

RESEARCH PAPER



A global pandemic in the time of viral memes: COVID-19 vaccine misinformation and disinformation on TikTok

Corey H. Basch^a, Zoe Meleo-Erwin^a, Joseph Fera^b, Christie Jaime^a, and Charles E. Basch^c

^aDepartment of Public Health, William Paterson University, Wayne, New Jersey, USA; ^bDepartment of Mathematics, Lehman College, The City University of New York, New York, New York, USA; ^cDepartment of Health and Behavior Studies, Teachers College, Columbia University, New York, New York, USA

ABSTRACT

Misinformation and disinformation regarding COVID-19 and vaccination against it may be contributing to vaccine hesitancy. Social media outlets have reportedly made efforts to limit false information yet untruths related to COVID-19 persist online. The purpose of this study was to describe the content on COVID-19 vaccination on TikTok, an emerging social media platform. One-hundred trending videos were identified from the hashtag #covidvaccine and were coded for content. Collectively, these videos garnered over 35 million views. The coding category with the highest number of videos was “Discouraged a Vaccine” (n = 38), followed by “Encouraged a Vaccine” (n = 36). While only 36 videos discouraged a vaccine, these videos garnered over 50% of the total cumulative views and just under 50% of the total likes; the 38 videos that discouraged a vaccine garnered 39.6% of the total cumulative views, 44.3% of likes, and 47.4% of comments. Of the 38 videos discouraging the vaccine, 25 (65.79%) showed a parody of an adverse reaction and, collectively, received 71.07% of the total views among videos in this category. Twenty-two of these 38 videos (57.89%) falsely conveyed that a vaccine was available, as they were not at the time of the study. Anti-vaccination messaging may undermine efforts to ensure widespread uptake of the various COVID-19 vaccines, particularly for young people who are more likely than other age cohorts to use TikTok.

ARTICLE HISTORY

Received 23 December 2020
Revised 1 February 2021
Accepted 19 February 2021

KEYWORDS

TikTok; COVID-19; social media; vaccine; prevention; anti-vaccination

Introduction

On December 3, 2020, government regulators in the United Kingdom authorized emergency use of the Pfizer and BioNTech mRNA COVID-19 vaccine.¹ Days later, 90-year-old grandmother Margaret Keenan made history by becoming the first person in the West to be vaccinated.² On December 11th, the regulators in the United States followed suit, approving emergency use of the same vaccine.³ The following Monday, a nurse at the Long Island Jewish Medical Center in Queens, New York City – Sandra Lindsay – became the first American to receive the vaccine. News outlets reported that following the vaccination, onlookers applauded, and Lindsay commented, “I hope this marks the beginning to the end of a very painful time in our history”.⁴ In a bittersweet turn of events, on this same date the United States hit a grim milestone as the COVID-19 death toll surpassed 300,000.⁵

The rapid development and emergency use authorization of what appears to be a safe and effective vaccine for COVID-19 is cause for celebration and provides a beacon of hope in the face of what has been a devastating global pandemic. Other vaccines are in various stages of the research, development, and approval pipeline. Their eventual release will help to increase supply around the world. However monumental these developments, they are only half of the battle.

Beyond issues with supply, storage, transport, distribution, and equity, concerns remain about the willingness of individuals around the world to be vaccinated. Within the United States, a September 2020 poll conducted by the Kaiser Family Foundation⁶ found that most Americans believed that the Trump administration was rushing approval of the vaccine without ensuring safety and efficacy. Roughly 40% of the respondents expressed concern that COVID-19 vaccine decision-making on the part of both the Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC) would be impacted by political pressures. More recently, a December 2020 poll suggested that over 61% of the individuals in the United States were willing to be vaccinated.⁷ Though the results indicated that acceptance of vaccination for COVID-19 was increasing in the country, vaccine hesitancy nevertheless remains of utmost concern. Without widespread uptake of COVID-19 vaccines, mitigation and control efforts will be severely undermined, leading to untold preventable morbidity and mortality.

