
23 (rss adj2 feed*).mp. (49)
24 (weibo or flickr).mp. (171)
25 ((virtual or video* or content? or project? or audio or digital or online or forum? or web) adj2 (world? or reality or place? or communit* or communicat* or collaborat* or shar*)).mp. (23762)
26 (web adj2 application*).mp. (2856)
27 ((user adj generated) or usergenerated).mp. (359)

28 (wikipedia or wiki* or "web 2.0").mp. (1786)
29 ((knowledge or internet or (electronic adj mail) or email or e-mail or health or listserv*) adj2 (share* or communicat* or sharing? or collaborat*)).mp. (15600)
30 or/9-29 (296669)
31 8 and 30 (4486)
32 limit 31 to yr="2005 -Current" (3436)

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EMBASE Search Strategy

#33 #32 AND (2005:py OR 2006:py OR 2007:py OR 2008:py OR 2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py OR 2016:py OR 2017:py OR 2018:py OR 2019:py OR 2020:py OR 2021:py OR 2022:py) **5551**

#32 #31

#31 #9 AND #30 **6193**

#30 #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 **334472**

#29 (knowledge OR internet OR electronic) NEAR/2 (mail OR email OR 'e mail' OR health OR listserv*) NEAR/2 (share* OR communicat* OR sharing* OR collaborat*) **2485**

#28 wikipedia OR wiki* OR 'web 2.0' **2900**

#27 (user NEXT/1 generated) OR usergenerated **407**

#26 web NEAR/2 application* **3670**

#25 (virtual OR video* OR content* OR project* OR audio OR digital OR online OR forum* OR web) NEAR/2 (world* OR reality OR place* OR communit* OR communicat* OR collaborat* OR shar*) **44943**

#24 weibo OR flickr **1657**

#23 rss NEAR/2 feed* **72**

#22 podcast* OR 'pod cast*' OR webcast* OR 'web cast*' **1687**

#21 'webcast'/de **310**

#20 tumblr OR instagram OR myspace OR researchgate OR academia OR figshare OR Mendeley **41870**

#19 (google NEXT/1 plus) OR google?+ **63**

#18 facebook OR twitter OR tweet* OR linkedin OR pinterest **7561**

#17 'social network'/exp **13447**

#16 tout OR wordpress OR yammer OR citeulike OR zotero OR evernote OR delicious OR digg OR picasa OR youtube OR vimeo OR reddit OR snapchat **4608**

#15 blog* OR microblog* OR 'micro blog*' OR weblog* **3710**

#14 'blogging'/de **260**

#13 ((social OR digital) NEAR/2 (medium OR media* OR network* OR 'net work*' OR bookmark* OR 'book mark*' OR application? OR debate* OR channel* OR communication? OR collaborat*)) OR (institution* NEAR/2 repositor*) **44828**

#12 'social media'/de **13939**

#11 columnist* OR reporter* OR correspondent* OR commentator* OR reviewer* **172962**

#10 'mass medium'/exp **17396**

#9 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 **224956**

#8 (financ* OR gift* OR 'gift giving') NEAR/3 (disclos* OR report* OR declar* OR reveal* OR receiv* OR giv* OR gave OR accept* OR award* OR admit*) **10745**

#7 'gift giving'/de **1086**

#6 disclos* **89957**

#5 (financ* OR monetary OR industr* OR pharmaceutical*) NEAR/3 (fund* OR pay* OR paid OR support OR contributi* OR compensat* OR sponsor* OR backing OR 'kick back' OR incentive* OR re*imburse* OR subsidi* OR award* OR endow* OR disclos* OR tie OR ties OR link* OR associat* OR affiliat* OR relation* OR grant*) **80180**

#4 research NEAR/1 support **6650**

#3 'funding'/de **37321**

#2 (competing OR conlict*) NEAR/3 (interest* OR influence* OR relationship*) **22710**

