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Maternal vaccines during the Covid-19 pandemic: A qualitative interview study with UK pregnant women

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ABSTRACT

Background: There is suboptimal uptake of recommended maternal vaccines (pertussis and influenza) during pregnancy in the UK. The Covid-19 pandemic has impacted healthcare services, and potentially vaccine coverage, and brought the need for new vaccines to be tested and rolled out.

Objectives: To explore: i) the impact of the Covid-19 pandemic on pregnant women's access to, and attitudes towards, routine maternal vaccines and; ii) women's attitudes towards testing Covid-19 vaccines on pregnant women and their personal willingness to take part in such a trial.

Design: Qualitative interview study with pregnant women in the Bristol and surrounding area (UK).

Methods: Semi-structured telephone/videoconference interviews were conducted (following a topic guide), transcribed verbatim and subjected to thematic analysis.

Results: Thirty-one pregnant women (selected for demographic range) were interviewed in April/May 2020. Participants felt the pandemic had elevated the importance of routine maternal vaccines, though women were concerned about safety management around appointment attendance. Women were wary of receiving a new Covid-19 vaccine, with most perceiving it as riskier than Covid-19 itself.

Conclusions: It is important to maximise the safety and efficiency of maternity appointments to encourage uptake of routine maternal vaccines, and to communicate this well. For pregnant women to gain a new vaccine or participate in a vaccine trial, they need to be convinced that the risk posed by the virus is greater than any risk of receiving a new vaccine.

1. Background

In the United Kingdom (UK), the routine maternal vaccines currently offered via the National Health Service (NHS) are pertussis (whooping cough), recommended for all pregnant women to receive between 16-32 weeks' gestation (NHS, 2019), and influenza, recommended for women pregnant during the winter season (September to March) (NHS, 2019a, 2019b). These vaccines have been shown to be safe (Donegan et al., 2014, Naleway et al., 2014) and effective (Amirthalingam et al., 2014, Nunes and Madhi, 2018). However, UK coverage rates are suboptimal with overall uptake at 70% for pertussis (Public Health England 2020) and around 44% for influenza (Public Health England 2020). Common barriers to receiving vaccination in pregnancy are women's concerns around vaccine safety, lack of healthcare professional (HCP) recommendation, access issues and conflicting advice (Bisset and Paterson, 2018).

Evidence suggests most women will accept prenatal vaccinations if recommended by a trusted HCP for their baby's health and if they have good access (Wilson et al., 2015). The pertussis vaccine is delivered in primary care or at the 20-week foetal anomaly scan in many UK maternity services, while the influenza vaccine is mainly offered in primary care and at some pharmacies.

The Covid-19 pandemic hit the UK in early 2020, and social distancing measures implemented from March 2020 onwards affected services across the NHS, including major changes to maternity care (Jardine et al., 2020). It is unclear at present exactly how the changes impacted on pregnant women's access to routine vaccines, though we saw an overall reduction in UK pertussis coverage in pregnant women from March 2020 compared to previous years (Public Health England 2020). Covid-19 also placed the topic of vaccines centre-stage, and public confidence and attitudes are core to the success of vaccine programmes (Verger and

Abbreviations: HCP, Healthcare professional; IMD, Index of multiple deprivation; NHS, National Health Service; PIP Study, Pregnant in a Pandemic Study; UK, United Kingdom.

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Dubé, 2020). It is unclear what impact the pandemic may have had on pregnant women's attitudes towards their routine maternal vaccines.

New vaccines for Covid-19 have been developed and are continuing to be developed (Tregoning et al., 2020, Parker et al., 2020). Vaccines must be tested on the populations due to receive them. To date, no Covid-19 vaccine clinical trial has specifically focused on pregnant women (Craig et al., 2020), despite pregnant women being classed as 'at increased risk of severe illness from the virus that causes Covid-19' by the Centers for Disease Control and Prevention (Control CfD, Prevention. *People with Certain Medical Conditions* 2020) and as 'clinically vulnerable' to Covid-19 in the UK (National Health Service (NHS), 2020). Inclusion of pregnant women in vaccine trials has been consistently advocated – for example by the American College of Obstetrics and Gynecology (Craig et al., 2020) and for Covid-19 vaccine testing specifically (Kampmann, 2021, Vora et al., 2020), not least because in the pandemic context, the frontline healthcare workforce has a disproportionately high number of women who could become, or are, pregnant.

