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The influence of the COVID-19 pandemic and social media on behaviour of pregnant and lactating women towards vaccination: a scoping review

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The influence of the COVID-19 pandemic and social media on behaviour of pregnant and lactating women towards vaccination: a scoping review

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Abstract

OBJECTIVES

Pregnant women, foetuses and infants are at risk for infectious disease-related complications. Maternal vaccination is a strategy developed to better protect pregnant women and their offspring against infectious disease-related morbidity and mortality and is already implemented on a broad scale for influenza, pertussis and recently also for COVID-19. Yet, still a significant amount of hesitancy towards maternal vaccination policies exists. Furthermore, contradictory messages circulating on social media impact vaccine confidence.

This scoping review aims to give an answer on the impact of COVID-19 and COVID-19 vaccination on vaccine confidence in pregnant and lactating women. Additionally, the role of social media in creating opinions towards vaccination in these target groups is studied.

METHODS

Literature was searched using the PubMed database. Search terms linked to pregnancy, lactation, vaccination, vaccine hesitancy, COVID-19 and social media were used. In total, 37 papers were included in this review. Two additional papers were yielded via the snowball method.

RESULTS

Although there is a wide variety in COVID-19 vaccine acceptance during pregnancy and lactation according to period and region, pregnant and lactating women are in general less likely to accept a COVID-19 vaccine compared to non-pregnant and non-nursing women. The main reason to refuse maternal vaccination are safety concerns, both for the baby as well as for the woman herself. A positive link between COVID-19 vaccine willingness and acceptance of other vaccines during pregnancy was detected. Internet and social media are identified as important information sources for maternal vaccination.

DISCUSSION & CONCLUSION

Vaccine hesitancy in pregnant and lactating women remains an important issue, expressing the need for new and effective interventions to increase vaccine confidence and coverage. The role of social media in vaccine uptake remains unclear. However, social media messages impact vaccine confidence in pregnant and lactating women.

Strengths and limitations

- A concrete research question with targeted search terms was used for completing this review.

- The search was only limited to one database (PubMed) and not systematic, which can lead to the lack of certain information.

Introduction

Several infectious diseases are associated with adverse outcomes in pregnant women, foetuses and infants. Therefore, in recent years, both the strategy of vaccination during pregnancy as well as vaccination during lactation is gaining more interest in view of its ability to reduce infectious disease-related morbidity and mortality in these target populations (1–3).

When pregnant women contract influenza, they have an increased risk for influenza-related complications and hospitalisation compared to non-pregnant women (2,4). Besides, influenza infections during pregnancy are also linked to an increased risk for preterm delivery and small for gestational age infants. Additionally, infants below six months of age are at high risk for severe influenza, often associated with hospitalisation and mortality (2).

Next, pertussis mainly forms a serious threat for neonates with the highest incidence, disease burden and case fatality rate in the first year of life (5,6).

A COVID-19 infection during pregnancy is not only linked to an increased risk for hospitalisation, admission to intensive care unit and death in pregnant women themselves (7,8), but also a higher risk for preterm delivery, stillbirth and pre-eclampsia is described (7,9,10). Furthermore, low birth weight, foetal distress and other respiratory symptoms are more frequent in neonates born to a COVID-19 infected mother (7,10). Infants infected with COVID-19 in the postpartum period can experience critical illness (11).

To better protect pregnant women, foetuses and infants against infectious disease-related complications, vaccination during pregnancy is an important approach and already implemented for influenza, pertussis and recently for COVID-19 by public health authorities worldwide (5,12–15).

After vaccinating during pregnancy, vaccine-specific antibodies are induced protecting pregnant women from severe illness. Subsequently, these vaccine-induced antibodies are transferred from mother to baby across the placenta during pregnancy and after birth via breastfeeding (12). Therefore, if women did not receive a pertussis and/or influenza vaccine during pregnancy or are not yet fully vaccinated against COVID-19 with the advised vaccine doses, it is recommended to vaccinate in the postpartum period (16,17).

Despite the proven benefit of vaccination during pregnancy and lactation and the implementation of the vaccination strategy on a broad scale, there still exists a significant amount of hesitancy towards maternal vaccination policies, reflected by poor vaccine uptake in diverse regions and various or lacking maternal vaccination programs and recommendations in different countries (12,13,18,19). Before the start of the COVID-19 pandemic, Kilich et al. defined in a systematic review factors that could possibly influence vaccination decision-making among pregnant women where they defined a recommendation to vaccinate during pregnancy by a healthcare provider (HCP) as the most important factor. However, other determinants such as previous vaccination behaviour and vaccine-specific factors can mute this HCP recommendation. Also, they stated that some pregnant women searched for information about vaccination through Internet or other media, but these channels were not noted as the most trustworthy by these women (20).

With the still ongoing COVID-19 pandemic waves and the licensing of COVID-19 vaccines, the vaccine debate flared up again. Pregnant and lactating women were initially excluded from pre-marketing clinical trials for licensing of COVID-19 vaccines resulting in doubts about safety, immunogenicity and efficacy of the vaccines in these target groups. However, based on evidence generated from other vaccines already used in pregnant and lactating women, no safety or efficacy issues were expected. After weighing the vaccine benefits against the disease complications, different countries immediately started to approve COVID-19 vaccination in these groups. Different opinions, scientifically based or not, were shared via all sorts of social media, both by the general public as well as by HCPs. This scoping review updates the review of Kilich et al. and moreover, includes factors influencing vaccine decision-making in lactating women. The review gives an answer on the impact of COVID-19 and its accompanying vaccination campaign on vaccine confidence in pregnant and breastfeeding women. Additionally, the role of social media in creating opinions towards vaccination during pregnancy and/or lactation is studied.

Methods

To conduct this scoping review, literature was searched using the database PubMed. Keywords were identified based on the systematic review by Kilich et al. (20) and additional search terms linked to social media and COVID-19 were added:

vaccin*, immuniz*, immunis*, antibodies, immune response, confidence, awareness, attitude*, anxiety, trust*, intent*, dilemma, perception*, misconception*, behaviour, behavior, anti-vaccin*, decision making, vaccination refusal, fear*, distrust, mistrust, hesitancy, controvers*, belief*, criticis*, misinformation, intent*, choice*, concern*, knowledge, acceptance, willingness, uptake, barrier*, disinformation, complacency, fake news, pregnan*, maternal, prenatal, antenatal, parent*, lactating*, lactation, breast milk, breastfeeding, social media, internet, website*, communication*, social network*, social behavior, social behaviour, message*, forum, fora, blog*, discussion group*, online, Facebook, Twitter, Pinterest, LinkedIn, Instagram, Reddit, Youtube, Messenger, Whatsapp, Telegram, COVID*, SARS-CoV-2, COVID19*, corona*.

Publication date was limited from November 23rd 2018 since Kilich et al. searched articles published by November 22nd 2018. The search was done on July 18th 2022.

Overall, 477 records were identified via our PubMed search. All records were screened by title and abstract, from which 46 were retained to screen by full text. Articles without mentioning pregnant and/or lactating women, COVID-19 pandemic or vaccination and/or social media were excluded. Finally, after screening by full text, 37 records were selected to be included in this scoping review. The references of the selected records were also screened ("snowball method"). This method yielded two additional articles.

Patient and public involvement

None

Results

1. COVID-19 VACCINE ACCEPTANCE IN PREGNANT, PLANNING TO BE PREGNANT AND
    LACTATING WOMEN

In total, 32 articles about willingness to get vaccinated against COVID-19 during pregnancy, lactation and when planning to get pregnant were identified and included in this review. A summary of the selected articles can be found in Table 1.

   1.1.   *COVID-19 vaccine confidence in pregnant women and women planning to be*
          pregnant

Several studies were conducted in pregnant and lactating women before the availability of COVID-19 vaccines (N= 12). Of these studies, four found that pregnant women were less likely to accept a future COVID-19 vaccine (29.7%-62.1%) in comparison to breastfeeding women (38.6%-69.0%) and non-pregnant women (73.4%-81.2%) (21–24). In contrast, Erchick et al. found that more pregnant women (65.9%) were willing to get vaccinated against COVID-19 compared to non-pregnant women (59.6%), although the difference was not significant (25). In addition, Tao et al. also detected a high COVID-19 vaccine acceptance rate in pregnant women in China, i.e. 77.4% (26). Also, willingness to get vaccinated during pregnancy varied largely by country: COVID-19 vaccine readiness level was above 80.0% for pregnant women in India and Mexico and lower than 45.0% in Russia, Australia and the USA (22). Within the study of Ceulemans et al., six European countries were compared. The highest COVID-19 vaccine willingness during pregnancy was seen in Belgium (78.1%) whereas the lowest rate was found in Switzerland (29.7%) (21).

Twenty surveys were performed after licensure of COVID-19 vaccines, but some before there was an official recommendation from WHO and/or national authorities to vaccinate all pregnant women against COVID-19. Sutton et al. concluded that pregnant women, at that moment, were still less likely to accept a COVID-19 vaccine (44.3%) compared to breastfeeding (55.2%) and non-pregnant women (76.2%) (27). Samannodi et al. made the same significant conclusion for pregnant women and women planning to get pregnant compared to non-pregnant women and women not planning to get pregnant (28). Perez et al. divided their responders into two groups: i.e. (1) female HCPs preventing pregnancy (2) female HCPs who

are pregnant/lactating/attempting pregnancy. They found a significant difference in vaccine desire between both groups where group (1) desired significantly more to receive the vaccine compared to group (2) (29). Thirteen studies also mentioned COVID-19 vaccine coverage rates in pregnant women. Schaal et al. measured COVID-19 vaccine coverages in pregnant women in Germany at the same time period (March-April 2021) as Razzaghi et al. in the USA with a remarkable difference in coverage between both studies: 2.4% in Germany versus 21.7% in the USA (30,31).

1.2. COVID-19 vaccine confidence in lactating women

Fifteen studies included lactating/postpartum women in their study population of which three studies found that lactating women were more likely to accept a COVID-19 vaccine (39.4%-69.0%) compared to pregnant women (13.8%-61.0%) (21,27,31). Nevertheless, lactating women remain less willing to receive a COVID-19 vaccine than non-pregnant and non-nursing women (27). In the follow-up study of Germann et al., 35.0% of postpartum women were willing to be vaccinated compared to only 14.0% of pregnant women. However, breastfeeding status of the postpartum women was not clear (32). Gutierrez et al. found that women currently nursing or planning to breastfeed were less willing to receive COVID-19 vaccination compared to women who were not (33). As for pregnant women, there is a wide variety of acceptance among different countries with a 79.2% acceptance rate in Belgium compared to 38.6% in Switzerland (21).

Table 1: overview of vaccine confidence studies of COVID-19 vaccines in pregnant / lactating women							
Authors (year of publication)	Reference	Study period	Country of execution	Study design	N° of participants	COVID-19 vaccine coverage	COVID-19 vaccine willingness
Abuhammad (2022)	(34)	Sept 2021 – Oct 2021	Jordan	Survey	414 participants: 195 pregnant women 218 lactating women	50.8% in pregnant and lactating women	NA
Ceulemans et al. (2021)	(21)	16 Jun 2020 – 14 Jul 2020	Ireland, Norway, Switzerland, the Netherlands, UK	Survey	16063 participants: 6661 pregnant women 9402 lactating women	NA	61.0% by pregnant women 69.0% by lactating women
		10 Apr 2020 – 31 May 2020	Belgium				
Citu et al. (2022)	(35)	1 Oct 2021 – 1 Dec 2021	Romania	Survey	345 participants: 184 pregnant women 161 non-pregnant women of reproductive age	NA	47.8% by pregnant women 59.7% by non-pregnant women of reproductive age
Citu et al. (2022)	(36)	1 Jan 2022 – 1 May 2022	Romania	Survey	345 pregnant women	53.3% in pregnant women	NA
Egloff et al. (2022)	(37)	18 Feb 2021 – 5 Apr 2021	France	Survey	664 pregnant women	NA	29.5% by pregnant women
Erchick et al. (2022)	(25)	15 Dec 2020 – 23 Dec 2020	USA	Survey	8481 participants: 233 pregnant women 8248 non-pregnant women	NA	65.9% by pregnant women 59.6% by non-pregnant women
Geoghegan et al. (2021)	(38)	4 Dec 2020 – 14 Jan 2021	Ireland	Survey	300 pregnant women	NA	38.0% during pregnancy 63.0% after pregnancy
Germann et al. (2022)	(32)	22 Mar 2021 – 2 Apr 2021	USA	Survey	456 participants: 435 pregnant women 21 postpartum women	NA	60.0% by pregnant and postpartum women
		29 Jun 2021 – 20 Nov 2021		Follow-up survey	290 participants: 68 pregnant women 222 postpartum women	52.0% in pregnant and postpartum women	14.0% by pregnant women 35% by postpartum women
Gutierrez et al. (2022)	(33)	Jan 2021	USA	Survey	5269 participants: 1190 pregnant and postpartum women	NA	53.4% by pregnant and postpartum women 57.1% by other participants
Hosokawa et al. (2022)	(39)	24 Jul 2021 – 30 Aug 2021	Japan	Survey	1621 pregnant women	13.4% in pregnant women	49.1% by pregnant women
Kuciel et al. (2022)	(40)	1 Jul 2021 – 30 Aug 2021	Poland	Survey	118 participants: 28 pregnant women 60 lactating women	NA	NA