In 2014, the World Health Organization (WHO) Strategic Advisory Group of Experts (SAGE) on Immunization defined vaccine hesitancy as a “delay in acceptance or refusal of vaccination despite the availability of vaccination services.”⁸ The WHO identified vaccine hesitancy as one of the top ten threats to global health in 2019.⁹ Though sometimes attributed merely to misunderstanding,¹⁰ vaccine hesitancy is not a straight-

forward phenomenon, with variation over time, by place, and by type of vaccine.¹¹ Attitudes toward vaccination are often driven by a complex of factors including trust (or lack thereof) in health care professionals, health care systems, science, and government,¹¹ cultural and religious factors,¹² and the trauma of and mistrust due to historical and ongoing systemic racism.¹³

In contrast to staunch opponents, vaccine-hesitant “fence-sitters” may be driven by concerns of safety and adverse effects.¹¹ This population therefore must be a key target for public health education and outreach. The need to develop clear, understandable, and effective health communication and education messaging that addresses not only vaccine hesitancy per se but the various reasons why the public may hold ambivalent attitudes toward COVID-19 vaccination could not be more pressing.

Misinformation and disinformation about the coronavirus in general (e.g., conspiracy theories about the origins of the virus, the promotion of inefficacious and potentially dangerous treatments) and vaccination against the coronavirus specifically (e.g., safety and efficacy) may be contributing to COVID-19 vaccine hesitancy. Whereas misinformation involves drawing erroneous conclusions about a given phenomenon based on incorrect or incomplete facts, a disinformation campaign involves active effort to spread false information to advance a particular agenda.¹⁴ Notably, a July 2020 Pew Research Center poll found that nearly 75% of the American public was familiar with a conspiracy theory surrounding the coronavirus and 25% of the respondents believed the theory was at least partially true.¹⁵

Given the severity of the COVID-19 global pandemic, some may have assumed that such practices might have waned. In fact, an “infodemic” pertaining to COVID-19 has proliferated.^{16,17} As with such inaccurate vaccination content prior to the pandemic,¹¹ the internet – including social media – is a key communication channel through which COVID-19 mis- and disinformation have rapidly spread.^{16,17} Social media outlets have reportedly made strident efforts, nevertheless untruths related to COVID-19 persist online.^{18,19} Such falsehoods come in many forms, including memes. While intended to be humorous, it is possible that repeated exposure to COVID-19 memes may reinforce inaccurate information.

Individuals of all ages use social media, with different age cohorts gravitating toward different platforms.²⁰ Youth generally prefer sites such as TikTok as well as Instagram and Snapchat.^{20,21} The use of TikTok, a short-form mobile video sharing app, appears to have increased substantially during 2020, with some estimates putting growth at 75% since the start of the year.²² In August of 2020, TikTok saw over 2 billion global downloads.²³ Within the United States, approximately one in six individuals uses TikTok weekly.²²

Recent research suggests that young people (ages 18–29) are less likely than older adults to hold negative attitudes toward COVID-19 vaccination.²⁴ Nevertheless, younger adults often rely on social media for health information²⁵ and tend to have low levels of health literacy.²⁶ Youth may therefore be particularly vulnerable to mis- and disinformation about COVID-19 vaccines spread via social media.

Though combatting vaccine hesitancy is not an easy endeavor,²⁷ efforts to do so should involve awareness of and targeted responses to COVID-19 vaccine misinformation and disinformation proliferating online.^{17,28} The results of our prior study on general information about COVID-19 on TikTok indicated a lack of focus on prevention.²⁹ Despite the growth and reach of TikTok, and the importance of effective communication to the public to motivate and enable them to make informed decisions about vaccination, we did not identify any published studies on COVID-19 vaccination on TikTok. The purpose of this study was, therefore, to describe TikTok content on COVID-19 vaccination.

Methods

The methods for this study mirrored those used for our prior studies of TikTok and COVID-19.^{29,30} One-hundred trending videos were identified from the hashtag #covidvaccine. At the time of the study, this was the most popular of the COVID-19 hashtags with approximately 73.8 million views.

Content categories were created using a fact sheet from the CDC³¹ and our prior study on YouTube and COVID-19 vaccines.³² Details coded included number of videos, number and percent of cumulative views, video likes and comments, language (English or Spanish), and if the video incorporated dance, music or humor. Additionally, the source of the post was determined to be consumer (members of the general public) or professionals (registered nurses, doctors, researchers, etc.).

Coding began by identifying if the video discouraged or encouraged the vaccine. One post was excluded and replaced for being in a language other than English or Spanish. Further content categories included if the video highlighted any of the following: the false claim that a vaccine was available for uptake (at the time the data was collected, it was not available in the US), a parody/meme of an adverse reaction, the vaccine development process, and identification of a specific company. Additional categories included mention of the following, trial volunteers, a human trial, manufacturing process and/or cost, dosing, length of time to develop, and fast-tracking. Final categories included that COVID-19 is a hoax, that the vaccine is a hoax, focus on an animal trial, herd immunity, that a vaccine should be mandatory for schools, or raised religious objections to a vaccine.