We aimed to gain understanding of women's perceptions and experiences of these issues to guide policy and practice both for continuing routine maternal vaccination and for introducing Covid-19 vaccines to pregnant women. At the time, no Covid-19 vaccines were available, trials were underway but pregnant women were routinely excluded from these. We only had evidence that a minority of pregnant women would be willing to participate in vaccine trials generally (Jaffe et al., 2020, Palmer et al., 2016) though it was not known whether they would be willing to participate in a Covid-19 vaccine trial specifically.

2. Methods

2.1. Aim

The aims of the current study were to explore: i) the impact of the Covid-19 pandemic on pregnant women's access to, and attitudes towards, routine maternal vaccines (pertussis and influenza) and; ii) women's attitudes towards testing Covid-19 vaccines on pregnant women and their personal willingness to take part in such a trial.

2.2. Design

As part of the 'Pregnant in a Pandemic' (Pip) qualitative interview study (Anderson et al., 2021), this sub-study was designed to explore pregnant women's experiences and attitudes around routine maternal vaccines and future Covid-19 vaccine testing in the context of the pandemic in the UK.

2.3. Recruitment and sampling

Eligible participants were pregnant women of any gestation, living in Bristol, UK or the immediate surrounding counties, aged 18 years or above, able to read and speak English to a sufficient level to consent and participate. The recruitment and sampling methods for the Pip study are presented in detail elsewhere (Anderson et al., 2021). In brief, pregnant women were invited opportunistically to express interest in taking part in a study on social distancing (via local news, University communications, social media and local radio). Respondents filled in an online expression of interest form including demographics. Purposive sampling was applied (according to participant age, ethnicity, Index of Multiple Deprivation [IMD] derived from home postcode, gestation, and avoiding over-representation of those with medical/nursing training) to select a range of women for interview. Full informed consent was established prior to interview. Participants were offered shopping vouchers for taking part. The aim was to recruit around 30 pregnant women, aiming for data saturation of key themes to answer the research question (Shaw et al., 2019). All participants were invited to answer extra questions on vaccines at the end of the social distancing interviews.

2.4. Data collection

Semi-structured interviews were conducted remotely via telephone/videoconference by authors who all have experience of qualitative research applied to healthcare and a background in health psychology and/or maternity service research (EA, AB, JI, AD, ES). Interviews followed a topic guide exploring social distancing in the pandemic, and interviewees were given the option of answering extra questions about vaccines at the end. The questions were: *How important do you think it is to have vaccination in pregnancy against 'flu and whooping cough? Has the pandemic changed your thoughts about the importance of vaccines during pregnancy? Has the pandemic impacted whether you have had or been able to get these vaccines during pregnancy? Do you think that new vaccines being developed to protect against Covid-19 should be tested in pregnant women to see if they are safe and effective? Would you be willing to take the vaccine?* These were designed to initiate conversations to explore the key study aims, and interviewers allowed flexibility for extra discussion and invited further comments at the end of the discussion. Interviews were audio-recorded, professionally transcribed verbatim and pseudonymized before being imported into NVivo 11 software (Castleberry, 2012) for analysis, ensuring secure storage (encrypted/password-protected).

2.5. Analysis

The data were analysed using thematic methods (Braun and Clarke, 2006) of building codes into themes and sub-themes using the process of constant comparison, facilitated by NVivo software. Themes were compared within and across the sample and structured around the interview questions while also seeking inductive and cross-cutting themes from the data. Independent coding was conducted (EA and AB) and transcripts were then double coded (ES). Differences were resolved via team discussion to ensure robust analysis.

3. Results

Ninety-five women expressed an interest in participation and provided basic demographic and contact details, of whom 83 were eligible and 31 were selectively sampled aiming for demographic diversity according to age, ethnicity, gestation and to avoid overrepresentation of those with a medical/nursing background. Participant characteristics are presented in Table 1. Of the 31 women in the sample, 20 were primiparous (first time expectant mothers); the age range was 24-48 years (mean 33), at the time of interview gestation ranged from 10-39 weeks (mean 24). Every IMD level was represented and the ethnicity of our sample was: 24 (77%) White British, 7 (23%) other ethnicities (1 White European, 2 Asian, 1 Black, 3 mixed). Two had medical/nursing training. All interviews took place (via telephone/videoconference) between 24 April and 7 May 2020. While the vaccine questions were presented as optional, no interview participant declined to answer them.

