

## RESEARCH ARTICLE

# Prenatal care providers' perceptions of the SARS-Cov-2 vaccine for themselves and for pregnant women

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## Abstract

### Background

Prenatal care providers will play an important role in the acceptance of SARS-Cov-2 vaccination for pregnant women.

### Objective

To determine the perceptions of French prenatal care providers: midwives, general practitioners (GPs) and obstetricians and gynaecologists (Ob-Gyn) regarding SARS-CoV-2 vaccination during pregnancy.

### Study design

An anonymous online survey was sent to members of French professional societies representing prenatal practitioners. The participants were asked to answer questions on their characteristics and give their opinions of the SARS-CoV-2 vaccine for themselves and women who are pregnant or willing to become pregnant.

### Results

Access to the survey was opened from January 11th, 2021, to March 1st, 2021. A total of 1,416 responses were collected from 749 Ob-Gyn, 598 midwives and 69 GPs. Most respondents (86.7% overall, 90.4% for Ob-GYN, 81.1% for GPs and 80.1% for midwives) agreed

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to receive the SARS-CoV-2 vaccine. Vaccination against SARS-CoV-2 would be offered to pregnant women by 49.4% 95%CI [48.1–50.8] of the participants. Midwives were less likely to recommend vaccination than GP and Ob-Gyn (37.5%, 50.7% and 58.8%, respectively). The multinomial logistic regression revealed that being an obstetrician, working in a group, usually offering a flu vaccine and wanting to be vaccinated against SARS-CoV-2 were positively associated with considering pregnant women for SARS-CoV-2 vaccination.

## Conclusion

Most French prenatal healthcare providers are favourable towards vaccinating pregnant women, but a large minority express reservation. More evidence on safety and involvement by professional organisations will be important to encourage the access of pregnant women to vaccination against SARS-CoV-2.

## Introduction

Pregnant women with COVID-19 are at an increased risk of adverse pregnancy outcomes and severe forms of COVID-19 [1–4]. Although preventive measures can significantly decrease SARS-CoV-2 transmission, vaccination is the most promising strategy for combatting COVID-19 [5, 6].

Several international scientific societies strongly recommend that pregnant women have access to SARS-CoV-2 vaccines in all phases of future vaccine campaigns [7–9]. Here, vaccination counselling should balance the available data on vaccine safety and individual risks to pregnant women from COVID-19 infection [10]. A worldwide survey interviewed a total of 19,519 adults between July 24, 2020, and August 7, 2020. Globally, 74% agreed that they would get a SARS-CoV-2 vaccine should it become available, while 26% disagreed. In Europe, the rates of acceptance ranged from 85% in the UK to 56% in Poland [11]. These rates might be lower for pregnant women [12, 13] because immunisation is usually not well accepted by obstetricians and pregnant women—despite recommendations—because of concerns about the lack of safety data on the vaccination of pregnant women [14–16].

Research has demonstrated that strategies based on practitioners' involvement are effective in increasing immunisation rates [17]. However, to adapt the content of educational pieces before improving knowledge of provider, it is recommended to conduct a survey on healthcare workers to understand their views. Thus, we aimed to collect answers of a survey from health care workers (obstetricians, midwives and GPs) involved in the management of pregnant women to evaluate their perceptions of the SARS-CoV-2 vaccination.

## Material and methods

A link to an anonymous online survey was sent on January 11th to the members of the French College Obstetrician and Gynaecologist (CNGOF), French College of Foetal Ultrasonography (CFEF), Federation of French Perinatal Health Networks (FFRP), research group of infection and pregnancy (GRIG), Federation of Prenatal Diagnosis Centres (CPDPN), Union of French Obstetricians and Gynaecologists (SYNGOF) and French College of Midwives (CNSF). The link was also published on LinkedIn®, Twitter® and Facebook®. The study began before the release of the “Haute Autorité de Santé” statement that recommended SARS-CoV-2 for high-risk pregnant women [18].

The questionnaire (S1 Fig) included questions on practitioners' demographic information (gender, year of diploma, profession, place and mode of professional exercise) and their flu vaccination habits for themselves and their patients ("yes", "yes only for pregnant women with risk factor i.e. age over 35, obesity, diabetes and essential hypertension", or "no"). The participants were asked if they would be vaccinated themselves and if they would offer the vaccine against SARS-CoV-2—and which type—to pregnant women or those willing to become pregnant and, if not, the reasons.

All statistical analyses were performed by a dedicated statistician using R software (R Foundation for Statistical Computing, Vienna, Austria. <http://www.r-project.org/>) v. 4.0. For quantitative variables, descriptive statistics used the median and interquartile range. The discrete variables are presented as number and percentages. Missing data were not replaced. For the variables of interest, the confidence interval was estimated to be at 95%. To detect and represent the underlying structures in the data set [19], a multiple correspondence analysis for nominal categorical data was performed on the predefined set, including nine covariates (gender, profession, experience, practice, habits on flu vaccination for themselves or pregnant women, opinions on SARS-CoV-2 vaccination for themselves and pregnant women or women willing to be pregnant). Then, the association between the prescription of SARS-CoV-2 vaccination to a pregnant woman (three modalities of response) and the prenatal caregiver's characteristics and their behaviour to the flu vaccination was assessed by a multinomial logistic regression using a first bivariate analysis (only for the two major groups of Ob-Gyn and midwives). The expected response rate was estimated at 30% among the members of the medical societies (around 10,000 members) for an expected margin of sampling error fixed at 1%. The study protocol was approved by the Institutional Review Board -IRB 00006477- of HUPNVS, Paris 7 University, AP-HP (N° CER-2021-67). When answering the survey, the participants agreed to participate to the study.