One individual (CJ) coded all videos and a second (CHB) coded a 10% random sample to demonstrate inter-rater reliability, which was high overall ($\kappa = .94$). In fact, across all categories there were only six discrepancies: uses dance (1), mentions length of time to develop (1), mentions emergency use (1), mentions a specific company (1), concerns about effectiveness (2). Quantitative analysis considered number of views, likes, and comments, and the examined differences in content addressed in high count (>20) videos by sentiment that encouraged vs. discouraged use of the COVID-19 vaccine. MS Excel was utilized to tabulate all observations and to run descriptive statistics. As per their protocol, the Institutional Review Board (IRB) at William Paterson University did not review

this study as it did not involve human subjects. This study was considered exempt by the IRB at Teachers College, Columbia University.

Results

In total, the 100 videos studied garnered 35,338,600 views with an average of 353,386 (SD = 570,440). The videos collectively received 5,443,223 likes and 119,004 comments with respective averages of 54,432 (SD = 106,924) and 1,190 (SD = 2,385), respectively. One video was recorded and coded in Spanish, while all others were recorded and coded in English. In total, 35 videos used music and 14 used dance. The videos using music accounted for 24.3% of the views, 28.3% of the comments, and 26.7% of the likes. Those that used dance accounted for 9.5% of the views, 19.0% of the comments, and 15.6% of the likes.

Table 1 shows a list of content categories by number of videos, number and percent of cumulative views, number and percent of likes and comments. The coding category conveyed in the highest number of videos was “Discouraged a Vaccine” (n = 38), followed by “Encouraged a Vaccine” (n = 36). While only 36 videos “Encouraged a Vaccine,” these videos garnered over 50% of the total cumulative views and just under 50% of the total likes, while the 38 videos that “Discouraged a Vaccine” accounted for 39.6% of the total cumulative views, 44.3% of likes, and 47.4% of comments. Vaccine effectiveness in conferring immunity, duration of immunity, emergency use, universal vaccine, vaccine distribution, and who should be vaccinated was only addressed in one of the 100 trending videos, while none of the videos covered herd immunity, that a vaccine should be mandatory for schools, or raised religious objections to a vaccine (data not shown).

Independent t-tests (alpha=0.05) indicate that encouraging vs. discouraging the COVID-19 vaccination did not have a statistical effect on the number of views ($p = .1951$), likes ($p = .3718$), or comments ($p = .39$). There were three content coding categories with a video count greater than 20: (1) vaccine development process (2) falsely claims vaccine availability for public uptake (3) shows a parody/meme of an adverse reaction. Chi-square tests displayed statistically significant differences ($P < .001$) between videos that discouraged versus encouraged use of a vaccine in all three content categories (Table 2). Of the 36 videos that encouraged the vaccine, only 1 (2.78%) showed a parody of an adverse reaction. This 1 video received 7.24% of the total views among videos that encouraged a vaccine. Seven of these 36 videos (19.44%) falsely convey that a vaccination is available, as no vaccine was available for distribution in the United States at the time of study. These 7 videos received 26.31% of the total views among videos that encouraged the vaccine. Of the 38 videos that discouraged the vaccine, 25 (65.79%) showed a parody of an adverse reaction, and collectively, these videos received 71.07% of the total views received by videos that discouraged the vaccine. Twenty-two of these 38 videos (57.89%) falsely conveyed that a vaccination was available. These 22 videos received 68.78% of the total views among videos that discouraged the vaccine. Videos discouraging a vaccine were less likely to cover the vaccination development process when compared to videos that encouraged a vaccine (2.63% vs. 47.22%).

Discussion

To our knowledge, this is the first study to examine COVID-19 vaccine sentiment and content on TikTok. While a slightly

Table 1. Characteristics and content of 100 trending TikTok videos related to COVID-19 vaccinations.