An overview of the main themes identified is presented in Table 2 and these are described in more detail below.

3.1. General attitude to routine maternal vaccines

3.1.1. It is "very important" to have routine pregnancy vaccines

Most women in this study felt it was "very important" to have their recommended maternal vaccines (pertussis, and influenza in 'flu season) and reported general pro-vaccination attitudes; "I believe in vaccines" (ID83), "I am very pro vaccination" (ID41). Reported reasons included trust in NHS/healthcare professional advice generally, and many stated that "it protects the baby" (e.g. ID17) and/or themselves.

"if it's one that is recommended by the NHS then there's a good reason for doing, so" (ID31)

"to protect myself and my baby" (ID25)

Table 1
Participant characteristics.

Consent ID	IMD (from home post-code)	Gestation at time of interview* (weeks)	Current age*(years)	Do you have children already?*
01	9	25-27	30-34	No
03	3	16-18	35-39	No
05	1	28-31	30-34	No
06	10	32-35	30-34	No
09	7	10-12	35-39	Yes
11	5	22-24	25-30	No
13	6	28-31	30-34	No
14	1	28-31	20-24	No
17	2	36+	25-29	No
18	8	36+	35-39	Yes
19	4	19-21	25-32	No
20	7	16-18	30-34	No
21	5	36+	30-34	No
24	4	32-35	35-39	Yes
25	2	22-24	30-34	Yes
31	4	28-31	40+	Yes
32	5	13-15	35-39	Yes
37	3	19-21	25-33	No
39	7	10-12	35-39	Yes
40	9	10-12	20-24	No
41	4	32-35	25-34	No
45	2	14-20	30-34	Yes
46	5	28-31	30-34	No
53	2	19-21	40+	Yes
54	4	32-35	30-34	No
60	7	16-18	25-31	No
62	6	10-12	35-39	No
79	2	32-35	40+	Yes
82	2	22-24	30-34	Yes
83	7	14-20	35-39	No
85	1	22-24	30-34	No

* Participant data presented as a range to preserve anonymity. Individual ethnicity data not presented to preserve anonymity.

**information collected during interview. All other demographic information in this table was collected within the expression of interest form to inform sample selection.

Table 2
Thematic analysis: Overview of themes.

Main area of questioning	Themes identified
1) General attitude to routine maternal vaccines	1.1) It is “very important” to have routine pregnancy vaccines; 1.2) Lack of knowledge/awareness
2) Impact of pandemic on attitudes towards routine maternal vaccines	2.1) “Elevating the importance”; 2.2) “I thought they were important before and I still think they are”
3) Impact of pandemic on access to routine maternal vaccines	3.1) No impact (so far); 3.2) Safety management around the appointment; 3.3) Access and communication issues around routine vaccines
4) Should Covid-19 vaccines be tested on pregnant women?	4.1) “I think they should be tested on pregnant women (but I wouldn't volunteer)”; 4.2) “That's a really tough question” – ethics of risk to the baby; 4.3) “Hell no”: Covid-19 vaccines should not be tested on pregnant women
5) Personal willingness to participate in a Covid-19 vaccine trial	5.1) “I am not going to be a guinea pig” – personal unwillingness to participate in a vaccine trial; 5.2) Would consider taking part in a vaccine trial if...

One participant differentiated in her attitudes towards pertussis and influenza vaccines in terms of protection of her baby versus of herself:

“I would have the one that protects the baby [...] I don't think I would be worried if I got the flu [...] because I feel I can fight things off. I don't like the idea of having loads of things if I don't necessarily have to” (ID62).

