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Improving uptake of vaccines in pregnancy: A service evaluation of an antenatal vaccination clinic at a tertiary hospital in the UK

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ABSTRACT

Background: Vaccination against pertussis and seasonal influenza is recommended for all pregnant women in the UK. More recently COVID-19 vaccination has also been offered to women in pregnancy.
Objectives: To evaluate the uptake of vaccines in pregnant women within a midwife-led immunisation clinic and to assess factors influencing pregnant women's decisions about accepting vaccination.
Methods: Uptake of vaccines amongst pregnant women referred to a single UK centre for antenatal care between 01/01/19 and 02/10/19 was assessed. Interviews with 20 pregnant women explored views of antenatal vaccination and experiences of the vaccination service.
Findings: Amongst 4420 women, uptake was 90.6% for pertussis and 78.8% for influenza vaccines. Factors influencing vaccine-related decision-making amongst 20 interviewed women were: healthcare professional recommendation, perceived susceptibility and risk of infection, and previous experience of vaccination and vaccine-preventable disease.
Conclusions and Implications for Practice: Uptake of pertussis and influenza vaccines within a secondary care immunisation service was higher than the national or regional average. The model of vaccine delivery was associated with high levels of satisfaction. This model of vaccine delivery could be implemented elsewhere to increase vaccine uptake, and should be considered for delivery of COVID-19 vaccines in the future.

Background

Maternal vaccination

Young infants are vulnerable to severe disease and death if infected by Bordetella pertussis (the causative agent of pertussis [whooping cough]) (Vojtek et al., 2018). In 1999, there were an estimated 390,000 deaths from pertussis in children younger than five years globally (Crowcroft et al., 2003). This fell to 160,700 in 2014, largely due to increased vaccination against pertussis during pregnancy and infancy (Yeung et al., 2017).

Influenza infection during pregnancy puts pregnant women and their infants at greater risk of complications such as hospitalisation and death (Vojtek et al., 2018).

Maternal vaccination aims to increase the concentration of antibodies specific to pertussis and influenza in the mother to provide protection for the infant against severe disease and death during early life (Jones et al., 2018; Marchant et al., 2017; Vojtek et al., 2018). Maternal immunoglobulin G (IgG) antibodies are transferred across the placenta during gestation, increasing the antibody levels in the fetus. These antibodies provide protection to the infant during early life, when infants have inexperienced immune systems and are too young to receive vaccines (Argondizo-Correia et al., 2019; Vojtek et al., 2018).

All pregnant women in England are recommended to receive pertussis and seasonal influenza vaccines to protect the mother and infant from severe disease (Vojtek et al., 2018). The recommended window for pertussis vaccination is between 16- and 32-weeks' gestation (Joint Committee on Vaccination and Immunisation, 2016), while influenza vaccine should be given to any woman who is pregnant during the influenza season (Public Health England, 2014). More recently, women who are pregnant have been offered the COVID-19 vaccination, in line with recommendations

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for the population of a similar age (Public Health England, 2021a; Ueda et al., 2021).

Efficacy and safety of vaccines in pregnancy

Giving pertussis vaccine in pregnancy is safe both for the pregnant women and her fetus (Donegan et al., 2014; Kharbanda et al., 2014) and effectively protects infants from severe disease (Amirthalingam et al., 2014, 2016; Munoz et al., 2014). Influenza vaccine is also highly effective in protecting both pregnant women (Madhi and Nunes, 2018) and their infants (Madhi and Nunes, 2018; Omer et al., 2018) and has a good safety profile (Kharbanda et al., 2013; Ludvigsson et al., 2015; McMillan et al., 2015).

Vaccine uptake in pregnancy

Antenatal vaccine uptake is higher in the UK compared to many other countries with similar recommendations (Abu-Raya et al., 2020). In April 2015, pertussis vaccine uptake in England was 55.6%. There has been significant improvement since then, with uptake of 70.3% in 2019, however coverage reduced to 67.8% during 2020–2021 during the COVID pandemic (Public Health England, 2021b; Public Health England, 2020). There is still scope for further improvement in uptake, particularly amongst women from ethnic minorities.

Influenza vaccine uptake is undesirably low – uptake amongst pregnant women in the 2014–15 influenza season was 44.1% in England, with a marginal improvement to 45.2% in the 2018–19 season (Public Health England, 2019; Public Health England, 2015). There was a slight reduction in coverage to 43.6% in the 2020-2021 season (Public Health England, 2021c). Further strategies to increase uptake of influenza vaccine should be implemented in the UK.

Models of vaccine delivery

In most areas of England, antenatal vaccines are delivered within primary care, with arranging this appointment being the women's responsibility. This creates a logistical barrier to vaccination and reduces clarity of where responsibility for discussion of vaccination recommendations lies (Wilcox et al., 2019b). One strategy to improve antenatal vaccine uptake is midwife-led delivery of vaccines in routine antenatal care, since studies have shown an increase in willingness to be vaccinated amongst women offered vaccines by their antenatal care provider (Mohammed et al., 2018; Taksdal et al., 2013). Increasing numbers of National Health Service (NHS) trusts are now delivering vaccines in routine antenatal care (Llamas et al., 2020).

COVID-19 vaccines are currently being delivered in vaccine hubs, outside of maternity services, however with the anticipation that vaccines to protect the population against COVID are likely beyond the short-term, it is vital that we understand optimal models of delivery to best serve the needs of pregnant women. Other vaccines are currently progressing through clinical trials, including those to protect against group B Streptococcus (GBS) and respiratory syncytial virus (RSV), and so vaccination in pregnancy is increasingly becoming a vital way to protect women and infants against common infections (Heath et al., 2017).

The antenatal vaccination clinic at a tertiary hospital in the UK

In 2017, a clinic was set up at our tertiary hospital in the UK with the aim to improve uptake of pertussis and influenza vaccines in pregnancy, by offering vaccines alongside other antenatal appointments. Routine antenatal care visits are attended by most pregnant women, so targeting women in this setting provides a wide-reaching opportunity for education about maternal vaccination. The role of the midwife as the first contact for pregnant women supports the importance of midwife endorsement of maternal vaccination to address potential vaccine hesitancy or concerns regarding vaccination.

This service evaluation aimed to determine the uptake of vaccines in a midwife-led vaccination service, assess factors influencing pregnant women's decisions about accepting vaccination within the antenatal vaccination clinic, and identify how antenatal vaccination services could be improved.

Methods

Study setting

This study was carried out at a tertiary hospital which provides maternity care for about 5500 women each year. Data from the Vaccine Referral Database (a database containing records of vaccine referral, appointments and receipt for all women referred to our site for their antenatal care between 01/01/19 and 02/10/19) was analysed. Pregnant women receiving antenatal care at our site were interviewed. The process that the vaccination service follows is illustrated in Fig. 1.

