YouTube as a source of information regarding the effect of vitamin C on coronavirus disease

Hyunsong Lee , Min Cheol Chang *

Department of Rehabilitation Medicine, College of Medicine, Yeungnam University, Daegu, Republic of Korea

A B S T R A C T

Objectives: With the expansion of the internet, social media platforms have become a major source of medical information. However, medical information on online multimedia platforms is often inaccurate. In the current study, we evaluated the reliability, quality, and accuracy of the most viewed YouTube videos featuring the effects of vitamin C on COVID-19.
Methods: A search was conducted on YouTube on January 13, 2022, using the keywords ("ascorbic acid" OR "vitamin C" OR "sodium ascorbate" OR "L-ascorbic") AND ("coronavirus" OR "COVID 19" OR "COVID-19" OR "Corona" OR "COVID" OR "SARSCoV2"). We assessed the 50 most-viewed videos using a modified DISCERN scale (mDISCERN) and Global Quality Scale (GQS). Additionally, the accuracy of the information in each video was evaluated.
Results: Out of the 50 most-viewed videos featuring the effect of vitamin C on COVID-19, 54% were not reliable. Furthermore, 62% presented poor quality, and 74% were misleading or neither accurate nor misleading. The average mDISCERN and GQS scores of the 50 included videos were 2.2 ± 1.4 (≥ 3: highly reliable) and 2.2 ± 1.1 (2: generally poor), respectively. Although the videos were made by medical doctors, their reliability, quality, and accuracy were not significantly different from those displayed in other sources, including fitness channels, television or internet-based news or programs, consumers, company channels, product advertisements, or prepared by nurses.
Conclusions: The reliability, quality, and accuracy of the 50 most-viewed videos on the effect of vitamin C on COVID-19 were not high. Video creators, especially medical doctors, should make an effort so that the videos present reliable content with high-quality and correct information is disseminated to people.

1. Introduction

Since the first confirmed case of coronavirus disease (COVID-19) was reported in December 2019, COVID-19 rapidly spread worldwide in a short span of 2–3 months, threatening public health.[1] As of 2022, despite the development and distribution of vaccines against COVID-19, it continues to spread due to the emergence of various mutations.[2] Patients with COVID-19 experience various symptoms, including fever, chills, cough, runny nose, dyspnea, confusion, dizziness, and chest pain.[3,4] Symptomatic treatment is used to manage COVID-19, and hospitalization is required if the symptoms are severe.[1] Pneumonia is a potential complication of COVID-19, affecting 10–20% of patients, as is acute respiratory distress syndrome.[1] In severe cases of pneumonia, intensive care is required to reduce the risk of mortality.

The immunocompromised population is more likely to develop severe COVID-19.[5] Furthermore, if the pro-inflammatory cytokines in patients with severe COVID-19 are activated and the inflammation continues, then the symptoms of COVID-19 may aggravate and result in death.[6] Vitamin C increases immunity by increasing the immune cell function.[7–9] It exerts anti-inflammatory effects by inhibiting the pro-inflammatory cytokine production, neutralizing reactive oxygen species, modulating nuclear transcription factor kappa B, and assisting immunomodulation as a cofactor in various biosynthetic pathways in the immune system.[7–9] Therefore, it was supposed that vitamin C activation not only prevents severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and worsening of the symptoms after infection, but also helps to treat severe COVID-19.[10–12] However, no reports to date have demonstrated that vitamin C effectively prevents

SARS-CoV-2 infection. Several studies have examined the effect of vitamin C treatment in patients with COVID-19[10–18]; however, the reported results varied, and recent meta-analyses reported no treatment effects.[19,20] Therefore, there is no strong evidence regarding the effect of vitamin C on COVID-19.

With the expansion of the internet, people can easily obtain medical information online and decide which medical services to receive.[21] People also seek advice from medical experts and listen to other patients' experiences through social media. However, the medical information available on online multimedia platforms is not always accurate, which leads to patients making incorrect decisions.[21] YouTube, the most popular and largest media-sharing online platform, is considered the most important online platform for disseminating medical information.

This study investigated the reliability, quality, and accuracy of the most frequently viewed YouTube videos on the effects of vitamin C on COVID-19.

2. Methods

2.1. Video selection

This cross-sectional study conducted a search on https://www.youtube.com/ on January 13, 2022, using the keywords "ascorbic acid" OR "vitamin C" OR "Sodium Ascorbate" OR "L-ascorbic" AND "coronavirus" OR "COVID 19″ OR "COVID-19″ OR "Corona" OR "COVID" OR "SARSCoV2." The inclusion criteria for the videos were content related to the effect of vitamin C on COVID-19 and videos in English. The exclusion criteria were duplicated videos and absence of audio. The 50 most-viewed videos fulfilling these criteria were included in the review. Ethics committee approval was not required for this study, as it did not include any human participants and the videos were publicly accessible.

