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United States internet searches for “infertility” following COVID-19 vaccine misinformation

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Abstract

Context: On December 1, 2020, Drs. Wolfgang Wodarg and Michael Yeadon petitioned to withhold emergency use authorization of the BNT162b2 messenger ribonucleic acid vaccine for coronavirus disease 2019 (COVID-19) manufactured by BioNTech and Pfizer, raising concern for female infertility risks but acknowledging the lack of evidence. The European Medicines Agency and the US Food and Drug Administration ultimately issued emergency use authorizations, but misinformation claiming that COVID-19 vaccines cause female infertility began circulating on social media, potentially influencing public perception and medical decision making among pregnant patients or those seeking to become pregnant.

Objectives: To determine the potential influence misinformation may have had on public interest in infertility related topics, as analyzed through internet search statistics in the US.

Methods: The Google Trends tool was used to analyze results for the search terms “infertility,” “infertility AND vaccine,” and “infertility AND COVID vaccine” in the US from February 4, 2020 to February 3, 2021. We applied

autoregressive integrated moving average models to forecast expected values, comparing them with actual observed values.

Results: At peak interest (100), the forecasted relative search volumes interest for the search terms “infertility,” “infertility AND vaccine,” and “infertility AND COVID vaccine” were 45.47 (95% CI, 33.27–57.66; $p < 0.001$), 0.88 (95% CI, 2.87–4.63; $p < 0.001$), and 0.29 (95% CI, –2.25–2.82; $p < 0.001$). The actual relative search volumes at peak searching represented 119.9, 11,251, and 34,900% increases, respectively, when compared with forecasted values.

Conclusions: COVID-19 vaccine misinformation corresponded with increased internet searches for topics related to infertility in the US. Dispelling misinformation and informing patients about the risks and benefits of COVID-19 vaccination may prevent unnecessary vaccine hesitancy or refusal, contributing to successful vaccination efforts.

Keywords: COVID-19; Google Trends; infertility; internet searches; patient information; vaccine.

Drs. Wolfgang Wodarg and Michael Yeadon submitted a petition to the European Medicines Agency (EMA) on December 1, 2020, requesting that emergency authorization for the BNT162b2 messenger ribonucleic acid (mRNA) coronavirus 2019 (COVID-19) vaccine manufactured by BioNTech and Pfizer be withheld pending further demonstration of safety and efficacy [1]. The petition claimed that the clinical trial design was inadequate and posed irreparable public harm [1]. Specifically, the petitioners raised concern for possible female infertility risks. The petitioners alleged that female infertility could arise secondary to vaccine induced antibodies against Syncytin-1, a mammalian placental protein that shares short homologous sequences with a severe acute respiratory syndrome (SARS) coronavirus spike protein [2]. Additionally, the Pfizer-BioNTech COVID-19 vaccine clinical trial did not include pregnant or lactating women, and safety and efficacy data among this population is lacking [3]. Though there may be biological merit for concerns about COVID-19 illness and pregnancy complications [4], the

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petitioners acknowledged the absence of any evidence for female infertility risks associated with COVID-19 vaccines [1].

The EMA ultimately issued emergency authorization on December 21, 2020, providing the first means of long term protection against COVID-19 transmission in the EU [5]. The US Food and Drug Administration also issued emergency authorization for the BNT162b2 COVID-19 vaccine [6] as well as the mRNA-1273 COVID-19 vaccine manufactured by Moderna [7] in December 2020. However, as distribution efforts began, misinformation stemming from inappropriate interpretations of the EMA petition by antivaccination campaigns began to circulate on social media platforms [8]. Misinformation claiming that COVID-19 vaccines cause female infertility without evidence presents a public health concern that may hinder successful vaccination efforts, especially among pregnant patients or those seeking to become pregnant. Thus, we sought to examine changes in public interest via internet searches for infertility and COVID-19 vaccines in the US after the spread of misinformation on social media.

Methods

The Oklahoma State University Institutional Review Board determined that this study did not qualify as human subjects research.

Google Trends (<https://trends.google.com/trends/>) is useful for identifying regional population interests and was used to monitor mental health concerns early in the COVID-19 pandemic [9]. We used the Google Trends tool on March 4, 2021 to examine internet traffic associated with the search term “infertility” in the US from February 4, 2020 through February 3, 2021. We used this date range to include the day the EMA petition was released (December 1, 2020), to build a strong model, and to avoid confounding from other events possibly related to infertility. We also included the combined search term “infertility AND vaccine” to capture baseline searches for infertility topics related to vaccines in general over the same time period, as well

as the combined search term “infertility AND COVID vaccine” to quantify searches specifically related to infertility and COVID-19 vaccines.

