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Do previously held vaccine attitudes dictate the extent and influence of vaccine information seeking behaviour during pregnancy?

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Pregnancy represents a high information need state, where uncertainty around medical intervention is common. As such, the pertussis vaccination given during pregnancy presents a unique opportunity to study the interaction between vaccine attitudes and vaccine information seeking behaviour.

We surveyed a sample of pregnant women (N = 182) during early pregnancy and again during late pregnancy. The variables of vaccine confidence and risk perception of vaccination during pregnancy were measured across two questionnaires. Additional variables of decision conflict and intention to vaccinate were recorded during early pregnancy, while vaccine information-seeking behaviour and vaccine uptake were recorded during late pregnancy.

pertussis vaccination during pregnancy (p = .004), spent significantly more time seeking information about the pertussis vaccination.

Women's perception of risk related to vaccination during pregnancy significantly changed throughout the pregnancy ($t(182) = 4.685$ $p < .001$), with women perceiving the risk of pertussis disease higher as compared to the risk of side effects from the vaccine as the pregnancy progresses.

The strength and influence of information found through seeking was predicted by intention to vaccinate (p = .011). As such, we suggest that intention to vaccinate during early pregnancy plays a role in whether the information found through seeking influences women towards or away from vaccination.

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When facing a vaccination decision, people often commit substantial time and effort to seeking out additional information in regards to the vaccine, the disease the vaccine protects against, and the systems related to the vaccination programme. Vaccine information-seeking behaviour is common in individuals regarding their own immunisation (1–5), and the immunisation of their children (6–11). This seeking behaviour frequently relates to the perception of previously acquired information as inadequate (8,12,13), confusing (14,15) or conflicting (16). Consequently, a person may seek information about vaccination to feel reassured about a decision, get a 'second opinion' or prepare for a consultation with a healthcare professional (16,17), sometimes with the intention of challenging a recommendation (18,19). The content of such information gathered through seeking often centres around safety concerns related to a specific vaccine (16), the signs and symptoms of a disease the vaccine is intended to prevent (13) or gaining information on aspects of trust and morality such as financial interests, misconduct and intentions of individuals within the healthcare system or pharmaceutical industry (18). As such, the information gained through vaccine information-seeking can be categorised as information pertaining to trust and personal risk management (20).

Such vaccine information-seeking behaviour is present in sizable minority of both individuals that accept (2,6) but also those that decline (1,4,5) vaccination. The binary distinction of searching or not searching for additional vaccine information, therefore, appears to be a poor predictor of overall vaccine uptake. Extent of vaccine information-seeking behaviour however, may prove a reliable indicator of vaccine refusal, with extensive information

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seeking being associated with vaccine hesitant beliefs and behaviours, such as delay in acceptance or refusal of vaccines despite vaccine availability (6,9,21). A reliable relationship also appears to exist between the channels[1] of information that are utilised during the information seeking process and the likelihood of vaccinating.

People seeking information from a healthcare professional, or the wider health care system, are substantially less likely to refuse vaccination (22,23). Concerns exist, however, in regards to those individuals that seek information predominantly through other means, such as the internet or friends and family members. Numerous studies have documented that the internet is rife with misinformation about vaccination (24–27) and that such misinformation can flow through intimate, online and offline, social networks (28,29). Furthermore, the work by Betsch and others (30–32) demonstrates that after consuming misinformation critical of vaccination, for as little as five to ten minutes in some cases (30), individuals perceive the risk related to vaccination significantly higher, and the risk related to not vaccinating as significantly lower, than those viewing control information.

With pregnancy often cited as a high information need state (33,34) and events such as the thalidomide tragedy (35) cementing the teratogenic risks of pharmaceutical products in the minds of many parents-to-be (36–39), vaccination during pregnancy lends itself well to the examination of vaccine information-seeking behaviour. Due to the sessional variability of the influenza during pregnancy vaccine, we selected the vaccination of pertussis (also known as whooping cough) during pregnancy as the vaccine decision of interest for this current study.

[1] Throughout this study, we make a distinction between a "channel" of information and a "source" of information. We take Rogers and Shoemaker's definitions whereby an information channel is, "the means by which the message gets from the source to the receiver" (Rogers & Shoemaker. 1971, pp.24, cited from Johnson & Case 2012, pp 32), while an information source is, "…an individual or an institution that originates a message" (Rogers & Shoemaker. 1971, pp.251, cited from Johnson & Case 2012, pp 33). With such definitions, a single source of information, such as the NHS, can communicate through multiple channels (for example, the NHS can communicate vaccine information through a healthcare professional and through their website). Our study predominantly focuses on channels of information as opposed to sources of information.

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Women in the UK are currently recommended an immunisation for pertussis during each pregnancy (40). With waning immunity and increased levels of circulation of the disease in adolescent and adult population (41) a sizable outbreak of pertussis occurred in 2012 prompted the introduction of this additional pertussis vaccination campaign. Vaccinating during pregnancy grants mothers immunity from pertussis during their pregnancy and passes on immunity to their babies, protecting children during the crucial first few weeks of life until they are old enough to receive their own vaccinations for the disease (42–44). Latest uptake statistics of the recommended pertussis containing vaccine (Boostrix IPV) during pregnancy in the UK are approximately 71.9% (April- June 2018) (42) indicating the successful initial implementation of the program, however, there still exists considerable room for improvement.

