YouTube videos as health decision aids for the public: An integrative review

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WHY THIS ARTICLE IS IMPORTANT TO DENTAL HYGIENISTS

- The public is increasingly using YouTube videos to gain knowledge on health-related issues.
- Health care providers have a responsibility to ensure that videos containing evidence-based information are readily accessible to searchers.
- Dental hygienists should consider the 10 factors that increase accessibility of YouTube content when creating oral health education videos for the public.

ABSTRACT

Objective: To determine the potential value of YouTube videos as health decision aids for the public. **Methods:** An integrative review was performed to explore 3 questions: 1) What is the validity of health-related YouTube videos created for the public? 2) Are YouTube videos an effective tool for supporting the public in decision making regarding the treatment, prevention, and diagnosis of disease? 3) How can health professionals ensure their videos will be readily accessible to those searching online for health-related information? Systematic searches of PubMed, CINAHL, and Web of Science were conducted. The returns were screened using inclusion and exclusion criteria and studies found were critically appraised. **Results:** Fifty-eight studies assessed the validity of videos on given topics and 9 studies examined the effectiveness of videos in supporting decision making. These studies demonstrated that the majority of health-related YouTube videos lack validity. However, evidence-based videos do exist and have the potential to be an effective instrument in supporting the public in making health decisions. Ten studies examined ways to increase the accessibility of such videos to the public. **Discussion:** Creators of evidence-based videos must take into consideration content and content-agnostic factors to improve the accessibility of their videos to searchers. Recommendations to support creators in making their evidence-based health videos readily accessible to the public are provided. **Conclusions:** By exploiting appropriate content and content-agnostic factors, video creators can ensure that valid health information is readily accessible to information seekers.

RÉSUMÉ

Objectif : Afin de déterminer la valeur potentielle des vidéos YouTube en tant qu'aide à la population dans leur prise de décision en matière de santé. **Méthodologie :** Une étude intégrée a été effectuée afin d'explorer les 3 questions suivantes : 1) Quelle est la validité des vidéos YouTube liées à la santé, créées pour la population? 2) Les vidéos YouTube sont-elles un outil efficace pour appuyer la population dans leur prise de décision à l'égard du traitement, de la prévention et du diagnostic d'une maladie? 3) Comment les professionnels de la santé peuvent-ils veiller à ce que leurs vidéos soient facilement accessibles à ceux qui cherchent en ligne pour de l'information liée à la santé? Des recherches systématiques sur PubMed, CINAHL et Web of Science ont été effectuées. Les trouvailles ont été triées au moyen de critères d'inclusion et d'exclusion et les études trouvées ont été évaluées de façon critique. **Résultats :** Cinquante-huit études ont évalué la validité des vidéos sur des sujets donnés et 9 études ont examiné l'efficacité des vidéos dans leur soutien de la prise de décision. Ces études ont démontré que la majorité des vidéos YouTube liées à la santé manquent de validité. Cependant, des vidéos fondées sur des données probantes existent et ont le potentiel d'être un instrument efficace pour soutenir la population dans leur prise de décision. Dix études ont examiné les façons d'augmenter l'accessibilité de la population à de telles vidéos. **Discussion :** Les créateurs de vidéos fondées sur des données probantes doivent considérer le contenu et les facteurs d'indifférence au contenu afin d'améliorer l'accessibilité de leurs vidéos aux chercheurs. Une liste de recommandations pour appuyer les créateurs dans leurs vidéos sur la santé, fondées sur des données probantes et facilement accessibles à la population est comprise. **Conclusions :** En exploitant le contenu approprié et les facteurs d'indifférence au contenu, les créateurs de vidéo peuvent assurer que de l'information valide sur la santé est facilement accessible aux chercheurs d'information.

Keywords: consumer health information, health knowledge, information dissemination, review, social media, YouTube

CDHA Research Agenda category: capacity building of the profession

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INTRODUCTION

The internet is a key source of health information for the public. In 2012, 72% of internet users (59% of adults) in the United States reported searching for health information online.[1] Similar trends have been observed in Canada where 70% of home internet users reported searching for health information.[2] In the United States, most health-related online searches (77%) are initiated through a search engine (e.g., Google), which frequently leads to social media sites (e.g., Facebook, Instagram, Tumblr, Twitter, YouTube).[1,3] As the percentage of people with internet access in Canada and the United States grows, these proportions will surely increase.[4]

In recent years, studies have examined the reasons people turn to the internet as a source of health-related information. Users typically seek specific information pertaining to their own or others' health concerns.[1,3,5-7] The internet is purported to support users in self-diagnosis, improving their knowledge of present conditions and/or procedures, reducing anxiety, finding treatment options, obtaining details on the purpose and side effects of specific medications, and in finding support.[1,3,5-7] In addition, people also search the internet for information on health programs and services.[6-9]

The proposed benefits of public access to health information via the internet include gathering knowledge about chronic diseases[10] or perceived conditions prior to seeing a health professional.[1,3,5-8] Other benefits include supporting individuals in making health care decisions and verifying health care information, thereby potentially improving the efficiency of interactions between patients and their health care providers.[3,8,9] Access to online health care information has also been purported to empower individuals to support and advise others with similar symptoms and/or conditions,[3,6,8,9,11] thus, increasing their own comfort level and coping strategies.[3]

Social media platforms are a popular means of sharing health information with the public.[6,8,11] One prominent form of social media is YouTube. Established in 2005, YouTube has become one of the most popular video-sharing sites in the world. Currently, YouTube has more than 1 billion registered users, and billions of videos are watched each day including approximately 30 million health-related videos.[12] Part of this success is credited to video discovery mechanisms such as a keyword-based search engine, the video recommendation system, the ability to highlight videos on YouTube homepages, and the capacity to embed YouTube videos in webpages, blogs, and social network sites.[13] Anyone can publish and upload YouTube videos regardless of qualifications or profession and, because these videos are not peer reviewed, the validity of health information available on YouTube cannot be guaranteed.

