

Pertussis vaccination of pregnant women: a mixed methods study investigating uptake and its associated factors (PREVACOQ-2.1)

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Abstract

Background

Despite high pertussis vaccination coverage rates in infants, pertussis evolves in high-income countries in epidemic cycles, causing an upsurge in hospitalisations and even mortality, especially in children under six months of age. Pertussis vaccination of pregnant women, the complementary vaccination measure encouraged by the World Health Organization in 2012, has been recommended in France since 2022. This study aims to measure pertussis vaccination uptake among pregnant women in Loire-Atlantique, and to highlight the barriers to and drivers of this strategy.

Methods

This mixed-methods study included a cross-sectional survey and interviews amongst women having recently given birth in three maternity wards. Vaccination status and sociodemographic data were collected face-to-face and semi-structured interviews were conducted among a sample of women. Descriptive statistics and multivariate analysis of the sociodemographic factors associated with vaccination were performed to analyse quantitative data; thematic analyses were applied to qualitative data.

Results

A total of 388 participants were included in the study between March and September 2024. Of these, 306 had received a pertussis vaccine during pregnancy, representing an estimated vaccination coverage of 79% (95% confidence interval (CI), 74–83%), while vaccination coverage rates for influenza and for Covid-19 were 37% (145/388) and 16% (61/388), respectively. Multivariate analysis revealed that primiparity, a high level of education, and influenza vaccination were associated with pertussis vaccination (odds ratios (OR), 2.64 [95% CI, 1.47–4.90], 1.82 [95% CI, 1.03–3.23], and 5.64 [95% CI, 2.79–12.6], respectively). The qualitative data suggested that the benefits for themselves and their infants were important factors in the women's decision to be vaccinated, but emphasised that they needed more information about vaccines in order to make that choice and be confident about their decision.

Conclusion

Two years after the national vaccination recommendation, the pertussis vaccination uptake rate among pregnant women in Loire-Atlantique is high. The favourable factors and barriers identified offer avenues for improving vaccination coverage among pregnant women, particularly those identified as more hesitant, and for facilitating dialogue with healthcare professionals involved in antenatal care.

Clinical trial number

Not applicable

Background

Pertussis is an endemic and potentially fatal disease with most deaths occurring before the age of six months. Even when vaccination coverage rates are over 90% for the administration of three doses by the age of 12 months, there remains a number of pertussis cases and deaths in the population that are difficult to reduce [1]. A particularly widespread outbreak in 2011–2012 affected numerous countries, prompting the 2012 WHO recommendation for maternal vaccination [2].

In France, the RENACOQ network recorded an average of 137 hospitalisations per year among children under one year of age between 2013 and 2024, as well as 21 deaths, with outbreaks occurring every 3 to 5 years despite high vaccination coverage and the ‘cocooning’ strategy [3]. Following a severe outbreak in Mayotte in 2018, in a context of low vaccination coverage, maternal vaccination was recommended in this overseas department and region [4]. It was not until 2022 that this strategy was extended to the whole of France, with the French Health Agency (HAS) recommending that pregnant women be vaccinated between the 20th and 36th weeks of pregnancy, regardless of their vaccination status [5]. This recommendation took into account the results of the PREVACOQ acceptability regional study, carried out in 2017 [6].

The main objective of the PREVACOQ-2.1 study was to assess pertussis vaccination coverage among pregnant women in the Loire-Atlantique department in north-western France and to explore facilitators and barriers to that vaccination.

Methods

Study design and population

This multicentre study was conducted in three of the six maternity wards in the Loire-Atlantique department: Nantes University Hospital, Clinique Santé Atlantique and Saint-Nazaire Hospital (9,700 births per year, representing 80% of births in this geographical area).

The quantitative part consisted of a short structured questionnaire administered to women over 18 years who had recently given birth to a live child, and who were able to respond, either alone or in the presence of their partner.