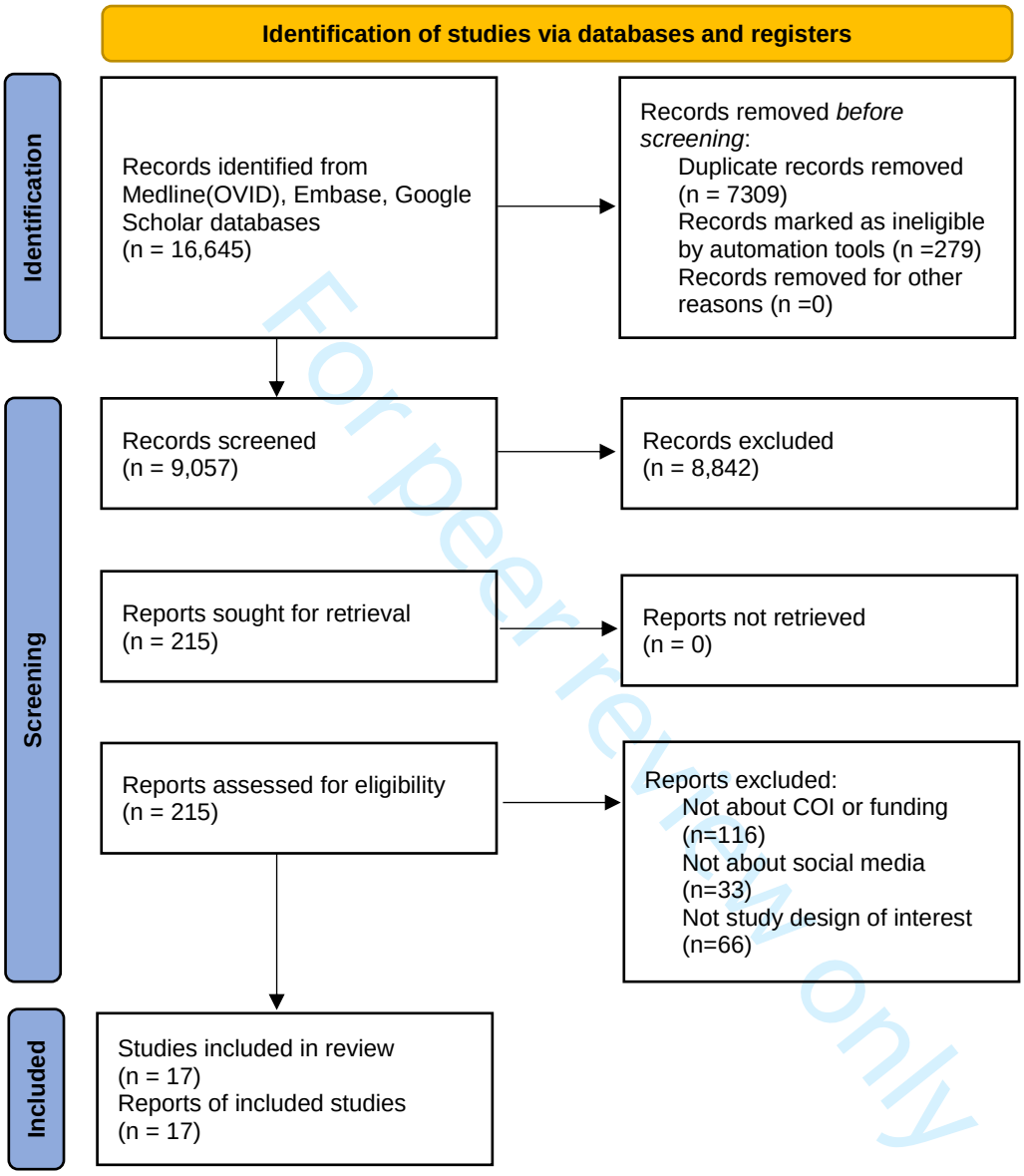
#1 'conflict of interest'/exp **11111**

……..

Google Scholar

("Conflict of Interest" OR "Conflict of Interests" OR "Competing Interest" OR "Competing Interests" OR "financial support" OR "financial declaration") AND (Facebook OR Instagram OR twitter OR tweet OR Pinterest OR LinkedIn OR fig share OR Mendeley OR Snapchat OR "social media")
Picked: 200 articles

Supplementary file 3: PRISMA 2020 flow diagram for systematic reviews



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

Supplementary File 4: Excluded studies in full-text screening with their corresponding reason of exclusion.