2.2. Data extraction

We extracted data from each video. The data included title, production source, duration on YouTube, video length, and total number of views, likes, and subscribers. The video production source was categorized as nutrition, wellness, or fitness channels, television or internet-based news or programs, videos by consumers (clips uploaded by an individual without any professional affiliation), company channels or product advertisements (videos uploaded by a supplement producing company or for sales/promotion of products), videos by medical professionals (medial doctors), or by nurses.

2.3. Assessment of reliability, quality, and accuracy

The reliability of the video content was assessed using the modified DISCERN (mDISCERN) scale, which was adapted from the original DISCERN for the assessment of written health information by Charnock et al.[22] The mDISCERN scale includes the following five questions: (1) Are the aims clear and achieved; (2) Are reliable sources of information used; (3) Is the information presented balanced and unbiased; (4) Are additional sources of information listed for patient reference; and (5) Are areas of uncertainty mentioned. A higher mDISCERN score indicates greater reliability. When the mDISCERN score is ≥ 3, the information is considered highly reliable.

The Global Quality Scale (GQS) was used to assess the quality of the video content.[23] This evaluation tool was originally developed to evaluate website resources and to assess the flow and ease of use of the available information. The information can be classified as follows using the GQS: (1) poor quality, poor flow, and most information is missing, and hence not helpful for people; (2) generally poor with some information given but of limited use to people; (3) moderate quality and some important information is adequately discussed; (4) good quality, good flow, and most relevant information is covered, making it useful for people; and (5) excellent quality and excellent flow, making it very

Table 1
General features and results of the assessment of the videos.

Video Features	Mean ± SD (Min, Max)
Duration on YouTube (months)	15.8 ± 5.4(4, 24)
Video length (seconds)	1200.7 ± 2521.6(42, 16832)
Number of views (n)	392,367 ± 1127,183.2(4346, 7019077)
Number of likes (n)	7053.0 ± 17,909.0(44, 95000)
Number of subscribers (n)	1368,112.2 ± 2995,298.9(105, 15300000)
mDISCERN score	2.2 ± 1.4 (1, 5)
GQS score	2.2 ± 1.1 (1, 5)

(SD, standard deviation; mDISCERN, modified DISCERN; GQS, Global Quality Scale).

useful for people. A higher GQS score indicates greater quality of information.

In addition, each video was classified as accurate, misleading, or neither accurate nor misleading. When the videos included at least one correct or one inaccurate scientific statement about the effect of vitamin C on COVID-19, they were classified as accurate videos and misleading videos, respectively. If the videos had no scientific information on the effect of vitamin C on COVID-19, they were considered neither accurate nor misleading videos. When a video contained both accurate and inaccurate statements, it was classified as misleading. Two reviewers (H. S.L and M.C.C) assessed the reliability, quality, and accuracy of the included videos, and any discrepancies in assessment were discussed until consensus was reached. The assessment was conducted based on previously published meta-analyses and review articles.[19,20]

2.4. Statistical analysis

Statistical Product and Service Solutions, version 22 (IBM, Armonk, NY, USA) was used for the statistical analysis. The Kruskal–Wallis test and chi-square test were used to evaluate statistically significant differences in the general features and assessment results of the videos of the groups categorized according to the production sources. The Mann–Whitney U-test was used for comparison between videos with mDISCERN scores ≥ 3 and < 3, between videos with moderate to excellent quality (GQS ≥3) and poor quality (GQS <3), and between accurate videos and misleading or neither accurate nor misleading videos. P-values < 0.05 were considered statistically significant.

3. Results

The general features (production source, duration on YouTube, video length, and total number of views, likes, and subscribers) of the 50 most-viewed videos are presented in Table 1. The web address, title of the videos on YouTube, and detailed data are presented in Supplementary 1. Of the 50 videos, 17 were produced by hospitals or physicians, 17 by television or internet-based news or programs, and 9 by nutrition, wellness, or fitness channels. Additionally, three videos were produced by consumers, three by company channels or product advertisements, and two by nurses. The average mDISCERN score of the included 50 videos was 2.2 ± 1.4. Of these videos, 46% (n = 23) contained information with high reliability. The distribution of the videos according to the mDISCERN scores was as follows: 5 points, n = 3; 4 points, n = 5; 3 points, n = 15; 2 points, n = 7; 1 point, n = 15; and 0 points, n = 5. Regarding the assessment of information quality, the average GQS score of the included videos was 2.2 ± 1.1 (2 points, generally poor). Furthermore, 19 videos (36%) were of moderate (n = 13, 26%), good (n = 5, 10%), or excellent (n = 1, 2%) quality, whereas 18 (36%) and 13 (26%) videos were of poor and generally poor quality, respectively. Additionally, 26% (n = 13) were classified as accurate videos and 48% (n = 24) as misleading videos. The remaining 26% (n = 13) were classified as neither accurate nor misleading. The inter-rater reliabilities of the mDISCERN, GQS, and accuracy were high (intra-class correlation coefficient; mDISCERN = 0.896, GQS = 0.862, and accuracy = 0.906).