Pregnant women are offered antenatal vaccination appointments by the vaccination team if they have not been offered or did not accept referral at booking appointment, giving an additional opportunity to promote antenatal vaccination. Vaccination appointments are arranged to coincide with routine antenatal appointments to make vaccination appointments more convenient for pregnant women.

Database analysis

Vaccine midwives and administrative staff regularly update the Vaccine Referral Database. Although all women who are referred to our site for antenatal care should be included in the database, women may be missing for reasons including: moving out of area, miscarriage, human error, unprocessed paper referral, referral through diabetes team, emergency referral or late referral.

Data from an anonymised version of the Vaccine Referral Database were deduplicated and recoded. Missing values were identified and the reasons for this missing data were identified as miscarriage, stillbirth, termination of pregnancy, moved away, or data entry for receipt of vaccine not entered at time of analysis. Missing data were excluded from analyses. Descriptive statistics, McNemar's test and chi squared tests were used to analyse data using SPSS Statistics. Statistical significance was inferred by a p value of less than 0.05.

Interview recruitment

Following permission from the midwives running clinics, pregnant women attending glucose tolerance test appointments were approached opportunistically by one of the investigators (KR) and asked to participate in a short interview to explore factors influencing their decision to accept or decline vaccines in pregnancy and their experience of the antenatal vaccination service. Recruitment through the glucose tolerance test clinic ensured women who had varying attitudes towards vaccination were interviewed. Participation was voluntary, and participants were made aware that their participation would not affect the care that they received. Participants were informed that the investigator was a medical student who was not involved in their care and that the interviews formed part of a student research project. Inclusion criteria were pregnant women who were over the age of 18, able to

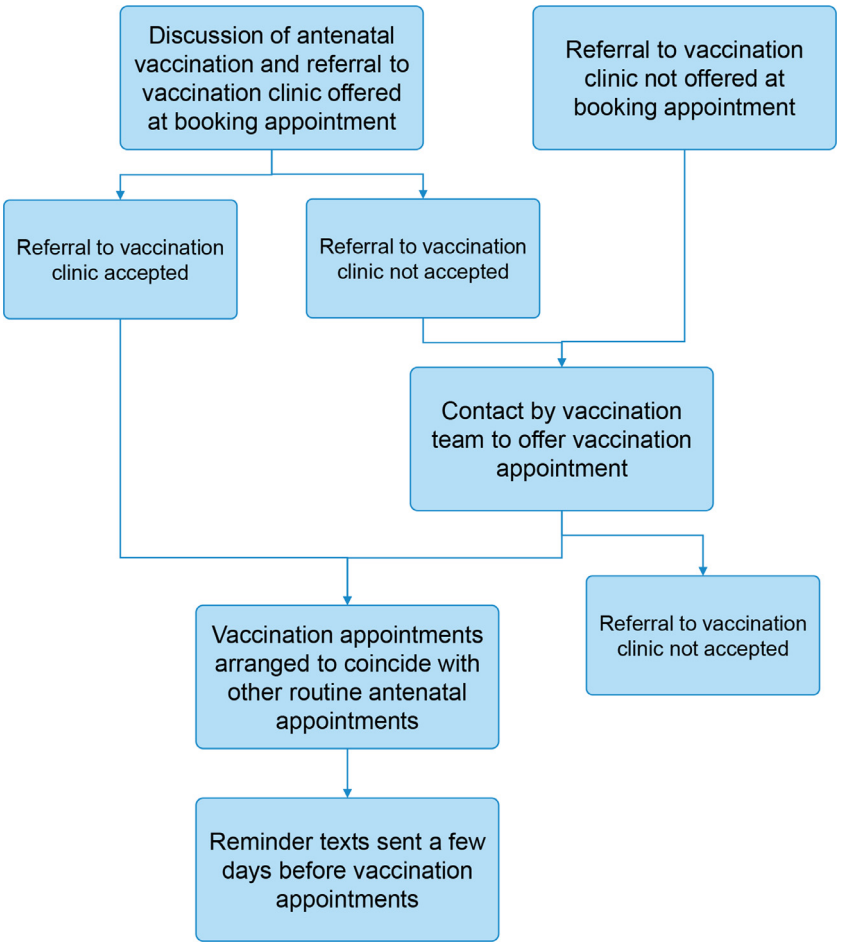

Fig. 1. Summary of the midwife-led antenatal vaccination service.

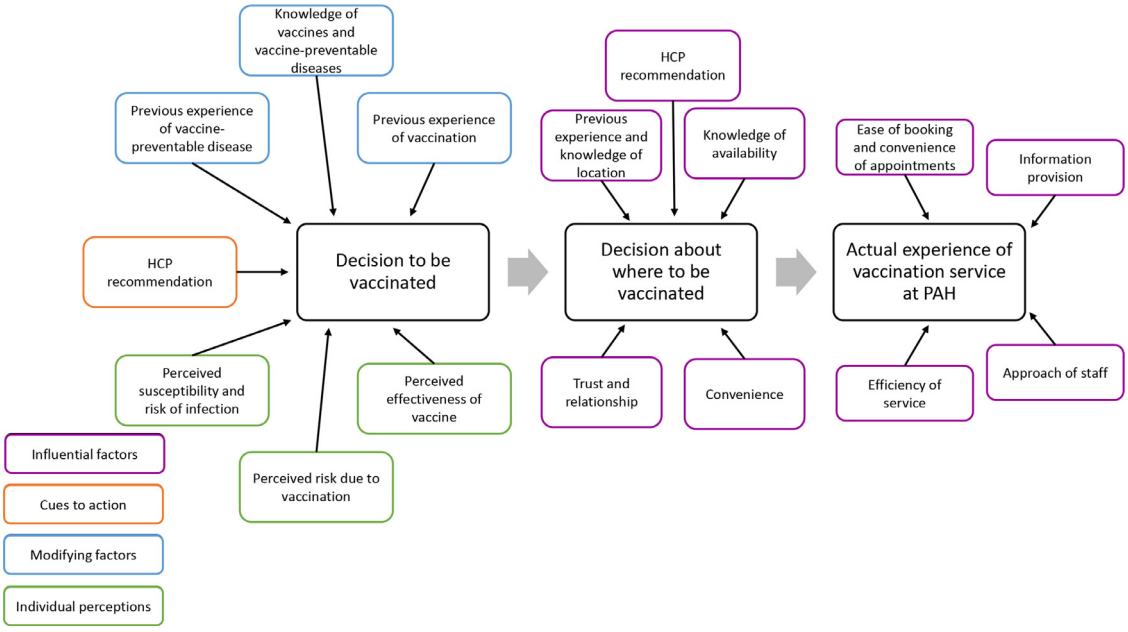

Fig. 2. Conceptual model of the decision-making process for vaccination in pregnancy.

Table 1
Pertussis and influenza vaccine uptake amongst women on the vaccine referral database and data missingness.

