**Current practice and attitudes towards vaccination during pregnancy: a survey of general practitioners across England**

Christopher R Wilcox 1, Paul Little 2, Christine E Jones 3

1: NIHR Clinical Research Facility, University Hospital Southampton NHS Foundation Trust, Southampton, UK

2: Department of Primary Care and Population Sciences, Aldermoor Health Centre, University of Southampton, Southampton, UK

3: Faculty of Medicine and Institute for Life Sciences, University of Southampton and University Hospital Southampton NHS Foundation Trust, Southampton, UK

**Corresponding author**

* Dr Christopher Wilcox
* NIHR Clinical Research Facility, Southampton Centre for Biomedical Research, C Level West Wing, Mailpoint 218, Southampton General Hospital, Tremona Road, Southampton, SO16 6DY
* Email: christopher.wilcox@soton.ac.uk
* Telephone: 02381204956

**Keywords –** Vaccination; Pregnancy; Antenatal vaccination; Influenza; Pertussis; General Practitioners

**How this fits in**

Antenatal vaccines are commonly delivered in Primary Care, yet the views of General Practitioners (GPs) regarding these programmes have been neglected in research to-date. We distributed a survey to GPs across England in order to establish their attitudes towards antenatal vaccination, and their views on the current delivery of this service. We found strong support amongst the 1586 respondents for the vaccination programme to be further embedded within routine midwife/obstetrician-delivered antenatal care. Many respondents also had low confidence discussing vaccination with pregnant women and desired further educational resources (specifically designed for the needs of GPs) in order to facilitate opportunistic promotion of vaccination in the future.

**Abstract**

**Background**

Antenatal vaccines are commonly delivered in Primary Care, yet the views of General Practitioners (GPs) regarding these programmes have been neglected in research to-date.

**Aim**

To establish the attitudes and current practice of GPs towards antenatal vaccination and their views on the optimal location for delivery of this service.

**Design and setting**

Multi-centre questionnaire.

**Methods**

Online questionnaire completed by GPs across England (December 2018 - January 2019).

**Results**

The majority of 1586 respondents considered antenatal vaccination safe (96% for influenza, 89% pertussis). GPs were significantly less confident in their knowledge of pertussis compared to influenza vaccination (64% vs 80% were confident, p<0.001), and many desired further education (76% vs 48%, p<0.001). Few (37%) discussed vaccination with pregnant women regularly, but most (80%) felt their recommendation would influence decision-making. Those with greater confidence in their knowledge of pertussis and influenza vaccination and who were >2 years since qualifying discussed vaccination significantly more often (OR: 3.52, p<0.001; OR: 2.34, p=0.001; OR: 1.76, p=0.003 respectively), regardless of whether they routinely saw pregnant women. Most (83%) reported that antenatal vaccination was GP-led in their region, yet only 26% thought it should be primarily GP-based. GPs expressed disconnect from antenatal care, and many suggested that midwives and/or Secondary Care take greater responsibility for the delivery of antenatal vaccination.

**Conclusion**

There is support amongst GPs to embed vaccination programmes within routine antenatal care. Further educational resources, specifically designed for the needs of GPs, are needed to facilitate opportunistic discussion with pregnant women about vaccination.

**Introduction**

Pertussis and influenza infection can have severe consequences for pregnant women and their infants, including respiratory illness and death 1  2 . Antenatal vaccination is an effective means of protecting newborns until the time of infant vaccination, or until the window-period of greatest susceptibility to severe disease has passed 3–6 . Vaccination against pertussis and influenza have been routinely recommended during pregnancy in the UK since 2012 and 2010, respectively 7 . Although initial uptake of antenatal vaccination in the UK was encouraging for a new programme, coverage has since plateaued and further gains are still to be made to ensure optimal protection of pregnant women and their infants. This trend is echoed globally, and the World Health Organisation (WHO) has recently called for research into the socio-economic determinants of vaccine attitudes  8  9 . The uptake of antenatal vaccination against pertussis and influenza in England over the winter season 2017-2018 was 73% and 47% 10–13 , respectively, however coverage rates vary markedly between different regions of the country, and uptake is 10-20% lower in London than in northern England.

