

RESEARCH PAPER



Understanding the content of COVID-19 vaccination and pregnancy videos on YouTube: An analysis of videos published at the start of the vaccine rollout

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ABSTRACT

Over 2 years into the COVID-19 pandemic, information on the safety and efficacy of COVID-19 vaccination, particularly for people in high-risk populations, has become a popular topic of discussion. The purpose of this study was to analyze the content and characteristics of YouTube videos related to COVID-19 vaccination and pregnancy. The 50 most viewed English language videos on pregnancy and COVID-19 vaccination were included in this study. The 50 YouTube videos were viewed 4,589,613 times, with 6% uploaded by consumers, 40% by medical professionals, and 44% by television or internet-based news. Videos from consumer sources more often mentioned a human trial of the COVID-19 vaccine (75% of consumer videos vs. 65% of medical professional videos and 31.8% of television or internet-based news videos, $P = .036$) and more often mentioned anti-vaccination sentiment, fear, or distrust of the vaccines (37.5% of consumer videos vs 5.0% of medical professional videos and 4.5% of television or internet-based news videos, $P = .018$). Videos uploaded by medical professionals more often mentioned emergency use of the COVID-19 vaccines ($P = .016$), passive immunity in general ($P = .011$), and that the COVID-19 vaccine is either unlikely to or will not cause harm in breastfeeding more often than did videos from consumer or television-based news sources ($P = .034$). New information regarding COVID-19 vaccination and pregnancy is continuing to emerge, and this study highlights that the information found in the most viewed YouTube videos on this topic can quickly become outdated.

ARTICLE HISTORY

Received 5 April 2021
Revised 30 March 2022
Accepted 13 April 2022

KEYWORDS

YouTube; social media; misinformation; vaccination; pregnancy; COVID-19

Introduction

COVID-19

Since the start of the COVID-19 pandemic over 2 years ago, COVID-19 continues to spread worldwide. It has been established that SARS-CoV-2 is easily transmissible as it can travel in respiratory droplets.¹ Further compounding the issue is the fact that those who are asymptomatic but contagious can unknowingly spread the virus to others.¹ As there is no cure for COVID-19, limiting transmission is paramount for community mitigation.² The United States Centers for Disease Control and Prevention (CDC) recommends measures such as wearing masks and social distancing to prevent the spread of COVID-19.² In addition to these measures, vaccinations offer the highest level of protection. According to the CDC, COVID-19 vaccinations protect one from contracting COVID-19 and can also minimize serious illness.³ In the US, two mRNA vaccines were initially cleared for emergency approval by the U.S. Food and Drug Administration (FDA), with a modified adenovirus vaccine being later approved.⁴ This approval suggests that they are efficacious and that benefits far outweigh the potential side effects.⁵

COVID-19 vaccination and pregnancy

One of the important questions related to COVID-19 vaccine recommendations is how they should address pregnant people. The CDC has consistently been recommending vaccination for

pregnant people,⁶ whereas the World Health Organization (WHO) did not initially, but has since changed their stance to be in favor of vaccinating pregnant people.⁷ Vaccination during pregnancy or breastfeeding would protect the gestational parent from COVID-19 and reduce the risk of neonates' exposure to coronavirus,⁸ thus presenting an important choice for pregnant individuals to make.

Pregnant individuals and their fetuses are high-risk population during an outbreak of pandemic diseases, including COVID-19.⁹ As of March 21, 2022, over 190,000 cases of laboratory-confirmed COVID-19 infection in pregnant people have been reported to the CDC.¹⁰ According to Liu and colleagues, some studies suggest that pregnant people are more likely to contract COVID-19 than the general population because they are more vulnerable to respiratory pathogens.¹¹ While asymptomatic or "mild" cases of COVID-19 among pregnant people are common, pregnant people are at an increased risk for severe illness with COVID-19 than non-pregnant populations,¹² including increased risk of hospitalization, need for intense care, and need for mechanical ventilation.⁹

Moreover, a higher prevalence of preterm deliveries, cesarean delivery, and postpartum hemorrhage has been reported amongst pregnant individuals identified with severe or critical COVID-19 disease.¹² Other important considerations are that individuals of child-bearing potential account for a significant portion of the workers in workplaces with higher exposure to SARS-CoV-2, such as healthcare providers.¹³