	Number of women who received vaccine	Number of women who did not receive vaccine	Number of women offered the vaccine	Missing data, n	Missing data of those who were offered the vaccine, n (%)
Pertussis vaccine	2506	261	4181	1653	1414 (33.8)
Influenza vaccine	1233	331	3705	2856	2141 (57.8)

For pertussis vaccine, the reasons for missing data were: pregnancy not yet completed ($n = 1414$), miscarriage ($n = 207$), stillbirth ($n = 1$), termination of pregnancy ($n = 16$), and moved away ($n = 15$).
For influenza vaccine, the reasons for missing data were: pregnancy not yet completed ($n = 2623$), miscarriage ($n = 203$), stillbirth ($n = 1$), termination of pregnancy ($n = 16$), and moved away ($n = 13$).

read and converse in English and able to give fully informed consent. Exclusion criteria for interviews were women in active labour or deemed acutely unwell or distressed. Interviews took place between 01/10/19 and 14/11/19. A total of 20 women were interviewed, as data collection was discontinued once data saturation was reached – defined as when additional interviews were not deemed likely to provide significant new information.

The interview guide (see Supplementary 1) was designed and used to facilitate the semi-structured interviews. Follow-up questions were allowed to provide further clarification of responses or to explore emerging themes or topics.

The interviews took place following written informed consent in a private area. Interviews were conducted by one investigator (KR, female). As the interviewer (KR) was a medical student with no credentials, the first interview was observed by a second investigator (RD, male) with a BMBS qualification to ensure that the interview was focused and carried out sensitively. Interviews took between 10 and 15 min per participant. Audio recordings were taken with permission and stored on university servers and deleted once analysis was complete. There was no follow-up of participants following the interview. No repeat interviews were carried out and transcripts were not returned to participants for comment or correction. Participants did not provide feedback on findings.

Interview analysis

Transcription and analysis were carried out by one investigator (KR). For analysis of participant demographics, where data was normally distributed, means were used and where data was not normally distributed, medians were used. Thematic analysis was carried out according to the six steps described by Braun and Clarke: familiarisation with the data, identification of initial codes, searching for themes, reviewing themes and subthemes, defining and naming themes and subthemes, and writing up the analysis (Braun and Clarke, 2006). The transcripts were coded line-by-line using NVivo software and initial themes were identified. Themes and subthemes were reviewed and defined. A second investigator (CJ) reviewed the themes and agreement was reached. Themes emerged from a review of all the transcripts. Themes were mapped to the Health Belief Model, which was selected a priori, because it is one of the most widely understood models of understanding health behaviours and includes constructs such as 'perceived threat' which are pertinent to vaccine-decision making and are not included in other models (e.g. Theory of Planned Behaviour and COM-B) (Coulson et al., 2016; Taylor et al., 2007). This enabled results to be structured and provided clarity of the themes. In the extracts, (…) indicates material has been omitted and material in square brackets [] was added for clarification by authors.

Results

Uptake of vaccines

Of the 4420 women on the Vaccine Referral Database, records of pertussis vaccine receipt were available for 2767 women, as some pregnancies were not yet completed. Of those women with completed pregnancies, 90.6% of women referred to our site for antenatal care received pertussis vaccine. 2434 (88.0%) women received pertussis vaccine at the vaccination clinic, 72 (2.6%) received pertussis vaccine elsewhere and 261 (9.4%) did not receive pertussis vaccine.

Records of influenza vaccine receipt were available for 1564 women. Of those women with completed pregnancies, 78.8% of women referred to our site for antenatal care received influenza vaccine. 725 (46.3%) women received influenza vaccine at the vaccination clinic, 508 (32.5%) received influenza vaccine elsewhere and 331 (21.2%) did not receive influenza vaccine. Table 1 presents the number of women who received each vaccine at any location, the number of women who did not receive each vaccine and the missing data.

Table 2
Demographic characteristics of interview participants.

Characteristic	Value ($N = 20$)
Mean age (years)	30.8
Median gestational age (weeks)	26.5
	No. (%)
Ethnicity	
White	13 (65)
Mixed or Multiple ethnic groups	2 (10)
Asian or Asian British	4 (20)
Black, African, Caribbean or Black British	0 (0)
Other ethnic group	1 (5)
Have they had children before?	
Yes	9 (45)
No	11 (55)
Receipt of pertussis vaccine	
Yes, at the vaccination clinic	17 (85)
Yes, elsewhere	1 (5)
No	2 (10)
Undecided	0 (0)
Receipt of influenza vaccine	
Yes, at the vaccination clinic	8 (40)
Yes, elsewhere	7 (35)
No	4 (20)
Undecided	1 (5)

Interview participant demographics

Between 01/10/19 and 14/11/19, 27 pregnant women were approached for participation in the study. Seven women declined (four did not have time, two did not speak English confidently and one felt unwell). A total of 20 pregnant women were interviewed.

Table 2 describes the interview participants' demographic characteristics.

Themes and subthemes emerged from the interviews, see Fig. 2 and Table 3.

Factors influencing decision to be vaccinated

Knowledge of vaccines and vaccine-preventable diseases

Trusted vaccine-positive sources of knowledge reported by pregnant women included healthcare professionals, family and friends and online forums.

Table 3
Themes and subthemes emerging from interviews.

Themes	Subthemes
Decision to be vaccinated	Knowledge of vaccines and vaccine-preventable diseases
	Previous experience of vaccine-preventable disease
	Previous positive experience of vaccination
	Previous negative experience of vaccination
	Perceived susceptibility and risk of infection
	Perceived risk due to vaccination
	Perceived effectiveness of vaccine
	Healthcare professional recommendation
Decision about where to be vaccinated	Convenience
	Knowledge of availability
	Previous experience and knowledge of location
	Trust and relationship with healthcare professional
Actual experience of vaccination clinic at our site	Information provision
	Ease of booking and convenience of appointments
	Efficiency of service
	Approach of staff

"I'm on a baby group app, and a lot of people are saying it's better to have [vaccines] than not… that kind of made me feel a bit better"

(P3 - Received pertussis at our site, intending to receive influenza at our site)

"My friends and my family were like if [healthcare professionals are] telling you to get it then you should get it… If other people didn't tell me to go get it, I wouldn't have got it."

(P16 - Received pertussis and influenza vaccines at our site)

Some online sources of information such as social media had a negative influence on women's decision to vaccinate.

"The opinions in social media, where everyone is trying to be natural… there's a lot of mums out there who are against vaccines for their kids… I suppose that influenced me because I was hearing more of the cons from them, and you think I really don't want developmental problems"

(P8 - Received pertussis vaccine at our site and intends to receive influenza vaccine at work)

Previous experience of vaccine-preventable disease

Pregnant women who had a previous negative experience of pertussis or influenza, either personally or a close family member, recognised the importance of maternal immunisation in protecting against disease.

"My two eldest… both had whooping cough, not seriously bad, but um it's not pleasant. So if you can protect them against it, it's always best to."

(P1 - Received pertussis and influenza vaccines at our site)

"Last year, I got the flu and it was really horrible, I was ill for two weeks, so I knew that I definitely didn't want to get the flu whilst being pregnant."