The popularity of YouTube as a source of unregulated health information is a concern among health professionals. Hundreds of primary studies have examined the validity of health-related content on YouTube and the effectiveness of these videos in supporting individuals with their health decisions. Independently, these studies portray the validity of health-related videos as ranging from good to poor. Despite this large body of work, only minimal attempts have been made to synthesize the outcomes of these primary studies in a comprehensive and systematic manner. Therefore, it is difficult to draw conclusions of the overall validity and effectiveness of health-related information presented in YouTube videos.[10,14]

A further issue related to the use of YouTube videos as an instrument for supporting the public in making health decisions lies in the fact that there is no guarantee valid videos (i.e., those containing evidence-based content), if they exist, will be readily accessible to a searcher. When YouTube searches are conducted, the most popular videos are listed at the top of the Search Engine Result Page (SERP). Numerous studies have revealed either no correlation or an inverse correlation between video content validity and popularity within the YouTube system.[15-29] That is, YouTube videos are not ranked according to the quality of information and consequently videos of excellent validity may fall to the back pages of the YouTube viewing list. As a result, individuals searching for health information on YouTube often watch the most popular videos, but not the most evidence-based videos.

This situation has led researchers to call for the creation of videos that are not only of excellent validity but are also attractive to persons searching for health-related information, thereby ensuring the videos will appear nearer to the top of the SERP.[15,16,18,20,21,23,24,30] There are a number of studies in other domains that have investigated the attributes of videos which increase their accessibility to searchers. To date, there are no studies that synthesize this information to support health professionals in creating accessible videos.

The purpose of this study is to inform and make recommendations to health care professionals tasked with creating YouTube videos to support the public in making informed health decisions. To do this, the research team examined 3 distinct but related questions: 1) What is the consensus on the validity (i.e., is the content evidence-based) of health-related YouTube videos created for the public? 2) Are YouTube videos an effective tool for supporting the public in the decision-making process for the treatment, prevention, and diagnosis of disease? 3) How can health professionals ensure their videos will be readily accessible to those searching online for health-related information?

METHODS

Literature search

An integrative review was conducted following the framework proposed by Whittemore and Knafl.[31] This framework utilizes a defined, systematic method to reduce the risk of bias and improve reliability of the findings. This research method was chosen because it supports the

Figure 1a. Research flow chart for Questions 1 and 2

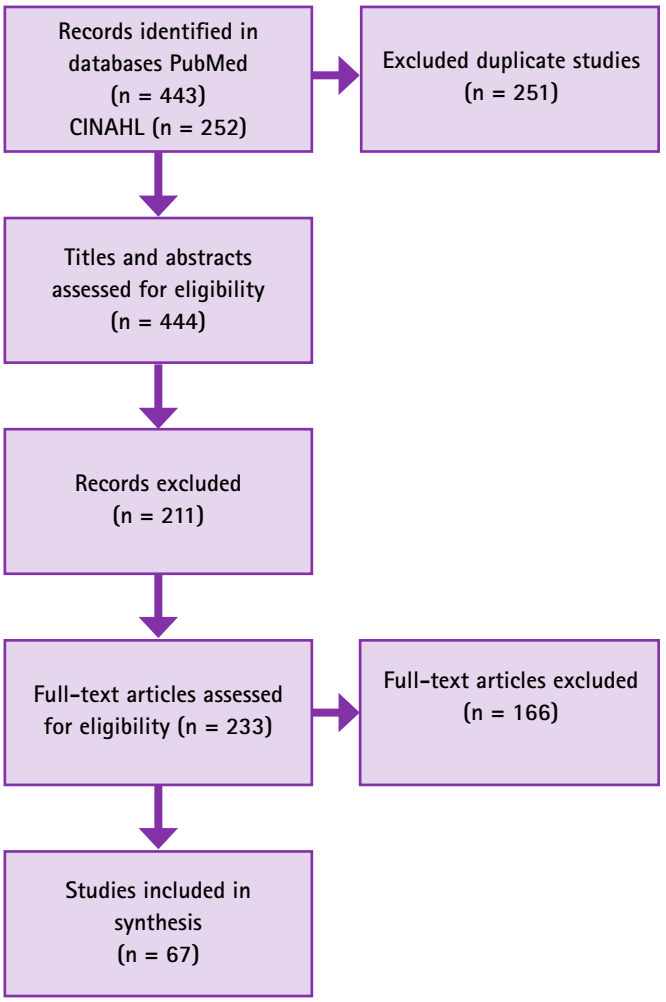
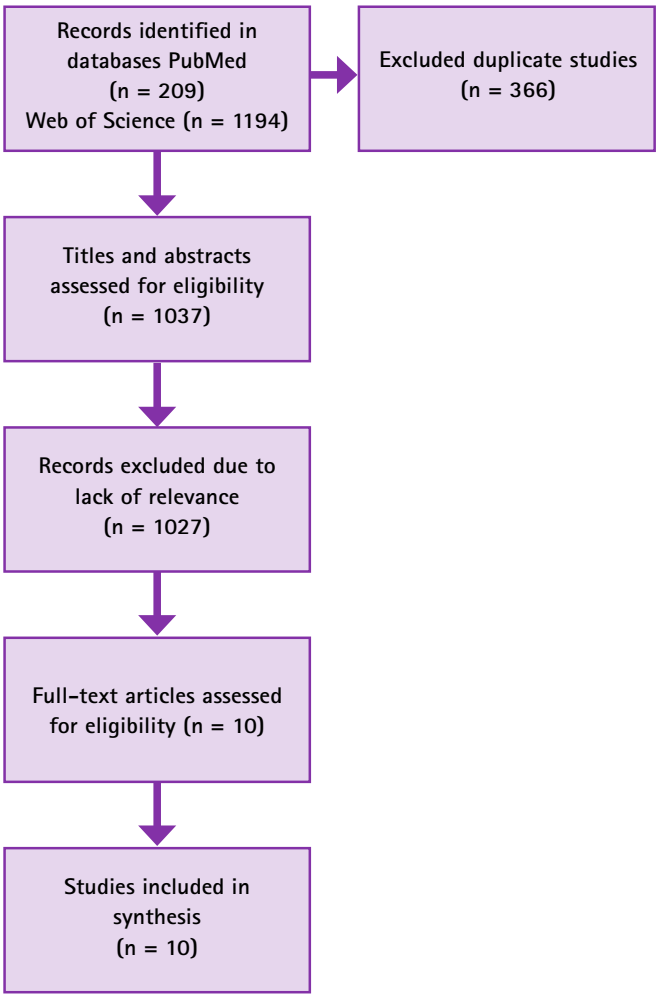