There was evidence that several women were motivated by personal experiences of illness in themselves or in a child:

“I've had flu, you feel like you're dying” (ID05)

“I had whooping cough as a child and I wouldn't wish it on anyone, so I will be getting that” (ID03)

“My son had flu when he was four and a half, and ended up in hospital for a couple of nights” (ID18)

Other motivating factors mentioned in interviews included susceptibility to illness during pregnancy, that being ill while pregnant or with a new-born baby would be harder, and one woman mentioned additional altruistic motives:

“you are slightly more susceptible to flu-related things when you're pregnant” (ID24)

“it is pretty essential to reduce any risks[...] because I wouldn't want to risk me becoming unwell which could affect the baby” (ID14)

“it protects your child and also then any other children when your child is born, it stops infections from spreading” (ID19)

3.1.2. Lack of knowledge/awareness

By contrast, two women commented that they lacked knowledge about vaccines offered in pregnancy, though both mentioned that they would accept what was recommended:

“I didn’t really know too much about” (ID01)

“it is not something I have thought about” (ID62)

3.2. Impact of pandemic on attitudes towards routine maternal vaccines

3.2.1. Elevating the importance

When discussing the impact of the pandemic on their attitudes towards routine maternal vaccines, many women made comments along the lines of *“it just shows how important they are”* (ID39), and while feeling vaccines were always important, women reported that Covid-19:

“heightens it and makes you more aware” (ID40)

“reinforces that they are important” (ID14)

“was elevating the importance of it.” (ID13)

One woman thought the influenza vaccine may help protect against Covid-19, stating;

“I feel as if that might build up your immune system more towards it. I know they say it’s not like a ‘flu, but having that vaccine in place might protect you a little bit more” (ID17).

3.2.2. I thought they were important before and I still think they are

Other women described that the pandemic had no impact on their attitudes because they had always seen vaccination as very important:

“I feel exactly the same, I still feel they are important.” (ID32);

“I always thought they were important; it’s not really changed anything.” (ID19)

“I thought they were important before and I still think they are.” (ID54).

3.3. Impact of pandemic on access to routine maternal vaccines

3.3.1. No impact (so far)

Women with more advanced pregnancy at the time of interview reported that the pandemic had not impacted their ability to gain the vaccine, and they recognised their good fortune:

“I had those vaccines before this all happened.” (ID05)

“luckily I got them all before everything hit the fan.” (ID54).

At least four women reported receiving their pertussis vaccine after the pandemic had hit the UK:

“I had whooping cough about three weeks ago, four weeks ago, whilst we were in the middle of the pandemic.” (ID06).

Two women commented that the services were continuing to offer essential services, suggesting that these women perceived routine vaccines as basic needs:

“I think they are really trying to do what’s needed basically” (ID82)

“I am getting all the basic stuff I need.” (ID83)

Those in earlier stages of pregnancy had not reached the timepoint where vaccines were due, so were unsure of how access would be impacted:

“I see my midwife in week 16 so I will ask her then.” (ID32)

“I have to call my GP and say I need a whooping cough vaccination. So I suppose it depends how easy it is, I don’t know” (ID09).

3.3.2. Safety management around the appointment

When describing receiving their vaccines, some women spontaneously mentioned social distancing measures taken for the appointment:

“it was in full swing, all the social distancing and PPE and stuff, and it was fine [...] it was very quick, she did it and I was out” (ID85)

“I had to go to the GP for that [pertussis vaccine], but it was a first morning appointment when there was no one else in the surgery” (ID01).

There was evidence that the pandemic caused women to weigh up the benefits of attending appointments versus the risk of Covid-19 exposure generally, and specifically for vaccine appointments, for example, one woman (with comorbid health issues) commented:

“I suppose I am trying to limit the number of times that I go to hospital because attending there is a risk, so if I had to go just to get a vaccine I probably wouldn’t have gone. But because I had to go and get a scan, I was able to do it at the same time I did go, if that makes sense?” (ID53)

3.3.3. Access and communication issues around routine vaccines

There was also evidence that some (at least 3) women had experienced issues in obtaining their vaccines;

“so when I went for my twenty-week (scan) I presumed that was what was going to happen again, but it didn’t, and because I don’t know the routine of it I just assumed that you didn’t do it at that point” (ID01).

This is the same participant who reported a lack of knowledge/awareness of vaccines (presented above, along with ID62). Two more women reported communication issues around the influenza vaccine:

“I wasn’t really given any information.” (ID60)

“never had information on flu vaccine or why you should have it” (ID40)

One woman reported having to make a separate GP appointment for her pertussis vaccine because, although it was offered at the twenty-week scan,

“they ran really behind and we had to go” (ID14)

It was not clear that these delays or communication issues were specifically due to the pandemic.

