JORMA International Journal of Health and Social Sciences
Volume 2, No. 2, Pages 1-28

Predicting COVID-19 Vaccination Intentions Among UK Parents Using Protection Motivation Theory

Kennedy Oberhiri Obohwemu, PhD
Department of Health, Wellbeing and Social Care, Oxford Brookes University, GBS Partnership, Birmingham, United Kingdom.
PENKUP Research Institute, Birmingham, United Kingdom
ORCID ID: 0000-0001-5175-1179

ABSTRACT

Parents' intentions to vaccinate their children against COVID-19 remain a critical factor in achieving sufficient immunization coverage. Understanding the psychological and social factors that influence vaccination decisions is essential for developing effective public health strategies. This study applied Protection Motivation Theory (PMT) to examine predictors of COVID-19 vaccination intention among parents of young children in the UK. Key constructs of PMT, threat appraisal and coping appraisal were evaluated alongside sociodemographic variables to identify the strongest determinants of parental vaccine acceptance. A cross-sectional online survey was conducted among 774 parents and guardians of children aged 0–6 years in the UK. Participants responded to a validated PMT questionnaire measuring intention, perceived severity, susceptibility, self-efficacy, response efficacy, response costs, intrapersonal characteristics, and past experience. Sociodemographic data were also collected. Hierarchical logistic regression analyses were performed to assess the relative importance of these factors. The results showed that disease severity, intrapersonal characteristics, past experience, response efficacy, and response costs were the most influential predictors of COVID-19 vaccination intention. While sociodemographic factors such as age and gender had some predictive value, the PMT constructs, particularly severity and efficacy-related measures provided more robust insights into parental decision-making processes. The final regression model explained 35.5% of the variance in vaccination intention. This study highlights the importance of PMT constructs in understanding parental COVID-19 vaccination intentions. Interventions should focus on increasing awareness of disease severity, enhancing confidence in vaccine efficacy, and addressing perceived response costs. Public health campaigns tailored to these psychological factors, coupled with transparent communication from trusted healthcare providers, are likely to be more effective in reducing vaccine hesitancy among parents in the UK.

Keywords: COVID-19 vaccination, Protection Motivation Theory, vaccine hesitancy, parental attitudes, public health interventions, UK, childhood immunization.

INTRODUCTION

It is essential to evaluate the role of psychological factors and theoretical frameworks to understand individual variations in vaccination behaviour and identify the factors influencing parental responses to perceived risks. The application of behavioural theories helps integrate complex processes and extend their relevance beyond initial contexts (Camerini et al., 2019). Evidence suggests that theory-driven interventions yield more favourable behavioural outcomes (Lippke & Ziegelmann, 2008). Public health organizations, both in the UK and globally, can leverage established theories and empirical findings to tailor vaccine messaging and initiatives effectively.

Despite the proven value of theoretical approaches, research on vaccine uptake, particularly in primary studies, has rarely utilized established behavioural change models. The Protection Motivation Theory (PMT), for instance, has been underused despite its well-documented efficacy (Schmid et al., 2017; Cordina and Lauri, 2021; Shmueli, 2021). According to PMT, the intention to engage in protective behaviours—such as vaccination—arises from the combined influence of perceived threat severity and coping appraisal. This model incorporates two key pathways: threat appraisal, which includes perceived severity, susceptibility, and maladaptive response rewards, and coping appraisal, which addresses self-efficacy, response efficacy, and perceived costs (Rogers, 1975, 1983; Maddux & Rogers, 1983; Shiloh, Peleg and Nudelman, 2021).

By emphasizing both the threat and coping pathways, PMT offers a structured framework for understanding why individuals might choose to vaccinate. When individuals perceive a health threat as severe and believe that the recommended protective action is effective and manageable, they are more likely to engage in preventive measures (Shiloh, Peleg and Nudelman, 2021; Grano, Singh and Pucchio, 2022). This dual-pathway approach aligns PMT with other behavioural models like the Health Belief Model (HBM) and theories of planned behaviour, providing a robust foundation for vaccine-related health interventions.