Although there is no definitive evidence, recent research suggests neonates can get the SARS-CoV-2 from gestational parents via vertical transmission.¹⁴ Neonates with confirmed COVID-19 were primarily infected due to postnatal exposure to infectious respiratory secretions from infected gestational parents or caregivers.¹⁵

The WHO maintains that pregnant individuals are at higher risk of severe COVID-19 illness, and that those pregnant individuals at increased risk of COVID-19 exposure should consult with their healthcare providers about receiving the vaccine.¹⁶ While the vaccine development process typically takes 10–15 years,¹⁷ the development of COVID-19 vaccines has been accelerated. Despite this accelerated development process, the WHO offers assurance that “all usual safety and efficacy monitoring mechanisms remain in place, such as adverse event surveillance, safety data monitoring and long-term follow-up”.¹⁸ The Emergency Use Authorization has been utilized by the U.S. Food and Drug Administration (FDA) to facilitate the availability and use of COVID-19 vaccines under section 564 of the Federal Food, Drug, and Cosmetic Act.¹⁹ In addition, many other actions, including continuous dialogue between regulatory experts and developers and simultaneous resource mobilization, contributed to fast-track vaccine development.¹⁹ Beyond the Emergency Use Authorization, the FDA approved the Pfizer-BioNTech COVID-19 Vaccine, which is now licensed and being marketed as the Comirnaty vaccine.²⁰ This FDA approval enhances the stature of the vaccine for the prevention of COVID-19 in individuals ages 16 and older.²⁰

However, there is limited data about the utility, safety, and efficacy of COVID-19 vaccines in pregnancy. At the time this paper was written, no clinical trial evaluating COVID-19 vaccines that included pregnant individuals had been completed.²¹ There is also a lack of pregnancy-related research on COVID-19 interventions.²² Further, limited data is available on animal developmental and reproductive toxicity studies.²³

There has been an increased recognition that more attention needs to be paid to this area and more action is needed to ensure equal access to vaccines.²⁴ The CDC also states that there is no need to avoid pregnancy before or after vaccination.⁶ Despite these recommendations, this is an unprecedented and confusing time, which no doubt leaves many searching for answers.

YouTube as a source of information

Information on health and COVID-19 is more accessible than ever due to internet connectivity and electronic media. There is an abundance of information related to COVID-19 on television,^{25,26} social media,²⁷ websites and newspapers.²⁸ Social media platforms such as YouTube, Instagram, Facebook are also major sources of information,²⁹ but recent studies suggest that widespread misinformation about COVID-19 on the internet has posed new challenges to the pandemic.^{30,31}

YouTube is one of the most popular online platforms, with more than two billion global users and over 500 hours of content uploaded to the site per minute.³² It was also recognized as a frequented source of health information, including

pathogenesis, diagnosis, treatment, and prevention of various health conditions.³³ Increasingly, individuals are using YouTube to better understand health concerns.³³ However, valid health information and misleading information that has the potential to promote unapproved treatment or contradicting reference guidelines are both readily accessible by information seekers. For example, a study of YouTube found that 50% of videos in the sample were against immunization in general.³⁴ Misinformation during the COVID-19 pandemic is dangerous because it impacts individual responses to the pandemic, such as whether or not a person chooses to wear a mask, maintains social distance, or uses unapproved medications, including chloroquine, against COVID-19.³⁵

YouTube content may have the potential to change people's attitudes on controversial issues. Because the contents of YouTube videos have this potential to change people's attitudes regarding COVID-19 vaccine and pregnancy, the aim of this study was to review and evaluate the contents of the most frequently viewed English language YouTube videos related to COVID-19 vaccine and pregnancy.

Methods

The methods for this study were adapted from prior studies which analyzed YouTube videos pertaining to the COVID-19 vaccination in the general public.^{36,37} Videos were searched for on February 17, 2021, prior to President Biden's March 3, 2021, announcement of plans to make the COVID-19 vaccine available to every adult in the U.S. by May 2021.³⁸ The keywords “pregnancy and COVID-19 vaccine” were used to search for the videos. After sorting by number of views, the following information was gathered for the 50 most-widely viewed videos in English: URL, upload date, source of video upload (consumer, medical professional, or television or internet-based news), number of views, length of video (in minutes and seconds), and gender of person providing information in the video, were identified. Source of video was classified as consumer (uploaded by lay people), medical professional (videos featuring a physician, advanced practice provider, or nurse providing information), or television or internet-based news (segments uploaded by news divisions, newspapers or internet news organizations).