Participants for the qualitative study were selected from the quantitative cohort. In addition to previous eligibility criteria, the women interviewed had to be French-speaking.

Outcomes

The primary outcome of the quantitative part was to estimate pertussis vaccination coverage during pregnancy in Loire-Atlantique. Women were considered to have been vaccinated at the appropriate time if the vaccine was administered between weeks 16 and 36 of gestation and at least four weeks before delivery.

The secondary outcomes were estimating influenza and Covid-19 vaccination coverage, and identifying factors associated with pertussis vaccination.

Data collection

Each researcher (CLG and MB) visited two of the three maternity wards on a rotating basis, one day in seven, for six months. All postpartum women were systematically invited to participate in the study. Women were interviewed individually, face-to-face, by one of the two investigators about vaccines administered during pregnancy and socio-demographic characteristics. Data collection for vaccines was based on self-reporting, but supported by written evidence when available. Data was then entered into an Excel anonymous database.

Data collection for the qualitative part consisted of semi-structured interviews conducted by the same two investigators until data saturation was reached. An interview guide, which was developed for this study and comprising the following seven open-ended questions was used and adapted during the interviews: 1) What are your past experiences of vaccination? 2) What is your general opinion on vaccination, and have you had the opportunity to express it? 3) Which vaccines were offered to you during your pregnancy? 4) What do you know about childhood illnesses? 5) What was your reaction when you were offered the vaccination? 6) If you were to become pregnant again, what might make you change your mind? 7) Is there anything you would like to share today, or do you have any questions? The complete interview guide is provided in the supplementary file. The interviews were carried out in settings and at a time convenient to participants. After receiving a brief reminder about the study, the women provided written consent, after which the interview was conducted and audio-recorded.

Sample size, data management and statistical analysis

For the quantitative study, the number of subjects needed, calculated based on the size of the source population for a margin of error of 5%, a confidence level of 95% and a hypothetical vaccination coverage rate of 50%, was 385.

Missing data were identified as such. Descriptive and analytical statistics were performed using R statistical software (version 4.4.1, R Foundation for Statistical Computing, Vienna, Austria). Factors associated with maternal pertussis immunization were first assessed with univariate logistic regression analyses. Variables associated with vaccination uptake with $p < 0.20$ in univariate analysis were entered

into multiple logistic regression models, both without and with statistical interaction analyses. A p-value of less than 0.05 was considered statistically significant.

Qualitative data were analysed thematically. The interviews were audio-recorded and transcribed verbatim manually. An inductive thematic analysis was conducted independently by two researchers, following Braun & Clarke's analysis model [7], with discrepancies resolved through discussion. This process continued until data saturation was reached, *i.e.* until no new themes, concepts, or ideas emerged from the data.

Results

Quantitative part

Study period and description of inclusions

The study was conducted from 30 April to 30 October 2024. A total of 414 women having given birth to a live child were approached in maternity units, and 388 of them were included. The reasons for non-participation in the study were a verbal refusal by the patient herself or a 'Do Not Disturb' sign on her door (24 women). Two women were ineligible as they were under 18 years of age. There were no missing data in this part.

Description of the population

The socio-demographic characteristics and obstetrical histories of all women and women by centre are detailed in Table 1. Overall, there were no significant differences in terms of age and obstetrical history between the women studied at the three maternity hospitals; they were representative of the overall population of young mothers in Loire-Atlantique [8]. By contrast, the three centres differed significantly in terms of country of birth, level of education and professional activity.