(P17 - Received pertussis vaccine at our site and influenza vaccine at GP surgery)

Previous personal experience of surviving pertussis infection contributed to beliefs that the disease is not life-threatening and therefore the vaccine is unnecessary.

"I don't feel like [whooping cough and influenza are] that serious… as a kid, I had whooping cough and I was fine, like I was absolutely fine… it's not life-threatening."

(P13 - Did not receive pertussis or influenza vaccines)

Previous positive experience of vaccination

Having previously received the influenza vaccine or family members doing so without experiencing side effects was also an incentivising factor.

"I've always been a bit concerned about the flu jab being a live vaccine, um, but my dad has to have one every year, and my mum's had one every year for the last couple of years, um, and knowing that they've not, sort of, suffered with anything… I feel fine having one."

(P5 - Received pertussis vaccine at our site and intends to receive influenza vaccine at GP surgery)

"I'd had it in my previous pregnancies, and I didn't have any side effects, I thought yeah, it'd be right for me to have it again."

(P20 - Received pertussis and influenza vaccines at our site)

Previous negative experience of vaccination

Fear of risk to the baby due to vaccination was influenced by negative experiences of vaccination amongst family members.

"I have a friend who had both vaccines in pregnancy and her child has got autism… That really scared me… it's caused her a considerable amount of upset and seeing her go through that really put me off."

(P10 - Did not receive pertussis or influenza vaccines)

Previous negative experience of influenza vaccination caused vaccine hesitancy.

"I've had one flu jab done in my entire life and I've had a bad experience after that, which I have to say my health, like flu-wise and cold-wise was worse after I've had that flu jab done. So I've had a concern [about having the influenza vaccine]"

(P19 - Received pertussis and influenza vaccines at our site)

Perceived susceptibility and risk of infection

Perceptions of pertussis infection tended to be more serious than those of influenza. Descriptions of pertussis included "dangerous", "fatal" and "scary", while influenza was described as "one of those things", "not that serious" and "really horrible". The desire of mothers to protect their baby and prioritise their baby's health encouraged vaccine acceptance.

"I would do anything to keep the baby safe, so if that means I need to have a vaccination, I'll do it… better to have it done, rather than later regret that something has happened."

(P19 - Received pertussis and influenza vaccines at our site)

Some pregnant women believed that a healthy lifestyle reduced their susceptibility of infection and that if they normally recovered quickly from illness then this would not be different in pregnancy, so vaccines in pregnancy are unnecessary. They referenced having had healthy children without vaccines previously.

"I've never suffered with [whooping cough], [the vaccine is] just really not something that I feel like I need whatsoever…. I live a healthy lifestyle, I eat healthily, I make sure I take all my vitamins. I'm doing everything right. I very rarely get sick, if I do, it's not like the end of the world."

(P13 - Did not receive pertussis or influenza vaccines)

"I have two healthy children without having had the vaccines… I know people who have had the vaccines and still have children that don't have great immune systems… we have our own immune systems that are designed naturally to fight infection… I don't see that the risks justify vaccinations."

(P10 - Did not receive pertussis or influenza vaccines)

Perceived risk due to vaccination

The most influential factor in vaccine hesitancy amongst women interviewed was fear of risk to the baby due to vaccination (e.g. birth defects and autism).

"I was really worried that after the birth there would be some defect, something would go wrong with the baby because there's these foreign bodies in them from the vaccines that I had… after speaking to my husband, reading the information, we realised that there could be worse consequences if we didn't have the vaccines."

(P8 - Received pertussis vaccine at our site and intends to receive influenza vaccine at work)

Perceived risk of influenza infection as a result of receiving the influenza vaccine caused vaccine hesitancy.

"Some people will get sick after they've had the [influenza] vaccine."

(P10 - Did not receive pertussis or influenza vaccines)

Perceived effectiveness of vaccine

Many women considered the vaccines to be effective and some reported that information given to them at their vaccination appointment confirmed this.

"[I was given] a simple information leaflet that just explained that it's not going to harm the baby, the fact that it helps them to develop antibodies and get stronger, and it won't harm me either… it says [the vaccine] will protect you, it will protect the baby, and make sure that they are able to fight off anything that tries to invade their system."

(P8 - Received pertussis vaccine at our site and intends to receive influenza vaccine at work)

The perception that influenza vaccines may not be effective due to inaccurate predictions of changes in virus strain discouraged influenza vaccine acceptance.

"Flu vaccines are vaccinations against a particular strain of flu, and it's kind of a guessing game because there might be a different strain, so it's not 100% guaranteed to protect you in any event."

(P10 - Did not receive pertussis or influenza vaccines)

Women who did not accept vaccines believed that the baby would receive sufficient antibodies (e.g. from breastmilk) without vaccines.

"I think the baby will get enough [antibodies] from like the milk… I don't really feel like I need [the vaccine]."

(P13 - Did not receive pertussis or influenza vaccines)

Healthcare professional recommendation

HCP recommendation was often pivotal in decision-making regarding maternal immunisation. Many participants who did not receive influenza vaccine were unaware of the recommendations for receipt during pregnancy due to lack of HCP recommendation.

"If it's recommended, then for me that's enough… [The midwife] put it in a way that was, this is recommended, um, and we encourage you to do it."

(P5 - Received pertussis vaccine at our site and intends to receive influenza vaccine at GP surgery)

"If the doctor, the midwife or health professional and the generalised thing is have the whooping cough vaccination… then I'm going to take it… I've not been offered [influenza vaccine] I don't think… But I would have it if I had."

(P6 - Received pertussis vaccine at our site and undecided about influenza vaccine)

Factors influencing decision about where to be vaccinated

Convenience

Convenience was the most important factor that encouraged receipt of vaccines at the vaccination clinic. The efficiency of the service was also an incentivising factor.

"[The vaccination service] was really convenient because, as I say, it coincided with my 20-week scan. It wasn't a long wait. Sometimes, you know, when you call your GP, they say "oh, 2 weeks!" and you think, it's too long… [The vaccination service] booked it in straight away. So it was fast, convenient, and the information was reliable."

(P8 - Received pertussis vaccine at our site and intends to receive influenza vaccine at work)

"I like the fact that you do it when you have your 20-week scan so it all, it's not an extra appointment you have to specifically come for… especially when you're working, to ask for time off for another maternity appointment, it can be quite difficult."

(P17 - Received pertussis vaccine at our site and influenza vaccine at GP surgery)

Conversely, benefits of vaccination at GP surgeries included walk-in clinics on Saturdays and free parking, while vaccination at work meant women didn't have to travel.

"[The GP surgery has] a walk-in centre, so we went in on a Saturday… I didn't have to take time out from work, so that was easier… [there was] free parking, and I was literally in and out within a minute, so yeah. It fitted my day more."

(P7 - Received pertussis vaccine at our site and influenza vaccine at GP surgery)

Knowledge of availability

Some women thought that influenza vaccines were only available at GP surgeries and workplaces.