## Results

Access to the online survey was opened from January 11th, 2021, to March 1st, 2021. A total of 1,416 participants completed the survey, including 749 obstetricians and gynaecologists (Ob-Gyn), 598 midwives and 69 general practitioners (GPs). Full data are available at <https://doi.org/10.17026/dans-25w-r4wf>. Table 1 shows the participants' characteristics. The respondents were predominantly women (76.3%) and working for a median of 17 years [8–29] since graduation. All French departments were represented, with 43% of the respondents being from the Paris area. The main modality of exercise was private practice (32.7%), followed by university hospital activity (26.2%) and general hospital activity (17.8%). Most respondents (78.4% 95% CI [77.3–79.5]) had been vaccinated themselves against flu. Midwives were less likely to be vaccinated than Ob-Gyn and general practitioners (68.9, 85.4 and 84.1% respectively). Most of the participants usually prescribe flu vaccine to pregnant women (86.2% 95% CI [85.2–87.1]).

Table 2 presents the respondents' perceptions of the SARS-CoV-2 vaccine. A large majority (86.7% 95% CI [85.7–87.6]) would agree to be vaccinated against SARS-CoV-2. Among those who did not want to receive the vaccine, the main reasons were the lack of data on adverse effects (31.7%) or effectiveness (26.3%), the need for information from professional societies (91, 21.7%) or from other sources (44, 10.5%) or a greater fear of the vaccine than SARS-CoV-2 itself (40, 9.5%). About half of the participants would not offer the SARS-CoV-2 vaccine to pregnant women (50.6% 95% CI [49.2–51.9]). The rate was higher among midwives (62.5% 95% CI [60.6–64.5]) and GP (49.3% 95% CI [43.3–55.3]) compared to Ob-Gyn (41.1% 95% CI [39.3–42.9]). Most of those who answered 'no' were waiting for extra information from medical societies (25.6%), from other sources (14.7%) and from the Ministry of Health (13.3%);

**Table 1. Prenatal caregivers' demographic information and flu vaccination habits for themselves and their patients.**

	All responders N = 1416	Ob-Gyn N = 749 (52.9)	GP N = 69 (4.9)	Midwives N = 598 (42.2)
<b>Gender (Na = 10)</b>				
Women	1078 (76.3)	451 (60.7)	54 (79.4)	573 (95.8)
Men	328 (23.2)	292 (39.3)	14 (20.6)	22 (3.7)
<b>Time since graduation (years)</b>	17 [8–29]	19 [9–32]	15 [7–29]	16 [8–26]
<b>Medical practice</b>				
Group practice	953 (67.3)	549 (73.3)	30 (43.5)	374 (62.5)
University hospital	371 (26.2)	203 (27.1)	2 (2.9)	166 (27.8)
General hospital	252 (17.8)	143 (19.1)	6 (8.7)	103 (17.2)
Clinics	112 (7.9)	97 (13.0)	1 (1.4)	14 (2.3)
Mixed activity	141 (10.0)	93 (12.4)	10 (14.5)	38 (6.4)
other	77 (5.4)	13 (1.7)	11 (15.9)	53 (8.9)
Private practice	463 (32.7)	200 (26.7)	39 (56.5)	224 (37.5)
<b>Geographic area of exercise (Na = 32)</b>				
Paris area	589 (42.6)	203 (27.9)	34 (50.0)	352 (59.9)
others	795 (57.4)	525 (72.1)	34 (50.0)	236 (40.1)
<b>Do you usually get the flu vaccine?</b>				
Yes	1110 (78.4)	640 (85.4)	58 (84.1)	412 (68.9)
No	306 (21.6)	109 (14.6)	11 (15.9)	186 (31.1)
<b>Do you usually prescribe the flu vaccine to pregnant women?</b>				
Yes	1220 (86.2)	675 (90.1)	56 (81.2)	489 (81.8)
No	196 (13.8)	74 (9.9)	13 (18.8)	109 (18.2)

Values are given as N (%) or Median [IQR].

Ob-Gyn = Obstetricians and Gynaecologist.

GP = General Practitioners.

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here, 11.5% considered that inputs on side effects insufficient. 43.9%, 95%CI [42.6–45.6] would recommend vaccination to women willing to become pregnant, and 27.5%, 95%CI [26.3–28.9] only would recommend it if there were risk factors. The three professions would first offer an mRNA vaccine to pregnant women (overall = 50.6%; Ob-Gyn 49.9%, GP = 50.7%, midwives = 42.2%).

Fig 1 shows the symmetric map resulting from multiple correspondence analyses of the perceptions of the SARS-CoV-2 vaccine dimensions, here adjusted for the prenatal caregiver's characteristics. A group practice was positively correlated with a positive vaccination practice among caregivers and their patients and with a positive perception of the SARS-CoV-2 vaccine for them and their patients (pregnant or to be pregnant). Being a midwife was positively correlated (angle less than 90 degrees) with unwillingness to offer the vaccine to pregnant women or preconception women and being vaccinated against SARS-CoV-2. A particular cluster was observed considering the comorbidities associated with SARS-CoV-2. Answers to the three questions about the perceptions of the SARS-CoV-2 vaccine were affected by the concept of comorbidities, which was positively correlated with the obstetrician's group (angle less than 90 degrees) and negatively with the midwife's group (angle more than 90 degrees). Individual repartition of the three groups of professions.