Table 2

Comparison of the general features and results of the assessment of the videos among the groups according to production sources.

Variables	Nutrition, wellness, or fitness channels (n = 9)	Television or internet-based news or programs (n = 17)	Consumers (n = 3)	Company channels or product advertisements (n = 2)	Medical professionals (medical doctors) (n = 17)	Nurses (n = 2)	p-value
mDISCERN	1.78 ± 0.83/ 2 (1, 3)	2.47 ± 1.37/ 3 (0, 5)	1.33 ± 1.53/ 1 (0, 3)	2 ± 1.41/ 2 (1, 3)	2.47 ± 1.59/ 3 (0, 5)	0.5 ± 0.71/ 0.5 (0, 1)	0.277
GQS	1.67 ± 0.71/ 2 (1, 3)	2.35 ± 0.93/ 2 (1, 4)	1.33 ± 0.58/ 1 (1, 2)	2 ± 1.41/ 2 (1, 3)	2.53 ± 1.33/ 3 (1, 5)	1 ± 0/ 1 (1, 1)	0.138
Accuracy							0.135
Misleading	7 (77.8)	8 (47.1)	1 (33.3)	1 (50)	7 (41.2)	0 (0)	
Neither accurate nor misleading	2 (22.2)	4 (23.5)	2 (66.7)	1 (50)	3 (17.6)	2 (100)	
Accurate	0 (0)	5 (29.4)	0 (0)	0 (0)	7 (41.2)	0 (0)	
Duration on YouTube (months)	13.33 ± 6/ 13 (4, 22)	17.82 ± 4.91/ 20 (10, 24)	17.33 ± 4.51/ 17 (13, 22)	18.5 ± 0.71/ 18.5 (18, 19)	15.12 ± 5.41/ 13 (7, 22)	10 ± 5.66/ 10 (6, 14)	0.272
Video length	3350.89 ± 5576.09/ 751 (156, 16,832)	656.47 ± 709.92/ 311 (84, 2746)	1114.33 ± 1155.87/ 823 (132, 2388)	900 ± 422.85/ 900 (601, 1199)	715.18 ± 657.66/ 504 (42, 2394)	708 ± 16.97/ 708 (696, 720)	0.728
Views	59,192.56 ± 66,785.55/ 33,597 (4456, 210,859)	138,130.7 ± 306,307.4/ 11,319 (4346, 1032,403)	15,850 ± 12,171.97/ 13,442(5062, 29,046)	9034 ± 3723.62/ 9034 (6401, 11,667)	976,715.1 ± 1800,001.4/ 127,130 (5112,7019,077)	33,809 ± 16,222.44/ 33,809 (22,338, 45,280)	0.112
Likes	1783.25 ± 2863.17/ 744.5 (146, 8700)	2165.76 ± 5192.56/ 272 (44, 21,000)	201.67 ± 173.67/ 158 (54, 393)	796.5 ± 169/ 796.5 (677, 916)	17150.12 ± 28014.96/ 1900 (107, 95000)	382 ± 175.36/ 382 (258, 506)	0.074
Subscribers	1004,306.7 ± 2301,854.7/ 16,000 (717, 6200,000)	2686,008.9 ± 4599,092.3/ 521,000 (105,15,300,000)	4086.67 ± 2265.93/ 3830 (1960, 6470)	125,950 ± 159,876.8/ 125,950 (12,900,239,000)	897,266 ± 1617,490.4/ 495,000 (132, 6770,000)	47,600 ± 0/ 47,600 (47600, 47,600)	0.389

Values are presented as frequencies (percentages) or means ± standard deviations/medians (minimum, maximum).
The p-values were obtained using chi-square test or Kruskal–Wallis test for non-parametric data.
(mDISCERN, modified DISCERN; GQS, Global Quality Scale)

The videos did not differ significantly with respect to the production sources, mDISCERN score, GQS score, and accuracy (p > 0.05 for all in the Kruskal–Wallis and chi-square tests) (Table 2). In addition, there was no significant difference in the other data, including duration on YouTube, video length, number of views, number of likes, and number of subscribers for the different production sources (p > 0.05 for all in the Kruskal–Wallis test) (Table 2).