It is well-acknowledged that a recommendation from a familiar healthcare professional is one of the strongest determinants of vaccination uptake 14  15 . General Practitioners (GPs) are one of the primary points of contact for pregnant women in the UK, are well-placed to communicate the benefits of vaccination, and remain highly-rated as sources of advice amongst pregnant women 16–18 . Yet despite this, there is a paucity of research into the current practice and attitudes of GPs towards antenatal vaccination 19  20 . Improving our understanding in this area may be important in important in explaining current vaccination attainment levels, and identifying areas for future intervention.

Establishing the optimal location for delivery of the antenatal vaccination programme is also topic of significant debate internationally. In the UK, antenatal vaccination is usually delivered within Primary Care, which (for many women) presents an additional barrier to accessing vaccination as it usually requires an appointment additional to those for routine antenatal care. More recently, some National Health Service (NHS) Trusts have started to embed vaccination in pregnancy within antenatal services in the community or in Secondary Care, as recent evidence suggests that this may be an effective approach to increase uptake  21–25 . A number of studies have explored the views of midwives and obstetricians towards implementing this 26–29 , yet the views of GPs have been significantly under-represented 26 .

The aims of this questionnaire study were to establish the attitudes and current practice of GPs towards antenatal vaccination and their views on the optimal location for delivery of this service.

**Methods**

**Questionnaire design and development**

An anonymous survey was developed by the study team, consisting of a series of closed questions and a free-text box in which participants could add further comments (see supplementary information). The questionnaire had not previously been validated. Participants were asked questions about their current practice and their attitudes (including perceived responsibility) with regards to discussing antenatal vaccination with pregnant women, as well as their confidence in their knowledge of its risks and benefits, and attitudes to the introduction of new antenatal vaccines. Participants were also asked about the logistics of vaccine administration in their region, and their opinion as to the optimal healthcare site for vaccine administration.

**Study population and recruitment**

The survey was administered to qualified GPs working at GP practices across England. Recruitment took place from 11thDecember 2018 to 25th January 2019. Overall study coordination was undertaken centrally by the principal investigator (CW), in collaboration with the National Institute for Health Research (NIHR) Primary Care Clinical Research Network (CRN), who were responsible for recruitment. Individual GP practices were identified and contacted by research administrators from local CRNs across England, and invitations for participation (containing a link to the online questionnaire) were distributed to these practices via email. Reminders were sent to practices that did not respond to initial email invitation. Participation was voluntary and all participants gave informed consent. The study was granted ethical approval (reference 17/LO/0537) and registered on ClinicalTrials.gov (NCT03096574) prior to recruitment.

**Questionnaire data analysis**

Data was automatically entered into iSurvey (www.isurvey.soton.ac.uk) upon questionnaire completion. Statistical analysis was performed using IBM SPSS Version 25. Wilcoxon signed-rank testing and multi-variate ordinal regression analyses were performed, and adjusted odds ratios (ORs) were calculated. P-values <0.05 were considered statistically significant. Multi-collinearity was examined using the tolerance test and the Variance Inflation Factor (VIF) to ensure variables with a VIF value exceeding 2.5 were not entered into the regression model. Coding and thematic analysis of the open-text comments was performed using NVivo Version 12 (QSR International).

**Results**

A total of 1586 GPs took part in the study; all were included in the analysis. There was good distribution of participants from across England, and spread of experience working in general practice. One fifth (n=335, 22%) stated that they had some form of additional qualification or special interest in paediatrics/obstetrics/vaccination or a related subject, and 2% (36/1496) had worked as a paediatric or obstetric specialist trainee prior to general practice. The full characteristics of participants are displayed in Table 1.

**Current practice and attitudes towards routine antenatal vaccination**

Most GPs felt that antenatal vaccination is safe and were confident discussing its risks and benefits with pregnant women (see Figure 1), however they had significantly less confidence discussing pertussis vaccination compared to influenza (64% vs 80% were confident or very confident, Z: -14.1, p<0.001), and were more likely to consider further education on pertussis to be helpful for them (76% vs 48% agreed or strongly agreed that education would be helpful, Z: -10.1, p<0.001). The majority of GPs strongly agreed/agreed that a recommendation from them would influence women to receive vaccination against influenza (1236/1565, 79%) and pertussis (1207/1578, 76%).