					109 mothers		
Levy et al. (2021)	(41)	14 Dec 2020 – 14 Jan 2021	USA	Survey	662 pregnant women	NA	58.3% by pregnant women
Mappa et al. (2021)	(42)	27 Dec 2020	Italy	Survey	161 pregnant women	NA	52.9% by pregnant women
Mohan et al. (2021)	(43)	15 Oct 2020 – 15 Nov 2020	Qatar	Survey	341 pregnant and lactating women	NA	49.1% by participants
Nguyen et al. (2021)	(44)	Jan – Feb 2021	Vietnam	Survey	651 participants: pregnant women or just delivered	NA	60.4% by all participants
Oluklu et al. (2021)	(45)	11 Feb 2021 – 21 Mar 2021	Turkey	Survey	412 postpartum women: 363 lactating women	NA	33.3% by postpartum women
Perez et al. (2021)	(29)	8 Jan 2021 – 31 Jan 2021	USA	Survey	11405 female HCP of reproductive age: 955 women & 67 lactating attempting pregnancy 2196 pregnant women 2250 lactating women 91 women pregnant and lactating 5846 preventing pregnancy	73.6% in all participants	75.3% of all participants strongly desire(d) vaccination – 1.5% are strongly adverse
Perrotta et al. (2022)	(46)	1 Mar 2021 – 23 Jul 2021	USA	Survey	299 pregnant women	20.7% in pregnant women	42.8% by pregnant women
Pisula et al. (2022)	(47)	24 Oct 2021 – 9 Nov 2021	Poland	Survey	515 pregnant women	58.1% in pregnant women	6.2% by pregnant women
Razzaghi et al. (2022)	(30)	31 Mar 2021 – 16 Apr 2021	USA	Survey	1561 pregnant women	21.7% in pregnant women	24.0% by pregnant women
Redmond et al. (2022)	(48)	June 2020 – Aug 2020	USA	Survey	26 pregnant women 1 postpartum woman	NA	63.0% by pregnant and postpartum women
Riad et al. (2021)	(49)	Aug 2021 – Oct 2021	Czechia	Survey	362 participants: 278 pregnant women 84 lactating women	NA	66.6% by pregnant and lactating women
Saleh et al. (2022)	(50)	End Sep 2020 – mid-Jan 2021	Israel	Survey	410 participants: 293 pregnant women 117 postpartum women of whom 84 were lactating	NA	40% by participants after giving birth
Samannodi et al. (2021)	(51)	12 Jun 2021 – 1 Aug 2021	Saudi Arabia	Survey	431 women: 214 women pregnant or planning to be pregnant	57.1% in all participants	NA

Schaal et al. (2021)	(31)	30 Mar 2021 – 19 Apr 2021	Germany	Survey	2339 participants: 1043 pregnant women 1296 lactating women	2.4% in pregnant women 13.7% in lactating women	13.8% by pregnant women 39.4% by lactating women
Skirrow et al. (2022)	(24)	3 Aug 2020 – 11 Oct 2020	UK	Survey	1181 pregnant women	NA	62.1% during current pregnancy 81.2% after delivery
		7 Dec 2020 – 16 Dec 2020		Semi-structured interviews	10 pregnant women		
Skjefte et al. (2021)	(22)	28 Oct 2020 – 18 Nov 2020	Italy, Chile, Peru, New Zealand, Russia, Australia, Colombia, Brazil, Spain, South Africa, India, Mexico, Philippines, Argentina, USA, UK	Survey	17871 participants: 5294 pregnant women 12562 non-pregnant women	NA	52.0% by pregnant women 73.4% by non-pregnant women
Stuckelberger et al. (2021)	(52)	18 Jun 2020 – 12 Jul 2020	Switzerland	Survey	1551 participants: 515 pregnant women 1036 lactating women	NA	29.7% by pregnant women 38.6% by lactating women
Sutton et al. (2021)	(27)	7 Jan 2021 – 29 Jan 2021	USA	Survey	1012 participants: 216 pregnant women 122 lactating women 656 non-pregnant women	1.9% in pregnant women 3.3% in lactating women 13.3% in non-pregnant women	44.3% by pregnant women 55.2% by lactating women 76.2% by non-pregnant women
Tao et al. (2021)	(26)	13 Nov 2020 – 27 Nov 2020	China	Survey	1392 pregnant women	NA	77.0% by pregnant women
Ward et al. (2022)	(53)	NA	Australia	Survey	218 pregnant women	44.0% in pregnant women	7.4% by pregnant women
Waring et al. (2022)	(54)	Mid-Feb 2021 – Mid-Mar 2021	USA	Survey	203 women: 15 pregnant women 188 non-pregnant women (mothers)	47.3% in pregnant and non-pregnant women	66.0% by pregnant women 73.0% by non-pregnant women

2. COVID-19 VACCINE CONFIDENCE IN HCP

Deruelle et al. investigated the perception of French HCPs towards COVID-19 vaccination during pregnancy. The survey was performed between January 11th and March 1st, 2021. Overall, midwives were less likely to recommend COVID-19 vaccination during pregnancy (37.5%) compared to general practitioners (50.7%) and obstetricians (58.8%) (55).

Also, Bradfield et al. performed a survey in women (including pregnant and lactating women), midwives, doctors providing maternity care and midwifery students in Australia in early 2021 to investigate provider's perceptions on COVID-19 vaccination during pregnancy. They found that doctors and midwifery students were significantly more likely to advise COVID-19 vaccination during pregnancy compared to midwives. Of note, when looking at influential factors determining pregnant and lactating women's decision to be vaccinated , they did not ask whether a HCP recommendation was a motivational factor or not (56).

3. DETERMINANTS PREDICTING COVID-19 VACCINE ACCEPTANCE

Most of the surveys (N= 26) included in this review not only measured readiness to get vaccinated against COVID-19 during pregnancy or lactation, but also described determinants influencing COVID-19 vaccine acceptance.

3.1.   Factors influencing COVID-19 vaccine acceptance during pregnancy

Important reasons to refuse COVID-19 vaccination during pregnancy are safety concerns, described in 19 studies (22,24–27,30–32,37–39,41–43,46–49,53). These safety concerns include possible harm for the baby and for the mother, both on short and long term. Other concerns mentioned were not enough clinical trial data on COVID-19 vaccination in pregnancy (22,24,27,31,32,46) and COVID-19 vaccines not being trustworthy because of rapid development and approval (22,24,30,39). Hosowaka et al. defined mistrust in the government as the only significant factor linked to vaccine hesitancy in pregnant women in Japan (39). Not believing in vaccines and in the existence of the SARS-CoV-2 virus, not being afraid of COVID-19 and trusting rumours on social media were also described by Citu et al. as statistically independent risk factors for vaccine hesitancy in pregnant women (35).

Positive determinants linked to acceptance of COVID-19 vaccination in pregnant women were receipt of an influenza vaccine (27,30,32,37,52) and/or pertussis vaccine during pregnancy (24,32), a HCP recommendation/discussion about COVID-19 vaccines (30,32,37,38,48,53), the believe of being at high risk of or concerns about contracting COVID-19 (22,29,32), awareness of being at increased risk of severe illness due to COVID-19 (53), and living with individuals with or suffering themselves from co-morbidities/high risk conditions (30).

Demographic factors associated with better COVID-19 vaccine willingness are higher educational level (22,32,33,36,37,39,41,42,46,47,49,50,52), being employed (30,32,42,50), higher income (22,24,33,35,36,46,47), older age (22,24,25,32,33,37,41,46,49,52), being in the third trimester of gestation (26,36,38,49,52), multiparity (37,49) and living in an urban area (35,36,47,50). Also, race and ethnicity are demographic factors linked to COVID-19 vaccine willingness (24,29,30,41,43,50). Interestingly, Tao et al. found that Chinese pregnant women with younger age and lower education were more likely to accept COVID-19 vaccination (26).

3.2. Factors influencing COVID-19 vaccine acceptance during lactation

Similar safety concerns as in pregnant women are described in lactating women/postpartum women (27,31,32,45,49). Also, the lack of reliable data about COVID-19 vaccine administration and effectiveness during lactation is mentioned as reason to refuse the vaccine or to hesitate about getting it (31,45). Additionally, Sutton et al. described the concern a COVID-19 vaccine would cause infertility in this target group (27).

Gutierrez et al. and Stuckelberger et al. described demographic factors in pregnant and lactating/postpartum women associated with low vaccination likelihood: younger age (33,52), lower level of education (33,52) and lower income (33). However, they both did not distinguish pregnant and lactating/postpartum women (33,52). Riad et al. found that there was no significant difference in age and educational level in the lactating vaccine accepting group and vaccine resistant group. However, lactating healthcare workers had a significantly higher COVID-19 vaccine acceptance level compared to non-healthcare workers (49).

4. THE IMPACT OF THE COVID-19 PANDEMIC ON OTHER VACCINATIONS

Gencer et al. found that the 77.0% of the interrogated pregnant women had or intended to have a vaccine during pregnancy. In 50.6% of the women, the COVID-19 pandemic had not affected their views of being vaccinated in the future (57).

Saleh et al. evaluated the effect of the COVID-19 pandemic on seasonal influenza vaccine compliance among pregnant and postpartum women in Israel from September 2020 until Mid-January 2021. They found that, despite the high incidence of COVID-19, there was similar vaccine uptake as pre-pandemic with 54.4% of the women reported to be vaccinated against influenza (50).

Pisula et al. investigated the knowledge and attitudes towards influenza vaccination in pregnant women in 2021. In total, 21.0% had been vaccinated against influenza during pregnancy and 17.5% were planning to get vaccinated. They stated that there is a link between influenza and COVID-19 vaccine uptake in pregnant women. Women who refused COVID-19 vaccination were not intended to get an influenza vaccine and vice versa (47).

Skirrow et al. explored the experience of women getting vaccinated against pertussis during pregnancy in times of COVID-19. An online survey spread from the 3rd of August until 11th of October 2020 was completed by 922 pregnant women and 482 postpartum women who were pregnant at some point after the first lockdown in the United Kingdom. They found that 72.1% of pregnant women and 84.0% of postpartum women had received a pertussis vaccine during pregnancy even when access was hampered due to COVID-19 restrictions (58).

5. THE IMPACT OF SOCIAL MEDIA ON COVID-19 VACCINE CONFIDENCE

Riad et al. stated that social media is an important source of information on COVID-19 vaccines in pregnant and lactating women. However, only 8.3% of the pregnant and lactating women reported media/social media as an impact factor for their decision towards COVID-19 vaccination (49).

Hahn et al. conducted three surveys in remote Alaskan communities, focusing on the impact of COVID-19 on daily life and attitude towards COVID-19 vaccination between November 2020 and September 2021. By September 2021, misunderstandings about vaccine recommendations during pregnancy and the effects of COVID-19 vaccination on fertility and

DNA were present where social media was identified as the primary source of information (59).

Maugeri et al. investigated the changes in Google Search interest on vaccination during pregnancy after the introduction of COVID-19 vaccination in Italy via Google Trends. Data from 1 January 2019 to 31 October 2021 were searched. This way, monitoring the change from two years before the introduction of COVID-19 vaccination until present (31 October 2021) was possible. The analysis of Google Trends indicated that the search interest for 'Vaccination in pregnancy' was significantly increased (both qualitative and quantitative) compared to the predicted trend after the start of the Italian COVID-19 vaccination campaign. Moreover, further qualitative analysis showed that the increase was most likely due to worries about COVID-19 vaccination (60).

Citu et al. identified trusting rumours on social media to have the greatest impact on vaccine hesitancy in Romanian pregnant women. Significantly more pregnant women (78.1%) answered "yes" to the question if they trust social media rumours compared to non-pregnant women (63.0) (35). In a survey conducted a few months later, Citu et al. found that unvaccinated pregnant women (44.7%) were still significantly more likely to select social media as trustworthy decision factor compared to vaccinated pregnant women (25.0%) (36).

Marcell et al. set up a social media campaign in Washington called "One Vax Two Lives" to encourage the spread of scientifically based information about the risks of COVID-19 and benefits of COVID-19 vaccination during pregnancy. They reached a lot of people with ads on Facebook and Instagram, but in contrast, visitors of their informative website remained rather low. It is not clear what the actual impact of their campaign was on vaccine confidence and uptake in pregnant women (61).

Discussion

Maternal vaccination already showed to be effective in preventing infectious disease-related morbidity and mortality in pregnant women, foetuses and infants. During the current COVID-19 pandemic, vaccination during pregnancy and lactation got a lot of attention. HCPs were one of the first priority groups for COVID-19 vaccination. Since a lot of these HCPs were of fertile age, pregnant and/or lactating, these women were in the beginning vaccinated against COVID-19 based on previous reassuring evidence on the use of inactivated vaccines during pregnancy/lactation. However, lack of robust safety, immunogenicity and efficacy data from COVID-19 vaccine trials and the existence of various recommendations about COVID-19 vaccination during pregnancy and lactation in different areas of the world were the start of an important debate on COVID-19 vaccination during pregnancy and lactation.

Already before the start of the COVID-19 pandemic, the World Health Organization (WHO) defined vaccine hesitancy as one of the top ten threats to global health (62). Therefore, insight in factors influencing willingness to get vaccinated are crucial to plan effective interventions to increase vaccine coverage, especially in high-risk groups, such as pregnant and lactating women. Surveys performed during the COVID-19 pandemic, both before and after licensure of COVID-19 vaccines, demonstrated that willingness to get vaccinated against COVID-19 during pregnancy or lactation is in general lower than in non-pregnant and non-nursing women, which is not new. The trend of hesitancy towards vaccination in pregnant and lactating women is already observed before on a global scale. Many studies in literature have reported low coverage rates for influenza and Tdap vaccines in pregnant and lactating women and also low vaccine confidence in this population. However, it seems that the overall reluctance to COVID-19 vaccination is even higher compared to other vaccines recommended to be administered during pregnancy and/or lactation. This is possibly caused by the belief that COVID-19 vaccines were tested and approved too quickly and that no data were collected in the initial pre-marketing trials in pregnant and lactating women.

Safety concerns are reported as the main reason for refusal of COVID-19 vaccination during pregnancy and lactation. The belief that COVID-19 vaccines could cause harm for the reproductive system, foetus/baby and/or for the women is the most cited driver for vaccine hesitancy. The presence of safety concerns as a barrier to get vaccinated during pregnancy is not a new observation. Before the COVID-19 pandemic, Wilson et al. already reported these concerns as the most frequently cited barrier for being vaccinated during pregnancy (63).

Drivers for hesitancy towards COVID-19 vaccination in pregnant and lactating women are comparable to those in the general population where concerns about safety, efficacy and the quick development and approval of the vaccines are also the key determinants for COVID-19 vaccine refusal (64). These observations highlight the importance of high-quality clinical trials including pregnant and lactating women and the clear and transparent communication of findings from these trials to all population groups to increase vaccine coverage rates.