With the present study, we investigated vaccine information-seeking behaviour over the course of the pregnancy vaccination decision-making process with three main aims. First, we wanted to determine the extent to which previously held vaccine hesitant attitudes during pregnancy, are associated with the extent and perceived influence of vaccine information-seeking behaviour. We hypothesised that lower levels of vaccine confidence, higher perception of risk associated with the vaccine, higher decision conflict and lower intention to vaccinate would predict higher total number of hours of vaccine information-seeking behaviour (Hypothesis 1) as well as the perceived strength, and direction of influence, of information found through seeking (Hypothesis 2). Second, we wanted to investigate the predictor variables of accepting the pertussis vaccine during pregnancy. We hypothesised that higher perception of risk associated with the vaccine, lower vaccine confidence, higher intention to vaccinate, higher strength of recommendation from a healthcare professional and the behaviour of information-seeking would positively predict vaccine uptake (Hypothesis 3). Third, we wanted to examine whether the strength of recommendation from a healthcare

professional, the behaviour of vaccinating and the behaviour of seeking information during the decision-making process predict a change in attitude towards vaccination between early and late pregnancy (Hypothesis 4).

Finally, we also had some exploratory aims, specifically we asked two research questions. The first being, how often do women use the various channels of vaccine information (friends and family members, healthcare professionals and the internet) and how influential do they perceived them? And the second being, do the various channels of information used by participants differ across vaccine uptake and non-uptake?

Methods

Design Overview

To examine the decision-making process we designed a two-part cross-sectional questionnaire study: before and after a prompt to vaccinate. In the first part (Questionnaire T1), we gathered responses from women early in their pregnancy (>4 and <18 weeks of their pregnancy) -- before the decision to vaccinate for pertussis is usually prompted by a healthcare professional. In the second part (Questionnaire T2), we gathered information from the same women after they made their decision whether to take or not take the recommended vaccine (after 36th week of their pregnancy).

Participants and Procedure

To be eligible to participate in our study, women were required to be (i) fluent in English, (ii) between 4 and 18 weeks of pregnancy, and (iii) currently living in England or Wales. Recruitment of this sample involved identifying a total of 1,664 public groups and relevant professionals related to pregnancy (e.g. antenatal groups, yoga groups, doulas and hypnobirthing practitioners) through the use of the local pregnancy/antenatal listings on the

website www.netmums.com and enlisting their assistance in advertising the study to their group members.

A total of 357 participants followed the link provided to start Questionnaire T1 between June and November of 2017. Of these 273 participants fully completed Questionnaire T1. A question indicating the current number of weeks pregnant in Questionnaire T1 was used to dictate when a follow up message with the link to Questionnaire T2 was to be sent to the participant (i.e. >36 weeks of pregnancy). When subsequently re-contacted, 193 of the 273 participants that fully completed the questionnaire at time 1 clicked on the link to start the questionnaire at time 2, with 187 participants fully completing Questionnaire T2 (31.5% attrition rate). Analysis was performed only on those that had fully completed both questionnaires.

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Participant demographics

After the removal of outliers (see the Results section for more detail), 182 participants were included in the final data analysis. The recorded socio-demographic characteristics of the participants are reported in table 1. Participants were predominantly White British (88.5%) and aged 22-42 years (M = 31.97, SD = 3.84 years). 21.4% of participants reported their current pregnancy as their first pregnancy, the week of pregnancy at Questionnaire T1 were equally spread across the required 4 to 18 week range, and 94.5% of participants were aware of the pertussis vaccination programme during pregnancy. When re-contacted for Questionnaire T2 after 36 weeks of pregnancy, 89.6% reported having received the pertussis vaccine during their pregnancy.

[Table 1]

Scales and Measures

Questionnaire overview

The content of each questionnaire were as follows (a full description of each included scale of measurement is included thereafter):

Questionnaire T1 – Pre-decision: This questionnaire included a number of demographic and control questions, followed by two psychometric scales: *Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale* and the *Vaccine Confidence Scale*. All participants were then presented with NHS information related to the pertussis vaccination campaign in pregnancy, asked to indicate their intention to vaccinate against pertussis during their pregnancy and complete *the decision conflict scale* in regards to their upcoming vaccination decision.

Questionnaire T2 – Post-decision: This questionnaire again included the *Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale* and the *Vaccine Confidence Scale* used in the Questionnaire T1. Participants were then asked to report if they received the pertussis vaccine during their pregnancy, their vaccine information-seeking behaviour during the intervening period and the perceived influence of sought information.

[Figure 1]

The following sections outline the psychometric scales and measures included in the study. The full version of the two questionnaires, as seen by the participants at each time point, can be found in the provided supplemental materials.

The Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale

The *Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale* is a custom-made scale tailored towards the measurement of risk perception as related to pertussis and the pertussis vaccination recommended during pregnancy. Adapted in part from scales used in Henninger, Naleway, Cane, Donahue and Irving (45) and Wallace, Leask and Trevena (46). The scale has its bases in the severity and susceptibility elements of the Health

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Belief Model (47), and can be used to capture perceptions of vaccination and disease susceptibility and severity for both the mother and her baby. The scale consists of 10 statements (e.g. "*Whooping cough (as a disease) is common in my area among adults"*) that are assessed on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The final score is expressed as a subtraction of the vaccine related items from the disease related items with final higher values indicating a higher perception of risk related to the disease of whooping cough as compared to the vaccine. Lower values on this scale indicate a higher perception of risk for the vaccine as compared to the disease of whooping cough.