Figure 1b. Research flow chart for Question 3



integration of findings from various types of research designs, thereby enabling a more holistic understanding of the phenomenon of interest. This integrative review identified and critically appraised research studies that addressed 3 related but distinct questions about YouTube videos as a source of health information for the public.

As this field is extremely diverse the research team (n = 7) began by conducting a broad preliminary search in PubMed using the keyword "YouTube" in fall 2016. The search was restricted to English language studies published within the past 5 years. A total of 521 studies were identified. The team reviewed the titles and abstracts of these publications. This preliminary search defined the development of specific research questions and vocabulary (e.g., keywords) for subsequent systematic searches.

After the initial search, the team used the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement to guide the subsequent question development and systematic literature search.[32] Depending on the question, searches were conducted in PubMed and CINAHL or in PubMed and Web of Science, using the following inclusion criteria: a) published in peer-reviewed sources; b) clear methodologies; c) conducted in western countries; d) written in English; e) published within the past 10 years. The time period was expanded from 5 years in the preliminary search to 10 years to ensure a comprehensive search of the available literature. The following were excluded: a) corporate advertisements; b) case reports; c) letters to the editor; and d) studies of YouTube videos developed to educate health professionals.

To answer Questions 1 and 2 (What is the consensus on the validity [i.e., is the content evidence-based] of existing health-related YouTube videos created for the public? and Are YouTube videos an effective tool for supporting the public in the decision-making process for the treatment, prevention, and diagnosis of disease?), a common systematic literature search was conducted in PubMed and CINAHL using the following search keywords and combinations:

- YouTube AND prevention
- YouTube AND diagnosis
- YouTube AND treatment

- YouTube AND health promotion
- YouTube AND public health

To answer Question 3 (How can health professionals ensure their videos will be readily accessible to those searching online for health-related information?), the following keywords and search combinations were applied in PubMed and Web of Science:

- YouTube AND keywords
- YouTube AND rank
- YouTube AND views
- YouTube AND recommendation
- YouTube AND popularity

Outlines of the search process and results relevant to the study questions are provided in Figures 1a and 1b. Results from database searches were consolidated and duplicates were removed. The titles and abstracts of remaining studies were screened for relevance based on the inclusion and exclusion criteria. Next, a minimum of 2 authors screened the remaining papers by reading the full text to further confirm eligibility and evaluate methodological quality. Reference lists of included studies were checked to identify studies that might have been missed through the systematic literature search. Defined outcomes (e.g., measures of effectiveness or validity for Questions 1 and 2) were extracted and discussed by the full research team.

Studies obtained from the systematic literature searches were critically appraised for methodological soundness using tools from the Critical Appraisal Skills Programme (CASP).[33] CASP tools were adapted to suit methodological expectations of the various studies identified. These adaptations were facilitated by established relevant critical appraisal guides (e.g., the Consolidated Standards of Reporting Trials Statement for Randomized Controlled Trials[34] and the Consolidated Criteria for Reporting Qualitative Research[35] for studies using qualitative approaches). It is important to keep in mind such tools serve as guides to appraisal and should only be used by persons with expertise in the relevant designs.[36]

RESULTS

Questions 1 and 2

The initial literature search identified 695 studies in 2 scientific databases. Duplicates were identified, resulting in 444 unique studies. The titles and abstracts were reviewed to determine relevance, resulting in the exclusion of an additional 211 studies. The full texts of 233 studies were examined, resulting in the exclusion of a further 166 studies. Twenty-nine percent of the excluded studies examined YouTube as an educational tool for health professionals, 3% were case studies, 5% pertained to advertising, 9% were letters or commentaries, and 38% were deemed not relevant to the research question. The remaining 67 studies met the inclusion criteria (Figure 1a). No study was excluded due to poor methodological quality.

Sixty-three of the included studies used quantitative methodologies and 4 used qualitative methodologies (Table 1). Most of the quantitative studies were evaluative; they critically appraised or assessed the validity, effectiveness, values or character of YouTube videos. All studies that assessed validity employed a systematic approach in identifying and selecting videos and expert review of the video content.

The research team rated the 67 included studies on their methodological rigor and on the level of evidence. These critical appraisals were guided by the CASP. In general, the team rated studies that were adequately powered, used valid and reliable measures, and were well described as "high." Whereas, included studies that were deemed "low" had inadequate sample sizes and/or had poorly described interventions that were unlikely to be reproducible. A minimum of 2 team members independently rated each study; a third person was used when consensus on assessment scores could not be reached. No studies were excluded on the basis of methodological quality.

