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A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet

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Cover Letter

Dear Editor,

We would like to submit to you the manuscript under the title of "A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet".

Our work sets out to evaluate the quality of information available to the public regarding both the treatment and prevention of COVID-19 using validated assessment tools. These tools, which have been used in the past to assess quality, include the Ensuring Quality Information for Patients (EQIP) tool, JAMA benchmark and the DISCERN tool, all of which have been proven to be robust and effective at assessing online health information.

To the best of our knowledge this is the first study to evaluate the nature and quality of information regarding COVID-19 currently available to the public. Our findings indicate that most websites were unable to provide adequate information on both treatment and preventative methods and were generally of poor quality. Without interventions to improve these websites, they will likely impact the awareness and actions of the wider public and, by extension, affect the efficacy of public health measures. Our study reflects the ongoing need for high quality information while it is still possible to influence its dissemination, especially for countries that are now entering the growth phase.

We believe that this report as well as the subtopics it addresses will be of interest for the readers of your respectable journal.

We hereby certify that the authors of the above manuscript have all: 1) Conceived, planned, and performed the work leading to this article, 2) Written the article or reviewed successive versions and shared in their revisions, 3) Approved the final version. Further, we certify that this work has neither been published in whole or in part elsewhere nor is under consideration elsewhere, and we accept full responsibility for the design and conduct of the study.

Yours sincerely,

Ka Siu Fan, BSc and Shahi Abdul Ghani, MSc, DHMSA

On behalf of Dimitri Aristotle Raptis, MD, MSc, PhD and the authors

A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet

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Abstract

Objective: To evaluate the quality of information regarding the treatment and prevention of COVID-19 available to the general public from all countries.

Design: Systematic analysis using the 'Ensuring Quality Information for Patients' (EQIP) tool (score 0-36), JAMA benchmark (score 0-4) and the DISCERN tool (score 16-80) to analyse websites containing information targeted at the general public.

Data Sources: Twelve popular search terms, including 'Coronavirus', 'COVID 19', 'Wuhan virus', 'How to treat coronavirus' and 'COVID 19 Prevention' were identified by 'Google Trends'. The first 100 websites for each term were identified and evaluated on its quality of information.

Eligibility Criteria for selecting studies: All websites written in English language, and provides information on prevention or treatment of COVID-19 intended for the general public were considered eligible. Any websites intended for professionals, or specific isolated populations, such as students from one particular school, were excluded, as well as websites with only video content, marketing content, daily caseload update or news dashboard pages with no health-related information.

Results: Of the 1275 identified websites, 321 (25%) were eligible for analysis. The overall EQIP, JAMA and DISCERN scores were 17.8, 2.7 and 38.0. Websites originated from 34 countries, with the majority from the USA (55%). News Services (50%) and Government/Health Departments (27%) were the most common sources of information and their information quality varied significantly. Majority of websites discuss prevention alone despite popular search trends of COVID-19 treatment. Websites discussing both treatment and prevention (n=73, 22%) score significantly higher across all tools ($P<0.001$).

Conclusion: This comprehensive assessment of online COVID-19 information using EQIP, JAMA and DISCERN tools indicate that most websites were inadequate. This necessitates improvements in online resources to facilitate public health measures during the pandemic.

Strengths and Limitations of this study

- This study evaluated 321 websites, significantly improving our data coverage and representativeness over currently available studies.
- Top indexed websites from 12 different search terms were used, including both synonyms to COVID-19 and 'open' phrases, to capture the bulk of the available online resources.
- Quality of information on each website was evaluated using three validated tools, EQIP, DISCERN and JAMA, and were also evaluated by a second assessor to increase accuracy and minimise bias.
- The utility of each evaluation tool may be limited as they were not originally designed to assess online information during pandemics, however, their combinational use may offer enhanced accuracy and improved assessments as shown in other studies.
- The website database is obtained based on the popularity of different search terms on the Google Search Engine and, hence, results may be subject to change throughout the pandemic and serves as an indirect indicator for which websites the public uses.

Introduction

With the increasing popularity of the Internet, both the accessibility and availability of health information has increased drastically and is now a primary source of information for many.[1,2] It is known that health information-seeking behaviour also applies to the use of online resources and has become ever more important during the current Coronavirus disease 2019 (COVID-19) pandemic[3] Information on such widely-discussed topic will inevitably be produced in quantity and vary in production quality, potentially adversely affecting patient awareness and health-seeking behaviour.[4] Many of these resources read by the public may be unreliable or produced from non-peer-reviewed sources and affect behaviours such as recognition of symptoms, taking appropriate preventative precautions or seeking timely treatment.[3,5,6] Furthermore, inaccurate online information may contradict healthcare professionals and potentially compromise the trusting relationship with patients, worsening outcomes.[7]

Since the declaration of COVID-19 as a pandemic on 12th March 2020, its prevalence and mortality has continued to rise[8,9] and lead to the introduction of various measures such as social distancing, quarantine procedures and lockdown protocols.[10] As evidenced from previous outbreaks, effective public education and public health intervention relies on access to health information[11,12], which is now primarily delivered through the Internet. Many countries have since introduced lockdown and quarantine protocols as their mainstay preventative measures[13] but public health continues to be threatened by certain populations.[14] Due to both the novelty and rapid developments of COVID-19, there is a significant barrier for individuals to critically appraise online resources and, hence, necessitates a quantitative evaluation of the popular information sources available to the wider public.

Many instruments have been developed to evaluate patient information and may also be applied to online COVID-19 information.[15] The modified Ensuring Quality of Information for Patients (EQIP) tool is a reproducible modality used in previous studies to evaluate the reliability and quality of online patient information[16–18]. Previously, our group evaluated online information using the modified EQIP tool in a variety of conditions and procedures including bariatric surgery[19], Dupuytren's

disease[20], carpal tunnel disease[21], breast augmentation[22], liposuction[16] and liver transplantation[23]. Tools such as the Journal of American Medical Association (JAMA) benchmark and the DISCERN tool (no acronym) have also been used to evaluate online health information and their combinational use can provide a more comprehensive evaluation.[18,24] Given that the Internet has become an ever-important source of information and can determine health-seeking behaviour, which by extension can affect the progression of COVID-19. Hence, our study aims to assess the quality of information of top indexed websites that discuss information, prevention, or treatment of COVID-19 using the modified EQIP tool, JAMA benchmark and DISCERN tool.

Methods

Eligibility criteria, information sources and data selection

On 27th March 2020, 12 search terms and phrases were queried on the most used search engine, Google[25–27], to obtain a database of websites. Only Google was used as previous studies have shown that the use of multiple search engines will only provide duplicate results. To increase the number of results, more search terms were used: 'Coronavirus', 'COVID 19', 'Stop getting Coronavirus', 'Corona Virus', 'How to treat coronavirus', 'Coronavirus safety tips', 'Drugs for coronavirus', 'What is self isolation coronavirus', 'China virus', 'Wuhan virus', 'Coronavirus Medicine' and 'COVID 19 prevention'. These were commonly searched phrases identified using the 'Google Adwords Keyword Planner'[28]. Only the first 100 websites were identified and recorded as previous work suggest patients tend to stay within the first 100 returned webpages[17,23]. Various search terms and their relative popularity were also collected directly from Google Trends[29] for further comparative analysis.

All websites written in English language and providing information on prevention, treatment or management of COVID-19 intended for the general public or COVID-19 patients were considered eligible for inclusion. Any subsidiary pages or subdirectories of a website that contained information for the public and were easily accessible are also assessed. Websites or articles intended for professionals or specific population subsets, such as students alone, were excluded. Weblinks to purely video content, marketing content, daily caseload update or news dashboard pages with no educational

purposes were also excluded. The creation of the website database, eligibility assessment, website assessment and statistical analysis were performed within 4 weeks between March and April 2020.

Website Scraping

A website scraping tool was developed to identify and record the first 100 web links from Google. The tool utilises custom PHP to make HTTP requests to the search engine to mimic the requests made by the public. The queries were made from a server located in Texas, USA but no preferences were made to limit searches by geographical region. The tool makes repeated requests and logs the first 100 unique URLs. Duplicates were then removed from the database. A minority of websites were restricted by General Data Protection Regulation (GDPR) and were accessed through the use of virtual private networks (VPN) as any websites that could reasonably be accessed by the general public were included.

Data entry

Six assessors, (SAG. KSF, KHF, LL, AS and DR), all of whom fluent in English, independently assessed the websites between 30 March and 13 April 2020. Evaluation included 36 EQIP items and four items on JAMA benchmark, all assessed through 'Yes, No or N/A' questions. DISCERN tool adds a further 16 items to assess reliability and quality of information on treatment using scales of 1 to 5. Assessors also recorded the country of origin, and type of source: Academic centre, Charity/Non-Governmental Organisation, Encyclopaedia, Government/Health Department, Hospital, Industry, News service, Patient group, Practitioner, and Professional Society. Qualitative information about preventative methods and treatment was also recorded. After the initial round of data entry, each website was evaluated by a second assessor between 14 April and 21 April and any contradictory results were resolved by consensus.

EQIP Tool

The modified EQIP tool includes 36 criteria for a comprehensive assessment of patient information. This tool sets out to satisfy both the guidelines of British Medical Association (BMA)[30] and International Patient Decision Aids Standards (IPDAS) collaboration[31] on ideal information for

patients and have been utilised in a variety of specialities previously.[16–18] 36 items across three domains were included: Content (items 1-18), Identification (items 19-24) and Structure (items 25-36). Similar to previous uses, 'Yes/No' questions reduce assessor subjectivity in partial answers. 'N/A' option was also included if items were not relevant for the type of source. A cut-off point of 75th percentile was set for EQIP score to discriminate between high-scoring from low-scoring websites as was done in previous studies.

JAMA benchmark criteria

Critical appraisals of Internet-based resources are also assessed by the core standards identified by JAMA in 1997.[32] This checklist was proposed by Silberg *et al.* to assist the appraisal and evaluation of the credibility of unregulated Internet resources and have been used in various studies previously[33,34].This is evaluated by four items: Authorship, Attribution, Disclosure and Currency: Authorship requires identification of authors, credentials and their affiliations; Attribution requires appropriate citations on written information; Disclosure requires transparency of the website owner and conflicts of interests; Currency requires a clear indication of the date of publication and updates. Similarly, 'Yes/No' criterion is implemented to reduce the subjectivity of partial answers.

DISCERN Tool

The DISCERN evaluation tool was first developed in 1998 at Oxford to judge the quality of information regarding treatment choices.[35] This tool has been validated and used across various specialities to assess treatment information.[33,36] This consisted of 16 items, of which the first 15 assesses the reliability of and level of details provided on treatments and the last rates the overall quality of the information. A score between 1 and 5 can be assigned to each item, with 1 being 'No', 3 being 'Partial' and 5 being 'Yes'. To improve assessment accuracy, overall quality of information will be scored in proportion to the mean scores calculated from the answers to items 1-15, with 1 being the lowest and 5 being the highest.

Additional Items

Additional items were included to further assess the websites, including whether a website discussed prevention methods, current treatments and the role of empirical evidence in the prevention or treatment for COVID-19. Data collected were in the form of 'Yes/No' to reduce ambiguity of partial answers again. Additionally, details provided by the website on these items were recorded if the item scores 'Yes'. Websites were further analysed by whether their purpose is prevention, treatment, or both.

Statistical Analysis

The dataset consisted of both continuous and categorical variables, which are reported as median and interquartile range (IQR) as well as numbers and percentages respectively. Scores above the 75th percentile are considered as high-scoring. Mann-Whitney and Kruskal-Wallis tests were used for analysis of continuous variables where appropriate. Fisher's or χ^2 tests were used to analyse proportions where appropriate. All P values were two-tailed and considered significant when P <0.05. R version 3.3.2 (R Core Team, GNU GPL v2 License), R Studio version 1.0.44 (RStudio, Inc. GNU Affero General Public License v3, Boston, MA, 2016) and their respective graphical user interface (GUI) rBiostatistics.com (rBiostatistics.com, London, Switzerland, 2017)[37] was used to perform the statistical analysis.

Results

Gathering of websites with information on COVID-19, its prevention and its management

A database of websites was gathered from the first 100 unique URLs returned using the 12 search terms. Additional hits on the last page of each search were also gathered if unique. The final dataset included 1275 URLs. After filtering out duplicate results and websites that failed to meet our inclusion criteria, 321 remained eligible for analysis. The workflow of dataset creation is shown in **Figure 1**. List of websites were obtained on a single day, 27th March 2020, and website evaluation was completed within two weeks.

Website demographics and search trends

The most popular search terms were 'Coronavirus', followed by 'COVID' and 'Corona Virus', while search popularity peaked in mid- and late-March 2020 respectively. COVID-19-specific searches regarding treatment and masks were significantly more popular (P<0.001) than prevention and peaked in mid-March and early-April respectively. **Figure 2** summarises the most popular search trends. The returned websites originated from 34 different countries (**Figure 3**): the USA produced the most websites (n=178), followed by the United Kingdom (n=52), Australia (n=18) and Canada (n=18). The source of information and website category is shown in **Table 1**. News Services were the most common source of information (n=163), followed by Health Departments/Government (n=87).

Forty-six websites (14.3%) described treatment methods alone, 202 websites (62.9%) mentioned treatment methods alone and 73 websites (22.7%) discussed both prevention and treatment. Of the mentioned prevention methods, 205 (63.9%) described social isolation, 169 (52.7%) physical distancing, 157 (48.9%) advised staying home and 136 (42.4%) described the benefits of disinfecting or cleaning surfaces. With regards to mentioned treatment methods, 55 (17.1%) described the use of antiviral medications, 31 (9.7%) described hydroxychloroquine or chloroquine and 26 (8.1%) described the use of non-steroidal anti-inflammatory drugs such as paracetamol and ibuprofen. Only 31 (9.7%) websites discussed the use of oxygen, ventilation or fluids as a possible treatment method.

Overall performance

The mean Total score for EQIP, JAMA and DISCERN is 17.78, 2.69 and 38.00 respectively and their respective 75th percentile high-score cut-offs were 21, 4 and 43 (**Figure 4**). No website achieved the maximum score for EQIP Content (out of 18) or Structure (out of 6) domain but one website did attain maximum for EQIP Identification (out of 12). Seventy-four websites fulfilled all the JAMA criteria (out of 4). Four websites achieved the maximum for DISCERN Reliability (out of 40) but none scored fully in DISCERN Treatment (out of 40). 74 high-scoring websites were identified for EQIP and JAMA and 76 for DISCERN tool. The mean scores for each tool and domain are as follows: EQIP Content (9.99 vs 6.07; P<0.001), EQIP Identification (4.03 vs 3.34; P<0.001), EQIP Structure (8.45 vs 6.96; P<0.001), Total EQIP (22.46 vs 16.37; P<0.001), Total JAMA (4.00 vs 2.30; P<0.001), DISCERN Reliability (31.72 vs 25.44; P<0.001), DISCERN Treatment (13.49 vs 10.31; P=0.002) and Total DISCERN (45.21 vs 35.76; P<0.001).

All tools and subsequent domains, except DISCERN Reliability and Total DISCERN scores, varied significantly between websites of different sources, notably with the Encyclopaedia (n=5) cohort holding the highest score for all domains. All tools and domains varied between website cohorts, with websites that include both Treatment and Prevention scoring above the mean values. **Table 2** and **Table 3** summarises the variation of information quality with the source of information and website category respectively.

Subset analysis of Government/Health Department and News Services

Collectively, 250 (77.9%) of all web links were either Government/Health Departments and News Services websites, of which 121 (37.7%) were based in the USA. Globally, there is significant variation between Government/Health Departments and News Services in EQIP Content (mean 8.11 vs 6.22; P<0.001), Total EQIP (mean 18.90 vs 17.06; P<0.001), Total JAMA (mean 2.16 vs 2.98; P<0.001) and DISCERN Treatment (mean 9.02 vs 11.72; P=0.001). Variations in US websites were similar except for EQIP structure (P=0.148). The US-based cohort scored lower in Total EQIP than the global cohort but USA News Services specifically scored better in Total JAMA (3.17 vs 2.98) and Total DISCERN (39.25 vs 38.04). Breakdowns of comparison between the cohorts are shown in **Table 4**.

High-scoring websites

Sixteen websites scored above 75th percentile across all three evaluation tools, 13 were from the USA, 2 from the UK and 1 from Canada. Most were from News Services (n=10), followed by industry (n=4), Encyclopaedia (n=1) and Government/Health Departments (n=1). The 4 websites with the highest Total EQIP and Total DISCERN scores are shown in **Table 5** with their respective breakdowns.

Discussion

Our search terms included various synonyms to COVID-19 to capture the bulk of the available material as well as 'open' search terms to capture websites that specifically intend to display prevention and treatment information. Our analysis identified that the overall quality of information was low across all assessment tools, as indicated by the low 75th percentile cut-offs for EQIP and DISCERN, at 21 and 43 respectively, which are only at 58.3% and 53.8% of their respective full scores. Regarding EQIP, websites generally scored poorly, with a mean and median approximately 18 (IQR 15-20) out of a total of 36. Despite having less marks allocated for EQIP Structure, websites generally outperform the EQIP

Content domain (7.30 vs 6.97), indicating that while their information may not be of high quality, the design and the ease-of-use of these websites are adequate. However, as these websites can be easily used and navigated irrespective of background, it may present a potential pitfall where low-quality information can appear credible as user-friendly designs alone have been shown to improve information credibility.[38] The indicators assessing website referencing quality, such as JAMA benchmark and DISCERN Reliability, scored similarly, 2.69 (67.3% of maximum) and 26.93 (67.3% of maximum) respectively, but is lower in EQIP Identification domain 3.50 (58.3% of maximum), likely attributable to its additional assessment of whether there is patient involvement in the production of the material.

Most sources scored poorly due to several possible reasons. First and foremost, the lack of primary scientific research limits our knowledge on COVID, an emergent disease COVID only identified in early December 2019[39] and recognised as a pandemic in March 2020.[40] While research efforts have since gained traction and shifted to COVID, both the production of quality research and its subsequent peer-review process takes a considerable amount of time. This may limit the amount and speed of research output in comparison to the rapid progression of the COVID from local clusters to epidemic to pandemic. However, many journals have since implemented the fast-tracking of COVID research as well as making them freely accessible.[41–43] Similarly, efforts from Governments and Health Departments have also cooperated to help support and fast-track COVID studies in response to the growing pandemic.[44] Together, these efforts have facilitated the publication of COVID research where the WHO database alone has already indexed an excess of 5,000 articles.[45] However, it is also important to note the role of preprint servers on publications during the pandemic. Preprints are accessible to the public through various databases and while they have helped facilitate the peer-review process through improved accessibility, non-peer-reviewed articles can potentially be used, or cherry-picked, by non-professionals and cause potentially profound and unhelpful effects on public perception and awareness of COVID.[46–49]

Upon publication, research articles have to be reviewed and summarised by journalists who act as a bridge of information between scientists and the wider public. This often allows for efficient dissemination of critical research information to the public who often lack the scientific or medical background to be able to critically appraise and evaluate the latest developments. This is particularly

important as 52% (n=169) of all sources were classified as 'News Services'. As only 12 (7.4%) News Services website scored highly in all three tools respectively, it was clear that very few websites provided a comprehensive account of all current and relevant information on COVID, reflecting both the difficulty in matching the pace of rapid developments as well as the having the technical knowledge and expertise required to deliver concise and relevant information to readers. In such trying times, the health information-seeking behaviour of citizens will inevitably lead them to obtain information from news services[50] which can often be of variable quality.

Previous studies have already identified that many health journalists lacked the knowledge and training required for accurate and reliable dissemination of health news and can have profound, or even harmful, impact on the health of readers.[51,52] This is reflected by the low scores across the various tools, indicating the overall inadequacy in both reliability and accuracy of these online resources. Potential causes and pitfalls in health journalism was highlighted by a survey of medical journalists in 37 countries and revealed three most common constraints: the lack of time, space and knowledge, impairs their ability to deliver quality articles.[53] While their work stresses the ability to work quickly and summarise content concisely, many of the experienced journalists self-reported the lack of knowledge as a barrier. As they noted the importance of accumulating such knowledge throughout their career, the lack of expert knowledge in a rapidly progressing scientific field such as COVID can likely impact journalists' understanding and quality of conveyed information significantly. Furthermore, journalists reported difficulty in finding experts to explain scientific jargon, further limiting the information they produce. This potentially presents a large barrier towards disseminating quality COVID information as many countries and institutions have been re-directing their research efforts towards COVID, which in turn likely reduces the availability of experts to assist with medical journalism.[54,55] This is also demonstrated from one of the highest-scoring entries, an article whose author holds a PhD. in molecular genetics, which scored 22 in Total EQIP, 4 in JAMA and 74 in DISCERN.[56] When compared against the majority of the other sources, this underlines the importance of a relevant academic background in being able to disseminate novel scientific developments both reliably and accurately.

Based on our analysis, Governments or health departments constitute another major source of information. We identified that the majority of these websites belonged to the local Governments of

various states in the USA, many of whom have based their information and advice on CDC. As both the nature and purpose of these information sources vary, they may be visited by different subsets of the population according to demographics and their information-seeking behaviour. A recent study has identified the importance of awareness and trust in information originating from the Government such as those of the Centers for Disease Control and Prevention (CDC), revealing that while up to 83.6% of American adults are aware of the CDC, only 64.6% of them report that they trust this source.[57] American adolescents were, however, less aware of the CDC (55.8%), but were more trusting of their information (72.2%). As previously established, the importance of trust in a government is a predictor of various health behaviours and outcomes such as use of health services and intention to vaccinate.[58–60] Similarly, as access and usage of online health information is known to vary between different demographic populations, it is paramount to create and provide targeted and effective educational material for public use.[61,62]

A comparison between the global Government/Health Department against News Services websites revealed significant differences between EQIP Content, Total EQIP, Total and DISCERN Treatment. The EQIP Content scores likely reflect the differences in how new information is obtained as Government/Health Departments are directly involved in primary research, allowing more in-depth and accurate information dissemination compared to journalists who take on the role of secondary research. However, News Services scored higher in DISCERN Treatment and this may be due to the reluctance of the Government to prematurely disclose information on treatment at such an early stage of discovery, whereas journalists may be less limited by such constraints and willing to report the results of all potential studies. Interestingly, the majority of USA Government websites had some form of copy-pasted information from the Centre for Disease Control and Prevention (CDC), likely with the aim of maintaining consistency as well as to centralise their source of information. This contrasts with the majority of other sources where information may be re-written based on a variety of sources. However, while American sources display a similar pattern of variation, the EQIP Identification scores of Government/Health Departments had statistically significant differences and also scored lower than News Services (mean 3.34 vs 3.78; P=0.011). This verbatim use of CDC information may have neglected the importance of clarity and transparency in displaying the source of information as these

Government websites primarily serve to disseminate information instead of justifying or providing a critical appraisal of available literature.

Google Trends also identified that search popularity of treatment has increased rapidly and outgrown prevention searches since early-March. The increased interests suggest that the demand for preventative measures may have been sufficiently met and that the public interests may be shifting towards treatment methods. However, while 275 (85%) websites addressed prevention methods to some degree, the cohort scored below the mean Total EQIP score (17.12 vs 17.78; P<0.001), Total JAMA score (2.53 vs 2.69; P=0.001) and Total DISCERN score (34.64 vs 38.00; P<0.001). This suggests that while numerous, the quality of websites that focus on preventative methods remain subpar across all quality indicators. Similarly, of the 46% of websites that focussed on treatment alone, they scored below the mean in Total EQIP score (16.89 vs 17.78; P<0.001) despite scoring the highest in EQIP Identification domain (3.87 vs 3.50; P<0.001), suggesting that treatment websites tend to be better referenced and adept at sourcing evidence. This is also reflected by its above-average JAMA score (3.13 vs 2.69; P=0.001) and Total DISCERN (45.07 vs 38.00; P<0.001) scores. Contrarily, the 73 websites that discussed both treatment and prevention of COVID-19 consistently scored higher than the mean across all indicators, Total EQIP (20.15 vs 17.78; P<0.001), Total JAMA (2.85 vs 2.69; P=0.001) and Total DISCERN (42.84 vs 38.00; P<0.001). As these are websites that explore multiple aspects of the virus, its production likely requires processing information from multiple sources. This likely necessitates better understanding on the writer's behalf, leading to both the production of substantially higher quality articles as well as the tendency to reference its numerous resources clearly and appropriately. It is nonetheless important to maintain and improve the quality of such online resources in order to combat the increasingly dangerous COVID-19 myths, of which one of the latest suggests injection of disinfectants as treatment.[63,64]

Similar to the tools used in this study, the Minervation validation instrument (LIDA)[65], Flesch Reading Ease (FRE) Score and the Flesch-Kincaid Grade (FKG) have also been used to evaluate the quality of online health information.[66] However, LIDA was not considered as an appropriate assessment tool here as it does not provide a quantitative or qualitative assessment of either benefits or risks to interventions. Additionally, the majority of its items in 'Accessibility' and 'Usability' sections assess the design and ease-of-access of a website which is already adequately covered by the modified

EQIP tool. Similarly, the use of FRE and FKG only provides an assessment of total sentences, words and syllables and does not evaluate the content itself.[67]

This study has several limitations. Only the most popular search engine, 'Google', was used and may not be reflective of those who use other search engines. The searches may also be affected by the geographical location of the requesting computer, which means results could still be centred around a particular continent despite disabling the geolocation features. Similarly, the search terms were obtained using 'Google Adwords Keyword Planner' and 'Google Trends', which provided commonly searched phrases but may not be truly indicative of search patterns of the wider public when seeking for COVID-related information. Hence, we opted to use 12 different search terms, containing both variations of 'COVID-19' names as well as different phrases that patients may search for. Another limitation is the exclusion of non-English language websites, which reduces the representativeness of all the available information, especially given the international nature of the pandemic. A minority of URLs, particularly of News Services, updated their content regularly or modified to redirect visitors, which may affect the second round of evaluation and subsequent statistical analysis. Additionally, as modified EQIP tool, JAMA benchmark and DISCERN tool were not originally designed for the specific purpose of assessing the highly variable information produced during pandemics, it may be considered as a limitation. However, the EQIP tool was designed to assess any type of patient information and demonstrated high inter-rater reliability.[16] Similarly, JAMA benchmark was designed to evaluate website reliability alone and DISCERN examines both reliability and content accuracy, thus, the combinational use of tools enhances the accuracy and objective assessment of websites. Finally, the extracted websites were limited temporally as the results might no longer be representative of online information at time of publication due to the fast-paced developments of COVID as many websites found during our search in March 2020 may inevitably be updated or removed since our search.

Conclusion

In short, the abundance of Internet resources providing COVID-19 information is exemplified by the numerous identified websites during our search. The information available to the public may affect their health decisions, which, subsequently, affects the efficacy and outcome of public health measures

implemented by the state. As effective treatments and vaccines research are underway, COVID-19 is primarily addressed with preventative measures, hence necessitating a critical review of the quality and nature of information accessible to the public. Our results demonstrated that the websites were chiefly produced by News Services and Government/Health Departments but were nonetheless of low quality. While the majority of websites addressed prevention, and likely met the information needs of the public as reflected by search trends, there is a relative deficit in websites that discuss treatment methods. A minority of websites discussed both prevention methods and treatment and were generally good resources but the majority websites were of inadequate quality. Thus, there is a need for higher quality for online COVID-19 resources to facilitate public education and enable better cooperation and outcomes of public health measures.