The bivariate (Table 3A) and multivariate analyses of the two major groups are detailed in Table 3A and 3B. After adjustment, when we compared the answers 'yes' versus 'no' for the vaccination of pregnant women, the main factors associated with not offering vaccination

Table 2. Practitioners' perceptions of the SARS-CoV-2 vaccine.

	All responders	Ob-Gyn	GP	Midwives
	N = 1416	N = 749 (52.9)	N = 69 (4.9)	N = 598 (42.2)
<b>Would you be willing to be vaccinated against SARS-CoV-2?</b>				
No	87 (6.1)	23 (3.1)	8 (11.6)	56 (9.4)
No because I do not have any risk factor for severe SARS-CoV-2	102 (7.2)	34 (4.5)	5 (7.2)	63 (10.5)
Yes	1143 (80.7)	641 (85.6)	53 (76.8)	449 (75.1)
Yes because I have at least one risk factor for severe SARS-CoV-2	84 (6.0)	51 (6.8)	3 (4.3)	30 (5.0)
<b>Reasons if answer no (multiple choice) (Na = 9)</b>				
There is not sufficient data on the effectiveness	110 (26.3)	27 (23.7)	7 (28.0)	76 (27.2)
There is not sufficient data on the side effects	<b>133 (31.7)</b>	<b>42 (36.8)</b>	<b>10 (40.0)</b>	<b>81 (29.0)</b>
I am more afraid of the side effects of the vaccine than of the disease	40 (9.5)	14 (12.3)	0 (0)	26 (9.3)
I need other sources of information	44 (10.5)	7 (6.1)	3 (12.0)	34 (12.2)
I need information from professional societies	91 (21.7)	24 (21.1)	5 (20.0)	62 (22.2)
<b>In the current state of knowledge, would you prescribe the SARS-CoV-2 vaccine to a pregnant woman?</b>				
Yes for all pregnant woman	405 (28.6)	270 (36.0)	20 (29.0)	115 (19.2)
Yes but only for pregnant woman with at least one risk factor*	295 (20.8)	171 (22.8)	15 (21.7)	109 (18.3)
No	716 (50.6)	308 (41.1)	34 (49.3)	374 (62.5)
<b>Reasons if answer No (Na = 9)</b>				
Because of the type of vaccine currently available	78 (4.0)	39 (9.1)	7 (7.8)	32 (3.0)
There is not sufficient data on the effectiveness	111 (5.8)	36 (8.4)	6 (6.7)	69 (6.5)
There is not sufficient data on the side effects	222 (11.5)	88 (20.6)	15 (16.7)	119 (11.2)
I am afraid about a teratogenic effect of the vaccine	183 (9.5)	64 (15.0)	7 (7.8)	112 (10.5)
I am more afraid of the side effects of the vaccine than of the disease	32 (1.7)	15 (3.5)	1 (1.1)	16 (1.5)
I consider that this is not a population at risk of severe form	39 (2.0)	27 (6.3)	3 (3.3)	9 (0.8)
I am waiting for other sources of information	283 (14.7)	104 (24.4)	11 (12.2)	167 (15.7)
I am waiting information from professional societies	<b>494 (25.6)</b>	<b>209 (49.0)</b>	<b>20 (22.2)</b>	<b>265 (24.9)</b>
I am awaiting information from ministry of health	257 (13.3)	104 (24.4)	8 (8.9)	145 (13.6)
Not recommended by the French health authority for this population	212 (11.0)	80 (18.7)	12 (13.3)	120 (11.3)
other reason	21 (1.1)	11 (2.6)	0 (0)	10 (0.9)
<b>Would you prescribe the SARS-CoV-2 vaccine to women willing to become pregnant?</b>				
Yes for all pregnant woman	622 (43.9)	361 (48.2)	24 (34.8)	237 (39.6)
Yes only for pregnant woman with risk factor*	389 (27.5)	223 (29.8)	19 (27.5)	147 (24.6)
No	405 (28.6)	165 (22.0)	26 (37.7)	214 (35.8)
<b>Among the following vaccines, considering that they are all available, choose the one or those that you would prescribe during pregnancy?</b>				
AstraZeneca and Oxford AZD1222	430 (13.4)	273 (14.1)	25 (17.0)	132 (11.9)
BioNTech-Pfizer	<b>879 (27.4)</b>	<b>516 (26.6)</b>	<b>41 (27.9)</b>	<b>322 (29.0)</b>
GSK-Sanofi	615 (19.2)	347 (17.9)	27 (18.4)	241 (21.7)
J and J-Janssen Ad23.COVS	343 (10.7)	215 (11.1)	19 (12.9)	109 (9.8)
Moderna mRAN-1273	744 (23.2)	451 (23.3)	35 (23.8)	258 (23.2)
Novavax	195 (6.1)	136 (7.0)	10 (6.8)	49 (4.4)