The majority of studies included in this integrative review were determined to be of medium quality (n = 60; 90%). Primary weaknesses of these studies included a failure to describe the creation of tools (rubrics/scales) used to guide the assessment (expert review) of video(s) validity; failure to blind the study evaluators; and failure to comprehensively describe the qualifications of those individuals performing the expert review of video content. Three studies (4%) were deemed of low quality. One study was a narrative review—narrative reviews by design are of lesser quality due to the lack of transparency in the selection of studies for inclusion, and a lack of defined critical appraisal—and the other 2 studies were low in methodological rigor and did not contain sufficient description for reproduction. The 4 remaining studies (6%) were determined to be of high quality, meeting all critical requirements of their design (Tables 1 and 2).

Of the 67 studies included, 58 assessed the validity of video content on a given topic. Thirty-one of these studies (54%) concluded that the videos had overall poor validity (i.e., the majority of videos presented facts that were not evidence based, and often misleading or potentially harmful). Seven studies (12%) found videos on a given topic to be of variable validity (i.e., similar numbers of good and poor validity), and 20 studies (34%) determined videos on a given topic to be of good validity (i.e., the majority of videos contained information that was evidence-based). Three of the studies that found videos to be of good validity had restricted their video selection to those created by sources they perceived to be credible.[15,37,38]

Nine studies examined the effectiveness of YouTube for supporting change in knowledge, skill, attitudes, and behaviour pertaining to the treatment and prevention of disease (Table 2). The majority of studies were determined to be of medium and high quality. Four of these studies

Table 1. Summary of included studies for Question 1

Author	Video subject area (number of videos examined)	Methodology[a]	Study quality (high, med, low)	Validity of the YouTube videos studied (good, variable, poor)
Abedin 2015[58]	Diabetes (n = 89)	Qn, SS, ER	Med	Poor
Addar 2017[59]	Distal radius fracture (n = 16)	Qn, SS, ER	Med	Poor
Adhikari 2016[60]	Cervical cancer (n = 172)	Qn, SS, ER	Med	Poor
Athanasopoulou 2016[61]	Schizophrenia (n = 52)	QI, CS, SS, ER	Med	Poor
Backinger 2011[62]	Smoking (n = 191)	QI, CS, SS, ER	Med	Variable
Basch 2017[63]	Vaccines (n = 87)	Qn, SS, ER	Med	Poor
Basch 2016[64]	Multivitamins (n = 97)	Qn, SS, ER	Med	Poor
Basch 2015[65]	Skin cancer (n = 140)	Qn, SS, ER	Med	Variable
Basch 2015[66]	Ebola virus (n = 100)	Qn, SS, ER	Med	Variable
Bert 2016[67]	Kidney transplant (n = 46)	Qn, SS, ER	Med	Poor
Biggs 2013[68]	Rhinosinusitis (n = 100)	Qn, SS, ER	Med	Poor
Brna 2013[69]	Seizure (n = 167)	Qn, SS, ER	High	Poor
Butler 2013[70]	First aid for burns (n = 20)	Qn, SS, ER	Med	Poor
Camm 2013[71]	Cardiac (n = 22)	Qn, SS, ER	Med	Poor
Carroll 2013[72]	Smoking (n = 127)	QI, CS, SS, ER	Med	Variable
Covolo 2017[73]	Vaccinations (n =123)	QI, CS, SS, ER	Med	Variable
de Carvalho 2013[74]	Breastfeeding (n = 175)	Qn, SS, ER	Med	Good
Delli 2016[75]	Sjögren's syndrome (n = 70)	Qn, SS, ER	Med	Variable
Desai 2013[15]	Cardiovascular (n = 607)	Qn, SS, ER	Med	Good
Dubley 2014[16]	West Nile virus (n = 106)	Qn, SS, ER	Med	Good
ElKarmi 2016[17]	Early childhood caries (n = 30)	Qn, SS, ER	Med	Poor
Farkas 2015[76]	Needle pain (n = 25)	Qn, SS, ER	Med	Good
Fat 2012[77]	Tourette syndrome (n = 41)	Qn, SS, ER	Med	Good
Fat 2011[78]	Infantile spasms (n = 54)	Qn, SS, ER	Med	Good
Garg 2015[29]	Dialysis (n = 115)	Qn, SS, ER	Med	Good
Gonzalez-Estrada 2015[79]	Asthma (n = 200)	Qn, SS, ER	Med	Poor
Gooding 2011[80]	Music therapy (n = 59)	Qn, SS, ER	Low	Good

Table 1 cont'd...