"I thought it was GP and workplace… I didn't know flu vaccines were given in the vaccination clinic as well, I had no idea."

(P12 - Received pertussis vaccine at our site and influenza vaccine at work)

Lack of influenza vaccine stock at the vaccination clinic was another reason for receipt elsewhere.

"I've had whooping cough here and the flu jab at my doctor's surgery because they hadn't had the vaccines here, but I would've happily have had the flu one here as well."
(P17 - Received pertussis vaccine at our site and influenza vaccine at GP surgery)

Previous experience and knowledge of location

Previous positive experience of care and the good reputation of our site encouraged vaccine receipt at the vaccination clinic.

"I just find the staff very friendly. I feel at ease… They give you all the information you need, they explain everything if you don't understand it, they take time, you don't feel rushed, whereas I think in a GP you kind of do sometimes feel a bit rushed."
(P11 - Received pertussis and influenza vaccines at our site)

"I always choose [this hospital] because it's got a really good reputation… and when I had my first son here, they did a really good job of looking after me."
(P17 - Received pertussis vaccine at our site and influenza vaccine at GP surgery)

Trust and relationship with healthcare professional

Many women reported having a good relationship with their midwife and for some this was an encouraging factor to use the vaccination clinic.

"I feel like my midwife cares more than my GP… she's more like my friend than just a doctor. And I feel really comfortable with her as well, which is good… I trust her opinion more."
(P16 - Received pertussis and influenza vaccines at our site)

Actual experience of the vaccination service

Information provision

One suggestion for improvement was greater information provision through verbal discussion rather than written information alone. Information was not always given about influenza vaccine.

"The very first time you see a midwife, it's very new anyway. So to then be bombarded with leaflets about everything… trying to read them all at once is, yeah, a bit overwhelming."
(P5 - Received pertussis vaccine at our site and intends to receive influenza vaccine at GP surgery)

"I think [the information] was just whooping cough… I can't remember anything I've been given about the influenza one."
(P6 - Received pertussis vaccine at our site and undecided about influenza vaccine)

Ease of booking and convenience of appointments

Most women interviewed described booking as easy and flexible.

"It was very flexible basically… they choose the time that I, that was suitable for me not the time that they had free or what they allocated for me, so it was convenient."
(P15 - Received pertussis and influenza vaccines at our site)

Increased availability of appointments outside working hours was a suggested improvement of the service.

"[I would prefer to have appointments] later in the day or really early in the morning… so I don't have to take the day off work, because I think it's from 9 o'clock until 5 or 4, something like that, the appointments."
(P20 - Received pertussis and influenza vaccines at our site)

Efficiency of service

Most women described the clinic as efficient and easy to find. Interviewees found the reminder texts helpful.

"[At the GP,] I had to wait about forty-five minutes just to get my flu jab… I've never had to wait a long time for my appointments here, which is good… I thought [the reminder text] was good because I'm really forgetful."
(P16 - Received pertussis and influenza vaccines at our site)

Approach of staff

The friendly approach of staff was praised, although one woman stated feeling rushed.

"The ladies that did it were so nice and so understanding and very chatty… it's just a relaxed environment and all of my worries about the vaccine seemed to disappear."
(P8 - Received pertussis vaccine at our site and intends to receive influenza vaccine at work)

"The lady who did it was really nice. She spoke to me while she did it, asked me if I wanted to ask any questions, and she was quite talkative… Maybe, they rush them, but I understand that they probably have a lot of people, so I assume that's why they try and get them done quickly."
(P18 - Received pertussis and influenza vaccines at our site)

This framework was based on the Health Belief Model, which focuses on individual perceptions, modifying factors and cues to action when considering reasons for health behaviours. The framework was used concurrently with interview transcripts to identify emerging themes during analysis.

Discussion

This study has shown the overall success of the antenatal vaccination clinic in improving uptake of pertussis and influenza vaccines. When compared to the national (England) and regional averages in 2019 (70.3% and 74.5%, respectively) (Public Health England, 2020), the pertussis vaccine uptake amongst women referred to our site for antenatal care significantly exceeds these figures at 90.6% overall and 88.0% in the vaccination clinic at our site. In the 2018-19 influenza season, national and regional average influenza vaccine uptake was 45.2% and 49.1%, respectively (Public Health England, 2019), and despite the uptake in the vaccination clinic at our site alone being comparable with these figures at 46.3%, the overall uptake amongst women receiving antenatal care at our site was 78.8%, significantly surpassing these averages. One reason for high uptake may be the additional contact by the vaccination team as part of the vaccination service at our site. Midwife endorsement and trust in the information given to women by their midwives encouraged vaccination amongst women interviewed. This is consistent with other studies where healthcare professional recommendation is reported as women's most trusted source of information and increases uptake of antenatal vaccines (Beel et al., 2013; Collins et al., 2014; Donaldson et al., 2015; Wiley et al., 2013; Winslade et al., 2017). Another factor which may have contributed to the high uptake in our study is the convenience of the vaccination service at our site when compared with receiving vaccines in primary care, which supports previous research that em-

bedding vaccination into routine antenatal care improves uptake (Mohammed et al., 2018; Taksdal et al., 2013). Understanding the sociodemographic characteristics of women who did not choose to be vaccinated would be beneficial to devise approaches to increase vaccine uptake, however sociodemographic data was not captured within the database, so this is outside the scope of this study. However, it is likely that lower vaccine coverage is found amongst women of non-White ethnicity, women for whom English is not their first language, and women from lower socioeconomic backgrounds (Campbell et al., 2015; Wilson, 2018; Wilson et al., 2015).

There are other centres that use similar models of vaccine delivery to our site. In 2017/18, 86 (61.0%) of the 141 maternity services in England delivered antenatal pertussis vaccines through various models including offering vaccines at routine appointments, offering vaccines opportunistically (e.g. at Day Assessment Units) and arranging additional appointments for vaccination (Llamas et al., 2020). However, of the maternity services with complete vaccine coverage data available, only 7.1% vaccinated more than 40% of pregnant women receiving antenatal care through their site (Llamas et al., 2020). Considering the importance of convenience in vaccine-related decision-making for pregnant women in our study, implementation of models similar to the vaccination clinic at our site (in which vaccines are offered at routine appointments) is likely to improve uptake of vaccines in maternity services. With the introduction of COVID-19 vaccines in pregnancy, similar midwife-led models of vaccine delivery should also be considered to increase uptake of COVID-19 vaccines amongst pregnant women.