Before the start of the pandemic, Kilich et al. defined HCP recommendation as the most important factor to improve vaccine confidence during pregnancy (20). Also for COVID-19 vaccination, HCP recommendation is identified as a valuable method to increase vaccine acceptance. Redmond et al. pinpointed a HCP recommendation as the most influential strategy increasing vaccine willingness (48). However, recommendations from HCP are still often overshadowed by anxiety for side effects and circulating messages on social media. Also, it is worrying that not all HCPs support COVID-19 vaccination during pregnancy. Especially midwives seem to be less confident to advise COVID-19 vaccination during pregnancy, a conclusion already made for other vaccines before the pandemic (65). Therefore, the access to tailored information on vaccination for HCPs is crucial. Moreover, proper education of HCPs concerning the effect and importance of vaccines during pregnancy and lactation should be encouraged.

Besides clear formulation of vaccination recommendations during pregnancy/lactation, it is of equal importance that correct information on these recommendations reaches the target groups. In a survey in remote Alaskan communities, Hahn et al. found that 22.8% of the participants were not aware that COVID-19 vaccination was recommended during pregnancy, 26.5% of them were unsure about a recommendation in pregnant women and 28.1% of the participants were uncertain if COVID-19 vaccination would affect fertility or not. Furthermore,

pregnancy and lactation were often cited by the participants as reasons to postpone COVID-19 vaccination (59). Additionally, in a questionnaire in Saudi Arabia about public knowledge towards COVID-19 vaccination, 46.2% of the males and 24.2% of the females did not know if COVID-19 vaccination was recommended for pregnant women or not. Also, 72.4% of the female participants assented that COVID-19 vaccination was not preferred during pregnancy (66).

To avoid the misconceptions mentioned above and make sure target groups are aware of the most recent recommendations, specific programs and tools can be developed, adapted according to region, language and accessibility. Here, proper education of HCPs is again key to support these programs and tools and making these interventions effective.

To inform women who are planning to be pregnant, pregnant and/or lactating about vaccine recommendations, social media platforms can be used. Social media has become an integral part of our life. It is an important source to gather information and to form an opinion about several topics including COVID-19 and COVID-19 vaccination. As Maugeri et al. showed in their research, Google Search interest for 'Vaccination in pregnancy' increased significantly with the start of the COVID-19 vaccination campaign in Italy (60), but further research still needs to be done to detect the relation between social media search and actual vaccine uptake during pregnancy or lactation.

A six month follow-up study comparing COVID-19 vaccine hesitancy and actual vaccine uptake in pregnant and postpartum women concluded that the presence of vaccine hesitancy at baseline persisted, with only 10% of individuals transitioning from vaccine hesitant to being vaccinated (32). This highlights the need for the development of efficient interventions and educational strategies to increase vaccine confidence and subsequently vaccine coverage rates in pregnant and postpartum women. Therefore, at the University of Antwerp, a project was started funded by the Vaccine Confidence Fund to identify factors linked to social media that may influence vaccine confidence and in the long run uptake of pertussis, influenza and COVID-19 vaccines in women of childbearing age, pregnant and lactating women. The overall aim of this project, of which this review is also part of, is to identify the efficient interventions to increase vaccine confidence in pregnant and lactating women.

Conclusion

Vaccine hesitancy during pregnancy and lactation remains an important topic to focus on, especially in times of a pandemic and fast development of new vaccines. To improve vaccine confidence in these target groups, the inclusion of pregnant and lactating women in clinical trials could reduce safety concerns, as this is identified as the main reason to refuse vaccination. In addition, proper education of HCPs and clear, universal recommendations can also contribute to increase vaccine willingness. Further research is necessary to define the role of social media in actual vaccine uptake. However, social media messages can influence vaccine confidence in pregnant and lactating women.

Author's contribution

LDB and KM conducted the review. PVD, GH, KP, WD read the review and gave input and comments. All authors contributed to the article and approved the submitted version.

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Competing interest

None declared

Ethics approval statement

This study does not involve human participants.

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The influence of the COVID-19 pandemic and social media on the behaviour of pregnant and lactating women towards vaccination: a scoping review

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The influence of the COVID-19 pandemic and social media on the behaviour of pregnant and lactating women towards vaccination: a scoping review

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Abstract

BACKGROUND Pregnant women, foetuses and infants are at risk of infectious disease-related complications. Maternal vaccination is a strategy developed to better protect pregnant women and their offspring against infectious disease-related morbidity and mortality. Vaccines against influenza, pertussis and recently also COVID-19 are widely recommended for pregnant women. Yet, there is still a significant amount of hesitation towards maternal vaccination policies. Furthermore, contradictory messages circulating social media impact vaccine confidence.

OBJECTIVES This scoping review aims to reveal how COVID-19 and COVID-19 vaccination impacted vaccine confidence in pregnant and lactating women. Additionally, this review studied the role social media plays in creating opinions towards vaccination in these target groups.

ELIGIBILITY CRITERIA Articles published between 23 November 2018 and 18 July 2022 that are linked to the objectives of this review were included. Reviews, articles not focusing on the target group, abstracts, articles describing outcomes of COVID-19 infection/COVID-19 vaccination were excluded.

SOURCES OF EVIDENCE the PubMed database was searched to select articles. Search terms used were linked to pregnancy, lactation, vaccination, vaccine hesitancy, COVID-19 and social media.

CHARTING METHODS Included articles were abstracted and synthesized by one reviewer. Verification was done by a second reviewer. Disagreements were addressed through discussion between reviewers and other researchers.

RESULTS Pregnant and lactating women are generally less likely to accept a COVID-19 vaccine compared to non-pregnant and non-nursing women. The main reason to refuse maternal vaccination is safety concerns. A positive link was detected between COVID-19 vaccine willingness and acceptance of other vaccines during pregnancy. The Internet and social media are identified as important information sources for maternal vaccination.

DISCUSSION & CONCLUSION Vaccine hesitancy in pregnant and lactating women remains an important issue, expressing the need for effective interventions to increase vaccine confidence and coverage. The role social media plays in vaccine uptake remains unclear.

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Strengths and limitations

- A concrete research question with targeted search terms was used to complete this review.

- The search was only limited to one database (PubMed) which can lead to a lack of certain information.

- The search was not systematic since timing to perform the review was limited (within the VCF project). Nevertheless, this scoping review, conducted following the PRISMA guidelines, gives a good impression of what is already known and what not about the influence of COVID-19 and social media on vaccine confidence in pregnant and lactating women. Further research and interventions can be set up based on this review.

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Introduction

Several infectious diseases are associated with adverse outcomes in pregnant women, foetuses and infants. Therefore, a strategy which has gained interest in recent years is vaccination during pregnancy as well as during lactation, as a means to reduce infectious disease-related morbidity and mortality in these target populations (1–3).

Pregnant women who contract influenza have an increased risk of influenza-related complications and hospitalisation compared to non-pregnant women (2,4). In addition, influenza infections during pregnancy are linked to an increased risk of preterm delivery and small-for-gestational-age infants. Infants younger than six months of age are at high risk of having severe influenza-related complications, often associated with hospitalisation and mortality (2).

Another infectious disease that forms a serious threat for neonates is pertussis, of which the disease burden and case fatality rate is highest in the first year of life (5,6).

A COVID-19 infection during pregnancy is linked to an increased risk of hospitalisation, admission to an intensive care unit and death in pregnant women (7,8). Several studies have also found that there is a higher risk of preterm delivery, stillbirth and pre-eclampsia (7,9,10). Furthermore, low birth weight, foetal distress and other respiratory symptoms are more frequent in neonates born to a mother who experienced a COVID-19 infection (7,10). Infants infected with COVID-19 in the postpartum period can become critically ill (11).

To better protect pregnant women, foetuses and infants against infectious disease-related complications, vaccination during pregnancy is an important strategy. Public health authorities worldwide have already implemented this approach for influenza and pertussis, while recently also adding vaccination against COVID-19 (5,12–15).

Vaccination during pregnancy induces vaccine-specific antibodies that protect pregnant women against severe illness. Subsequently, these vaccine-induced antibodies are transferred from mother to baby across the placenta during pregnancy and via breastfeeding after birth (12). Therefore, if women did not receive a pertussis and/or influenza vaccine during pregnancy or are not yet fully vaccinated against COVID-19 with the advised vaccine doses, it is recommended to vaccinate in the postpartum period (16,17).

Despite the proven benefits of vaccination during pregnancy and lactation and the implementation of the vaccination strategy on a broad scale, there is still a significant amount of hesitation towards maternal vaccination policies. This is reflected by poor vaccine uptake in different regions and varying or lacking maternal vaccination programmes and recommendations in various countries (12,13,18,19). Before the start of the COVID-19 pandemic, Kilich et al. published a systematic review which defined factors that could possibly influence vaccination decision-making among pregnant women. The most important factor was found to be the recommendation from a healthcare provider (HCP) to vaccinate during pregnancy. However, other determinants such as previous vaccination behaviour and vaccine-specific factors could negate the recommendation from a HCP. Kilich et al. also found that pregnant women used the Internet or other media to search for information about vaccination, but these women did not perceive these channels to be the most trustworthy sources (20).

With the still ongoing COVID-19 pandemic and the licensing of COVID-19 vaccines, debates around vaccination flared up again. Pregnant and lactating women were initially excluded from pre-marketing clinical trials for licensing of COVID-19 vaccines, which resulted in doubts about safety, immunogenicity and the efficacy of the vaccines in these target groups. However, based on evidence from other vaccines already administered to pregnant and lactating women, no safety or efficacy issues were expected. After weighing the benefits of vaccination against the complications of disease, different countries immediately started to approve COVID-19 vaccination for these groups. Different opinions, scientifically-based or not, were shared via all sorts of social media, both by the general public and by HCPs. This scoping review provides an update to the review by Kilich et al., but also identifies additional factors related to vaccine decision-making in lactating women. Furthermore, this review reveals how COVID-19 and its accompanying vaccination campaign impacted vaccine confidence in pregnant and lactating women. Additionally, the role social media plays in creating opinions towards vaccination during pregnancy and/or lactation is studied.

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Methods

This scoping review was conducted following the PRISMA guidelines (Supplementary file 1). First a research protocol was written and grey literature was searched (Supplementary file 2). Scientific literature was found by searching the PubMed database, without language restrictions. Keywords were identified based on the systematic review from Kilich et al. (20) and additional search terms linked to social media and COVID-19 were added:

vaccin*, immuniz*, immunis*, antibodies, immune response, confidence, awareness, attitude*, anxiety, trust*, intent*, dilemma, perception*, misconception*, behaviour, behavior, anti-vaccin*, decision-making, vaccination refusal, fear*, distrust, mistrust, hesitancy, controvers*, belief*, criticis*, misinformation, intent*, choice*, concern*, knowledge, acceptance, willingness, uptake, barrier*, disinformation, complacency, fake news, pregnan*, maternal, prenatal, antenatal, parent*, lactating*, lactation, breast milk, breastfeeding, social media, internet, website*, communication*, social network*, social behavior, social behaviour, message*, forum, fora, blog*, discussion group*, online, Facebook, Twitter, Pinterest, LinkedIn, Instagram, Reddit, YouTube, Messenger, WhatsApp, Telegram, COVID*, SARS-CoV-2, COVID19*, corona*.

Publication dates were limited starting from 23 November 2018 since Kilich et al. covered articles published until 22 November 2018. The search was done on 18 July 2022 (Supplementary file 3).

Overall, 477 records were identified in the PubMed search. All records were screened by title and abstract, from which 46 were retained to screen by full text. Articles that did not mention pregnant and/or lactating women, the COVID-19 pandemic or vaccination and/or social media were excluded. Also, reviews and abstracts without full text were not included. If the article focused on outcomes of a COVID-19 infection or COVID-19 vaccination during pregnancy/lactation, the article was rejected. Finally, after screening by full text, 37 records were selected to be included in this scoping review. Screening the references of the selected records – known as 'the snowball search method' or 'snowballing' – yielded two additional articles.

Patient and public involvement

Since this article reviews the literature, no patients were involved.

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Results

1. COVID-19 VACCINE ACCEPTANCE IN PREGNANT AND LACTATING WOMEN AND WOMEN
   PLANNING TO BE PREGNANT

In total, 32 articles about willingness to get vaccinated against COVID-19 during pregnancy,
lactation and when planning to get pregnant were identified and included in this review. A
summary of the selected articles can be found in Table 1.

   1.1.   *COVID-19 vaccine confidence in pregnant women and women planning to be*
           pregnant

Several studies were conducted on vaccination willingness in pregnant women before the
availability of COVID-19 vaccines (N= 12). In four of these studies pregnant women were less
likely to accept a future COVID-19 vaccine (29.7%-62.1%) compared to breastfeeding women
(38.6%-69.0%) and non-pregnant women (73.4%-81.2%) (21–24). In contrast, Erchick et al.
found that more pregnant women (65.9%) were willing to get vaccinated against COVID-19
compared to non-pregnant women (59.6%), although the difference was not significant (25).
In addition, Tao et al. detected a high COVID-19 vaccine acceptance rate in pregnant women
in China at 77.4% (26). Furthermore, willingness to get vaccinated during pregnancy varied
greatly by country: COVID-19 vaccine readiness level was above 80.0% for pregnant women
in India and Mexico and lower than 45.0% in Russia, Australia and the USA (22). In the study
by Ceulemans et al., six European countries were compared. The highest COVID-19 vaccine
willingness during pregnancy was seen in Belgium (78.1%), whereas the lowest rate was found
in Switzerland (29.7%) (21).

Twenty surveys were performed after licensure of COVID-19 vaccines, but some were
conducted before the World Health Organization (WHO) and/or national authorities officially
recommended vaccinating all pregnant women against COVID-19. Sutton et al. concluded that
pregnant women - at that moment - were still less likely to accept a COVID-19 vaccine (44.3%)
compared to breastfeeding (55.2%) and non-pregnant women (76.2%) (27). Samannodi et al.
made the same significant conclusion for pregnant women and women planning to get
pregnant compared to non-pregnant women and women not planning to get pregnant (28).
Perez et al. divided their responders into two groups: i.e. (1) female HCPs preventing

pregnancy and (2) female HCPs who are pregnant/lactating/attempting pregnancy. They found a significant difference in vaccine willingness between both groups where group (1) significantly desired more to receive the vaccine compared to group (2) (29). Thirteen studies also mentioned COVID-19 vaccine coverage rates in pregnant women. Schaal et al. measured COVID-19 vaccine coverage in pregnant women in Germany during the same time period (March-April 2021) as Razzaghi et al. in the USA, with a remarkable difference in coverage between both studies: 2.4% in Germany versus 21.7% in the USA (30,31).