Author	Video subject area (number of videos examined)	Methodology[a]	Study quality (high, med, low)	Validity of the YouTube videos studied (good, variable, poor)
Gupta 2016[30]	Peripheral neuropathy (n = 200)	Qn, SS, ER	Med	Poor
Hassona 2016[18]	Mouth cancer (n = 188)	Qn, SS, ER	Med	Good
Haymes 2016[19]	Nosebleed (n = 45)	Qn, SS, ER	Med	Poor
Ho 2016[81]	Implant dentistry (n = 202)	Qn, SS, ER	Med	Good
Jamwal 2016[82]	Palliative care	Review, not evaluation study	Low	Poor
Keelan 2007[83]	Immunization (n = 153)	Qn, SS, ER	Med	Poor
Kerber 2012[44]	Epley maneuver (n = 33)	Qn, SS, ER	Med	Good
Knösel 2011[84]	Orthodontics (n = 60)	Qn, SS, ER, non-expert reviewers	Med	Poor
Koller 2016[20]	Hip arthritis (n = 133)	Qn, SS, ER	Med	Poor
Kumar 2014[21]	Hypertension (n = 209)	Qn, SS, ER	Med	Good
Kwok 2017[22]	Varicose veins (n = 228)	Qn, SS, ER	Med	Variable
Lee 2014[23]	Gallstone disease (n = 131)	Qn, SS, ER	Med	Poor
Lopez-Jornet 2017[85]	Oral care for organ and hematopoietic patients (n = 50)	Qn, SS, ER	Med	Poor
Meng 2015[45]	Body image (n = 4)	Qn, Non-controlled, not evaluation study	High	Good
Murugiah 2011[86]	Cardiopulmonary resuscitation (n = 52)	Qn, SS, ER	Med	Good
Nagpal 2015[87]	Ebola (n = 86)	Qn, SS, ER	Med	Poor
Nason 2016[88]	Root canal treatment (n = 60)	Qn, SS, ER	Med	Poor
Nour 2017[89]	Schizophrenia (n = 35)	Qn, SS, ER	Med	Poor
O'Connor 2016[38]	Hip and knee replacement	RCT, not evaluation study	High	NA
Pandey 2010[90]	H1N1 (n = 142)	Qn, SS, ER	Med	Good
Pant 2012[24]	Acute myocardial infarction (n = 104)	Qn, SS, ER	Med	Poor
Pathak 2015[91]	Ebola virus (n = 118)	Qn, SS, ER	Med	Good
Rittberg 2016[25]	Methotrexate self-injection (n = 51)	Qn, SS, ER	Med	Poor
Singh 2012[92]	Rheumatoid arthritis (n = 102)	Qn, SS, ER	Med	Good
Sood 2011[93]	Kidney stone (n = 199)	Qn, SS, ER	Med	Good

Table 1 cont'd...

Author	Video subject area (number of videos examined)	Methodology[a]	Study quality (high, med, low)	Validity of the YouTube videos studied (good, variable, poor)
Sorensen 2013[26]	Adenotonsillectomy Ear tube surgery (n = 102)	Qn, SS, ER	Med	Poor
Staunton 2015[27]	Scoliosis (n = 50)	Qn, SS, ER	Med	Poor
Steinberg 2010[94]	Prostate cancer (n = 51)	Qn, SS, ER	Med	Poor
Stellefson 2014[95]	COPD (n = 223)	Qn, SS, ER	Med	Good
Strychowsky 2013[96]	Tonsillectomy (n = 156)	Qn, SS, ER	Med	Good
Syed-Abdul 2013[28]	Anorexia (n = 40)	Qn, SS, ER	Med	Good
Tourinho 2012[97]	Life support & CPR (n = 61)	Qn, SS, ER	Med	Poor
Yaylaci 2014[98]	Life support & CPR (n = 209)	Qn, SS, ER	Med	Poor

[a]Qn: quantitative study; Ql: qualitative study; CS: cross-sectional; SS: systematic search; ER: expert review. Unless otherwise stated, all papers were evaluation studies.

Table 2. Summary of included studies for Question 2

Author	Video subject area (number of videos examined)	Methodology[a]	Study quality (high, med, low)	Outcome measures	Results
Axtell 2017[46]	Inhaler technique (n = 1)	Quantitative RCT	High	Change in skill	Demonstrated failure to elicit intended change in skill
Bottorff 2014[42]	Breast cancer (n = 2)	Quantitative exploratory descriptive study	Med	Change in knowledge	Demonstrated increase in intended knowledge (no statistical analysis)
Harrison 2016[43]	Vaccination pain (n = 1)	Quantitative survey	Low	Change in attitude	Demonstrated intended change in attitude (no statistical analysis)
Kerber 2012[44]	Epley maneuver (n = 33)	Qualitative SS,ER	Med	Behaviour change	Demonstrated intended change in behaviour
Kopf 2015[37]	Parkinson's disease (n = 15)	Quantitative SS, pre-post single arm	Med	Readiness for change Self-efficacy	Demonstrated increase in readiness for change ($p < 0.05$) Trend for increased self-efficacy ($p < 0.18$)
Lauckner 2016[39]	Cancer risk	Quantitative convenience sampling	High	Message recall/test Attitudes	Demonstrated increase in intended knowledge ($p < 0.05$) Demonstrated intended change in attitude ($p < 0.05$)
Lee 2017[41]	Humorous anti-tobacco videos (n = 2)	Quantitative RCT	High	Change in knowledge Change in attitudes	Demonstrated increase in knowledge ($p < 0.01$) Demonstrated intended change in attitude ($p < 0.01$)
O'Connor 2016[38]	Hip and knee replacement (n=16)	Quantitative RCT	Med	Change in attitude	Trend towards intended change in attitude (no statistical analysis)
Tse 2015[40]	Adolescent health literacy	Quantitative CS	Med	Literacy assessment	Demonstrated increase in knowledge ($p < 0.005$)