Content categories developed in prior studies analyzing YouTube videos on COVID-19 vaccinations were included in this study and are described in detail elsewhere.^{36,37} These content categories include content related to vaccine development, manufacturing, fast-tracking, emergency use authorization, eligibility, concerns about adverse reactions, fear, and effectiveness.^{36,37}

Additional categories incorporated into this study include were adapted from a CDC factsheet on COVID-19 vaccination,³⁹ a CDC factsheet on COVID-19 vaccination in pregnant and lactating individuals,⁶ and joint statements on COVID-19 vaccination from the American College of Obstetrics and Gynecology (ACOG) and the Society for Maternal and Fetal Medicine (SMFM).⁴⁰ These content categories included: 1) Immunity (Table 1, Video characteristic 12, 18, 27) 2) Vaccine development and distribution (Table 1, Video characteristics, 4–10,13) 3) Vaccine dosing (Table 1,

Video characteristic 14) 4) Herd immunity (Table 1, Video characteristic 15) 5) Harms/benefits of vaccines (Table 1, Video characteristics 16 and 17) 6) Vaccine composition (Table 1, Video characteristics 30, 33 and 34) 7) Vaccine safety (Table 1, Video characteristics 11, 22 and 32) 8) Data on pregnant individuals (Table 1, Video characteristics 24, 29, 31) 9) Data on breastfeeding (Table 1, Video characteristic 28) 10) Safety of vaccine in breastfeeding (Table 1, Video characteristic 21) 11) Fertility (Table 1, Video characteristics 19 and 20) 12) Shared decision-making (Table 1, Video characteristic 23).

In addition, the authors of this study were interested in exploring whether or not videos about COVID-19 vaccination in pregnant people contained anti-vaccination sentiments or mistrust of the vaccines. The authors were also intrigued by new findings of SARS-CoV-2 antibodies in breastmilk.⁴¹ Thus, the following additional categories were included: Anti-vaccine sentiment (mentions fear or mistrust of the contents of the COVID-19 vaccine or claims that the vaccine is more dangerous than COVID-19) and Passive immunity (in general and specifically through breastmilk).

Coverage of the content found in each of the 50 videos was coded as “yes” or “no” for whether each video mentioned the previously described characteristics. The videos were analyzed by one researcher (PEL), and interrater reliability was determined by a second researcher (CHB) coding a random sample of five videos. Cohen’s kappa ($\kappa = 0.97$) revealed interrater reliability to be excellent. Frequencies and percentages were calculated for all categorical variables. For the variables of number of views and video length, means, standard deviations, and ranges were determined. Chi-square tests and ANOVA were used to determine potential associations between video upload source and the characteristics and content of the videos. All analyses were performed using SPSS version 27 (IBM SPSS, Armonk, NY). Per the policies at both Columbia University and William Paterson University, this protocol was not reviewed by an Institutional Review Board since it did not involve human subjects.

Results

The 50 YouTube videos that were analyzed in this study were viewed 4,589,613 times between April 14, 2020 and February 14, 2021. Of these views, 67.6% (3,103,342/4,589,613) were of videos from a television or internet-based news source (Table 1). The mean number of views was 91,792.26 (SD 359,593.50), with the mean number of views for consumer, medical professional, and television or internet-based news videos of 34,663.00 (SD 28,571.676), 60,448.35 (SD 72,388.46), and 141,061.00 (SD 540,353.89), respectively. The mean length of the videos was 9 minutes 11 seconds (SD 8 minutes 27 seconds). Most videos were uploaded between September 15, 2020 and February 14, 2021 (43/50, 86%), and were sourced from television or internet-based news (22/50, 44%).

Consumer videos more often mentioned a human trial of the COVID-19 vaccine (75% of consumer videos (6/8) vs. 65% of medical professional videos (13/20) and 31.8% of television or internet-based news videos (7/22), $P = .036$). Additionally, consumer videos also mentioned anti-vaccination sentiment,

fear, or distrust of the vaccines more often than did medical professional videos and television or internet-based news videos (37.5%, (3/8) vs 5.0% (1/20) and 4.5% (1/22), respectively, $P = .018$).