1.2. COVID-19 vaccine confidence in lactating women

Fifteen studies included lactating/postpartum women in their study population of which three studies found that lactating women were more likely to accept a COVID-19 vaccine (39.4%-69.0%) compared to pregnant women (13.8%-61.0%) (21,27,31). Nevertheless, lactating women remain less willing to receive a COVID-19 vaccine than non-pregnant and non-nursing women (27). In the follow-up study by Germann et al., 35.0% of postpartum women were willing to be vaccinated compared to only 14.0% of pregnant women. However, the breastfeeding status of the postpartum women was not clear (32). Gutierrez et al. found that women currently nursing or planning to breastfeed were less willing to receive a COVID-19 vaccine compared to women who were not (33). As for pregnant women, the acceptance rate widely varies among different countries with a 79.2% acceptance rate in Belgium compared to 38.6% in Switzerland (21).

Authors (year of publication)	Reference	Study period	Country of execution	Study design	N° of participants	COVID-19 vaccine coverage	COVID-19 vaccine willingness
Table 1: Overview of studies analysing vaccine confidence in COVID-19 vaccines of pregnant / lactating women							
Abuhammad (2022)	(34)	Sept 2021 – Oct 2021	Jordan	Survey	414 participants: 195 pregnant women 218 lactating women	50.8% of pregnant and lactating women	NA
Ceulemans et al. (2021)	(21)	16 Jun 2020 – 14 Jul 2020	Ireland, Norway, Switzerland, Netherlands, UK	Survey	16,063 participants: 6,661 pregnant women 9,402 lactating women	NA	61.0% of pregnant women 69.0% of lactating women
		10 Apr 2020 – 31 May 2020	Belgium				
Citu et al. (2022)	(35)	1 Oct 2021 – 1 Dec 2021	Romania	Survey	345 participants: 184 pregnant women 161 non-pregnant women of reproductive age	NA	47.8% of pregnant women 59.7% of non-pregnant women of reproductive age
Citu et al. (2022)	(36)	1 Jan 2022 – 1 May 2022	Romania	Survey	345 pregnant women	53.3% of pregnant women	NA
Egloff et al. (2022)	(37)	18 Feb 2021 – 5 Apr 2021	France	Survey	664 pregnant women	NA	29.5% of pregnant women
Erchick et al. (2022)	(25)	15 Dec 2020 – 23 Dec 2020	USA	Survey	8,481 participants: 233 pregnant women 8,248 non-pregnant women	NA	65.9% of pregnant women 59.6% of non-pregnant women
Geoghegan et al. (2021)	(38)	4 Dec 2020 – 14 Jan 2021	Ireland	Survey	300 pregnant women	NA	38.0% during pregnancy 63.0% after pregnancy
Germann et al. (2022)	(32)	22 Mar 2021 – 2 Apr 2021	USA	Survey	456 participants: 435 pregnant women 21 postpartum women	NA	60.0% of pregnant and postpartum women
		29 Jun 2021 – 20 Nov 2021		Follow-up survey	290 participants: 68 pregnant women 222 postpartum women	52.0% of pregnant and postpartum women	14.0% of pregnant women 35% of postpartum women
Gutierrez et al. (2022)	(33)	Jan 2021	USA	Survey	5,269 participants: 1,190 pregnant and postpartum women	NA	53.4% of pregnant and postpartum women 57.1% of other participants
Hosokawa et al. (2022)	(39)	24 Jul 2021 – 30 Aug 2021	Japan	Survey	1,621 pregnant women	13.4% of pregnant women	49.1% of pregnant women
Kuciel et al. (2022)	(40)	1 Jul 2021 – 30 Aug 2021	Poland	Survey	118 participants: 28 pregnant women 60 lactating women 109 mothers	NA	NA
Levy et al. (2021)	(41)	14 Dec 2020 – 14 Jan 2021	USA	Survey	662 pregnant women	NA	58.3% of pregnant women
Mappa et al. (2021)	(42)	27 Dec 2020	Italy	Survey	161 pregnant women	NA	52.9% of pregnant women
Mohan et al. (2021)	(43)	15 Oct 2020 – 15 Nov 2020	Qatar	Survey	341 pregnant and lactating women	NA	49.1% of participants
Nguyen et al. (2021)	(44)	Jan – Feb 2021	Vietnam	Survey	651 participants: pregnant women or postpartum	NA	60.4% of all participants
Oluklu et al. (2021)	(45)	11 Feb 2021 – 21 Mar 2021	Turkey	Survey	412 postpartum women: 363 lactating women	NA	33.3% of postpartum women
Perez et al. (2021)	(29)	8 Jan 2021 – 31 Jan 2021	USA	Survey	11,405 female HCP of reproductive age: 955 women attempting pregnancy 2,196 pregnant women 2,250 lactating women 67 lactating women attempting pregnancy	73.6% of all participants	75.3% of all participants strongly desire or desired vaccination – 1.5% are strongly adverse

Study	Ref	Date	Country	Type	Participants		
					91 women pregnant and lactating 5,846 preventing pregnancy		
Perrotta et al. (2022)	(46)	1 Mar 2021 – 23 Jul 2021	USA	Survey	299 pregnant women	20.7% of pregnant women	42.8% of pregnant women
Pisula et al. (2022)	(47)	24 Oct 2021 – 9 Nov 2021	Poland	Survey	515 pregnant women	58.1% of pregnant women	6.2% of pregnant women
Razzaghi et al. (2022)	(30)	31 Mar 2021 – 16 Apr 2021	USA	Survey	1,561 pregnant women	21.7% of pregnant women	24.0% of pregnant women
Redmond et al. (2022)	(48)	June 2020 – Aug 2020	USA	Survey	26 pregnant women 1 postpartum woman	NA	63.0% of pregnant and postpartum women
Riad et al. (2021)	(49)	Aug 2021 – Oct 2021	Czechia	Survey	362 participants: 278 pregnant women 84 lactating women	NA	66.6% of pregnant and lactating women
Saleh et al. (2022)	(50)	End Sep 2020 – mid-Jan 2021	Israel	Survey	410 participants: 293 pregnant women 117 postpartum women of whom 84 were lactating	NA	40% of postpartum participants
Samannodi et al. (2021)	(51)	12 Jun 2021 – 1 Aug 2021	Saudi Arabia	Survey	431 women: 214 women pregnant or planning to be pregnant	57.1% of all participants	NA
Schaal et al. (2021)	(31)	30 Mar 2021 – 19 Apr 2021	Germany	Survey	2,339 participants: 1,043 pregnant women 1,296 lactating women	2.4% of pregnant women 13.7% of lactating women	13.8% of pregnant women 39.4% of lactating women
Skirrow et al. (2022)	(24)	3 Aug 2020 – 11 Oct 2020	UK	Survey	1,181 pregnant women	NA	62.1% during current pregnancy
		7 Dec 2020 – 16 Dec 2020		Semi-structured interviews	10 pregnant women		81.2% after delivery
Skjefte et al. (2021)	(22)	28 Oct 2020 – 18 Nov 2020	Italy, Chile, Peru, New Zealand, Russia, Australia, Colombia, Brazil, Spain, South Africa, India, Mexico, Philippines, Argentina, USA, UK	Survey	17,871 participants: 5,294 pregnant women 12,562 non-pregnant women	NA	52.0% of pregnant women 73.4% of non-pregnant women
Stuckelberger et al. (2021)	(52)	18 Jun 2020 – 12 Jul 2020	Switzerland	Survey	1,551 participants: 515 pregnant women 1,036 lactating women	NA	29.7% of pregnant women 38.6% of lactating women
Sutton et al. (2021)	(27)	7 Jan 2021 – 29 Jan 2021	USA	Survey	1,012 participants: 216 pregnant women 122 lactating women 656 non-pregnant women	1.9% of pregnant women 3.3% of lactating women 13.3% of non-pregnant women	44.3% of pregnant women 55.2% of lactating women 76.2% of non-pregnant women
Tao et al. (2021)	(26)	13 Nov 2020 – 27 Nov 2020	China	Survey	1,392 pregnant women	NA	77.0% of pregnant women
Ward et al. (2022)	(53)	NA	Australia	Survey	218 pregnant women	44.0% of pregnant women	7.4% of pregnant women
Waring et al. (2022)	(54)	Mid-Feb 2021 – mid-Mar 2021	USA	Survey	203 women: 15 pregnant women 188 non-pregnant women (mothers)	47.3% of pregnant and non-pregnant women	66.0% of pregnant women 73.0% of non-pregnant women

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2. COVID-19 VACCINE CONFIDENCE IN HCP

Deruelle et al. investigated the perception of French HCPs towards COVID-19 vaccination during pregnancy. The survey was performed between 11 January and 1 March 2021. Overall, midwives were less likely to recommend COVID-19 vaccination during pregnancy (37.5%), compared to general practitioners (50.7%) and obstetricians (58.8%) (55).

To study how HCPs view COVID-19 vaccination during pregnancy, Bradfield et al. conducted a survey of women (including pregnant and lactating women), midwives, doctors providing maternity care and midwifery students in Australia in early 2021. They found that doctors and midwifery students were significantly more likely to advise COVID-19 vaccination during pregnancy compared to midwives. Unfortunately, in this study, pregnant and lactating women were not asked if a recommendation from a HCP was a motivational factor or not when looking at influential factors that determined pregnant and lactating women's decision to be vaccinated (56).

3. DETERMINANTS PREDICTING COVID-19 VACCINE ACCEPTANCE

Most of the surveys (N= 26) included in this review not only measured readiness to get vaccinated against COVID-19 during pregnancy or lactation, but also described determinants influencing COVID-19 vaccine acceptance.

3.1. Factors influencing COVID-19 vaccine acceptance during pregnancy

The most important reason for refusing COVID-19 vaccination during pregnancy is safety concerns, as described in 19 studies (22,24–27,30–32,37–39,41–43,46–49,53). These safety concerns include possible harm to the baby and to the mother, both in the short and long term. Other concerns include that there is not yet enough clinical trial data on COVID-19 vaccination during pregnancy (22,24,27,31,32,46) and that COVID-19 vaccines are seen as not being trustworthy because they were developed and approved rapidly (22,24,30,39). Hosowaka et al. defined mistrust in the government as the only significant factor linked to vaccine hesitancy among pregnant women in Japan (39). Not believing in vaccines and in the existence of the SARS-CoV-2 virus, not being afraid of COVID-19, and trusting rumours on social media were also described by Citu et al. as statistically independent risk factors for vaccine hesitancy among pregnant women (35).

Receiving an influenza vaccine (27,30,32,37,52) and/or pertussis vaccine during pregnancy (24,32) are positive determinants for accepting COVID-19 vaccination among pregnant women. Other positive factors are a recommendation by a HCP or having a discussion with a HCP about COVID-19 vaccines (30,32,37,38,48,53), believing to be at high risk of or concerns about contracting COVID-19 (22,29,32), being aware of having an increased risk of severe illness due to COVID-19 (53), and living with individuals with or themselves suffering from co-morbidities/high risk conditions (30).

Demographic factors associated with better COVID-19 vaccine willingness are a higher level of education (22,32,33,36,37,39,41,42,46,47,49,50,52), being employed (30,32,42,50), having a higher income (22,24,33,35,36,46,47), older age (22,24,25,32,33,37,41,46,49,52), being in the third trimester of gestation (26,36,38,49,52), multiparity (37,49), and living in an urban area (35,36,47,50). Other demographic factors linked to COVID-19 vaccine willingness are race and ethnicity (24,29,30,41,43,50). Interestingly, Tao et al. found that pregnant Chinese women of younger age and with a lower level of education were more likely to accept COVID-19 vaccination (26).

3.2. Factors influencing COVID-19 vaccine acceptance during lactation

Lactating/postpartum women were found to have similar safety concerns to pregnant women (27,31,32,45,49). One of the reasons for refusing the vaccine or being hesitant about getting it is the lack of reliable data on the administration and effectiveness of a COVID-19 vaccine during lactation (31,45). Additionally, Sutton et al. described that there were concerns in this target group that the COVID-19 vaccine could cause infertility (27).
Gutierrez et al. and Stuckelberger et al. described several demographic factors in pregnant and lactating/postpartum women associated with a lower likelihood of vaccination: younger age (33,52), lower level of education (33,52) and lower income (33). However, both studies did not distinguish between pregnant and lactating/postpartum women (33,52). Riad et al. found that there was no significant difference in age and educational level in the group of lactating women willing to accept the vaccine and the group of lactating women resistant to the vaccine. However, lactating healthcare workers had a significantly higher COVID-19 vaccine acceptance level compared to non-healthcare workers (49).

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4.   THE IMPACT OF THE COVID-19 PANDEMIC ON OTHER VACCINATIONS

Several studies also discussed vaccination willingness for other diseases during pregnancy in COVID-19 times. Two studies focused on influenza, one focused on pertussis while another one focused on vaccines during pregnancy in general (47,50,57,58). Gencer et al. found that 77.0% of the pregnant women they interviewed received or intended to receive vaccination during pregnancy. For 50.6% of these women, the COVID-19 pandemic had not affected their views on being vaccinated in the future (57).

The study by Saleh et al. analysed the effect of the COVID-19 pandemic on seasonal influenza vaccine compliance among pregnant and postpartum women in Israel from September 2020 until mid-January 2021. They found that, despite the high incidence of COVID-19, vaccine uptake was similar to pre-pandemic times with 54.4% of the women studied being vaccinated against influenza (50).

Pisula et al. investigated the knowledge and attitudes of pregnant women towards influenza vaccination in 2021. In total, 21.0% had been vaccinated against influenza during pregnancy and 17.5% were planning to get vaccinated. They stated that there is a link between influenza vaccine uptake and COVID-19 vaccine uptake in pregnant women. Women who refused COVID-19 vaccination did not intend to get an influenza vaccine and vice versa (47).

Skirrow et al. explored the experience of women getting vaccinated against pertussis during pregnancy in COVID-19 times. The study used an online survey which was spread from 3 August until 11 October 2020. The survey was completed by 922 pregnant women and 482 postpartum women who had been pregnant at some point after the first lockdown in the United Kingdom. They found that 72.1% of pregnant women and 84.0% of postpartum women had received a pertussis vaccine during pregnancy even when access was hampered due to COVID-19 restrictions (58).