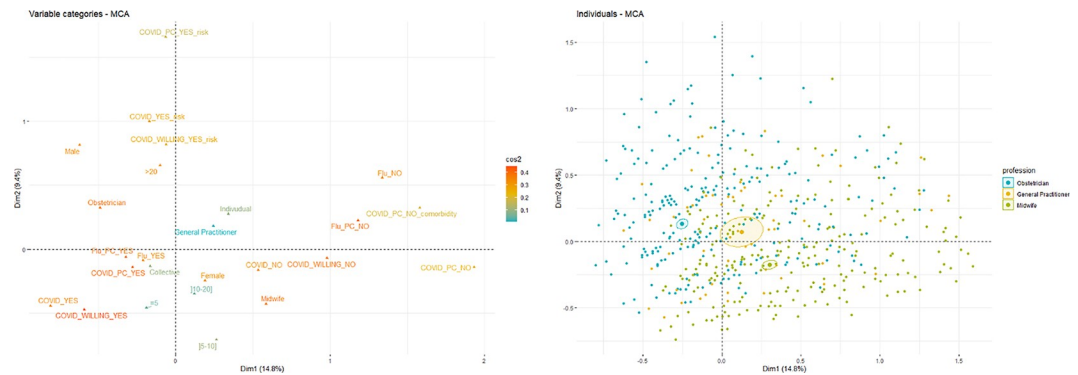
Values are given as N (%) or Median [IQR]; in bold the first modality of response

\* Risk factor included age up to 35, obesity, diabetes, essential blood pression.

Ob-Gyn = Obstetricians and Gynaecologist.

GP = General Practitioners.

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**Fig 1. Multiple correspondence analysis map (projections on the first two dimensions) for prenatal caregiver's answers and the perceptions of the SARS-Cov-2 vaccine for variable variables (left) and individual (right).** Active variables: gender (woman and man); profession (obstetrician, general practitioner, midwife); experience ( $\leq 5$ ,] 5–10],] 10–15] or  $\geq 15$ ); modalities of exercise (collective or individual); practitioners' flu vaccine (yes or no); pregnant women flu vaccine (yes or no); practitioners' SARS-CoV-2 vaccination for themselves (no, no because I do not have risk factors, yes or yes because I have risk factors), pregnant women's SARS-CoV-2 vaccination (yes, yes only for pregnant women with risk factors) and women willing to be pregnant SARS-CoV-2 vaccination (yes, yes only for pregnant women with risk factors). The categories defining the horizontal axis, which explain 15% of the variability, are refusing to be vaccinated and refusing to be vaccinated under the argument of lack of comorbidity (towards the right of the map) and at the opposite the agreement to vaccinate pregnant women and women willing to be pregnant (towards the left). The vertical axis accounts for 9% of the variability of the system, being the one that best discriminates between the categories of the variable 'profession', with obstetricians and gynaecologists and midwives having a negative association (angle value close to 180 degrees).

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were being a midwife, a woman, working individually, and not wanting to be vaccinated. When we compared 'yes' and 'yes' with comorbidity, gender and prenatal caregivers' perceptions for themselves, gender remained negatively associated with vaccination, while experience and vaccination for oneself were contributing factors.

## Discussion

Our study demonstrates that half of prenatal practitioners would spontaneously prescribe vaccines against SARS-CoV-2 to pregnant women and would recommend an mRNA vaccine. Being an obstetrician in a group practice, being used to prescribe seasonal influenza vaccines or being supportive of the vaccine for oneself improved intentions of vaccine prescription. Therefore, our study gives a snapshot of the nonvaccinators who must be convinced and should be the target of information and educative actions.

There are numerous barriers to and predictors of the vaccination of pregnant women. A review based on 75 articles listed 25 obstacles from the point of view of patients and 24 from the point of view of professionals, along with 18 facilitating elements [20]. As in our study, barriers from knowledge or awareness included concerns about side effects and/or safety to pregnant patients and foetuses, along with confusion regarding institutional recommendations [20]. Current evidence suggests that the role of healthcare providers is a key factor in vaccination decision making [21]. In the face of emerging vaccine hesitancy, healthcare providers remain the most trusted advisers and influencers of vaccination decisions [22]. This result allows us to be optimistic because most caregivers surveyed were motivated to explain and offer the vaccine to their patients.

We found that the respondents who wanted to be vaccinated themselves were more likely to offer vaccines to pregnant women. This is consistent with the finding regarding another preventive recommendation that providers who regularly took a multivitamin were more than twice as likely to recommend multivitamin use to women of childbearing age [23]. Healthcare



**Table 3. a (bivariate analysis) and b (multivariate analysis).** Association between intention to vaccinate the pregnant women and prenatal caregiver's characteristics for the 1,347 responders (obstetrician and gynaecologists and midwives).