Author/Journal, year	Reason of exclusion
Aase 2010 [1]	Not study design of interest
Abdel-Wahab 2019 [2]	Not about COI
Aboujaoude 2019 [3]	Not about COI
Addiction 2011 [4]	Not about social media
Ahc 2019 [5]	Not about social media
AIDS alert 2011 [6]	Not about social media
Aiken 2012 [7]	Not about COI
Al-Balushi 2020 [8]	Not study design of interest
Alshaikh 2019 [9]	Not about social media
Anderson 2010 [10]	Not about COI
Anderson 2010 [10]	Not study design of interest
Anderson 2013 [11]	Not about COI
Apperson 2019 [12]	Not about COI
Au 2021 [13]	Not study design of interest
Azizi 2013 [14]	Not about COI
Back letter 2008 [15]	Not about social media
Back letter 2008 [16]	Not about social media
Baier 2019 [17]	Not about COI
Bamat 2018 [18]	Not study design of interest
Barber 2020 [19]	Not about social media
Barreda 2015 [20]	Not about COI
Baxter 2009 [21]	Not study design of interest
Bayne 2017 [22]	Not about COI
Bechini 2021 [23]	Not about social media
Becker 2015 [24]	Not about social media
Bertholf 2021 [25]	Not study design of interest
Bhat 2019 [26]	Not study design of interest
Bibault 2017 [27]	Not study design of interest
Blastl 2020 [28]	Not study design of interest
Bosslet 2011 [29]	Not about COI
Braccia 2009 [30]	Not about COI
Braillon 2018 [31]	Not study design of interest
Braunstein 2012 [32]	Not about COI
Bredenoord 2017 [33]	Not about COI
Bukhari 2021 [34]	Not about social media
Bullock 2014 [35]	Not about COI
Cain 2010 [36]	Not about COI
Capel 2019 [37]	Not about COI
Carson 2018 [38]	Not about COI
Casigliani 2020 [39]	Not study design of interest
Casswell 2018 [40]	Not about social media

Chan 2012 [41]	Not study design of interest
Chretien 2013 [42]	Not study design of interest
Coutts 2018 [43]	Not about social media
Cunningham 2014 [44]	Not about COI
Dainton 2009 [45]	Not about COI
De Ambrogi 2019 [46]	Not study design of interest
DeCamp 2012 [47]	Not study design of interest
DeCamp 2013 [48]	Not study design of interest
DeCamp 2013 [49]	Not study design of interest
DeChello 2012 [50]	Not study design of interest
Denecke 2014 [51]	Not study design of interest
Dolgin 2019 [52]	Not about social media
Douglas 2020 [53]	Not study design of interest
Drone 2015 [54]	Not about COI
Dugdale 2021 [55]	Not study design of interest
ED management 2005 [56]	Not about COI
Englund 2012 [57]	Not about COI
Essary 2011 [58]	Not about COI
Failli 2021 [59]	Not about social media
Faloon 2006 [60]	Not about COI
Farrelly 2014 [61]	Not about COI
Fattore 2019 [62]	Not about COI
Fontanarosa 2019 [63]	Not about social media
For the Record 2011 [64]	Not study design of interest
For the record 2013 [65]	Not study design of interest
Frankish 2012 [66]	Not about COI
Galbraith 2014 [67]	Not about COI
Gifford 2021 [68]	Not study design of interest
Gilligan 2019 [69]	Not study design of interest
Gordon 2010 [70]	Not about COI
Gottlieb 2020 [71]	Not study design of interest
Grace 2021 [72]	Not about COI
Grummer-Strawn 2019 [73]	Not about social media
Guo 2020 [74]	Not study design of interest
Gupta 2020 [75]	Not study design of interest
Haddas 2021 [76]	Not study design of interest
Haldar 2010 [77]	Not about COI
Hampton 2005 [78]	Not about social media
Hanley 2012 [79]	Not about COI
Harris 2012 [80]	Not about COI
Henderson 2014 [81]	Not about COI
Henderson 2020 [82]	Not about COI
Henry 2014 [83]	Not about COI
Hernandez-Aguado 2020 [84]	Not about COI