The Mann–Whitney U-test analysis of the videos with mDISCERN scores ≥ 3 and < 3 did not show a significant difference in the duration on YouTube (p = 0.314), video length (p = 0.355), number of views (p = 0.661), number of likes (p = 0.638), and number of subscribers (p = 0.716). In addition, the Mann–Whitney U-test analysis of videos with moderate to excellent quality (GQS ≥3) and poor quality (GQS <3) did not show a significant difference in the duration on YouTube (p = 0.315), video length (p = 0.849), number of views (p = 0.624), number of likes (p = 0.845), and number of subscribers (p = 0.492). Similarly, in the comparison between the accurate videos and the misleading or neither accurate nor misleading videos, no significant difference was observed with the Mann-Whitney U-test (duration on YouTube, p = 0.824; video length, p = 0.283; number of views, p = 0.868; number of likes, p = 0.937; number of subscribers, p = 0.216).

4. Discussion

This study showed that 54% of the 50 most-viewed videos on the effect of vitamin C on COVID-19 were not reliable. Moreover, 62% had poor quality, and 74% were either misleading or neither accurate nor misleading. Hence, there is concern regarding the reliability, quality, and accuracy of the 50 most-viewed videos on the Internet on the effect of vitamin C on COVID-19.

Several previous studies have evaluated the effect of vitamin C on COVID-19, but their results were inconsistent.[10–18] These inconsistent results have contributed to the increased confusion regarding the use of vitamin C for managing COVID-19 patients. Some recent meta-analysis studies concluded that there is a lack of evidence supporting the therapeutic use of vitamin C in COVID-19 patients.[19,20] We cannot determine whether vitamin C is effective in controlling the COVID-19 symptoms and in reducing the mortality rate, hospitalization rate, and length of hospital stay. In addition, no study has reported the beneficial effects of vitamin C in preventing COVID-19. Therefore, the information that vitamin C is effective in managing COVID-19 symptoms and that it results in good therapeutic outcomes or prevents COVID-19 is inaccurate or misleading. Only 26% of the videos contained accurate information regarding the effect of vitamin C on COVID-19. Furthermore, more than half of the included videos were not reliable and had poor quality content. Inaccurate or biased videos can result in misconceptions regarding the effect of vitamin C on COVID-19, which can lead to the application of unnecessary treatment in patients.

Prior to conducting this study, we assumed that the videos made by doctors would have higher reliability, quality, and accuracy as compared to those made by other sources. However, even though the videos were made by doctors, their reliability, quality, and accuracy results did not differ significantly from those of the other videos, including those made by fitness channels, television or internet-based news or programs, consumers, company channels or product advertisements, or nurses. Our study showed that even doctors posted videos that were inaccurate and of low reliability and low quality. Doctors should review previous studies thoroughly prior to making videos and create their videos based on accurate and verified facts. Likewise, individuals, companies, or broadcast stations need to consult specialists with sufficient knowledge regarding the effectiveness of vitamin C treatment in COVID-19 patients.

Videos with high reliability or quality and those containing accurate information did not have more likes or subscribers than those with poor reliability or poor quality and inaccurate information. This suggests that the public has difficulty in assessing whether the information provided in videos is correct. For the public to have accurate knowledge of the effect of vitamin C on COVID-19, the medical professionals' society should create videos with accurate information and share them on social media platforms, such as YouTube.

5. Conclusions

In conclusion, we found that the reliability, quality, and accuracy of the most-viewed 50 YouTube videos on the effect of vitamin C on COVID-19 were low. With the growing and advancing importance of social media in the health field, video creators, especially medical professionals, should make an effort to post content that is reliable and of high quality to ensure that correct information is disseminated. Our study is the first to evaluate the reliability, quality, and accuracy of the information provided by YouTube videos on the effect of vitamin C on COVID-19. However, it included only 50 most-viewed videos, which is a limitation. Although our statistical analyses did not reveal any significant intergroup differences, we think that such differences may become apparent if a larger number of videos are included in future analyses. Future studies compensating for this limitation are warranted.

CRediT authorship contribution statement

Hyunsong Lee, Min Cheol Chang: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Roles/Writing – original draft, Writing – review & Editing. **Hyunsong Lee**: Project administration. **Min Cheol Chang**: Supervision.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgments

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ctim.2022.102827.