Table 1
Characteristics of postpartum women, overall and by centre

Variables	Nantes n = 128 ¹	Santé Atlantique, n = 131 ¹	Saint- Nazaire, n = 129 ¹	Overall n = 388 ¹	p- value ²
Age (years, median and IQR)	31 (27.8–34)	31 (28–35)	31 (27–34)	31 (27–35)	0.4
Child rank					> 0.9
1	54 (42)	57 (44)	57 (44)	168 (43)	
> 1	74 (58)	74 (56)	72 (56)	220 (57)	
Obstetrical history ³					0.3
No	97 (76)	94 (72)	87 (67)	278 (72)	
Yes	31 (24)	37 (28)	42 (33)	110 (28)	
Country of birth					< 0.001
France	66 (52)	114 (87)	101 (78)	281 (72)	
Abroad	62 (48)	17 (13)	28 (22)	107 (28)	
Education level					0.010
High school or below	62(49)	50(39)	56 (44)	168 (43)	
Foundation degree level	9 (7)	14 (11)	14 (11)	37 (9.5)	
Bachelor's degree	21 (16)	26 (20)	31 (24)	78 (20)	
Master's degree or higher	36 (28)	41 (31)	28 (22)	105 (27)	
Employment status					< 0.001
Employed	74 (58)	116 (89)	101 (78)	291 (75)	
Unemployed	54 (42)	15 (11)	28 (22)	97 (25)	
Pertussis vaccination					0.018
Yes	110 (86)	99 (76)	97 (75)	306 (79)	
No	18 (14)	32 (24)	32 (25)	82 (21)	
Offered pertussis vaccination					0.2
Yes	121 (95)	115 (88)	117 (91)	353 (91)	
No	7 (5.5)	16 (12)	12 (9.3)	35 (9)	

Variables	Nantes n = 128 ¹	Santé Atlantique, n = 131 ¹	Saint- Nazaire, n = 129 ¹	Overall n = 388 ¹	p- value ²
Influenza vaccination					< 0.001
Yes	49 (38)	63 (48)	33 (26)	145 (37)	
No	79 (62)	68 (52)	96 (74)	243 (63)	
Covid-19 vaccination					0.091
Yes	16 (12%)	28 (21%)	17 (13%)	61 (16%)	
No	112 (88%)	103 (79%)	112 (87%)	327 (84%)	
¹ Statistics presented: n (%); Median (IQR)					
² Statistical tests: Chi-square test of independence; Fisher's exact test; Kruskal-Wallis test					
³ Spontaneous abortion or fetal death					

Pertussis vaccination coverage

Of the 388 patients interviewed, 306 reported having been vaccinated against pertussis during pregnancy, giving an overall coverage rate of 78.9% (95% confidence interval CI [74.4–82.8]). Almost all the women (294/306) had been vaccinated within the optimal timeframe (Table 1).

Among vaccinated women, 100% had been proposed vaccination, whereas 42.7% of non-vaccinated women stated that they had not been offered it.

Pertussis vaccination coverage was not identical between the three centres (p = 0.018): 85.9% (95% CI [78.4–91.2]) in Nantes University Hospital and 75.6% (95% CI [67.1–82.5]) and 75.2% (95% CI [66.7–82.2]) in Clinique Santé Atlantique and Saint-Nazaire Hospital, respectively (Table 1).

Influenza and Covid-19 vaccination coverage

Overall, influenza and Covid-19 vaccination coverage was 37% and 16%, respectively. Again, vaccination coverages were not identical between the three centres (p < 0.001) (Table 1).

Factors associated with pertussis vaccination: univariate analysis

Having given birth to a first child and having a higher level of education were significantly associated with pertussis vaccination (Supplemental Table 1). Having been offered pertussis vaccination, vaccination against influenza and Covid-19 were also significantly associated. Conversely, being born

abroad and receiving follow-up at a centre other than Nantes University Hospital were associated with lower pertussis vaccination rates. Obstetrical history did not appear to influence vaccination rates.

Factors independently associated with pertussis vaccination: multivariate analysis

The results of the multivariate analysis, with and without taking interactions into account, are presented in Tables 2 and 3, respectively.