Hessari 2019 [85]	Not study design of interest
Hetzler 2020 [86]	Not about COI
Holden 2017 [87]	Not about COI
Huby 2016 [88]	Not about COI
Hwang 2016 [89]	Not health field
Hwong 2014 [90]	Not study design of interest
Islam 2019 [91]	Not study design of interest
Jiang 2017 [92]	Not about COI
Jones 2021 [93]	Not about COI
Joshi 2020 [94]	Not study design of interest
Journal of Instructional Psychology 2012 [95]	Not about COI
Journal of Korean medical science 2015 [96]	Not about COI
Katz 2014 [97]	Not about COI
Kh 2009 [98]	Not about social media
Kirschner 2013 [99]	Not study design of interest
Kleebauer 2014 [100]	Not about COI
Knoepfler 2016 [101]	Not about COI
Knopf 2018 [102]	Not about COI
Korman 2021 [103]	Not about social media
Kullgren 2014 [104]	Not about COI
Kunze 2020 [105]	Not about COI
Lachman 2013 [106]	Not about COI
Lackner 2012 [107]	Not about social media
Lagu 2011 [108]	Not about COI
Layng 2012 [109]	Not about COI
Lazard 2020 [110]	Not about COI
Lee 2016 [111]	Not health field
Lee 2020 [112]	Not about COI
Lerner 2013 [113]	Not about COI
Lin 2016 [114]	Not about COI
Lusis 2009 [115]	Not about COI
Macauley 2021 [116]	Not study design of interest
MacWilliam 2006 [117]	Not study design of interest
Mansfield 2011 [118]	Not about COI
Margaret 2019 [119]	Not about COI
Mayes 2018 [120]	Not about social media
McCarthy 2018 [121]	Not study design of interest
McComas 2008 [122]	Not about COI
McCullough 2010 [123]	Not about COI
Medical marketing 2016 [124]	Not study design of interest
Militello 2021 [125]	Not study design of interest
Milton 2014 [126]	Not about COI
Milton 2016 [127]	Not about COI
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Minhas 2006 [129]	Not study design of interest

Modern Healthcare 2017 [130]	Not about COI
Moodley 2013 [131]	Not about COI
Moses 2014 [132]	Not about COI
Moukarzel 2021 [133]	Not study design of interest
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Muzumdar 2021 [135]	Not study design of interest
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Nau 2017 [137]	Not about COI
Neuer 2019 [138]	Not about social media
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Nursing standard 2016 [142]	Not study design of interest
Nursing times 2011 [143]	Not study design of interest
O'Glasser 2020 [144]	Not study design of interest
O'Hanlon 2011 [145]	Not about COI
O'Keeffe 2019 [146]	Not study design of interest
O'Rourke 2015 [147]	Not about COI
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Ong 2021 [149]	Not study design of interest
OR Manager 2009 [150]	Not about COI
Oransky 2006 [151]	Not study design of interest
Ornstein 2011 [152]	Not about social media
Padeiro 2021 [153]	Not about COI
Pagoto 2019 [154]	Not about COI
Parasidis 2019 [155]	Not about COI
Paterson 2019 [156]	Not study design of interest
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Pelton 2012 [158]	Not about COI
Pierce 2019 [159]	Not about COI
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Ragan 2012 [162]	Not about COI
Ranpariya 2020 [163]	Not study design of interest
Ravn 2020 [164]	Not about COI
Rechenberg 2013 [165]	Not about social media
Redick 2022 [166]	Not about social media
Research Practitioner 2011 [167]	Not about social media
Roucka 2014 [168]	Not about COI
Roupret 2014 [169]	Not about COI
Samsa 2019 [170]	Not about social media
Santillan-Doherty 2020 [171]	Not about COI
Santoro 2015 [172]	Not about COI
Santoro 2022 [173]	Not study design of interest
Sartor 2019 [174]	Not about social media

Scruth 2015 [175]	Not about COI
Seppey 2017 [176]	Not about social media
Sh 2019 [177]	Not about COI
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Shore 2011 [179]	Not about COI
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Van Eperen 2010 [193]	Not about COI
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Weijs 2019 [202]	Not about COI
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Williams 2011 [207]	Not about COI
Wisniewski 2017 [208]	Not about COI
Yan 2020 [209]	Not study design of interest
Yeh 2018 [210]	Not about COI
Yeo 2020 [211]	Not about COI
Zember 2015 [212]	Not about COI
Zenone 2021 [213]	Not study design of interest
Zhitomirsky 2016 [214]	Not study design of interest
Zhou 2018 [215]	Not study design of interest

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Supplementary file 5: Characteristics of the 17 included studies related to conflicts of interest.