A Bivariate analysis	Reference Yes vs. No			Reference Yes vs. Comorbidity		
	Crude OR	95%CI	pvalue	Crude OR	95%CI	pvalue
Type of profession (ref Midwife vs. Obstetrician)	0.35	[0.27–0.46]	<0.0001	0.67	[0.48–0.92]	<b>0.015</b>
Gender (ref woman vs; man)	0.41	[0.31–0.55]	<0.0001	0.63	[0.44–0.89]	<b>0.009</b>
Time since graduation (years)	1.00	[0.99–1.01]	0.709	1.01	[1.00–1.02]	0.129
Modalities of exercise (ref Individual vs. collective)	0.55	[0.41–0.72]	<0.0001	0.70	[0.49–0.99]	<b>0.041</b>
Practitioners' flu vaccine for themselves (ref Yes vs. No)	2.49	[1.78–3.50]	<0.0001	1.64	[1.08–2.48]	<b>0.020</b>
Pregnant women flu vaccination (ref Yes vs. No)	2.92	[1.88–4.52]	<0.0001	1.77	[1.04–3.02]	<b>0.036</b>
Practitioners' SARS-CoV-2 vaccination for themselves (ref Yes)						
No	9.23	[3.68–23.15]	<0.0001	2.91	[0.96–8.78]	0.059
No I do not have risk factors	24.50	[5.97–100.6]	<0.0001	20.99	[4.93–89.28]	<0.0001
Yes I have risk factors	1.62	[0.91–2.86]	0.098	1.97	[1.03–3.76]	<b>0.039</b>
<b>B. Multivariate analysis</b>						
Variables	Adjusted OR	95%CI	pvalue	Adjusted OR	95%CI	pvalue
Type of profession (ref Midwife vs. Obstetrician)	0.51	[0.38–0.70]	<0.0001	0.86	[0.60–1.24]	0.415
Gender (ref woman vs. man)	0.60	[0.43–0.84]	<b>0.003</b>	0.64	[0.43–0.95]	<b>0.025</b>
Time since graduation (years)	1.00	[0.99–1.01]	0.645	1.01	[1.00–1.03]	<b>0.044</b>
Modalities of exercise (ref Individual vs. collective)	0.66	[0.48–0.89]	<b>0.008</b>	0.83	[0.58–1.20]	0.330
Practitioners' flu vaccine for themselves (ref Yes vs. No)	1.09	[0.73–1.62]	0.671	1.01	[0.63–1.63]	0.959
Pregnant women influenza vaccination (ref Yes vs. No)	1.92	[1.17–3.15]	<b>0.010</b>	1.34	[0.74–2.43]	0.324
Practitioners' opinion on SARS-CoV-2 vaccination for themselves (ref Yes)						
No	5.52	[2.14–14.24]	<0.001	2.40	[0.77–7.45]	0.130
No I do not have risk factors	16.10	[3.86–67.17]	<0.001	19.07	[4.40–82.57]	<0.0001
Yes I have risk factors	1.66	[0.92–3.01]	0.093	1.91	[0.99–3.68]	0.055

\* pvalue of wald test using a multinomial logistic regression; in bold the significative pvalue considering the threshold of 0.05.

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workers with higher levels of confidence in the benefits and safety of vaccines or who were vaccinated will recommend vaccines to their patients [24, 25]. Although we have these data on other vaccines such as influenza, we can extrapolate similar effects with the SARS-CoV-2 vaccine. However, as a pandemic that is placed in the context of public opinion and that is heavily influenced by the media and social networks, it will be interesting to study these factors of the SARS-CoV-2 vaccine, especially in pregnant women.

Any prescription during pregnancy—more specifically vaccination—is a cause for concern because of the hypothetical risk of teratogenicity or complications for both the mother and new-born. Most SARS-CoV-2 vaccines have acceptable safety profiles and have been found to be efficacious against symptomatic SARS-CoV-2 or severe forms in nonpregnant cohorts [26–30]. There are few data on the evaluation of the vaccine in pregnant women. A recent study on 131 women, including 84 pregnant women, found that SARS-CoV-2 mRNA vaccines generated robust humoral immunity in pregnant and lactating women, with immunogenicity and reactogenicity similar to that observed in nonpregnant women [31]. Fears about vaccines in pregnant women generally have included uncertainty about vaccine safety and a lack of data regarding vaccine risks during pregnancy [32]. Surprisingly, in our study, a vaccine using new

technology was not a limiting factor because in our survey, RNA vaccines were the preferred ones for immunising pregnant women.

Many experts consider that vaccination programmes are threatened by growing concerns among the population regarding the safety and usefulness of vaccines [24, 25]. Vaccine hesitancy does not spare caregivers. In nurses, the vaccine hesitancy prevalence rate was 44% and most often concerned seasonal influenza vaccine and hepatitis B vaccine [33]. Even if worried about SARS-CoV-2, the rates of intention to receive a SARS-CoV-2 vaccine might be low in healthcare workers [34]. In an US survey, which was conducted on all employees of a health care system, in December, before the issuance of vaccine emergency use authorisations by the US Food and Drug Administration, only 55% of healthcare employees considered receiving the vaccine, but as of February 18, 2021, 67.2% have received at least one COVID-19 vaccine dose. In our study, more than 80% of the respondents would consider vaccination for themselves. New vaccines are usually singled out because of a perceived lack of testing for vaccine safety and efficacy [35]. Antivaccine positions are also ideological. A study among Finnish healthcare workers showed that although the majority of healthcare workers had high confidence in vaccination, a notable share reported low vaccination confidence [36]. They questioned the benefits and safety of vaccines, and even expressed distrust in the professional competences and intentions of health professional [36]; however, none of these elements are supported by scientific data. For SARS-CoV-2, the efficacy, duration of protection and side effects are important factors for vaccine acceptance.

In our study, midwives would be less likely to support pregnant women becoming vaccinated against SARS-CoV-2 than obstetricians or GPs. These differences in attitudes across professions are consistent with the findings of previous studies on pregnancy or childhood vaccination [37, 38]. The reasons are multiple, but a majority of the midwives are waiting for guidelines from their society or the ministry of health. They were also more likely to fear the side or teratogenic effects. Vilca et al. found that the most important vaccination barrier for influenza or pertussis during pregnancy was the concern related to the vaccine's adverse events (25.9%), and more midwives than obstetrician-gynaecologists expressed this concern (30.8% vs. 10%,  $p = 0.02$ ) [39]. In a recent review on midwives' attitudes, beliefs and concerns about childhood vaccination, the authors stated that most midwives supported vaccination although a spectrum of beliefs and concerns emerged [40]. A minority expressed reservations about the scientific justification for vaccination, which focused on what is not yet known rather than mistrust of current evidence. They also suggested that the midwifery model of care was shown to focus on providing individualised care, with patient choice being placed at a premium [40]. In France, midwives were only recently allowed to prescribe and administer a large set of vaccines [41], this may influence their perceptions. Indeed, it has been showed that health care workers who have the right to administer vaccines and who reported that they either discussed or administered vaccines frequently considered vaccines to be more beneficial and safe [36].