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Table 1. Website demographic and background information

Type	Total (n,%)	Treatment (n,%)	Prevention (n,%)	Treatment and Prevention (n,%)
Academic Centre	10 (3.12%)	1 (0.31%)	4 (1.25%)	5 (1.56%)
Charity/NGO	12 (3.74%)	1 (0.31%)	9 (2.8%)	2 (0.62%)
Encyclopaedia	5 (1.56%)	0 (0%)	1 (0.31%)	4 (1.25%)
Government/Health Department	87 (27.10%)	1 (0.31%)	65 (20.25%)	21 (6.54%)
Hospital	7 (2.18%)	0 (0%)	5 (1.56%)	2 (0.62%)
Industry	30 (9.35%)	8 (2.49%)	10 (3.12%)	12 (3.74%)
Military	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
News Service	163 (50.78%)	34 (10.59%)	102 (31.78%)	27 (8.41%)
Patient group	1 (0.10%)	1 (0.31%)	0 (0%)	0 (0%)
Professional society	4 (1.25%)	0 (0%)	4 (1.25%)	0 (0%)
Research Centre	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
Total	321	46 (14.33%)	202 (62.93%)	73 (22.74%)

Table 2. Overall quality of information of all sources of information

Indicator/ (Mean, SD)	Academic centre	Charity/NGO	Encyclopaedia	Government/Health Department	Hospital	Industry	Military	News Service	Patient group	Professional society	Research Centre	P Value
EQIP Content	7.70 (2.50)	6.75 (3.33)	10.80 (3.11)	8.11 (2.49)	7.14 (2.19)	7.13 (2.60)	5.00 (0)	6.22 (2.11)	10.00 (0)	5.50 (3)	5.00 (0)	<0.001

EQIP Identification	2.90 (1.20)	3.08 (0.90)	4.80 (0.45)	3.44 (1.03)	2.71 (1.38)	3.4 (1.13)	1.00 (0)	3.62 (0.73)	3.00 (0)	4.00 (0)	4.00 (0)	0.003
EQIP Structure	7.90 (1.85)	7.67 (1.30)	8.60 (1.67)	7.34 (1.45)	7.43 (0.98)	6.97 (1.83)	9.00 (0)	7.22 (1.39)	10.00 (0)	7.25 (0.5)	5.00 (0)	0.08
EQIP Total	18.50 (3.66)	17.50 (4.32)	24.20 (3.56)	18.9 (3.79)	17.29 (3.50)	17.5 (4.48)	15.00 (0)	17.06 (3.19)	23.00 (0)	16.75 (3.4)	14.00 (0)	<0.001
JAMA Total	2.50 (0.97)	2.50 (1.00)	3.40 (0.55)	2.16 (0.86)	2.14 (1.57)	2.73 (1.23)	1.00 (0)	2.98 (0.85)	3.00 (0)	3.50 (0.58)	3.00 (0)	<0.001
DISCERN Reliability	27.20 (6.78)	26.25 (6.51)	35.60 (4.77)	27.47 (5.96)	29.86 (5.58)	26.6 (7.46)	23.00 (0)	26.31 (6.3)	27.00 (0)	29.50 (4.2)	26.00 (0)	0.128
DISCERN Treatment	13.00 (6.70)	9.42 (2.39)	16.00 (9.30)	9.02 (3.14)	8.71 (1.89)	13.33 (6.39)	8.00 (0)	11.72 (6.22)	13.00 (0)	8.50 (1)	17.00 (0)	0.001
DISCERN Total	40.20 (10.38)	35.67 (7.67)	51.60 (12.3)	36.49 (7.50)	38.57 (5.47)	39.93 (10.45)	31.00 (0)	38.04 (10.44)	40.00 (0)	38.00 (5.1)	43.00 (0)	0.167

Table 3. Overall quality of information of all websites subsets

Indicator/(Mean, SD)	Overall	Treatment	Prevention	Treatment and Prevention	P Value
EQIP Content	6.97 (2.52)	6.26 (1.81)	6.55 (2.30)	8.58 (2.84)	<0.001

EQIP Identification	3.50 (0.93)	3.87 (0.72)	3.32 (0.97)	3.78 (0.80)	<0.001
EQIP Structure	7.30 (1.47)	6.76 (1.46)	7.25 (1.46)	7.79 (1.37)	<0.001
EQIP Total	17.78 (3.71)	16.89 (2.84)	17.12 (3.45)	20.15 (3.95)	<0.001
JAMA Total	2.69 (0.98)	3.13 (0.72)	2.53 (1.05)	2.85 (0.84)	0.001
DISCERN Reliability	26.93 (6.35)	26.98 (6.92)	26.04 (5.72)	29.37 (7.04)	<0.001
DISCERN Treatment	11.07 (5.60)	18.09 (6.04)	8.60 (2.45)	13.47 (6.73)	<0.001
DISCERN Total	38.00 (9.61)	45.07 (11.67)	34.64 (6.52)	42.84 (10.93)	<0.001

Table 4. Comparison between Government and News Services

Indicator	Global (USA inclusive) (n=250)					USA (n=121)				
	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value

EQIP Content	8.11	161.34	6.22	106.37	<0.001	7.66	75.80	6.17	54.22	0.002
EQIP Identification	3.44	118.28	3.62	129.35	0.207	3.34	50.29	3.78	65.90	0.011
EQIP Structure	7.34	129.90	7.22	123.15	0.464	7.55	67.54	7.08	58.01	0.148
EQIP Total	18.90	151.52	17.06	111.61	<0.001	18.55	71.21	17.04	56.33	0.029
JAMA Total	2.16	85.72	2.98	146.73	<0.001	2.03	34.28	3.17	73.23	<0.001
DISCERN Reliability	27.47	137.15	26.31	119.28	0.062	26.53	60.26	26.66	61.34	0.876
DISCERN Treatment	9.02	110.95	11.72	133.27	0.001	8.84	47.99	12.59	66.96	0.001
DISCERN Total	36.49	105.32	38.04	136.27	0.963	35.37	54.72	39.25	63.87	0.182

Table 5. Websites with the highest EQIP and DISCERN scores

URL	Country	Treatment or Prevention	Total EQIP	Total JAMA	Total DISCERN
https://www.cnet.com/how-to/coronavirus-explained-all-your-questions-about-covid-19-answered/	USA	Both	27	4	52
https://www.wikihow.com/Prevent-Coronavirus	USA	Prevention	27	4	46
https://www.sciencenews.org/article/coronavirus-covid19-repurposed-treatments-drugs	USA	Treatment	22	4	75
https://www.vox.com/science-and-health/2020/3/4/21154590/coronavirus-vaccine-treatment-covid-19-drug-cure	USA	Both	22	4	74

Figure 4. Scores of all websites for EQIP tool, JAMA benchmark and DISCERN tool, with scores above 75th percentile marked as high

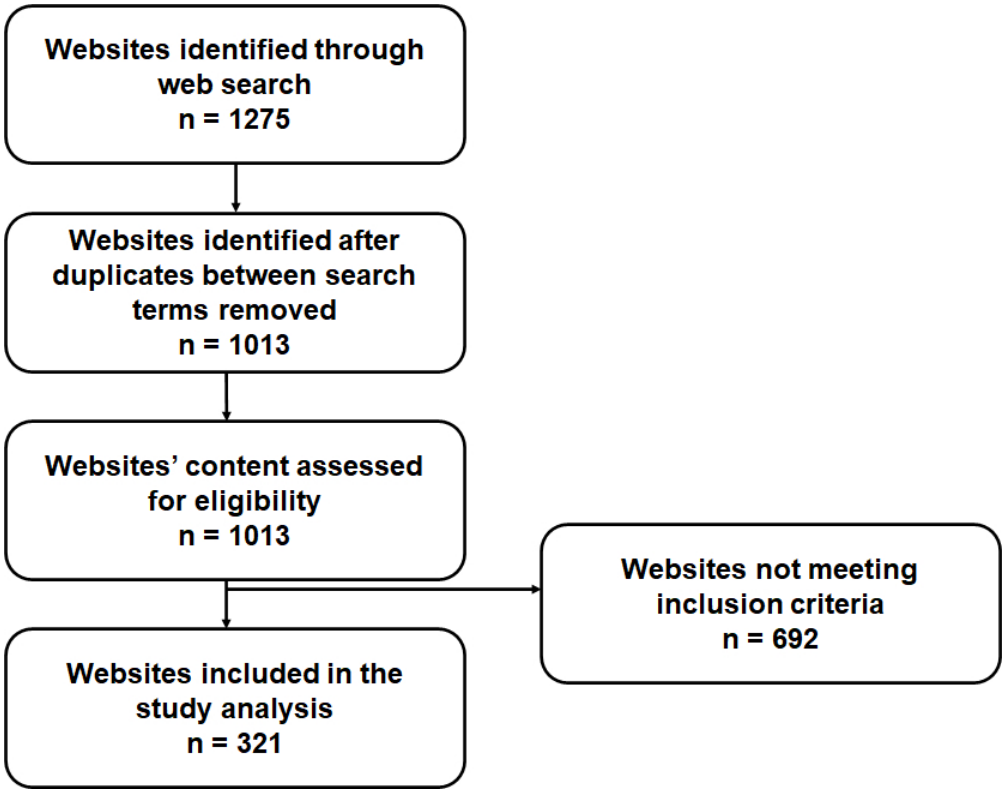

Figure 1. Workflow of webscraping and exclusion

70x55mm (300 x 300 DPI)

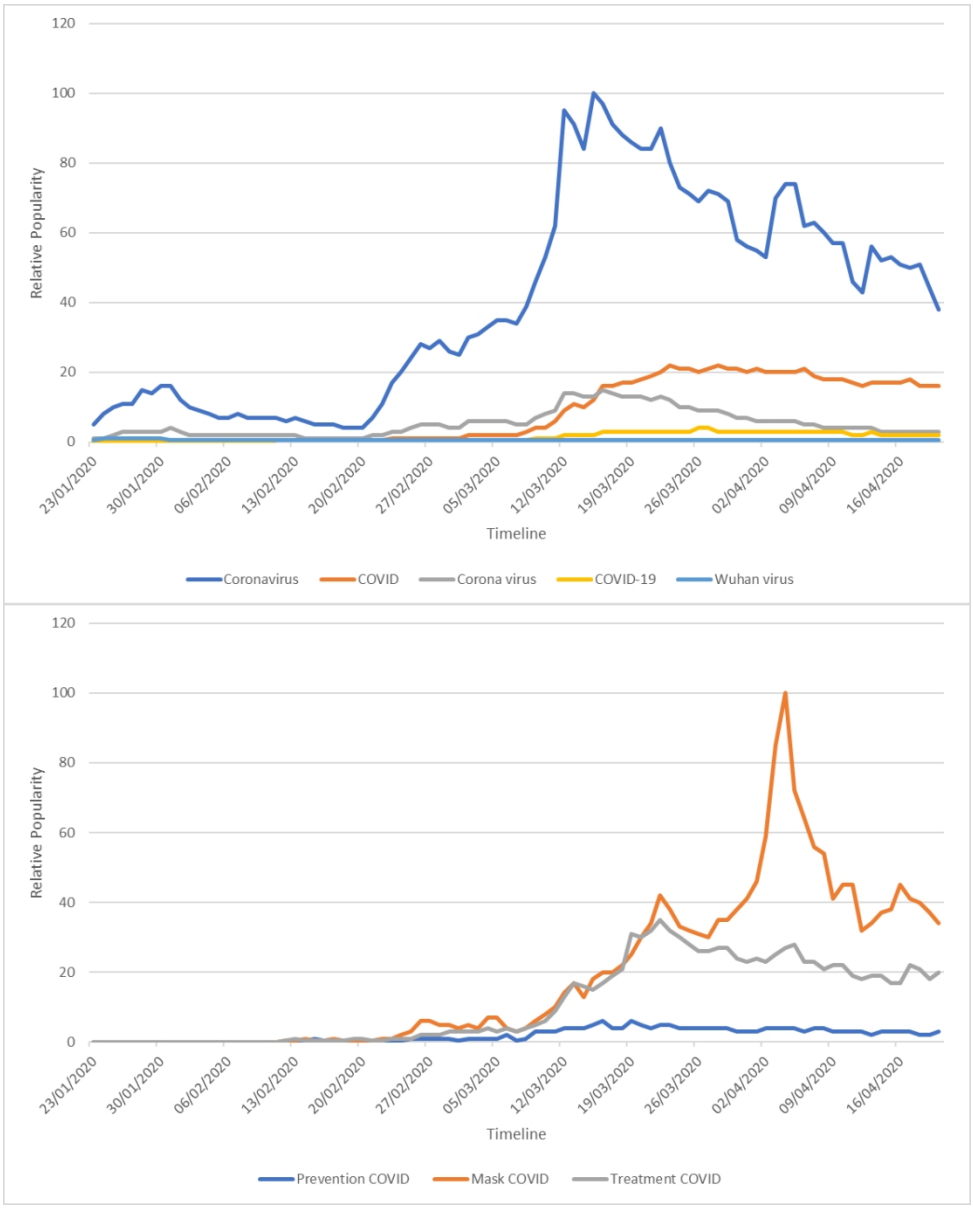

Figure 2. Popular search terms

99x123mm (300 x 300 DPI)

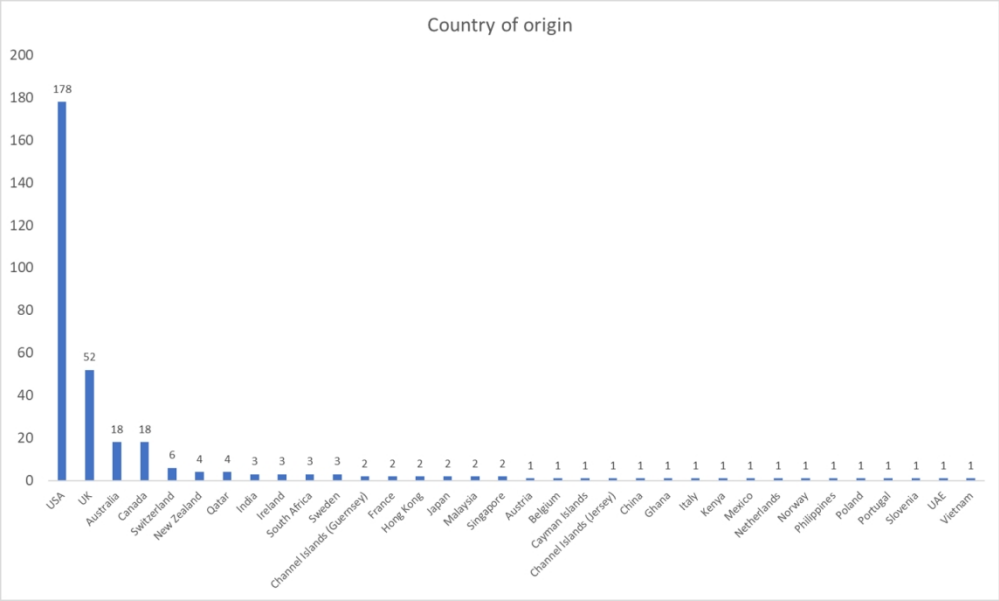

Figure 3. Country of origin of websites

132x79mm (300 x 300 DPI)

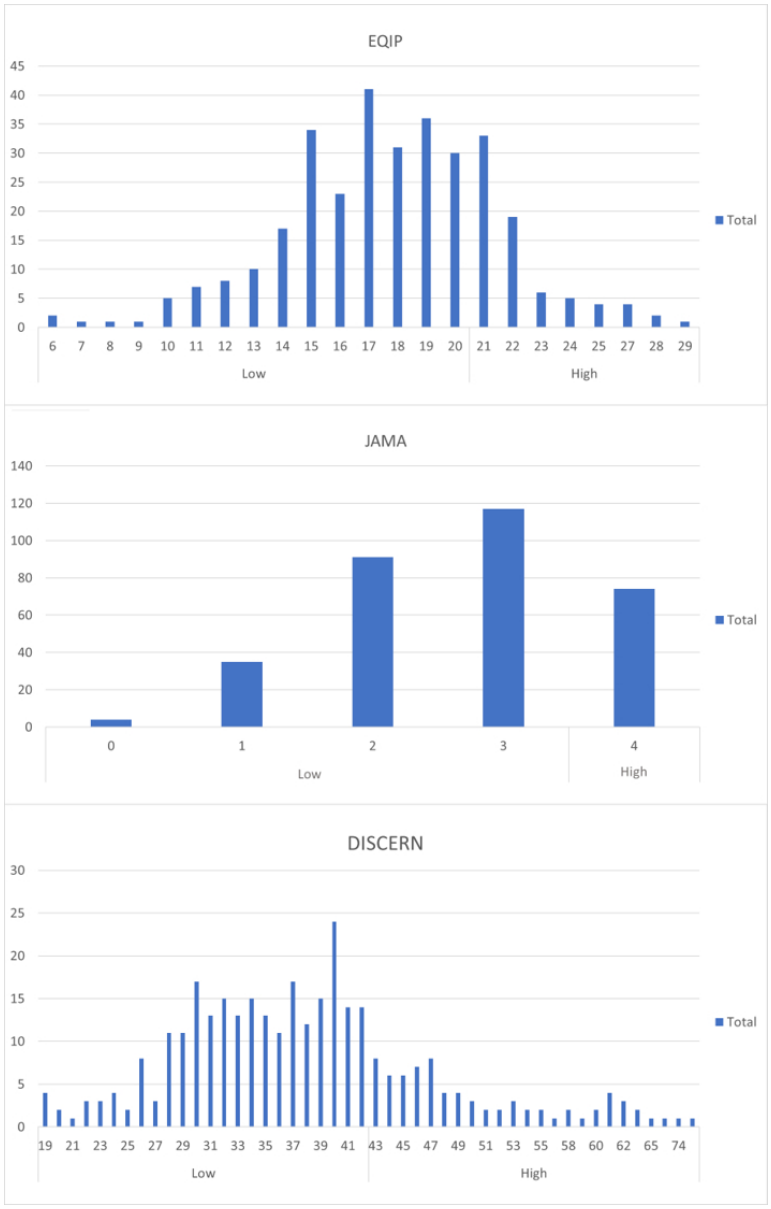

Figure 4. High-score distribution of websites

60x94mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	6-7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	6-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	8
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7-8
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7-8
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7-8
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-8
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-10
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-10
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8-10
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	10

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	10, Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	10-11
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	N/A
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10-12
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	12-17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	17-18
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	2

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A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet

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Cover Letter

Dear Editor,

We would like to submit to you the manuscript under the title of “A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet”.

Our work sets out to evaluate the quality of information available to the public regarding both the treatment and prevention of COVID-19 using validated assessment tools. These tools, which have been used in the past to assess quality, include the Ensuring Quality Information for Patients (EQIP) tool, JAMA benchmark and the DISCERN tool, all of which have been proven to be robust and effective at assessing online health information.

To the best of our knowledge, this is the first study to evaluate the nature and quality of information regarding COVID-19 currently available to the public. Our findings indicate that most websites were unable to provide adequate information on both treatment and preventative methods and were generally of poor quality. Without interventions to improve these websites, they will likely impact the awareness and actions of the wider public and, by extension, affect the efficacy of public health measures. Our study reflects the ongoing need for high-quality information while it is still possible to influence its dissemination, especially for countries that are now entering the growth phase.

We believe that this report, as well as the subtopics it addresses, will be of interest for the readers of your respectable journal.

We hereby certify that the authors of the above manuscript have all: 1) Conceived, planned, and performed the work leading to this article, 2) Written the article or reviewed successive versions and shared in their revisions, 3) Approved the final version. Further, we certify that this work has neither been published in whole or in part elsewhere nor is under consideration elsewhere, and we accept full responsibility for the design and conduct of the study.

Yours sincerely,

Ka Siu Fan, BSc and Shahi Abdul Ghani, MSc, DHMSA

On behalf of Dimitri Aristotle Raptis, MD, MSc, PhD and the authors

A systematic analysis and quality assessment of COVID-19 treatment and prevention information on the Internet

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Study conception and design: DAR, NM, SAG, KSF

Acquisition of data: SAG, KSF, LL, KHF, DR, AS

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Abstract

Objective: To evaluate the quality of information regarding the treatment and prevention of COVID-19 available to the general public from all countries.

Design: Systematic analysis using the 'Ensuring Quality Information for Patients' (EQIP) tool (score 0-36), JAMA benchmark (score 0-4) and the DISCERN tool (score 16-80) to analyse websites containing information targeted at the general public.

Data Sources: Twelve popular search-terms, including 'Coronavirus', 'COVID 19', 'Wuhan virus', 'How to treat coronavirus' and 'COVID 19 Prevention' were identified by 'Google AdWords' and 'Google Trends'. Unique links from the first 10 pages for each search-term were identified and evaluated on its quality of information.

Eligibility Criteria for selecting studies: All websites written in the English language, and provides information on prevention or treatment of COVID-19 intended for the general public were considered eligible. Any websites intended for professionals, or specific isolated populations, such as students from one particular school, were excluded, as well as websites with only video content, marketing content, daily caseload update or news dashboard pages with no health information.

Results: Of the 1275 identified websites, 321 (25%) were eligible for analysis. The overall EQIP, JAMA and DISCERN scores were 17.8, 2.7 and 38.0. Websites originated from 34 countries, with the majority from the USA (55%). News Services (50%) and Government/Health Departments (27%) were the most common sources of information and their information quality varied significantly. Majority of websites discuss prevention alone despite popular search trends of COVID-19 treatment. Websites discussing both treatment and prevention (n=73, 23%) score significantly higher across all tools (P<0.001).

Conclusion: This comprehensive assessment of online COVID-19 information using EQIP, JAMA and DISCERN tools indicate that most websites were inadequate. This necessitates improvements in online resources to facilitate public health measures during the pandemic.

Section 1: What is already known on this topic

- Since the declaration of COVID-19 as a pandemic on 12th March, the WHO, UN and EU have reported that unreliable information, or worse, disinformation has reduced the impact of their efforts in informing the public on matters related to the pandemic; leading to poor uptake of public health advice amongst certain communities.
- Research from previous outbreaks such as the Ebola outbreak from 2013-16 has identified that effective public education and public health intervention relies on public access to high-quality health information.
- As governments are relying heavily on a widespread concordance to public health advice during the COVID-19 pandemic, it is important to characterise the health information seeking habits of the public, the quality of the information that is available, and whether the information meets the needs identified through search habits at this time.

Section 2: What this study adds

- For this study, we identified 12 search-terms used by those seeking information related to COVID-19, 321 of the 1275 obtained websites met our eligibility criteria for analysis.
- An analysis with three widely respected tools (EQIP, DISCERN and JAMA benchmark) identified that the majority of websites poorly referenced sources of information or provided inadequate information, reflecting the ongoing need for better quality information regarding COVID-19 aimed at the public.

Introduction

With the increasing popularity of the Internet, both the accessibility and availability of health information has increased drastically and is now a primary source of information for many.[1,2] It is known that health information-seeking behaviour also applies to the use of online resources and has become ever more important during the current Coronavirus disease 2019 (COVID-19) pandemic[3] Information on such a widely-discussed topic will inevitably be vast and vary in production quality, potentially adversely affecting patient awareness and health-seeking behaviour.[4] Many of these resources read by the public may be unreliable or produced from non-peer-reviewed sources and affect behaviours such as recognition of symptoms, taking appropriate preventative precautions or seeking timely treatment.[3,5,6] Furthermore, inaccurate online information may contradict healthcare professionals and potentially compromise the trusting relationship with patients, worsening outcomes.[7]

Since the declaration of COVID-19 as a pandemic on 12th March 2020, its prevalence and mortality have continued to rise[8,9] and lead to the introduction of various measures such as social distancing, quarantine procedures and lockdown protocols.[10] As evidenced by previous outbreaks, effective public education and public health intervention rely on access to health information[11,12], which is now primarily delivered through the Internet. Many countries have since introduced lockdown and quarantine protocols as their mainstay preventative measures[13] but public health continues to be threatened by certain populations.[14] Due to both the novelty and rapid developments of COVID-19, there is a significant barrier for individuals to critically appraise online resources and, hence, necessitates a quantitative evaluation of the popular information sources available to the wider public.

Many instruments have been developed to evaluate patient information and may also be applied to online COVID-19 information.[15] The modified Ensuring Quality of Information for

Patients (EQIP) tool is a reproducible modality used in previous studies to evaluate the reliability and quality of all information types, providing a robust assessment of quality, readability and design aspects of any written information[16–18]. Previously, our group evaluated online information using the modified EQIP tool in a variety of conditions and procedures including bariatric surgery[19], Dupuytren's disease[20], carpal tunnel disease[21], breast augmentation[22], liposuction[16] and liver transplantation[23]. The Minervation validation instrument (LIDA)[24], Flesch Reading Ease (FRE) Score and the Flesch-Kincaid Grade (FKG) have also been used to evaluate the quality of online health information.[25] However, they are not considered appropriate here as only assesses readability and website design, which is adequately covered by EQIP.[26] Tools such as the Journal of American Medical Association (JAMA) benchmark and the DISCERN tool (no acronym) have also been used to evaluate online health information and their combinational use can provide a more comprehensive evaluation.[18,27,28] Given that the Internet has become an ever-important source of information and can determine health-seeking behaviour, which by extension can affect the progression of COVID-19. Hence, our study aims to assess the quality of information of top indexed websites that discuss information, prevention, or treatment of COVID-19 using the modified EQIP tool, JAMA benchmark and DISCERN tool.

Methods

Eligibility criteria, information sources and data selection

On 27th March 2020, 12 search-terms and phrases were queried on the most used search engine, Google[29–31], to obtain a database of websites. Only Google was used as previous studies have shown that the use of multiple search engines will only provide duplicate results. To increase the number of results, more search-terms were used: 'Coronavirus', 'COVID 19', 'Stop getting Coronavirus', 'Corona Virus', 'How to treat coronavirus', 'Coronavirus safety tips', 'Drugs for coronavirus', 'What is self isolation coronavirus', 'China virus', 'Wuhan virus', 'Coronavirus Medicine' and 'COVID 19 prevention'. These were

commonly searched phrases identified using the 'Google Adwords Keyword Planner'[32]. Google AdWords allows the input of a term (in this case coronavirus) which then provides popular related keyword suggestions. The most popular search-terms were 'Coronavirus', followed by 'COVID' and 'Corona Virus' and their respective search popularity peaked in mid- and late-March 2020 respectively. **Figure 1** summarises the most popular search trends. Only the first 10 pages of unique websites were identified and recorded as previous work suggests patients tend to stay within the first 100 returned webpages[17,23]. Various search-terms and their relative popularity were also collected directly from Google Trends[33] for further comparative analysis.