In its revised form, PMT incorporates additional variables such as information sources, social norms, and past experiences. These elements expand the model's applicability, making it particularly valuable in vaccine hesitancy research. By addressing the influence of societal attitudes, media messaging, and interpersonal communication, the model reflects the broader social context in which vaccination decisions are made (Rogers, 1983; Floyd et al., 2000). Furthermore, PMT's constructs—such as self-efficacy and response efficacy—enable researchers to pinpoint key leverage points for promoting vaccination acceptance, especially among hesitant populations.

The practical implications of PMT have been demonstrated in studies of influenza and MMR vaccines, where constructs like perceived severity, self-efficacy, and response efficacy have been linked to increased vaccine uptake (Weinstein et al., 2007; Freimuth et al., 2017; Camerini et al., 2019). However, the role of maladaptive response rewards and their impact on new vaccines, such as COVID-19 vaccines, has received less attention. This highlights the need for comprehensive studies that evaluate all PMT constructs and their interrelations.

In public health practice, PMT provides a valuable lens through which to examine vaccination behaviours. By analyzing threat and coping appraisals, public health professionals can develop more targeted and effective communication strategies, address underlying psychological barriers, and ultimately improve vaccine coverage and acceptance.

The Context of Coronavirus Vaccination

In December 2019, a novel, highly transmissible virus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in Wuhan, Hubei Province, China (Wölfel et al., 2020). This respiratory disease, commonly referred to as coronavirus disease 2019 (COVID-19), rapidly spread across the globe by early 2020 (Xu et al., 2020). On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic (WHO, 2020a). By mid-April 2020, Johns Hopkins

University reported over two million confirmed cases worldwide (Dong et al., 2020), though the actual number was likely much higher due to limited testing of individuals with mild symptoms (WHO, 2020a). Governments responded by implementing sweeping measures, such as restricting public gatherings, closing schools and universities, and postponing cultural events (Anderson et al., 2020). Despite these efforts, the virus continued to spread, with over 660 million infections and more than six million deaths reported by the end of December 2022 (WHO, 2022a).

Although COVID-19 is less virulent than SARS-CoV or MERS-CoV (Khosravi, 2020), its rapid transmission and initial lack of vaccines or treatments made containment extremely challenging (Xu et al., 2020; Lai et al., 2020; Abdulamir & Hafidh, 2020). Non-pharmaceutical interventions were widely promoted, including wearing face masks, practicing good hygiene, limiting travel, and maintaining social distance (Thunstrom et al., 2020; Khosravi, 2020). Public health officials faced ongoing challenges in encouraging widespread adoption of these protective measures.

Public perceptions of pandemic risk are central to the uptake of precautionary behaviours (Shiloh, Peleg and Nudelman, 2021; Ryu et al., 2022; Grano, Singh and Pucchio, 2022). Protection Motivation Theory (PMT) suggests that perceived health risk strongly influences people's willingness to engage in preventive health actions. Access to accurate information from public health experts, government authorities, and the media can enhance awareness of the threat and motivate protective behaviours (Alwreikat, Shehata and Edakar, 2021).

Recognizing the urgency of halting COVID-19 transmission and reducing mortality, researchers began efforts to develop a safe and effective vaccine shortly after the SARS-CoV-2 genetic sequence was published on January 11, 2020 (Le et al., 2020). Human clinical trials for the first COVID-19 vaccine candidate commenced on March 16, 2020 (Lee et al., 2020). Since then, multiple vaccines have received approval, and development efforts continue worldwide (Le et al., 2020).

The success of vaccination programs depends not only on vaccine efficacy but also on achieving high immunization rates (Obohwemu et al., 2022; Obohwemu, 2024a; Obohwemu, 2024b). Widespread vaccination leads to herd immunity, which protects the entire community, including those who remain susceptible to infection (Andersson et al., 2022). In the UK, for example, herd immunity can be achieved when approximately 80% of the population becomes immune through vaccination or recovery from prior infections (Lourenco et al., 2020). However, attaining herd immunity is complicated by vaccine hesitancy, a persistent issue that undermines immunization coverage in many regions (MacDonald, 2015).