References

1 Chang MC, Park YK, Kim BO, Park D. Risk factors for disease progression in COVID-19 patients. *BMC Infect Dis*. 2020;20:445.

2 Zhou W, Wang W. Fast-spreading SARS-CoV-2 variants: challenges to and new design strategies of COVID-19 vaccines. *Signal Transduct Target Ther*. 2021;6:226.

3 Baj J, Karakuła-Juchnowicz H, Teresiński G, et al. COVID-19: specific and non-specific clinical manifestations and symptoms: the current state of knowledge. *J Clin Med*. 2020;9:1753.

4 Lee J, Kim SY, Sung H, Choe YJ, Hong KH, eds. *J Korean Med Sci*. 2020;35, e338.

5 Fung M, Babik JM. COVID-19 in immunocompromised hosts: what we know so far. *Clin Infect Dis*. 2021;72:340–350.

6 Hariyanto TI, Japar KV, Kwenandar F, et al. Inflammatory and hematologic markers as predictors of severe outcomes in COVID-19 infection: a systematic review and meta-analysis. *Am J Emerg Med*. 2021;41:110–119.

7 Carr AC, Maggini S. Vitamin C and immune function. *Nutrients*. 2017;9:1211.

8 Chen Y, Luo G, Yuan J, et al. Vitamin C mitigates oxidative stress and tumor necrosis factor-alpha in severe community-acquired pneumonia and LPS-induced macrophages. *Mediat Inflamm*. 2014;2014, 426740.

9 Härtel C, Strunk T, Bucsky P, Schultz C. Effects of vitamin C on intracytoplasmic cytokine production in human whole blood monocytes and lymphocytes. *Cytokine*. 2004;27:101–106.

10 Gao D, Xu M, Wang G, et al. The efficiency and safety of high-dose vitamin C in patients with COVID-19: a retrospective cohort study. *Aging (Albany NY)*. 2021;13:7020–7034.

11 Kumari P, Dembra S, Dembra P, et al. The role of vitamin C as adjuvant therapy in COVID-19. *Cureus*. 2020;12, e11779.

12 Zhao B, Liu M, Liu P, et al. High dose intravenous vitamin C for preventing the disease aggravation of moderate COVID-19 pneumonia. a retrospective propensity matched before-after study. *Front Pharm*. 2021;12, 638556.

13 JamaliMoghadamSiahkali S, Zarezade B, Koolaji S, et al. Safety and effectiveness of high-dose vitamin C in patients with COVID-19: a randomized open-label clinical trial. *Eur J Med Res*. 2021;26:20.

15 Li M, Ching TH, Hipple C, Lopez R, Sahibzada A, Rahman H. Use of Intravenous Vitamin C in Critically Ill Patients With COVID-19 Infection. *J Pharm Pract*. 2021, 8971900211015052.

16 Suna K, Melahat UŞ, Murat Y, Figen ÖE, Ayperi Ö. Effect of high-dose intravenous vitamin C on prognosis in patients with SARS-CoV-2 pneumonia. *Med Clin (Barc)*. 2021;S0025–7753(21):00252–00259.

17 Thomas S, Patel D, Bittel B, et al. Effect of high-dose zinc and ascorbic acid supplementation vs usual care on symptom length and reduction among ambulatory patients with SARS-CoV-2 infection: the COVID A to Z randomized clinical trial. *JAMA Netw Open*. 2021;4, e210369.

18 Zhang J, Rao X, Li Y, et al. Pilot trial of high-dose vitamin C in critically ill COVID-19 patients. *Ann Intensive Care*. 2021;11:5.

19 Kwak SG, Choo YJ, Chang MC. The effectiveness of high-dose intravenous vitamin C for patients with coronavirus disease 2019: A systematic review and meta-analysis. *Complement Ther Med*. 2021;64, 102797.

20 Rawat D, Roy A, Maitra S, Gulati A, Khanna P, Baidya DK. Vitamin C and COVID-19 treatment: A systematic review and meta-analysis of randomized controlled trials. *Diabetes Metab Syndr*. 2021;15, 102324.

21 Chang MC, Park D. YouTube as a source of information on epidural steroid injection. *J Pain Res*. 2021;14:1353–1357.

22 Charnock D, Shepperd S, Needham G, Gann R. DISCERN: an instrument for judging the quality of written consumer health information on treatment choices. *J Epidemiol Community Health*. 1999;53:105–111.

23 Bernard A, Langille M, Hughes S, et al. A systematic review of patient inflammatory bowel disease information resources on the World Wide Web. *Am J Gastroenterol*. 2007;102:2070–2077.