Videos by medical professionals more often mentioned emergency use authorization of the COVID-19 vaccines (25% of medical professional videos (5/15) vs 0% of consumer videos and 0% of television or internet-based news videos, $P = .016$). Passive immunity in general was mentioned more often in videos from medical professionals (35% of medical professional videos (7/20) vs 25% of consumer videos (2/8) and 0% of television or internet-based news videos, $P = .011$). From medical professionals also mentioned the COVID-19 vaccine is either unlikely to or will not cause harm in breastfeeding more often than did videos from consumer or television-based news sources (35% of medical professional videos (7/20) vs 12.5% of consumer videos (1/8) and 4.5% of television or internet-based news videos (1/22), $P = .034$). Television or internet-based news videos less often mentioned passive immunity specifically from antibodies passed through breastfeeding (0% of television or internet-based news videos vs 25% of consumer videos (2/8) and 25% of medical professional videos (5/20), $P = .041$) and also less often mentioned the Society for Maternal and Fetal Medicine (SMFM) (0% of television or internet-based news videos vs 25% of consumer videos (2/8) and 25% of medical professional videos (5/20), $P = .041$).

Overall, the videos in this sample often mentioned that vaccines studies did not include pregnant patients (56%, 28/50), that there is not enough data regarding the vaccine and pregnant people (48%, 24/50), and that pregnant people who get COVID-19 have more risk to experience a worse outcome (54%, 27/50).

Discussion

To our knowledge, this is the first peer-reviewed paper describing the content of YouTube videos related to COVID-19 vaccination in pregnant individuals. Most videos were uploaded between September 15, 2020 and February 14, 2021, during which the first COVID-19 vaccine was administered in the U.S. on December 14, 2020⁴² and ACOG and SMFM released a joint statement on COVID-19 vaccination and pregnancy on January 27, 2020.⁴⁰ The 50 most viewed videos on COVID-19 vaccination in pregnancy have been viewed 4,589,613 times as of March 16, 2021, and that number has only increased since. Thus, it is evident that YouTube is a popular platform for individuals seeking information on COVID-19 vaccination and pregnancy. Because of this, public health campaigns to educate pregnant and breastfeeding individuals about vaccine uptake could benefit from creating content on YouTube due to the popularity and accessibility of the platform. These public health campaigns could seek to gain the trust of consumers by partnering with popular medical professional YouTube creators to create content that clears misconceptions about human trials, COVID-19 vaccination and pregnancy.

Consumer videos more often mentioned a human trial of the COVID-19 vaccine as well anti-vaccination sentiment, fear, or distrust of the vaccines more often than did medical

Table 1. Associations between video upload source and video characteristics, n = 50.