All websites written in the English language and providing information on prevention or treatment of COVID-19 intended for the general public or COVID-19 patients were considered eligible for inclusion. Any subsidiary pages or subdirectories of a website that contained information for the public and were easily accessible are also assessed. Websites or articles intended for professionals or specific population subsets, such as students alone, were excluded. Weblinks to purely video content, marketing content, daily caseload update or news dashboard pages with no educational purposes were excluded. The creation of the website database, eligibility assessment, website assessment and statistical analysis was performed within 4 weeks between March and April 2020.

Website Scraping

A website scraping tool was developed to identify and record all unique websites from the first 10 pages of Google results. The tool utilises custom PHP to make HTTP requests to the search engine to mimic the requests made by the public. The queries were made from a server located in Texas, USA but no preferences were made to limit searches by geographical region. The tool makes repeated requests, logs the first 10 pages of unique URLs and outputs the dataset after excluding all duplicate links within each search-term A minority of websites were restricted by General Data Protection Regulation (GDPR) and

were accessed through the use of virtual private networks (VPN) as any websites that could reasonably be accessed by the general public were included.

Data entry

Six assessors, (SAG, KSF, KHF, LL, AS and DR), all of whom fluent in English, independently assessed the websites between 30 March and 13 April 2020. The evaluation included 36 EQIP items and four items on JAMA benchmark, all assessed through 'Yes, No or N/A' questions. DISCERN tool adds a further 16 items to assess reliability and quality of information on treatment using scales of 1 to 5. Assessors also recorded the country of origin, and type of source: Academic Centre, Charity/Non-Governmental Organisation, Encyclopaedia, Government/Health Department, Hospital, Industry, News Service, Patient Group, Practitioner, and Professional Society. Organisations that primarily serves patients, such as Patient.info, is considered a 'Patient Group' whereas non-governmental organisations that oversee a broader demographic, like Red Cross and World Health Organization (WHO), are classified as 'Charity/Non-Governmental Organisation'. News service includes both primary and secondary news articles that are not written for professionals. 'Practitioner' considers the for-profit webpages of individual medical practitioners, whereas 'Industry' considers organisations within the medical industry. 'Academic Centres' consider all sources from academic institutions, while 'Professional Society' refer to non-profit groups of healthcare professionals. Qualitative information about preventative methods and treatment was also recorded. After the initial round of data entry, each website was verified on a second-round between 14 April and 21 April by a verifier who has had previous experience performing data entry for evaluation of patient health information.

EQIP Tool

The Ensuring Quality Information for Patients (EQIP) tool consists of 20 items, acting as a checklist for criteria such as quality of written work, design and coherence.[34] More

recently, modifications were made to the EQIP tool, expanding the criteria to 36 items[35], to satisfy both the guidelines of British Medical Association (BMA)[36] and International Patient Decision Aids Standards (IPDAS) collaboration[37] on ideal information for patients and have been utilised in a variety of specialities previously.[16–18] A decision was made to use the modified EQIP tool as the inclusion of 'partly yes' in the original EQIP introduces subjectiveness into the responses and has been shown to lower its reliability.[23,34] 36 items across three domains were included: Content (items 1-18), Identification (items 19-24) and Structure (items 25-36). Similar to previous uses, 'Yes/No' binary questions reduce assessor subjectivity in partial answers. 'N/A' option was also included if items were not relevant for the type of source. The Content domain assesses whether an adequate amount of information is included in an article, ranging from a description of the medical problem itself (items 1-3,11,14) to details of its management and complications (items 4-11). Identification domain assesses how well a website displays its production details, including date of issue, author, finance sources and bibliography (items 19-24). Structure domain evaluates the readability of a website and how well it accommodates to its audience, such as delivering the information through short, non-contradictory statements arranged in a logical layout (items 25-36). As COVID-19 is an emergent disease, certain items are tailored to accommodate for the limited evidence: describing treatment (item 3) include articles that address the lack of proven treatment, and alert signs (item 14) include recognised COVID-19 symptoms such as fever, cough and changes in taste or smell. A cut-off point of 75th percentile was set for EQIP score to discriminate between high-scoring from low-scoring websites as was done in previous studies.

JAMA Benchmark

Critical appraisals of Internet-based resources are also assessed by one of the earliest core standards identified by JAMA in 1997.[38] This checklist was proposed by Silberg *et al.* to assist the appraisal and evaluation of the credibility of unregulated Internet resources and

have been used in various studies previously[39,40]. This is evaluated by four items: Authorship, Attribution, Disclosure and Currency: Authorship requires identification of authors, credentials and their affiliations; Attribution requires appropriate citations on written information; Disclosure requires transparency of the website owner and conflicts of interests; Currency requires a clear indication of the date of publication and updates. Similarly, the 'Yes/No' criterion is implemented to reduce the subjectivity of partial answers.

DISCERN Tool

The DISCERN evaluation tool was first developed in 1998 at Oxford to judge the quality of information regarding treatment choices.[41] This tool has been validated and used across various specialities to assess treatment information.[28,39,42] This consisted of 16 items to assesses both the reliability and level of detail on treatments as well as the overall quality of the information. The reliability section (items 1-8) evaluates the ability of a website to achieve its aims while remaining unbiased and providing its sources of information. Quality section (items 9-15) evaluates the content specifically for describing the rationale, methods and alternatives to the current management of a disease. Criteria for treatment section was adjusted to accommodate the treatment uncertainty and items are considered fulfilled as long as the website discusses the relevant information with regards to potential drugs or interventions such as assisted ventilation. A score between 1 and 5 can be assigned to each item, with 1 being 'No', 3 being 'Partial' and 5 being 'Yes'. To improve assessment accuracy, overall quality of information will be scored in proportion to the mean scores calculated from the answers to items 1-15, with 1 being the lowest and 5 being the highest.

Additional Items

Additional items were included to further assess the websites, including whether a website discussed prevention methods, current treatments and the role of empirical evidence in the prevention or treatment for COVID-19. Data collected were in the form of 'Yes/No' to reduce the ambiguity of partial answers again. Additionally, details provided by the website on these

items were recorded if the item scores 'Yes'. Websites were further analysed by whether their purpose is prevention, treatment, or both.

Statistical Analysis

The dataset consisted of both continuous and categorical variables, which are reported as the mean, median and interquartile range (IQR) as well as numbers and percentages respectively. High-scoring websites are identified as those with scores above the 75th percentile for all three tools. Kruskal-Wallis tests were used for the analysis of continuous variables where appropriate and intraclass correlation coefficient (ICC) was calculated to identify the correlation between website analysis test methods. Fisher's or χ^2 tests were used to analyse proportions where appropriate. Inter-rater reliability of each assessor was evaluated using Bland-Altmann plots. All P values were two-tailed and considered significant when $P<0.05$. R version 3.3.2 (R Core Team, GNU GPL v2 License), R Studio version 1.0.44 (RStudio, Inc. GNU Affero General Public License v3, Boston, MA, 2016) and their respective graphical user interface (GUI) rBiostatistics.com (rBiostatistics.com, London, Switzerland, 2017)[43] was used to perform the statistical analysis.

Patient and Public Involvement

There were no patient or public involvement in the conception, design or data collection of the study or the production of the manuscript.

Results

Gathering of websites with information on COVID-19, its prevention and its management

A database of websites was gathered from the first 10 pages of unique URLs returned using the 12 search-terms. The final dataset included 1275 URLs. After filtering out duplicate results and websites that failed to meet our inclusion criteria, 321 remained eligible for

analysis. The workflow of dataset creation is shown in **Figure 2**. List of websites was obtained on a single day, 27th March 2020, and website evaluation was completed within two weeks.

Website demographics and search trends

COVID-19-specific searches regarding treatment and masks were significantly more popular (P<0.001) than prevention and peaked in mid-March and early-April respectively. The returned websites originated from 34 different countries (**Figure 3 and 4**): the USA produced the most websites (n=178), followed by the United Kingdom (n=52), Australia (n=18) and Canada (n=18). However, no statistically significant differences were observed between the four countries across all tools. The source of information and website category is shown in **Table 1**. News Services were the most common source of information (n=163), followed by Health Departments/Government (n=87).

Forty-six websites (14.3%) described treatment methods alone, 202 websites (62.9%) mentioned treatment methods alone and 73 websites (22.7%) discussed both prevention and treatment. Of the mentioned prevention methods, 205 (63.9%) described social isolation, 169 (52.7%) physical distancing, 157 (48.9%) advised staying home and 136 (42.4%) described the benefits of disinfecting or cleaning surfaces. With regards to mentioned treatment methods, 55 (17.1%) described the use of antiviral medications, 31 (9.7%) described hydroxychloroquine or chloroquine and 26 (8.1%) described the use of non-steroidal anti-inflammatory drugs such as paracetamol and ibuprofen. Only 31 (9.7%) websites discussed the use of oxygen, ventilation or fluids as a possible treatment method.

Overall performance

The mean total score for EQIP, JAMA and DISCERN are 17.78, 2.69 and 38.00 respectively and their respective 75th percentile high-score cut-offs were 21, 4 and 43. No website achieved the maximum score for EQIP Content (out of 18) or Structure (out of 6) domain but

one website did attain maximum for EQIP Identification (out of 12). Seventy-four websites fulfilled all four JAMA criteria. Four websites achieved the maximum for DISCERN Reliability (out of 40) but none scored fully in DISCERN Treatment (out of 40). 74 high-scoring websites were identified for EQIP and JAMA and 76 for DISCERN tool. The mean scores for each tool and domain are as follows: EQIP Content (9.99 vs 6.07; P<0.001), EQIP Identification (4.03 vs 3.34; P<0.001), EQIP Structure (8.45 vs 6.96; P<0.001), Total EQIP (22.46 vs 16.37; P<0.001), Total JAMA (4.00 vs 2.30; P<0.001), DISCERN Reliability (31.72 vs 25.44; P<0.001), DISCERN Treatment (13.49 vs 10.31; P=0.002) and Total DISCERN (45.21 vs 35.76; P<0.001).

All tools and subsequent domains, except DISCERN Reliability and Total DISCERN scores, varied significantly between websites of different sources, notably with the Encyclopaedia (n=5) cohort holding the highest score for all domains. All tools and domains varied between website cohorts, with websites that include both Treatment and Prevention scoring above the mean values. **Table 2** and **Table 3** summarises the variation of information quality with the source of information and website category respectively. A detailed breakdown of the performance of each item and each tool is displayed in **Supplementary Table 1, 2 and 3**.

Subset analysis of Government/Health Department and News Services

Collectively, 250 (77.9%) of all web links were either Government/Health Departments and News Services websites, of which 121 (37.7%) were based in the USA. Globally, there is significant variation between Government/Health Departments and News Services in EQIP Content (mean 8.11 vs 6.22; P<0.001), Total EQIP (mean 18.90 vs 17.06; P<0.001), Total JAMA (mean 2.16 vs 2.98; P<0.001) and DISCERN Treatment (mean 9.02 vs 11.72; P=0.001). Variations in US websites were similar except for EQIP structure (P=0.148). The US-based cohort scored lower in Total EQIP than the global cohort but USA News Services specifically scored better in Total JAMA (3.17 vs 2.98) and Total DISCERN (39.25 vs 38.04). Breakdowns of comparison between the cohorts are provided in **Table 4**.

High-scoring websites

Sixteen websites scored above 75th percentile across all three evaluation tools, 13 were from the USA, 2 from the UK and 1 from Canada. Most were from News Services (n=10), followed by industry (n=4), Encyclopaedia (n=1) and Government/Health Departments (n=1). The top 5 websites with the highest Total EQIP and Total DISCERN scores are shown in **Table 5** with their respective breakdowns. Top JAMA websites were not shown as there were 74 that scored the full four points.

Intraclass correlation between tools

Intraclass correlation (ICC) between the 3 analysis tools is provided in **Supplementary Figure 1**. The ICC between all three tools was moderate to high 0.48 (95% CI 0.37-0.56). Furthermore, as the JAMA benchmark only offers four scoring variations, the Kruskal-Wallis analysis is used to correlate JAMA with EQIP and DISCERN. The results are shown in **Supplementary Figure 2** and demonstrate statistically significant moderate-high correlation for both JAMA-EQIP and JAMA-DISCERN.

Inter-rater reliability

Kappa coefficients, ranges and outliers. Mean kappa and SD for each tool. Supplementary Data. Intraclass correlation, 95% CI intervals. Bland-Altman plots. The biases of each tool and assessor are within 95% CI interval limits. The Bland-Altman plots and individual degree of bias have been provided in **Supplementary Figure 3**. The mean degree of bias and 95% confidence intervals for each assessor is identified. Mean bias for EQIP, JAMA and DISCERN were -0.36, +0.29 and +0.51 respectively. Bias for each assessor, within each tool, was minimal and falls within their respective 95% CI.

Discussion

To our knowledge, this is the first study to evaluate the content intended for the public seeking information for preventing or treating of COVID-19. Our search-terms included various synonyms of COVID-19 and "open" search-terms to capture the majority of materials related to our study. While no tools are validated to assess information specifically during pandemics; this study used a combination of EQIP, JAMA and DISCERN. The combined scope and efficacy of these tools enable a comprehensive evaluation of all important aspects for a layperson seeking health information from articles; namely readability, coherence, design and quality of information.

Evaluation of the websites

We determined the quality of information to be low, as indicated by the low 75th percentile cut-offs for EQIP and DISCERN, at 21 and 43 respectively, or 58.3% and 53.8% of their respective full scores. Abundant COVID-19 content is being produced, as evident in **Figure 1**, with the majority being excluded due to its nature rather than inter-term duplications. Most frequently excluded websites were either daily caseload updates or general news articles lacking information on prevention and treatment.

Websites generally scored poorly, with an EQIP mean and median of 18 (IQR 15-20). Despite fewer marks allocated to Structure, websites generally outperform the Content domain (7.30 vs 6.97), suggesting information quality is less adequate than usability. The indicators assessing referencing quality, such as JAMA benchmark and DISCERN Reliability, scored similarly at 2.69 (67.3% of maximum) and 26.93 (67.3% of maximum) respectively but scored lower in the EQIP Identification domain 3.50 (58.3% of maximum), likely due to more items (i.e. whether patients were involved in the material's production). Generally, high-scoring websites performed better in the Content domain, with odds ratios (OR) between 3-7. The OR was significantly higher for item 4 (defining the purpose of interventions) (OR 27.78; 95% CI 4.695-1000; P<0.001), suggesting that high-scoring websites provided greater reasoning behind preventative and treatment measures. While

high-scoring websites scored significantly higher across 23 of the 36 EQIP items, quantitative benefits (item 8) is a notable exception where both cohorts performed poorly (4.1% vs 2.4%; OR 1.695; 95% CI 0.267-8.197; P=0.436), significantly lower than available literature.[17,22,23] This likely reflects the general lack of COVID-19 knowledge compared to previously explored diseases and treatments. High-scoring websites similarly performed better in Identification (OR ranged between 1.312 and 5.376), with the inclusion of bibliography (item 23) differing most (41.89% vs 11.74%; OR 5.376; 95% CI 1.727-7.407; P<0.001) as the majority of said websites seem to lack bibliographies, potentially due to subpar production quality in a high turnover topic. Structure revealed both high- and low-scoring websites to provide clear information (item 30; 98.65% vs 89.88%; OR 8.197; 95% CI 1.294-333.3; P=0.013). High scoring websites provided poor benefit-risk balancing(item 31; 39.19% vs 10.93%; 5.208; 95% CI 2.703-10.101; P<0.001), as did most other websites assessed (17.5% overall), comparable to existing studies ranging 11% to 44%. As shown in **Figure 5**, EQIP scores were relatively homogeneous, ranging from 6 to 29, with the majority between 14-22. Overall performance agreed with available literature that information is inadequate, as median EQIP scores ranged between 15-19 and IQR ranged 12-20 and 16-22.[17,19,21,22,44] Furthermore, scores for describing intervention sequence (item 6) and quantitative risks (item 10) were much lower (15.9% and 0.9% respectively) when compared against the study on gallstone disease (27% and 21% respectively) or liver transplantation (66% and 53% respectively). This likely reflects the prioritisation of discussing prevention and treatment method efficacy over treatment sequences and risks. Item 23 also scored poorly, both in itself and against literature: only 18.7% of websites provided a short bibliography whereas studies ranged from 19% in liver transplantation to 47% in orthognathic surgery. Interestingly, COVID-19 websites scored well in dating (item 19; 87.2%) compared literature, likely reflecting the demanding and time-sensitive nature to understand how the COVID-19 pandemic affect individuals. Unsurprisingly, encyclopaedias (n= 5) scored the highest in content (10.80), identification (4.80) domains and overall EQIP (24.20), holding the highest proportion of websites discussing both prevention and treatment

(n=4; 80%). Encyclopaedias' high scores are attained through their endeavours to provide neutral summaries meeting the majority of the EQIP criterion.[45] Nonetheless, while overall EQIP scores do not differ substantially from existing literature, it is important to recognise that the quality of information assessed is significantly influenced by the rapid turnover of information, a phenomenon not present in other comparable studies.

JAMA benchmark scores, unlike EQIP and DISCERN, were more consistent as only four points are available. Hence, high-scoring websites often fulfilled all four criteria while the majority of remaining entries scored two or three. Low-scoring websites scored significantly lower (P<0.001) in Authorship and Attribution, with only 44.13% and 17.81% fulfilling the criteria, reflecting congruence with the findings from EQIP regarding bibliography inclusion. Contrarily, website ownership and funding assessment, under Disclosure, (86.23%) and assessments of publishing and updating dates, under Currency (81.78%), varied to a lesser degree, albeit still scoring significantly lower (P<0.001). Comparative to the related EQIP sections, Disclosure and Currency likely scored better by assessing attributes separate to the content itself. Professional societies (n= 4; 3.50), closely followed by encyclopaedias (n=5; 3.40), scored the highest (scored highest what?), whereas the mean JAMA scores were only 2.69, with four websites scoring zero. This is likely attributable to the lack of additional assessment criteria by the JAMA benchmark due to JAMA's development during a time of rudimentary online resources. Regardless, the tool is still effective at identifying high-quality content as high-scoring websites scored significantly better across each item (P<0.001).

DISCERN's mean score of 38.0 across 16 items averaged 2.38 out of five per item. The DISCERN handbook details a rating of one when the information does not provide the appropriate information, three where it addresses it partially and five for a complete and adequate inclusion. Based on these guidelines, the majority of websites meet the listed criteria to a minimal extent. Similar to EQIP, DISCERN scores vary significantly, ranging 19

to 75 with a majority distributed within 25 to 47. Of the 16 items, 12 presented statistically significant differences between high- and low-scoring websites. Interestingly, the Reliability section provided the greatest difference in scoring, seen between item 4, clear display of information sources (mean 4.16 vs 2.55; P=0.019), and item 5, a clear indication of where sources were used (mean 3.54 vs 2.28; P=0.007). This corroborates with results from EQIP and JAMA assessments, highlighting the inadequacies of informative material production.

Quality of treatment information scores varied less, albeit all statistically significant, with largest differences observed between item 9, describing how each treatment works (1.76 vs 1.43; P=0.005) and item 10, detailing treatment benefits (1.78 vs 1.43; P<0.001). Despite accommodating for the treatment uncertainty during the assessment, almost all items evaluating treatment scored poorly, including high-scoring websites, and may be reflective of its lower journalistic priority or demand as we also found the majority of websites tailored towards discussing prevention. As a whole, DISCERN scores specifically addressing treatment options were poor, scoring 45.07 (SD 11.68) for websites that only discuss treatment as well as 42.84 (SD 10.93) for websites that discuss both prevention and treatment. These scores are also lower than those of other DISCERN studies, which have mean scores between 45.8 and 56.1, with SD between 8.76 and 13.6.[46–48] While the majority of websites DISCERN scores were low, they scored similarly in Reliability section. The mean scores for items 1,2 and 3 were the highest of all indicators, averaging 4.37, 4.29 and 4.33, whereas treatment section scored between 1 and 2, with a maximum of 1.66. The treatment section of DISCERN shows much more variation, with prevention alone (8.60; n=202) scoring lowest, treatment alone (18.09; n=46) scoring highest and websites discussing both (13.47; n=73) in between. This suggests that many websites do not include treatment information and, of those that do, websites tend to avoid discussion rather than provide the limited information available.

In short, all three tools utilised here are validated based on international recommendations and provides a comprehensive assessment of online information: EQIP delivers an all-

rounded evaluation of health information, DISCERN excels at scrutinising treatment and JAMA benchmark assesses all of a website's content as a whole. Additionally, as design alone is known to improv perception of information credibility[49], the higher emphasis on quality of content in EQIP and DISCERN will likely prevent well-presented and user-friendly websites with poor content from attaining high scores over poorly-presented websites with good content. Altogether the tools suggest that the majority of COVID-19 websites are generally of poor quality and that quality fluctuates highly. The need to improve public awareness and education exist and through these tools, expectations can be held across different sources of information. This may subsequently impair the ability of the public to filter out websites of low validity and reliability and, hence, increase their risk of unsafe health behaviours during the pandemic.

Reasons for poor quality information

Most sources scored poorly due to several possible reasons. Firstly, as COVID-19 was only identified in early December 2019[50] and recognised as a pandemic in March 2020[51], the general lack of information from which to produce patient information prevents accurate and reliable conclusions to be drawn. While research efforts have since gained traction, production of research, reviewing and publication is a lengthy process comparative to the rapid spread of COVID-19. Journals have since implemented fast-tracking of COVID-19 research.[52–54] Similarly, Governments and Health Departments have also cooperated to support and fast-track COVID-19 studies.[55] The combined efforts have facilitated the publication of over 5,000 COVID-19 articles in the WHO database alone.[56] It is also important to note the role of preprint servers during the pandemic as they are accessible to the public. While improving accessibility helps facilitate peer-reviewing; non-peer-reviewed articles can potentially be used, or cherry-picked, by non-professionals which can adversely affect public understanding.[57–60]

Health literacy plays a crucial role in how COVID-19 information influences health behaviour. The associations between health literacy and health behaviour are well documented, with low literacy common among older adults with poor health behaviour (P<0.005) ranging from lifestyles, such as physical activity, dietary habits and obesity, to social factors, such as loneliness and social isolation.[61–63] The effects of primary preventative measures, such as social distancing, self-isolation and other hygiene recommendations, may become impaired by the abundance of poorly written and incorrect information online. In particular, the elderly, most vulnerable population, suffer from even higher risks due to their lower health literacy.[64] Although health literacy, and by extension, health behaviours, can be improved through education[65], effective dissemination of credible information is critical during the pandemic. The public, and journalists, need to excise caution when accessing research and pre-prints during this period as inadequate health literacy may lead to counterproductive effects. Similarly, mass production of online information greatly increases the difficulty in distinguishing reliable information from the sea of misinformation, and hence, a greater emphasis must be placed on authors and journalists to deliver unbiased, credible and accurate information to the public.[66,67]

Upon publication, articles are reviewed and summarised by journalists who bridges the knowledge gap between scientists and the wider public. This allows efficient dissemination of critical research to those who lack the scientific background to critically appraise and evaluate research. Notably, while 52% (n=169) of websites were ‘News Services’, only 12 (7.1%) were considered high-scoring, reflecting that very few provide a comprehensive account of COVID-19 information, possibly explained by the difficulty in matching the pace of COVID-19 research and technical inadequacies in delivering accurate and concise scientific information. As health information-seeking behaviour of the public will likely be based on news services[68], the highly variable and generally poor content is problematic.

Previous studies have identified many health journalists lack the training required to accurately disseminate health news, leading to potentially harmful health effects.[69,70] The low scores across all tools indicate overall inadequacy of both reliability and accuracy. A survey of medical journalists across 37 countries highlighted the 3 most common barriers against quality content: lack of time, space and knowledge.[71] While journalism stresses the ability to summarise content quickly and concisely, experienced journalists often report the lack of knowledge as a barrier. The lack of expert knowledge in a rapidly progressing scientific field can impact the quality of conveyed information significantly. Furthermore, journalists reported difficulty in finding experts to explain jargon, further impacting quality. This presents a large barrier towards disseminating quality COVID-19 information as the redirected efforts of many countries and institutions' scientists into research reduces availability to assist with medical journalism. [72,73] Expertise in a relevant academic background likely helps improve the content, as indicated by the highest-scoring entry, whose author holds a PhD in molecular genetics which scoring 22 in EQIP, 4 in JAMA and 74 in DISCERN.[74] In short, our findings highlight the importance of addressing health outcomes through health literacy of both the public and authors.

Our analysis identified the majority of websites as sources from Governments or health departments across various states of the USA, many of which have based information and advice from the Centers for Disease Control and Prevention (CDC). As both the nature and purpose of these sources vary, the visiting population and demographics would similarly vary due to different information-seeking behaviours. A recent study has identified a deficit of awareness and trust in information originating from the Government such as those of the CDC, revealing that while up to 83.6% of American adults are aware of the CDC, only 64.6% trust this source.[75] American adolescents were, however, less aware of the CDC (55.8%), but were more trusting of their information (72.2%). As previously established, the trust in a government is a predictor of health outcome as it affects behaviours such as service usage and vaccination rates. .[76–78] Similarly, as access and usage of online health information

vary between different demographic populations, it is paramount we create and provide targeted and effective educational material for public use.[79,80]

A comparison between the global Government/Health Department and News Services websites revealed significant differences between EQIP Content, Total EQIP, Total and DISCERN Treatment. The EQIP Content scores reflect differences in information retrieval methods between Government/Health Departments' using primary research for more in-depth accurate information dissemination, and journalists utilising secondary research. However, News Services scored higher in DISCERN Treatment, potentially due to the Government's reluctance to prematurely disclose treatment information at early stages of discovery, whereas journalists may freely report results of all potential studies. Interestingly, the majority of USA Government websites had some form of copy-pasted information from the Centre for Disease Control and Prevention (CDC), likely with the aim of maintaining consistency and centralisation information sources. In contrast, the majority of other sources rewrite information based on a variety of sources. American sources display a similar pattern of variation but the EQIP Identification scores of Government/Health Departments show statistically significant differences, scoring lower than News Services (mean 3.34 vs 3.78; P=0.011). Verbatim use of CDC information on these Government websites may have neglected the importance of clarity and transparency, discarding justification and critical appraisal of available literature and focusing on information dissemination instead.

Is the current information online adequate?