As shown in Table 2, influenza vaccination was positively and significantly associated with vaccination against pertussis (OR, 5.48, 95%CI [2.74-12.0]). Women giving birth to their first child were also 2.43 times more likely to be vaccinated against pertussis (OR, 2.43, 95%CI [1.37–4.44]).

Without taking the interaction between the maternity ward and the country of birth into account, being born abroad and being followed up at Clinique Santé Atlantique or Saint-Nazaire Hospital was significantly associated with poorer pertussis vaccination.

After introducing the interaction factor, neither country of origin nor centre alone had a significant influence on vaccination. However, the finding that being both born in another country and being followed up at Clinique Santé Atlantique was significantly associated with poorer vaccination (OR, 0.10, 95%CI [0.02–0.54]), suggests that the centre may influence the effect of country of birth on pertussis vaccination, or *vice versa*. Finally, in this analysis, it appears that a higher level of education was significantly associated with vaccination against pertussis (OR, 1.82, 95%CI [1.03–3.23]).

Table 2
Maternal factors associated with pertussis vaccination of pregnant women: multivariate analysis without introducing interaction factor

Variables	OR	95%CI	p-value
Flu vaccination			
No	-	-	
Yes	5.48	2.74-12	< 0.001
Child rank			
> 1	-	-	
1	2.43	1.37–4.44	0.003
Maternity ward			
Nantes University Hospital	-	-	
Saint-Nazaire Hospital	0.37	0.17–0.76	0.008
Clinique Santé Atlantique	0.26	0.12–0.55	< 0.001
Country of birth			
France	-	-	
Abroad	0.45	0.24–0.84	0.012
Level of education			
Low	-	-	
High	1.55	0.90–2.70	0.11
OR,Odds Ratio; CI, Confidence Interval			

Table 3

Maternal factors associated with pertussis vaccination of pregnant women: multivariate analysis with interaction factor

Variables	OR	95% CI	p-value
Flu vaccination			
No	-	-	
Yes	5.64	2.79, 12.6	< 0.001
First child			
No	-	-	
Yes	2.64	1.47, 4.90	0.001
High level of education			
No	-	-	
Yes	1.82	1.03, 3.23	0.039
Maternity ward			
Nantes University Hospital	-	-	
Saint-Nazaire Hospital	0.78	0.29, 1.93	0.6
Clinique Santé Atlantique	0.63	0.24, 1.56	0.3
Country of birth			
France	-	-	
Abroad	1.45	0.48, 4.28	0.5
Maternity*Country of birth			
St-Nazaire * Other	0.27	0.06, 1.16	0.076
PCA * Other	0.10	0.02, 0.54	0.007
OR, Odds Ratio; CI, Confidence Interval			

Qualitative part

Participants and setting

Data saturation was achieved through 12 interviews (duration: 20 to 50 minutes). Two of them were conducted via video call to accommodate for the women's convenience.

Participants were 26 to 40 years old. Only one had not been vaccinated against pertussis during pregnancy. Their sociodemographic characteristics are detailed in Table 4.

Table 4
Characteristics of interviewed women and interviews

Participant	Age range (years)	Child rank	Vaccinations received	Duration of interview (hour:minutes)	Conditions of interview
1	30–34	2	Pertussis	28	Face-to-face
2	40–44	3	Pertussis	35	Face-to-face
3	25–29	2	None	20	Face-to-face
4	35–39	2	Pertussis Influenza	23	Face-to-face
5	33–34	1	Pertussis Influenza Covid-19	43	Face-to-face
6	30–34	2	Pertussis Influenza Covid-19	22	Face-to-face
7	30–34	2	Pertussis Influenza Covid-19	38	Face-to-face
8	30–34	2	Pertussis	31	Video call
9	30–34	1	Pertussis Influenza Covid-19	50	Face-to-face
10	30–34	2	Pertussis Influenza Covid-19	36	Video call
11	25–29	1	Pertussis Influenza	31	Face-to-face
12	25–29	2	Pertussis Influenza Covid-19	46	Face-to-face

Thematic analysis

Four main categories of vaccination determinants were identified: patient factors, perception of the vaccine, role of caregivers, and pregnancy context.