PMT and Coronavirus Vaccination

Protection Motivation Theory (PMT) has been used to predict vaccination intentions in various contexts, including a rural Chinese community where it successfully identified key cognitive factors influencing adult migrant workers' intentions to receive the hepatitis B vaccine (Liu et al., 2016). Data from 1684 participants in six provinces and Beijing revealed that susceptibility and response efficacy were critical PMT components driving vaccination intention and behaviour. However, unlike hepatitis B vaccination, coronavirus vaccination involves parental decision-making, introducing executive functions and a heightened sense of accountability for another individual (Victor, 2020).

In the context of coronavirus vaccination, PMT's threat appraisal pathway hinges on parents' perceptions of COVID-19 severity and their children's susceptibility to the disease. Both perceived severity and susceptibility are believed to positively correlate with the intention to mitigate the threat (Alwreikat, Shehata & Edakar, 2021). The coping appraisal pathway—comprising self-efficacy, response efficacy, and response costs—evaluates how parents respond adaptively to the health threat (Shiloh, Peleg & Nudelman, 2021). Response efficacy reflects parents' confidence in the COVID-19 vaccine's ability to protect their children from the virus (Alwreikat, Shehata & Edakar, 2021). Previous studies have consistently found significant positive relationships between vaccination intention and actual vaccination behaviour (Britt et al., 2014; Liu et al., 2016; Chen et al., 2021; Grano, Singh & Di Pucchio, 2022). Self-efficacy similarly emerges as a strong predictor of vaccine uptake (Britt et al., 2014; Liu et al., 2016).

Response costs—such as perceived side effects or other negative consequences of vaccination—also play a critical role (Posey, Roberts & Lowry, 2015). Parents who delay or refuse vaccines often perceive higher risks of long-term health issues arising from vaccinations, as well as a greater likelihood that vaccines are harmful (Rey et al., 2018; McDonald et al., 2019). Studies underscore the importance of documenting vaccine side effects and addressing concerns directly, as these factors strongly influence parental vaccination decisions (Wheeler & Buttenheim, 2013; Henrikson et al., 2017; Dubé et al., 2018; Limaye et al., 2021; Dubé et al., 2021).

Beyond the core PMT pathways, the current research considers additional factors, such as societal norms, parents' prior experiences with COVID-19 vaccines, and their exposure to various information sources. Parents' past decisions to vaccinate their children against COVID-19 and their firsthand or secondhand experiences with the vaccine's side effects influence their future willingness to follow official guidelines (Lee et al., 2020). These decisions are critical because COVID-19 can affect children as well (Wang et al., 2020). Moreover, the study acknowledges the role of multiple information sources—official, unofficial, online, and offline—in shaping parents' threat and coping appraisals, and ultimately their vaccination intentions (Huang et al., 2020; Li et al., 2020; Ko et al., 2020).

By identifying the factors influencing parental adherence to official COVID-19 vaccination guidelines, this research aims to inform the design of targeted intervention strategies for childhood immunization programs in the UK.

MATERIALS AND METHODS

Research Hypothesis

In the context of COVID-19 vaccination, the fundamental concepts of PMT were examined for associations with the behavioural intention to prevent disease. The following hypotheses were thus generated for this research:

H1. The intention to obtain a COVID-19 vaccine will significantly positively correlate with COVID-19's perceived severity.

H2. The intention to obtain a COVID-19 vaccine will significantly positively correlate with the perceived susceptibility to COVID-19.

H3. The intention to obtain a COVID-19 vaccine will significantly positively correlate with the vaccine's perceived efficacy (response efficacy).

H4. The intention to obtain a COVID-19 vaccine will significantly positively correlate with the confidence in one's ability to obtain the vaccine (self-efficacy).

H5. The intention to obtain a COVID-19 vaccine will significantly negatively correlate with maladaptive response rewards.

H6. The intention to obtain a COVID-19 vaccine will significantly negatively correlate with the perceived severity of and perceived susceptibility to coronavirus vaccine side effects.