We used autoregressive integrated moving average (ARIMA) models to forecast search behavior for these terms from December 1, 2020 onward, comparing actual values to projected values. Data extracted from Google Trends is presented in the form of relative search volume (RSV) ranging from 0–100, with 100 representing peak searches for the specified region over the specified time period. All analyses were conducted in R Version 4.0.2 (R Core Team).

Results

Peak searches for “infertility” and “infertility and vaccine” occurred during the week of December 6, 2020, while peak searches for “infertility and COVID vaccine” occurred on December 13, 2020. The peak forecasted RSV for “infertility” was 45.47 (95% confidence interval [CI], 33.27–57.66; $p < 0.001$) compared with the actual RSV of 100, representing a 119.9% increase in RSV compared with expected values. The peak forecasted RSV for “infertility and vaccine” was 0.88 (95% CI, 2.87–4.63; $p < 0.001$) compared with the actual RSV of 100, representing a 11,251% increase in RSV compared with expected values. The peak forecasted RSV for “infertility and COVID vaccine” was 0.29 (95% CI, –2.25–2.82; $p < 0.001$) compared with the actual RSV of 100, representing 34,900% increase in RSV compared to expected values (Figure 1). The actual RSV at peak searching (100) for each term was outside of the 95% CI generated by the ARIMA models.

Each term’s actual RSV was higher than the forecasted values at 4 and 8 weeks from the EMA petition’s release. The mean differences between each search term’s actual and forecasted RSVs were statistically significant at 8 weeks (Table 1). RSV data for each term are listed at 4 week intervals over the course of our study period in Table 2.

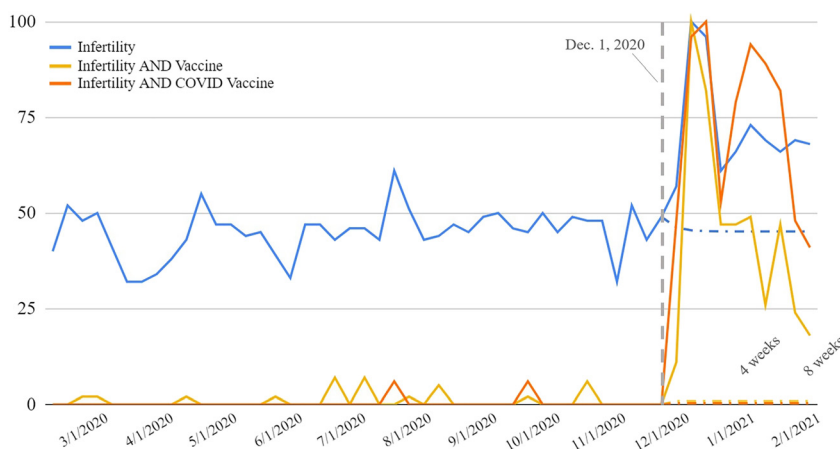


Figure 1: Actual relative search volumes for each term are designated by the colored solid lines. The colored, dashed lines are the forecasted values from the autoregressive integrated moving average models for each term. The vertical dashed line on December 1, 2020 signifies the day the European Medicines Agency petition [1] was submitted and made publicly available.

Table 1: Forecasted versus actual relative search volumes (RSV) for Google Trends terms at 4 and 8 weeks from December 1, 2020.

Search term	Four weeks from December 1, 2020			Eight weeks from December 1, 2020		
	Forecasted RSV, mean (SD)	Actual RSV, mean (SD)	<i>t</i> , p-Value	Forecasted RSV, mean (SD)	Actual RSV, mean (SD)	<i>t</i> , p-Value
Infertility	45.54 (0.47)	78.5 (22.63)	-2.92, 0.06	45.36 (0.36)	73.50 (15.90)	-5.00, 0.002
Infertility and vaccine	0.88 (0.0)	60.00 (39.39)	-3.00, 0.06	0.88 (0.0)	51.13 (28.38)	-5.00, 0.002
Infertility and 'COVID vaccine'	0.29 (0.0)	74.25 (27.55)	-5.37, 0.012	0.29 (0.0)	80.13 (19.61)	-11.52, <0.0001

SD, standard deviation.

Discussion

Our findings suggest that circulating misinformation claiming COVID-19 vaccines cause female infertility corresponded with significant increases in internet searches for topics related to infertility and COVID-19 vaccines in the US, possibly reflecting COVID-19 vaccine safety concerns. Although the most recent data from the Centers for Disease Control (CDC) [10] indicates that 63.0% of individuals who received COVID-19 vaccines from December 14, 2020 to January 14, 2021 were female, this is likely due to the high prevalence of female healthcare professionals [11] and female nursing home residents [12]. Additionally, women are generally more likely to seek and receive healthcare than men [13]. Therefore, these data do not permit assessing the potential impact of COVID-19 vaccine misinformation on vaccine acceptance among women. Careful surveillance for such an impact is warranted, especially as COVID-19 vaccines become more widely available.