	Count	Video Views		Video Likes		Video Comments	
	100	35,338,600	%	5,443,223	%	119,004	%
Discouraged a Vaccine	38	14,008,600	39.64%	2,411,488	44.30%	56,431	47.42%
Encouraged a Vaccine	36	17,964,700	50.84%	2,622,820	48.19%	47,203	39.67%
Falsely Claims Vaccine Availability for Public Uptake	31	15,195,600	43.00%	2,070,254	38.03%	53,300	44.79%
Parody/Meme of an Adverse Reaction	26	11,255,900	31.85%	1,557,844	28.62%	41,075	34.52%
Vaccine Development Process	23	13,859,000	39.22%	2,013,108	36.98%	33,857	28.45%
Specific Company Identified	17	5,566,600	15.75%	1,159,267	21.30%	15,032	12.63%
Trial Volunteers	13	6,994,800	19.79%	801,485	14.72%	19,415	16.31%
Human Trial	11	5,860,500	16.58%	704,115	12.94%	14,879	12.50%
Manufacturing Process and/or Cost	9	7,166,600	20.28%	1,129,634	20.75%	17,994	15.12%
Dosing	7	3,345,100	9.47%	443,033	8.14%	10,031	8.43%
Length of Time to Develop	6	4,259,700	12.05%	536,149	9.85%	11,193	9.41%
Vaccine Being Fast-Tracked	4	2,163,000	6.12%	260,004	4.78%	7,126	5.99%
COVID is a Hoax	3	251,500	0.71%	25,191	0.46%	1,337	1.12%
Vaccine is a Hoax	3	296,900	0.84%	40,330	0.74%	1,583	1.33%
Animal Trial	2	1,852,300	5.24%	245,700	4.51%	1,465	1.23%

Table 2. Content addressed in high count (>20) videos by sentiment that encouraged vs. discouraged use of the COVID-19 vaccine.

	Encouraged Vaccine (n=36)		Discouraged Vaccine (n=38)	
	Count	% of Total	Count	% of Total
Covers the Vaccine Development Process	17	47.22%	1	2.63%
Falsely Claims Vaccine Availability for Public Uptake	7	19.44%	22	57.89%
Parody/Meme of an Adverse Reaction	1	2.78%	25	65.79%

larger number of posts discouraged versus encouraged a COVID-19 vaccine, the more troubling aspect of the discouraging posts was the display of a parody/meme of an adverse reaction, even before the vaccine was being distributed to the public. We believe this reflects a deliberate and dangerous effort to communicate anti-vaccination sentiment.

The limitations of this study include the inability to generalize the results due to the cross-sectional design and the relatively small sample size. Further, like all social media platforms, TikTok is changing at a rapid pace. The content examined was delimited in scope and different categories may warrant examination. Nevertheless, this study of TikTok and COVID-19 vaccination examines an emerging social media channel reaching tens of millions of people and illustrates how it can be used to encourage or discourage vaccine messages among youth.

The vast majority of young people between the ages of 18 and 30 years of age rely on online sources of health information.²⁵ While young people may have high levels of digital literacy, they tend to have comparatively low levels of health literacy, limiting their ability to critically evaluate online content, including that found on social media.^{26,33} Recent investigations have also suggested that youth have been more likely than other age cohorts to adopt conspiracy theories about COVID-19, including the origins of the SARS-CoV-2 virus as well as its seriousness, with ongoing negative impacts on preventative behaviors.¹⁸ At the same time, there is some indication that young people want further information about vaccines and to be more actively engaged in family decision-making around vaccination.³⁴

Social media is a dominant set of communication channels that can help engage young adults and reach vaccine-hesitant populations with up-to-date science about the safety and effectiveness of vaccines for COVID-19 and other infectious diseases. Our findings, however, show that millions are viewing videos conveying anti-vaccination sentiment. As health teams throughout the nation design and implement educational outreach and communication campaigns to help the public make informed decisions about COVID-19 vaccination, anti-vaccination messaging may undermine efforts to ensure widespread uptake of the various COVID-19 vaccines.