Interviewees highlighted that the most important factors in vaccine-related decision-making in pregnancy are healthcare professional recommendation, perceived susceptibility and risk of infection and previous experience of vaccination and vaccine-preventable disease. Women prioritised their baby's health over their own, and since influenza was considered to be a disease affecting the mother while pertussis was seen as affecting the baby, pertussis was perceived as a greater threat, providing an explanation for why receipt of pertussis vaccine was higher than that of influenza. This supports the findings of previous interview studies (Wiley et al., 2015, 2013; Winslade et al., 2017). In addition, the perception that influenza vaccine can cause influenza infection, particularly amongst women who had previous negative experience after receiving influenza vaccine, caused vaccine hesitancy, which corroborates previous research (Collins et al., 2014). While previous positive experiences of vaccination encouraged vaccine acceptance, negative experiences discouraged vaccination amongst participants, due to fear of perceived risks such as autism and birth defects. The influence of previous experiences on vaccine hesitancy has been seen in qualitative studies (Collins et al., 2014; Donaldson et al., 2015; Wiley et al., 2013). Some of these concerns stemmed from online websites, where inaccurate articles criticising the safety and efficacy of vaccines persist (Wilcox et al., 2018), illustrating the need for information provision by midwives to refute misconceptions arising from these sources. The belief that a healthy lifestyle and fast recovery from illness pre-pregnancy reduce susceptibility and risk of infection in pregnancy were stated as reasons for vaccine hesitancy amongst women in our study, supporting findings of previous studies (Collins et al., 2014; Donaldson et al., 2015).

Most women were satisfied with the vaccination service; however, the most common suggestion for improvement was increased information provision. Many women felt that written information was not detailed enough, and that verbal discussion by midwives at booking appointment was needed to reinforce written information. A survey from London found that 78.8% of women who received pertussis vaccine during pregnancy reported healthcare professional recommendation as a reason, although only 30.8% of vaccinated women could name the vaccine that they had received, indicating that education of mothers regarding vaccination must be improved (Donaldson et al., 2015). There is evidence that midwives do not feel confident discussing vaccination (Vishram et al., 2018; Webb et al., 2014; Wilcox et al., 2019a), so training for midwives in discussing antenatal vaccination could result in more consistent information provision. Some women did not receive information until their vaccination appointment and felt that this was too late, showing the importance of education at the booking appointment. Many women were not offered referral to clinic at booking appointment, illustrating the value of additional contact by the vaccination service in increasing vaccine acceptance and the need to increase referral rates at booking appointment.

Strengths and limitations

One limitation of this study was that data on vaccine receipt was missing for some women because the data was collected before their vaccination appointments had taken place. The amount of missing data was particularly high for influenza vaccines, as the 2019/2020 influenza season had only just begun. In addition, some women who received antenatal care at our site were not included in the Vaccine Referral Database (e.g. due to human error or alternative referral process), although this figure is likely to be relatively low, estimated at 8.55%. The addition of date of last menstrual period to the database would facilitate an assessment of whether women are receiving pertussis vaccine in the correct timeframe.

Recruitment of participants for interviews through the GTT clinic may limit the generalisability of our findings. Women who attend the GTT clinic may have a greater exposure to healthcare professionals and greater number of healthcare visits, so our findings may not be generalisable to the general population of pregnant women. However, at the tertiary hospital where this study was carried out, there are broad criteria for performing a GTT. As a result, the population of women attending the GTT clinic is likely to be similar to the wider population of women receiving antenatal care at the tertiary hospital.

The short timeframe of this study resulted in a small sample of interview participants who declined vaccination. However, this was reflective of the high uptake of vaccines amongst women receiving antenatal care at our site. Interviewees were taken from a self-selecting population, so were more likely to engage with health behaviours such as vaccination. A strength of this study was that participants included women who had not used the vaccination service, although intention regarding vaccination may have changed after interview so participant demographics could be inaccurate.

Conclusions

There is a need for improved uptake of vaccines in pregnancy worldwide. The antenatal vaccination clinic at our site has achieved uptake much greater than national and regional averages for pertussis and influenza vaccines. This model of vaccine delivery could be implemented elsewhere to increase vaccine uptake. Healthcare professional recommendation is an important factor in vaccine-related decision-making in pregnancy, so consistent information provision and recommendation by midwives should be implemented. Ensuring influenza vaccine is in stock right at the beginning of influenza season and offering appointments outside of working hours should also be an objective of vaccination services. After these improvements are made, vaccination services such as our site should be re-evaluated. Vaccine-hesitant women should be particularly targeted in future interview studies to gain a greater understanding of factors discouraging vaccination. These findings are highly applicable to the roll out of COVID-19 vaccines which

includes pregnant women in the UK. Maternity service-based models of vaccine delivery should be considered to increase uptake of the COVID-19 vaccines in pregnancy, particularly if there is a need for an ongoing programme of vaccination against COVID-19 in the mid- to long-term.

Reflective questions

(1) What vaccination services are available to pregnant women in your area and how do these services integrate into routine antenatal care?
(2) How could the delivery of vaccines to pregnant women be improved in your area?
(3) What information about vaccination in pregnancy is important to give to pregnant women considering vaccination? Do you need further information yourself in order to effectively provide counselling to pregnant women?
(4) What factors might encourage or discourage women to receive vaccines in pregnancy?
(5) If COVID-19 vaccines are needed in the longer-term, what do you consider to be the best ways for women to access these vaccines, for example: in primary care, secondary care, pharmacies, vaccine hubs, pop-up locations – or should a combination of locations be used?

Ethical approval

Ethical approval for this study was granted by the Faculty of Medicine Ethics Committee at the University of Southampton (ERGO ID: 49414). As this study was a service evaluation, it did not require NHS ethics.

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Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Kate MI Ralph and Robert B Dorey declare no competing financial interests or personal relationships that could have influenced the work reported in this paper. Rebecca Rowe declares no competing financial interests however is affiliated with the setting up and running of the vaccination service which this article is based upon. Christine E Jones runs clinical trials of vaccines in pregnancy funded by vaccine manufactures, including Pfizer and Novavax, all funding is paid to her institution. She has received payment from Pfizer, MSD and Sanofi Pasteur for consultancy or advisory boards related to vaccination in pregnancy.

CRediT authorship contribution statement

Kate MI Ralph: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization. **Robert B Dorey:** Supervision, Writing – review & editing. **Rebecca Rowe:** Conceptualization, Resources. **Christine E Jones:** Conceptualization, Methodology, Supervision, Writing – review & editing.

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Supplementary materials

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References

Abu-Raya, B., Maertens, K., Edwards, K.M., Omer, S.B., Englund, J.A., Flanagan, K.L., Snape, M.D., Amirthalingam, G., Leuridan, E., Damme, P.V., Papaevangelou, V., Launay, O., Dagan, R., Campins, M., Cavaliere, A.F., Frusca, T., Guidi, S., O'Ryan, M., Heininger, U., Tan, T., Alsuwaidi, A.R., Safadi, M.A., Vilca, L.M., Wanlapakorn, N., Madhi, S.A., Giles, M.L., Prymula, R., Ladhani, S., Martinón-Torres, F., Tan, L., Michelin, L., Scambia, G., Principi, N., Esposito, S., 2020. Global perspectives on immunization during pregnancy and priorities for future research and development: an international consensus statement. Front. Immunol. doi:10.3389/fimmu.2020.01282.