When asked whether they routinely discuss antenatal vaccination with pregnant women, 10% (160/1574) selected everytime, 27% (n=423) often, 35% (n=555) occasionally, 24% (n=371) rarely and 4% (n=65) never. Regarding whether discussing antenatal vaccination is a responsibility of GPs, 12% (183/1561) strongly agreed, 46% (n=720) agreed, 28% (n=444) neutral, 14% (n=214) disagreed, and none strongly disagreed. Multivariate ordinal regression analysis identified that GPs were significantly more likely to discuss vaccination with pregnant women if they were confident in their knowledge of pertussis (OR: 3.52; CI: 2.45-5.07; p<0.001) and influenza vaccination (OR: 2.34; CI: 1.40-3.91; p=0.001), Table 2. Other significant predictors included more experience as a GP, belief that discussing vaccination is a responsibility of GPs, and whether or not they saw pregnant women as part of routine antenatal care.

GPs were also asked for their views regarding the primary target of protection from antenatal vaccination. For pertussis vaccination, 52% (829/1583), 38% (n=602) and 10% (n=152) selected “the baby”, “the mother” and “both equally”, respectively. For influenza vaccination 2% (35/1583), 48% (n=753) and 50% (n=795) selected “the baby”, “the mother” and “both equally”, respectively.

**Attitudes regarding the optimal healthcare site for administration of antenatal vaccination**

When asked which staff member would usually administer antenatal vaccination in their practice 83% (1227/1486) selected practice nurse, 9% (n=141) midwife, 4% (n=59) healthcare assistant, 4% (n=56) GPs, and 0.2% (n=3) reported that no-one vaccinates. The large majority (83%, 990/1191) believed that pregnant women in their region would need to arrange a separate appointment if they wished to receive vaccination. When asked where they thought antenatal vaccination should primarily be delivered, 41% (651/1584) selected community midwifery, 29% (n=454) both primary and secondary care, 26% (n=417) GP practices, 4% (n=57) secondary care, and 0.3% (n=5) both GP practices and community midwifery, Figure 2.

**Attitudes to the introduction of new antenatal vaccines**

GPs were also asked to select the top three factors which would influence their recommendation of a new vaccine. The commonest selected option was the risk of side effects for the developing baby (1160/1499, 77%), followed by effectiveness at preventing severe disease (n=861, 57%), seriousness of infection in young children (n=710, 47%), effectiveness at preventing infection (n=673, 45%), risk of side effects for the mother (n=627, 42%), number of women who had received the vaccine in research studies (n=265, 18%) and how common the infection is in children (n=211, 14%).

**Open-text comments**

Further comments were provided by 34% (n=539) of the GPs. A number of GPs (n=119, 22%) stated having very little/no involvement in routine antenatal care. As antenatal care is predominately midwife and/or obstetrician-led in the UK, many GPs stated that their interaction with pregnant women was opportunistic only, and some reported feeling de-skilled with regards to offering advice to pregnant women. Many (n=242, 45%) suggested that midwives and/or Secondary Care should take greater responsibility towards promoting and delivering antenatal vaccination, and that uptake might improve if these were embedded within routine antenatal visits. A small number (n=9, 2%) suggested that antenatal vaccination was best-placed exclusively within general practice.

GP119: *“I do think getting midwives to discuss and administer vaccines would be helpful to improve uptake. As GPs we rarely see the majority of well pregnant women so have little opportunity to influence their choices regarding vaccination”*

GP245*: “As GPs are side-lined in antenatal care it seems silly not to have this area dealt with by the community midwifes as part of routine antenatal care”*

Further promotion and education regarding vaccination aimed at pregnant women and the general public was suggested by 69 GPs (13%). Specific ideas included public health campaigns, advertisement through media channels (including social media), public role models or celebrity endorsement, and building specific guidance into commonly-used antenatal books and face-to-face classes, such as National Childbirth Trust (NCT) groups. Further education for healthcare professionals was suggested by 48 GPs (9%), and 35 (6%) suggested improving the resources and guidance on antenatal vaccination available to them, in order to facilitate discussion about vaccination with pregnant women.

GP246: “*Improved GP education and awareness of vaccination in pregnancy would be useful, especially as most GPs are not routinely involved in antenatal care but may need to counsel a patient who has concerns regarding vaccination in pregnancy”*

**Discussion**

Improving uptake rates of antenatal vaccination is a global health priority. The aim of this study was to better understand the current practice and attitudes of GPs in England towards antenatal vaccination, and their opinion as to the optimal healthcare site for delivery of the antenatal vaccine programmes.