ORCID

Corey H. Basch  <http://orcid.org/0000-0003-4862-4229>

References

- Ledford H, Cyranoski D, Van Noorden R. The UK has approved a COVID vaccine – here's what scientists now want to know. *Nature*. 2020 Dec 3. [accessed 2020 Dec 18]. <https://www.nature.com/articles/d41586-020-03441-8>.
- National Public Radio. Much relief in the U.K. as inoculations against COVID-19 begin. 2020 Dec 9. [accessed 2020 Dec 18]. <https://www.npr.org/2020/12/09/944528438/much-relief-in-the-u-k-as-inoculations-against-covid-19-begin>.
- U.S. Food & Drug Administration. FDA takes key action in fight against COVID-19 by issuing emergency use authorization for first COVID-19 vaccine. 2020 Dec 11. [accessed 2020 Dec 18]. <https://www.fda.gov/news-events/press-announcements/fda-takes-key-action-fight-against-covid-19-issuing-emergency-use-authorization-first-covid-19#:~:text=Today%2C%20the%20U.S.%20Food%20and,years%20of%20age%20and%20older>
- Hart B. Watch: first New Yorker vaccinated against COVID-19. *New York Magazine*. 2020 Dec 14. [accessed 2020 Dec 18]. <https://nymag.com/intelligencer/2020/12/sandra-lindsay-is-first-new-yorker-vaccinated-against-covid.html>
- Harmon A The number of people with the virus who died in the U.S. passes 300,000. *New York Times*. 2020 Dec 14. [accessed 2020 Dec 18]. https://www.nytimes.com/live/2020/12/14/world/covid-19-coronavirus?campaign_id=60&emc=edit_na_20201214&instance_id=0&nl=breaking-news&ref=headline®i_id=38375348&segment_id=46904&user_id=cdbc6cf5198e60a6acaff7d46a2a46e2# covid-us-deaths
- Kaiser Family Foundation. Poll: Most Americans worry political pressure will lead to premature approval of a COVID-19 vaccine; half say they would not get a free vaccine approved before election day. 2020 Sep 10. [accessed 2020 Dec 18]. <https://www.kff.org/coronavirus-covid-19/press-release/poll-most-americans-worry-political-pressure-will-lead-to-premature-approval-of-a-covid-19-vaccine-half-say-they-would-not-get-a-free-vaccine-approved-before-election-day/>.
- Marist Poll. NPR/PBS NewsHour/Marist Poll Results & Analysis. 2020 Dec 9. [accessed 2020 Dec 18]. <http://maristpoll.marist.edu/npr-pbs-newshour-marist-poll-results-analysis-20/#sthash.OWweEyqt.rGK66R2r.dpbc>.
- MacDonald NE. Vaccine hesitancy: definition, scope and determinants. *Vaccine*. 2015;33(34):4161–64. PMID: 25896383. doi:10.1016/j.vaccine.2015.04.036.
- World Health Organization. Ten threats to global health in 2019. n.d. [accessed 2020 Dec 18]. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>.
- Palamenghi L, Barello S, Boccia S, Graffigna G. Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. *Eur J Epidemiol*. 2020;35:785–88. doi:10.1007/s10654-020-00675-8.
- Verger P, Dubé E. Restoring confidence in vaccines in the COVID-19 era. *Expert Rev Vaccines*. 2020;8:1–3. Epub ahead of print. PMID: 32940574. doi:10.1080/14760584.2020.1825945.
- Harrison EA, Wu JW. Vaccine confidence in the time of COVID-19. *Eur J Epidemiol*. 2020;(4):325–30. PMID: 32318915. doi:10.1007/s10654-020-00634-3.
- Hoffman J 'I won't be used as a guinea pig for white people.' 2020 Oct 7. [accessed 2020 Dec 18]. <https://www.nytimes.com/2020/10/07/health/coronavirus-vaccine-trials-african-americans.html>.
- Igoe KJ Establishing the truth: vaccines, social media, and the spread of misinformation. 2019 Jul 10. [accessed 2020 Dec 18]. <https://www.hsph.harvard.edu/ecpe/vaccines-social-media-spread-misinformation/>.
- Schaeffer K A look at the Americans who believe there is some truth to the conspiracy theory that COVID-19 was planned. 2020, July 24. [accessed 2021 Jan. 31]. <https://www.pewresearch.org/fact-tank/2020/07/24/a-look-at-the-americans-who-believe-there-is-some-truth-to-the-conspiracy-theory-that-covid-19-was-planned/>.
- World Health Organization. Novel Coronavirus (2019-nCoV) Situation Report – 13. 2020 Feb 2. [accessed 2020 Dec 18]. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200202-sitrep-13-ncov-v3.pdf?sfvrsn=195f4010_6.
- Chou WS, Budenz A. Considering emotion in COVID-19 vaccine communication: addressing vaccine hesitancy and fostering vaccine confidence. *Health Commun*. 2020;35(14):1718–22. Epub 2020 Oct 30. PMID: 33124475. doi:10.1080/10410236.2020.1838096.
- Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. *Soc Sci Med*. 2020;263:113356. Epub 2020 Sep 21. PMID: 32967786. doi:10.1016/j.socscimed.2020.113356.
- Issac M Facebook says it will remove coronavirus vaccine misinformation. *New York Times*. 2020 Dec 3. [accessed 2020 Dec 18]. <https://www.nytimes.com/2020/12/03/technology/facebook-coronavirus-vaccine-misinformation.html>.
- Smith A, Anderson M Social media use in 2018. 2018 Mar 1. [accessed 2020 Dec 18]. Pew Research Center. <https://www.pewresearch.org/internet/2018/03/01/social-media-use-in-2018/>.