[a]CS: cross-sectional; SS: systematic search; ER: expert review

Table 3. Summary of included studies for Question 3

Authors	Aim[a]	Methodology[b] (number of videos)	Findings	Study quality
Borghol et al. 2012[46]	Examine CF/CAF that most impact video popularity	CM,SS,API,HTML scraping to access metadata (video statistics, view counts, and influential events) (n = 1761)	CF Video quality is an important factor at early stages of release CAF The 2 most influential affecting video popularity are total number of views and video age Video referrals increase views Google is the primary source of referral Keywords one of the main factors in initially finding a video Keywords should be colloquial and relevant to intended viewers Viewership is increased by linking to other social media tools (The larger the social network of the video creator, the more likely it will become top-ranked)	High
Chatzopoulou 2010[52]	Examine CAF influencing video popularity	CM,API metadata (n = 37 million)	CAF High correlation between view count, number of comments, and number of favourites	High
Chelaru et al. 2014[53]	Evaluate the impact of social features on video rank.	CM,API (likes, dislikes, comments, and views) (n > 400 million views)	Combining the basic and social features optimizes viewership: certain pairings generate higher ranking CAF Keywords are main factor in finding a video Keywords should be colloquial and relevant Keywords are important to ensuring potential users discover the video Efforts to increase social responses (likes, dislikes, comments) can boost rankings	High
Gill et al. 2007[50]	Examine usage patterns, file properties, popularity and referencing characteristics, and transfer behaviours of most popular YouTube videos	CM: Used the feature "most viewed videos: day, week, month, and all time" to identify the top 100 videos. API: Duration, category, and rating (n = 100)	CF Short duration (<10 minutes); ideally 3 to 5 minutes in length are more popular CAF As a video ages popularity declines. Interaction (via comments) with users sustains popularity	High
Kim 2012[49]	Investigate the institutionalization of YouTube	NR	CAF Viewers may perceive videos with advertisements or an association with an institution to be of higher quality	Low
Tatar et al. 2014[47]	Understand what makes web content popular	NR of web content popularity prediction methods	CF Emotion, video quality, and geographic relevance impact popularity CAF Likes and sharing on social networks (Facebook, Twitter, etc.) increase video popularity The larger the social network of the publisher, the more likely the video will become popular Understanding internet services (i.e., search tools, keywords, and recommendation systems) can support the creation of popular videos	Med
Welbourne & Grant 2015[45]	Examine CF/CAF influencing the popularity of science communication videos	Quantitative: random sampling with content analysis (n = 390)	CF User-generated videos are significantly more popular than professionally generated videos Fast-paced videos are more popular CAF Uploading content regularly to YouTube and regular interaction with one's audience boosts popularity of videos The perceived credibility of the source (based on expertise, experience, impartiality, affinity) impacts popularity RS Influence video popularity	High

Authors	Aim[a]	Methodology[b] (number of videos)	Findings	Study quality
Zhou et al. 2010[48]	Investigate the impact of the RS on video discovery and major sources driving views	CM,HTML,API (n = 700,661) plus (n = 356,891 from related video lists)	RS Helps viewers discover videos of interest and is the main source of views Videos are more likely to be discovered when placed by the RS with highly viewed (related) videos Position on the related video list is crucial to obtaining initial views	High
Zhou et al. 2016[49]	Determine what titles/ keywords a video should use to boost its views through the RS	CM,API,HTML Markov clustering algorithm (n = 114,460) plus (n = 190,233 from related video lists)	CAF Using the same keywords as those found in highly ranked videos boosts the probability that the video will be recommended RS 80% of video views are derived by the RS Videos linked to highly viewed videos have an increased chance of being viewed	High
Zhou et al 2016[13]	Examine patterns of views of major view sources (related video recommendation, YouTube search, and video highlights)	CM,API,HTML,SS Randomized video selection (n = 484,000)	CAF Search and highlights (i.e., popular list, video embedding on social media, etc.) create the "rich get richer" effect Contribution to number of views from video highlights fades quickly. Continued highlighting supports continued views RS Increases viewer diversity Increases visibility of videos that users are interested in, instead of popular videos	High

[a]CAF: content-agnostic factors; CF: content factors; RS: recommendation system
[b]API: utilizing YouTube application program interface to access metadata; CM: computational modeling; HTML: hypertext markup language; NR: narrative review; SS: systematic search

examined and demonstrated YouTube's ability to increase users' knowledge.[39-42] Five studies investigated and confirmed YouTube's capacity for supporting an intended change in attitude.[38-41,43] Finally one study investigated and demonstrated YouTube's ability to change behaviour[44] and one study demonstrated improved self-efficacy.[37] Collectively, these studies demonstrated that YouTube videos were more effective than non-video methods in imparting health information[37,38]; YouTube had higher impact on recall (knowledge), attitudes, and behaviours when compared to written material on other social media platforms (i.e., Facebook, Twitter, and blogs).[39,40] One study demonstrated that effectiveness increased when the video is embedded in Facebook.[41] Four studies demonstrated effectiveness but did not draw comparisons against other approaches.[42-44] One study comparing the use of YouTube videos to in-person training on inhaler use determined YouTube to be less effective in improving skill.[46]

Question 3

When people search for YouTube videos on a given topic, the videos that appear at the top of the SERP are the ones people typically view first and are therefore the most "accessible" videos. This review sought to examine studies that investigated mechanisms by which a video creator can ensure their video will be readily accessible to searchers. To do this, a systematic review of the literature was conducted by 3 members of the team. The initial literature search identified 1403 studies in 2 scientific databases: PubMed and Web of Science. Following duplicate removal, 1037 unique studies remained. Titles and abstracts of these studies were reviewed to determine relevance, resulting in the exclusion of 1027 records. This number was anticipated given that general science databases like the "Web of Science" have less sophisticated limits and filters. In total, 10 studies met the inclusion criteria (Figure 1b). A review of the full text of these studies determined that their methodological quality was sufficient for inclusion in this review.

Of the 10 included studies, 8 employed quantitative approaches. Seven of these used computational modeling designs. Computational modeling uses mathematics, physics, and computer science to study and simulate the behaviours of complex systems like YouTube. One study was a content analysis of a random sample of videos. The 2 additional studies were narrative reviews. All studies sought to gain a broader understanding of factors that affect video viewership on YouTube; the narrative reviews were used to gain further perspective. The 8 quantitative studies were determined to be of high methodological quality while the narrative reviews were determined to be of low quality. Summaries of the critical appraisal of these studies are found in Supplemental Tables 1A and 1B, published online at www.cdha.ca/cjdh.