Author, Year	Date of search/data collection	Start Upload Date	End Upload Date	Period of coverage	Population	Study outcomes	Funding of the study	COI of study authors	Country of study authors	Country of the subjects of study	Type of social media	Focus	Language of posts	Subject of COI	Type of COI	Sources of COI	Tools to assess the presence of COI	**Results**
Betschart 2020 [22]	May 2019	July 2007	May 2019	12 years	Cross-sectional: Survey of 159 YouTube videos addressing treatment options for lower urinary tract symptoms with benign prostatic hyperplasia	Frequency of reporting of COI	Not reported	None	Switzerland Germany	Not reported	YouTube	Urology: lower urinary tract symptoms associated with benign prostatic hyperplasia.	English	Physicians, clinic, hospital, or university Others: Industry, news media, societies/organizations	Not specified	Not specified	None	▪ **1.3%** (2/159) videos included a disclosure of conflicts of interest ▪ 83.6% (133/159) of the videos were subject to commercial bias (defined as information presented in a manner that attempts to sway participants' opinions in favor of a particular commercial product for the express purpose of furthering a commercial entity's business, meaning a deliberate intent to mislead).
Chretien 2009 [30]	March/April 2009	N/A	N/A	N/A	Cross-sectional: Electronic survey of 78 deans of student affairs, their representatives, or counterparts from US medical schools in the Association of American Medical Colleges	Unprofessional incidents involving COI	Not reported	None	United States	United States	Web 2.0: not specified otherwise	General	English[1]	Medical students	Not specified	Industry	None	▪ **4%** (2/46) of all reported unprofessional incidents involved conflicts of interest (e.g., product endorsement without a COI disclosure)
Chretien 2011[21]	May 2010	May 1, 2010	May 31, 2010	1 month	Cross-sectional:	Unprofessional	Not reported	None	United States	United States,	Twitter	General: surgery,	English	Physicians	Not specified	Industry	None	▪ **8.3%** (12/144) of unprofessional tweets

					Survey of 5156 tweets of 260 self-identified physicians with >500 followers	tweets involving 'possible' COI				Europe, Canada, Asia, Australia, not specified		internal medicine, family medicine, pediatrics, psychiatry, emergency medicine, obstetrics/gynecology, and not specified						involved 'possible' conflicts of interest (i.e., making unsupported claims about a product being sold on the physician's website or repeatedly promoting specific health products)
Greysen 2012 [10]	N/A	N/A	N/A	N/A	Cross-sectional: Survey of 48 executive directors of all medical and osteopathic boards in the US	Unprofessional incidents involving COI	Funded by the Robert Wood Johnson Foundation and the Department of Veterans Affairs	1/5 reported serving as a scientific advisory board member for Fair Health Inc and receiving funding as a collaborator on the Yale University Open Data Access project	United States	United States	Not specified	General	English[1]	Physicians	Not specified	Not specified	None	▪ **56%** of state medical boards indicated that they received reports of violations related to "failure to reveal conflicts of interest online" (estimated percentage from the figure)
Hessari 2019 [31]	December 2016	January 2016	December 2016	1 year	Cross-sectional: Survey of a total of 2805 tweets of Alcohol industry (AI)-	Association between COI and content of posting	None	None	United Kingdom	United Kingdom, Ireland, Australia	Twitter	Social aspects/public relations organizations related to alcohol	English[1]	Alcohol industry (AI)-funded organizations and non-AI-funded charities	Sponsorship by alcohol industry	Alcohol industries	None	▪ **None** (0/1156) of alcohol-industry funded organizations tweets mentioned alcohol marketing, advertising, and sponsorship; issues related to alcohol pricing; physical health harms, including cancers, heart disease,

					funded organizations (1156 tweets) and non-AI-funded charities (1649 tweets)							awareness						dementia and diabetes; and fertility and pregnancy ▪ **10.1% (**166/1649) of non-industry-funded organizations tweets mentioned alcohol marketing, advertising, and sponsorship; issues related to alcohol pricing; physical health harms, including cancers, heart disease, dementia and diabetes; and fertility and pregnancy
Kaestner 2017 [29]	Jan 7-25, 2017	N/A	N/A	N/A	Cross-sectional: Survey of twitter accounts of 156 hematologist-oncologists in the US with a FCOI (at least US$1000 in 2014), and frequent tweets (at least 100 total Tweets); physicians with private accounts were excluded	Proportion of undisclosed COI Association between COI and content of posting	Not reported	1/4 reported receiving payments for his book "Ending Medical Reversal".	United States	United States	Twitter	Hematology-oncology	English	Hematology-oncology physicians	Financial COI: payment	Biopharmaceutical industry	Open Payments database	▪ **1.3%** (2/156 physicians) of U.S-based hematologist-oncologists, who had financial conflicts of interest according to OPD, included disclosures of their payments, and these were in their 5-line twitter biography. ▪ **81%** (126/156) of physicians mentioned at least one drug from a company for which they had a FCOI ▪ Of 4358 total drug mentions, 52% (2252/4358) regarded conflicted drugs. ▪ Association between COI and coding of tweets (positive, neutral, or negative): conflicted tweets were more likely to be positive (p=0.02), similarly likely to be neutral (p=0.45), and less likely to be negative (p=0.008) ▪ General payment FCOI: Median $13,668 (IQR, $4,292-$33,213) Range $1,031-$444,055