Study Population

This cross-sectional survey was conducted among 818 parents and guardians of UK children who were 0 to 6 years old. This age range was chosen because it falls within the recommended vaccination dosage sequence for children under the age of seven (CDC, 2010), and because this series includes the immunisations that typically cause doubt (Opel et al., 2013; Repalust et al., 2017). Parents/guardians of children between the ages of 0 and 6 were requested to provide information on only one child in order to prevent data duplication. Usually, this child was the one who needed immunisations (Tsuzuki et al., 2020).

Inclusion and Exclusion Criteria

Parents and guardians who met the following criteria participated in the study:

1. had a child that was at least 6 years old.
2. were above the age of 18
3. granted permission
4. understood the English language.

Parents and guardians who met the following criteria were excluded from the study:

1. being too sick or anxious to complete the survey
2. not residing in the UK
3. having a child that is immuno-compromised and cannot receive some vaccinations.

Sampling Technique

Convenience sampling was employed, which indicates that individuals from the target group who were accessible at a specific time or ready to take part in the study were included (Etikan, Musa & Alkassim, 2016). In accordance with earlier studies (Tomietto et al., 2022a), snowball sampling was also utilised to help the survey reach the target demographic more widely. The specific features of networking and recommendation are fundamental to this sample method (Parker, Scott & Geddes, 2019). The researcher starts with a handy selection of first contacts who meet the requirements for the study and are invited to participate (Etikan, Alkassim & Abubakar,2016). The next step was to request more connections from the consenting adults who meet the eligibility requirements. These contacts then suggest additional possible participants, and so on. As a result, social networks are employed to create the first linkages, with sampling momentum growing from them and catching an ever-longer chain of respondents (Parker, Scott & Geddes, 2019).

Data Collection

The data were collected online. Data from the study were collected and managed using Qualtrics, a safe gateway for online electronic data collection provided by the University of Sunderland. The online survey platform was utilised by participants to fill out a questionnaire that asked about sociodemographic factors and other indicators.

Participant Recruitment

The researcher created a landing page (https://vaccinehesitancy.uk) specifically for this study. Participants learned about the research and the researcher on the homepage. With this strategy, participants were confident that the study team comprised of academics and not those looking to get personal information for illegal purposes (Sloan & Quan-Haase, 2017). Participants could click the link on the webpage to go to Qualtrics and access the survey. The weblink was also shared widely across social media platforms. Google adverts were used to speed up the online recruitment process.

As part of the recruitment strategy, a promotional video containing a link to the landing webpage was made by the researcher and shared on social media on 19th November 2021. The video (https://youtu.be/ztgyxhnsyOA) garnered over four thousand (4,000) views on YouTube alone.

Furthermore, the researcher had earlier presented the research proposal at the Public Health England's 2021 Public Health Research and Science Conference (held from Monday 24th May to Thursday 27th May 2021). The video of that presentation was shared on social media on 4th December 2021 and a link to the landing webpage was added to the video's description. The video (https://youtu.be/mrBdzv7bclM) has had over forty thousand (40,000) views on YouTube.

Study Instrument

There were two sections on the survey tool:

1. Sociodemographic characteristics – age, gender, marital status, educational level, work category, yearly family income, ethnicity, number of children, political philosophy, and social ideology (i.e., whether participants have a conservative or liberal viewpoint on political and social matters), in line with prior research (Opel et al., 2011a; Opel et al., 2011b; Opel et al., 2013).
2. PMT questionnaire – to investigate the factors, including demographics and attitudes, that predict parents' intention to embrace childhood vaccinations in the UK, including the intention to obtain the novel coronavirus vaccine, while taking into account a variety of outcome measures (perceived severity, perceived susceptibility, self-efficacy, and other PMT constructs), in accordance with prior studies (Opel et al., 2013; Azizi et al., 2017).

For this research, the PMT questionnaire was used (see Appendix). The validated scales from previous research (Ling et al., 2019; Camerini et al., 2019) were modified to create the PMT questionnaire.