Amirthalingam, G., Andrews, N., Campbell, H., Ribeiro, S., Kara, E., Donegan, K., Fry, N.K., Miller, E., Ramsay, M., 2014. Effectiveness of maternal pertussis vaccination in England: an observational study. Lancet 384, 1521–1528. doi:10.1016/S0140-6736(14)60686-3.

Amirthalingam, G., Campbell, H., Ribeiro, S., Fry, N.K., Ramsay, M., Miller, E., Andrews, N., 2016. Sustained effectiveness of the maternal pertussis immunization program in England 3 years following introduction. Clin. Infect. Dis. 63, S236–S243. doi:10.1093/cid/ciw559.

Argondizo-Correia, C., Rodrigues, A.K.S., De Brito, C.A., 2019. Neonatal immunity to bordetella pertussis infection and current prevention strategies. J. Immunol. Res. doi:10.1155/2019/7134168.

Beel, E.R., Rench, M.A., Montesinos, D.P., Mayes, B., Healy, C.M., 2013. Knowledge and attitudes of postpartum women toward immunization during pregnancy and the peripartum period. Hum. Vaccines Immunother. 9, 1926–1931. doi:10.4161/hv.25096.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3, 77–101. doi:10.1191/1478088706QP063OA.

Campbell, H., Jan Van Hoek, A., Bedford, H., Craig, L., Yeowell, A.-L., Green, D., Yarwood, J., Ramsay, M., Amirthalingham, G., 2015. Attitudes to immunisation in pregnancy among women in the UK targeted by such programmes. British Journal of Midwifery 23, 566–573. doi:10.12968/BJOM.2015.23.8.566.

Collins, J., Alona, I., Tooher, R., Marshall, H., 2014. Increased awareness and health care provider endorsement is required to encourage pregnant women to be vaccinated. Hum. Vaccines Immunother. 10, 2922–2929. doi:10.4161/21645515.2014.971606.

Coulson, N.S., Ferguson, M.A., Henshaw, H., Heffernan, E., 2016. Applying theories of health behaviour and change to hearing health research: time for a new approach. International Journal of Audiology doi:10.3109/14992027.2016.1161851.

Crowcroft, N.S., Stein, C., Duclos, P., Birmingham, M., 2003. How best to estimate the global burden of pertussis? Lancet Infect. Dis. doi:10.1016/S1473-3099(03)00669-8.

Donaldson, B., Jain, P., Holder, B.S., Lindsay, B., Regan, L., Kampmann, B., 2015. What determines uptake of pertussis vaccine in pregnancy? A cross sectional survey in an ethnically diverse population of pregnant women in London. Vaccine 33, 5822–5828. doi:10.1016/j.vaccine.2015.08.093.

Donegan, K., King, B., Bryan, P., 2014. Safety of pertussis vaccination in pregnant women in UK: observational study. BMJ 349. doi:10.1136/bmj.g4219, (Online).

Heath, P.T., Culley, F.J., Jones, C.E., Kampmann, B., Le Doare, K., Nunes, M.C., Sadarangani, M., Chaudhry, Z., Baker, C.J., Openshaw, P.J.M., 2017. Group B streptococcus and respiratory syncytial virus immunisation during pregnancy: a landscape analysis. Lancet Infect. Dis. 17, e223–e234. doi:10.1016/S1473-3099(17)30232-3.

Joint Committee on Vaccination and Immunisation, 2016. Minutes of the meeting held February 2016. Public Health England. URL https://app.box.com/s/iddfb4ppwkmtjusir2tc/file/229171963867 (accessed 9.18.19).

Jones, C.E., Calvert, A., Le Doare, K., 2018. Vaccination in pregnancy-recent developments. Pediatr. Infect. Dis. J. 37, 191–193. doi:10.1097/INF.0000000000001822.

Kharbanda, E.O., Vazquez-Benitez, G., Lipkind, H., Naleway, A., Lee, G., Nordin, J.D., 2013. Inactivated influenza vaccine during pregnancy and risks for adverse obstetric events. Obstet. Gynecol. 122, 659–667. doi:10.1097/AOG.0b013e3182a1118a.

Kharbanda, E.O., Vazquez-Benitez, G., Lipkind, H.S., Klein, N.P., Cheetham, T.C., Naleway, A., Omer, S.B., Hambidge, S.J., Lee, G.M., Jackson, M.L., McCarthy, N.L., DeStefano, F., Nordin, J.D., 2014. Evaluation of the association of maternal pertussis vaccination with obstetric events and birth outcomes. JAMA J. Am. Med. Assoc. 312, 1897–1904. doi:10.1001/jama.2014.14825.

Llamas, A., Amirthalingam, G., Andrews, N., Edelstein, M., 2020. Delivering prenatal pertussis vaccine through maternity services in England: what is the impact on vaccine coverage? Vaccine 38, 5332–5336. doi:10.1016/j.vaccine.2020.05.068.

Ludvigsson, J.F., Ström, P., Lundholm, C., Cnattingius, S., Ekbom, A., Örtqvist, Å., Feltelius, N., Granath, F., Stephansson, O., 2015. Maternal vaccination against H1N1 influenza and offspring mortality: population based cohort study and sibling design. BMJ 351, h5585. doi:10.1136/bmj.h5585.

Madhi, S.A., Nunes, M.C., 2018. Experience and challenges on influenza and pertussis vaccination in pregnant women. Hum. Vaccines Immunother. doi:10.1080/21645515.2018.1483810.

Marchant, A., Sadarangani, M., Garand, M., Dauby, N., Verhasselt, V., Pereira, L., Bjornson, G., Jones, C.E., Halperin, S.A., Edwards, K.M., Heath, P., Openshaw, P.J., Scheifele, D.W., Kollmann, T.R., 2017. Maternal immunisation: collaborating with mother nature. Lancet Infect. Dis. 17, 197–208. doi:10.1016/S1473-3099(17)30229-3.

McMillan, M., Porritt, K., Kralik, D., Costi, L., Marshall, H., 2015. Influenza vaccination during pregnancy: a systematic review of fetal death, spontaneous abortion, and congenital malformation safety outcomes. Vaccine doi:10.1016/j.vaccine.2015.02.068.

Mohammed, H., Clarke, M., Koehler, A., Watson, M., Marshall, H., 2018. Factors associated with uptake of influenza and pertussis vaccines among pregnant women in South Australia. PLoS One 13, e0197867. doi:10.1371/journal.pone.0197867.

Munoz, F.M., Bond, N.H., Maccato, M., Pinell, P., Hammill, H.A., Swamy, G.K., Walter, E.B., Jackson, L.A., Englund, J.A., Edwards, M.S., Healy, C.M., Petrie, C.R., Ferreira, J., Goll, J.B., Baker, C.J., 2014. Safety and immunogenicity of tetanus diphtheria and acellular pertussis (Tdap) immunization during pregnancy in mothers and infants: a randomized clinical trial. JAMA J. Am. Med. Assoc. 311, 1760–1769. doi:10.1001/jama.2014.3633.