One woman reported being symptomatic at the time of her influenza vaccine appointment, so had to delay for two weeks due to Covid-19 measures which ended after the March cut-off date for receiving it:

“So yeah I’ve missed that one.” (ID60).

3.4. Should Covid-19 vaccines be tested on pregnant women?

Participants’ responses to the question of whether Covid-19 vaccines should be tested (generally) on pregnant women ranged from feeling it is important, to stating it should not be done, with some feeling unsure either way mainly due to ethical/risk issues, as shown below.

3.4.1. “I think they should be tested on pregnant women (but I wouldn’t volunteer)”

Many participants recognised the importance of testing Covid-19 vaccines on pregnant women, though most mentioned in the same sentence their unwillingness to do this themselves (e.g. ID21, ID83, ID82, ID40) or that it would be “great if somebody would want to” (ID09). Most just stated it was generally important, or to see if it works, while one commented that it was important:

“because pregnant women are vulnerable as well, because they have got weaker immune systems” (ID17).

Several participants answered with a positive, though less certain “Yes, I guess” (ID24, ID18) while again (spontaneously) mentioning their personal unwillingness to be in a trial:

“I guess they should be, but I personally wouldn’t want it” (ID11).

3.4.2. “That’s a really tough question” – ethics of risk to the baby

When asked if Covid-19 vaccines should be tested on pregnant women generally, several participants commented along the lines of this being “a really tough question” (ID39) or a “difficult one” (ID41). It was perceived as an especially challenging question because “there’s another life involved.” (ID19), and many women felt they were “on the fence” (ID41) or simply stated “I don’t know” (ID18). Many described ethical concerns:

“there’s an ethical side to it isn’t there, because if you’re testing it you don’t potentially know what the effects could be so it could harm the baby” (ID39)

“That’s a really hard question, because we need to know that they are safe but it’s a risk, and it’s a risk not necessarily just to the woman but also to the child who doesn’t get a say in it.” (ID19)

One participant expressed uncertainty but felt it was “very much down to the mother”, feeling that if there were women “of sound mind who are able to rationale the decision to take a vaccine as a test then I think that’s up to them” (ID25). One participant commented “maybe at a later stage”, after tests had showed the vaccine was safe in healthy people and those with different conditions first (ID13).

3.4.3. “Hell no”: Covid-19 vaccines should not be tested on pregnant women

Three women felt that Covid-19 vaccines should not be tested on pregnant women due to the risks. There was a sense that this was specifically because it was so new, and side-effects were unknown:

“No, I think there’s too much risk. I think most things aren’t tested on pregnant women so I don’t see why they should test that on them either.” (ID32)

“Hell no, no test on the general population first please” (ID53)

“No I don’t think they should be done on pregnant women, just because you don’t know the side effects, you know nothing about it.” (ID60).

3.5. Personal willingness to participate in a Covid-19 vaccine trial

When asked directly about their personal willingness to take part in a Covid-19 vaccine trial, the majority of participants were unwilling, some were unsure, and others cited conditions under which they would consider it, as outlined below.

3.5.1. “I am not going to be a guinea pig” – personal unwillingness to participate in a vaccine trial

As we have seen, when asked whether Covid-19 vaccines should be tested on pregnant women generally, women spontaneously commented that they would not be willing to take part in a vaccine trial themselves. When directly asked about their personal willingness, most participants responded similarly:

“No, definitely not.” (ID32)

“I am not going to be a guinea pig” (ID79)

“without knowing what the testing processes are and what the risks are is my automatic gut reaction to just say no.” (ID19).

Though recognising the importance of testing, women described themselves as risk-averse during pregnancy, preferring to keep themselves safe in other ways:

“I would much rather social distance at this stage” (ID46).

“I know it probably could help but you just you almost go into a bubble shell to protect everything” (ID01)

Women cited the unknown safety to them and their baby of a new vaccine as the main reason for personal unwillingness to take a trial Covid-19 vaccine, as well as comments about lack of confidence due to its novelty:

“I think it’s really unfair to ask because there’s just too much at stake, there’s two lives that could be ruined or affected negatively, so no.” (ID45)

“Yeah, I worry enough about having a miscarriage or something like that just naturally, so I think adding a potential further risk factor would make me think twice.” (ID39)

“it’s not the risk to myself, it’s the risk to my baby which would be a potentially unknown, so that would be my reason.” (ID25)

“just because it’s so new [...] I wouldn’t have any confidence in it yet” (ID62).