Video upload source	Total (n=50)	Consumer, n=8	Medical professional, n=20	Television or internet-based news, n=22	p-value
Video characteristics		N(%)	N (%)	N (%)	
1. Number of views	4,589,613	277,304 (6.04)	1,208,967 (26.3)	3,103,342 (67.6)	0.425
Mean (SD)	91,792.26 [359,593.50]	34,663.00 [28,571.676]	60,448.35 [72,388.46]	141,061.00 [540,353.89]	
Range	4,561–2,556,197	4,691–75,575	5,468–232,107	4,561–2,556,197	
2. Video length					0.511
Mean (SD)	9:11 [8:27]	10:10[08:38]	09:11[06:16]	08:51[10:17]	
Range, mm:ss	00:38-41:18	01:57-24:52	01:56-20:19	00:38-41:18	
3. Video Upload date					0.591
04/14/20-09-14-2020	7 (14.0)	1 (12.5)	4 (20.0)	2 (9.1)	
09-15-20-02-14-2021	43 (86.0)	7 (87.5)	16 (80.0)	20 (90.9)	
4. Mentions need for volunteers					0.465
Yes	1 (2.0)	0 (.0)	1 (5.0)	0 (.0)	
No	49 (98.0)	8 (100.0)	19 (95.0)	22 (100.0)	
5. Mentions vaccine was rushed or rapidly developed					0.091
Yes	6 (12.0)	2 (25.0)	0 (.0)	4 (18.2)	
No	44 (88.0)	6 (75.0)	20 (100.0)	18 (81.8)	
6. Mentions emergency use					0.016*
Yes	5 (10.0)	0 (.0)	5 (25.0)	0 (.0)	
No	45 (90.0)	8 (100.0)	15 (75.0)	22 (100.0)	
7. Mentions adverse reactions and/or safety concerns					0.440
Yes	16 (32.0)	4 (50.0)	5 (25.0)	7 (31.8)	
No	34 (68.0)	4 (50.0)	15 (75.0)	15 (68.2)	
8. Mentions a specific company manufacturing vaccine					0.256
Yes	22 (44.0)	5 (62.5)	10 (50.0)	7 (31.8)	
No	28 (56.0)	3 (37.5)	10 (50.0)	15 (68.2)	
9. Mentions a human trial					0.036*
Yes	26 (52.0)	6 (75.0)	13 (65.0)	7 (31.8)	
No	24 (48.0)	2 (25.0)	7 (35.0)	15 (68.2)	
10. Mentions an animal trial					0.512
Yes	5 (10.0)	1 (12.5)	3 (15.0)	1 (4.5)	
No	45 (90.0)	7 (87.5)	17 (85.0)	21 (95.5)	
11. Mentions anti-vaccination sentiment, fear, or distrust of vaccines					0.018*
Yes	5 (10.0)	3 (37.5)	1 (5.0)	1 (4.5)	
No	45 (90.0)	5 (62.5)	19 (95.0)	21 (95.5)	
12. Mentions how long immunity will last					0.560
Yes	3 (6.0)	0 (.0)	2 (10.0)	1 (4.5)	
No	47 (94.0)	8 (100.0)	18 (90.0)	21 (95.5)	
13. Mentions ability to distribute vaccine widely					0.465
Yes	1 (2.0)	0 (.0)	1 (5.0)	0 (.0)	
No	49 (98.0)	8 (100.0)	19 (95.0)	22 (100.0)	
14. Mentions vaccine dosing					0.348
Yes	9 (18.0)	2 (25.0)	5 (25.0)	2 (9.1)	
No	41(82.0)	6 (75.0)	15 (75.0)	20 (90.9)	
15. Mentions herd immunity					0.632
Yes	3 (6.0)	0 (.0)	1 (5.0)	2 (9.1)	
No	47 (94.0)	8 (100.0)	19 (95.0)	20 (90.9)	
16. Mentions benefits of vaccines					0.659
Yes	19 (38.0)	3 (37.5)	9 (45.0)	7 (31.8)	
No	31 (62.0)	5 (62.5)	11 (55.0)	15 (68.2)	
17. Mentions harm of vaccines					0.086
Yes	4 (8.0)	2 (25.0)	0 (.0)	2 (9.1)	
No	46 (92.0)	6 (75.0)	20 (100.0)	20 (90.9)	
18. Mentions passive immunity in general					0.011*
Yes	9 (18.0)	2 (25.0)	7 (35.0)	0 (.0)	
No	41 (82.0)	6 (75.0)	13 (65.0)	22 (100.0)	
19. Mentions COVID-19 vaccine can make someone sterile					0.091
Yes	2 (4.0)	1 (12.5)	1 (5.0)	0 (.0)	
No	47 (94.0)	6 (75.0)	19 (95.0)	22 (100.0)	
Unsure	1 (2.0)	1 (12.5)	0 (.0)	0 (.0)	
20. Mentions COVID-19 vaccine unlikely to/will not make someone sterile					0.150
Yes	13 (26.0)	2 (25.0)	8 (40.0)	3 (13.6)	
No	37 (74.0)	6 (75.0)	12 (60.0)	19 (86.4)	
21. Mentions vaccine is unlikely to/will not cause harm in breastfeeding					0.034*
Yes	9 (18.0)	1 (12.5)	7 (35.0)	1 (4.5)	
No	41 (82.0)	7 (87.5)	13 (65.0)	21 (85.5)	

(Continued)

Table 1. (Continued).