																		More than half of drug mentions refer to a median of six companies that pay these physicians
Lagu 2008 [23]	December 14, 2006	January 1, 2006	December 14, 2006	1 year	Cross-sectional: Survey of 271 health-related blogs by doctors or nurses	Frequency of reporting of COI	Partially funded by The Robert Wood Johnson Foundation Clinical Scholars program	None	United States	Not reported	Blogs (Medlogs, Yahoo Health and Medicine Blogs and The Medical Blog Network)	General	English[1]	Physicians and nurses	Not specified	Industry	None	▪ **None** (0/31) of the blogs that explicitly promoted a specific healthcare product (i.e., providing product images, descriptions, or advocacy) disclosed conflicts of interest.
Miller 2011 [12]	June 2007 and May 2008	N/A	N/A	N/A	Cross-sectional: Survey of 951 health blogs	Frequency of reporting of COI	Not reported	Not reported	United States	Not reported	Blogs	General	English	Physicians Others: other non-physician health professionals, patient, individual, consumer, caregiver	Funding/sponsorship	Corporation, Web site, medical group, foundation, or other entity	None	▪ **15.6%** (148/951) of health blogs reported sponsorship Sponsorship stratified by occupation (p=0.053): ▪ 14.9% (29/194) of physicians reported sponsorship in their blogs ▪ 19.7% (50/254) of other health professionals reported sponsorship in their blogs ▪ 12.9% (58/451) of non-health-related occupations reported sponsorship in their blogs
Niforatos 2019 [18]	N/A	June 1, 2017	June 1, 2018	1 year	Cross-sectional: Survey of 31 FOAMed blogs and websites	Prevalence of COI Proportion of undisclosed COI	Not reported	None	United States	United States	Blog posts and website entries	Emergency medicine	English[1]	Emergency medicine physicians	Financial: 1) compensation for services other than consulting, including serving as faculty or as a speaker at a venue	Industry	Open Payments database	▪ **15.4%** (45/292) of U.S-based healthcare providers had FCOI in the 2017 Open Payments database. ▪ Of the 12 bloggers who had 'significant' FCOI (defined as general or research payments>$5,000 from a single company over a 12-month period): **0%**

															other than a continuing education program; 2) consulting fee; 3) travel and lodging; 4) honoraria; 5) food and beverage; and (6) education.			(0/12) disclosed FCOI in their FOAMed content. ▪ General payment FCOI: Median $191 (IQR, $94.1–$829) Range $38,132 ▪ Research payment FCOI: Median $15,703 (IQR, $10,262–$72,916) Range $127,261 ▪ Type of FCOI: Food and beverages (85.8%), Travel and lodging (8.6%), Other services (1.9%), Honoraria (1.9%), consulting (1.2%), and education (0.6%).
Nishizaki 2021 [24]	August 2021	N/A	N/A	N/A	Cross-sectional: Survey of 72 YouTube videos reporting on pediatrics nocturnal enuresis	Frequency of reporting of COI	Not reported	None	Japan	Japan	YouTube	Pediatrics: nocturnal enuresis	Japanese	1. Physicians, nurses 2. non-health personnel: (1) academic (authors/uploaders affiliated with research groups or universities/colleges); (2) non-physician health personnel (pharmacists/chiropractors/acupuncturists); (4) independent user (nursery	Not specified	Not specified	None	▪ **0%** (0/72) of videos had a conflicts of interest declaration by the uploader ▪ 0% (0/72) videos were judged to have a commercial bias