Google Trends identified search popularity of treatment to have increased rapidly, outgrowing prevention searches since early-March. This suggests that initial demands for preventative information have been sufficiently met and interests now shift towards treatment. The 275 websites addressing prevention scored below the mean EQIP (17.12 vs 17.78; P<0.001), JAMA (2.53 vs 2.69; P=0.001) and DISCERN scores (34.64 vs 38.00; P<0.001), showing that quality of preventative information remains subpar across all quality

indicators. Similarly, websites demonstrated their efficacy in sourcing over discussing information, excelling in Identification (3.87 vs 3.50; P<0.001), as a treatment alone (46%) scored below the mean in EQIP (16.89 vs 17.78; P<0.001). This is also reflected by its above-average JAMA (3.13 vs 2.69; P=0.001) and DISCERN (45.07 vs 38.00; P<0.001) scores. Contrarily, the 73 websites that discussed both treatment and prevention of COVID-19 consistently scored higher than the mean across all indicators: EQIP (20.15 vs 17.78; P<0.001), JAMA (2.85 vs 2.69; P=0.001) and DISCERN (42.84 vs 38.00; P<0.001). These websites explored multiple aspects of the virus, likely utilising a variety of sources, thus producing a higher quality article through a better understanding of the topic. To combat increasingly dangerous COVID-19 myths, such as injection of disinfectants as treatment, continued maintenance and improvement to online available resources is paramount.[81,82]

Limitations

Although our utilised search engine, 'Google', is the most commonly used, it is not wholly representative as searches are often affected by the location of the requesting server and previous Internet usage. While querying from every country is not practical, the utilised server has not conducted any other COVID-19 searches, thus impact should be minimised. A further search was conducted on 10th July 2020 on the top 10 scoring EQIP and DISCERN websites through VPN servers in Texas, London, Toronto and Sydney. Only three of the websites were found within the first 10 pages of results using the same search-terms on the original server, with London and Sydney returning two of the results, Toronto returning none (**Supplementary Table 4**) and the remaining URL redirecting to another page. The search also confirms differences in results between the location of the search, however, all three results from the Texas server were covered by London and Sydney. As websites can be updated or removed any time, our results are representative only at the time of the search, demonstrated by the distinct lack of the original websites in July. Similarly, search-terms obtained using 'Google Adwords Keyword Planner' and 'Google Trends', may not truly be indicative of search patterns of the wider public. Hence, 12 different variations of 'COVID-19'

names and phrases potentially used by patients were utilised as search-terms. As popularised social media is in sharing health information, our study focused on search engines because previous studies have identified a lacking trust in social media information responsible, developing subsequent barriers towards public engagement.[83] Similarly, while video-based information constitutes a valuable source of information, no tools have been validated in assessing video-based information, particularly for COVID-19, to the best of our knowledge. Forced inclusion of video content would likely yield inaccurately low scores across current tools as videos typically do not include as much written information. Another limitation is the exclusion of non-English language websites, especially reducing the representation of publicly available information given the international nature of the pandemic. A minority of URLs, particularly of News Services, regularly update their content or redirect visitors, potentially affecting the second round of evaluation and subsequent statistical analysis. Additionally, modified EQIP tool, JAMA benchmark and DISCERN tool were limited as they were not designed to specifically assess the highly variable information produced during pandemics. However, the EQIP tool was designed to assess any type of patient information and demonstrated high inter-rater reliability.[16] Similarly, JAMA benchmark was designed to evaluate website reliability alone and DISCERN examines both reliability and content accuracy, thus, the combinational use of tools enhances the accuracy and objective assessment of websites.

Conclusion

In short, the abundance of Internet resources providing COVID-19 information is exemplified by the numerous identified websites during our search. The information available to the public may affect their health decisions, which, subsequently, affects the efficacy and outcome of public health measures implemented by the state. As effective treatments and vaccines research is underway, COVID-19 is primarily addressed with preventative measures, hence necessitating a critical review of the quality and nature of the information accessible to the public. Our results demonstrated that the websites were chiefly produced

by News Services and Government/Health Departments but were nonetheless of low quality. While the majority of websites addressed prevention, and likely met the information needs of the public as reflected by search trends, there is a relative deficit in websites that discuss treatment methods. A minority of websites discussed both prevention methods and treatment and were generally good resources but the majority websites were of inadequate quality. Thus, there is a need for higher quality for online COVID-19 resources to facilitate public education and enable better cooperation and outcomes of public health measures.

Contributorship statement

Study conception and design: DAR, NM, SAG, KSF

Acquisition of data: SAG, KSF, LL, KHF, DR, AS

Analysis and interpretation of data: KSF, SAG, NM, DAR

Drafting of manuscript: KSF, SAG, NM, KHF

Critical revision: KSF, SAG, NM, DAR

Competing interests

Authors have declared that no competing interests exist.

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Data sharing statement

All relevant data are within this manuscript and supplementary files.

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Table 1. Website demographic and background information

Type	Total (n,%)	Treatment (n,%)	Prevention (n,%)	Treatment and Prevention (n,%)
Academic Centre	10 (3.12%)	1 (0.31%)	4 (1.25%)	5 (1.56%)
Charity/NGO	12 (3.74%)	1 (0.31%)	9 (2.8%)	2 (0.62%)
Encyclopaedia	5 (1.56%)	0 (0%)	1 (0.31%)	4 (1.25%)
Government/Health Department	87 (27.10%)	1 (0.31%)	65 (20.25%)	21 (6.54%)
Hospital	7 (2.18%)	0 (0%)	5 (1.56%)	2 (0.62%)
Industry	30 (9.35%)	8 (2.49%)	10 (3.12%)	12 (3.74%)
Military	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
News Service	163 (50.78%)	34 (10.59%)	102 (31.78%)	27 (8.41%)
Patient group	1 (0.10%)	1 (0.31%)	0 (0%)	0 (0%)
Professional society	4 (1.25%)	0 (0%)	4 (1.25%)	0 (0%)
Research Centre	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
Total	321	46 (14.33%)	202 (62.93%)	73 (22.74%)

Table 2. Overall quality of information of all sources of information

Indicator/ (Mean, SD)	Academic centre	Charity/NGO	Encyclopaedia	Government/Health Department	Hospital	Industry	Military	News Service	Patient group	Professional society	Research Centre	P Value

EQIP Content	7.70 (2.50)	6.75 (3.33)	10.80 (3.11)	8.11 (2.49)	7.14 (2.19)	7.13 (2.60)	5.00 (0)	6.22 (2.11)	10.00 (0)	5.50 (3)	5.00 (0)	<0.001
EQIP Identification	2.90 (1.20)	3.08 (0.90)	4.80 (0.45)	3.44 (1.03)	2.71 (1.38)	3.4 (1.13)	1.00 (0)	3.62 (0.73)	3.00 (0)	4.00 (0)	4.00 (0)	0.003
EQIP Structure	7.90 (1.85)	7.67 (1.30)	8.60 (1.67)	7.34 (1.45)	7.43 (0.98)	6.97 (1.83)	9.00 (0)	7.22 (1.39)	10.00 (0)	7.25 (0.5)	5.00 (0)	0.08
EQIP Total	18.50 (3.66)	17.50 (4.32)	24.20 (3.56)	18.9 (3.79)	17.29 (3.50)	17.5 (4.48)	15.00 (0)	17.06 (3.19)	23.00 (0)	16.75 (3.4)	14.00 (0)	<0.001
JAMA Total	2.50 (0.97)	2.50 (1.00)	3.40 (0.55)	2.16 (0.86)	2.14 (1.57)	2.73 (1.23)	1.00 (0)	2.98 (0.85)	3.00 (0)	3.50 (0.58)	3.00 (0)	<0.001
DISCERN Reliability	27.20 (6.78)	26.25 (6.51)	35.60 (4.77)	27.47 (5.96)	29.86 (5.58)	26.6 (7.46)	23.00 (0)	26.31 (6.3)	27.00 (0)	29.50 (4.2)	26.00 (0)	0.128
DISCERN Treatment	13.00 (6.70)	9.42 (2.39)	16.00 (9.30)	9.02 (3.14)	8.71 (1.89)	13.33 (6.39)	8.00 (0)	11.72 (6.22)	13.00 (0)	8.50 (1)	17.00 (0)	0.001
DISCERN Total	40.20 (10.38)	35.67 (7.67)	51.60 (12.3)	36.49 (7.50)	38.57 (5.47)	39.93 (10.45)	31.00 (0)	38.04 (10.44)	40.00 (0)	38.00 (5.1)	43.00 (0)	0.167

Table 3. Overall quality of information of all websites subsets

Indicator/(Mean, SD)	Overall	Treatment	Prevention	Treatment and Prevention	P Value

EQIP Content	6.97 (2.52)	6.26 (1.81)	6.55 (2.30)	8.58 (2.84)	<0.001
EQIP Identification	3.50 (0.93)	3.87 (0.72)	3.32 (0.97)	3.78 (0.80)	<0.001
EQIP Structure	7.30 (1.47)	6.76 (1.46)	7.25 (1.46)	7.79 (1.37)	<0.001
EQIP Total	17.78 (3.71)	16.89 (2.84)	17.12 (3.45)	20.15 (3.95)	<0.001
JAMA Total	2.69 (0.98)	3.13 (0.72)	2.53 (1.05)	2.85 (0.84)	0.001
DISCERN Reliability	26.93 (6.35)	26.98 (6.92)	26.04 (5.72)	29.37 (7.04)	<0.001
DISCERN Treatment	11.07 (5.60)	18.09 (6.04)	8.60 (2.45)	13.47 (6.73)	<0.001
DISCERN Total	38.00 (9.61)	45.07 (11.67)	34.64 (6.52)	42.84 (10.93)	<0.001

Table 4. Comparison between Government and News Services

Indicator	Global (USA inclusive) (n=250)	USA (n=121)

	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value
EQIP Content	8.11	161.34	6.22	106.37	<0.001	7.66	75.80	6.17	54.22	0.002
EQIP Identification	3.44	118.28	3.62	129.35	0.207	3.34	50.29	3.78	65.90	0.011
EQIP Structure	7.34	129.90	7.22	123.15	0.464	7.55	67.54	7.08	58.01	0.148
EQIP Total	18.90	151.52	17.06	111.61	<0.001	18.55	71.21	17.04	56.33	0.029
JAMA Total	2.16	85.72	2.98	146.73	<0.001	2.03	34.28	3.17	73.23	<0.001
DISCERN Reliability	27.47	137.15	26.31	119.28	0.062	26.53	60.26	26.66	61.34	0.876
DISCERN Treatment	9.02	110.95	11.72	133.27	0.001	8.84	47.99	12.59	66.96	0.001

DISCERN Total	36.49	105.32	38.04	136.27	0.963	35.37	54.72	39.25	63.87	0.182

Table 5. Top 5 websites based on EQIP and DISCERN scores

URL	Country	Treatment or Prevention	Total EQIP	Total JAMA	Total DISCERN
Top Scoring EQIP Sites					
https://www.gov.je/health/coronavirus/Pages/index.aspx	Channel Islands (Jersey)	Both	29	3	49
https://en.wikipedia.org/wiki/2019%E2%80%9320_coronavirus_pandemic	USA	Both	28	3	61
https://www.health.nsw.gov.au/Infectious/alerts/Pages/coronavirus-faqs.aspx	Australia	Both	28	3	46
https://www.ageuk.org.uk/information-advice/coronavirus/coronavirus/#	UK	Both	27	3	48
https://www.wikihow.com/Prevent-Coronavirus	USA	Prevention only	27	4	46
Top Scoring DISCERN Sites					
https://www.sciencenews.org/article/coronavirus-covid19-repurposed-treatments-drugs	USA	Treatment only	22	4	75
https://www.vox.com/science-and-health/2020/3/4/21154590/coronavirus-vaccine-treatment-covid-19-drug-cure	USA	Both	22	4	74

https://en.wikipedia.org/wiki/Coronavirus_disease_2019	USA	Both	25	3	68
https://www.bloomberg.com/news/articles/2020-03-25/hydroxychloroquine-no-better-than-regular-covid-19-care-in-study	USA	Treatment only	21	3	65
https://www.theverge.com/2020/2/4/21122327/coronavirus-experimental-medication-treatment-wuhan-china-gilead-hiv	USA	Treatment only	18	4	64

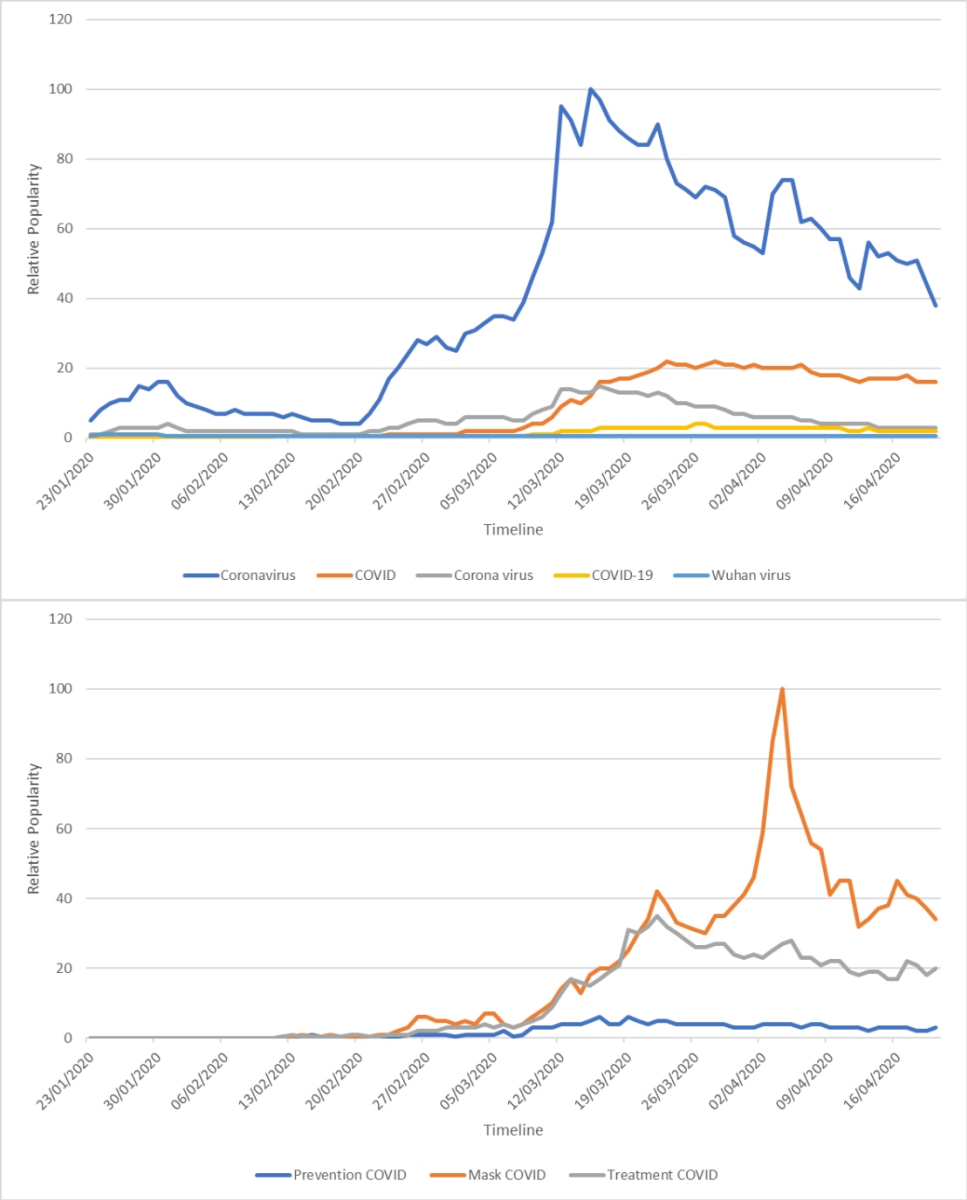


Figure 1. Popular Search Terms

99x123mm (300 x 300 DPI)

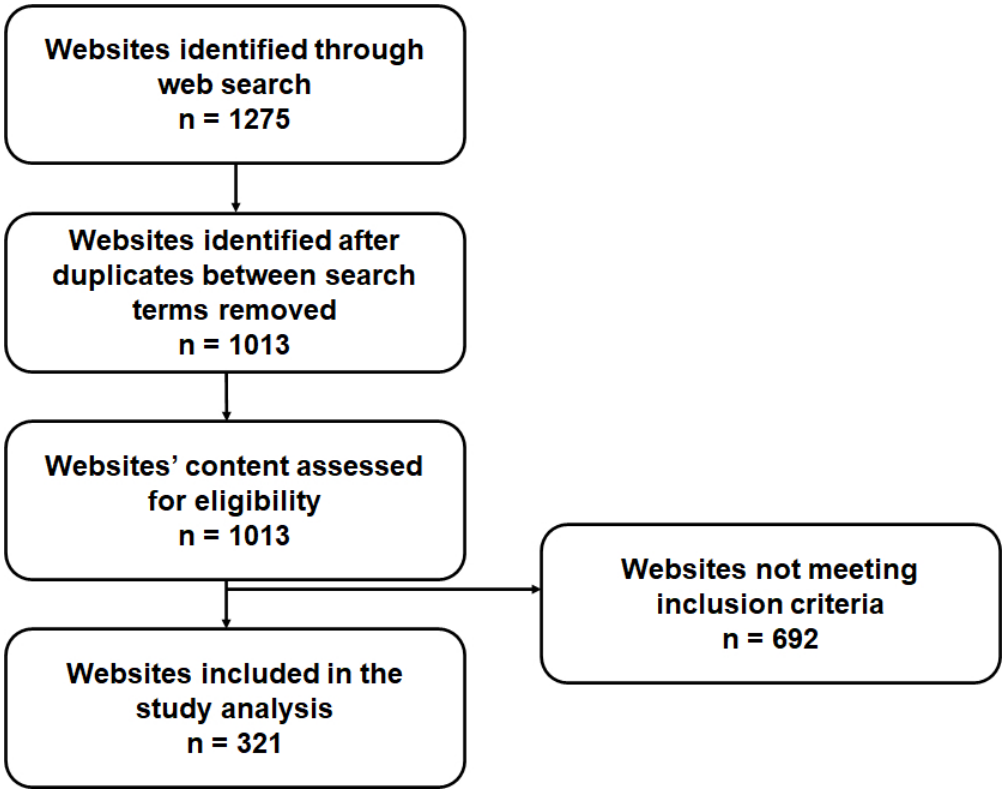


Figure 2. Workflow of Webscraping and Exclusion

70x55mm (300 x 300 DPI)

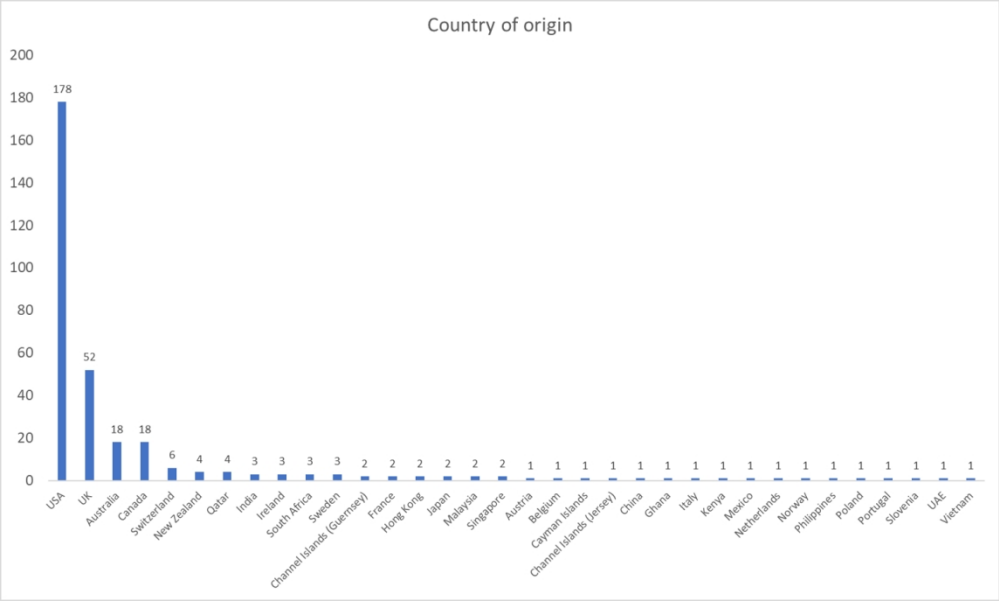


Figure 3. Country of origin of websites

132x79mm (300 x 300 DPI)

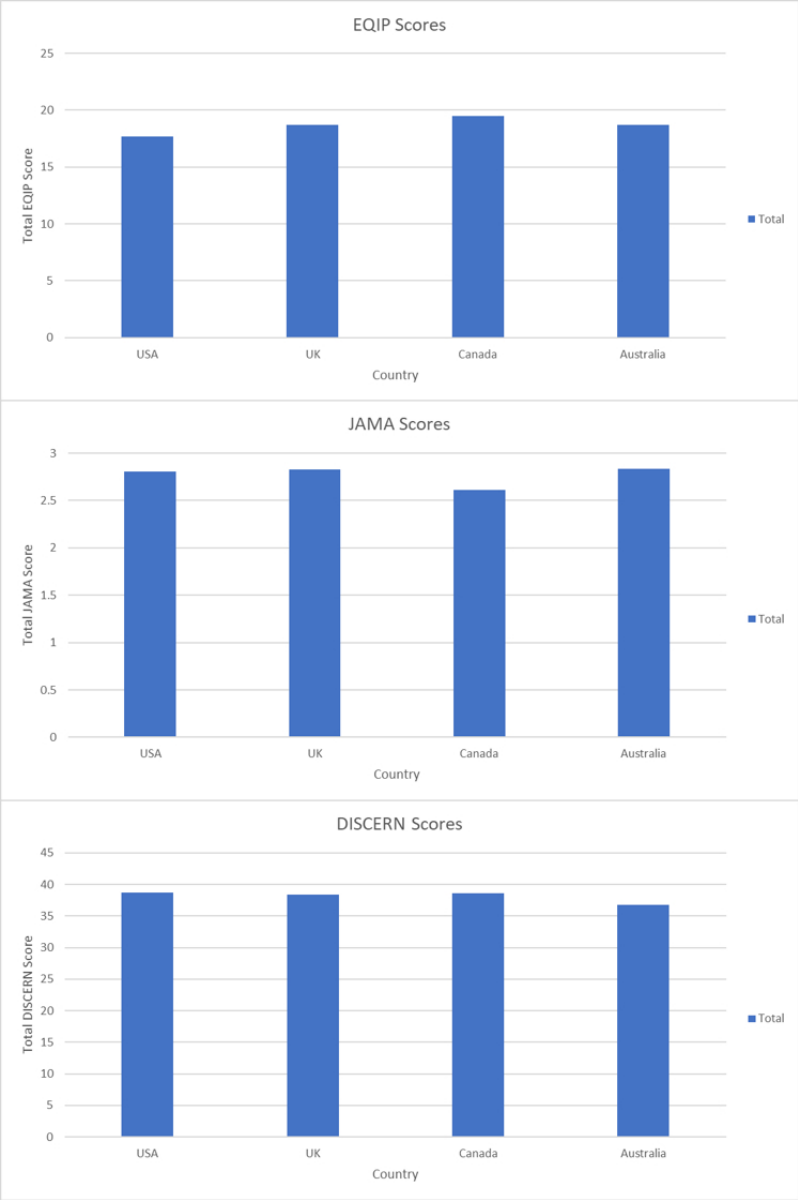


Figure 4. Scores by top contributing countries

63x94mm (300 x 300 DPI)

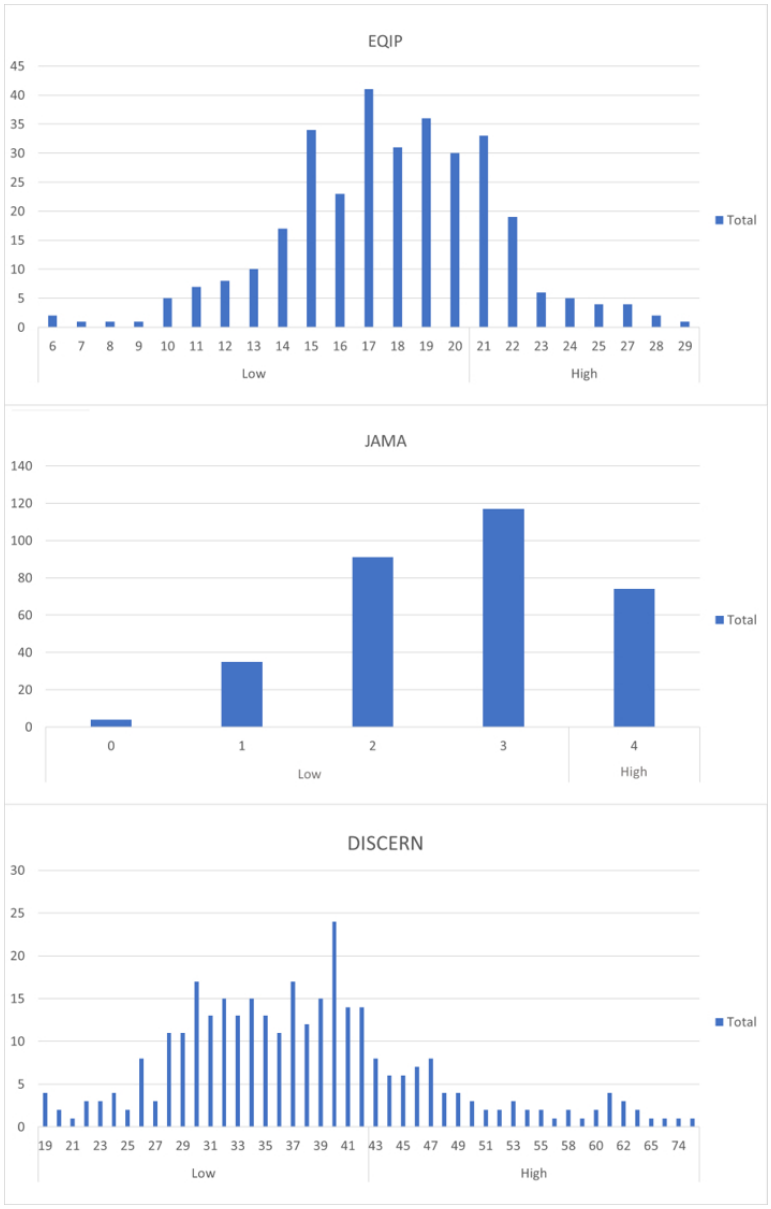


Figure 5. High-score distribution

60x94mm (300 x 300 DPI)