The strengths of our study include a large number of respondents nationwide. Our survey was proposed when the first vaccines were available and before the Astra-Zeneca® controversy about an increased risk of thrombo-embolic events, so this could not have affected the results. We cannot exclude that our study has some limitations. Our survey was limited to one country with its own habits and organisation. Nonetheless, SARS-CoV-2 vaccine hesitancy and concerns are global issues. The response rate of the GPs was weak compared with their representation over all French caregivers. However, GPs follow less than 20% of all pregnant women and are usually only seen in early pregnancy [42]. Given our recruitment approach, we were unable to determine the number and characteristics of providers who received the invitation to participate but declined. Likewise, we did not have data on the representativeness of the respondents on all practitioners. Our study reflects acceptability at a given point in time, but



this is likely to vary significantly in the context of SARS-CoV-2 based on recommendations and available data, which regularly give rise to controversy.

## Conclusion

In conclusion, understanding caregivers' perceptions of vaccination against SARS-CoV-2 for pregnant women is important for targeting training. Our study demonstrated that French prenatal healthcare practitioners are convinced of vaccinating pregnant women, but some express reservations that must be overcome. Statements from professional organisations and governmental institutions will be important to encourage offering the vaccine to pregnant women. Improved evidence-based knowledge would reduce fears related to adverse effects. The use of forthcoming publications from countries where vaccinations are more advanced and have reached more pregnant women will be very useful [43].

## Supporting information

**S1 Fig. The S1 Fig details the different questions of the questionnaire.**  
(DOCX)

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## References

1. Di Mascio D, Khalil A, Saccone G, Rizzo G, Buca D, Liberati M, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *Am J Obstet Gynecol MFM* 2020; 2:100107. <https://doi.org/10.1016/j.ajogmf.2020.100107>. PMID: 32292902
2. Huntley BJF, Huntley ES, Di Mascio D, Chen T, Berghella V, Chauhan SP. Rates of Maternal and Perinatal Mortality and Vertical Transmission in Pregnancies Complicated by Severe Acute Respiratory