5.   THE IMPACT OF SOCIAL MEDIA ON COVID-19 VACCINE CONFIDENCE

Riad et al. stated that social media is an important source of information on COVID-19 vaccines for pregnant and lactating women. However, only 8.3% of the pregnant and lactating women studied reported that media/social media was an impactful factor when deciding to receive or not receive COVID-19 vaccination (49).

Hahn et al. conducted three surveys in remote Alaskan communities, focusing on the impact of COVID-19 on their daily life and their attitude towards COVID-19 vaccination between November 2020 and September 2021. By September 2021, misunderstandings about vaccine recommendations during pregnancy and the effects of COVID-19 vaccination on fertility and DNA were present in participants where social media was identified as the primary source of information (59).

Using Google Trends, Maugeri et al. investigated the changes in Google Search interest on vaccination during pregnancy after the introduction of COVID-19 vaccination in Italy. The data covered searches from 1 January 2019 until 31 October 2021. This made it possible to monitor the changes over two years from before the introduction of COVID-19 vaccination until 31 October 2021. The analysis of Google Trends indicated that the search interest for 'vaccination in pregnancy' was increased significantly (both qualitative and quantitative) compared to the predicted trend after the start of the Italian COVID-19 vaccination campaign. Moreover, further qualitative analysis showed that the increase was most likely due to concerns about COVID-19 vaccination (60).

Citu et al. identified that trusting rumours on social media had the greatest impact on vaccine hesitancy among pregnant Romanian women. Compared to non-pregnant women (63.0%), significantly more pregnant women (78.1%) answered 'yes' to the question if they trusted social media rumours (35). In a survey conducted a few months later, Citu et al. found that unvaccinated pregnant women (44.7%) were significantly more likely to select social media as a trustworthy decision-making factor compared to vaccinated pregnant women (25.0%) (36).

In a study by Marcell et al., a social media campaign was set up in Washington called 'One Vax Two Lives' to encourage the spread of scientifically-based information about the risks of COVID-19 and benefits of COVID-19 vaccination during pregnancy. They reached a lot of people through ads on Facebook and Instagram, but the number of visitors to their informative website remained rather low. It is not clear what the actual impact of their campaign was on vaccine confidence and uptake in pregnant women (61).

Discussion

Maternal vaccination has already proven to be an effective means to prevent infectious disease-related morbidity and mortality in pregnant women, foetuses and infants. During the COVID-19 pandemic, the topic of vaccination during pregnancy and lactation received a lot of attention. In many countries, HCPs were one of the priority groups to receive vaccination against COVID-19. A lot of these HCPs are of fertile age, pregnant and/or lactating. These women were among the first fertile/pregnant/lactating women to be vaccinated against COVID-19. The vaccine was assumed to be safe for these target groups, based on previous research which generated reassuring evidence on the use of inactivated vaccines during pregnancy/lactation. However, lack of robust data on the safety, immunogenicity and efficacy of the COVID-19 vaccines and the existence of varying recommendations concerning COVID-19 vaccination during pregnancy and lactation in different areas of the world started an important debate on COVID-19 vaccination during pregnancy and lactation.

Even before the start of the COVID-19 pandemic, the World Health Organization (WHO) defined vaccine hesitancy as one of the top ten threats to global health (62). Therefore, insights into factors influencing willingness to get vaccinated are crucial to plan effective interventions to increase vaccine coverage, especially in high-risk groups (such as pregnant and lactating women). Surveys performed during the COVID-19 pandemic - both before and after licensure of COVID-19 vaccines - demonstrated that willingness to get vaccinated against COVID-19 is generally lower in pregnant and lactating women than in non-pregnant and non-nursing women, which was not a surprising finding. On a global scale, vaccine hesitancy is more common in pregnant and lactating women. Many studies have reported that there are low coverage rates for influenza and Tdap vaccines in pregnant and lactating women. This population also shows low vaccine confidence. However, the overall reluctance towards COVID-19 vaccination is even higher compared to other vaccines recommended to be administered during pregnancy and/or lactation. This is possibly caused by the belief that COVID-19 vaccines were tested and approved too quickly and that in the initial pre-marketing trials no data were collected on pregnant and lactating women.

Safety concerns are reported as the main reason for refusal of COVID-19 vaccination during pregnancy and lactation. The belief that COVID-19 vaccines could cause harm to the reproductive system, foetus/baby and/or to the women themselves is the most commonly cited driver for vaccine hesitancy. This is not a new observation; before the COVID-19 pandemic, Wilson et al. already reported these concerns as the most frequently cited barrier to being vaccinated during pregnancy (63).

The reasons for vaccine hesitancy towards COVID-19 vaccination in pregnant and lactating women are comparable to those in the general population, where concerns about safety, efficacy and the rapid development and approval of the vaccines are also the key determinants for COVID-19 vaccine refusal (64). These observations highlight the importance of high-quality clinical trials that include pregnant and lactating women. Furthermore, it is important to clearly and transparently communicate the findings from these trials to all population groups to increase vaccine coverage rates.

Before the start of the pandemic, Kilich et al. defined a HCP recommendation as the most important factor affecting vaccine confidence during pregnancy (20); later studies found the same for COVID-19 vaccination. Redmond et al. pinpointed recommendations from HCPs as the most influential strategy to increase vaccine willingness (48). However, these recommendations are often still overshadowed by anxiety about side effects and messages circulating social media. Another worrying factor is that not all HCPs support COVID-19 vaccination during pregnancy. Especially midwives seem to be less likely to recommend COVID-19 vaccination during pregnancy, which is in line with studies on other vaccines before the pandemic (65). Therefore, it is crucial to provide HCPs access to tailored information on vaccination. Moreover, proper education of HCPs concerning the effects and importance of vaccines during pregnancy and lactation is needed.

Besides clear formulation of vaccination recommendations during pregnancy/lactation, it is of equal importance that correct information on these recommendations reaches the target groups. In a survey conducted in remote Alaskan communities, Hahn et al. found that 22.8% of the participants were not aware that COVID-19 vaccination was recommended during pregnancy, 26.5% of the participants were unsure about a recommendation for pregnant women, and 28.1% of the participants were uncertain if COVID-19 vaccination would affect

fertility or not. Furthermore, participants often cited pregnancy and lactation as reasons to postpone COVID-19 vaccination (59). Additionally, in a questionnaire in Saudi Arabia on public knowledge regarding COVID-19 vaccination, 46.2% of males and 24.2% of females did not know if COVID-19 vaccination was recommended for pregnant women or not. Also, 72.4% of female participants stated that COVID-19 vaccination was not preferred during pregnancy (66).

To avoid the misconceptions mentioned above and to make sure that target groups are made aware of the most recent recommendations, specific programmes and tools need to be developed – each adapted according to region, language and accessibility. Here, proper education of HCPs is again key to support these programmes and tools to make these interventions effective.

Since social media has become an integral part of our lives, these platforms can be used to inform women who are pregnant, lactating or planning to be pregnant about vaccine recommendations. For many, it has become an important source of information and it is used to form an opinion about all kinds of topics, including COVID-19 and COVID-19 vaccination. In Italy, research by Maugeri et al. showed that Google Search interest for 'vaccination in pregnancy' increased significantly after Italy's COVID-19 vaccination campaign had started (60). Further research is still needed to accurately define the relation between social media and Internet searches and actual vaccine uptake during pregnancy or lactation.

A six month follow-up study comparing COVID-19 vaccine hesitancy and actual vaccine uptake in pregnant and postpartum women concluded that being hesitant towards COVID-19 vaccines at baseline persisted, with only 10% of individuals transitioning from being vaccine hesitant to being vaccinated (32). This highlights that efficient interventions and educational strategies need to be developed to increase vaccine confidence, which subsequently increases vaccine coverage rates in pregnant and postpartum women. Therefore, a project was started at the University of Antwerp funded by the Vaccine Confidence Fund to identify which factors linked to social media influence vaccine confidence and in the long run the uptake of pertussis, influenza and COVID-19 vaccines in women of childbearing age, and pregnant and lactating women. The overall aim of this project - which this review is also part of - is to identify which interventions are efficient in increasing vaccine confidence in pregnant and lactating women.

Conclusion

Vaccine hesitancy during pregnancy and lactation remains an important topic to study, especially in times of a pandemic and with the fast development of new vaccines. To improve vaccine confidence in these target groups, the inclusion of pregnant and lactating women in clinical trials could reduce safety concerns, as this was identified as the main reason to refuse vaccination. In addition, proper education of HCPs and clear, universal recommendations can also contribute to increase vaccine willingness. Further research is necessary to define the role social media plays in actual vaccine uptake. However, from our findings it can be concluded that social media messages can influence vaccine confidence in pregnant and lactating women.

Author's contribution

LDB and KM conducted the review. PVD, GH, KP, WD read the review and provided input and comments. All authors contributed to the article and approved the submitted version.

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Competing interest

None declared.

Ethics approval

Not applicable.

Data sharing statement

No additional data are available.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	p. 1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	p. 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	p. 4-5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	p. 5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Supplementary file 2 (not registered)
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	p. 6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	p. 6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary file 3
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	p. 6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Supplementary file 2
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	p. 6
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	NA

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Supplementary file 2
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	p. 7-8, p. 12
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	p. 9-11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	p. 7-15
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	p. 9-11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	p. 16-18
Limitations	20	Discuss the limitations of the scoping review process.	p. 19
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	p. 19
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	p. 19

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data *charting*.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

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RESEARCH PROTOCOL

The influence of the COVID-19 pandemic and social media on behaviour of pregnant and lactating women towards vaccination: a scoping review

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Background

In March 2020, the World Health Organization (WHO) announced that the COVID-19 outbreak, caused by the SARS-CoV-2 virus, could be characterized as a pandemic. As of November 8th 2021, there have been >400 million confirmed COVID-19 cases and almost 6 million COVID-19 confirmed deaths worldwide. Similar to other populations, pregnant and lactating women can encounter SARS-CoV-2 and might contract COVID-19. SARS-CoV-2 infection during pregnancy is associated with increased rates of stillbirth, preterm birth, pre-eclampsia and caesarian delivery. Furthermore, pregnant women are at increased risk of hospitalization, admission to intensive care unit and death compared to non- pregnant women (1,2). If breastfeeding women contract COVID-19, they can become seriously ill impeding them from continuing breastfeeding. Besides, they can transmit the disease via droplet transmission to their newborn child (3).

One of the most important approaches to control the ongoing pandemic is COVID-19 vaccination. Since the beginning of 2021, several COVID-19 vaccines have been licensed and

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implemented worldwide. Since pregnant and lactating women were initially not included in pre-marketing clinical trials, many questions rose about development, safety, immunogenicity and effectiveness of COVID-19 vaccines in these target groups. Although there was absence of data on safety and efficacy of COVID-19 vaccines during pregnancy or lactation, several countries started to recommend vaccination in these target groups (4).

The COVID-19 pandemic and its accompanying vaccination campaign led to an abundance of misinformation about vaccination on the Internet (5). Fake news that has circulated about COVID-19 vaccination in pregnant women, women of childbearing age and lactating women included: 1. COVID-19 vaccination could cause infertility 2. there is an increased risk of miscarriage/stillbirth after receiving a COVID-19 vaccine while pregnant 3. it is unsafe for breastfeeding women to receive a COVID-19 vaccine (6). These myths can feed vaccine hesitancy in this important target group. Since the World Health Organization (WHO) described in 2019 vaccine hesitancy as one of the top 10 global health threats (7), it is important to tackle these obstacles and to improve vaccine uptake.

To set up right interventions to improve vaccine confidence, it is necessary to determine the factors that influence vaccine decision-making in pregnant and lactating women. The systematic review of Kilich et al. describes determinants that influence vaccine confidence among pregnant women (8). However, this study is limited to pre-pandemic information, does not include lactating women and does not focus on social media.

Research question

What is the impact of the COVID-19 pandemic and social media on vaccine confidence in pregnant and lactating women?

Objectives

1. Comparing vaccine confidence in pregnant and lactating women before and after the COVID-19 pandemic.

2. Describing vaccine willingness towards COVID-19 vaccination in pregnant and lactating women.

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3. Determination of factors linked to vaccine (un)willingness towards COVID-19 vaccination in pregnant and lactating women.

4. Appraise the impact of social media on vaccine confidence in pregnant and lactating women.

Methods

We propose to answer the research question above by conducting a scoping review following the PRISMA guidelines. The study will begin November 2021 and will be finished as soon as possible (before end of December 2021).

Search strategy

The review will be conducted by doing a literature study. First, grey literature will be searched. This search includes a general web search on Google (limited to the first 50 results) and Google Scholar (limited to the first 200 results). Search terms will be adjusted and refined based on the number and types of relevant hits. If there is a relevant publication found, it will be considered for inclusion.

PubMed will be used as database to search literature. Due to time pressure, only one database will be searched. Since PubMed gives access to three components (MEDLINE, PuBMed Central and Bookshelf) and contains more than 34 million citations and abstracts of biomedical literature and life sciences, this database is selected.

Inclusion and exclusion criteria

All articles, without language restriction, published from November 22nd 2018 (since Kilich et al. searched all articles by November 22nd 2018) related to the research question will be included.

Following criteria will lead to exclusion:

1. Reviews

2. Articles whose focus is not our target population (pregnant and lactating women)

3. Abstracts, no full text available

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4. Articles describing outcomes of COVID-19 infection or COVID-19 vaccination in pregnant and lactating women.

Data charting

Included articles will be abstracted and synthesized by one reviewer following the procedure described below. Verification will be done by a second reviewer. Disagreements will be addressed through discussion between the reviewers and the other researchers.