Recognizing the potential impact this misinformation may have had on patients deciding whether to receive COVID-19 vaccination will help clinicians ensure that such decisions are adequately informed. In the absence of safety and efficacy data regarding COVID-19 vaccines among pregnant and lactating patients, risk and benefit assessment of vaccination should be tailored to the individual. According to the CDC, observational data suggests that pregnant patients with COVID-19 are at increased risk for severe illness compared with nonpregnant individuals [14]. Moreover, COVID-19 related illness during pregnancy may increase the risk of pregnancy and birth complications [3]. Thus, vaccinating pregnant patients may prevent more severe COVID-19 related illness and pregnancy complications, as long as safety and efficacy are retained. Clinical trials assessing the safety and efficacy of COVID-19 vaccines in pregnant patients are currently in development or

already under way. Regarding lactation, evidence shows that non live vaccines are safe for lactating individuals, and therefore, COVID-19 vaccines are thought to carry no risk to breastfeeding infants [3, 14].

The American College of Obstetricians and Gynecologists (ACOG) currently recommends that COVID-19 vaccines not be withheld from pregnant patients who meet criteria for vaccination based on priority groups recommended by the Advisory Committee on Immunization Practices (ACIP) and those at increased risk for COVID-19 acquisition, such as women healthcare workers [15]. ACOG also recommends that COVID-19 vaccines should be offered to lactating patients in a similar fashion to nonlactating individuals when they meet ACIP criteria [15]. ACOG also stated that excluding pregnant individuals from COVID-19 vaccine eligibility would violate their bodily autonomy and put them at risk of adverse outcomes and mortality stemming from COVID-19 related illness [16]. The American Society for Reproductive Medicine echoed the stance of ACOG, endorsing the recommendation for pregnant patients or those contemplating pregnancy to receive COVID-19 vaccination to mitigate risk of poorer outcomes [17]. We recommend that pregnant patients discuss COVID-19 vaccine decisions with their primary care physicians and obstetricians, and that physicians support patients in their personal decision to receive or refuse COVID-19 vaccines.

Limitations

A limitation of this study is that it is correlational and could not assess causality. Further studies are needed to investigate whether misinformation stemming from the December 2020 petition will impact vaccine hesitancy and acceptance by pregnant patients or those seeking to become pregnant. The nature of our study precludes it from

Table 2: Relative search volumes for Google Trends search terms in 4-week intervals.

Week of	March 1 2020	March 29 2020	March 26 2020	May 24 2020	June 21 2020	July 19 2020	August 16 2020	September 13 2020	October 11 2020	November 8 2020	December 6 2020	January 3 2021	January 31 2021
<i>Infertility</i>													
Actual value	50	34	47	39	43	61	47	46	49	52	100	73	68
Forecasted (95%CI)											45.47 (33.27–57.67)	45.18 (32.95–57.41)	45.18 (32.95–57.41)
<i>Infertility and vaccine</i>													
Actual value	2	0	0	2	7	0	0	0	0	0	100	49	18
Forecasted (95%CI)											0.88 (–2.87–4.63)	0.88 (–2.87–4.63)	0.88 (–2.87–4.63)
<i>Infertility and COVID vaccine</i>													
Actual value	0	0	0	0	0	6	0	0	0	0	96	94	41
Forecasted (95% CI)											0.29 (–2.25–2.82)	0.29 (–2.25–2.82)	0.29 (–2.25–2.82)

CI, confidence interval.

claiming causality and results should be interpreted accordingly.

Conclusions

Our results showed significant increases in internet searches for topics related to infertility and COVID-19 vaccines following misinformation about a December 2020 petition regarding safety and efficacy data for the BNT162b2 COVID-19 vaccine manufactured by BioNTech and Pfizer. The influence of COVID-19 vaccine misinformation on public perception may lead to changes in medical decision making. It is the duty of physicians and healthcare professionals to understand patient concerns, to be prepared with evidenced based information to help answer questions, and to assist patients in medical decision making. Dispelling misinformation and informing patients about the risks and benefits of COVID-19 vaccination may prevent unnecessary vaccine hesitancy or refusal, contributing to more successful vaccination efforts.

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Ethical approval: The Oklahoma State University Institutional Review Board determined that this study did not qualify as human subjects research.

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