The Vaccine Confidence Scale

The *Vaccine Confidence Scale* was adapted for use in this study from a similar scale outlined in the 2014 SAGE working group on vaccine hesitancy report (48). The scale focuses on the perceived effectiveness, efficacy, importance and safety of vaccination. This scale consists of 10 statements (e.g. *"All childhood vaccines offered by the government program in my community are beneficial"*) that are assessed on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The final score is expressed as an average of each of the statement scores with higher values indicating greater confidence held towards vaccination.

The decision conflict scale

The *decision conflict scale* (49,50) was developed to assist in evaluating shared health care decisions by identifying when a patient feels stress, distress or conflict during a medical decision. In its development and testing, it was used to assess influenza vaccination decision-making. As the pertussis vaccination during pregnancy is a similar adult vaccination decision, we therefore judged this an appropriate tool for measuring decision conflict caused by a decision to vaccinate during pregnancy. The scale has also been used previously to evaluate

the effectiveness of decision aids for the MMR vaccine decision (51). This scale consists of 12 statements related to a decision (e.g. *"It's hard to decide if the benefits are more important to me than the risks, or if the risks are more important than the benefits"*) and a separate standalone statement on intention to receive the vaccination (*"I intend to vaccinate for whooping cough during my current pregnancy"*). The 12 statements are assessed on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5), whereas the intention statement was assessed on a seven-point Likert scale also ranging from strongly disagree (1) to strongly agree (7). The final decision conflict score is expressed as an average of each statement, with higher values indicating greater levels of decision conflict. Intention to vaccinate was taken as a standalone variable with higher values indicating a higher intention to vaccinate.

Vaccine information-seeking behaviour measures

Participants were asked to report approximately how long they spent seeking information through friends and family members, through a healthcare professional and through the internet. For each of the three information channels participants were asked to select the number of hours and minutes, with zero as a possibility, they spent seeking information and the perceived influence of the information they found. A variable of total vaccine information-seeking behaviour was taken as a summation of these three questions. In the statistical analysis we took the logarithm of this total so as to meet parametric assumption.

Perceived influence of the information was measured on a seven-point Likert scale. The scale ranged from, influencing greatly away from vaccination (1) to influencing greatly towards vaccination (7), with no influence as a mid-point between the two.

Statistical analyses

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For the purposes of analysis, the study data was downloaded from the Qualtrics servers in a comma separated values format. The data from the two surveys were linked through the use of a contact email address given by the participants at the end of Questionnaire T1 and at the beginning of Questionnaire T2. This and any additional identifiable information were subsequently deleted from the data set to preserve participant anonymity. Statistical analyses were carried out using SPSS v.24 for Windows. Power calculations were performed using the G*Power v.3.1.9.2 application (52).

Each scale was scored and consolidated into variables for use in the analysis. Multiple regression models were used to test Hypothesis 1, 2 & 4 while a logistic regression was used to test Hypothesis 3.

Results

Outliers

To investigate our data for outliers we calculated Mahalanobis distances (MD) for the total number of hours participants spent seeking information about vaccination. Mahalanobis distance values were assessed using $X^2(4, N = 187)$ at $p < .01$. The results indicated that five values exceeded the critical value (i.e. 13.816) and were as such rejected from the analysis.

Predicting information-seeking behaviour (Hypothesis 1)

We performed a multiple linear regression to test if the variables *vaccine confidence, risk perception of vaccination during pregnancy, decision conflict* and *intention to vaccinate* predicted the total number of hours of vaccine information-seeking behaviour (log variable). The variables significantly predicted the total number of hours of vaccine information-seeking behaviour (log variable), $F(4, 181) = 6.597$, $p < .001$, and successfully explained 11.0% of the variance in vaccine information-seeking behaviour (Adjusted $R^2 = 0.110$). The

variance inflation factor (VIF) for each variable indicated low multicollinearity. Table 2 presents the regression coefficients and VIF statistic for the predictor variables.

[Table 2]

Two out of the four variables were found to be significant predictors of the total number of hours of vaccine information-seeking behaviour (log variable): vaccine confidence (B = -.371, p = .004) and risk perception of vaccination during pregnancy (B = .206, p = .004). Holding a higher perception of risk towards the disease of whooping cough, as opposed to the risk of the vaccine, and having a lower confidence in vaccination were significantly associated with spending longer looking at information.

Predicting the perceived influence of information (Hypothesis 2)

We performed a multiple linear regression to test if the variables *vaccine confidence (T1)*, *risk perception of vaccination during pregnancy (T1)*, *decision conflict* and *intention to vaccinate* predict the perceived strength and direction of influence of information found through seeking. For this analysis only participants that had reported seeking information from one or more of the three information channels were included in the analysis (n = 161). The variables significantly predicted the perceived strength and direction of influence of information found through seeking, $F(4,160) = 3.794$, p = .006, and successfully explained 6.5% of the variance (Adjusted $R^2 = 0.065$). The variance inflation factor (VIF) for each variable indicated low multicollinearity. Table 3 presents the regression coefficients and VIF statistic for the included variables.

[Table 3]

One variable, intention to vaccinate, was found to be a significant predictor (B = .227, p = .011) and indicated that the greater the level of intention to vaccinate at T1 the more likely

the participant was to perceive the information that they found as pointing them towards vaccination.