														schoolteachers/schoolteachers), and (5) patient and family				
Pratsinis, 2021 [25]	October 2019	December 2006	December 2018	12 years	Cross-sectional: 100 YouTube videos addressing treatment options of urinary stones	Frequency of reporting of COI	None	None	Switzerland, Germany	Not reported	YouTube	Urology: surgical treatment of urinary stones	English	Physicians, clinic, hospital or university Industry, consumer/patient, medical societies/organizations and news media	Not specified	Not specified	None	▪ **9%** (9/100) of YouTube videos had a declaration of COI ▪ 72% of all videos were issued by healthcare providers or medical industry
Pratsinis 2021 [26]	October 2020	January 2008	June 2020	12 years	Cross-sectional: Survey of 240 YouTube videos reporting on benign prostatic hyperplasia, prostate cancer, and urinary stone disease. The 20 most viewed videos for each urological condition and language were included in the analysis.	Frequency of reporting of COI	None	None	Switzerland	Not reported	YouTube	Urology: benign prostatic hyperplasia, prostate cancer, and urinary stone disease	English, French, German, and Italian	Physicians, clinic, hospital or university Industry, consumer/patient, medical societies/organizations and news media	Not specified	Not specified	None	▪ "Majority" of all videos did not have declaration of conflicts of interest ▪ Estimated percentage of COI declaration: across 12 categories, proportion of videos reporting on COI ranges from 4.4%-35%, with a median of 19%; the total percentage of reporting of COI in the 240 videos is 19% ▪ No differences in reported COI for the different languages assessed

Shrank 2011 [28]	November 17, 2010.	N/A	N/A	N/A	Cross-sectional: Survey of 15 social networking sites (93% featured blogging)	Frequency of reporting of COI	Funded (by a research grant from CVS Caremark and a career development award from the National Heart, Lung, and Blood Institute)	None	United States	All countries	Social network websites	Diabetes	All languages	Health bloggers	Financial	Volunteer donation, foundation, pharmaceutical manufacturer, device manufacturer, insurer, not-for-profit, webhost	None	1. Industry sponsorship: Pharmaceutical manufacturers: **53.3%** (8/15) Diabetes device manufacturers: **60%** (9/15) Webhost Sponsorship: **13.3%** (2/15) 2. Foundation sponsorship: **20%** (3/15) 3. Voluntary donations: **26.7%** (4/15) 4. No industry sponsorship: **20%** (3/15) 5. Insurers: **20%** (3/15) 6. Not-for-profit: ▪ **26.7%** (4/15)
Tao 2017 [19]	June 1 - August 1, 2016	N/A	N/A	N/A	Cross-sectional: Survey of Twitter accounts of 634 hematologist-oncologists in the US	Prevalence of COI	Funded by Laura and John Arnold Foundation	1/4 reported receiving payments for contributions to Medscape	United States	United States	Twitter	Hematology-oncology	English[1]	Hematology-oncology physicians	Financial (general payments and research payments)	Industry	Open Payments database	▪ **79.5%** (504/634) of U.S-based hematologist-oncologists were reported on the Open Payment Database for having at least 1 FCOI ▪ Type of COI: General and research payments: 41% (262/634) of hematologist-oncologists Receiving general payment: 72.4% (459/634) of hematologist-oncologists Prevalence research payment: 48.4% (307/634) of hematologist-oncologists ▪ General payment FCOI: Median $1,644 (IQR, $129-$13,744) ▪ Research payment FCOI:

																		Median $11,064 (IQR, $0-$175164) General payments seemed consistent regardless of the extent of Twitter use, while research payments appeared greatest among those who use Twitter the least
Toth 2019 [13]	November 2017	N/A	N/A	N/A	Cross-sectional: Survey of 10 blog posts of nutritionists and registered dieticians in Ontario	Prevalence of 'potential' COI	None	1/5 reported being the chair of the Professional Titles for Dietitians in Ontario Advocacy Group and 5/5 of authors are Ontario registered dietitians	Canada	Canada	Blogs	Detoxification diets	English	Nutritionists and registered dietitians in Ontario	Not specified	Detox diets industry	None	▪ **80%** (4/5) of nutritionist blog posts had a 'potential' COI (i.e., selling a product or service related to detox diets, including selling books, meal plan guides, and products such as juices) ▪ **None** of registered dietitians blog posts had a 'potential' COI
Vu 2021 [27]	March 2021	February 2008 (surgery) November 2008 (radiotherapy)	September 2019	11 years	Cross-sectional: Survey of 80 YouTube videos on optimal treatment of prostate cancer: surgical therapy versus radiotherapy	Frequency of reporting of COI	None	None	Switzerland	Not reported	YouTube	Urology oncology: surgical therapy or radiotherapy of prostate cancer	English	Physicians, clinic, hospital or university Others: patients, societies (foundations, governmental institutions, academic journals), industry, and news media	Not specified	Not specified	None	▪ **10%** (surgery) and **5%** (radiotherapy) of the providers included a disclosure of their conflicts of interest ▪ Commercial bias: 15% (surgery videos) and 23% (radiotherapy videos) of the videos contained commercial bias