Synthesis of included articles:

a. Study characteristics
    i. Author(s)
    ii. Year of publication
    iii. Year the study was conducted
    iv. Type of publication (e.g. clinical trial, survey,…)
    v. Publication title
    vi. Journal in which study is published
    vii. Country of publication
    viii. Language of dissemination
    ix. Topic of the study

b. Study methods
    i. Study location (country, city)
    ii. Study design
    iii. Study population
    iv. Study sample size (N= xxx)
    v. Follow-up time / timing of the study

c. Results
    i. COVID-19 vaccine coverage (N= xxx)
    ii. COVID-19 vaccine willingness (N= xxx)
    iii. Factors influencing COVID-19 vaccine willingness
    iv. Vaccine coverage other than COVID-19 (N= xxx)
    v. Vaccine willingness other than COVID-19 (N= xxx)
    vi. Social media platforms described

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              vii.   Influence of social media

   d.   Quality of the study

              i.   Strengths

              ii.   Limitations

             iii.   Bias (selection / performance / performance / attrition / reporting / other)

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Supplementary file 3: full search strategy

<u>Database</u>**:** PubMed

<u>Date searched</u>: 18th July 2022

<u>Filters used</u>: from 2018/11/23 – 2022/7/18 (present day)

<u>Results</u>**:** 477 results

Query	Results
Search: **(((((Vaccin* OR Immuniz* OR immunis* OR antibodies OR immune response))))) AND ((((confidence OR awareness OR attitude* OR anxiety OR trust* OR intent* OR dilemma OR perception* OR misconception* OR behaviour OR behavior OR anti-vaccin* OR decision making OR vaccination refusal OR fear* OR distrust OR mistrust OR hesitancy OR controvers* OR belief* OR criticis* OR misinformation OR intent* OR choice* OR concern* OR knowledge OR acceptance OR willingness OR uptake OR barrier* OR disinformation OR complacency OR fake news)))) AND (((pregnan* OR maternal OR prenatal OR antenatal OR parent* OR lactating* OR lactation OR breast milk OR breastfeeding))) AND ((social media OR internet OR website* OR communication* OR social network* social behavior OR social behaviour OR message* OR forum OR fora OR blog* OR discussion group* OR online OR Facebook OR Twitter OR Pinterest OR LinkedIn OR Instagram OR Reddit OR Youtube OR Messenger OR Whatsapp OR Telegram)) AND (COVID* OR SARS-CoV-2 OR COVID19* OR corona*)** Filters: **from 2018/11/23 - 2022/7/18** Sort by: **Most Recent**	477

The database was searched without language restrictions. The languages used within the 477 records were French, German and English. Since the authors are educated in these languages, this formed no issue.

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The influence of the COVID-19 pandemic and social media on the behaviour of pregnant and lactating women towards vaccination: a scoping review

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Abstract : 298 words

Article : 4,107 words

References : 66

Abstract

BACKGROUND Pregnant women, foetuses and infants are at risk of infectious disease-related complications. Maternal vaccination is a strategy developed to better protect pregnant women and their offspring against infectious disease-related morbidity and mortality. Vaccines against influenza, pertussis and recently also COVID-19 are widely recommended for pregnant women. Yet, there is still a significant amount of hesitation towards maternal vaccination policies. Furthermore, contradictory messages circulating social media impact vaccine confidence.

OBJECTIVES This scoping review aims to reveal how COVID-19 and COVID-19 vaccination impacted vaccine confidence in pregnant and lactating women. Additionally, this review studied the role social media plays in creating opinions towards vaccination in these target groups.

ELIGIBILITY CRITERIA Articles published between 23 November 2018 and 18 July 2022 that are linked to the objectives of this review were included. Reviews, articles not focusing on the target group, abstracts, articles describing outcomes of COVID-19 infection/COVID-19 vaccination were excluded.

SOURCES OF EVIDENCE The PubMed database was searched to select articles. Search terms used were linked to pregnancy, lactation, vaccination, vaccine hesitancy, COVID-19 and social media.

CHARTING METHODS Included articles were abstracted and synthesized by one reviewer. Verification was done by a second reviewer. Disagreements were addressed through discussion between reviewers and other researchers.

RESULTS Pregnant and lactating women are generally less likely to accept a COVID-19 vaccine compared to non-pregnant and non-nursing women. The main reason to refuse maternal vaccination is safety concerns. A positive link was detected between COVID-19 vaccine willingness and acceptance of other vaccines during pregnancy. The Internet and social media are identified as important information sources for maternal vaccination.

DISCUSSION & CONCLUSION Vaccine hesitancy in pregnant and lactating women remains an important issue, expressing the need for effective interventions to increase vaccine confidence and coverage. The role social media plays in vaccine uptake remains unclear.

Strengths and limitations

- A concrete research question with targeted search terms was used to complete this review.

- The search was limited to one database (PubMed) which could have led to missing out on important studies not included in the searched database.

- The search was not systematic since timing to perform the review was limited (within the VCF project).

- This scoping review followed the PRISMA guidelines for scoping reviews.

Introduction

Several infectious diseases are associated with adverse outcomes in pregnant women, foetuses and infants. Therefore, a strategy which has gained interest in recent years is vaccination during pregnancy as well as during lactation, as a means to reduce infectious disease-related morbidity and mortality in these target populations (1–3).

Pregnant women who contract influenza have an increased risk of influenza-related complications and hospitalisation compared to non-pregnant women (2,4). In addition, influenza infections during pregnancy are linked to an increased risk of preterm delivery and small-for-gestational-age infants. Infants younger than six months of age are at high risk of having severe influenza-related complications, often associated with hospitalisation and mortality (2).

Another infectious disease that forms a serious threat for neonates is pertussis, of which the disease burden and case fatality rate is highest in the first year of life (5,6).

A COVID-19 infection during pregnancy is linked to an increased risk of hospitalisation, admission to an intensive care unit and death in pregnant women (7,8). Several studies have also found that there is a higher risk of preterm delivery, stillbirth and pre-eclampsia (7,9,10). Furthermore, low birth weight, foetal distress and other respiratory symptoms are more frequent in neonates born to a mother who experienced a COVID-19 infection (7,10). Infants infected with COVID-19 in the postpartum period can become critically ill (11).

To better protect pregnant women, foetuses and infants against infectious disease-related complications, vaccination during pregnancy is an important strategy. Public health authorities worldwide have already implemented this approach for influenza and pertussis, while recently also adding vaccination against COVID-19 (5,12–15).

Vaccination during pregnancy induces vaccine-specific antibodies that protect pregnant women against severe illness. Subsequently, these vaccine-induced antibodies are transferred from mother to baby across the placenta during pregnancy and via breastfeeding after birth (12). Therefore, if women did not receive a pertussis and/or influenza vaccine during pregnancy or are not yet fully vaccinated against COVID-19 with the advised vaccine doses, it is recommended to vaccinate in the postpartum period (16,17).

Despite the proven benefits of vaccination during pregnancy and lactation and the implementation of the vaccination strategy on a broad scale, there is still a significant amount of hesitation towards maternal vaccination policies. This is reflected by poor vaccine uptake in different regions and varying or lacking maternal vaccination programmes and recommendations in various countries (12,13,18,19). A previous systematic review (20), conducted before the start of the COVID-19 pandemic, defined factors that could possibly influence vaccination decision-making among pregnant women. The most important factor was found to be the recommendation from a healthcare provider (HCP) to vaccinate during pregnancy. However, other determinants such as previous vaccination behaviour and vaccine-specific factors could negate the recommendation from a HCP. This work also found that pregnant women used the Internet or other media to search for information about vaccination, but these women did not perceive these channels to be the most trustworthy sources (20).

With the still ongoing COVID-19 pandemic and the licensing of COVID-19 vaccines, debates around vaccination flared up again. Pregnant and lactating women were initially excluded from pre-marketing clinical trials for licensing of COVID-19 vaccines, which resulted in doubts about safety, immunogenicity and the efficacy of the vaccines in these target groups. However, based on evidence from other vaccines already administered to pregnant and lactating women, no safety or efficacy issues were expected. After weighing the benefits of vaccination against the complications of disease, different countries immediately started to approve COVID-19 vaccination for these groups. Different opinions, scientifically-based or not, were shared via all sorts of social media, both by the general public and by HCPs. The aim of this scoping review is to give a post-pandemic update of the pre-pandemic systematic review mentioned above (20). The research tries to reveal how COVID-19 and its accompanying vaccination campaign impacted vaccine confidence in pregnant and lactating women. Additionally, this review intends to identify additional factors related to vaccine decision-making in lactating women. Furthermore, the role social media plays in creating opinions towards vaccination during pregnancy and/or lactation is studied.

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Methods

This scoping review was conducted following the PRISMA guidelines (Supplementary file 1). First, a research protocol was written and grey literature was searched (Supplementary file 2). Scientific literature was found by searching the PubMed database, without language restrictions. Keywords were identified based on the previous systematic review (20) and additional search terms linked to social media and COVID-19 were added:

vaccin*, immuniz*, immunis*, antibodies, immune response, confidence, awareness, attitude*, anxiety, trust*, intent*, dilemma, perception*, misconception*, behaviour, behavior, anti-vaccin*, decision-making, vaccination refusal, fear*, distrust, mistrust, hesitancy, controvers*, belief*, criticis*, misinformation, intent*, choice*, concern*, knowledge, acceptance, willingness, uptake, barrier*, disinformation, complacency, fake news, pregnan*, maternal, prenatal, antenatal, parent*, lactating*, lactation, breast milk, breastfeeding, social media, internet, website*, communication*, social network*, social behavior, social behaviour, message*, forum, fora, blog*, discussion group*, online, Facebook, Twitter, Pinterest, LinkedIn, Instagram, Reddit, YouTube, Messenger, WhatsApp, Telegram, COVID*, SARS-CoV-2, COVID19*, corona*.

Publication dates were limited starting from 23 November 2018 since the pre-pandemic systematic review (20) covered articles published until 22 November 2018. The search was done on 18 July 2022 (Supplementary file 3).

Overall, 477 records were identified in the PubMed search. All records were screened by title and abstract, from which 46 were retained to screen by full text. Articles that did not mention pregnant and/or lactating women, the COVID-19 pandemic or vaccination and/or social media were excluded. Also, reviews and abstracts without full text were not included. If the article focused on outcomes of a COVID-19 infection or COVID-19 vaccination during pregnancy/lactation, the article was rejected. Finally, after screening by full text, 37 records were selected to be included in this scoping review. Screening the references of the selected records – known as 'the snowball search method' or 'snowballing' – yielded two additional articles.

Patient and public involvement

We did not involve patients/the public in the design or conduct of our study.

Results

1. COVID-19 VACCINE ACCEPTANCE IN PREGNANT AND LACTATING WOMEN AND WOMEN
    PLANNING TO BE PREGNANT

In total, 32 articles about willingness to get vaccinated against COVID-19 during pregnancy, lactation and when planning to get pregnant were identified and included in this review. A summary of the selected articles can be found in Table 1.

1.1. *COVID-19 vaccine confidence in pregnant women and women planning to be pregnant*

Several studies were conducted on vaccine willingness in pregnant women before the availability of COVID-19 vaccines (N= 12). In four of these studies pregnant women were less likely to accept a future COVID-19 vaccine (29.7%-62.1%) compared to breastfeeding women (38.6%-69.0%) and non-pregnant women (73.4%-81.2%) (21–24). In contrast, one study found that more pregnant women (65.9%) were willing to get vaccinated against COVID-19 compared to non-pregnant women (59.6%), although the difference was not significant (25). In addition, a high COVID-19 vaccine acceptance rate in pregnant women in China was detected (77.4%) (26). Furthermore, willingness to get vaccinated during pregnancy varied greatly by country: COVID-19 vaccine readiness level was above 80.0% for pregnant women in India and Mexico and lower than 45.0% in Russia, Australia and the USA (22). In a study where six European countries were compared, the highest COVID-19 vaccine willingness during pregnancy was seen in Belgium (78.1%), whereas the lowest rate was found in Switzerland (29.7%) (21).

Twenty surveys were performed after licensure of COVID-19 vaccines, but some were conducted before the World Health Organization (WHO) and/or national authorities officially recommended vaccinating all pregnant women against COVID-19. A survey study conducted at the New York Presbyterian Hospital (USA) concluded that pregnant women - at that moment - were still less likely to accept a COVID-19 vaccine (44.3%) compared to breastfeeding (55.2%) and non-pregnant women (76.2%) (27). Another survey study conducted in Saudi Arabia made the same significant conclusion for pregnant women and women planning to get pregnant compared to non-pregnant women and women not planning

to get pregnant (28). A study performed in January 2021 in the USA divided the responders into two groups: i.e. (1) female HCPs preventing pregnancy and (2) female HCPs who are pregnant/lactating/attempting pregnancy. The research found a significant difference in vaccine willingness between both groups where group (1) significantly desired more to receive the vaccine compared to group (2) (29). Thirteen studies also mentioned COVID-19 vaccine coverage rates in pregnant women. Two studies measured the COVID-19 vaccine coverage in pregnant women during the same time period (March-April 2021) in two different countries: Germany (30) and the USA (31). A remarkable difference in coverage between both studies was observed: 2.4% in Germany versus 21.7% in the USA (30,31).

1.2. COVID-19 vaccine confidence in lactating women

Fifteen studies included lactating/postpartum women in their study population of which three studies found that lactating women were more likely to accept a COVID-19 vaccine (39.4%-69.0%) compared to pregnant women (13.8%-61.0%) (21,27,30). Nevertheless, lactating women remain less willing to receive a COVID-19 vaccine than non-pregnant and non-nursing women (27). In an American follow-up study, 35.0% of postpartum women were willing to be vaccinated compared to only 14.0% of pregnant women. However, the breastfeeding status of the postpartum women was not clear (32). Another study from the USA found that women currently nursing or planning to breastfeed were less willing to receive a COVID-19 vaccine compared to women who were not (33). As for pregnant women, the acceptance rate widely varies among different countries with a 79.2% acceptance rate in Belgium compared to 38.6% in Switzerland (21).