The following metrics were taken into account when constructing the PMT questionnaire:

Intention: The intention of adopting a protective health behaviour, such as "I am likely to present my child for COVID-19 vaccination," was evaluated using the mean of three responses (1 = Strongly Disagree, 5 = Strongly Agree). The more points, the stronger the desire to become immunised.

Severity: Respondents were asked to rate how strongly they concur (1 = Strongly Disagree, 5 = Strongly Agree) with the following statement: "COVID-19 is an infective disease that can have severe consequences for one's health."

Susceptibility: Respondents were asked to rate how much they concur (1 = Strongly Disagree, 5 = Strongly Agree) with one statement that suggested they were susceptible to COVID-19's severe negative effects if they had had not received the vaccine: “If my child was not vaccinated against COVID-19, he would be likely to suffer from the infection during the course of his life”.

Self-Efficacy: Respondents were asked to rate how strongly they concur (1 = Strongly Disagree, 5 = Strongly Agree) with the statement: “I am confident about my ability to decide regarding the COVID-19 vaccination of my child”, which showed their degree of confidence in making important decisions about coronavirus vaccinations.

Response Efficacy: Three statements that suggested receiving a coronavirus vaccine might lessen COVID-19 severity and susceptibility were presented to participants, and they were asked to rate how much they concur (1 = Strongly Disagree, 5 = Strongly Agree). For example, one statement read, “It is possible to prevent COVID-19 by vaccinating during childhood”. Response efficacy was calculated using the average of the three responses. The more points received, the higher the response efficacy.

Response Costs: Three statements, one of which was “It is likely that my child will have side-effects from the COVID-19 vaccines” were presented to participants to find out if a coronavirus vaccination was connected with expenses (both financial and non-financial). Respondents were asked to rate how much they concur (1 = Strongly Disagree, 5 = Strongly Agree). Response efficacy was calculated using the average of the three responses. The response cost increased as the score increased.

Intrapersonal Characteristics: Respondents were asked to rate how much they concur (1 = Strongly Disagree, 5 = Strongly Agree) with two statements that evaluated social behaviours, attitudes and norms (e.g., "The vaccination of my child helps to prevent the diffusion of COVID-19 in the population").

Past Experience: Respondents were asked to rate how much they concur (1 = Strongly Disagree, 5 = Strongly Agree) with three statements about their prior exposure to COVID-19 (e.g., "I know somebody who has experienced COVID-19 vaccine side effects”).

COVID-19 Information Sources: Respondents were questioned where they learned about the COVID-19 vaccination (family, friends, the internet, doctors, other health professionals, or other sources).

Study Variables

Parents' attitudes towards childhood immunisations served as the response variable, whereas sociodemographic factors (for instance, age, gender, level of education, and the number of children) served as the explanatory variable. Education was divided into seven categories: GCSE, diploma, some college but not a graduate, bachelor's, master's, and doctoral degrees). The number of children were divided into four groups (1, 2, 3, 4 or more).

Statistical Analysis

With the help of the SPSS programme version 26.0, data was input and analysed. Cronbach's alpha was employed to evaluate the surveys' internal consistency and reliability. Responses to questions were summarised using frequency and percentages.

To ascertain the relationship between participant sociodemographic variables and vaccine hesitancy, univariate analyses utilising the chi-squared test statistic were performed. Further establishing the direction of the correlation between participant sociodemographic traits and vaccine hesitancy required regression analysis.

To ascertain if there were notable variations in participants' vaccine hesitancy levels based on the observed differences in marital status, annual household income, children's number per household, ethnicity, child's birth order, relationship to child (father/mother), political ideology and social ideology, analysis of variance (ANOVA) was used.

Ethical Consideration

The University of Sunderland's ethical committee gave its permission for the study to be executed. Recruitment was entirely voluntary, and no one was coerced into participation. Participants had the option to skip any question(s) they felt uncomfortable with. Participants received assurances that the information they provided was kept private. The responses were anonymous since there was no way to give names or other personal identification. There was no support for external tracking tools (like Google Analytics) and cookies were immediately deactivated. Additionally, because the required settings were enabled, which remove personally identifying information from a response before saving it in the database, the IP addresses of participants were inaccessible. The study was executed in compliance with the UK Research Integrity Office Code of Practice for Research, which assures that information is maintained as fully confidential, responses are kept anonymous, and data collection is done only for research reasons (Desmond & Dierickx, 2021).