- Syndrome Coronavirus 2 (SARS-CoV-2) Infection: A Systematic Review. *Obstet Gynecol* 2020; 136:303–12. <https://doi.org/10.1097/AOG.0000000000004010> PMID: 32516273
3. Martinez-Portilla RJ, Sotiriadis A, Chatzakis C, Torres-Torres J, Espino Y Sosa S, Sandoval-Mandujano K, et al. Pregnant women with SARS-CoV-2 infection are at higher risk of death and severe pneumonia: propensity score-matched analysis of a nationwide prospective cohort study (COV19Mx). *Ultrasound Obstet Gynecol Off J Int Soc Ultrasound Obstet Gynecol* 2020. <https://doi.org/10.1002/uog.23575>.
  4. Badr DA, Mattern J, Carlin A, Cordier A-G, Maillart E, El Hachem L, et al. Are clinical outcomes worse for pregnant women at  $\geq 20$  weeks' gestation infected with coronavirus disease 2019? A multicenter case-control study with propensity score matching. *Am J Obstet Gynecol* 2020; 223:764–8. <https://doi.org/10.1016/j.ajog.2020.07.045> PMID: 32730899
  5. Lerner AM, Folkers GK, Fauci AS. Preventing the Spread of SARS-CoV-2 With Masks and Other “Low-tech” Interventions. *JAMA* 2020; 324:1935–6. <https://doi.org/10.1001/jama.2020.21946> PMID: 33104157
  6. Lyu W, Wehby GL. Community use of face masks and COVID-19: Evidence from a natural experiment of state mandates in the US. *Health Aff (Millwood)* 2020; 39. <https://doi.org/10.1377/hlthaff.2020.00818> PMID: 32543923
  7. Maykin MM, Heuser C, Feltovich H, with the Society for Maternal-Fetal Medicine Health Policy Advocacy Committee. Pregnant people deserve the protection offered by SARS-CoV-2 vaccines. *Vaccine* 2020. <https://doi.org/10.1016/j.vaccine.2020.12.007>.
  8. Ledford H, Cyranoski D, Van Noorden R. The UK has approved a COVID vaccine—here's what scientists now want to know. *Nature* 2020; 588:205–6. <https://doi.org/10.1038/d41586-020-03441-8> PMID: 33288887
  9. Rasmussen SA, Jamieson DJ. Pregnancy, Postpartum Care, and COVID-19 Vaccination in 2021. *JAMA* 2021. <https://doi.org/10.1001/jama.2021.1683>.
  10. Adhikari EH, Spong CY. COVID-19 Vaccination in Pregnant and Lactating Women. *JAMA* 2021. <https://doi.org/10.1001/jama.2021.1658> PMID: 33555297
  11. WEF\_survey\_vaccine\_confidence\_2020.pdf n.d.
  12. Carbone L, Mappa I, Sirico A, Girolamo RD, Saccone G, Mascio DD, et al. Pregnant women perspectives on SARS-COV-2 vaccine. *Am J Obstet Gynecol Mfm* 2021. <https://doi.org/10.1016/j.ajogmf.2021.100352>.
  13. Skjefte M, Ngirbabul M, Akeju O, Escudero D, Hernandez-Diaz S, Wyszynski DF, et al. COVID-19 vaccine acceptance among pregnant women and mothers of young children: results of a survey in 16 countries. *Eur J Epidemiol* 2021:1–15. <https://doi.org/10.1007/s10654-021-00728-6> PMID: 33649879
  14. Obstetrician-gynecologists' practices and perceived knowledge regarding immunization.—Abstract—Europe PMC n.d. <https://europepmc.org/article/med/19596538> (accessed December 20, 2020).
  15. Gonik B, Jones T, Contreras D, Fasano N, Roberts C. The obstetrician-gynecologist's role in vaccine-preventable diseases and immunization. *Obstet Gynecol* 2000; 96:81–4. [https://doi.org/10.1016/S0029-7844\(00\)00860-7](https://doi.org/10.1016/S0029-7844(00)00860-7) PMID: 10862847
  16. Nichol KL, Zimmerman R. Generalist and subspecialist physicians' knowledge, attitudes, and practices regarding influenza and pneumococcal vaccinations for elderly and other high-risk patients: a nationwide survey. *Arch Intern Med* 2001; 161:2702–8. <https://doi.org/10.1001/archinte.161.22.2702> PMID: 11732935
  17. Poland GA, Shefer AM, McCauley M, Webster PS, Whitley-Williams PN, Peter G, et al. Standards for adult immunization practices. *Am J Prev Med* 2003; 25:144–50. [https://doi.org/10.1016/S0749-3797\(03\)00120-X](https://doi.org/10.1016/S0749-3797(03)00120-X) PMID: 12880883
  18. Stratégie de vaccination contre le Sars-Cov-2—Actualisation des facteurs de risque de formes graves de la Covid-19 et des recommandations sur la stratégie de priorisation des populations à vacciner. Haute Aut Santé n.d. [https://www.has-sante.fr/jcms/p\\_3240117/fr/strategie-de-vaccination-contre-le-sars-cov-2-actualisation-des-facteurs-de-risque-de-formes-graves-de-la-covid-19-et-des-recommandations-sur-la-strategie-de-priorisation-des-populations-a-vacciner](https://www.has-sante.fr/jcms/p_3240117/fr/strategie-de-vaccination-contre-le-sars-cov-2-actualisation-des-facteurs-de-risque-de-formes-graves-de-la-covid-19-et-des-recommandations-sur-la-strategie-de-priorisation-des-populations-a-vacciner) (accessed April 2, 2021).
  19. Le Roux B, Rouanet H. MULTIPLE CORRESPONDENCE ANALYSIS. SAGE publications; 2010.
  20. Lutz CS, Carr W, Cohn A, Rodriguez L. Understanding barriers and predictors of maternal immunization: Identifying gaps through an exploratory literature review. *Vaccine* 2018; 36:7445–55. <https://doi.org/10.1016/j.vaccine.2018.10.046> PMID: 30377064
  21. Wilson RJ, Paterson P, Jarrett C, Larson HJ. Understanding factors influencing vaccination acceptance during pregnancy globally: A literature review. *Vaccine* 2015; 33:6420–9. <https://doi.org/10.1016/j.vaccine.2015.08.046> PMID: 26320417