Predicting vaccine uptake (Hypothesis 3)

We performed a logistic regression to test if the variables risk perception of vaccination during pregnancy, vaccine confidence, vaccine information-seeking behaviour, intention to vaccinate and strength of recommendation from a healthcare professional predicted vaccine uptake (Table 4 shows the point-biserial correlations for variables in this analysis). A total of 173 cases were analysed and the full model significantly predicted vaccine uptake (omnibus $Chi^2 = 55.825$, df = 5 $p < .001$). The model accounted for between 27.6% and 64.1% of the variance in vaccine uptake, with 99.4% of vaccinating participates predicted and 71.4% of non-vaccinating participants predicted. The Hosmer and Lemeshow test indicated that the data adequately fit the model ($Chi^2 = 14.5$, df = 8, $p = .07$). Table 5 gives the regression coefficients and associated statistics.

[Table 5]

One variable, *vaccine confidence*, significantly predicts vaccine uptake. With an increase in vaccine confidence increasing the likelihood of vaccine uptake ($OR = 9.46$, $p = .037$).

Predicting the change in risk perception of vaccination during pregnancy (Hypothesis 4)

There was a significant difference in mean risk perception between the participants responses taken at time 1 (Questionnaire T1 $M = 1.01$, $SD = 0.90$) and the participants responses taken at time 2 (Questionnaire T2 $M = 1.28$, $SD = 0.94$), $t(182) = 4.685$ $p < .001$. This finding indicated significantly less focus on risk associated with the vaccine (and more of a focus on risk associated with pertussis) after 36 weeks of pregnancy as compared to before 18 weeks of pregnancy. There was no significant difference in mean vaccine confidence across the two

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questionnaires, $t(185) = .233$ $p = .816$ (Questionnaire T1 $M = 4.00$, $SD = .73$, Questionnaire T2 $M = 3.99$, $SD = 0.76$).

We performed a multiple linear regression to test if the variables *vaccine uptake, total hours of vaccine information-seeking behaviour* (log variable), and *strength of recommendation* significantly predicted the difference in risk perception of vaccination during pregnancy. The variables did not significantly predicted difference in risk perception of vaccination during pregnancy, $F(3,172) = 1.118$ $p = .343$.

Exploratory analysis of information-seeking data

88.8% of participants reported seeking additional information about vaccination, of which 91.3% reported seeking such information from friends, family members or the internet. The total hours of vaccine information-seeking behaviour variable used in the above analysis involved the summation of three common channels of vaccine information: friends and family members, a healthcare professional and the internet. Table 6 contains the perceived influence of each channel and the amount of time participants used each channel.

[Table 6]

Two sections of Questionnaire T2 asked participants about their information-seeking behaviour. All participants were asked if they used any of a range of information channels. Table 7 demonstrates the frequency that each channel was used and how this differed between acceptors and decliners of the pertussis vaccination. The data lacked sufficient power to conduct Chi Squared tests to determine significant differences.

[Table 7]

Discussion

In the current study, we examined the pertussis vaccine related beliefs and perceptions of pregnant women, before and after health care professionals typically recommend the

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vaccination for pertussis. We used self-reported vaccine information-seeking behaviour, during the intervening period, to examine the changes in perception that occur over the course of pregnancy, and used additional variables to predict the extent and perceived influence of such vaccine information-seeking behaviour.

One of the strongest findings in our study was that of the change in vaccine related risk perception between early and late pregnancy. A comparison across the two time points indicated an increasing perceived risk towards the disease of pertussis, as compared to the vaccine. While previous studies have indicated increased levels of disease related risk perception during pregnancy (53,54), the current study appears to be the first to record a significant change occurring between early and late pregnancy. None of the additional variables we recorded, including strength of recommendation from a health care professional, significantly predicted this shift in risk perception.

Vaccine information-seeking behaviour was found to play a complex role in the vaccine decision-making process. The perceived susceptibility to, and severity of pertussis, and lower levels of vaccine confidence were both associated with spending longer searching for information about the pertussis vaccine. When it came to the influence of such information, however, only intention to vaccinate significantly predicted in which direction the found information was likely to influence the participant. With higher intention to vaccinate being associated with finding information that was perceived as pointing participants towards vaccination and a lower intention to vaccinate being associated with finding information that was perceived as pointing participants away from vaccination. This form of search behaviour appears to be akin to the *confirmation bias* whereby evidence is reviewed in such a way so as to support pre-existing beliefs and expectations (55).

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When separated by information channel, the positive influence of a health care professionals becomes evident, with 62% stating that seeking information from a health care professional influenced them towards vaccination, what was particularly interesting however was the influence of friends and family members and the internet. When information was sought out from friends and family member's, participants largely reported no influence (68.4%). This could indicate one of two possibilities, either the information gained was not used to inform the decision-making process or it confirmed pre-existing beliefs and therefore did not move the participant in one direction or the other. As for the internet, while this channel is often cited as a detriment to vaccine uptake (8,56), the information sought through the internet overwhelming pointed participants towards vaccination (57% influencing towards compared to 7% influencing away from vaccination). This finding likely indicates the positive effects of having a strong evidence-based web presence such as that of the NHS in the UK.

Practical implications

The results of this study have a number of implications for vaccine communication. Firstly, spending additional time seeking information about vaccination outside of the health care professional relationship does not appear to have a negative effect on vaccine uptake. With the internet often talked about in somewhat hyperbolic terms (24,57) in the vaccine hesitancy literature it is important to note that the vast majority of people that search for information through the internet are saying that the information they found is pointing them towards vaccination. The exception would be with individuals that indicate a particularly low intention to vaccinate, internet information seeking for these individuals could potentially move them more away from vaccination. Instead, additional time with a health care professional for these individuals may help address their concerns.