Table 1: Overview of studies analysing vaccine confidence in COVID-19 vaccines of pregnant / lactating women							
Authors (year of publication)	Reference	Study period	Country	Study design	N° of participants	COVID-19 vaccine coverage	COVID-19 vaccine willingness
Abuhammad (2022)	(34)	Sept 2021 – Oct 2021	Jordan	Survey	414 participants: 195 pregnant women 218 lactating women	50.8% of pregnant and lactating women	NA
Ceulemans et al. (2021)	(21)	16 Jun 2020 – 14 Jul 2020	Ireland, Norway, Switzerland, Netherlands, UK	Survey	16,063 participants: 6,661 pregnant women 9,402 lactating women	NA	61.0% of pregnant women 69.0% of lactating women
		10 Apr 2020 – 31 May 2020	Belgium				
Citu et al. (2022)	(35)	1 Oct 2021 – 1 Dec 2021	Romania	Survey	345 participants: 184 pregnant women 161 non-pregnant women of reproductive age	NA	47.8% of pregnant women 59.7% of non-pregnant women of reproductive age
Citu et al. (2022)	(36)	1 Jan 2022 – 1 May 2022	Romania	Survey	345 pregnant women	53.3% of pregnant women	NA
Egloff et al. (2022)	(37)	18 Feb 2021 – 5 Apr 2021	France	Survey	664 pregnant women	NA	29.5% of pregnant women
Erchick et al. (2022)	(25)	15 Dec 2020 – 23 Dec 2020	USA	Survey	8,481 participants: 233 pregnant women 8,248 non-pregnant women	NA	65.9% of pregnant women 59.6% of non-pregnant women
Geoghegan et al. (2021)	(38)	4 Dec 2020 – 14 Jan 2021	Ireland	Survey	300 pregnant women	NA	38.0% during pregnancy 63.0% after pregnancy
Germann et al. (2022)	(32)	22 Mar 2021 – 2 Apr 2021	USA	Survey	456 participants: 435 pregnant women 21 postpartum women	NA	60.0% of pregnant and postpartum women
		29 Jun 2021 – 20 Nov 2021		Follow-up survey	290 participants: 68 pregnant women 222 postpartum women	52.0% of pregnant and postpartum women	14.0% of pregnant women 35% of postpartum women
Gutierrez et al. (2022)	(33)	Jan 2021	USA	Survey	5,269 participants: 1,190 pregnant and postpartum women	NA	53.4% of pregnant and postpartum women 57.1% of other participants
Hosokawa et al. (2022)	(39)	24 Jul 2021 – 30 Aug 2021	Japan	Survey	1,621 pregnant women	13.4% of pregnant women	49.1% of pregnant women
Kuciel et al. (2022)	(40)	1 Jul 2021 – 30 Aug 2021	Poland	Survey	118 participants: 28 pregnant women 60 lactating women 109 mothers	NA	NA
Levy et al. (2021)	(41)	14 Dec 2020 – 14 Jan 2021	USA	Survey	662 pregnant women	NA	58.3% of pregnant women
Mappa et al. (2021)	(42)	27 Dec 2020	Italy	Survey	161 pregnant women	NA	52.9% of pregnant women
Mohan et al. (2021)	(43)	15 Oct 2020 – 15 Nov 2020	Qatar	Survey	341 pregnant and lactating women	NA	49.1% of participants
Nguyen et al. (2021)	(44)	Jan – Feb 2021	Vietnam	Survey	651 participants: pregnant women or postpartum	NA	60.4% of all participants
Oluklu et al. (2021)	(45)	11 Feb 2021 – 21 Mar 2021	Turkey	Survey	412 postpartum women: 363 lactating women	NA	33.3% of postpartum women
Perez et al. (2021)	(29)	8 Jan 2021 – 31 Jan 2021	USA	Survey	11,405 female HCP of reproductive age: 955 women attempting pregnancy 2,196 pregnant women 2,250 lactating women 67 lactating women attempting pregnancy	73.6% of all participants	75.3% of all participants strongly desire or desired vaccination – 1.5% are strongly adverse

					91 women pregnant and lactating 5,846 preventing pregnancy		
Perrotta et al. (2022)	(46)	1 Mar 2021 – 23 Jul 2021	USA	Survey	299 pregnant women	20.7% of pregnant women	42.8% of pregnant women
Pisula et al. (2022)	(47)	24 Oct 2021 – 9 Nov 2021	Poland	Survey	515 pregnant women	58.1% of pregnant women	6.2% of pregnant women
Razzaghi et al. (2022)	(31)	31 Mar 2021 – 16 Apr 2021	USA	Survey	1,561 pregnant women	21.7% of pregnant women	24.0% of pregnant women
Redmond et al. (2022)	(48)	June 2020 – Aug 2020	USA	Survey	26 pregnant women 1 postpartum woman	NA	63.0% of pregnant and postpartum women
Riad et al. (2021)	(49)	Aug 2021 – Oct 2021	Czechia	Survey	362 participants: 278 pregnant women 84 lactating women	NA	66.6% of pregnant and lactating women
Saleh et al. (2022)	(50)	End Sep 2020 – mid-Jan 2021	Israel	Survey	410 participants: 293 pregnant women 117 postpartum women of whom 84 were lactating	NA	40% of postpartum participants
Samannodi et al. (2021)	(51)	12 Jun 2021 – 1 Aug 2021	Saudi Arabia	Survey	431 women: 214 women pregnant or planning to be pregnant	57.1% of all participants	NA
Schaal et al. (2021)	(30)	30 Mar 2021 – 19 Apr 2021	Germany	Survey	2,339 participants: 1,043 pregnant women 1,296 lactating women	2.4% of pregnant women 13.7% of lactating women	13.8% of pregnant women 39.4% of lactating women
Skirrow et al. (2022)	(24)	3 Aug 2020 – 11 Oct 2020	UK	Survey	1,181 pregnant women	NA	62.1% during current pregnancy
		7 Dec 2020 – 16 Dec 2020		Semi-structured interviews	10 pregnant women		81.2% after delivery
Skjefte et al. (2021)	(22)	28 Oct 2020 – 18 Nov 2020	Italy, Chile, Peru, New Zealand, Russia, Australia, Colombia, Brazil, Spain, South Africa, India, Mexico, Philippines, Argentina, USA, UK	Survey	17,871 participants: 5,294 pregnant women 12,562 non-pregnant women	NA	52.0% of pregnant women 73.4% of non-pregnant women
Stuckelberger et al. (2021)	(52)	18 Jun 2020 – 12 Jul 2020	Switzerland	Survey	1,551 participants: 515 pregnant women 1,036 lactating women	NA	29.7% of pregnant women 38.6% of lactating women
Sutton et al. (2021)	(27)	7 Jan 2021 – 29 Jan 2021	USA	Survey	1,012 participants: 216 pregnant women 122 lactating women 656 non-pregnant women	1.9% of pregnant women 3.3% of lactating women 13.3% of non-pregnant women	44.3% of pregnant women 55.2% of lactating women 76.2% of non-pregnant women
Tao et al. (2021)	(26)	13 Nov 2020 – 27 Nov 2020	China	Survey	1,392 pregnant women	NA	77.0% of pregnant women
Ward et al. (2022)	(53)	NA	Australia	Survey	218 pregnant women	44.0% of pregnant women	7.4% of pregnant women
Waring et al. (2022)	(54)	Mid-Feb 2021 – mid-Mar 2021	USA	Survey	203 women: 15 pregnant women 188 non-pregnant women (mothers)	47.3% of pregnant and non-pregnant women	66.0% of pregnant women 73.0% of non-pregnant women

2.   COVID-19 VACCINE CONFIDENCE IN HCP

The perception of French HCPs towards COVID-19 vaccination during pregnancy was investigated via an anonymous survey distributed from January until March 2021. Overall, midwives were less likely to recommend COVID-19 vaccination during pregnancy (37.5%), compared to general practitioners (50.7%) and obstetricians (58.8%) (55).

To study how HCPs view COVID-19 vaccination during pregnancy, a survey of women (including pregnant and lactating women), midwives, doctors providing maternity care and midwifery students was conducted in Australia in early 2021. The study found that doctors and midwifery students were significantly more likely to advise COVID-19 vaccination during pregnancy compared to midwives. Unfortunately, in this study, pregnant and lactating women were not asked if a recommendation from a HCP was a motivational factor or not when looking at influential factors that determined pregnant and lactating women's decision to be vaccinated (56).

3.   DETERMINANTS PREDICTING COVID-19 VACCINE ACCEPTANCE

Most of the surveys (N= 26) included in this review not only measured readiness to get vaccinated against COVID-19 during pregnancy or lactation, but also described determinants linked with COVID-19 vaccine acceptance.

3.1.   Factors influencing COVID-19 vaccine acceptance during pregnancy

The most important reason for refusing COVID-19 vaccination during pregnancy is safety concerns, as described in 19 studies (22,24–27,30–32,37–39,41–43,46–49,53). These safety concerns include the assumption of potential harm to the baby and to the mother, both in the short and long term. Other concerns include that there is not yet enough clinical trial data on COVID-19 vaccination during pregnancy (22,24,27,30,32,46) and that COVID-19 vaccines are seen as not being trustworthy because they were developed and approved rapidly (22,24,31,39). In Japan, mistrust in the government was determined as the only significant factor linked to vaccine hesitancy among pregnant women (39). Not believing in vaccines and in the existence of the SARS-CoV-2 virus, not being afraid of COVID-19, and trusting rumours on social media were also described as statistically independent risk factors for vaccine hesitancy among pregnant women (35).

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Receiving an influenza vaccine (27,31,32,37,52) and/or pertussis vaccine during pregnancy (24,32) are positive determinants for accepting COVID-19 vaccination among pregnant women. Other positive factors are a recommendation by a HCP or having a discussion with a HCP about COVID-19 vaccines (31,32,37,38,48,53), believing to be at high risk of or concerns about contracting COVID-19 (22,29,32), being aware of having an increased risk of severe illness due to COVID-19 (53), and living with individuals with or themselves suffering from co-morbidities/high risk conditions (31).

Demographic factors associated with better COVID-19 vaccine willingness are a higher level of education (22,32,33,36,37,39,41,42,46,47,49,50,52), being employed (31,32,42,50), having a higher income (22,24,33,35,36,46,47), older age (22,24,25,32,33,37,41,46,49,52), being in the third trimester of gestation (26,36,38,49,52), multiparity (37,49), and living in an urban area (35,36,47,50). Other demographic factors linked to COVID-19 vaccine willingness are race and ethnicity (24,29,31,41,43,50). Interestingly, pregnant Chinese women of younger age and with a lower level of education were more likely to accept COVID-19 vaccination (26).

3.2.   Factors influencing COVID-19 vaccine acceptance during lactation

Lactating/postpartum women were found to have similar safety concerns to pregnant women (27,30,32,45,49). One of the reasons for refusing the vaccine or being hesitant about getting it is the lack of reliable data on the administration and effectiveness of a COVID-19 vaccine during lactation (30,45). Additionally, there were concerns in this target group that the COVID-19 vaccine could cause infertility (27).

Two studies described several demographic factors in pregnant and lactating/postpartum women associated with a lower likelihood of vaccination: younger age (33,52), lower level of education (33,52) and lower income (33). However, both studies did not distinguish between pregnant and lactating/postpartum women (33,52). Another study found that there was no significant difference in age and educational level in the group of lactating women willing to accept the vaccine and the group of lactating women resistant to the vaccine. However, lactating healthcare workers had a significantly higher COVID-19 vaccine acceptance level compared to non-healthcare workers (49).

4. THE IMPACT OF THE COVID-19 PANDEMIC ON OTHER VACCINATIONS

Several studies also discussed vaccine willingness for other diseases in pregnancy during the COVID-19 pandemic. Two studies focused on influenza, one focused on pertussis while another one focused on vaccines during pregnancy in general (47,50,57,58). A study conducted in Turkey found that 77.0% of the interviewed pregnant women received or intended to receive vaccination during pregnancy. For 50.6% of these women, the COVID-19 pandemic had not affected their views on being vaccinated in the future (57).

Another study analysed the effect of the COVID-19 pandemic on seasonal influenza vaccine compliance among pregnant and postpartum women in Israel from September 2020 until mid-January 2021. The research found that, despite the high incidence of COVID-19, vaccine uptake was similar to pre-pandemic times with 54.4% of the women studied being vaccinated against influenza (50).

The knowledge and attitudes of Polish pregnant women towards influenza vaccination was searched in 2021. In total, 21.0% had been vaccinated against influenza during pregnancy and 17.5% were planning to get vaccinated. The study stated that there is a link between influenza vaccine uptake and COVID-19 vaccine uptake in pregnant women. Women who refused COVID-19 vaccination did not intend to get an influenza vaccine and vice versa (47).

Furthermore, the experience of women getting vaccinated against pertussis during pregnancy in COVID-19 times was explored in the United Kingdom. The study used an online survey which was spread from 3 August until 11 October 2020. The survey was completed by 922 pregnant women and 482 postpartum women who had been pregnant at some point after the first lockdown. The study found that 72.1% of pregnant women and 84.0% of postpartum women had received a pertussis vaccine during pregnancy even when access was hampered due to COVID-19 restrictions (58).

5. THE IMPACT OF SOCIAL MEDIA ON COVID-19 VACCINE CONFIDENCE

Social media is an important source of information on COVID-19 vaccines for pregnant and lactating women. However, only 8.3% of the pregnant and lactating women studied reported that media/social media was an important factor when deciding to receive or not receive COVID-19 vaccination (49).

Three surveys conducted in remote Alaskan communities between November 2020 and September 2021 focused on the impact of COVID-19 on the daily life and attitude towards COVID-19 vaccination of adults, including pregnant women, living in these communities. By September 2021, misunderstandings about vaccine recommendations during pregnancy and the effects of COVID-19 vaccination on fertility and DNA were present in participants where social media was identified as the primary source of information (59).

The changes in Google Search interest on vaccination during pregnancy after the introduction of COVID-19 vaccination in Italy was investigated by using Google Trends. The data covered searches from 1 January 2019 until 31 October 2021. This made it possible to monitor the changes over two years from before the introduction of COVID-19 vaccination until 31 October 2021. The analysis of Google Trends indicated that the search interest for 'vaccination in pregnancy' was increased significantly (both qualitative and quantitative) compared to the predicted trend after the start of the Italian COVID-19 vaccination campaign. Moreover, further qualitative analysis showed that the increase was most likely due to concerns about COVID-19 vaccination (60).

Among pregnant Romanian women, trusting rumours on social media had the greatest impact on vaccine hesitancy according to a study performed from 1 October until 1 December 2021. Compared to non-pregnant women (63.0%), significantly more pregnant women (78.1%) answered 'yes' to the question if they trusted social media rumours (35). In a survey conducted a few months later, Romanian unvaccinated pregnant women (44.7%) were significantly more likely to select social media as a trustworthy decision-making factor compared to vaccinated pregnant women (25.0%) (36).