**Summary**

Most GPs surveyed felt that antenatal vaccination is safe, but confidence in their knowledge was sub-optimal (particularly for pertussis vaccination), and many felt that further education would be helpful for them. Only a third discussed vaccination with pregnant women regularly, but most felt that a recommendation from them would influence women to receive antenatal vaccination. Those with greater confidence in their knowledge of pertussis and influenza vaccination, and more than two years since qualifying, discussed vaccination significantly more often, regardless of whether they routinely saw pregnant women in their normal role. With regards to the logistics of accessing antenatal vaccination, the large majority reported that pregnant women in their region would have to book a separate appointment at the GP practice to do so, yet only one-quarter thought antenatal vaccination should be primarily the responsibility of the GP practice. Less than 10% reported that midwives administered antenatal vaccination at their practice. These findings were echoed in the open-text comments, where many GPs described feeling a disconnect between themselves and antenatal care, and suggested that midwives and obstetricians take greater responsibility for promotion and administration of vaccination within routine antenatal visits.

**Strengths and limitations**

This study had a significant number of respondents, and by distributing our questionnaire to GP practices across England we attempted to maximise the diversity of our study population. That said, we acknowledge that our respondents cannot taken as fully representative of the views all GPs nationally. We recognise that there may be an element of selection bias, as GPs with an interest in paediatrics, obstetrics, vaccination, or a related field may have been more likely to participate. The knowledge and attitudes regarding antenatal vaccination amongst our sample may therefore differ from GPs nationally. As this was solely an e-mail questionnaire, this may also contribute to selection bias by potentially excluding GPs not using e-mail regularly. Finally, the number of GP practices, and the number of GPs who received the invitation email but declined participation (as well as their reasons for doing so) could not be recorded, and we are therefore unable to report this data.

**Comparison with existing literature**

The findings of this survey highlight a number of areas for improvement with regards to facilitating promotion and delivery of antenatal vaccination. It is notable that a minority of the GPs surveyed promote antenatal vaccination on a regular basis, and this is supported by recent UK survey data showing that only 16-24% of women reported having a meaningful discussion with their GP about antenatal pertussis vaccination 15  30 . Further education (particularly for those newly-qualified) is clearly warranted and desired amongst GPs. This is crucial as whilst many may only interact with pregnant women opportunistically, familiar healthcare provider recommendation is strongly associated with vaccine uptake 14  15 and, indeed around 80% of GPs in this survey felt that a recommendation from them would influence pregnant women to receive vaccination. Furthermore, this view is supported by recent data showing that GPs remain highly-rated as sources of advice amongst pregnant women, despite the exponential increase in health-related online resources over recent years 16–18 . Further education might also address other barriers raised by GPs in previous studies, including concerns about liability, ambiguous guidelines, and a sense of isolation from colleagues in secondary care 19  20 .

Importantly, our findings demonstrate strong support from GPs in England for midwives and obstetricians to take further responsibly for the promotion and delivery of antenatal vaccination, and for this to be formally embedded within routine antenatal visits. Recent evidence demonstrates that adopting this approach, thereby bypassing the need for women to arrange a separate appointment in primary care, may significantly improve uptake rates 21–25 . Increasing numbers of institutions in the UK and Ireland are setting up such initiatives, whereby vaccination is routinely offered at antenatal appointments such as the booking visit, the 20-week fetal anomaly scan, and routine check-up appointments 31  32 . However, a number of studies (based in the UK 27,29,31 , Australia 26 and North America 20,24,25,33 ) have indicated that there may be a mixed response from midwives and obstetricians as to whether or not this is feasible, and whether they are adequately trained and prepared. Lack of formal training in vaccination, short appointments, inadequate staffing, lack of a suitable setting and facilities for safe vaccine storage, lack of financial reimbursement, and lack of confidence discussing vaccination with women, have been all been identified as barriers which would need addressing before this approach can be routinely adopted.

**Implications for research and practice**

A major implication of these findings is that there is support amongst GPs in England for embedding vaccination into routine antenatal care visits. Research would be beneficial in settings within which this approach has adopted and those where it has not, in order to establish its feasibility and effectiveness, as well as facilitators/barriers to its acceptance amongst pregnant women and maternity healthcare professionals.