Personal experience fed into attitudes, with one woman not keen based on anecdotal adverse outcomes from another vaccine, while another mentioning having known babies born with Covid-19 who “have been alright” so she was more worried about the vaccine:

“I would be more worried about the impact of a vaccine that hadn’t been trialled properly, having long term impact than having to navigate getting treatment if that makes sense?” (ID54)

“I have a friend that got really... she got ME and narcolepsy from the swine flu vaccine, because that was developed pretty quickly I think as well, and I think that’s just stuck with me” (ID45)

One woman alluded to the thalidomide tragedy (Kim and Scialli, 2011) and anxieties about the relative risks of vaccinating versus catching Covid-19, especially in the early stages, while another reported a conversation she had with friends about signing up for a vaccine trial, which indicated strong fears based on her understanding of the vaccine:

“the early stages where the baby is really developing its body and brain and everything [...] So there’s the worry of both catching it, and then there’s the worry of what a vaccination could do if it was the wrong thing.” (ID18)

“we were just like no because basically you’re injecting coronavirus to see if your body will create antibodies towards it, coronavirus kills people, basically you’re signing your death certificate” (ID05)

By contrast, two women commented that they were simply unsure about whether they would personally be willing to take a new vaccine, again considering risks associated with pregnancy:

“if I wasn’t pregnant I would definitely be up for taking part, it just feels like a bit of a risk. I am not sure, I would need to think about that one.” (ID03)

“would I be willing to take a vaccine? I don’t know is the answer [...] we just don’t know how it reacts, and pregnant women are a very vulnerable group of the population” (ID85).

3.5.2. Would consider taking part in a vaccine trial if...

Five women described conditions in which they would consider volunteering for a Covid-19 vaccine trial, which centred on increased risk of the virus to pregnant women, and more safety testing of the virus:

Two commented that their willingness to volunteer may change if their perceived balance of risks changed:

“if the illness was a lot more dangerous in pregnancy and I had a good chance of getting it anyway and the vaccine looked like it was promising” (ID31).

“In my age group the possibility of death is pretty low, if it was... for example if I was facing the possibility of death of an 80-year-old, if the virus changes if it's one out of two people could die from this, if the virus adapts or changes its structure then I may change my opinion on whether I would try a new vaccine. Basically I don't want to die and I don't want my husband to die and I don't want my baby to come out weird.” (ID83)

Three women reported a *potential* (though uncertain) willingness to take a vaccine within a trial while pregnant, or at least consider it, only if a certain amount, or type, of prior testing had already been completed:

“if we're talking two years down the line and then pregnant again and there's been multiple trials, so in that hypothetical example and like I say it's been well tested but it's just we're just looking at a test for pregnant women I would consider it then, but definitely not at this early stage.” (ID13).

“perhaps if they had done really in-depth preclinical studies and they had shown no side effects in ovulating women and maybe pregnant primates or something like that.” (ID37).

“if it was the end of the trial and they had already tested on hundreds of other pregnant women and there had been no reported side effects at this point and babies had been born healthy then possibly. But I would still be quite nervous about it I think.” (ID41).

By contrast, two women reported a more active willingness to volunteer for a vaccine trial while pregnant. One said:

“I would be willing to be part of a phase II or a phase III clinical trial knowing and having seen the data that had come beforehand.” (ID06)

The other focused on the risks of the vaccine equalling the risks of Covid-19 (as the vaccine would be a form of the virus) as well as altruistic motives:

“if you're pregnant and you do get it you're as likely as anyone else to have not really bad symptoms if you don't have any pre-existing other conditions [...] I am otherwise healthy and quite young, or youngish, middle aged, so I guess I would feel fairly okay about having it myself. So I would be willing to have the test and be part of that if it helped other pregnant women, definitely” (ID24)