Collectively, these studies determined that video accessibility is influenced by a combination of content factors, content-agnostic factors, and the YouTube recommendation system (Table 3). Content factors are

the stylistic and informational characteristics believed to affect a video's popularity.[47-50] Content-agnostic factors are characteristics external to the video that affect video distribution, promotion, and views, thereby increasing accessibility.[47-50] Finally, a built-in YouTube recommendation system supports accessibility by recommending videos with similar content to the current search, and by delivering personalized video recommendations based on the viewer's previous YouTube activity.[49,51]

This review identified a variety of content factors believed to be associated with increased video popularity. These include being fast paced,[47,52] of short duration (i.e., 3 to 5 minutes),[47,52] emotion evoking,[49] of good quality,[48,49,53] geographically relevant,[49] from credible sources,[47,49,53] recently uploaded, and relatable to the searcher.[47]

The two most influential content-agnostic factors for increasing video accessibility are the number of views[48-50] and the age of the video.[48,49,52,54] Increasing the number of views can be accomplished in many ways. One important method is through referrals. Since search engines (e.g., Google) are the primary source of referrals to YouTube,[48] having the appropriate keywords is essential to initial discovery of a video. Keywords that are relevant and colloquial to searchers increase accessiblity.[48,51,55]

Increasing the number of views can also be accomplished by exploiting the fundamental features inherent to YouTube. After watching a video, users can give feedback by liking, commenting or adding the video to their favourite list.[48,52,54] Another feature is sharing videos. This involves embedding a link to the video in other social media sites (e.g., Facebook, Twitter, Instagram or blogs).[41,49,50,55] The larger the social network of the video creator the more opportunity for sharing their work. By exploiting these features users can increase the accessibility of their video.

The second factor influencing video popularity is its apparent age (i.e., time since the video was uploaded on YouTube). Unfortunately, as a video ages, its popularity declines. To counteract this issue, interactions between the creator and the video users (i.e., via comments) and regularly sharing the video on social media sites sustain popularity by making it appear current.[13,47,52,55]

The third factor influencing viewership on YouTube is the built-in recommendation system. This system, which creates the SERP that appears to the right of the video being viewed, is designed to recommend additional videos deemed most relevant to a search. Being on this list is important as users will tend to scroll down this list and watch related videos.[50] In fact, 80% of YouTube video views are derived from this list.[13] A highly ranked position on this list is dependent upon the judicious use of content and content-agnostic factors. Of particular importance to the ranking is the video's ability to hold viewers' attention to the end. In other words, videos that are watched in their entirety rise higher on the recommendation list than those that are not watched to their conclusion.[13,50] Collectively, these factors improve a YouTube video's accessibility through a "rich-get-richer" phenomenon. Videos recommended by this system obtain more views, which in turn, boosts the accessibility of the video by moving it higher on the SERP.[48,52,54]

DISCUSSION

Given the ubiquitous use of the internet as a source of health information by the public[1,2] and the popularity of YouTube, it is important for clinicians and researchers to understand the potential benefits and risks associated with using videos to make informed health decisions. This study set out to synthesize current evidence pertaining to the validity of health information contained within YouTube videos and the potential for this medium to support the public in making health decisions.

It was surprising to discover that only a small number of peer-reviewed studies have evaluated the effectiveness of YouTube videos as a medium for supporting health-related knowledge acquisition and change in attitude and behaviour. Despite the low number of studies, evidence of its potential has been demonstrated. Having determined the potential effectiveness of YouTube videos, the research team next synthesized current studies investigating the validity of the content contained in YouTube videos.

Numerous investigations have examined the validity of video content across a variety of health topics. The general approach to such assessments is for content experts to examine video information and then draw a conclusion about the video's overall validity (i.e., accuracy and credibility of content; scientifically correct information; and portrayal of evidence-based practices).[14] This study synthesized the outcomes of 58 peer-reviewed studies and determined that, within a given health topic, the validity of YouTube videos can range from good to poor, including many that were deemed misleading or dangerous. Authors of these individual studies typically critiqued numerous videos (ranging from 1 to 607) obtained via a systematic search of YouTube. Because of the large number of available videos, most investigators limited their search, for example, to the first 300 relevant videos appearing on the SERP. These results often included user-generated testimonials which are not evidence-based, as well as valid videos. Unfortunately, the user-generated videos are typically more accessible than videos of good validity,[47] which presents a significant challenge to using YouTube videos for supporting the public in making health decisions. There is no guarantee that evidence-based videos, if they do exist, will be ranked highly on the SERP. Several studies have researched this phenomenon and have revealed either no correlation or an inverse correlation between video validity and popularity within the YouTube system.[15-29]

As a result, several authors have recommended that health care professionals create videos that not only have excellent validity, but are also readily accessible to persons searching for health information (i.e., videos

that will appear high up on the SERP).[15,16,18,20,21,23,24,30] To support professionals in this work, this study sought to synthesize current knowledge about the attributes that make YouTube videos highly accessible. Although the majority of studies investigating such attributes were not specific to health videos, a number of relevant peer-reviewed studies were identified.

An evaluation of themes in these studies revealed several prominent content and content-agnostic factors worth considering when creating, uploading, promoting, and sustaining a video on YouTube. To increase the probability that a video will be accessible from among the billions that are available online, the following 10 factors should be considered by creators.