The survey responses also highlight a clear need for GP-tailored education programmes and resources in order to improve confidence and knowledge, and empower them to promote vaccination to pregnant women. Educational opportunities may include face-to-face educational sessions, supported by easily-accessible online guidance, in which the safety and protective efficacy of vaccination is emphasised, and real-life cases describing the consequences of not vaccinating are highlighted 34 35 . Given our findings that a significant proportion of GPs only see pregnant women occasionally, the motivation for engaging with such educational resources may be limited. A simple and concise information sheet, containing essential information to discuss with women (together with frequently asked questions) might be more appropriate for those giving advice to pregnant women infrequently – and the study team has since developed this (to be published open-access in the BJGP). Even if antenatal vaccination programmes are eventually exclusively delivered within antenatal care, GPs will continue to have an important role in providing information and advice to pregnant women and so resources such as this will continue to be needed. Adding reminders to promote vaccination into GP antenatal care referral forms, as well as setting up automatic notifications or alerts which appear within the patient notes might also be beneficial to serve as reminder to healthcare professionals to signpost vaccination to pregnant women. The role of GP financial incentive schemes is controversial, especially given the mixed opinions regarding who should be taking primary responsibility for antenatal vaccination. Furthermore, whilst some institutions have reported improvements in vaccine uptake following their introduction 34 , they may receive a mixed response and actually impact negatively on internal motivation 36 .

Finally, ongoing promotion aimed at pregnant women and the general public should also be implemented to ensure that vaccination in pregnancy is perceived as a normal part of antenatal care and part of ‘collective knowledge’ of the public. Ensuring vaccination in pregnancy remains in the spotlight within mainstream media and social media may be important to this. Ongoing engagement with charities active in antenatal education, use of text message reminders 37 , smart phone apps (such as MatImms) 38 and positive social media 39 may also increase vaccine uptake. However, it is worth noting that social media is known to contain communities of users critical of vaccination, and a recent UK study showed that women who reported gathering information from such platforms were 58% less likely to undergo antenatal pertussis vaccination 40 . Crucially, clear educational resources should be readily available within GP practices and antenatal clinics, such as posters and Public Health England (PHE) information leaflets (available at: https://www.gov.uk/government/publications/resources-to-support-whooping-cough-vaccination” and “https://www.gov.uk/government/publications/flu-vaccination-leaflet-for-pregnant-women”). Two recent studies demonstrated a significant increase in both knowledge and uptake rates of antenatal influenza vaccination following routine provision of an information pamphlet in antenatal clinic  41  42 . Furthermore, these materials would have the added benefit of providing health professionals with resources to facilitate discussion with pregnant women, a technique which has been shown in a number of studies to improve patients’ knowledge, satisfaction and adherence to advice following primary care consultations  43 .

In conclusion: further education is warranted and desired amongst GPs to improve confidence and knowledge (particularly for pertussis vaccination), and accessible guidance and educational resources (specifically designed for the needs of GPs) should be made readily available to facilitate opportunistic discussion with pregnant women. There is strong support amongst GPs for midwives within the community and maternity healthcare professionals in Secondary Care to take greater responsibility for the promotion and administration of the antenatal vaccination programme, and to embed this within routine antenatal visits.

**Figure captions**

Figure 1: Responses to four questions regarding antenatal influenza (A-D) and pertussis (E-H) vaccination amongst the responding GPs in this study.

Figure 2: Respondents’ views about where antenatal vaccination should primarily be delivered.

**Acknowledgements**

The authors would like to thank all the GPs who took part in the study. We are also very grateful for the support of our local research and development team, the NIHR and the English primary care CRNs who helped distribute the questionnaire and facilitate recruitment.

**Author Contributions**

CW and CJ conceived the study. CW coordinated data collection (in collaboration with the NIHR clinical research network), performed the data analysis and drafted the manuscript. All authors contributed to questionnaire design and revision of the manuscript. All authors approved the final version of the manuscript.

**Conflicts of Interest Statement**

CW and CJ are investigators for clinical trials done on behalf of their respective institutions, sponsored by various vaccine manufacturers, but receive no personal funding for these activities.

**Funding**

The study was supported by a grant from the British Paediatric Allergy Immunity and Infection Group (BPAIIG). BPAIIG had no role in the study design, data collection, data analysis/interpretation, report writing, or the decision to submit the manuscript for publication.

**Clinical Trial Registration**

The questionnaire study was registered on ClinicalTrials.gov prior to recruitment (NCT03096574).

**Ethical Approval**

Ethical approval was granted from the West London & GTAC NHS Research Ethics Committee (reference 17/LO/0537).

**Study coordination**

Overall study coordination was undertaken centrally by the principal investigator (CW) in collaboration with clinical research network (CRN) Wessex. The study was adopted into the NIHR study portfolio (reference 39803) and invitations for participation were distributed to GP practices by primary care CRNs across England.