A social media campaign called 'One Vax Two Lives' was set up in Washington to encourage the spread of scientifically-based information about the risks of COVID-19 and benefits of COVID-19 vaccination during pregnancy. The campaign reached a lot of people through ads on Facebook and Instagram, but the number of visitors to the informative website linked to the project remained rather low. It is not clear what the actual impact of the campaign was on vaccine confidence and uptake in pregnant women (61).

Discussion

Maternal vaccination has already proven to be an effective means to prevent infectious disease-related morbidity and mortality in pregnant women, foetuses and infants. During the COVID-19 pandemic, the topic of vaccination during pregnancy and lactation received a lot of attention. In many countries, HCPs were one of the priority groups to receive vaccination against COVID-19. A lot of these HCPs are of fertile age, pregnant and/or lactating. These women were among the first fertile/pregnant/lactating women to be vaccinated against COVID-19. The vaccine was assumed to be safe for these target groups, based on previous research which generated reassuring evidence on the use of inactivated vaccines during pregnancy/lactation. However, lack of robust data on the safety, immunogenicity and efficacy of the COVID-19 vaccines and the existence of varying recommendations concerning COVID-19 vaccination during pregnancy and lactation in different areas of the world started an important debate on COVID-19 vaccination during pregnancy and lactation.

Even before the start of the COVID-19 pandemic, the World Health Organization (WHO) defined vaccine hesitancy as one of the top ten threats to global health (62). Therefore, insights into factors influencing willingness to get vaccinated are crucial to plan effective interventions to increase vaccine coverage, especially in high-risk groups (such as pregnant and lactating women). Surveys performed during the COVID-19 pandemic - both before and after licensure of COVID-19 vaccines - demonstrated that willingness to get vaccinated against COVID-19 is generally lower in pregnant and lactating women than in non-pregnant and non-nursing women, which was not a surprising finding. On a global scale, vaccine hesitancy is more common in pregnant and lactating women. Many studies have reported that there are low coverage rates for influenza and Tdap vaccines in pregnant and lactating women. This population also shows low vaccine confidence. However, the overall reluctance towards COVID-19 vaccination is even higher compared to other vaccines recommended to be administered during pregnancy and/or lactation. This is possibly caused by the belief that COVID-19 vaccines were tested and approved too quickly and that in the initial pre-marketing trials no data were collected on pregnant and lactating women.

Safety concerns are reported as the main reason for refusal of COVID-19 vaccination during pregnancy and lactation. The belief that COVID-19 vaccines could cause harm to the reproductive system, foetus/baby and/or to the women themselves is the most commonly cited driver for vaccine hesitancy. This is not a new observation; before the COVID-19 pandemic, similar concerns were mentioned as the most frequently cited barrier to being vaccinated during pregnancy (63).

The reasons for vaccine hesitancy towards COVID-19 vaccination in pregnant and lactating women are comparable to those in the general population, where concerns about safety, efficacy and the rapid development and approval of the vaccines are also the key determinants for COVID-19 vaccine refusal (64). These observations highlight the importance of high-quality clinical trials that include pregnant and lactating women. Furthermore, it is important to clearly and transparently communicate the findings from these trials to all population groups to increase vaccine coverage rates.

Before the start of the pandemic, a systematic review defined a HCP recommendation as the most important factor affecting vaccine confidence during pregnancy (20); later studies found the same for COVID-19 vaccination. Recommendations from HCPs were pinpointed as the most influential strategy to increase vaccine willingness (48). However, these recommendations are often still overshadowed by anxiety about side effects and messages circulating social media. Another worrying factor is that not all HCPs support COVID-19 vaccination during pregnancy. Especially midwives seem to be less likely to recommend COVID-19 vaccination during pregnancy, which is in line with studies on other vaccines before the pandemic (65). Therefore, it is crucial to provide HCPs access to tailored information on vaccination. Moreover, proper education of HCPs concerning the effects and importance of vaccines during pregnancy and lactation is needed.

Besides clear formulation of vaccination recommendations during pregnancy/lactation, it is of equal importance that correct information on these recommendations reaches the target groups. In a survey conducted in remote Alaskan communities, 22.8% of the participants were not aware that COVID-19 vaccination was recommended during pregnancy, 26.5% of the participants were unsure about a recommendation for pregnant women, and 28.1% of the participants were uncertain if COVID-19 vaccination would affect fertility or not. Furthermore,

participants often cited pregnancy and lactation as reasons to postpone COVID-19 vaccination (59). Additionally, in a questionnaire in Saudi Arabia on public knowledge regarding COVID-19 vaccination, 46.2% of males and 24.2% of females did not know if COVID-19 vaccination was recommended for pregnant women or not. Also, 72.4% of female participants stated that COVID-19 vaccination was not preferred during pregnancy (66).

To avoid the misconceptions mentioned above and to make sure that target groups are made aware of the most recent recommendations, specific programmes and tools need to be developed – each adapted according to region, language and accessibility. Here, proper education of HCPs is again key to support these programmes and tools to make these interventions effective.

Since social media has become an integral part of our lives, these platforms can be used to inform women who are pregnant, lactating or planning to be pregnant about vaccine recommendations. For many, it has become an important source of information and it is used to form an opinion about all kinds of topics, including COVID-19 and COVID-19 vaccination. In Italy, research showed that Google Search interest for 'vaccination in pregnancy' increased significantly after Italy's COVID-19 vaccination campaign had started (60). Further research is still needed to accurately define the relation between social media and Internet searches and actual vaccine uptake during pregnancy or lactation.

A six month follow-up study comparing COVID-19 vaccine hesitancy and actual vaccine uptake in pregnant and postpartum women concluded that being hesitant towards COVID-19 vaccines at baseline persisted, with only 10% of individuals transitioning from being vaccine hesitant to being vaccinated (32). This highlights that efficient interventions and educational strategies need to be developed to increase vaccine confidence, which subsequently increases vaccine coverage rates in pregnant and postpartum women. Therefore, a project was started at the University of Antwerp funded by the Vaccine Confidence Fund to identify which factors linked to social media influence vaccine confidence and in the long run the uptake of pertussis, influenza and COVID-19 vaccines in women of childbearing age, and pregnant and lactating women. The overall aim of this project - which this review is also part of - is to identify which interventions are efficient in increasing vaccine confidence in pregnant and lactating women.

Conclusion

Vaccine hesitancy during pregnancy and lactation remains an important topic to study, especially in times of a pandemic and with the fast development of new vaccines. To improve vaccine confidence in these target groups, the inclusion of pregnant and lactating women in clinical trials could reduce safety concerns, as this was identified as the main reason to refuse vaccination. In addition, proper education of HCPs and clear, universal recommendations can also contribute to increase vaccine willingness. Further research is necessary to define the role social media plays in actual vaccine uptake. However, from our findings it can be concluded that social media messages can influence vaccine confidence in pregnant and lactating women.

Author's contribution

LDB and KM conducted the review. PVD, GH, KP, WD read the review and provided input and comments. All authors contributed to the article and approved the submitted version.

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Competing interest

None declared.

Ethics approval

Not applicable.

Data sharing statement

No additional data are available.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	p. 1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	p. 2-3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	p. 4-5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	p. 5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Supplementary file 2 (not registered)
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	p. 6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	p. 6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary file 3
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	p. 6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	Supplementary file 2
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	p. 6
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	NA

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	Supplementary file 2
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	p. 7-8, p. 12
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	p. 9-11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	p. 7-15
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	p. 9-11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	p. 16-18
Limitations	20	Discuss the limitations of the scoping review process.	p. 19
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	p. 19
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	p. 19

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting*.*

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

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RESEARCH PROTOCOL

The influence of the COVID-19 pandemic and social media on behaviour of pregnant and lactating women towards vaccination: a scoping review

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Background

In March 2020, the World Health Organization (WHO) announced that the COVID-19 outbreak, caused by the SARS-CoV-2 virus, could be characterized as a pandemic. As of November 8th 2021, there have been >400 million confirmed COVID-19 cases and almost 6 million COVID-19 confirmed deaths worldwide. Similar to other populations, pregnant and lactating women can encounter SARS-CoV-2 and might contract COVID-19. SARS-CoV-2 infection during pregnancy is associated with increased rates of stillbirth, preterm birth, pre-eclampsia and caesarian delivery. Furthermore, pregnant women are at increased risk of hospitalization, admission to intensive care unit and death compared to non- pregnant women (1,2). If breastfeeding women contract COVID-19, they can become seriously ill impeding them from continuing breastfeeding. Besides, they can transmit the disease via droplet transmission to their newborn child (3).

One of the most important approaches to control the ongoing pandemic is COVID-19 vaccination. Since the beginning of 2021, several COVID-19 vaccines have been licensed and

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implemented worldwide. Since pregnant and lactating women were initially not included in pre-marketing clinical trials, many questions rose about development, safety, immunogenicity and effectiveness of COVID-19 vaccines in these target groups. Although there was absence of data on safety and efficacy of COVID-19 vaccines during pregnancy or lactation, several countries started to recommend vaccination in these target groups (4).

The COVID-19 pandemic and its accompanying vaccination campaign led to an abundance of misinformation about vaccination on the Internet (5). Fake news that has circulated about COVID-19 vaccination in pregnant women, women of childbearing age and lactating women included: 1. COVID-19 vaccination could cause infertility 2. there is an increased risk of miscarriage/stillbirth after receiving a COVID-19 vaccine while pregnant 3. it is unsafe for breastfeeding women to receive a COVID-19 vaccine (6). These myths can feed vaccine hesitancy in this important target group. Since the World Health Organization (WHO) described in 2019 vaccine hesitancy as one of the top 10 global health threats (7), it is important to tackle these obstacles and to improve vaccine uptake.

To set up right interventions to improve vaccine confidence, it is necessary to determine the factors that influence vaccine decision-making in pregnant and lactating women. The systematic review of Kilich et al. describes determinants that influence vaccine confidence among pregnant women (8). However, this study is limited to pre-pandemic information, does not include lactating women and does not focus on social media.

Research question

What is the impact of the COVID-19 pandemic and social media on vaccine confidence in pregnant and lactating women?

Objectives

1. Comparing vaccine confidence in pregnant and lactating women before and after the COVID-19 pandemic.
2. Describing vaccine willingness towards COVID-19 vaccination in pregnant and lactating women.

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3. Determination of factors linked to vaccine (un)willingness towards COVID-19 vaccination in pregnant and lactating women.

4. Appraise the impact of social media on vaccine confidence in pregnant and lactating women.

Methods

We propose to answer the research question above by conducting a scoping review following the PRISMA guidelines. The study will begin November 2021 and will be finished as soon as possible (before end of December 2021).

Search strategy

The review will be conducted by doing a literature study. First, grey literature will be searched. This search includes a general web search on Google (limited to the first 50 results) and Google Scholar (limited to the first 200 results). Search terms will be adjusted and refined based on the number and types of relevant hits. If there is a relevant publication found, it will be considered for inclusion.

PubMed will be used as database to search literature. Due to time pressure, only one database will be searched. Since PubMed gives access to three components (MEDLINE, PuBMed Central and Bookshelf) and contains more than 34 million citations and abstracts of biomedical literature and life sciences, this database is selected.

Inclusion and exclusion criteria

All articles, without language restriction, published from November 22nd 2018 (since Kilich et al. searched all articles by November 22nd 2018) related to the research question will be included.

Following criteria will lead to exclusion:

1. Reviews
2. Articles whose focus is not our target population (pregnant and lactating women)
3. Abstracts, no full text available

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4. Articles describing outcomes of COVID-19 infection or COVID-19 vaccination in pregnant and lactating women.

Data charting

Included articles will be abstracted and synthesized by one reviewer following the procedure described below. Verification will be done by a second reviewer. Disagreements will be addressed through discussion between the reviewers and the other researchers.

Synthesis of included articles:

a. Study characteristics
   i. Author(s)
   ii. Year of publication
   iii. Year the study was conducted
   iv. Type of publication (e.g. clinical trial, survey,...)
   v. Publication title
   vi. Journal in which study is published
   vii. Country of publication
   viii. Language of dissemination
   ix. Topic of the study

b. Study methods
   i. Study location (country, city)
   ii. Study design
   iii. Study population
   iv. Study sample size (N= xxx)
   v. Follow-up time / timing of the study

c. Results
   i. COVID-19 vaccine coverage (N= xxx)
   ii. COVID-19 vaccine willingness (N= xxx)
   iii. Factors influencing COVID-19 vaccine willingness
   iv. Vaccine coverage other than COVID-19 (N= xxx)
   v. Vaccine willingness other than COVID-19 (N= xxx)
   vi. Social media platforms described

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           vii.   Influence of social media

   d.   Quality of the study

           i.   Strengths

           ii.   Limitations

           iii.   Bias (selection / performance / performance / attrition / reporting / other)

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Supplementary file 3: full search strategy

Database**:** PubMed

Date searched: 18th July 2022

Filters used: from 2018/11/23 – 2022/7/18 (present day)

Results**:** 477 results

Query	Results
Search: **(((((Vaccin* OR Immuniz* OR immunis* OR antibodies OR immune response))))) AND ((((confidence OR awareness OR attitude* OR anxiety OR trust* OR intent* OR dilemma OR perception* OR misconception* OR behaviour OR behavior OR anti-vaccin* OR decision making OR vaccination refusal OR fear* OR distrust OR mistrust OR hesitancy OR controvers* OR belief* OR criticis* OR misinformation OR intent* OR choice* OR concern* OR knowledge OR acceptance OR willingness OR uptake OR barrier* OR disinformation OR complacency OR fake news)))) AND (((pregnan* OR maternal OR prenatal OR antenatal OR parent* OR lactating* OR lactation OR breast milk OR breastfeeding))) AND ((social media OR internet OR website* OR communication* OR social network* social behavior OR social behaviour OR message* OR forum OR fora OR blog* OR discussion group* OR online OR Facebook OR Twitter OR Pinterest OR LinkedIn OR Instagram OR Reddit OR Youtube OR Messenger OR Whatsapp OR Telegram)) AND (COVID* OR SARS-CoV-2 OR COVID19* OR corona*)** Filters: **from 2018/11/23 - 2022/7/18** Sort by: **Most Recent**	477

The database was searched without language restrictions. The languages used within the 477 records were French, German and English. Since the authors are educated in these languages, this formed no issue.