RESULTS

Participants' Characteristics

In all, 818 eligible parents and guardians responded to the surveys, yielding a 100% response rate. Of these respondents, 44 were removed from the analysis of the data because of inconsistent answers or incomplete data, leaving 774 respondents. Each participant's missing data were unique, and no pattern could be found. Given that just 5% of the sample had missing data, it was deemed reasonable to exclude them from the analyses (Petrie & Sabin, 2019).

About half of the research participants were White British, one-fifth were White Other, and just a small number were Black British or Black Caribbean, according to an analysis of their sociodemographic features (Table 1). The majority of the participants were more socially or politically conservative.

Table 1: Sociodemographic characteristics of the study participants

Variables	Median (IQR)*	Frequency	Percentages
Marital Status			
Married		369	47.7
Single		201	26.0
Living with a partner		89	11.5
Widowed		59	7.6
Separated		40	5.2
Divorced		15	1.9
Annual household Income			
£20,000 or less		215	28.0
£20,001-£40,000		310	40.3
£40,001-£60,000		186	24.2
£60,001 or more		58	7.5
Number of Children			
One		158	20.7
Two		258	33.7
Three		253	33.1
Four or More		96	12.5
Ethnicity			
White British		392	50.6
White Other		162	20.9
Black African		121	15.6
Black British		52	6.7
Others		30	3.9
Asian		9	1.0
Black Caribbean		8	1.0
Child's Birth Order			
First Child		555	71.9
Not First Child		216	28.1
Relationship			
Father		211	27.4
Mother		295	38.2
Other		265	34.4
Political ideology			
0-4	3 (2)	150	19.7
5		168	22.0
6-10	9 (2)	445	58.3
Social ideology			
0-4	4 (2)	114	14.9
5		176	23.0
6-10	8 (2)	475	62.1

*IQR = Interquartile range

About half of the participants were females (49.5%), over one third were between the ages of 25-34 years (37.8%), while over one quarter of them had bachelor's degree (25.8%). Parental age was classified as 18-24, 25-34, 35-44, 45-54, 55-64, and greater than 64 years.

To ascertain if there were notable variations in participants' vaccination intention levels due to differences in sociodemographic characteristics, further analysis was conducted. A logistic regression analysis insignificantly explained 67% variation in the likelihood of vaccination intention (Nagelkerke $R^2 = 0.671$, $X^2(7) = 3.054$, $P = 0.885$). The final outcomes of the regression only indicated that having

three children (relative to four) and being liberal or neutral politically (relative to being conservative) increased the intention to vaccinate (Table 2).

Table 2: Summary of Logistic Regression Analysis predicting Vaccine Intention by Sociodemographic Factors

Variables	B*	SE*	*β**
Marital Status			
Divorced	41.25	56841.374	817348487824186240.000
Living with a partner	15.28	40192.871	4329332.451
Married	23.17	40192.871	11529638725.104
Separated	40.09	43907.0	256519076274605824.000
Single	23.23	40192.871	12296090784.206
Widowed	Ref. group		
Annual household Income			
£20,000 or less	-2.446	1.976	.087
£20,001-£40,000	-.098	1.958	.906
£40,001-£60,000	-2.609	1.974	.074
£60,001 or more	Ref. group		
Number of Children			
One	-.008	1.756	.992
Two	3.332	1.759	27.991
Three	3.646	1.812	38.331*
Four or More	Ref. group		
Ethnicity			
Black African	-6.654	6.577	.001
Black British	-7.938	6.731	.000
Black Caribbean	-2.769	6.467	.063
White British	-6.654	6.577	.001
White Other	Ref. group	6.577	.001
Others	-4.059	6.351	.017
Child's Birth Order			
First Child	.820	1.129	2.271
Not First Child	Ref. group		
Relationship			
Father	-2.789	2.115	.062
Mother	-1.474	1.763	.229
Other	Ref. group		
Political ideology			
0-4	-4.028	1.613	.018*
5	-3.587	1.678	.028*
6-10	Ref. group		
Social ideology			
0-4	26.849	8144.020	457465832925.910
5	1.435	1.151	4.199
6-10	Ref. group		
Constant	-14.484	40192.872	.000