Item		Overall number of websites (n, %)	High-scoring websites (n, %)	Low-scoring websites (n,%)	OR
Modified EQIP Content Data					
1. Initial definition of which subjects will be	Yes	274 (85.36%)	71 (95.95%)	203 (82.19%)	5.102
	No	47 (14.64%)	3 (4.05%)	44 (17.81%)	
2. Coverage of the previously defined	Yes	273 (85.05%)	71 (95.95%)	202 (81.78%)	3.509
	No	48 (14.95%)	3 (4.05%)	45 (18.22%)	
3. Description of the medical	Yes	251 (78.19%)	73 (98.65%)	178 (72.06%)	5.882
	No	70 (21.81%)	1 (1.35%)	69 (27.94%)	
4. Definition of the purpose of the	Yes	216 (67.29%)	67 (90.54%)	149 (60.32%)	27.778
	No	105 (32.71%)	7 (9.46%)	98 (39.68%)	
5. Description of treatment alternatives	Yes	82 (25.55%)	40 (54.05%)	42 (17%)	6.250
	No	239 (74.45%)	34 (45.95%)	205 (83%)	
6. Description of the sequence of the	Yes	51 (15.89%)	26 (35.14%)	25 (10.12%)	4.785
	No	270 (84.11%)	48 (64.86%)	222 (89.88%)	
7. Description of the qualitative benefits for	Yes	114 (35.51%)	46 (62.16%)	68 (27.53%)	4.310
	No	207 (64.49%)	28 (37.84%)	179 (72.47%)	
8. Description of the quantitative benefits to	Yes	9 (2.8%)	3 (4.05%)	6 (2.43%)	1.695
	No	312 (97.2%)	71 (95.95%)	241 (97.57%)	
9. Description of the qualitative risks and	Yes	49 (15.26%)	25 (33.78%)	24 (9.72%)	4.717
	No	272 (84.74%)	49 (66.22%)	223 (90.28%)	
10. Description of the quantitative risks and	Yes	3 (0.93%)	3 (4.05%)	0 (0%)	-
	No	318 (99.07%)	71 (95.95%)	247 (100%)	
11. Addressing quality-of-life issues	Yes	137 (42.68%)	58 (78.38%)	79 (31.98%)	7.634
	No	184 (57.32%)	16 (21.62%)	168 (68.02%)	
12. Description of how complications are	Yes	35 (10.9%)	20 (27.03%)	15 (6.07%)	5.682
	No	286 (89.1%)	54 (72.97%)	232 (93.93%)	
13. Description of the precautions that the	Yes	265 (82.55%)	70 (94.59%)	195 (78.95%)	4.651
	No	56 (17.45%)	4 (5.41%)	52 (21.05%)	
14. Mention of alert signs that the patient	Yes	212 (66.04%)	66 (89.19%)	146 (59.11%)	5.682
	No	109 (33.96%)	8 (10.81%)	101 (40.89%)	
15. Addressing medical intervention costs and	Yes	68 (21.18%)	31 (41.89%)	37 (14.98%)	3.968
	No	253 (78.82%)	43 (58.11%)	210 (85.02%)	
16. Specific contact details for hospital	Yes	10 (3.12%)	3 (4.05%)	7 (2.83%)	-
	No	311 (96.88%)	71 (95.95%)	240 (97.17%)	

17. Specific details of other sources of reliable	Yes	185 (57.63%)	62 (83.78%)	123 (49.8%)	5.181
	No	136 (42.37%)	12 (16.22%)	124 (50.2%)	
18. Coverage of all relevant issues for the	Yes	4 (1.25%)	4 (5.41%)	0 (0%)	-
	No	317 (98.75%)	70 (94.59%)	247 (100%)	
Modified EQIP Identification Data					
19. Date of issue or revision	Yes	280 (87.23%)	69 (93.24%)	211 (85.43%)	2.347
	No	41 (12.77%)	5 (6.76%)	36 (14.57%)	
20. Logo of the issuing body	Yes	317 (98.75%)	74 (100%)	243 (98.38%)	-
	No	4 (1.25%)	0 (0%)	4 (1.62%)	
21. Names of the persons or entities that	Yes	254 (79.13%)	61 (82.43%)	193 (78.14%)	1.312
	No	67 (20.87%)	13 (17.57%)	54 (21.86%)	
22. Names of the persons or entities that	Yes	210 (65.42%)	62 (83.78%)	148 (59.92%)	3.448
	No	111 (34.58%)	12 (16.22%)	99 (40.08%)	
23. Short bibliography of the evidence-based data	Yes	60 (18.69%)	31 (41.89%)	29 (11.74%)	5.376
	No	261 (81.31%)	43 (58.11%)	218 (88.26%)	
24. Statement about whether and how	Yes	3 (0.93%)	1 (1.35%)	2 (0.81%)	1.675
	No	318 (99.07%)	73 (98.65%)	245 (99.19%)	
Modified EQIP Structure Data					
25. Use of everyday language and	Yes	3 (0.93%)	72 (97.3%)	229 (92.71%)	2.825
	No	318 (99.07%)	2 (5.41%)	18 (25.35%)	
26. Use of generic names for all medications or	Yes	88 (27.41%)	35 (47.3%)	53 (21.46%)	1.838
	No	233 (44.05%)	39 (35.14%)	194 (46.41%)	
27. Use of short sentences (<15 words on	Yes	296 (92.21%)	72 (97.3%)	224 (90.69%)	3.690
	No	25 (9.47%)	2 (2.99%)	23 (11.68%)	
28. Personal address to the reader	Yes	239 (74.45%)	65 (87.84%)	174 (70.45%)	3.021
	No	82 (21.03%)	9 (10.98%)	73 (23.7%)	
29. Respectful tone	Yes	308 (95.95%)	73 (98.65%)	235 (95.14%)	3.717
	No	13 (4.22%)	1 (1.35%)	12 (5.13%)	
30. Clear information (no ambiguities or	Yes	295 (91.9%)	73 (98.65%)	222 (89.88%)	8.197
	No	26 (31.71%)	1 (3.33%)	25 (48.08%)	
31. Balanced information on risks and benefits	Yes	56 (17.45%)	29 (39.19%)	27 (10.93%)	5.208
	No	265 (47.58%)	45 (37.82%)	220 (50.23%)	
32. Presentation of information in a logical	Yes	292 (90.97%)	74 (100%)	218 (88.26%)	-
	No	29 (9.12%)	0 (0%)	29 (11.84%)	

33. Satisfactory design	Yes	289 (90.03%)	73 (98.65%)	216 (87.45%)	10.417
and layout (excluding	No	32 (22.38%)	1 (2.33%)	31 (31%)	
34. Clear and relevant	Yes	111 (34.58%)	42 (56.76%)	69 (27.94%)	12.987
figures or graphs (NA if	No	210 (75.27%)	32 (65.31%)	178 (77.39%)	
35. Inclusion of a named	Yes	69 (21.5%)	17 (22.97%)	52 (21.05%)	1.119
space for the reader's	No	252 (100%)	57 (100%)	195 (100%)	
36. Inclusion of a printed	Yes	0 (0%)	0 (0%)	0 (0%)	-
consent form contrary to	No	321 (100%)	74 (100%)	247 (100%)	
*Some data is omitted due to odds ratio and confidence interval being infinite values					

95% CI	P Value
1.560 - 26.316	0.002
0.483 - 166.667	0.300
3.215 - 10.870	<0.001
4.695 - 1000.000	<0.001
2.725 - 16.949	<0.001
2.427 - 9.434	<0.001
2.416 - 7.752	<0.001
0.267 - 8.197	0.436
2.370 - 9.434	<0.001
-	0.012
4.032 - 15.152	<0.001
2.584 - 12.821	<0.001
1.621 - 18.519	0.001
2.571 - 14.286	<0.001
2.137 - 7.407	<0.001
-	0.228

2.604 - 11.111	<0.001
-	0.003
0.870 - 8.000	0.110
-	0.577
0.652 - 2.801	0.515
1.727 - 7.407	<0.001
1.727 - 7.407	<0.001
1.727 - 7.407	0.546
0.650 - 25.64	0.181
0.561 - 7.143	0.309
0.875 - 33.333	0.082
1.401 - 7.299	0.002
0.533 - 166.667	0.312
1.294 - 333.333	0.013
2.703 - 10.101	<0.001
-	0.001

1.675 - 500.000	0.003
3.086 - 111.111	<0.001
0.561 - 2.151	0.748
-	-

Item		Overall number of websites (n, %)	High-scoring websites (n, %)	Low-scoring websites (n,%)
JAMA Benchmark				
1. Authorship: Authors and contributors, their affiliations,	Yes	183 (57.01%)	74 (100%)	109 (44.13%)
	No	138 (42.99%)	0 (0%)	138 (55.87%)
2. Attribution: References and sources for all content should	Yes	118 (36.76%)	74 (100%)	44 (17.81%)
	No	203 (63.24%)	0 (0%)	203 (82.19%)
3. Disclosure: Web site "ownership", sponsorship, funding arrangements or	Yes	287 (89.41%)	74 (100%)	213 (86.23%)
	No	34 (10.59%)	0 (0%)	34 (13.77%)
4. Currency: Dates that content was posted and updated	Yes	276 (85.98%)	74 (100%)	202 (81.78%)
	No	45 (14.02%)	0 (0%)	45 (18.22%)
*Some data is omitted due to odds ratio and confidence interval being inf				

OR	95% CI	P Value
-	-	<0.001
-	-	<0.001
-	-	<0.001
-	-	<0.001

finite values

Item	Score	Overall number of websites (n, %)	High-scoring websites (n,%)	Low-scoring websites (n,%)
DISCERN Reliability				
1. Are the aims clear?	1	6 (1.87%)	0 (0%)	6 (2.45%)
	2	16 (4.98%)	2 (2.63%)	14 (5.71%)
	3	39 (12.15%)	9 (11.84%)	30 (12.24%)
	4	51 (15.89%)	6 (7.89%)	45 (18.37%)
	5	209 (65.11%)	59 (77.63%)	150 (61.22%)
2. Does it achieve its aims	1	7 (2.18%)	0 (0%)	7 (2.86%)
	2	18 (5.61%)	4 (5.26%)	14 (5.71%)
	3	45 (14.02%)	10 (13.16%)	35 (14.29%)
	4	57 (17.76%)	8 (10.53%)	49 (20%)
	5	194 (60.44%)	54 (71.05%)	140 (57.14%)
3. Is it relevant?	1	4 (1.25%)	0 (0%)	4 (1.63%)
	2	17 (5.3%)	3 (3.95%)	14 (5.71%)
	3	42 (13.08%)	14 (18.42%)	28 (11.43%)
	4	64 (19.94%)	3 (3.95%)	61 (24.9%)
	5	194 (60.44%)	56 (73.68%)	138 (56.33%)
4. Is it clear what sources of information were used to compile the publication (other than the author or producer)?	1	68 (21.18%)	3 (3.95%)	65 (26.53%)
	2	67 (20.87%)	3 (3.95%)	64 (26.12%)
	3	72 (22.43%)	14 (18.42%)	58 (23.67%)
	4	48 (14.95%)	15 (19.74%)	33 (13.47%)
	5	66 (20.56%)	41 (53.95%)	25 (10.2%)
5. Is it clear when the information used or reported in the publication was produced?	1	83 (25.86%)	2 (2.63%)	81 (33.06%)
	2	78 (24.3%)	12 (15.79%)	66 (26.94%)
	3	88 (27.41%)	28 (36.84%)	60 (24.49%)
	4	36 (11.21%)	11 (14.47%)	25 (10.2%)
	5	36 (11.21%)	23 (30.26%)	13 (5.31%)
6. Is it balanced and unbiased?	1	24 (7.48%)	4 (5.26%)	20 (8.16%)
	2	65 (20.25%)	16 (21.05%)	49 (20%)
	3	146 (45.48%)	33 (43.42%)	113 (46.12%)
	4	69 (21.5%)	14 (18.42%)	55 (22.45%)
	5	17 (5.3%)	9 (11.84%)	8 (3.27%)
	1	77 (23.99%)	4 (5.26%)	73 (29.8%)

7. Does it provide details of additional sources of support and information?	2	64 (19.94%)	15 (19.74%)	49 (20%)
	3	62 (19.31%)	19 (25%)	43 (17.55%)
	4	58 (18.07%)	17 (22.37%)	41 (16.73%)
	5	60 (18.69%)	21 (27.63%)	39 (15.92%)
8. Does it refer to areas of uncertainty?	1	99 (30.84%)	14 (18.42%)	85 (34.69%)
	2	61 (19%)	15 (19.74%)	46 (18.78%)
	3	75 (23.36%)	24 (31.58%)	51 (20.82%)
	4	44 (13.71%)	10 (13.16%)	34 (13.88%)
	5	42 (13.08%)	13 (17.11%)	29 (11.84%)
DISCERN Quality and Overall rating				
9. Does it describe how each treatment works?	1	250 (77.88%)	52 (68.42%)	198 (80.82%)
	2	24 (7.48%)	8 (10.53%)	16 (6.53%)
	3	18 (5.61%)	4 (5.26%)	14 (5.71%)
	4	13 (4.05%)	6 (7.89%)	7 (2.86%)
	5	16 (4.98%)	6 (7.89%)	10 (4.08%)
10. Does it describe the benefits of each treatment?	1	247 (76.95%)	52 (68.42%)	195 (79.59%)
	2	20 (6.23%)	6 (7.89%)	14 (5.71%)
	3	26 (8.1%)	6 (7.89%)	20 (8.16%)
	4	20 (6.23%)	7 (9.21%)	13 (5.31%)
	5	8 (2.49%)	5 (6.58%)	3 (1.22%)
11. Does it describe the risks of each treatment?	1	281 (87.54%)	60 (78.95%)	221 (90.2%)
	2	18 (5.61%)	6 (7.89%)	12 (4.9%)
	3	17 (5.3%)	7 (9.21%)	10 (4.08%)
	4	3 (0.93%)	1 (1.32%)	2 (0.82%)
	5	2 (0.62%)	2 (2.63%)	0 (0%)
12. Does it describe what would happen if no treatment is used?	1	283 (88.16%)	61 (80.26%)	222 (90.61%)
	2	15 (4.67%)	6 (7.89%)	9 (3.67%)
	3	13 (4.05%)	5 (6.58%)	8 (3.27%)
	4	7 (2.18%)	2 (2.63%)	5 (2.04%)
	5	3 (0.93%)	2 (2.63%)	1 (0.41%)
13. Does it describe how the treatment choices affect overall quality of life?	1	289 (90.03%)	62 (81.58%)	227 (92.65%)
	2	13 (4.05%)	5 (6.58%)	8 (3.27%)
	3	14 (4.36%)	8 (10.53%)	6 (2.45%)
	4	2 (0.62%)	0 (0%)	2 (0.82%)

	5	3 (0.93%)	1 (1.32%)	2 (0.82%)
14. Is it clear that there may be more than one possible treatment choice?	1	240 (74.77%)	52 (68.42%)	188 (76.73%)
	2	18 (5.61%)	5 (6.58%)	13 (5.31%)
	3	24 (7.48%)	6 (7.89%)	18 (7.35%)
	4	10 (3.12%)	2 (2.63%)	8 (3.27%)
	5	29 (9.03%)	11 (14.47%)	18 (7.35%)
15. Does it provide support for shared decision-making?	1	262 (81.62%)	59 (77.63%)	203 (82.86%)
	2	13 (4.05%)	7 (9.21%)	6 (2.45%)
	3	35 (10.9%)	4 (5.26%)	31 (12.65%)
	4	3 (0.93%)	2 (2.63%)	1 (0.41%)
	5	8 (2.49%)	4 (5.26%)	4 (1.63%)
16. Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about	1	241 (75.08%)	52 (68.42%)	189 (77.14%)
	2	48 (14.95%)	12 (15.79%)	36 (14.69%)
	3	25 (7.79%)	8 (10.53%)	17 (6.94%)
	4	7 (2.18%)	4 (5.26%)	3 (1.22%)
	5	0 (0%)	0 (0%)	0 (0%)

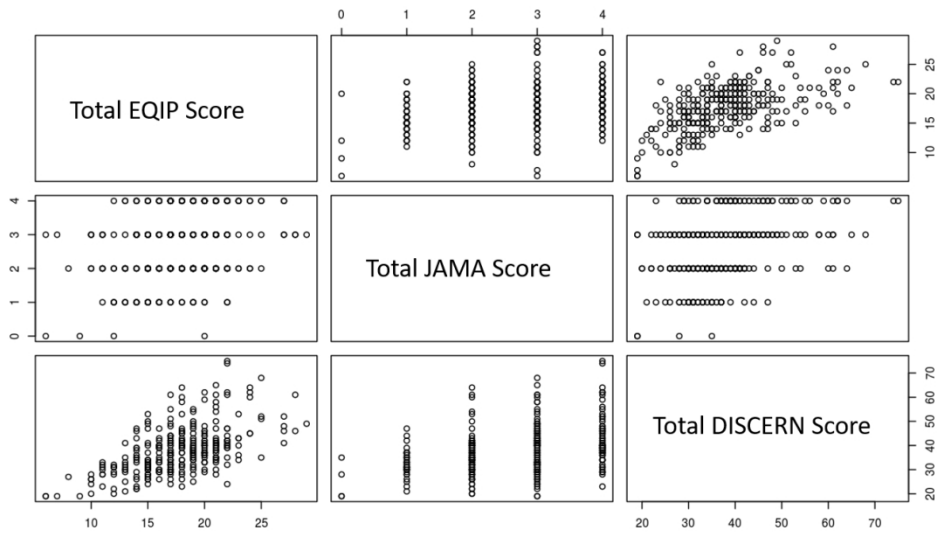
P Value
0.321
0.246
0.032
0.019
0.007
<0.001

0.093
<0.001
0.005
<0.001
0.016
<0.001
<0.001

<0.001
<0.001
<0.001

URL	Country	Original search term	Texas, USA March	Texas, USA July	London, UK July	Toronto, C
				Top Scoring EQIP Sites		
https://www.gov.ie/healt	UK	What is self isolation coronavirus	Page 4	None	None	No
https://en.wikipedia.org/	USA	Coronavirus	Page 1	None	None	No
https://www.health.nsw.g	Australia	Covid 19	Page 10	Page 4	None	No
https://www.ageuk.org.uk	UK	Stop getting coronavirus	Page 6	Page 4	Page 2	No
https://www.wikihow.co	USA	Stop getting coronavirus	Page 10	None	None	No
				Top Scoring DISCERN Sites		
https://www.sciencenews	USA	How to treat coronavirus	Page 10	None	None	No
https://www.vox.com/sci	USA	Drugs for coronavirus	Page 3	None	None	No
https://en.wikipedia.org/	USA	Covid 19	Page 1	Page 1	Page 1	No
https://www.bloomberg.c	USA	Drugs for coronavirus	Page 1	None	None	No
https://www.theverge.co	USA	Drugs for coronavirus	Page 32	None	None	No

anada July	Sydney, Australia July	URL Changes
ne	None	Same
ne	None	Changed
ne	Page 1	Same
ne	None	Same
ne	None	Same
ne	None	Same
ne	None	Same
ne	Page 9	Same
ne	None	Same
ne	None	Same



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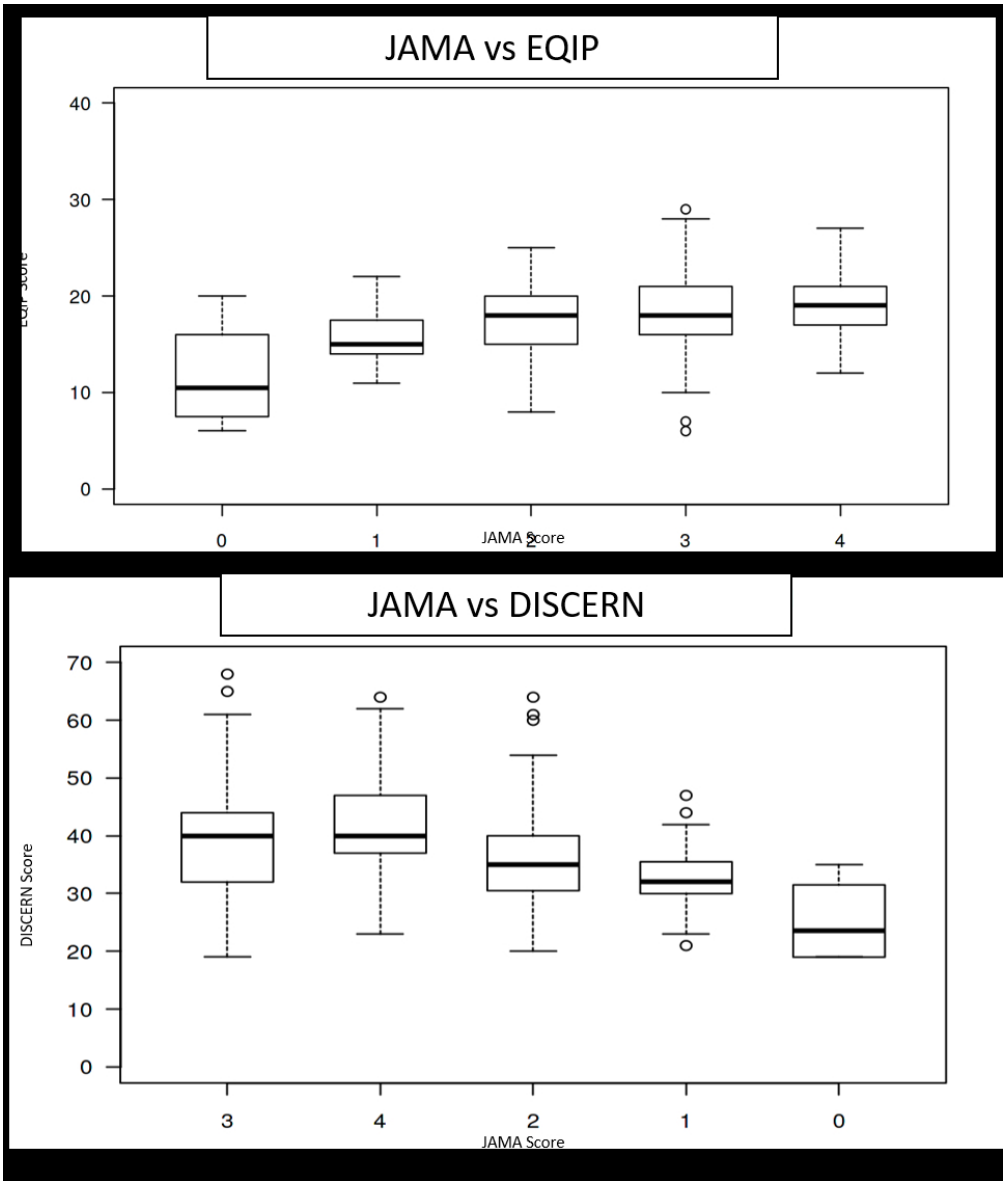
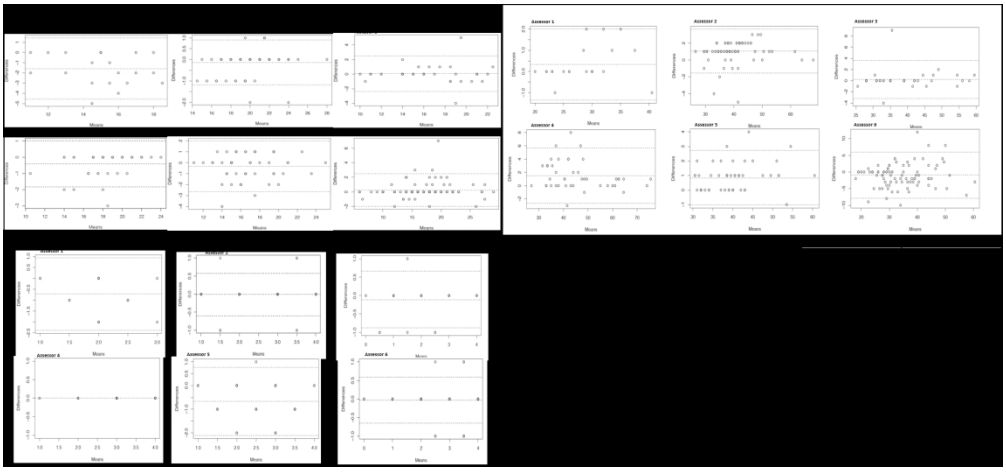


163x191mm (150 x 150 DPI)



333x154mm (150 x 150 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7-8
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7-9
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7-9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7-9
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-12
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-12
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12, Figure 2
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12-13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10-14
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16-24
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	24-25
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	24
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	2

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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COVID-19 prevention and treatment information on the Internet: a systematic analysis and quality assessment

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COVID-19 prevention and treatment information on the Internet: a systematic analysis and quality assessment

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Statement of Author Contribution:

Study conception and design: DAR, NM, SAG, KSF

Acquisition of data: SAG, KSF, LL, KHF, DR, AS

Analysis and interpretation of data: KSF, SAG, NM, DAR

Drafting of manuscript: KSF, SAG, NM, KHF

Critical revision: KSF, SAG, NM, DAR

Word count: 6297

Keywords: Coronavirus, Internet, Patient Education Handout, Public Health Informatics, Search Engine

Abstract

Objective: To evaluate the quality of information regarding the prevention and treatment of COVID-19 available to the general public from all countries.

Design: Systematic analysis using the 'Ensuring Quality Information for Patients' (EQIP) tool (score 0-36), JAMA benchmark (score 0-4) and the DISCERN tool (score 16-80) to analyse websites containing information targeted at the general public.

Data Sources: Twelve popular search-terms, including 'Coronavirus', 'COVID 19', 'Wuhan virus', 'How to treat coronavirus' and 'COVID 19 Prevention' were identified by 'Google AdWords' and 'Google Trends'. Unique links from the first 10 pages for each search-term were identified and evaluated on its quality of information.

Eligibility Criteria for selecting studies: All websites written in the English language, and provides information on prevention or treatment of COVID-19 intended for the general public were considered eligible. Any websites intended for professionals, or specific isolated populations, such as students from one particular school, were excluded, as well as websites with only video content, marketing content, daily caseload update or news dashboard pages with no health information.

Results: Of the 1275 identified websites, 321 (25%) were eligible for analysis. The overall EQIP, JAMA and DISCERN scores were 17.8, 2.7 and 38.0. Websites originated from 34 countries, with the majority from the USA (55%). News Services (50%) and Government/Health Departments (27%) were the most common sources of information and their information quality varied significantly. Majority of websites discuss prevention alone despite popular search trends of COVID-19 treatment. Websites discussing both prevention and treatment (n=73, 23%) score significantly higher across all tools (P<0.001).

Conclusion: This comprehensive assessment of online COVID-19 information using EQIP, JAMA and DISCERN tools indicate that most websites were inadequate. This necessitates improvements in online resources to facilitate public health measures during the pandemic.

Strengths and limitations of this study

- Over 1200 websites were identified by using 12 search-terms to improve the representativeness of returned COVID-19 websites.
- A comprehensive analysis can be achieved using a combination of modified 'Ensuring Quality Information for Patients' (EQIP) tool, JAMA benchmark and the DISCERN tool, all of which are respected and validated health information assessment tools.
- Representativeness of search results of the Google search engine may be influenced by geographical factors and may differ when performed elsewhere.
- Video-based health content was not within our scope and may provide a more comprehensive analysis of all online health information on COVID-19.
- This study provides a snapshot of online health information as information on the Internet is constantly changing.

Introduction

With the increasing popularity of the Internet, both the accessibility and availability of health information grew drastically and has now become a primary source of information for many.[1,2] It is known that health information-seeking behaviour also applies to the use of online resources and is ever more important during the current Coronavirus disease 2019 (COVID-19) pandemic.[3] Information on such a widely-discussed topic will inevitably be vast and vary in production quality, potentially adversely affecting patient awareness and health-seeking behaviour.[4] Many of these resources read by the public may be unreliable or produced from non-peer-reviewed sources and affect behaviours such as recognition of symptoms, taking appropriate preventative precautions or seeking timely treatment.[3,5,6] Furthermore, inaccurate online information may contradict healthcare professionals and potentially compromise the trusting relationship with patients, worsening outcomes.[7]

Since the declaration of COVID-19 as a pandemic on 12th March 2020, its prevalence and mortality have continued to rise[8–10] and lead to the introduction of various measures such as social distancing, quarantine procedures and lockdown protocols.[11] As evidenced by previous outbreaks, effective public education and public health intervention rely on access to health information[12,13], which is now primarily delivered through the Internet. Many countries have since introduced lockdown and quarantine protocols as their mainstay preventative measures[14] but public health continues to be threatened by certain populations.[15] Due to both the novelty and rapid developments of COVID-19, there is a significant barrier against the critical appraisal of online resources and, hence, necessitates a quantitative evaluation of the popular information sources available to the wider public.