21. Piper Sandler. Taking stock with teens – Fall 2020 Infographic. n.d. [accessed 2020 Dec 18]. <http://www.pipersandler.com/2col.aspx?id=6040>.
22. Koetsier J. Massive TikTok Growth: Up 75% this year, now 33x more users than nearest direct competitor. 2020 Sep 14. [accessed 2020 Dec 18]. *Forbes*. <https://www.forbes.com/sites/johnkoetsier/2020/09/14/massive-tiktok-growth-up-75-this-year-now-33x-more-users-than-nearest-competitor/?sh=14c37b044fe4>.
23. Sherman A TikTok reveals detailed user numbers for the first time. 2020 Aug 24. [accessed 2020 Dec 18]. *CNBC*. <https://www.cnbc.com/2020/08/24/tiktok-reveals-us-global-user-growth-numbers-for-first-time.html>.
24. Paul E, Steptoe A, Fancourt D. Attitudes towards vaccines and intention to vaccinate against COVID-19: implications for public health communications. *The Lancet*. 2020. [Online first] doi:10.1016/j.lanepi.2020.100012.
25. Prybutok G, Ryan S. Social media: the key to health information access for 18- to 30-year-old college students. *Comput Inform Nurs*. 2015;33(4):132–41. PMID: 25887107. doi:10.1097/CIN.0000000000000147.
26. Stelfefson M, Hanik B, Chaney B, Chaney D, Tennant B, Chavarria EA. eHealth literacy among college students: a systematic review with implications for eHealth education. *J Med Internet Res*. 2011;13(4):e102. PubMed: 22155629. doi:10.2196/jmir.1703.
27. Dubé E, Gagnon D, MacDonald E. Strategies intended to address vaccine hesitancy: review of published reviews. *Vaccine*. 2015;33(34):4191–203. doi:10.1016/j.vaccine.2015.04.041.
28. Wittman HO, Zikmund-Fisher BJ. The defining characteristics of Web 2.0 and their potential influence in the online vaccination debate. *Vaccine*. 2012;30(25):3734–40. doi:10.1016/j.vaccine.2011.12.039.
29. Basch CH, Hillyer GC, Jaime C. COVID-19 on TikTok: harnessing an emerging social media platform to convey important public health messages. *Int J Adolesc Med Health*. 2020. Epub ahead of print. PMID: 32776899. doi:10.1515/ijamh-2020-0111.
30. Basch CH, Fera J, Pierce I, Basch CE Promoting mask use on TikTok: an unconventional approach to public health education. *JMIR Preprints*. 10/ 12/2020:26392
31. Centers for Disease Control and Prevention. Vaccines and immunizations; 2020. [accessed 2020 January 24]. <https://www.cdc.gov/coronavirus/2019-ncov/index.html>.
32. Basch CH, Hillyer GC, Zagnit EA, Basch CE. YouTube coverage of COVID-19 vaccine development: implications for awareness and uptake. *Hum Vaccin Immunother*. 2020 Nov 1;16(11):2582–85. Epub 2020 Jul 23. PMID: 32701403. doi:10.1080/21645515.2020.1790280.
33. Robb M, Shellenbarger T. Influential factors and perceptions of eHealth literacy among undergraduate college students. *On-line J Nursing Inf*. 2014;18(3). doi:10.17645/mac.v7i2.1871.
34. Herman R, McNutt LA, Mehta M, Salmon DA, Bednarczyk RA, Shaw J. Vaccination perspectives among adolescents and their desired role in the decision-making process. *Hum Vaccin Immunother*. 2019;15(7–8):1752–59. Epub 2019 Mar 14. PMID: 30735440. doi:10.1080/21645515.2019.1571891.