Video upload source	Total (n=50)	Consumer, n=8	Medical professional, n=20	Television or internet-based news, n=22	p-value
Video characteristics		N(%)	N (%)	N (%)	
22. Mentions vaccine is safe					0.795
Yes	8 (16.0)	2 (25.0)	3 (15.0)	3 (13.6)	
No	36 (72.0)	6 (75.0)	14 (70.0)	16 (72.7)	
Likely	6 (16.0)	0 (.0)	3 (15.0)	3 (13.6)	
23. Mentions having conversation with clinician about getting COVID-19 vaccine					0.364
Yes	17 (34.0)	1 (12.5)	8 (40.0)	8 (36.4)	
No	33 (66.0)	7 (87.5)	12 (60.0)	14 (63.6)	
24. Mentions studies didn't include pregnant patients					0.745
Yes	28 (56.0)	5 (62.5)	12 (60.0)	11 (50.0)	
No	22 (44.0)	3 (37.5)	8 (40.0)	11 (50.0)	
25. Mentions American College of Obstetricians and Gynecologists (ACOG)					0.662
Yes	14 (28.0)	2 (25.0)	7 (35.0)	5 (22.7)	
No	36 (72.0)	6 (75.0)	13 (65.0)	17 (77.2)	
26. Mentions Society for Maternal and Fetal Medicine					0.041*
Yes	7 (14.0)	2 (25.0)	5 (25.0)	0 (.0)	
No	43 (86.0)	6 (75.0)	15 (75.0)	22 (100.0)	
27. Mentions passing maternal antibodies through breastmilk/breastfeeding					0.041*
Yes	7 (14.0)	2 (25.0)	5 (25.0)	0 (.0)	
No	43 (86.0)	6 (75.0)	15 (75.0)	22 (100.0)	
28. Mentions there is not enough data regarding effect of vaccine on breastmilk/nursing mothers					0.077
Yes	8 (16.0)	1 (12.5)	6 (30.0)	1 (4.5)	
No	42 (84.0)	7 (87.5)	14 (70.0)	21 (95.5)	
29. Mentions there is not enough data regarding the vaccine and pregnant people					0.377
Yes	24 (48.0)	3 (37.5)	8 (40.0)	13 (59.1)	
No	26 (52.0)	5 (62.5)	12 (60.0)	9 (40.9)	
30. Mentions the Syncytin-1 protein					0.512
Yes	5 (10.0)	1 (12.5)	3 (15.0)	1 (4.5)	
No	45 (90.0)	7 (87.5)	17 (85.0)	21 (95.5)	
31. Mentions pregnant people who get COVID-19 have more risk to experience a worse outcome					0.167
Yes	27 (54.0)	3 (37.5)	14 (70.0)	10 (45.5)	
No	23 (46.0)	5 (62.5)	6 (30.0)	12 (54.5)	
32. Mentions cannot get COVID-19 from vaccine					0.277
Yes	3 (6.0)	1 (12.5)	2 (10.0)	0 (.0)	
No	47 (94.0)	7 (87.5)	18 (90.0)	22 (100.0)	
33. Mentions vaccine contains MRNA					0.352
Yes	10 (20.0)	1 (12.5)	6 (30.0)	3 (13.6)	
No	40 (80.0)	7 (87.5)	14 (70.0)	19 (86.4)	
34. Mentions a vaccine that contains adenovirus					0.465
Yes	1 (2.0)	0 (.0)	1 (5.0)	0 (.0)	
No	49 (98.0)	8 (100.0)	19 (95.0)	22 (100.0)	

*denotes statistically significant at a $p < .05$ significance level.

professional videos and television or internet-based news videos. Previous studies have discussed how polarizing of an issue vaccination can be amongst Americans and how highly viewed videos on YouTube can often contain misinformation and anti-vaccine sentiments.^{36,43,44} These anti-vaccine sentiments/mistrust of vaccines in these videos could also potentially be compounded by the fact that the videos are about vaccination in pregnant people, who have historically been classified in research as a “vulnerable” population that requires special protections.⁴⁵ This classification of vulnerability could cause consumers uploading videos to be more distrustful of vaccines out of fear of a potential negative impact that could harm a pregnant person and their child, and reflect these ideas in their videos.