**References**

 1. McIntyre P & Wood N. Pertussis in early infancy: disease burden and preventive strategies. *Curr Opin Infect Dis* **22,** 215–23 (2009).

2. Mak T, Mangtani P, Leese J, Watson J & Pfeifer D. Influenza vaccination in pregnancy: current evidence and selected national policies. *Lancet Infect Dis* **8,** 44–52 (2008).

3. Poehling KA, Szilagyi PG, Staat MA, et al. Impact of maternal immunization on influenza hospitalizations in infants. Am J Obstet Gynecol **204**, S141–8 (2011).

4. Amirthalingam G, Andrews N, Campbell H, et al. Effectiveness of maternal pertussis vaccination in England: an observational study. Lancet. 2014;384(9953):1521–1528.

5. Zaman K, Roy E, Arifeen SE, et al. Effectiveness of maternal influenza immunization in mothers and infants. *New Eng J Med* **359,** 1555–64 (2008).

6. Madhi SA, Cutland CL, Kuwanda L, et al. Influenza Vaccination of Pregnant Women and Protection of Their Infants. *New Eng J Med* **371,** 918–931 (2014).

7. Jones CE, Calvert A. & Le Doare K. Vaccination in Pregnancy – Recent Developments. *Pediatr Infect Dis J* ***37****, 191-193* (2018).

8. Wilson RJ, Paterson P, Jarrett C & Larson HJ. Understanding factors influencing vaccination acceptance during pregnancy globally: A literature review. *Vaccine* **33,** 6420–9 (2015).

9. Larson H, Jarrett C, Schulz WS, et al*.* Measuring vaccine hesitancy: The development of a survey tool. *Vaccine* **33,** 4165–75 (2015).

10. Public Health England. Pertussis vaccination programme for pregnant women update: vaccine coverage in England, January to March 2018. *Health Protection Report* **11,** (2017).

11. Public Health England. Seasonal influenza vaccine uptake in GP patients: winter season 2017 to 2018. (2018).

12. Public Health England. Pertussis vaccination programme for pregnant women update: vaccine coverage in England, October to December 2017. *Health Protection Report* **12,** (2018).

13. Public Health England. Pertussis vaccination programme for pregnant women update: vaccine coverage in England, July to September 2017. *Health Protection Report* **12,** (2018).

14. Wiley KE, Massey PD, Cooper SC, Wood NJ, Quinn HE, Leask J*.* 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 (2013).

15. Donaldson B, Jain P, Holder BS, Lindsey B, Regan L, Kampmann B*.* 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 (2015).

16. McQuaidF, Jones C, Steven Z, *et al.* Factors influencing women’s attitudes towards antenatal vaccines, group B Streptococcus and clinical trial participation in pregnancy: an online survey. *BMJ Open* **6,** e010790 (2016).

17. Liu N, Sprague AE, Yasseen AS, *et al.* Vaccination patterns in pregnant women during the 2009 H1N1 influenza pandemic: a population-based study in Ontario, Canada. *Can J Public Health* **103,** e353–8 (2012).

18. Gauld N, Braganza C, Babalola O, Huynh T. & Hook S. Reasons for use and non-use of the pertussis vaccine during pregnancy: an interview study. *J Prim Health Care* **8,** 344 (2016).

19. O’Connell A, Tummon A, Coleman K, Jordan A, McCormack J, Kelly ME*.* Antenatal Pertussis Vaccination: Why are General Practitioners Reluctant? A Mixed Methods Study Setting. *Ir Med J* **110,** 634 (2017).

20. Tong A, Biringer A, Ofner-Agostini M, Upshur R & McGeer A. A cross-sectional study of maternity care providers’ and women's knowledge, attitudes, and behaviours towards influenza vaccination during pregnancy. *J Obstet Gynaecol Can* **30,** 404–10 (2008).

21. Mohammed H, Clarke M, Koehler A, Watson M & Marshall H. Factors associated with uptake of influenza and pertussis vaccines among pregnant women in South Australia. *Plos One* **13,** e0197867 (2018).

22. Krishnaswamy S, Wallace E, Buttery J & Giles M. Strategies to implement maternal vaccination: A comparison between standing orders for midwife delivery, a hospital based maternal immunisation service and primary care. *Vaccine* **36,** 1796–1800 (2018).