Factors related to patients

Regarding patient-related determinants, it was shown that women's individual beliefs and confidence influenced their decision to be vaccinated, as did their understanding of the benefit-risk balance and of the reduction of the risk of transmitting infectious diseases.

P6: *"I'm quite by-the-book, so once they tell me to do it, I do it."*

P5: *"If the side effects are things like a fever, mild flu-like symptoms, but of a lesser magnitude than if you caught the original virus, I consider that to be an acceptable symptom, an acceptable side effect."*

Their choice was also influenced by life circumstances, and past experiences, whether positive or negative. Indeed, their behaviour towards vaccination was directly affected by personal and family medical histories, as well as the professional environment in which they work.

P3: *"Since my first child was never sick... It's true that I wasn't very worried. I thought it would be the same for him. Well, when you haven't experienced... diseases, you worry less."*

P5: *"I remember fainting once... So, I dreaded vaccines a bit more as I got older."*

P4: *"Regarding vaccination, everything went well, I've never had a reaction, I have no traumas about it."*

P4: *"A little bit of mistrust, always. Yeah, because, in fact, before my first child, I had a miscarriage."*

Finally, acculturation and interest in the subject of health varied from patient to patient, which led to disparities in medical knowledge and, consequently, in decision-making.

P2: *"I looked up what whooping cough does to small babies on the internet. And when you see what it can cause... well, it can lead to hospitalizations, maybe even death."*

P8: *"I do feel a bit guilty for not actively seeking more information. I think the information is out there, and we would know where to find it."*

Factors related to vaccination and vaccines

For interviewees, the importance of vaccination, particularly in eliminating or controlling infectious diseases, providing both individual and collective protection, was a favourable factor. This helped to overcome any doubts that vaccination might raise.

P2: *"And I think that if we have eradicated diseases, it's thanks to... Well, without realizing it, it's thanks to vaccines."*

P5: *"I thought that, at first glance, there was also the idea of breaking the chains of transmission... For people more vulnerable than I am, I thought it was also important for the elderly, for young children."*

On the contrary, the novelty of a vaccine or of a vaccination recommendation appeared to be a key factor in the emergence of existing scepticism about vaccines. This skeptical stance was fuelled by complacency in the situation preceding the recommended change, or at any rate in the lack of understanding of the change, but also by the fear of undesirable effects, particularly neurological, delayed and/or persistent.

P2: *"Take whooping cough, for example. We've heard about it. Then I was asked to get vaccinated for it. I said I don't understand. We have never been asked to do that for the first two when I was pregnant. What's changed that it's now required?"*

P7: *"I think it's the novelty. Because it's a bit scary, you think, well, I'm getting vaccinated, but I might have side effects because we don't have much feedback on it yet."*

P5: *"Yes, well, what scares me a bit more would be side effects that show up later, in a more insidious way. Neurological diseases, like multiple sclerosis, well, that's really... you know, with the paralysis it causes, progressive... it's a pretty nightmarish side effect."*

Lastly, mandatory vaccination, whether implemented at a national level or in other countries, seemed to reinforce patients' confidence in vaccination. More generally, the global implementation of vaccination, irrespective of their mandatory nature, seemed to be an asset.

P2: *"I think that by making it mandatory, we might reach a higher percentage of people. Because some people would simply think, 'It's mandatory, so I have to do it.'"*

P7: *"And I remember her telling me, in France, we're always a bit hesitant about doing this, vaccinating during pregnancy, while in other countries, it's very common."*

P12: *"In every country in the world, they do it. And there's no effect on the children."*

Role of caregivers

Patient-doctor relationship, in particular the trust between patients and healthcare professionals was found to be central to decision-making, especially when choosing a primary care provider.