Videos from medical professionals more often mentioned passive immunity in general, emergency use of the vaccine, that the vaccine is unlikely/will not cause harm in breastfeeding, and the SMFM than did consumer and television or internet-based news videos. These videos likely mentioned these characteristics more often because as medical professionals, the uploaders have a greater knowledge base on the intricacies of the science behind immunity and the impact on breastfeeding, are more familiar with professional medical organizations and the research they publish, and have a greater understanding of how the FDA manages emergency use authorizations than would consumers and news organizations, and could thus go into greater depth on these subjects in their videos. from medical professionals have the greatest number of views, and

are likely viewed most often because medical professionals have greater knowledge and understanding of the intricacies of COVID-19 than do consumers. Thus, videos from medical professionals could help curb misinformation regarding COVID-19 and promote accurate scientific information regarding COVID-19 vaccination and pregnancy. Similarly, videos uploaded by television or internet-based news organizations also have more views than do videos uploaded by consumers, likely due to viewers seeking information about COVID-19 that they may believe has been thoroughly researched by the news organizations. Because viewers trust news organizations to present accurate information, it is essential that videos from news organizations promote factual COVID-19 prevention information in order to prevent further spread of COVID-19 misinformation.

Previous studies reveal that concerns over vaccine safety and low knowledge levels regarding the disease and vaccines have led to vaccine hesitancy amongst pregnant people.⁴⁶ Concerns about the lack of data on the safety of the COVID-19 vaccine amongst pregnant people as well as fear that the COVID-19 vaccine could harm the developing fetus have led many pregnant people to be hesitant to take the COVID-19 vaccine.⁴⁷ In addition, many people who would like to become pregnant in the future are unsure of taking the COVID-19 vaccine for fear that the vaccine would cause infertility.⁴⁸ Thus, it is evident that videos on the COVID-19 vaccine and pregnancy need to address these concerns in order to encourage pregnant people to get vaccinated. From the group of videos analyzed in this study, most lacked information on safety and benefits of taking the vaccine as well as the vaccine's impact on fertility. Public health organizations need to consider pregnant people's concerns regarding the COVID-19 vaccine and pregnancy into consideration when developing educational materials and videos on the COVID-19 vaccine. In order to be effective in encouraging pregnant people and people who may want to become pregnant to take the vaccine, more videos should be created that include specific information on COVID-19 vaccine safety and efficacy as well as evidence that the vaccine does not cause sterility.

This study was limited by the cross-sectional study design, small sample size, and the inclusion of English language videos only. Because of the cross-sectional nature of this study, the findings reflect a particular moment in time of which specific videos were available, which were the most viewed, and what the total view counts were at that point in time, and does not reflect that these aspects change on a daily basis. Additionally, the data collected on number of views of videos cannot account for number of unique viewers or information about the audience that is watching these videos. A final major limitation of this study was the timing in which the study took place. Because this study was conducted in the early days of COVID-19 vaccine distribution, the attitudes toward COVID-19 vaccination and pregnancy may not be reflective of current attitudes toward the COVID-19 vaccine.

The sample size of videos examined in this study was not representative of all content on COVID-19 vaccination and pregnancy on YouTube. In addition, this study was conducted shortly after the vaccine became widely available, and because pregnant and breastfeeding individuals were excluded from the original vaccine trials,⁸ data on the safety and efficacy of the

vaccine in pregnant and breastfeeding individuals was limited. Despite all of these limitations, this study contributes to current knowledge about information sources relevant to COVID-19 vaccination and pregnancy.

New findings regarding COVID-19 vaccination and pregnancy are quickly and continuously emerging. For example, after the analysis for this study was complete, a news report emerged that a mother in the US who received two doses of the Moderna vaccine birthed a baby who tested positive for COVID-19 antibodies when they were one-month old, suggesting that gestational parents can pass on antibodies from the vaccine to their babies.⁴⁹ This finding highlights the fact that the most viewed videos on COVID-19 vaccination and pregnancy may not be up-to-date with the latest scientific evidence; thus, continuous tracking of available information on YouTube about COVID-19 vaccination and pregnancy is needed to curb misinformation by determining what is and what is not being communicated. YouTube is a promising platform for public health and medical professionals to continuously disseminate new findings and accurate information, but measures must be taken to ensure the platform is effectively used to share timely and accurate information regarding COVID-19 vaccination and pregnancy. Further research on the accuracy of the content of existing videos related to COVID-19 vaccination and pregnancy is needed to determine the extent of misinformation on YouTube in order to develop strategies to counter this misinformation. Further study is needed on the impact of the COVID-19 vaccine on pregnancy, particularly on the topics of passive immunity from gestational parent to baby and vaccine safety.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article

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