23. Hayles EH, Cooper SC, Wood N, Skinner SR & Sinn JHK. Pertussis Booster Vaccination in Pregnancy: Women Who had it Compared to Those Who Waited. *Procedia Vaccinol* **9,** 59–65 (2015).

24. Bonville CA, Cibula DA, Domachowske JB & Suryadevara M. Vaccine attitudes and practices among obstetric providers in New York State following the recommendation for pertussis vaccination during pregnancy. *Hum vacc & immunother* **11,** 713–8 (2015).

25. Yudin MH, Salaripour M & Sgro MD. Acceptability and feasibility of seasonal influenza vaccine administration in an antenatal clinic setting. *J Obstet Gynaecol Can* **32,** 745–8 (2010).

26. Webb H, Street J. & Marshall H. Incorporating immunizations into routine obstetric care to facilitate Health Care Practitioners in implementing maternal immunization recommendations. *Hum Vaccin Immunother* **10,** 1114–21 (2014).

27. Ishola DA, Permalloo N, Cordery RJ & Anderson SR. Midwives’ influenza vaccine uptake and their views on vaccination of pregnant women. *J Public Health* **35,** 570–577 (2013).

28. Wu P, Griffin MR, Richardson A, Gabbe SG, Gambrell MA, Hartert TV*.* Influenza vaccination during pregnancy: opinions and practices of obstetricians in an urban community. *South Med J* **99,** 823–8 (2006).

29. Wilcox CR, Calvert A, Metz J, *et al.* Determinants of Influenza and Pertussis Vaccination Uptake in Pregnancy: A Multi-Centre Questionnaire Study of Pregnant Women and Healthcare Professionals. *Pediatric Infect Dis J* (2018).

30. WongCY, Thomas NJ, Clarke M, Boros C, Tuckerman J, Marshall HS*.* Maternal uptake of pertussis cocooning strategy and other pregnancy related recommended immunizations. *Hum Vacc Immunother* **11,** 1165–1172 (2015).

31. Vishram B, Letley L, Jan Van Hoek A, *et al.* Vaccination in pregnancy: Attitudes of nurses, midwives and health visitors in England. *Hum vacc & immunother* **14,** 179–188 (2018).

32. Green D, Labriola G, Smeaton L & Falconer M. Prevention of neonatal whooping cough in England: The essential role of the midwife. *B J Midwifery* **25,** 224–228 (2017).

33. Leddy MA, Anderson BL, Powel ML, Gall S, Gonik B, Schulkin J*.* Changes in and current status of obstetrician-gynecologists’ knowledge, attitudes, and practice regarding immunization. *Obstet Gynecol Surv* **64,** 823–9 (2009).

34. Baxter D. Approaches to the vaccination of pregnant women: experience from Stockport, UK, with prenatal influenza. *Hum Vaccin Immunother* **9,** 1360–3 (2013).

35. Wilcox CR, Bottrell K, Paterson P, *et al.* Influenza and pertussis vaccination in pregnancy: Portrayal in online media articles and perceptions of pregnant women and healthcare professionals. *Vaccine* **36**, 7625-7631 (2018).

36. McDonald R, Harrison S, Checkland K, Campbell S & Roland M. Impact of financial incentives on clinical autonomy and internal motivation in primary care: ethnographic study. *BMJ* **334,** 1357 (2007).

37. Gazmararian JA, Elon L, Yang B, Graham M & Parker R. Text4baby program: an opportunity to reach underserved pregnant and postpartum women? *Matern Child Health J* **18,** 223–32 (2014).

38. Holder B, Borqeau M, Donaldson B, Davies J, Kampmann B. MatImms: A smartphone app to inform and educate women about maternal immunisation. Poster presentation at 4th International Neonatal and Maternal Immunisation Symposium, Brussels, Belgium, 10-12/09/2017

39. Glanz JM, Wagner NM, Narwaney KJ, *et al.* Web-based Social Media Intervention to Increase Vaccine Acceptance: A Randomized Controlled Trial. *Pediatrics* **140,** e20171117 (2017).

40. Ford A & Alwan N. Use of social networking sites and women’s decision to receive vaccinations during pregnancy: A cross-sectional study in the UK. *Vaccine* **36,** 5294–5303 (2018).

41. Yudin MH, Salripour M & Sgro MD. Impact of patient education on knowledge of influenza and vaccine recommendations among pregnant women. *J Obstet Gynaecol Can* **32,** 232–7 (2010).