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Secondly, with the positive shift in risk perception surrounding the pertussis vaccine occurring over the course of a pregnancy if women decide earlier in the pregnancy not to get the vaccine, recommending it again later in the pregnancy may yield a different result. While the pertussis vaccine is recommended before 36 weeks of pregnancy, it is still possible for women to have it up until birth. This gives plenty of time for risk perception to change in the meantime.

Lastly, Betsch, Bodeker, Schmid & Wichmann (58) suggest that pregnancy vaccinations may be a good time to also provide information pertaining to childhood vaccinations. Seeing as a high proportion of women are active in the information gathering process guidance on appropriate sources of information at this stage would likely be highly beneficial.

Strengths and Limitations

Measuring the amount of information seeking an individual performs is an inherently difficult process. While the channels and sources of such information are important, there is also an element of subjectivity when it comes to interpreting information and a possible selection bias in who finds, consumes and applies what information to a vaccine decision. The study design aids in researching this process and the exploratory analysis highlights some of this nuance but much of what guides the vaccine information seeking process is left unmeasured. Foremost of these neglected areas is that of vaccine information scanning, the passive acquisition of information about vaccination which is not actively sought out. Information scanning is key to understanding the effect of vaccine information on social media and as of yet not well understood.

Participants in this study vaccinated at a higher rate (89.8%) than the national rate of 71.9%, indicating a possible self-selection bias related to participation and as such, caution should be taken when it comes to applying these results to those that refuse vaccination.

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Declaration of Interest Statement

All authors have no conflicts of interest.

Ethical Approval

Ethical approval was received from the London School of Hygiene & Tropical Medicine ethics committee on 18/5/2017.

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References

1. Manika D, Ball JG, Stout PA. Factors Associated with the Persuasiveness of Direct-to-Consumer Advertising on HPV Vaccination Among Young Women Factors Associated with the Persuasiveness of Direct-to-Consumer Advertising on HPV Vaccination Among Young Women. J Health Commun. 2014;19(11):1232–47.

2. Bults M, Beaujean DJMA, Richardus JH, Steenbergen JE van, Voeten HA. Pandemic influenza A (H1N1) vaccination in The Netherlands: Parental reasoning underlying child vaccination choices. Vaccine [Internet]. 2011;29(37):6226–35. Available from: http://dx.doi.org/10.1016/j.vaccine.2011.06.075

3. Walter D, Böhmer MM, Reiter S, Krause G, Wichmann O. Risk perception and information-seeking behaviour during the 2009/10 influenza A (H1N1) pdm09

pandemic in Germany. Eurosurveillance. 2012;17(13):1–8.

4. Cheung EKH, Lee S, Lee SS. Pattern of exposure to information and its impact on seasonal influenza vaccination uptake in nurses. J Hosp Infect [Internet]. 2017;97(4):376–83. Available from: https://doi.org/10.1016/j.jhin.2017.08.005

5. Kim S, Real K. A profile of inactive information seekers on influenza prevention: a survey of health care workers in Central Kentucky. Heal Inf Libr J [Internet]. 2016;33(3):n/a-n/a. Available from: http://doi.wiley.com/10.1111/hir.12132

6. Brunson EK. The Impact of Social Networks on Parents' Vaccination Decisions. Pediatrics [Internet]. 2013;131(5):e1397–404. Available from: http://pediatrics.aappublications.org/cgi/doi/10.1542/peds.2012-2452

7. Harmsen IA, Doorman GG, Mollema L, Ruiter RAC, Kok G, de Melker HE. Parental information-seeking behaviour in childhood vaccinations. BMC Public Health [Internet]. 2013;13:1219. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24358990

8. Weiner JL, Fisher AM, Nowak GJ, Basket MM, Gellin BG. Childhood immunizations: First-time expectant mothers' knowledge, beliefs, intentions, and behaviors. Am J Prev Med [Internet]. 2015;49(6):S426–34. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0749379715003529

9. Wheeler M, Buttenheim AM. Parental vaccine concerns, information source, and choice of alternative immunization schedules. Hum Vaccines Immunother. 2013;9(8):1782–9.

10. Stevens CF, Caughy MO, Lee SC, Wendy P, Tiro JA. Does language moderate the influence of information scanning and seeking on HPV knowledge and vaccine

Ma
ript

awareness and initation among Hispanics? Ethn Dis. 2013;23(1):95–102.

11. Jung M, Lin L, Viswanath K. Associations between health communication behaviors , neighborhood social capital , vaccine knowledge , and parents ' H1N1 vaccination of their children. Vaccine [Internet]. 2013;31(42):4860–6. Available from: http://dx.doi.org/10.1016/j.vaccine.2013.07.068

12. Boyd CA, Gazmararian JA, Thompson WW. Knowledge, attitudes, and behaviors of low-income women considered high priority for receiving the novel influenza A (H1N1) vaccine. Matern Child Health J. 2013;17(5):852–61.

13. King CL, Chow MYK, Wiley KE, Leask J. Much ado about flu: a mixed methods study of parental perceptions, trust and information seeking in a pandemic. Influenza Other Respi Viruses [Internet]. 2018;(January):1–8. Available from: http://doi.wiley.com/10.1111/irv.12547

14. Downs JS, de Bruin WB, Fischhoff B. Parents' vaccination comprehension and decisions. Vaccine. 2008;26(12):1595–607.

15. Harmsen IA, Bos H, Ruiter RAC, Paulussen TGW, Kok G, de Melker HE, et al. Vaccination decision-making of immigrant parents in the Netherlands; a focus group study. BMC Public Health [Internet]. 2015;15(1):1229. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2572-x

16. Mus M, Kreijkamp-kaspers S, Mcguire T, Deckx L, Driel M Van. What do health consumers want to know about from an Australian medicines call centre. Aust N Z J Public Health. 2017;41(1):74–9.