P1: *"I had a general practitioner who had been following me for a while, and I completely trusted him. In this case, it was a gynecologist who was following me, we didn't know each other as well, but I trusted her too. Afterward, I wouldn't say that would be the case with just any doctor."*

P4: *"Well, I get along very well with my midwife. There's a certain closeness, so yes, it reassured me."*

P11: *"And yes, the fact that I can... the feeling that I can ask the questions I need to ask. Well, and the fact that... Yeah, no, that's it, I'd say, about the trust relationship."*

The concordance of opinions and statements also appeared key in influencing the women's decisions. The interviewees emphasised that several professionals were involved in their follow-up, and that there was sometimes a sense of hierarchy depending on the professional involved. They were reassured by their unanimous approach, whereas differing opinions and counter-opinions increased their fears.

P2: *"I don't doubt the midwife's skills at all, but yes, of course, it's the pediatrician who's the specialist in children... I believed her more."*

P3: *"And we asked the gynecologist who had written the prescription, the hospital midwife, and the pharmacy, and we told ourselves if they all say it's necessary, we should do it."*

Finally, communication and accessibility appeared to be a driver. The provision of information and explanations enabled patients to make more informed decisions. They were also sensitive to the terminology employed by healthcare professionals. They regretted the lack of dissemination of information about novel vaccines.

P6: *"No. If I have something to say, it's that I think it's important to explain to mothers the importance of vaccination. Because sometimes, when something is imposed, we might resist a little. But I think as soon as it's well explained, well justified, and the baby's health is emphasized, it helps women accept it. For me, the exchange of information and support are crucial."*

P4: *"She didn't say it's mandatory. But she strongly encouraged me to do it."*

P11: *"And she was pretty clear, in fact, in her explanations, saying that the baby could only be vaccinated from two months, and that until then, it was important for him to be immunized."*

Factors related to maternity

Careful, early scheduling of vaccinations during pregnancy follow-up was identified as a factor facilitating women's acceptance of vaccines. For them, it was important to feel that the vaccination was carried out at the right time. Indeed, women mentioned the difficulties associated with the pregnancy schedule and therefore the need to organise themselves and anticipate the stages of pregnancy.

P1: *"At first, you already have a lot of information and quite a bit of stress as well... so it's not the best time. And then after the fifth month, you can anticipate a little."*

P11: *"This timeline is really useful. It avoids surprises during pregnancy. There's already a lot to handle. I appreciated knowing month by month what I would have to do, even for blood tests, etc."*

P12: *"I will schedule it at the right time. Yes, we will set a timeline. It's about anticipating before getting vaccinated."*

It was highlighted that the vulnerability of the fetus and the unborn child was both a source of concern and an incentive motivation for vaccination.

P2: *"He wasn't vaccinated against whooping cough. So, yes, it should be done. I really got the vaccine for him... If it was just to protect me from whooping cough, I wouldn't have done it."*

P3: *"I regretted it afterward. I thought, maybe I should have done it during pregnancy. That way, he would have been immunized. If he had gotten sick before his two month, I would have felt guilty."*

P9: *"She explained to me that it was related to the pregnancy, so that my baby would have some of the immunity I create for the first months of life. When it's explained like that, I say, yes, of course, I'll do it gladly."*

Pregnancy, on the other hand, appeared to reveal or increase fear of vaccine side effects, especially the potential risk of miscarriage. This fear was further heightened by the mother's sense of responsibility for her baby at the time of the decision to vaccinate.

P3: *"I'm hesitant about it during pregnancy. I don't know. It holds me back, thinking that if something happened, it would be my fault."*

P12: *"But mostly... Will the vaccine affect the child? Malformations, diseases?"*

Discussion

This study measured the overall vaccination coverage rate against pertussis, which was found to be close to 80% across all centres. An even higher vaccination rate was observed among women followed up at the Nantes University Hospital, reaching nearly 86%. Vaccination coverage rates for influenza and Covid-19 were far below, at 37% and 16%, respectively.