42. Meharry P, Cusson R, Stiller R & Vázquez M. Maternal Influenza Vaccination: Evaluation of a Patient-Centered Pamphlet Designed to Increase Uptake in Pregnancy. *Matern Child Healt J* **18,** 1205–1214 (2014).

43. Sustersic M, Gauchet A, Foote A & Bosson JL. How best to use and evaluate Patient Information Leaflets given during a consultation: a systematic review of literature reviews. *Health Expectations* **20,** 531–542 (2017).

|  |  |
| --- | --- |
| **Characteristic** | **N (%)** |
| TOTAL | 1586 (100%) |
|  |  |
| Region of England in which they are based |  |
|  North | 280 (18%) |
|  Midlands | 156 (10%) |
|  East | 318 (20%) |
|  South West | 394 (25%) |
|  Southern | 238 (15%) |
|  London | 107 (7%) |
|  Not stated | 93 (6%) |
|  |  |
| Amount of time spent working as a GP since qualification |  |
|  <2 years | 112 (7%) |
|  2-5 years | 196 (12%) |
|  6-10 years | 252 (16%) |
|  11-15 years | 250 (16%) |
|  16-20 years | 268 (17%) |
|  21+ years | 411 (26%) |
|  Not stated | 97 (6%) |
|  |  |
| Additional relevant qualification or specialist interest |  |
|  None | 1125 (71%) |
|  Diploma in paediatrics/obstetrics/family planning/public health/vaccination | 310 (20%) |
|  Switched to general practice during paediatric/obstetrics specialist training | 36 (2%) |
|  Informal special interest in paediatrics/obstetrics/vaccination | 25 (2%) |
|  Not stated | 90 (6%) |
|  |  |
| Whether they see pregnant women as part of routine antenatal care |  |
|  Yes | 525 (33%) |
|  No | 967 (61%) |
|  Not stated | 94 (6%) |

**Table 1:** Characteristics of the GPs who responded to the questionnaire

|  |  |  |
| --- | --- | --- |
| **Variable** | **Number of GPs who reported discussing antenatal vaccination with pregnant women ‘everytime’ or ‘often’**  | **Adjusted odds ratio (95% CI)** |
| ***Length of time working as a GP since qualification*** |  |  |
| >11 years | 360/922 (39%) | 1.84 (1.26-2.68) \*\* |
| 2-10 years | 154/445 (35%) | 1.61 (1.09-2.40) \* |
| *< 2 years* | 26/111 (23%) | 1.00 for reference |
| ***Presence of extra qualification or special interest in paediatrics, obstetrics, infectious disease or related subject*** |  |  |
| Yes | 183/393 (47%) | 1.21 (0.97-1.51) |
| No | 359/1085 (33%) | 1.00 for reference |
| **Review pregnant women routinely as part of their antenatal care** |  |  |
| Yes | 266/523 (51%) | 2.00 (1.63-2.47) \*\*\* |
| No | 278/958 (29%) | 1.00 for reference |
| **Extent to which they believed discussing vaccination was a responsibility of GPs** |  |  |
| Strongly agree | 129/181 (71%) | 11.58 (7.60-17.64) \*\*\* |
| Agree | 338/716 (47%) | 4.15 (3.01-5.65) \*\*\* |
| Neutral | 85/441 (19%) | 1.66 (1.21-2.29) \*\* |
| Disagree | 29/213 (14%) | 1.00 for reference |
| **Level of confidence in their knowledge of the risks/benefits of antenatal pertussis vaccination** |  |  |
| Strongly agree/agree | 452/1012 (45%) | 3.52 (2.45-5.07) \*\*\* |
| Neutral | 105/373 (28%) | 2.25 (1.53-3.30) \*\*\* |
| Disagree/strongly disagree | 20/181 (11%) | 1.00 for reference |
| **Level of confidence in their knowledge of the risks/benefits of antenatal influenza vaccination** |  |  |
| Strongly agree/agree | 516/1242 (42%) | 2.34 (1.40-3.91) \*\* |
| Neutral | 46/227 (20%) | 1.34 (0.77-2.31) |
| Disagree/strongly disagree | 10/84 (12%) | 1.00 for reference |

**Table 2 (supplementary information)**: Multivariate ordinal regression analysis of factors predicting how often GPs discussed antenatal vaccination with pregnant women

\* p<0.05; \*\* p<0.01; \*\*\* p<0.001