17. Jackson C, Cheater FM, Reid I. A systematic review of decision support needs of parents making child health decisions. Heal Expect. 2008;11(3):232–51.

Ma ript

18. Sporton RK, Francis S a. Choosing not to immunize: are parents making informed decisions? Fam Pract. 2001;18(2):181–8.

19. Gilmour J, Harrison C, Asadi L, Cohen MH, Vohra S. Childhood Immunization: When Physicians and Parents Disagree. Pediatrics [Internet]. 2011;128(Supplement 4):S167–74. Available from: http://pediatrics.aappublications.org/lookup/doi/10.1542/peds.2010-2720E

20. Siegrist M, Earle TC, Gutscher H. Trust in Cooperative Risk Management . 2007. 320 S.

21. The Strategic Advisory Group of Experts (SAGE). Report of the SAGE working group on vaccine hesitancy. 2014;(October):63. Available from: http://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf

22. Campbell H, Edwards A, Letley L, Bedford H, Ramsay M, Yarwood J. Changing attitudes to childhood immunisation in English parents. Vaccine [Internet]. 2017;35(22):2979–85. Available from: http://dx.doi.org/10.1016/j.vaccine.2017.03.089

23. Smith LE, Amlôt R, Weinman J, Yiend J, Rubin GJ. A systematic review of factors affecting vaccine uptake in young children. Vaccine [Internet]. 2017;35(45):6059–69. Available from: https://doi.org/10.1016/j.vaccine.2017.09.046

24. Kata A. A postmodern Pandora's box: Anti-vaccination misinformation on the Internet. Vaccine. 2010;28(7):1709–16.

25. Briones R, Nan X, Madden K, Waks L. When vaccines go viral: an analysis of HPV vaccine coverage on YouTube. Health Commun [Internet]. 2012;27(5):478–85.

Manuscript

Available from: http://www.ncbi.nlm.nih.gov/pubmed/22029723

26. Buchanan R, Beckett RD. Assessment of vaccination-related information for consumers available on Facebook. Health Info Libr J. 2014;31(3):227–34.

27. Babaoff C, Auria JPD, Hill C, Carolina N. Googling for Information About Alternative Vaccination Schedules. J Pediatr Heal Care [Internet]. 2015;29(4):379–84. Available from: http://dx.doi.org/10.1016/j.pedhc.2015.04.012

28. Cassell JA, Leach M, Poltorak MS, Mercer CH, Iversen A, Fairhead JR. Is the cultural context of MMR rejection a key to an effective public health discourse? Public Health [Internet]. 2006;120(9):783–94. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0033350606001041

29. Attwell K, Smith DT, Ward PR. 'The Unhealthy Other': How vaccine rejecting parents construct the vaccinating mainstream. Vaccine [Internet]. 2018;36(12):1621–6. Available from: https://doi.org/10.1016/j.vaccine.2018.01.076

30. Betsch C, Renkewitz F, Betsch T, Ulshofer C. The Influence of Vaccine-critical Websites on Perceiving Vaccination Risks. J Health Psychol [Internet]. 2010;15(3):446–55. Available from: http://hpq.sagepub.com/cgi/doi/10.1177/1359105309353647

31. Betsch C, Renkewitz F, Haase N. Effect of narrative reports about vaccine adverse events and bias-awareness disclaimers on vaccine decisions: a simulation of an online patient social network. Med Decis Making [Internet]. 2013;33(1):14–25. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22875721

32. Betsch C, Ulshofer C, Renkewitz F, Betsch T. The Influence of Narrative v. Statistical Information on Perceiving Vaccination Risks. Med Decis Mak [Internet].

Ma ript

2011;31(5):742–53. Available from: http://mdm.sagepub.com/cgi/doi/10.1177/0272989X11400419

33. Grimes HA, Forster DA, Newton MS. Sources of information used by women during pregnancy to meet their information needs. Midwifery [Internet]. 2014;30(1):e26–33. Available from: http://dx.doi.org/10.1016/j.midw.2013.10.007

34. Lowe P, Powell J, Griffiths F, Thorogood M, Locock L. Making it all normal: the role of the internet in problematic pregnancy. Qual Health Res. 2009;19(10):1476–84.

35. Kim JH, Scialli AR. Thalidomide : The Tragedy of Birth Defects and the Effective Treatment of Disease. 2011;122(1):1–6.

36. Hämeen-Anttila K, Nordeng H, Kokki E, Jyrkkä J, Lupattelli A, Vainio K, et al. Multiple information sources and consequences of conflicting information about medicine use during pregnancy: A multinational internet-based survey. J Med Internet Res. 2014;16(2):1–11.

37. Lupton DA. 'The best thing for the baby': Mothers' concepts and experiences related to promoting their infants' health and development. Health Risk Soc [Internet]. 2011;13(7–8):637–51. Available from: http://www.tandfonline.com/doi/abs/10.1080/13698575.2011.624179

38. Potts JM, Nelson-Piercy C. Prescribing in pregnancy. Obstet Gynaecol Reprod Med [Internet]. 2013;23(5):137–45. Available from: http://dx.doi.org/10.1016/j.ogrm.2013.03.006

39. Widnes SF, Schjøtt J. Risk perception regarding drug use in pregnancy. Am J Obstet Gynecol [Internet]. 2016;1–4. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0002937816331751

Manuscript

40. Flory D. Commissioning the pertussis (whooping cough) vaccination programme for pregnant women. London Dep Heal. 2012;1–6.