Factor 1: Choose your keywords carefully

Creating a valid (evidence-based) video is only the first step in getting your message to the audience. It is equally important to ensure that people will be able to find the video you have created. The best way to accomplish this is by using keywords relevant to your audience. Keywords, within the YouTube system, are words that identify and verbalize a problem or topic, are inputted at the time of video upload, and help searchers find videos.[55] When uploading a video to the YouTube system it is of foremost importance to consider the selection and number of appropriate keywords.[48]

When selecting keywords, creators should review existing popular videos on the topic. By using similar keywords the accessibily of your video increases and becomes incorporated in the recommendation system.[51] Creators should also use keywords that are colloquial and relevant to the searcher; that is lay terms instead of professional terminology.[48,55]

The number of keywords should be comprehensive enough to reach the targeted audience: more keywords increases the probability that a video will be discovered in a search, thereby increasing views.[48] To increase accessibility, keywords should be repeated 3 times: 1) in the video file name; 2) in the video title; and 3) at the start of the text description.[56] In addition to keywords, creators can "tag" their videos with words or phrases that describe the content. The YouTube recommendation system uses these tags similarly to keywords when placing videos on the SERP.[52]

Factor 2: Titles and end cards increase viewership

Titles are the first visual contact of a search. They are essential elements in any media format including YouTube. They can "make or break" the accessibility of a video, as the title may determine whether a viewer will watch. Titles should contain keywords and be relevant to the searchers' needs. However, a title should not be simply a stream of keywords, as this would not grab the viewers' attention. Instead the title should be catchy and relatable. The length of the title should not exceed 60 characters, otherwise, the end of the title will be cut off by the YouTube system.[57]

Another way to engage viewers and increase watch time is by using end screens or cards. These interactive cards can be placed in the last 5 to 20 seconds of a video and are used for promotion, interaction or to deliver further information. They do this by creating links to other videos, websites or blogs. Effective end cards do not overwhelm the viewer, and the page should have a professional, uncluttered appearance.[56,57]

Factor 3: Broad social sharing is critical to building views and likes

An important feature of the YouTube system is that it records and displays the number of times a video has been viewed. The number of times a video is watched, in its entirety, influences the recommendation system, which affects its placement on the SERP and therefore its accessibility. The challenge with posting a new video is ensuring that it quickly receives enough views to raise it on this list. One way of achieving this is through exploiting the creator's professional social media networks (e.g., association's Facebook, Twitter, Instagram, e-newsletters, blogs) as well as their personal networks.[47-49] To gain views and ensure video accessibility a creator might ask their professional association to embed the video in their media sites and to explain to their membership how they can help increase the accessibility of the video by watching it in its entirety and using the internal features, likes, comments, and sharing. Using the professional association's social media sites is critical for new videos as it increases the "first-discovery" advantage.[48] This results in the "rich get richer" phenomenon where the current viewing rate of a video is proportional to the total number of views the video will have during its lifespan.[47-50] For example, if your association has 3000 members and even a quarter of those members watch the video and share it on their social media networks, the likelihood that the video will quickly move to a place of prominence on the SERP is greatly improved.

Factor 4: Interaction with the audience sustains interest

Another inherent feature of the YouTube system is that it allows the searcher to comment on a video, potentially contributing to its popularity.[54] It is important for the video creator to read and respond to comments, address suggestions, and ask and answer questions. Because comments are viewable to searchers, robust discussions generate new interest and increase views. Through the comment section, the creator can encourage users to share, like, comment, and embed the video in their social media sites.

Factor 5: Association with a professional institution increases perceptions of validity

Videos using keywords or whose origins (video uploader title) demonstrate an association with an institution of higher learning, a well-known clinic or a professional body are often seen by searchers as having greater validity.[53] Therefore, when loading a video in the YouTube system, creators should use keyword and uploader titles that indicate such associations.

Factor 6: Fast-paced or short videos keep viewers watching to the end

Research has demonstrated that videos within the 3 to 5 minute range, or fast-paced videos that give the illusion of being shorter, are more likely to be watched to completion. This is important because advancement on the SERP increases when a video is watched in its entirety.[47,52] One way to make a video appear fast-paced is through the judicious use of visuals and audio, such as changing the background graphics, using appropriate volumes, changing the tone of the narrator's voice, and incorporating music.[47,52]

Factor 7: Videos that evoke emotion are more frequently shared

Videos that evoke emotions, such as, fear, joy, hope, pride, surprise, and trust, are more likely to be watched in their entirety.[49] Furthermore, videos that evoke high arousal (e.g., anxiety, humour) are more often shared within viewers' social media networks, thereby leading to increased accessibility.[41,49,50] For example, a video created with the intention to educate the public on the importance of oral cancer screening must be seen as trustworthy but might also include an aspect of fear or humour.

Factor 8: Being relatable sustains viewers' interest and increases popularity

Relatable videos (e.g., those incorporating storytelling) are generally more popular and have the ability to sustain a viewer's interest. Ways to increase relatability include keeping the information unpretentious, and using titles that are colloquial and relevant to potential searchers. In addition, videos that demonstrate geographic relevance are more apt to be watched[49] (i.e., Canadians are more likely to watch a video set in North America than from another continent).

Factor 9: The age of the video affects perception of relevance

Videos in the YouTube system are identified by their date of upload. Within certain contexts, older videos are less likely to be viewed than newer ones.[52] Searchers generally want to view the most current information. If the content of the older video is still current, one way to ensure its sustained usage is to regularly re-upload the video and continually share it on social media.[47]

Factor 10: Additional support for creators

A number of popular internet services (for profit and not for profit) have been created to help video creators develop and promote videos.[49] Two particularly useful services are the YouTube Creator Academy and Google Trends for YouTube.[55]

CONCLUSION

YouTube videos are a potentially effective means of disseminating knowledge and supporting health-related decision making by the public. This review demonstrates that valid, evidence-based YouTube videos exist. Unfortunately, being a valid video does not guarantee its accessibility to people who are searching for information.

The suggestions provided in this study are intended to support aspiring YouTube video creators in ensuring their videos are accessible to the searching public. By improving the accessibility of evidence-based videos, creators will increase the probability that the public will find those with excellent validity and avoid misleading or dangerous online content.

Limitations of this study

The major limitation of this review is the scarcity of original studies examining the factors that affect accessibility of health-related YouTube videos. The number of studies on the effectiveness of YouTube videos in influencing health-related decision making by the public is also limited.

Future research

Research, specifically randomized controlled trials, is required to further determine the effectiveness of YouTube videos as tools for supporting behavioural change capable of improving overall health.

CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

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