Many instruments have been developed to evaluate patient information and may also be applied to online COVID-19 information.[16] The modified Ensuring Quality of Information for Patients (EQIP) tool is a reproducible modality used in previous studies to evaluate the reliability and quality of all information types, providing a robust assessment of quality,

readability and design aspects of any written information[17–19]. Previously, our group evaluated online information using the modified EQIP tool in a variety of conditions and procedures including bariatric surgery[20], Dupuytren's disease[21], carpal tunnel disease[22], breast augmentation[23], liposuction[17] and liver transplantation[24]. The Minervation validation instrument (LIDA)[25], Flesch Reading Ease (FRE) Score and the Flesch-Kincaid Grade (FKG) have also been used to evaluate the quality of online health information.[26] However, they are not considered appropriate here as only readability and the website design are assessed, both of which are adequately covered by EQIP.[27] Tools such as the Journal of American Medical Association (JAMA) benchmark and the DISCERN tool (no acronym) have also been used to evaluate online health information and their combinational use can provide a more comprehensive evaluation.[19,28,29] The Internet has become an ever-important source of information and can determine health-seeking behaviour, which ultimately affects the progression of COVID-19. Hence, our study aims to assess the quality of information of top indexed websites that discuss information, prevention, or treatment of COVID-19 using the modified EQIP tool, JAMA benchmark and DISCERN tool.

Methods

Eligibility criteria, information sources and data selection

On 27th March 2020, 12 search-terms and phrases were queried on the most used search engine, Google[30–32], to obtain a database of websites. Only Google was used as previous studies have shown that the use of multiple search engines will only provide duplicate results. To increase the number of results, more search-terms were used: 'Coronavirus', 'COVID 19', 'Stop getting Coronavirus', 'Corona Virus', 'How to treat coronavirus', 'Coronavirus safety tips', 'Drugs for coronavirus', 'What is self isolation coronavirus', 'China virus', 'Wuhan virus', 'Coronavirus Medicine' and 'COVID 19 prevention'. These were commonly searched phrases identified using the 'Google Adwords Keyword Planner'[33]. Google AdWords allows the input of a term (in this case coronavirus) which then provides popular related keyword suggestions. The most popular search-terms were 'Coronavirus', followed by 'COVID' and 'Corona Virus'

and their respective search popularity peaked in mid- and late-March 2020 respectively. **Figure 1** summarises the most popular search trends. Only the first 10 pages of unique websites were identified and recorded as previous work suggests patients tend to stay within the first 100 returned webpages[18,24]. Various search-terms and their relative popularity were also collected directly from Google Trends[34] for further comparative analysis.

All websites written in the English language and providing information on prevention or treatment of COVID-19 intended for the general public or COVID-19 patients were considered eligible for inclusion. Any subsidiary pages or subdirectories of a website that contained information for the public and were easily accessible were also assessed. Websites or articles intended for professionals or specific population subsets, such as students alone, were excluded. Weblinks to purely video content, marketing content, daily caseload update or news dashboard pages with no educational purposes were excluded. The creation of the website database, eligibility assessment, website assessment and statistical analysis was performed between March and April 2020.

Website Scraping

A website scraping tool was developed to identify and record all unique websites from the first 10 pages of Google results. The tool utilises custom PHP to make HTTP requests to the search engine to mimic the requests made by the public. The queries were made from a server located in Texas, USA but no preferences were made to limit searches by geographical region. The tool makes repeated requests, logs the first 10 pages of unique URLs and outputs the dataset after excluding all duplicate links within each search-term. A minority of websites were restricted by General Data Protection Regulation (GDPR) and were accessed through the use of virtual private networks (VPN) as any websites that could reasonably be accessed by the general public were included.

Data entry

Six assessors, (KSF, SAG, KHF, LL, AS and DR), all of whom fluent in English, independently assessed the websites between 30 March and 13 April 2020. The evaluation included 36 EQIP items and four items on JAMA benchmark, all assessed through 'Yes, No or N/A' questions. DISCERN tool adds a further 16 items to assess reliability and quality of treatment information using scales of 1 to 5. Assessors also recorded the country of origin, and type of source: Academic Centre, Charity/Non-Governmental Organisation, Encyclopaedia, Government/Health Department, Hospital, Industry, News Service, Patient Group, Practitioner, and Professional Society. Organisations that primarily serve patients, such as Patient.info, is considered a 'Patient Group' whereas non-governmental organisations that oversee a broader demographic, like Red Cross and World Health Organization (WHO), are classified as 'Charity/Non-Governmental Organisation'. News service includes both primary and secondary news articles that are not written for professionals. 'Practitioner' considers the for-profit webpages of individual medical practitioners, whereas 'Industry' considers any for-profit organisation within the medical industry. 'Academic Centres' consider all sources from academic institutions, while 'Professional Society' refer to non-profit groups of healthcare professionals. Qualitative information about preventative methods and treatment was also recorded. After the initial round of data entry, each website was verified on a second-round between 14 April and 21 April by a verifier with previous experience performing data entry for the evaluation of patient health information.

EQIP Tool

The Ensuring Quality Information for Patients (EQIP) tool consists of 20 items, acting as a checklist for criteria such as quality of written work, design and coherence.[35] More recently, modifications were made to the EQIP tool, expanding the criteria to 36 items[36]. This serves to satisfy both the guidelines of British Medical Association (BMA)[37] and International Patient Decision Aids Standards (IPDAS) collaboration[38] on the ideal patient information and the modified EQIP tool have been utilised in a variety of specialities previously.[17–19] A decision was made to use the modified EQIP tool as the inclusion of 'partly yes' in the original EQIP

introduces subjectivity into the responses and has been shown to lower its reliability.[24,35] 36 items across three domains were included: Content (items 1-18), Identification (items 19-24) and Structure (items 25-36). Similar to previous uses, 'Yes/No' binary questions reduce assessor subjectivity in partial answers. 'N/A' option was also included if items were not relevant for the type of source. The Content domain assesses whether an adequate amount of information is included in an article, ranging from a description of the medical problem itself (items 1-3,11,14) to the details of its management and complications (items 4-11). Identification domain assesses how well a website displays its production details, including date of issue, author, finance sources and bibliography (items 19-24). Structure domain evaluates the readability of a website and how well it accommodates its audience, such as delivering information through short, non-contradictory statements arranged in a logical layout (items 25-36). As COVID-19 is an emergent disease, certain items are tailored to accommodate for the limited evidence: describing treatment (item 3) include articles that address the lack of proven treatment, and alert signs (item 14) include recognised COVID-19 symptoms such as fever, cough and changes in taste or smell. A cut-off point of 75th percentile was set for EQIP score to discriminate between high-scoring from low-scoring websites as was done in previous studies.

JAMA Benchmark

Critical appraisals of Internet resources are also assessed by one of the earliest core standards identified by JAMA in 1997.[39] This checklist was proposed by Silberg *et al.* to assist the appraisal and evaluation of the credibility of unregulated Internet resources and have been used in various studies previously[40,41]. This is evaluated by four items: Authorship, Attribution, Disclosure and Currency: Authorship requires identification of authors, their credentials and affiliations; Attribution requires appropriate citations on written information; Disclosure requires transparency of the website owner and conflicts of interests;

Currency requires a clear indication of the date of publication and updates. Similarly, the 'Yes/No' criterion is implemented to reduce the subjectivity of partial answers.

DISCERN Tool

The DISCERN evaluation tool was first developed in 1998 at Oxford to judge the quality of information regarding treatment choices.[42] This tool has been validated and used across various specialities to assess treatment information.[29,40,43] This consisted of 16 items to assess both the reliability and level of detail on treatments as well as the overall quality of the information. The reliability section (items 1-8) evaluates the ability of a website to achieve its aims while remaining unbiased and providing its sources of information. Quality section (items 9-15) evaluates the content specifically for describing the rationale, methods and alternatives to the current management of a disease. Criteria for treatment section was adjusted to accommodate the treatment uncertainty and items are considered fulfilled as long as the website discusses the relevant information with regards to potential drugs or interventions such as assisted ventilation. A score between 1 and 5 can be assigned to each item, with 1 being 'No', 3 being 'Partial' and 5 being 'Yes'. To improve assessment accuracy, overall quality of information will be scored in proportion to the mean scores calculated from the answers to items 1-15, with 1 being the lowest and 5 being the highest.

Additional Items

Additional items were included to further assess the websites, including whether a website discussed prevention methods, current treatments and the role of empirical evidence in the prevention or treatment for COVID-19. Data collected were in the form of 'Yes/No' to reduce the ambiguity of partial answers. Additionally, details provided by the website on these items were recorded if the item scores 'Yes'. Websites were further analysed by whether their purpose is prevention, treatment, or both.

Statistical Analysis

The dataset consisted of both continuous and categorical variables, which are reported as the mean, median and interquartile range (IQR) as well as numbers and percentages respectively. High-scoring websites are identified as those with scores above the 75th percentile for all three tools. Kruskal-Wallis tests were used for the analysis of continuous variables where appropriate and intraclass correlation coefficient (ICC) was calculated to identify the correlation between website analysis test methods. Fisher's or χ^2 tests were used to analyse proportions where appropriate. Inter-rater reliability of each assessor was evaluated using Bland-Altmann plots. All P values were two-tailed and considered significant when P<0.05. R version 3.3.2 (R Core Team, GNU GPL v2 License), R Studio version 1.0.44 (RStudio, Inc. GNU Affero General Public License v3, Boston, MA, 2016) and their respective graphical user interface (GUI) rBiostatistics.com (rBiostatistics.com, London, Switzerland, 2017)[44] was used to perform the statistical analysis.

Patient and Public Involvement

There was no patient or public involvement in the conception, design or data collection of the study or the production of the manuscript.

Results

Gathering of websites with information on COVID-19, its prevention and its management

A database of websites was gathered from the first 10 pages of unique URLs returned using the 12 search-terms. The final dataset included 1275 URLs. After filtering out duplicate results and websites that failed to meet our inclusion criteria, 321 remained eligible for analysis. The workflow of dataset creation is shown in **Figure 2**. The list of websites was obtained on a single day, 27th March 2020, and website evaluation was completed within two weeks.

Website demographics and search trends

COVID-19-specific searches regarding treatment and masks were significantly more popular (P<0.001) than prevention and peaked in mid-March and early-April respectively. The returned websites originated from 34 different countries (**Figure 3 and 4**): the USA produced the most websites (n=178), followed by the United Kingdom (n=52), Australia (n=18) and Canada (n=18). However, no statistically significant differences were observed between the four countries across all tools. The source of information and website category is shown in **Table 1**. News Services were the most common source of information (n=163), followed by Health Departments/Government (n=87).

Forty-six websites (14.3%) described treatment methods alone, 202 websites (62.9%) mentioned treatment methods alone and 73 websites (22.7%) discussed both. Of the prevention websites, 205 (63.9%) described social isolation, 169 (52.7%) physical distancing, 157 (48.9%) advised staying home and 136 (42.4%) described the benefits of disinfecting or cleaning surfaces. Of those that discussed treatment, 55 (17.1%) described the use of antiviral medications, 31 (9.7%) described hydroxychloroquine or chloroquine and 26 (8.1%) described the use of non-steroidal anti-inflammatory drugs such as paracetamol and ibuprofen. Only 31 (9.7%) websites discussed the use of oxygen, ventilation or fluids as a possible treatment method.

Overall performance

The mean total score for EQIP, JAMA and DISCERN are 17.78, 2.69 and 38.00 respectively, with a respective 75th percentile high-score cut-offs of 21, 4 and 43. No website achieved the maximum score for EQIP Content (out of 18) or Structure (out of 6) domain but one website did attain the maximum for EQIP Identification (out of 12). Seventy-four websites fulfilled all four JAMA criteria. Four websites achieved the maximum for DISCERN Reliability (out of 40) but none scored fully in DISCERN Treatment (out of 40). 74 high-scoring websites were identified for EQIP and JAMA and 76 for DISCERN tool. The mean scores of high- and low-scoring websites for each tool and domain are as follows: EQIP Content (9.99 vs 6.07;

P<0.001), EQIP Identification (4.03 vs 3.34; P<0.001), EQIP Structure (8.45 vs 6.96; P<0.001), Total EQIP (22.46 vs 16.37; P<0.001), Total JAMA (4.00 vs 2.30; P<0.001), DISCERN Reliability (31.72 vs 25.44; P<0.001), DISCERN Treatment (13.49 vs 10.31; P=0.002) and Total DISCERN (45.21 vs 35.76; P<0.001).

All tools and subsequent domains, except DISCERN Reliability and Total DISCERN scores, varied significantly between websites of different sources, notably with the Encyclopaedia (n=5) cohort holding the highest score across all domains. All tools and domains varied between website cohorts, with websites that discussed both Prevention and Treatment scoring above the mean values. **Table 2** and **Table 3** summarises the variation of information quality with the source of information and website category respectively. A detailed breakdown of the performance of each tool is displayed in **Supplementary Table 1, 2 and 3**.

Subset analysis of Government/Health Department and News Services

Collectively, 250 (77.9%) of all web links were either Government/Health Departments and News Services websites, of which 121 (37.7%) were based in the USA. Globally, there is significant variation between Government/Health Departments and News Services in EQIP Content (mean 8.11 vs 6.22; P<0.001), Total EQIP (mean 18.90 vs 17.06; P<0.001), Total JAMA (mean 2.16 vs 2.98; P<0.001) and DISCERN Treatment (mean 9.02 vs 11.72; P=0.001). Variations in US websites were similar except for EQIP structure (P=0.148). The US-based cohort scored lower in Total EQIP than the global cohort but USA News Services specifically scored higher in Total JAMA (3.17 vs 2.98) and Total DISCERN (39.25 vs 38.04). Breakdowns of comparison between the cohorts are provided in **Table 4**.

High-scoring websites

Sixteen websites scored above 75th percentile across all three evaluation tools, 13 were from the USA, 2 from the UK and 1 from Canada. Most were from News Services (n=10), followed by industry (n=4), Encyclopaedia (n=1) and Government/Health Departments (n=1). The top

5 websites with the highest Total EQIP and Total DISCERN scores are shown in **Table 5** with their respective breakdowns. Top JAMA websites were not shown as there were 74 that scored the full four points.

Intraclass correlation between tools

Intraclass correlation (ICC) between the 3 analysis tools is provided in **Supplementary Figure 1**. The ICC between all three tools was moderate to high at 0.48 (95% CI 0.37-0.56). Furthermore, as the JAMA benchmark only offers four scoring variations, the Kruskal-Wallis analysis is used to correlate JAMA with EQIP and DISCERN. The results are shown in **Supplementary Figure 2** and demonstrate statistically significant moderate-high correlation for both JAMA-EQIP and JAMA-DISCERN.

Inter-rater reliability

The biases of each tool and assessor are within 95% CI interval limits. The Bland-Altman plots and individual degree of bias have been provided in **Supplementary Figure 3**. The mean degree of bias and 95% confidence intervals for each assessor is identified. Mean bias for EQIP, JAMA and DISCERN were -0.36, +0.29 and +0.51 respectively. Bias for each assessor, within each tool, was minimal and falls within their respective 95% CI.

Discussion

To our knowledge, this is the first study to evaluate the content intended for the public seeking information for preventing or treating of COVID-19. Our search-terms included various synonyms of COVID-19 and “open” search-terms to capture the majority of materials related to our study. While no tools are validated to assess information specifically during pandemics; this study used a combination of EQIP, JAMA and DISCERN. The combined scope and efficacy of these tools enable a comprehensive evaluation of all the important aspects for a layperson seeking health information from articles; namely readability, coherence, design and quality of information.

Evaluation of the websites

We determined the quality of information to be low, as indicated by the low 75th percentile cut-offs for EQIP and DISCERN, at 21 and 43 respectively, or 58.3% and 53.8% of their respective full scores. Abundant COVID-19 content is being produced, as evident in **Figure 1**, with the majority being excluded due to its nature rather than inter-term duplications. Most frequently excluded websites were either caseload updates or general news articles lacking information on prevention and treatment.

Websites generally scored poorly, with an EQIP mean and median of 18 (IQR 15-20). Despite fewer marks allocated to Structure, websites generally outperform the Content domain (7.30 vs 6.97), suggesting information quality is less adequate than usability. The indicators assessing referencing quality, such as JAMA benchmark and DISCERN Reliability, scored similarly at 2.69 (67.3% of maximum) and 26.93 (67.3% of maximum) respectively but scored lower in the EQIP Identification domain 3.50 (58.3% of maximum), likely due to more items (i.e. whether patients were involved in the material's production). Generally, high-scoring websites performed better in the Content domain, with odds ratios (OR) between 3-7. The OR was significantly higher for item 4 (defining the purpose of interventions) (OR 27.78; 95% CI 4.695-1000; P<0.001), suggesting that high-scoring websites provided greater reasoning behind preventative and treatment measures. While high-scoring websites scored significantly higher across 23 of the 36 EQIP items, quantitative benefits (item 8) is a notable exception where both cohorts performed poorly (4.1% vs 2.4%; OR 1.695; 95% CI 0.267-8.197; P=0.436), significantly lower than available literature.[18,23,24] This likely reflects the general lack of COVID-19 knowledge compared to previously explored diseases and treatments. High-scoring websites similarly performed better in Identification (OR ranged between 1.312 and 5.376), with the inclusion of bibliography (item 23) differing most (41.89% vs 11.74%; OR 5.376; 95% CI 1.727-7.407; P<0.001) as the majority of websites lacked bibliographies, potentially due to subpar production quality in a high turnover topic. Structure

revealed both high- and low-scoring websites to provide clear information (item 30; 98.65% vs 89.88%; OR 8.197; 95% CI 1.294-333.3; P=0.013). High scoring websites provided poor benefit-risk balancing (item 31; 39.19% vs 10.93%; OR 5.208; 95% CI 2.703-10.101; P<0.001), as did most other websites assessed (17.5% overall), comparable to existing studies ranging 11% to 44%. As shown in **Figure 5**, EQIP scores were relatively homogeneous, ranging from 6 to 29, with the majority between 14-22. Overall performance agreed with available literature that online health information is inadequate, as median EQIP scores ranged between 15-19 and IQR ranged 12-20 and 16-22.[18,20,22,23,45] Furthermore, scores for describing intervention sequence (item 6) and quantitative risks (item 10) were much lower (15.9% and 0.9% respectively) when compared against the study on gallstone disease (27% and 21% respectively) or liver transplantation (66% and 53% respectively). This likely reflects the prioritisation of discussing prevention and treatment method efficacy over treatment sequences and risks. Item 23 also scored poorly, both in itself and against literature: only 18.7% of websites provided a short bibliography whereas studies ranged from 19% in liver transplantation to 47% in orthognathic surgery. Interestingly, COVID-19 websites scored well in dating (item 19; 87.2%) compared literature, likely reflecting the demanding and time-sensitive nature to understand how the COVID-19 pandemic affects individuals. Unsurprisingly, encyclopaedias (n= 5) scored the highest in content (10.80), identification (4.80) domains and overall EQIP (24.20), holding the highest proportion of websites discussing both prevention and treatment (n=4; 80%). Encyclopaedias' high scores are attained through their endeavours to provide neutral summaries which meet the majority of the EQIP criterion.[46] Nonetheless, while overall EQIP scores do not differ substantially from existing literature, it is important to recognise that the quality of information is significantly influenced by the rapid turnover of information, a phenomenon not present in previous studies.

JAMA benchmark scores, unlike EQIP and DISCERN, were more consistent as only four points are available. Hence, high-scoring websites often fulfilled all four JAMA criteria whereas the majority of other entries scored two or three. Low-scoring websites scored significantly

lower (P<0.001) in Authorship and Attribution, with only 44.13% and 17.81% fulfilling the criteria, reflecting congruence with the findings from EQIP regarding bibliography inclusion. Contrarily, website ownership and funding assessment, under Disclosure (86.23%), and assessments of publishing and updating dates, under Currency (81.78%), varied to a lesser degree, albeit still scoring significantly lower (P<0.001). Comparative to the related EQIP sections, Disclosure and Currency likely scored better by assessing attributes independent to the content itself. Professional societies (n=4; 3.50), closely followed by encyclopaedias (n=5; 3.40), scored the highest overall, whereas the mean JAMA scores were only 2.69 and four websites scoring zero. This is likely attributable to the lack of additional assessment criteria by the JAMA benchmark as it was developed during the infancy of web-based resources. Regardless, the tool is still effective at identifying high-quality content as high-scoring websites scored significantly better across each item (P<0.001).

DISCERN's mean score of 38.0 across 16 items averaged 2.38 out of five per item. The DISCERN handbook details a rating of one when the information does not provide the appropriate information, three where it addresses it partially and five for a complete and adequate inclusion. Based on these guidelines, the majority of websites meet the listed criteria to a minimal extent. Similar to EQIP, DISCERN scores vary significantly, ranging from 19 to 75, with the majority distributed between 25 to 47. Of the 16 items, 12 presented statistically significant differences between high- and low-scoring websites. Interestingly, the Reliability section provided the greatest difference in scoring, seen between item 4, clear display of information sources (mean 4.16 vs 2.55; P=0.019), and item 5, a clear indication of where sources were used (mean 3.54 vs 2.28; P=0.007). This corroborates with results from EQIP and JAMA assessments in highlighting the inadequacies of informative material production.

Quality of treatment information section scores varied less, albeit all with statistically significant differences. The greatest differences were in item 9, describing how each treatment works (1.76 vs 1.43; P=0.005) and item 10, detailing treatment benefits (1.78 vs 1.43; P<0.001).

Despite accommodating the treatment uncertainty during the assessment, almost all items evaluating treatment scored poorly, including high-scoring websites, and may be reflective of its lower journalistic priority or demand as the majority of websites were tailored towards discussing prevention. As a whole, DISCERN scores specifically addressing treatment options were poor, scoring 45.07 (SD 11.68) for websites that only discuss treatment as well as 42.84 (SD 10.93) for websites that discuss both prevention and treatment. These scores are also lower than those of other DISCERN studies, which have mean scores between 45.8 and 56.1, with SD between 8.76 and 13.6.[47–49] While the majority of DISCERN scores were low, websites scored similarly in the Reliability section. The mean scores for items 1, 2 and 3 were the highest of all indicators, averaging 4.37, 4.29 and 4.33, whereas the items in treatment section scored between 1 and 2, with a maximum mean score of 1.66 in Item 14. The treatment section of DISCERN shows much more variation, with prevention alone (8.60; n=202) scoring lowest, treatment alone (18.09; n=46) scoring highest and websites discussing both (13.47; n=73) in between. This suggests that many websites do not include treatment information and, of those that do, websites tend to avoid discussion rather than provide the limited information available.

In short, all three tools utilised are validated based on international recommendations and provides a comprehensive assessment of online information: EQIP delivers an all-rounded evaluation of health information, DISCERN excels at scrutinising treatment and JAMA benchmark assesses all of a website's content as a whole. Additionally, as design alone is known to improve the perception of information credibility[50], the higher emphasis on quality of content in EQIP and DISCERN will likely prevent well-presented and user-friendly websites with poor content from attaining high scores over poorly-presented websites with good content. Altogether the tools suggest that the majority of COVID-19 websites are generally of poor quality and that quality fluctuates highly. This may subsequently impair the ability of the public to filter out websites of low validity and reliability and, hence, increase their risk of unsafe health behaviours during the pandemic. Through the use of these tools, the same standards

can be held across different sources of information to produce higher quality educational material to improve both education and awareness.

Reasons for poor quality information

Most sources scored poorly due to several possible reasons. Firstly, as COVID-19 was only identified in early December 2019[51], and recognised as a pandemic in March 2020[52], the general lack of information to produce patient information prevents accurate and reliable conclusions to be drawn. While research efforts have since gained traction, production of research, reviewing and publication is a lengthy process comparative to the rapid spread of COVID-19. Journals have since implemented fast-tracking of COVID-19 research.[53–55] Similarly, Governments and Health Departments have also cooperated to support and fast-track COVID-19 studies.[56] The combined efforts have facilitated the publication of over 5,000 COVID-19 articles in the WHO database alone.[57] It is also important to note the role of preprint servers during the pandemic as they are accessible to the public. While improving accessibility helps facilitate peer-reviewing; non-peer-reviewed articles can potentially be used, or cherry-picked, by non-professionals which can adversely affect public understanding.[58–61]

Health literacy also plays a crucial role in how COVID-19 information influences health behaviour. The associations between health literacy and health behaviour are well documented: low literacy is common among older adults engaging in poor health behaviour ($P<0.005$) ranging from lifestyles, such as physical activity, dietary habits and obesity, to social factors, such as loneliness and social isolation.[62–64] The effects of primary preventative measures, such as social distancing, self-isolation and other hygiene recommendations, may become impaired by the abundance of poorly written and incorrect information online. In particular, the elderly, most vulnerable population, suffer from even higher risks due to their lower health literacy.[65] Although health literacy, and by extension, health behaviours, can be improved through education[66], effective dissemination of credible information is critical

during the pandemic. The public, and journalists, need to exercise caution when accessing research and pre-prints during this period as inadequate health literacy may lead to counterproductive effects. Similarly, mass production of online information greatly increases the difficulty in distinguishing reliable information from the sea of misinformation, and hence, a greater emphasis must be placed on authors and journalists to deliver unbiased, credible and accurate information to the public.[67,68]

Upon publication, articles are reviewed and summarised by journalists who bridge the knowledge gap between scientists and the wider public. This allows efficient dissemination of critical research to those who lack the scientific background to critically appraise and evaluate research. Notably, while 52% (n=169) of websites were 'News Services', only 12 (7.1%) were considered high-scoring, reflecting that very few provide a comprehensive account of COVID-19 information, possibly explained by the difficulty in matching the pace of COVID-19 research and technical inadequacies in delivering accurate and concise scientific information. As health information-seeking behaviour of the public will likely be based on news services[69], the highly variable and generally poor content is problematic.

Previous studies have identified that many health journalists lack the training required to accurately disseminate health news, leading to potentially harmful health effects.[70,71] The low scores across all tools indicate overall inadequacy of both reliability and accuracy. A survey of medical journalists across 37 countries highlighted the 3 most common barriers against quality content: lack of time, space and knowledge.[72] While journalism stresses the ability to summarise content quickly and concisely, experienced journalists often report the lack of knowledge as a barrier. The lack of expert knowledge in a rapidly progressing scientific field can impact the quality of conveyed information significantly. Furthermore, journalists reported difficulty in finding experts to explain the jargon, further impacting quality. This presents a large barrier towards disseminating quality COVID-19 information as the redirected efforts of many countries and institutions' scientists into research reduces availability to assist

with medical journalism.[73,74] Expertise in a relevant academic background likely helps improve the content, as indicated by the highest-scoring entry, whose author holds a PhD in molecular genetics which scored 22 in EQIP, 4 in JAMA and 74 in DISCERN.[75] In short, our findings highlight the importance of addressing health outcomes through health literacy of both the public and authors.