4. Discussion

This study is among the first to explore pregnant women's perceptions of how the Covid-19 pandemic has impacted access to, and attitudes towards, routine maternal vaccines in the UK and to explore pregnant women's views on participating in Covid-19 vaccine trials. In the time since these interviews, Covid-19 vaccines have been developed and rolled out to the general population - from December 2020 in the UK, starting with the elderly and clinically vulnerable. Initially the vaccine was not recommended for pregnant women due to lack of evidence, though the UK guidance changed to advise pregnant women to consider accepting a Covid-19 vaccine if they were at high risk of infection (e.g. working as a healthcare professional) on one-by-one basis. The guidance changed again (on 16 April 2021) to recommend that pregnant women accept the vaccine when invited with their age-cohort (JCVI, 2021). Our results provide important considerations for communication to promote vaccine uptake in pregnant women in this rapidly changing context.

Routine vaccines: Risk-aversion characterised participants' responses to all the questions in this study, echoing cultural and medical conceptualisations of pregnancy as a time for women to be vigilant of risks for the health of their baby (Rothman, 2014, Ballantyne et al., 2016). Women in our sample mostly described themselves as 'pro-vaccine' and felt that routine vaccines were very important, and even more so since the pandemic had hit, which aligns with early findings that Covid-19 strengthened positive attitudes towards vaccines in the general population (Blanchard-Rohner et al., 2020). Because of the timing of interviews (April/May 2020), and the timing of the pandemic

affecting services (March onwards), most comments on access to routine vaccines centred on pertussis, as influenza is administered seasonally (September to March). We found some evidence of difficulties in obtaining routine vaccines, and of a lack of knowledge/communication about maternal vaccines, though it was not clear if this was due to the pandemic or to pre-existing service issues. Despite recognising the importance of vaccines, the safety of attending for appointments was an important concern for these women when discussing vaccines (as presented) and maternal appointments generally (as presented elsewhere (Anderson et al., 2021)). We know that any barriers to vaccine access negatively affect uptake (Bisset and Paterson, 2018). Our findings align with evidence of disruption to pregnancy vaccination programmes internationally – largely due to access issues and user concerns about safety of attending appointments (Saso et al., 2020, Ceulemans et al., 2021) as well as evidence of comparable pandemic-related barriers to infant vaccination in the UK (Bell et al., 2020). Concern around the safety of attending appointments is a new barrier introduced by the Covid-19 context, which requires careful consideration by services if we are to maintain routine vaccine coverage and minimise the risks of vaccine-preventable illness.

Covid-19 vaccines: Most women expressed unwillingness to be a 'guinea pig' in Covid-19 vaccine trials, voicing fears about unknown effects of a new vaccine. Concerns centred on the risks of a vaccine (to themselves and their unborn baby), and women tended to view risks associated with a new vaccine as greater than that posed by Covid-19 itself. Some women identified conditions under which they would consider volunteering for a vaccine trial, centring on perceptions of illness risk and knowledge of vaccine safety. This is similar reasoning presented conversely to recommend that Covid-19 vaccines should not be withheld from pregnant women, but considered on an individual risk-benefit profile accounting for risk of exposure, health status and risk of Covid-19-related complications (Craig et al., 2020). The reluctance of the women we interviewed to accept a (hypothetical at the time) Covid-19 vaccine aligns with the findings of surveys indicating greater reluctance to accept a Covid-19 vaccine in pregnant women (compared with non-pregnant women) in the UK and internationally with key reasons being potential harms to the foetus and a desire for more evidence of safety and efficacy (Ceulemans et al., 2021, Skjefte et al., 2021, Skirrow et al., 2021, Goncu Ayhan et al., 2021). Interestingly, the study in Turkey found greater Covid-19 vaccine acceptance for the first trimester by contrast to our findings where women expressed more wariness about being vaccinated early in the pregnancy (Goncu Ayhan et al., 2021).

The strengths of this study are its novelty and relevance to the current and shifting pandemic context, the application of robust qualitative methods and maximum diversity sampling. One limitation is that participants in our sample were relatively homogenous in their 'pro-vaccine' views, and comments within interviews indicated that there may have been over-representation of university employees, though diversity according to key demographics was achieved. Our results may therefore under-represent the vaccine hesitancy at play in the wider population, though even in this pro-vaccine population, we have demonstrated how Covid-19 safety concerns can be a barrier to gaining routine vaccines and that pregnant women are very wary of receiving a new vaccine.