Walradt 2021 [20]	April 2020	No limit	April 2020	N/A	Cross-sectional: Survey of 956 tweets by gastroenterologists and surgeons, sharing gastrointestinal (GI) endoscopy videos/images. Selected after identifying those followed by at least 1 major US gastroenterology society and had > 500 followers	Prevalence of COI Proportion of undisclosed COI	None	Potential competing interests: Dr. Berzin is a consultant for Wision AI, Boston Scientific, and Medtronic. All other authors disclosed no financial relationships relevant to this publication.	United States	United States	Twitter	Gastroenterology	English	Gastroenterologists and surgeons	Financial	Industry	Open Payments database	▪ **37%** (7/19) of tweets that mentioned the name of a medical device were posted by a U.S physician who had received a payment (according to OPD) from the manufacturer of the device mentioned. ▪ **None** of the physicians who had received a payment from the manufacturer of the device mentioned disclosed any financial relationships.

[1]Language was assumed based on the country of the individuals posting

ABBREVIATIONS:

COI: conflict of interest

FCOI: financial conflict of interest

OPD: Open Payment Database

FOAMed: Free Open Access Medical Education

N/A: Not available

Supplementary file 6: Appraisal of the 17 included studies using Mixed Methods Appraisal Tool.

Mixed Methods Appraisal Tool (MMAT)

		SCREENING QUESTIONS		4. QUANTITATIVE DESCRIPTIVE STUDIES				
First author	Year	S1. Are there clear research questions?	S2. Do the collected data allow to address the research questions?	4.1. Is the sampling strategy relevant to address the research question?	4.2. Is the sample representative of the target population?	4.3. Are the measurements appropriate?	4.4. Is the risk of nonresponse bias low?	4.5. Is the statistical analysis appropriate to answer the research question?
Betschart [22]	2020	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Chretien [30]	2009	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chretien [21]	2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Greysen [10]	2012	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hessari [31]	2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kaestner [29]	2017	Yes	Yes	Yes	Yes	No[2]	Yes	Yes
Lagu [23]	2008	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Miller [12]	2011	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Niforatos [18]	2019	Yes	Yes	Yes	Yes	No[2]	Yes	Yes
Nishizaki [24]	2021	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Pratsinis [25]	2021	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Pratsinis [26]	2021	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Shrank [28]	2011	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Tao [19]	2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Toth [13]	2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vu [27]	2021	Yes	Yes	Yes	Yes	No[1]	Yes	Yes
Walradt [20]	2021	Yes	Yes	Yes	Yes	No[2]	Yes	Yes

[1] It was not clear from any of the studies whether the percentage referred to the number of COI statements (whether reporting the existing or not of COI) or to the number of statements reporting a COI.

[2] It was not clear from any of the studies whether the proportion referred to those who reported no COI or those who had no COI statement.

PRISMA 2020 for Abstracts Checklist

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	Yes
Registration	12	Provide the register name and registration number.	Yes

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Check PRISMA for abstracts checklist
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Pages 5-6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	~~Appendix B~~Supplementary file 2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Pages 6-7
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Pages 5~~-7and 7~~
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Pages 6-7
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 7
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Not applicable
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Pages 6-7
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Pages 6-7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Not applicable
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not applicable

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Not applicable
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Not applicable
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 8
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary file ~~4~~6
Study characteristics	17	Cite each included study and present its characteristics.	~~Appendix C~~Supplementary File 5
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	~~Appendix D~~Supplementary File 6
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Pages 8-12
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pages 8-12
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pages 8-12
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Not applicable
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not applicable
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not applicable
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Not applicable
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 1~~5~~3
	23b	Discuss any limitations of the evidence included in the review.	Page~~s~~ 1~~5~~3-14
	23c	Discuss any limitations of the review processes used.	Page~~s~~ 1~~5~~13-14
	23d	Discuss implications of the results for practice, policy, and future research.	Page~~s~~ 16-17-14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 5
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 1~~8~~5
Competing	26	Declare any competing interests of review authors.	Page 1~~8~~5

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
interests			
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 185

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