Our analysis identified the majority of websites as sources from Governments or health departments across various states of the USA, many of which have based information and advice from the Centers for Disease Control and Prevention (CDC). As both the nature and purpose of these sources vary, the visiting population and demographics would also vary due to differences in information-seeking behaviours. A recent study has identified a deficit of awareness and trust in information originating from the Government such as those of the CDC, revealing that while up to 83.6% of American adults are aware of the CDC, only 64.6% trust this source.[76] American adolescents were, however, less aware of the CDC (55.8%), but were more trusting of their information (72.2%). As previously established, trust in a Government is predictive of health outcomes as it affects behaviours such as service usage and vaccination rates.[77–79] Similarly, as access and usage of online health information vary between different demographics, it is paramount that we create and provide targeted and effective educational material for public use.[80,81]

A comparison between the global Government/Health Department and News Services websites revealed significant differences between EQIP Content, Total EQIP, Total and DISCERN Treatment. The EQIP Content scores reflect differences in where information is obtained, with Government/Health Departments using primary research whereas journalists tend to utilise secondary research. However, News Services scored higher in DISCERN Treatment, potentially due to the Government's reluctance to prematurely disclose treatment information at early stages of discovery, whereas journalists may freely report results of all potential studies. Interestingly, the majority of USA Government websites had some form of

copy-pasted information from the Centre for Disease Control and Prevention (CDC), likely with the aim of maintaining consistency and centralisation information sources. In contrast, the majority of other sources rewrite information based on a variety of sources. American sources display a similar pattern of variation but the EQIP Identification scores of Government/Health Departments show statistically significant differences and scores lower than News Services (mean 3.34 vs 3.78; P=0.011). The verbatim use of CDC information on these Government websites may have neglected the importance of clarity, transparency and critical appraisal of literature and focused on disseminating information instead.

Is the current information online adequate?

Google Trends identified the search popularity of treatment to have increased rapidly, outgrowing prevention searches since early-March. This suggests that initial demands for preventative information have been sufficiently met and interests now shift towards treatment. The 275 websites addressing prevention scored below the mean EQIP (17.12 vs 17.78; P<0.001), JAMA (2.53 vs 2.69; P=0.001) and DISCERN scores (34.64 vs 38.00; P<0.001), showing that quality of preventative information remains subpar across all indicators. Similarly, treatment websites demonstrated their efficacy in sourcing, over discussing information, as they excelled in Identification (3.87 vs 3.50; P<0.001) but scored poorly and below the mean in EQIP (16.89 vs 17.78; P<0.001). This is also reflected by its above-average JAMA (3.13 vs 2.69; P=0.001) and DISCERN (45.07 vs 38.00; P<0.001) scores. Contrarily, the 73 websites that discussed both prevention and treatment of COVID-19 consistently scored higher than the mean across all indicators: EQIP (20.15 vs 17.78; P<0.001), JAMA (2.85 vs 2.69; P=0.001) and DISCERN (42.84 vs 38.00; P<0.001). These websites explored multiple aspects of the virus, and likely utilises a variety of sources, thus producing higher quality articles through a better understanding of the topic. To combat increasingly dangerous COVID-19 myths, such as injection of disinfectants as treatment, continued maintenance and improvement to online available resources is paramount.[82,83]

Limitations

Although our utilised search engine, 'Google', is the most commonly used, it is not wholly representative as searches are often affected by the location of the requesting server and previous Internet usage. While querying from every country is not practical, the server used in the study was not used to conduct any other COVID-19-related searches, thus impact should be minimised. A further search was conducted on 10th July 2020 on the top 10 scoring EQIP and DISCERN websites through VPN servers in Texas, London, Toronto and Sydney. Only three of the websites were found within the first 10 pages of results using the same search-terms on the original server, with London and Sydney each returning two of the results, Toronto returning none (**Supplementary Table 4**) and a remaining URL redirecting to another page. The search also confirms differences in results between the location of the search, however, all three results from the Texas server were covered by London and Sydney. As websites can be updated or removed any time, our results are representative only at the time of the search, demonstrated by the distinct lack of the original websites in our second search in July. Similarly, search-terms obtained using 'Google Adwords Keyword Planner' and 'Google Trends', may not truly be indicative of search patterns of the wider public. Hence, 12 different variations of 'COVID-19' names and phrases potentially used by patients were utilised as search-terms. While social media is increasingly used to share health information, our study focused on search engines because previous studies have identified a lack of trust in social media information and which acts as a barrier against public engagement.[84] Similarly, while video-based information constitutes a valuable source of information, no tools have been validated in assessing video-based information, particularly for COVID-19, to the best of our knowledge. Forced inclusion of video content would likely yield inaccurately low scores across current tools as videos typically do not include as much written information. Another limitation is the exclusion of non-English language websites, especially reducing the representation of publicly available information given the international nature of the pandemic. A minority of URLs, particularly of News Services, regularly update their content or redirect visitors, potentially affecting the second round of evaluation and subsequent statistical analysis.

Additionally, modified EQIP tool, JAMA benchmark and DISCERN tool were limited as they were not designed to specifically assess the highly variable information produced during pandemics. However, the EQIP tool was designed to assess any type of patient information and demonstrated high inter-rater reliability.[17] Similarly, JAMA benchmark was designed to evaluate website reliability alone and DISCERN examines both reliability and content accuracy, thus, the combinational use of tools enhances the accuracy and objective assessment of these websites.

Conclusion

In short, the abundance of Internet resources providing COVID-19 information is exemplified by the numerous identified websites during our search. The information available to the public may affect their health decisions, which, subsequently, affects the efficacy and outcome of public health measures implemented by health departments. As effective treatments and vaccine research is underway, COVID-19 is primarily addressed with preventative measures, hence necessitating a critical review of the quality and nature of the information accessible to the public. Our results demonstrated that the websites were chiefly produced by News Services and Government/Health Departments but were nonetheless of low quality. While the majority of websites addressed prevention, and likely met the information needs of the public as reflected by search trends, there is a relative deficit in websites that discuss treatment methods. A minority of websites discussed both prevention methods and treatment and were generally good resources but the majority of websites were also of inadequate quality. Thus, there is a need for higher quality online COVID-19 resources to facilitate public education and enable better cooperation and outcomes of public health measures.

Contributorship statement

Study conception and design: DAR, NM, SAG, KSF

Acquisition of data: SAG, KSF, LL, KHF, DR, AS

Analysis and interpretation of data: KSF, SAG, NM, DAR

Drafting of manuscript: KSF, SAG, NM, KHF

Critical revision: KSF, SAG, NM, DAR

Competing interests

Authors have declared that no competing interests exist.

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Data sharing statement

All relevant data are within this manuscript and supplementary files.

Figures and Supplementary Figures

Figure 1. Popular search terms used in COVID-19 and their relative popularity throughout the pandemic provided by Google Trends

Figure 2. Workflow of webscraping and exclusion: initial 1275 websites returned were filtered for duplicates and assessed for eligibility to include 321 websites in the final dataset

Figure 3. Country of origin of websites in descending order of the number of websites contributed

Figure 4. Scores by top contributing countries (USA, UK, Canada and Australia) for EQIP tool, JAMA benchmark and DISCERN tool

Figure 5. High-score distribution of the final dataset compared against low-scoring websites for EQIP tool, JAMA benchmark and DISCERN tool

Supplementary Figure 1. Intraclass correlation plot demonstrating correlation between EQIP tool, JAMA benchmark and DISCERN tool

Supplementary Figure 2. Kruskal-Wallis box-plot of score distributions of JAMA benchmark against EQIP tool and DISCERN tool

Supplementary Figure 3. Bland-Altman Plot demonstrating assessor variations within each of the three tools and against other assessors

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Table 1. Website demographic and background information

Type	Total (n,%)	Treatment (n,%)	Prevention (n,%)	Prevention and Treatment (n,%)
Academic Centre	10 (3.12%)	1 (0.31%)	4 (1.25%)	5 (1.56%)
Charity/NGO	12 (3.74%)	1 (0.31%)	9 (2.8%)	2 (0.62%)
Encyclopaedia	5 (1.56%)	0 (0%)	1 (0.31%)	4 (1.25%)
Government/Health Department	87 (27.10%)	1 (0.31%)	65 (20.25%)	21 (6.54%)
Hospital	7 (2.18%)	0 (0%)	5 (1.56%)	2 (0.62%)
Industry	30 (9.35%)	8 (2.49%)	10 (3.12%)	12 (3.74%)
Military	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
News Service	163 (50.78%)	34 (10.59%)	102 (31.78%)	27 (8.41%)
Patient group	1 (0.10%)	1 (0.31%)	0 (0%)	0 (0%)
Professional society	4 (1.25%)	0 (0%)	4 (1.25%)	0 (0%)
Research Centre	1 (0.31%)	0 (0%)	1 (0.31%)	0 (0%)
Total	321	46 (14.33%)	202 (62.93%)	73 (22.74%)

Table 2. Overall quality of information of all sources of information

Indicator/ (Mean, SD)	Academic centre	Charity/NGO	Encyclopaedia	Government/Health Department	Hospital	Industry	Military	News Service	Patient group	Professional society	Research Centre	P Value

EQIP Content	7.70 (2.50)	6.75 (3.33)	10.80 (3.11)	8.11 (2.49)	7.14 (2.19)	7.13 (2.60)	5.00 (0)	6.22 (2.11)	10.00 (0)	5.50 (3)	5.00 (0)	<0.001
EQIP Identification	2.90 (1.20)	3.08 (0.90)	4.80 (0.45)	3.44 (1.03)	2.71 (1.38)	3.4 (1.13)	1.00 (0)	3.62 (0.73)	3.00 (0)	4.00 (0)	4.00 (0)	0.003
EQIP Structure	7.90 (1.85)	7.67 (1.30)	8.60 (1.67)	7.34 (1.45)	7.43 (0.98)	6.97 (1.83)	9.00 (0)	7.22 (1.39)	10.00 (0)	7.25 (0.5)	5.00 (0)	0.08
EQIP Total	18.50 (3.66)	17.50 (4.32)	24.20 (3.56)	18.9 (3.79)	17.29 (3.50)	17.5 (4.48)	15.00 (0)	17.06 (3.19)	23.00 (0)	16.75 (3.4)	14.00 (0)	<0.001
JAMA Total	2.50 (0.97)	2.50 (1.00)	3.40 (0.55)	2.16 (0.86)	2.14 (1.57)	2.73 (1.23)	1.00 (0)	2.98 (0.85)	3.00 (0)	3.50 (0.58)	3.00 (0)	<0.001
DISCERN Reliability	27.20 (6.78)	26.25 (6.51)	35.60 (4.77)	27.47 (5.96)	29.86 (5.58)	26.6 (7.46)	23.00 (0)	26.31 (6.3)	27.00 (0)	29.50 (4.2)	26.00 (0)	0.128
DISCERN Treatment	13.00 (6.70)	9.42 (2.39)	16.00 (9.30)	9.02 (3.14)	8.71 (1.89)	13.33 (6.39)	8.00 (0)	11.72 (6.22)	13.00 (0)	8.50 (1)	17.00 (0)	0.001
DISCERN Total	40.20 (10.38)	35.67 (7.67)	51.60 (12.3)	36.49 (7.50)	38.57 (5.47)	39.93 (10.45)	31.00 (0)	38.04 (10.44)	40.00 (0)	38.00 (5.1)	43.00 (0)	0.167

Table 3. Overall quality of information of all websites subsets

Indicator/(Mean, SD)	Overall	Treatment	Prevention	Prevention and Treatment	P Value

EQIP Content	6.97 (2.52)	6.26 (1.81)	6.55 (2.30)	8.58 (2.84)	<0.001
EQIP Identification	3.50 (0.93)	3.87 (0.72)	3.32 (0.97)	3.78 (0.80)	<0.001
EQIP Structure	7.30 (1.47)	6.76 (1.46)	7.25 (1.46)	7.79 (1.37)	<0.001
EQIP Total	17.78 (3.71)	16.89 (2.84)	17.12 (3.45)	20.15 (3.95)	<0.001
JAMA Total	2.69 (0.98)	3.13 (0.72)	2.53 (1.05)	2.85 (0.84)	0.001
DISCERN Reliability	26.93 (6.35)	26.98 (6.92)	26.04 (5.72)	29.37 (7.04)	<0.001
DISCERN Treatment	11.07 (5.60)	18.09 (6.04)	8.60 (2.45)	13.47 (6.73)	<0.001
DISCERN Total	38.00 (9.61)	45.07 (11.67)	34.64 (6.52)	42.84 (10.93)	<0.001

Table 4. Comparison between Government and News Services

Indicator	Global (USA inclusive) (n=250)	USA (n=121)

	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value	Government Mean Score	Government Mean Rank	News Mean Score	News Mean Rank	P Value
EQIP Content	8.11	161.34	6.22	106.37	<0.001	7.66	75.80	6.17	54.22	0.002
EQIP Identification	3.44	118.28	3.62	129.35	0.207	3.34	50.29	3.78	65.90	0.011
EQIP Structure	7.34	129.90	7.22	123.15	0.464	7.55	67.54	7.08	58.01	0.148
EQIP Total	18.90	151.52	17.06	111.61	<0.001	18.55	71.21	17.04	56.33	0.029
JAMA Total	2.16	85.72	2.98	146.73	<0.001	2.03	34.28	3.17	73.23	<0.001
DISCERN Reliability	27.47	137.15	26.31	119.28	0.062	26.53	60.26	26.66	61.34	0.876
DISCERN Treatment	9.02	110.95	11.72	133.27	0.001	8.84	47.99	12.59	66.96	0.001

DISCERN Total	36.49	105.32	38.04	136.27	0.963	35.37	54.72	39.25	63.87	0.182

Table 5. Top 5 websites based on EQIP and DISCERN scores

URL	Country	Treatment or Prevention	Total EQIP	Total JAMA	Total DISCERN
Top Scoring EQIP Sites					
https://www.gov.je/health/coronavirus/Pages/index.aspx	Channel Islands (Jersey)	Both	29	3	49
https://en.wikipedia.org/wiki/2019%E2%80%9320_coronavirus_pandemic	USA	Both	28	3	61
https://www.health.nsw.gov.au/Infectious/alerts/Pages/coronavirus-faqs.aspx	Australia	Both	28	3	46
https://www.ageuk.org.uk/information-advice/coronavirus/coronavirus/#	UK	Both	27	3	48
https://www.wikihow.com/Prevent-Coronavirus	USA	Prevention only	27	4	46
Top Scoring DISCERN Sites					
https://www.sciencenews.org/article/coronavirus-covid19-repurposed-treatments-drugs	USA	Treatment only	22	4	75
https://www.vox.com/science-and-health/2020/3/4/21154590/coronavirus-vaccine-treatment-covid-19-drug-cure	USA	Both	22	4	74

https://en.wikipedia.org/wiki/Coronavirus_disease_2019	USA	Both	25	3	68
https://www.bloomberg.com/news/articles/2020-03-25/hydroxychloroquine-no-better-than-regular-covid-19-care-in-study	USA	Treatment only	21	3	65
https://www.theverge.com/2020/2/4/21122327/coronavirus-experimental-medication-treatment-wuhan-china-gilead-hiv	USA	Treatment only	18	4	64

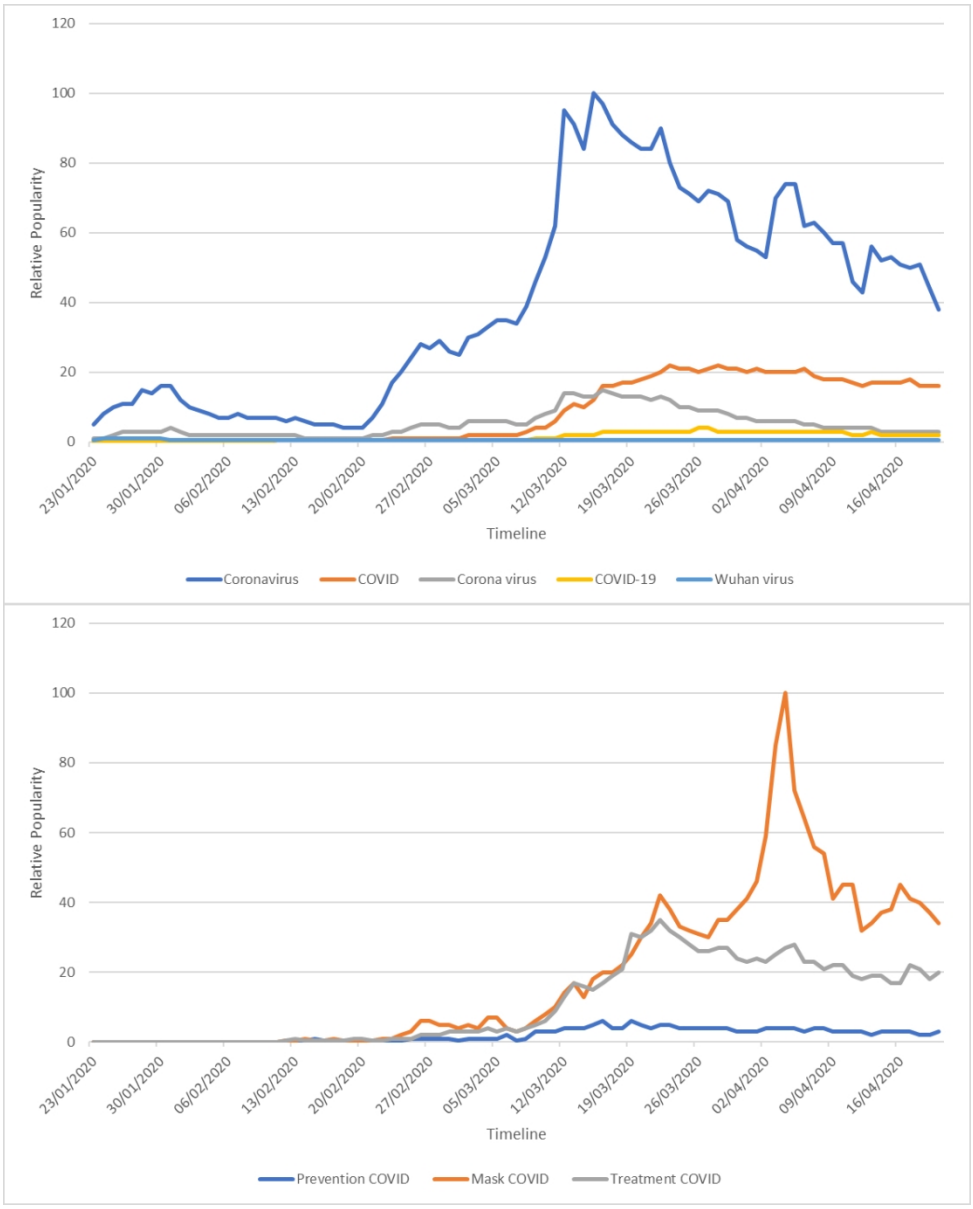


Figure 1. Popular Search Terms

99x123mm (300 x 300 DPI)

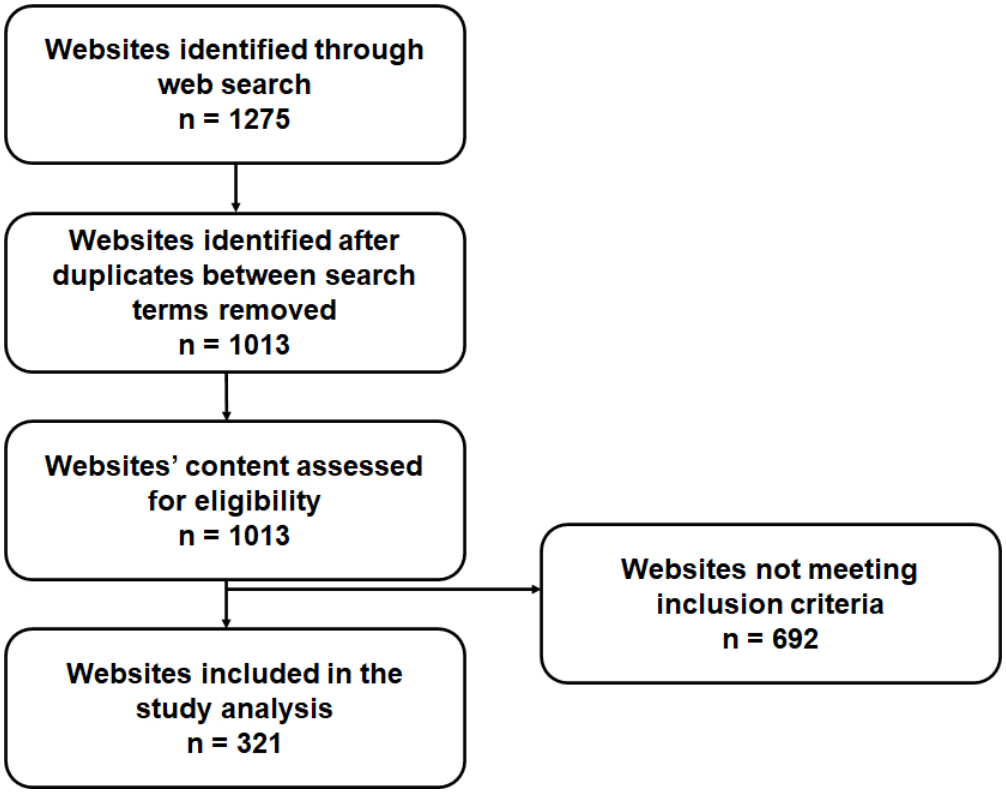


Figure 2. Workflow of Webscraping and Exclusion

70x55mm (300 x 300 DPI)

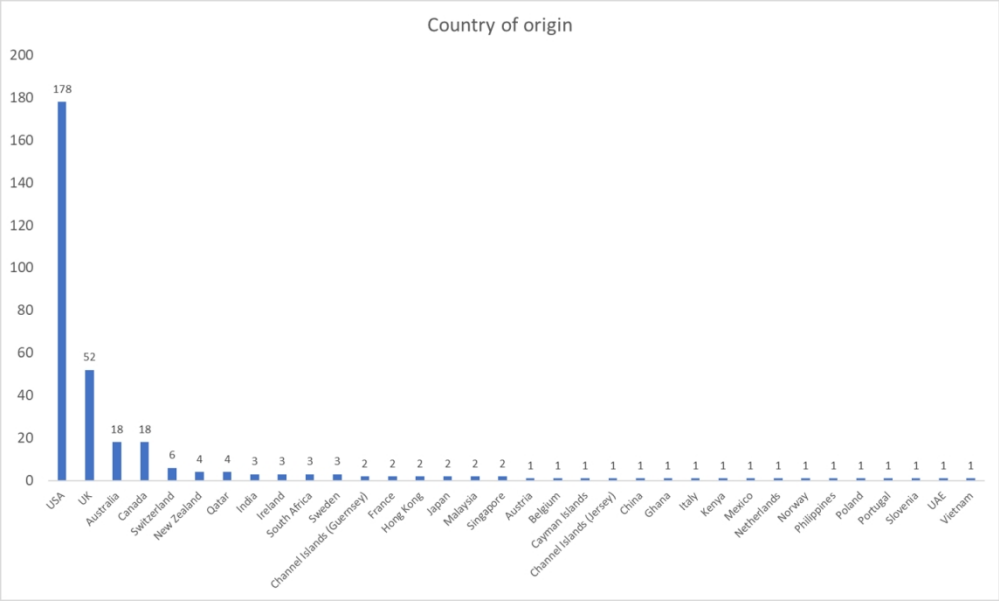


Figure 3. Country of origin of websites

132x79mm (300 x 300 DPI)

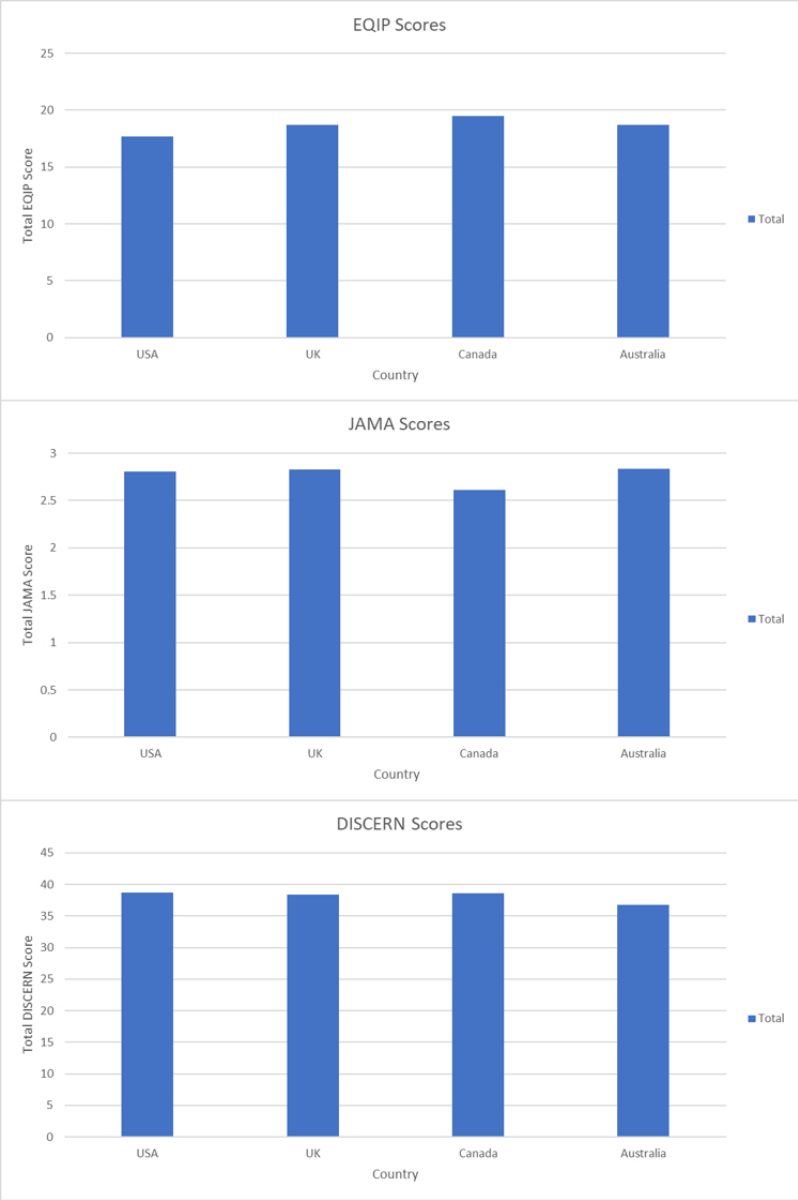


Figure 4. Scores by top contributing countries

63x94mm (300 x 300 DPI)