In France, a study published in November 2024 by the scientific interest group Épi-Phare estimated the national vaccination coverage against pertussis at 63.2% and highlighted significant regional disparities. Vaccination coverage rates were significantly higher than the national average in the northern and western regions of France, such as the Pays de la Loire region (80.9%)—which includes the Loire-Atlantique department, where vaccination coverage reached 82.1%—a finding consistent with the results of our study [9]. This study focused on pertussis vaccination coverage among women whose expected date of delivery was between May and December 2024, *i.e.* two months after the expected dates of delivery for the women included in our study. Consequently, vaccination coverage rates in our study were probably only marginally affected by the outbreak of pertussis that occurred in Europe in 2024. In April 2024, Santé publique France reported a resurgence of pertussis throughout the country since the start of the year [10]; the epidemic subsequently intensified, with increased media coverage from the summer onwards and the epidemic peaking in August [11]. Worldwide, 2024 data showed almost equivalent rates: 60% in the United States of America [12], around 60% in England, before the upsurge of pertussis [13] and 61% in Quebec [14]. These territories began recommending pertussis vaccination for pregnant women around ten years before France did and have observed a slight, gradual decline in vaccination

coverage rates in recent years. Thus, having met the challenge of achieving high vaccination coverage, the following challenge is to maintain public and healthcare professionals' support for this strategy.

The quantitative results identify several concrete measures for improving pertussis vaccination coverage among pregnant women. Firstly, being a first-time mother was consistently identified in our study – as in the general literature [15] – as a factor promoting pertussis vaccination. A plausible strategy would therefore be to encourage multiparous women to approach their current pregnancy with the same level of commitment to preventive measures as if it were their first pregnancy, in order to combat the complacency that can set in over successive pregnancies. Secondly, our analysis showed that the effect of being born abroad on vaccination status was modulated by the maternity unit attended, suggesting that certain practices already in place in services accustomed to caring for large numbers of women born abroad might foster greater trust in the care provided by healthcare professionals.

These quantitative factors are reflected in our qualitative findings, which provide further insight into them and highlight, among other factors, the central role played by trust in healthcare professionals, access to information and the timing of antenatal care.

The central role of trust between pregnant women and their healthcare professionals, highlighted in our qualitative data, is consistent with a wealth of international evidence: a strong and proactive recommendation from a trusted healthcare professional remains the most consistent predictor of maternal vaccination coverage [16,17]. Providing information and being transparent with patients appeared to be the essential variable for acquiring this trust, particularly among hesitant patients [18–20]. It should be emphasised that healthcare professionals are not immune to vaccine hesitancy, and that their own confidence in a vaccine's safety and in the scientific evidence supporting it determines their ability to recommend it convincingly – a dynamic that has been well documented among French healthcare professionals [21]. This issue is being examined in the PREVACOQ-2.2 study, which was conducted in parallel with this study amongst healthcare professionals providing care for pregnant women (results not yet published). Finally, improving vaccination coverage against pertussis may therefore depend as much on providing clear and up-to-date recommendations to midwives, obstetricians and general practitioners as well as on directly informing patients. While vaccine hesitancy and scepticism accordingly emerged as a recurring undercurrent across nearly all of the factors we identified, consistent with a global rise in hesitancy documented over the past decade [22], this study shows that it is, in particular, novelty and change that are met with a great deal of scepticism. It is therefore recommended that healthcare professionals and health authorities take this finding as a stimulus to explain new vaccines and new vaccination strategies. Alongside the issues of information and trust in healthcare professionals regarding vaccination, one participant mentioned that the compulsory nature of a vaccination instils confidence in her. This remark echoes the fact that in 2018, France expanded the compulsory vaccination programme for infants, which proved highly beneficial in terms of public perception, the views of healthcare professionals, and ultimately vaccination coverage [23]. Fear of harm to the pregnancy itself emerged as the dominant barrier among hesitant participants, who described anxiety about foetal malformation or miscarriage alongside a broader sense of