41. Berbers GAM, Greeff SC De, Mooi FR, Berbers GAM, Greeff SC De, Mooi FR. Improving pertussis vaccination Improving pertussis vaccination. 2009;8600.

42. Public Health England. Pertussis vaccination programme for pregnant women update : vaccine coverage in England , April to June 2018. 2018;12(42).

43. NHS Choices. Whooping cough: help protect your baby [Internet]. 2015. Available from: http://www.nhs.uk/conditions/Whooping-cough/Pages/Introduction.aspx

44. Maltezou HC, Ftika L, Theodoridou M. Nosocomial pertussis in neonatal units. J Hosp Infect [Internet]. 2013;85(4):243–8. Available from: http://dx.doi.org/10.1016/j.jhin.2013.09.009

45. Henninger M, Naleway A, Crane B, Donahue J, Irving S. Predictors of seasonal influenza vaccination during pregnancy. Obstet Gynecol [Internet]. 2013;121(4):741–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23635673

46. Wallace C, Leask J, Trevena LJ. Effects of a web based decision aid on parental attitudes to MMR vaccination: a before and after study. BMJ [Internet]. 2006;332(7534):146–9. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1336764&tool=pmcentrez&rendertype=abstract

47. Janz NK, Becker MH. The Health Belief Model: A Decade Later. Health Educ Q [Internet]. 1984;11(1):1–47. Available from: http://journals.sagepub.com/doi/10.1177/109019818401100101

48. SAGE. Report of the SAGE working group on vaccine hesitancy. 2014;(October):63.

Manuscript

Available from: http://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf

49. O'Connor A. Decisional Conflict Scale 2nd Edition. 1997;18.

50. O'Connor A. Validation of a Decisional Conflict Scale. Med Decis Mak. 1995;15(1):25–30.

51. Shourie S, Jackson C, Cheater FM, Bekker HL, Edlin R, Tubeuf S, et al. A cluster randomised controlled trial of a web based decision aid to support parents' decisions about their child's Measles Mumps and Rubella (MMR) vaccination. Vaccine [Internet]. 2013;31(50):6003–10. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0264410X13014011

52. Erdfelder E. G * Power 3 : A flexible statistical power analysis program for the social , behavioral , and biomedical sciences. 2007;39(2):175–91.

53. Bodeker B, Betsch C, Wichmann O. Skewed risk perceptions in pregnant women: the case of influenza vaccination. BMC Public Health [Internet]. 2016;16(1):1308. Available from: http://dx.doi.org/10.1186/s12889-015-2621-5

54. Collins J, Alona I, Tooher R, Marshall H. Increased awareness and health care provider endorsement is required to encourage pregnant women to be vaccinated. Hum Vaccin Immunother [Internet]. 2014;5515(October 2015):1–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25483464

55. Nickerson RS. Confirmation Bias : A Ubiquitous Phenomenon in Many Guises. 1998;2(2):175–220.

56. Jones AM, Omer SB, Bednarczyk RA, Halsey NA, Moulton LH, Salmon D. Parents'

Ma ript

source of vaccine information and impact on vaccine attitudes, beliefs, and nonmedical exemptions. Adv Prev Med [Internet]. 2012;2012:1–8. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3469070&tool=pmcentrez&rendertype=abstract

57. Stein RA. Editorial The golden age of anti-vaccine conspiracies. 2017;7(December):168–70.

58. Betsch C, Bödeker B, Schmid P, Wichmann O. How baby ' s first shot determines the development of maternal attitudes towards vaccination. Vaccine [Internet]. 2018;36(21):3018–26. Available from: https://doi.org/10.1016/j.vaccine.2018.04.023

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Table 1

Characteristics of sample and descriptive statistics

Questions (N=182)	*Number (%)*	
Age years		
20-24 yrs	5	(2.7)
25-29 yrs	48	(26.4)
30-34	80	(44.0)
35-39 yrs	46	(25.3)
40+ yrs	3	(1.6)
Ethnicity		
White - British	161	(88.5)
White - Other white background	11	(6.0)
Mixed/Multiple ethnic groups	8	(4.4)
Asian or Asian British	1	(0.5)
Other ethnicity not represented	1	(0.5)
Week of pregnancy during T1 questionnaire		
4-8 weeks	58	(31.9)
9-13 weeks	60	(33.0)
14-18 weeks	64	(35.1)
Number of pregnancies		
First pregnancy	39	(21.4)
1-2 previous pregnancies	134	(73.6)
3+ previous pregnancies	9	(4.9)
Number of participants aware of the pertussis vaccination during pregnancy at T1		
Yes	172	(94.5)
No	6	3.3
Not sure	4	(2.2)
Uptake of vaccine during pregnancy		
Yes	163	(89.6)
No	18	(9.9)
Cannot remember	1	(0.5)

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Table 2

Predictors of total time spent seeking information about vaccination (log variable). Multiple regression analysis

Variable	*B*	*t*	*p*	VIF
Constant	2.971			
Risk perception of vaccination during pregnancy	.206	2.918	.004	1.828
Vaccine confidence	-.371	-2.902	.004	2.886
Decision conflict	.058	.588	.557	2.033
Intention to vaccinate	-.055	-1.140	.256	2.199