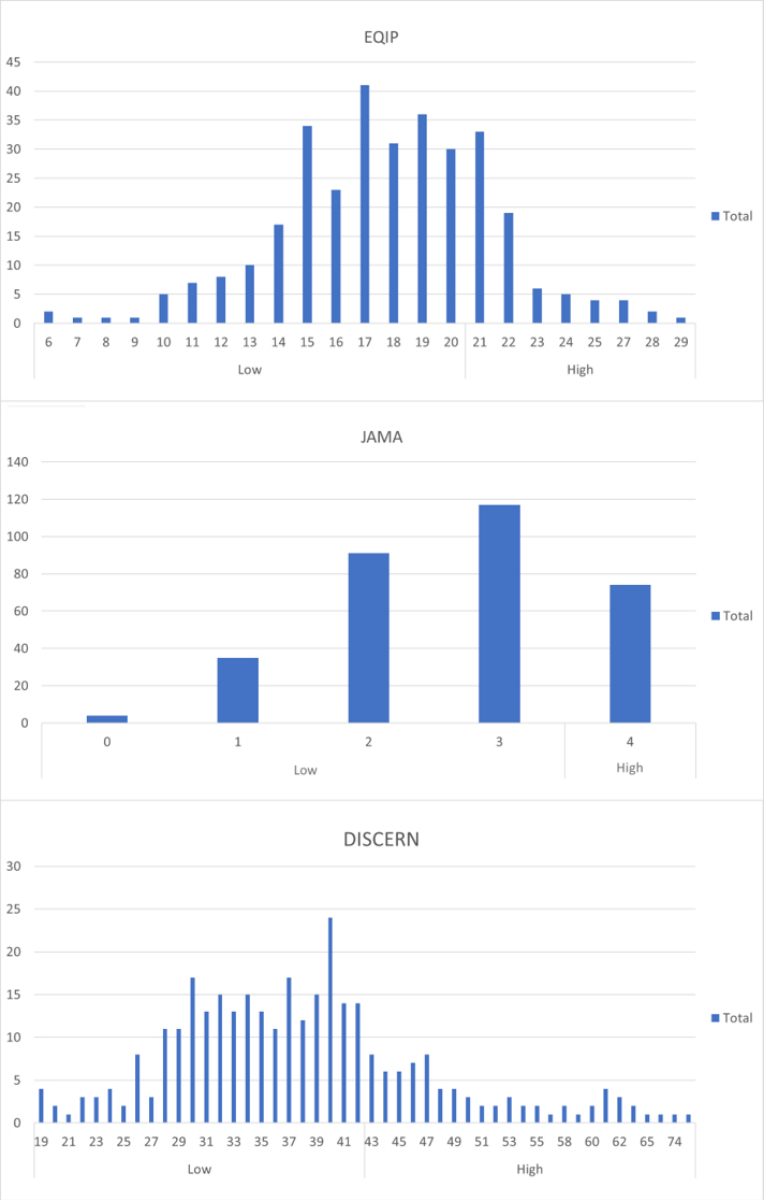


Figure 5. High-score distribution

60x94mm (300 x 300 DPI)

Item		Overall number of websites (n, %)	High-scoring websites (n, %)	Low-scoring websites (n,%)	OR
Modified EQIP Content Data					
1. Initial definition of which subjects will be	Yes	274 (85.36%)	71 (95.95%)	203 (82.19%)	5.102
	No	47 (14.64%)	3 (4.05%)	44 (17.81%)	
2. Coverage of the previously defined	Yes	273 (85.05%)	71 (95.95%)	202 (81.78%)	3.509
	No	48 (14.95%)	3 (4.05%)	45 (18.22%)	
3. Description of the medical	Yes	251 (78.19%)	73 (98.65%)	178 (72.06%)	5.882
	No	70 (21.81%)	1 (1.35%)	69 (27.94%)	
4. Definition of the purpose of the	Yes	216 (67.29%)	67 (90.54%)	149 (60.32%)	27.778
	No	105 (32.71%)	7 (9.46%)	98 (39.68%)	
5. Description of treatment alternatives	Yes	82 (25.55%)	40 (54.05%)	42 (17%)	6.250
	No	239 (74.45%)	34 (45.95%)	205 (83%)	
6. Description of the sequence of the	Yes	51 (15.89%)	26 (35.14%)	25 (10.12%)	4.785
	No	270 (84.11%)	48 (64.86%)	222 (89.88%)	
7. Description of the qualitative benefits for	Yes	114 (35.51%)	46 (62.16%)	68 (27.53%)	4.310
	No	207 (64.49%)	28 (37.84%)	179 (72.47%)	
8. Description of the quantitative benefits to	Yes	9 (2.8%)	3 (4.05%)	6 (2.43%)	1.695
	No	312 (97.2%)	71 (95.95%)	241 (97.57%)	
9. Description of the qualitative risks and	Yes	49 (15.26%)	25 (33.78%)	24 (9.72%)	4.717
	No	272 (84.74%)	49 (66.22%)	223 (90.28%)	
10. Description of the quantitative risks and	Yes	3 (0.93%)	3 (4.05%)	0 (0%)	-
	No	318 (99.07%)	71 (95.95%)	247 (100%)	
11. Addressing quality-of-life issues	Yes	137 (42.68%)	58 (78.38%)	79 (31.98%)	7.634
	No	184 (57.32%)	16 (21.62%)	168 (68.02%)	
12. Description of how complications are	Yes	35 (10.9%)	20 (27.03%)	15 (6.07%)	5.682
	No	286 (89.1%)	54 (72.97%)	232 (93.93%)	
13. Description of the precautions that the	Yes	265 (82.55%)	70 (94.59%)	195 (78.95%)	4.651
	No	56 (17.45%)	4 (5.41%)	52 (21.05%)	
14. Mention of alert signs that the patient	Yes	212 (66.04%)	66 (89.19%)	146 (59.11%)	5.682
	No	109 (33.96%)	8 (10.81%)	101 (40.89%)	
15. Addressing medical intervention costs and	Yes	68 (21.18%)	31 (41.89%)	37 (14.98%)	3.968
	No	253 (78.82%)	43 (58.11%)	210 (85.02%)	
16. Specific contact details for hospital	Yes	10 (3.12%)	3 (4.05%)	7 (2.83%)	-
	No	311 (96.88%)	71 (95.95%)	240 (97.17%)	

17. Specific details of other sources of reliable	Yes	185 (57.63%)	62 (83.78%)	123 (49.8%)	5.181
	No	136 (42.37%)	12 (16.22%)	124 (50.2%)	
18. Coverage of all relevant issues for the	Yes	4 (1.25%)	4 (5.41%)	0 (0%)	-
	No	317 (98.75%)	70 (94.59%)	247 (100%)	
Modified EQIP Identification Data					
19. Date of issue or revision	Yes	280 (87.23%)	69 (93.24%)	211 (85.43%)	2.347
	No	41 (12.77%)	5 (6.76%)	36 (14.57%)	
20. Logo of the issuing body	Yes	317 (98.75%)	74 (100%)	243 (98.38%)	-
	No	4 (1.25%)	0 (0%)	4 (1.62%)	
21. Names of the persons or entities that	Yes	254 (79.13%)	61 (82.43%)	193 (78.14%)	1.312
	No	67 (20.87%)	13 (17.57%)	54 (21.86%)	
22. Names of the persons or entities that	Yes	210 (65.42%)	62 (83.78%)	148 (59.92%)	3.448
	No	111 (34.58%)	12 (16.22%)	99 (40.08%)	
23. Short bibliography of the evidence-based data	Yes	60 (18.69%)	31 (41.89%)	29 (11.74%)	5.376
	No	261 (81.31%)	43 (58.11%)	218 (88.26%)	
24. Statement about whether and how	Yes	3 (0.93%)	1 (1.35%)	2 (0.81%)	1.675
	No	318 (99.07%)	73 (98.65%)	245 (99.19%)	
Modified EQIP Structure Data					
25. Use of everyday language and	Yes	3 (0.93%)	72 (97.3%)	229 (92.71%)	2.825
	No	318 (99.07%)	2 (5.41%)	18 (25.35%)	
26. Use of generic names for all medications or	Yes	88 (27.41%)	35 (47.3%)	53 (21.46%)	1.838
	No	233 (44.05%)	39 (35.14%)	194 (46.41%)	
27. Use of short sentences (<15 words on	Yes	296 (92.21%)	72 (97.3%)	224 (90.69%)	3.690
	No	25 (9.47%)	2 (2.99%)	23 (11.68%)	
28. Personal address to the reader	Yes	239 (74.45%)	65 (87.84%)	174 (70.45%)	3.021
	No	82 (21.03%)	9 (10.98%)	73 (23.7%)	
29. Respectful tone	Yes	308 (95.95%)	73 (98.65%)	235 (95.14%)	3.717
	No	13 (4.22%)	1 (1.35%)	12 (5.13%)	
30. Clear information (no ambiguities or	Yes	295 (91.9%)	73 (98.65%)	222 (89.88%)	8.197
	No	26 (31.71%)	1 (3.33%)	25 (48.08%)	
31. Balanced information on risks and benefits	Yes	56 (17.45%)	29 (39.19%)	27 (10.93%)	5.208
	No	265 (47.58%)	45 (37.82%)	220 (50.23%)	
32. Presentation of information in a logical	Yes	292 (90.97%)	74 (100%)	218 (88.26%)	-
	No	29 (9.12%)	0 (0%)	29 (11.84%)	

33. Satisfactory design and layout (excluding	Yes	289 (90.03%)	73 (98.65%)	216 (87.45%)	10.417
	No	32 (22.38%)	1 (2.33%)	31 (31%)	
34. Clear and relevant figures or graphs (NA if	Yes	111 (34.58%)	42 (56.76%)	69 (27.94%)	12.987
	No	210 (75.27%)	32 (65.31%)	178 (77.39%)	
35. Inclusion of a named space for the reader's	Yes	69 (21.5%)	17 (22.97%)	52 (21.05%)	1.119
	No	252 (100%)	57 (100%)	195 (100%)	
36. Inclusion of a printed consent form contrary to	Yes	0 (0%)	0 (0%)	0 (0%)	-
	No	321 (100%)	74 (100%)	247 (100%)	
*Some data is omitted due to odds ratio and confidence interval being infinite values					

95% CI	P Value
1.560 - 26.316	0.002
0.483 - 166.667	0.300
3.215 - 10.870	<0.001
4.695 - 1000.000	<0.001
2.725 - 16.949	<0.001
2.427 - 9.434	<0.001
2.416 - 7.752	<0.001
0.267 - 8.197	0.436
2.370 - 9.434	<0.001
-	0.012
4.032 - 15.152	<0.001
2.584 - 12.821	<0.001
1.621 - 18.519	0.001
2.571 - 14.286	<0.001
2.137 - 7.407	<0.001
-	0.228

2.604 - 11.111	<0.001
-	0.003
0.870 - 8.000	0.110
-	0.577
0.652 - 2.801	0.515
1.727 - 7.407	<0.001
1.727 - 7.407	<0.001
1.727 - 7.407	0.546
0.650 - 25.64	0.181
0.561 - 7.143	0.309
0.875 - 33.333	0.082
1.401 - 7.299	0.002
0.533 - 166.667	0.312
1.294 - 333.333	0.013
2.703 - 10.101	<0.001
-	0.001

1.675 - 500.000	0.003
3.086 - 111.111	<0.001
0.561 - 2.151	0.748
-	-

Item		Overall number of websites (n, %)	High-scoring websites (n, %)	Low-scoring websites (n,%)
JAMA Benchmark				
1. Authorship: Authors and contributors, their affiliations,	Yes	183 (57.01%)	74 (100%)	109 (44.13%)
	No	138 (42.99%)	0 (0%)	138 (55.87%)
2. Attribution: References and sources for all content should	Yes	118 (36.76%)	74 (100%)	44 (17.81%)
	No	203 (63.24%)	0 (0%)	203 (82.19%)
3. Disclosure: Web site "ownership", sponsorship, funding arrangements or	Yes	287 (89.41%)	74 (100%)	213 (86.23%)
	No	34 (10.59%)	0 (0%)	34 (13.77%)
4. Currency: Dates that content was posted and updated	Yes	276 (85.98%)	74 (100%)	202 (81.78%)
	No	45 (14.02%)	0 (0%)	45 (18.22%)
*Some data is omitted due to odds ratio and confidence interval being inf				

OR	95% CI	P Value
-	-	<0.001
-	-	<0.001
-	-	<0.001
-	-	<0.001

finite values

Item	Score	Overall number of websites (n, %)	High-scoring websites (n,%)	Low-scoring websites (n,%)
DISCERN Reliability				
1. Are the aims clear?	1	6 (1.87%)	0 (0%)	6 (2.45%)
	2	16 (4.98%)	2 (2.63%)	14 (5.71%)
	3	39 (12.15%)	9 (11.84%)	30 (12.24%)
	4	51 (15.89%)	6 (7.89%)	45 (18.37%)
	5	209 (65.11%)	59 (77.63%)	150 (61.22%)
2. Does it achieve its aims	1	7 (2.18%)	0 (0%)	7 (2.86%)
	2	18 (5.61%)	4 (5.26%)	14 (5.71%)
	3	45 (14.02%)	10 (13.16%)	35 (14.29%)
	4	57 (17.76%)	8 (10.53%)	49 (20%)
	5	194 (60.44%)	54 (71.05%)	140 (57.14%)
3. Is it relevant?	1	4 (1.25%)	0 (0%)	4 (1.63%)
	2	17 (5.3%)	3 (3.95%)	14 (5.71%)
	3	42 (13.08%)	14 (18.42%)	28 (11.43%)
	4	64 (19.94%)	3 (3.95%)	61 (24.9%)
	5	194 (60.44%)	56 (73.68%)	138 (56.33%)
4. Is it clear what sources of information were used to compile the publication (other than the author or producer)?	1	68 (21.18%)	3 (3.95%)	65 (26.53%)
	2	67 (20.87%)	3 (3.95%)	64 (26.12%)
	3	72 (22.43%)	14 (18.42%)	58 (23.67%)
	4	48 (14.95%)	15 (19.74%)	33 (13.47%)
	5	66 (20.56%)	41 (53.95%)	25 (10.2%)
5. Is it clear when the information used or reported in the publication was produced?	1	83 (25.86%)	2 (2.63%)	81 (33.06%)
	2	78 (24.3%)	12 (15.79%)	66 (26.94%)
	3	88 (27.41%)	28 (36.84%)	60 (24.49%)
	4	36 (11.21%)	11 (14.47%)	25 (10.2%)
	5	36 (11.21%)	23 (30.26%)	13 (5.31%)
6. Is it balanced and unbiased?	1	24 (7.48%)	4 (5.26%)	20 (8.16%)
	2	65 (20.25%)	16 (21.05%)	49 (20%)
	3	146 (45.48%)	33 (43.42%)	113 (46.12%)
	4	69 (21.5%)	14 (18.42%)	55 (22.45%)
	5	17 (5.3%)	9 (11.84%)	8 (3.27%)
	1	77 (23.99%)	4 (5.26%)	73 (29.8%)

7. Does it provide details of additional sources of support and information?	2	64 (19.94%)	15 (19.74%)	49 (20%)
	3	62 (19.31%)	19 (25%)	43 (17.55%)
	4	58 (18.07%)	17 (22.37%)	41 (16.73%)
	5	60 (18.69%)	21 (27.63%)	39 (15.92%)
8. Does it refer to areas of uncertainty?	1	99 (30.84%)	14 (18.42%)	85 (34.69%)
	2	61 (19%)	15 (19.74%)	46 (18.78%)
	3	75 (23.36%)	24 (31.58%)	51 (20.82%)
	4	44 (13.71%)	10 (13.16%)	34 (13.88%)
	5	42 (13.08%)	13 (17.11%)	29 (11.84%)
DISCERN Quality and Overall rating				
9. Does it describe how each treatment works?	1	250 (77.88%)	52 (68.42%)	198 (80.82%)
	2	24 (7.48%)	8 (10.53%)	16 (6.53%)
	3	18 (5.61%)	4 (5.26%)	14 (5.71%)
	4	13 (4.05%)	6 (7.89%)	7 (2.86%)
	5	16 (4.98%)	6 (7.89%)	10 (4.08%)
10. Does it describe the benefits of each treatment?	1	247 (76.95%)	52 (68.42%)	195 (79.59%)
	2	20 (6.23%)	6 (7.89%)	14 (5.71%)
	3	26 (8.1%)	6 (7.89%)	20 (8.16%)
	4	20 (6.23%)	7 (9.21%)	13 (5.31%)
	5	8 (2.49%)	5 (6.58%)	3 (1.22%)
11. Does it describe the risks of each treatment?	1	281 (87.54%)	60 (78.95%)	221 (90.2%)
	2	18 (5.61%)	6 (7.89%)	12 (4.9%)
	3	17 (5.3%)	7 (9.21%)	10 (4.08%)
	4	3 (0.93%)	1 (1.32%)	2 (0.82%)
	5	2 (0.62%)	2 (2.63%)	0 (0%)
12. Does it describe what would happen if no treatment is used?	1	283 (88.16%)	61 (80.26%)	222 (90.61%)
	2	15 (4.67%)	6 (7.89%)	9 (3.67%)
	3	13 (4.05%)	5 (6.58%)	8 (3.27%)
	4	7 (2.18%)	2 (2.63%)	5 (2.04%)
	5	3 (0.93%)	2 (2.63%)	1 (0.41%)
13. Does it describe how the treatment choices affect overall quality of life?	1	289 (90.03%)	62 (81.58%)	227 (92.65%)
	2	13 (4.05%)	5 (6.58%)	8 (3.27%)
	3	14 (4.36%)	8 (10.53%)	6 (2.45%)
	4	2 (0.62%)	0 (0%)	2 (0.82%)

	5	3 (0.93%)	1 (1.32%)	2 (0.82%)
14. Is it clear that there may be more than one possible treatment choice?	1	240 (74.77%)	52 (68.42%)	188 (76.73%)
	2	18 (5.61%)	5 (6.58%)	13 (5.31%)
	3	24 (7.48%)	6 (7.89%)	18 (7.35%)
	4	10 (3.12%)	2 (2.63%)	8 (3.27%)
	5	29 (9.03%)	11 (14.47%)	18 (7.35%)
15. Does it provide support for shared decision-making?	1	262 (81.62%)	59 (77.63%)	203 (82.86%)
	2	13 (4.05%)	7 (9.21%)	6 (2.45%)
	3	35 (10.9%)	4 (5.26%)	31 (12.65%)
	4	3 (0.93%)	2 (2.63%)	1 (0.41%)
	5	8 (2.49%)	4 (5.26%)	4 (1.63%)
16. Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information about	1	241 (75.08%)	52 (68.42%)	189 (77.14%)
	2	48 (14.95%)	12 (15.79%)	36 (14.69%)
	3	25 (7.79%)	8 (10.53%)	17 (6.94%)
	4	7 (2.18%)	4 (5.26%)	3 (1.22%)
	5	0 (0%)	0 (0%)	0 (0%)

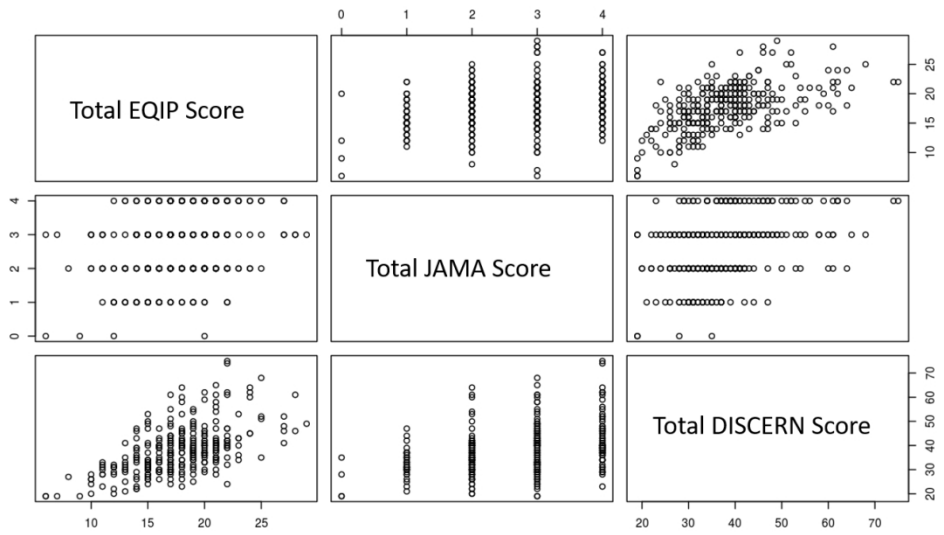
P Value
0.321
0.246
0.032
0.019
0.007
<0.001

0.093
<0.001
0.005
<0.001
0.016
<0.001
<0.001

<0.001
<0.001
<0.001

URL	Country	Original search term	Texas, USA March	Texas, USA July	London, UK July	Toronto, C
				Top Scoring EQIP Sites		
https://www.gov.ie/healt	UK	What is self isolation coronavirus	Page 4	None	None	No
https://en.wikipedia.org/	USA	Coronavirus	Page 1	None	None	No
https://www.health.nsw.g	Australia	Covid 19	Page 10	Page 4	None	No
https://www.ageuk.org.uk	UK	Stop getting coronavirus	Page 6	Page 4	Page 2	No
https://www.wikihow.co	USA	Stop getting coronavirus	Page 10	None	None	No
				Top Scoring DISCERN Sites		
https://www.sciencenews	USA	How to treat coronavirus	Page 10	None	None	No
https://www.vox.com/sci	USA	Drugs for coronavirus	Page 3	None	None	No
https://en.wikipedia.org/	USA	Covid 19	Page 1	Page 1	Page 1	No
https://www.bloomberg.c	USA	Drugs for coronavirus	Page 1	None	None	No
https://www.theverge.co	USA	Drugs for coronavirus	Page 32	None	None	No

anada July	Sydney, Australia July	URL Changes
ne	None	Same
ne	None	Changed
ne	Page 1	Same
ne	None	Same
ne	None	Same
ne	None	Same
ne	None	Same
ne	Page 9	Same
ne	None	Same
ne	None	Same



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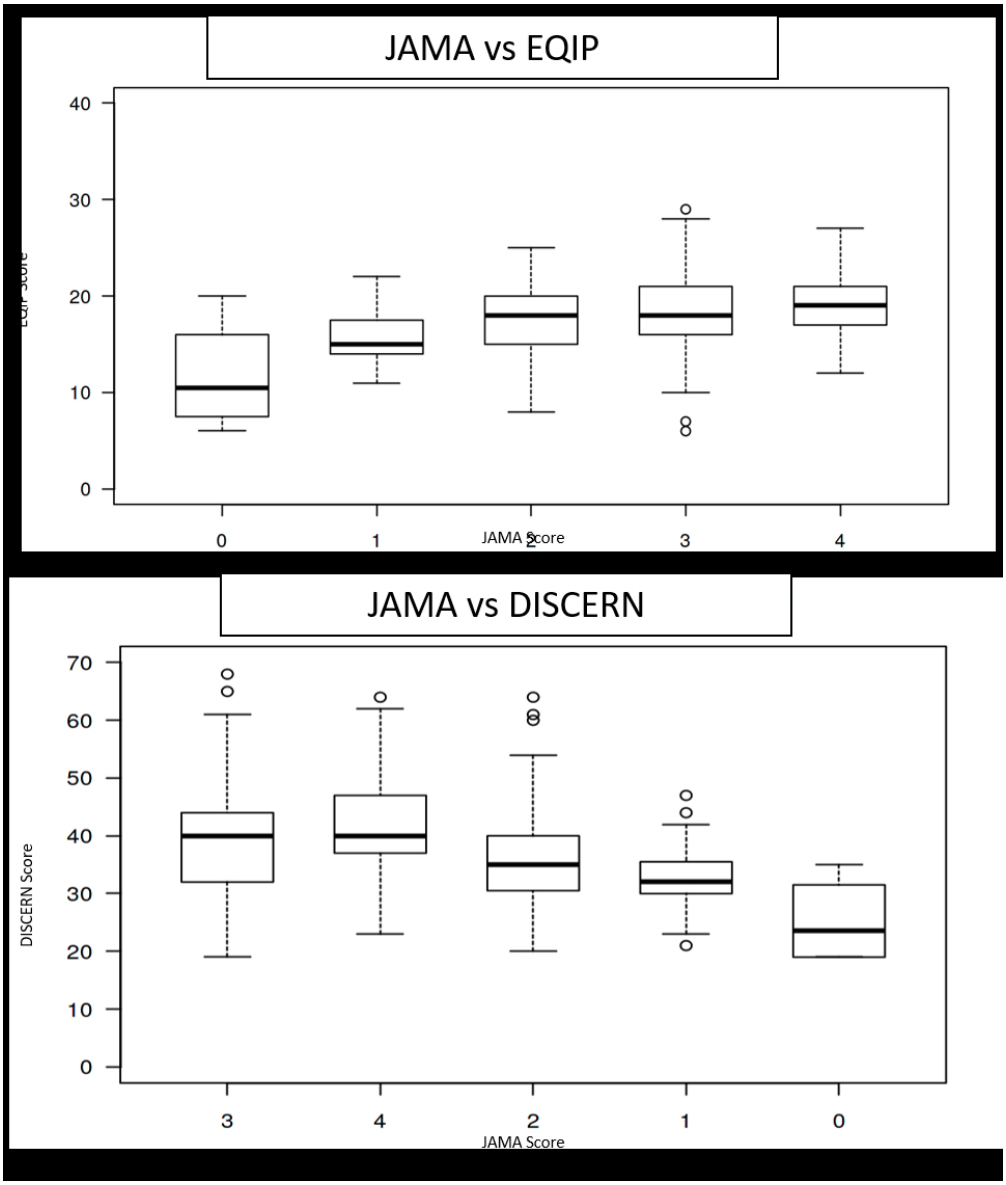

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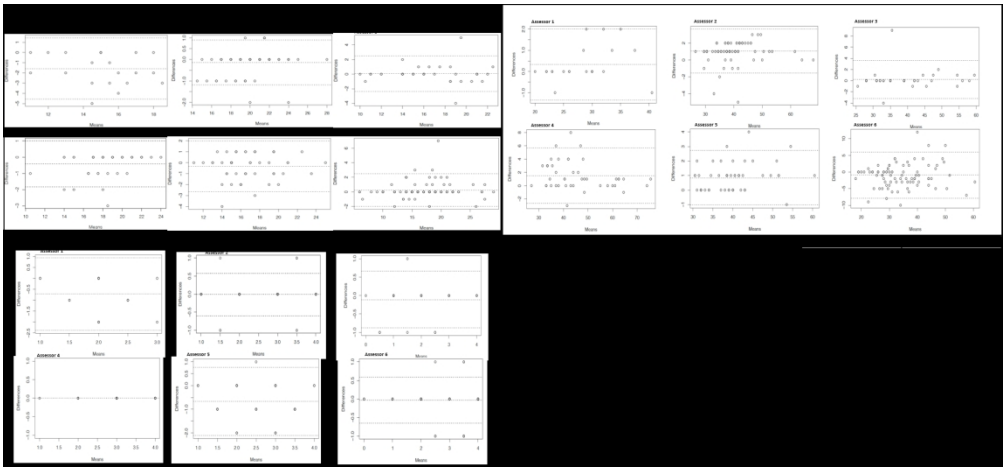

333x154mm (150 x 150 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-7
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-7
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	7-8
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	7-9
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	7-9
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	7-9
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-9
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8-12
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8-12
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	12
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-12
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	12

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	12, Figure 2
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12-13
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	N/A
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	10-14
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16-24
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	24-25
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	24
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	2

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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