Omer, S.B., Clark, D.R., Aqil, A.R., Tapia, M.D., Nunes, M.C., Kozuki, N., Steinhoff, M.C., Madhi, S.A., Wairagkar, N., 2018. Maternal influenza immunization and prevention of severe clinical pneumonia in young infants: analysis of randomized controlled trials conducted in Nepal, Mali and South Africa. Pediatr. Infect. Dis. J. 37, 436–440. doi:10.1097/INF.0000000000001914.

Public Health England, 2021a. COVID-19 vaccination: a guide for all women of childbearing age, pregnant or breastfeeding - GOV.UK [WWW Document]. URL: https://www.gov.uk/government/publications/covid-19-vaccination-women-of-childbearing-age-currently-pregnant-planning-a-pregnancy-or-breastfeeding/covid-19-vaccination-a-guide-for-women-of-childbearing-age-pregnant-planning-a-pregnancy-or-breastfeeding (accessed 7.13.21).

Public Health England, 2021b. Pertussis vaccination programme for pregnant women update: vaccine coverage in England, January to March 2021 and 2020 to 2021 annual coverage. Health Protection Report 15(9).

Public Health England, 2021c. Seasonal influenza vaccine uptake in GP patients: winter season 2020 to 2021. Health Protection Report.

Public Health England, 2014. Influenza vaccine in pregnancy: advice for healthcare professionals. URL https://www.gov.uk/government/publications/influenza-vaccination-in-pregnancy-advice-for-healthcare-professionals (accessed 7.13.21).

Public Health England, 2015. Seasonal influenza vaccine uptake amongst GP patients in England: final monthly data for 1 September 2014 to 31 January 2015. Health Protection Report.

Public Health England, 2019. Seasonal influenza vaccine uptake in GP patients: winter season 2018 to 2019. Health Protection Report.

Public Health England, 2020. Prenatal pertussis coverage estimates by area team and clinical commissioning group: England, July to September 2020. URL https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/940012/Pertussis_maternal_uptake_Q2_data.ods.

Taksdal, S.E., Mak, D.B., Joyce, S., Tomlin, S., Carcione, D., Armstrong, P.K., Effler, P.V., 2013. Predictors of uptake of influenza vaccination-a survey of pregnant women in Western Australia. Aust. Fam. Phys. 42, 582–586.

Taylor, D., Bury, M., Campling, N., Carter, S., Garfied, S., Newbould, J., Rennie, T., 2007. A Review of the use of the Health Belief Model (HBM), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Trans-Theoretical Model (TTM) to study and predict health related behaviour change. National Institute of Health and Care Excellence.

Ueda, R., Okada, T., Kita, Y., Ozawa, Y., Inoue, H., Shioda, M., Kono, Y., Kono, C., Nakamura, Y., Amemiya, K., Ito, A., Sugiura, N., Matsuoka, Y., Kaiga, C., Kubota, M., Ozawa, H., 2021. The quality of life of children with neurodevelopmental disorders and their parents during the Coronavirus disease 19 emergency in Japan. Sci. Rep. 11, 3042. doi:10.1038/s41598-021-82743-x.

Vishram, B., Letley, L., Jan Van Hoek, A., Silverton, L., Donovan, H., Adams, C., Green, D., Edwards, A., Yarwood, J., Bedford, H., Amirthalingam, G., Campbell, H., 2018. Vaccination in pregnancy: attitudes of nurses, midwives and health visitors in England. Hum. Vaccines Immunother. 14, 179–188. doi:10.1080/21645515.2017.1382789.

Vojtek, I., Dieussaert, I., Doherty, T.M., Franck, V., Hanssens, L., Miller, J., Bekkat-Berkani, R., Kandeil, W., Prado-Cohrs, D., Vyse, A., 2018. Maternal immunization: where are we now and how to move forward? Ann. Med. doi:10.1080/07853890.2017.1421320.

Webb, H., Street, J., Marshall, H., 2014. Incorporating immunizations into routine obstetric care to facilitate Health Care Practitioners in implementing maternal immunization. Hum. Vaccines Immunother. 10, 1114–1121. doi:10.4161/hv.27893.

Wilcox, C.R., Bottrell, K., Paterson, P., Schulz, W.S., Vandrevala, T., Larson, H.J., Jones, C.E., 2018. Influenza and pertussis vaccination in pregnancy: portrayal in online media articles and perceptions of pregnant women and healthcare professionals. Vaccine 36, 7625–7631. doi:10.1016/j.vaccine.2018.10.092.

Wilcox, C.R., Calvert, A., Metz, J., Kilich, E., MacLeod, R., Beadon, K., Heath, P.T., Khalil, A., Finn, A., Snape, M.D., Vandrevala, T., Nadarzynski, T., Coleman, M.A., Jones, C.E., 2019a. Determinants of influenza and pertussis vaccination uptake in pregnancy: a multicenter questionnaire study of pregnant women and healthcare professionals. Pediatr. Infect. Dis. J. 38, 625–630. doi:10.1097/INF.0000000000002242.

Wilcox, C.R., Woodward, C., Rowe, R., Jones, C.E., 2019b. Embedding the delivery of antenatal vaccination within routine antenatal care: a key opportunity to improve uptake. Hum. Vaccine Immunother. 1–4. 10.1080/21645515.2019.1640558

Wiley, K.E., Massey, P.D., Cooper, S.C., Wood, N., Quinn, H.E., Leask, J., 2013. Pregnant women's intention to take up a post-partum pertussis vaccine, and their willingness to take up the vaccine while pregnant: a cross sectional survey. Vaccine 31, 3972–3978. doi:10.1016/j.vaccine.2013.06.015.

Wiley, K.E., Cooper, S.C., Wood, N., Leask, J., 2015. Understanding pregnant women's attitudes and behavior toward influenza and pertussis vaccination. Qual. Health Res. 25, 360–370. doi:10.1177/1049732314551061.

Wilson, R.J., Paterson, P., Jarrett, C., Larson, H.J., 2015. Understanding factors influencing vaccination acceptance during pregnancy globally: a literature review. Vaccine 33, 6420–6429. doi:10.1016/j.vaccine.2015.08.046.

Wilson, R., 2018. I said no for a reason": Understanding factors influencing vaccination acceptance during pregnancy in Hackney. PhD thesis, London School of Hygiene and Tropical Medicine, London https://doi.org/10.17037/PUBS.04647005.

Winslade, C.G., Heffernan, C.M., Atchison, C.J., 2017. Experiences and perspectives of mothers of the pertussis vaccination programme in London. Public Health 146, 10–14. doi:10.1016/j.puhe.2016.12.018.

Yeung, K.H.T., Duclos, P., Nelson, E.A.S., Hutubessy, R.C.W., 2017. An update of the global burden of pertussis in children younger than 5 years: a modelling study. Lancet Infect. Dis. 17, 974–980. doi:10.1016/S1473-3099(17)30390-0.