ambivalence and vulnerability specific to pregnancy. These findings mirror those of a recent narrative review, which identified fear of adverse effects and low perceived susceptibility to infection as the two most frequently reported drivers of vaccine hesitancy in pregnant women [24]. Conversely, the vulnerability of the unborn baby and the fact that the main aim of vaccination is to protect the infant appear to be a key reason for agreeing to vaccination. Taken together, these findings suggest that no single lever will close the remaining gap to universal coverage. Sustained progress will instead depend on a combination of clear, consistent messaging; confident, well-supported healthcare professionals; and sufficient time within antenatal care to allow genuine dialogue rather than a one-off recommendation.

This multicentre, mixed-methods design is a major strength of the study: the large sample size gave sufficient statistical power to detect associations in the quantitative component, while the qualitative interviews allowed these findings to be interpreted in greater depth. However, as the study was conducted in a single French department, its findings may not be directly extrapolable to the rest of France or to other countries with different vaccination programmes and healthcare organisation. Vaccination status was based on self-report, and it was not possible to verify these declarations against medical records; some degree of recall or social-desirability bias cannot be excluded.

Participants for the qualitative study were purposively sampled from the quantitative cohort to ensure diversity in vaccination status, parity and educational level; however, only one woman who had declined pertussis vaccination during pregnancy could ultimately be included. This limits our ability to draw firm conclusions about the reasons for non-vaccination, although it does not undermine the study's capacity to identify the levers that can be used to inform and reassure hesitant or distrustful women, which was a central aim of the qualitative component. Other limitations include the exclusion of non-French-speaking women, for reasons of feasibility, which may have led us to miss perspectives specific to migrant populations already identified as less likely to be vaccinated in the quantitative results. Additionally, there is a possibility of interviewer bias, since the interviews were conducted by two members of the research team rather than an independent party.

Conclusion

In conclusion, this study shows that pertussis vaccination coverage among pregnant women in Loire-Atlantique is already high, two years after the national recommendation, but that the decision to vaccinate remains dynamic rather than fixed, shaped jointly by patient-level factors, perceptions of the vaccine itself, and the quality of the relationship with healthcare professionals. Sustaining and further improving this coverage will depend on treating each pregnant woman holistically, with healthcare professionals and public health authorities providing clear, transparent information and taking the time to listen, particularly for the groups identified here as more hesitant.

Abbreviations

CEDIS
Comité d'éthique de déontologie et d'intégrité scientifique
HAS
Haute Autorité de Santé
WHO
World Health Organisation

Declarations

Funding

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Availability of data and materials

Data are available from the authors upon reasonable request.

Ethics approval and consent to participate

Ethical approval was obtained from the University of Nantes Ethics, Professional Conduct and Scientific Integrity Committee (Comité d'Ethique de Déontologie et d'Intégrité Scientifique, CEDIS, n°IRB: IORG0011023) in March 2024 (DRPI n°2024-186, reference n°15032024-1). Oral informed consent was required for the quantitative part, while written informed consent was obtained from all the women interviewed for the qualitative component, in line with French legal guidelines. Participants did not receive any compensation.

All methods were carried out in accordance with relevant guidelines and regulations. The study follows the COREQ (COnsolidated criteria for REporting Qualitative research) and the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) reporting guidelines (see completed checklists in Additional Tables 2 and 3).

Consent for publication

All participants gave consent for the study's findings to be published. All authors also consented to the publication of this manuscript.

Competing interests

The authors declare that they have no competing interests.

AI use

The authors declare that they have used AI to help improving English and to help complete the grids STROBE and COREQ, always including supervision and marking of written work, where applicable (DeepL

and Anthropic Claude-ai). The data is original and authentic.

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