22. Paterson P, Meurice F, Stanberry LR, Glismann S, Rosenthal SL, Larson HJ. Vaccine hesitancy and healthcare providers. *Vaccine* 2016; 34:6700–6. <https://doi.org/10.1016/j.vaccine.2016.10.042> PMID: 27810314
23. Williams JL, Abelman SM, Fassett EM, Stone CE, Petrini JR, Damus K, et al. Health care provider knowledge and practices regarding folic acid, United States, 2002–2003. *Matern Child Health J* 2006; 10:S67–72. <https://doi.org/10.1007/s10995-006-0088-9> PMID: 16721664
24. Kreps S, Prasad S, Brownstein JS, Hswen Y, Garibaldi BT, Zhang B, et al. Factors Associated With US Adults' Likelihood of Accepting COVID-19 Vaccination. *JAMA Netw Open* 2020; 3:e2025594. <https://doi.org/10.1001/jamanetworkopen.2020.25594> PMID: 33079199
25. Black S, Rappuoli R. A crisis of public confidence in vaccines. *Sci Transl Med* 2010; 2:61mr1. <https://doi.org/10.1126/scitranslmed.3001738> PMID: 21148125
26. Voysey M, Clemens SAC, Madhi SA, Weckx LY, Folegatti PM, Aley PK, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. *Lancet Lond Engl* 2021; 397:99–111. [https://doi.org/10.1016/S0140-6736\(20\)32661-1](https://doi.org/10.1016/S0140-6736(20)32661-1).
27. Logunov DY, Dolzhikova IV, Zubkova OV, Tukhvatulin AI, Shcheblyakov DV, Dzharullaeva AS, et al. Safety and immunogenicity of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine in two formulations: two open, non-randomised phase 1/2 studies from Russia. *Lancet Lond Engl* 2020; 396:887–97. [https://doi.org/10.1016/S0140-6736\(20\)31866-3](https://doi.org/10.1016/S0140-6736(20)31866-3) PMID: 32896291
28. Ramasamy MN, Minassian AM, Ewer KJ, Flaxman AL, Folegatti PM, Owens DR, et al. Safety and immunogenicity of ChAdOx1 nCoV-19 vaccine administered in a prime-boost regimen in young and old adults (COV002): a single-blind, randomised, controlled, phase 2/3 trial. *Lancet Lond Engl* 2021; 396:1979–93. [https://doi.org/10.1016/S0140-6736\(20\)32466-1](https://doi.org/10.1016/S0140-6736(20)32466-1).
29. Zhu F-C, Li Y-H, Guan X-H, Hou L-H, Wang W-J, Li J-X, et al. Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: a dose-escalation, open-label, non-randomised, first-in-human trial. *Lancet Lond Engl* 2020; 395:1845–54. [https://doi.org/10.1016/S0140-6736\(20\)31208-3](https://doi.org/10.1016/S0140-6736(20)31208-3).
30. Zhu F-C, Guan X-H, Li Y-H, Huang J-Y, Jiang T, Hou L-H, et al. Immunogenicity and safety of a recombinant adenovirus type-5-vectored COVID-19 vaccine in healthy adults aged 18 years or older: a randomised, double-blind, placebo-controlled, phase 2 trial. *Lancet Lond Engl* 2020; 396:479–88. [https://doi.org/10.1016/S0140-6736\(20\)31605-6](https://doi.org/10.1016/S0140-6736(20)31605-6) PMID: 32702299
31. Gray KJ, Bordt EA, Atyeo C, Deriso E, Akinwunmi B, Young N, et al. COVID-19 vaccine response in pregnant and lactating women: a cohort study. *MedRxiv Prepr Serv Health Sci* 2021. <https://doi.org/10.1101/2021.03.07.21253094>.
32. Dolan SM, Cox S, Tepper N, Ruddy D, Rasmussen SA, MacFarlane K. Pharmacists' knowledge, attitudes, and practices regarding influenza vaccination and treatment of pregnant women. *J Am Pharm Assoc JAPhA* 2012; 52:43–51. <https://doi.org/10.1331/JAPhA.2012.10141>.
33. Wilson R, Zaytseva A, Bocquier A, Nokri A, Fressard L, Chamboredon P, et al. Vaccine hesitancy and self-vaccination behaviors among nurses in southeastern France. *Vaccine* 2020; 38:1144–51. <https://doi.org/10.1016/j.vaccine.2019.11.018> PMID: 31810781
34. Meyer MN, Gjorgjieva T, Rosica D. Trends in Health Care Worker Intentions to Receive a COVID-19 Vaccine and Reasons for Hesitancy. *JAMA Netw Open* 2021; 4:e215344. <https://doi.org/10.1001/jamanetworkopen.2021.5344> PMID: 33755164
35. Karafillakis E, Dinca I, Apfel F, Cecconi S, Würz A, Takacs J, et al. Vaccine hesitancy among healthcare workers in Europe: A qualitative study. *Vaccine* 2016; 34:5013–20. <https://doi.org/10.1016/j.vaccine.2016.08.029> PMID: 27576074
36. Karlsson LC, Lewandowsky S, Antfolk J, Salo P, Lindfelt M, Oksanen T, et al. The association between vaccination confidence, vaccination behavior, and willingness to recommend vaccines among Finnish healthcare workers. *PloS One* 2019; 14:e0224330. <https://doi.org/10.1371/journal.pone.0224330> PMID: 31671115
37. Wilcox CR, Calvert A, Metz J, Kilich E, MacLeod R, Beadon K, et al. Attitudes of Pregnant Women and Healthcare Professionals Toward Clinical Trials and Routine Implementation of Antenatal Vaccination Against Respiratory Syncytial Virus: A Multicenter Questionnaire Study. *Pediatr Infect Dis J* 2019; 38:944–51. <https://doi.org/10.1097/INF.0000000000002384> PMID: 31261362
38. Dubé E, Gagnon D, Kaminsky K, Green CR, Ouakki M, Bettinger JA, et al. Vaccination during pregnancy: Canadian maternity care providers' opinions and practices. *Hum Vaccines Immunother* 2020; 16:2789–99. <https://doi.org/10.1080/21645515.2020.1735225> PMID: 32271655
39. Vilca LM, Martínez C, Burballa M, Campins M. Maternal Care Providers' Barriers Regarding Influenza and Pertussis Vaccination During Pregnancy in Catalonia, Spain. *Matern Child Health J* 2018; 22:1016–24. <https://doi.org/10.1007/s10995-018-2481-6> PMID: 29417364

40. Attwell K, Wiley KE, Waddington C, Leask J, Snelling T. Midwives' attitudes, beliefs and concerns about childhood vaccination: A review of the global literature. *Vaccine* 2018; 36:6531–9. <https://doi.org/10.1016/j.vaccine.2018.02.028> PMID: 29483029
41. Décret n° 2016–743 du 2 juin 2016 relatif aux compétences des sages-femmes en matière d'interruption volontaire de grossesse par voie médicamenteuse et en matière de vaccination. 2016.
42. [[:fr]]Les Enquêtes Nationales Périnatales[:en]]French National Perinatal Surveys[:]. EPOPé n.d. <http://www.xn--epop-inserm-ebb.fr/grandes-enquetes/enquetes-nationales-perinatales> (accessed March 27, 2021).
43. COVID-19 vaccine response in pregnant and lactating women: a cohort study—*American Journal of Obstetrics & Gynecology* n.d. [https://www.ajog.org/article/S0002-9378\(21\)00187-3/fulltext](https://www.ajog.org/article/S0002-9378(21)00187-3/fulltext) (accessed March 27, 2021).