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Table 3

Predictors of perceived strength and direction of influence, of information found through seeking *(multiple regression analysis)*

Variable	*B*	*t*	*p*	VIF
Constant	-.744			
Risk perception of vaccination during pregnancy	.017	.144	.886	1.912
Vaccine confidence	.022	.096	.924	3.631
Decision conflict	.085	.516	.607	2.008
Intention to vaccinate	.227	2.581	.011	2.475

Table 4

Point-biserial correlations among variables in predicting vaccine uptake (N=173)

*p<.01

Variable	Risk perception of vaccination during pregnancy	Vaccine confidence	Vaccine information-seeking behaviour	Intention to vaccinate	Strength of recommendation from a healthcare professional
Vaccine uptake	.429*	.569*	-.111	.669*	.290*

Table 5

Predictors of vaccine uptake (binary logistic regression analysis)

Variable	*OR (Exp B)*	*Wald*	*df*	*p*
Constant	-	8.823	1	.003
Risk perception of vaccination during pregnancy	1.228	0.096	1	.756
Vaccine confidence	9.460	4.369	1	.037
Vaccine information-seeking behaviour	1.756	0.703	1	.402
Intention to vaccinate	1.718	2.745	1	.098
Strength of recommendation from a healthcare professional	1.513	2.187	1	.139

Table 6

Number (%) of participants by amount of time and influence of vaccine information-seeking behaviour's by channel type (N=182).

Information channel	*Not used*	*>0 to ≤15 minutes*	*>15 to ≤60 minutes*	*>60 to ≤120 minutes*	*>120 minutes*
Friends and	49 (26.9)	76 (41.7)	46 (25.3)	7 (3.8)	4 (2.2)

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family members					
A health care professional	40 (22)	123 (67.6)	18 (9.9)	0 (0)	1 (0.5)
The internet	68 (37.4)	48 (26.4)	50 (27.5)	8 (4.4)	8 (4.4)

Information channel	*Greatly away from vaccination*	*Somewhat away from vaccination*	*Slightly away from vaccination*	*No influence*	*Slightly towards vaccination*	*Somewhat towards vaccination*	*Greatly towards vaccination*
Friends and family members N=133 (73.1%)	0 (0)	0 (0)	7 (5.3)	91 (68.4)	11 (8.3)	9 (6.8)	15 (11.3)
A health care professional N=142 (78.0%)	1 (0.7)	0 (0)	1 (0.7)	52 (36.6)	29 (20.4)	21 (14.8)	38 (26.8)
The internet N=114 (62.6%)	1 (0.9)	3 (2.6)	4 (3.5)	41 (36)	27 (23.7)	17 (14.9)	21 (18.4)

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Table 7

Vaccine information-seeking behaviours conducted by participants in regards to the pertussis vaccine given during pregnancy (N=182).

Question text: *Since completing the previous survey (taken before 18 weeks of pregnancy) have you done any of the following, highlight all that apply. If none, please leave blank.*

	Count (%)	Acceptors	Decliners
Used the internet to read articles or news about the whooping cough vaccine given during pregnancy (e.g. NHS Choice, Net doctor, Patient.com).	83 (45.6)	71	12
Used the internet to read comments or discussions from other women that have talked publicly on forums about the whooping cough vaccine (e.g. Mumsnet, Netmums, Facebook, Twitter etc).	40 (22.0)	32	8
Actively brought up the topic of the whooping cough vaccine given during pregnancy with your GP, Midwife, health visitor or nurse practitioner.	52 (28.6)	46	6
Actively brought up the topic of the whooping cough vaccine given during pregnancy with a complementary/alternative health care professional.	10 (5.5)	7	3
Actively brought up the topic of the whooping cough vaccine given during pregnancy with a religious or spiritual leader.	2 (1.1)	2	0
Actively brought up the topic of the whooping cough vaccine given during pregnancy with a friend or family member that has had past medical training.	32 (17.6)	27	5
Actively brought up the topic of the whooping cough vaccine given during pregnancy with a friend or family member (not medically trained).	54 (29.7)	47	7
Searched health care during pregnancy books or e-books for additional information on the whooping cough vaccine given during pregnancy.	15 (8.2)	12	3
Other	4 (2.2)	3	1

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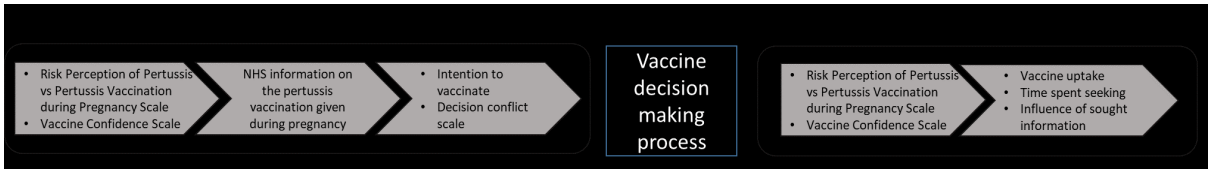
Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale
Vaccine Confidence Scale
NHS information on the pertussis vaccination given during pregnancy
Intention to vaccinate
Decision conflict scale
Vaccine decision making process
Risk Perception of Pertussis vs Pertussis Vaccination during Pregnancy Scale
Vaccine Confidence Scale
Vaccine uptake
Time spent seeking
Influence of sought information

Fig 1

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