Interviews were conducted within one two-week period at the beginning of the first UK lockdown. Comments concerned a hypothetical Covid-19 vaccine. Research has shown that healthcare professionals' willingness to accept a Covid-19 vaccine was higher after announcements of vaccine efficacy and authorisation of their use than prior to this when the question was about a hypothetical vaccine (Meyer et al., 2020). While it is possible that the authorisation and roll-out of new Covid-19 vaccines may have similarly shifted pregnant women's attitudes, a key difference is that efficacy and safety data have been missing for pregnant women due to their exclusion from Covid-19 vaccine trials to date.

While the evidence remains limited, we are now starting to see relevant safety and efficacy data related to Covid-19 infection and Covid-19

vaccines in pregnancy, which may affect women's attitudes. A systematic review found that Covid-19 infection was associated with increased risks of pre-eclampsia, pre-term birth and other adverse pregnancy outcomes (Wei et al., 2021). Gray et al (Gray et al., 2021) found that vaccinating pregnant women conferred robust maternal and neonatal immunity to Covid-19. A US study found no evidence of safety concerns for pregnant women receiving mRNA Covid-19 vaccines, though advised that more research is needed (Shimabukuro et al., 2021). Communicating such evidence of safety and effectiveness appropriately to pregnant women is vital.

The timing of interviews also meant that many women in this study had either received their routine vaccines prior to any service disruption or had not yet reached the timepoint when vaccines were due, so routine vaccine access issues were mostly unknown. Evidence of declining pertussis vaccine coverage in pregnant women since March 2020 (Public Health England 2020) and early evidence that the pandemic negatively impacted women's access to maternal (and infant) vaccines internationally (Saso et al., 2020) suggests there are systemic problems to be addressed. Future research should explore in more detail the full impact of the pandemic on women's access to routine maternal vaccines in the UK and what can be done to improve the situation at the service level.

5. Conclusions / Implications for policy and practice

Routine vaccination must remain a priority to avoid undoing years of progress on vaccine coverage and facing resurgence of vaccine-preventable disease (Saxena et al., 2020). It is important to maximise the safety and efficiency of maternity appointments during a pandemic to minimise the burden on women of risk-based decision-making around appointments and to increase the likelihood of vaccination. In this context it is even more important that the pertussis vaccine is offered at the foetal anomaly scan (approximately 20 weeks), or another important appointment, rather than women being required to make and attend a separate appointment solely for the vaccine. Access to influenza vaccines for pregnant women should follow similar lines – being as safe and easy to access as possible, reducing need for multiple appointments, along with good communication from healthcare providers.

Pregnancy is a time when women are expected to mitigate risk to themselves and their babies (Ballantyne et al., 2016), which was evident in this study. In this context, pregnant women are less likely than the general population to volunteer to accept a new vaccine and they need evidence of extensive safety-testing at least on the general population first. The changing policy and communication efforts which are now recommending Covid-19 vaccination in pregnancy must continue to address women's fears by presenting clear, unequivocal evidence to explain the rapid development of the vaccine and how it safely confers immunity. Continued research into vaccine safety and efficacy for pregnant populations is absolutely vital and the results must be scrutinised and well-communicated. The exclusion of pregnant women from vaccine trials is a key concern for gender-based equity of healthcare as it leaves women and healthcare workers without the necessary evidence to make a decision about vaccination. We need to prioritise the best way to include pregnant women in future vaccine trials rather than exclude them by default. For vaccine acceptance generally, pregnant women need to know that the risk posed by the virus is greater than any risk of receiving the new vaccine.

Availability of data and materials:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval

The study was reviewed and approved (16/04/2020) by the Faculty of Health Sciences Research Ethics Committee at the University of Bristol (reference: 102642). Informed consent was obtained from all participants prior to participating in accordance with the Declaration of Helsinki.

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Authors' contributions

EA led the study as Principal Investigator. EA, AB, AD and JI conceived the idea for the study. Ethics approval was sought by AB with support from EA, AD and JI. Data were collected by EA, AB, AD, JI and ES. Analyses were undertaken by EA, AB and ES, and data were interpreted with the support of all authors. EA led the manuscript drafting and all authors commented on and approved of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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