Model X^2 (7) = 3.054, P = 0.885, Nagelkerke R^2 = 0.671. Ref. group refers to the group on the basis of which reference to other groups are made. *B is the log of the odds ratio that measures the impact of each independent variable on the dependent variable. SE is the standard error, while the Greek B is the coefficient that measures the relative importance of the dependent variable in comparison to the independent variables.

Questionnaire Validity

The reliability and internal consistency of the questionnaire, determined using Cronbach's alpha, revealed a score of 0.83.

Descriptive Data on PMT Items

Frequency and percentage analysis of participants' responses to PMT questions (Table 3) revealed that over half of them indicated their affirmation to each of the questions. Of all the PMT variables, the highest affirmative response was indicated on the statement "COVID-19 is an infective disease that can have severe consequences for one's health" (Severity) (69.2%), followed by "I am confident about my ability to decide regarding the COVID-19 vaccination of my child" (SE) (61.1%), and "The vaccination of my child helps to prevent the diffusion of COVID-19 in the population" (IC 1) (57.3%). In contrast, "My child has previously been infected with COVID-19" (PE 1) had the least affirmative response (50.1%), followed by "Being vaccinated against COVID-19 is painful" (RC 3) (50.7%), "Only pharmaceutical companies can profit from the COVID-19 vaccinations" (R-E 3) (53.2%), and "Most parents I know vaccinate their children against COVID-19" (IC 2) (53.2%).

Table 3: Descriptive Data on PMT Items

Items and Response	N	%
COVID-19 is an infective disease that can have severe consequences for one's health (Severity)		
Agree	535	69.2
Disagree or unsure	238	30.8
If my child was not vaccinated against COVID-19, he would be likely to suffer from the infection during the course of his life (Susceptibility)		
Agree	426	55.1
Disagree or unsure	347	44.9
I am confident about my ability to decide regarding the COVID-19 vaccination of my child (SE)		
Agree	472	61.1
Disagree or unsure	301	38.9
The vaccination against COVID-19 is not efficient enough for fighting the disease (RE 1)		
Agree	430	55.6
Disagree or unsure	343	44.4
It is possible to prevent COVID-19 by vaccinating during childhood (RE 2)		
Agree	427	55.2
Disagree or unsure	346	44.8

Only pharmaceutical companies can profit from the COVID-19 vaccinations (RE 3)		
Agree	411	53.2
Disagree or unsure	362	46.8
It is likely that my child will have side-effects from the COVID-19 vaccines (RC 1)		
Agree	437	56.5
Disagree or unsure	336	43.5
People who receive COVID-19 vaccines are likely to experience severe side effects (RC 2)		
Agree	437	56.5
Disagree or unsure	336	43.5
Being vaccinated against COVID-19 is painful (RC 3)		
Agree	392	50.7
Disagree or unsure	381	49.3
The vaccination of my child helps to prevent the diffusion of COVID-19 in the population (IC 1)		
Agree	443	57.3
Disagree or unsure	330	42.7
Most parents I know vaccinate their children against COVID-19 (IC 2)		
Agree	411	53.2
Disagree or unsure	362	46.8
My child has previously been infected with COVID-19 (PE 1)		
Agree	387	50.1
Disagree or unsure	386	49.9
Somebody in the family has previously been infected with COVID-19 (PE 2)		
Agree	420	54.3
Disagree or unsure	353	45.7
I know somebody who has experienced COVID-19 vaccine side effects (PE 3)		
Agree	438	56.7
Disagree or unsure	334	43.3

SE = Self-efficacy; RE = Response efficacy); RC = Response costs; IC = Intrapersonal Characteristics; PE = Past experience

Vaccination Intention

Among those who identified as females, 49.5% had the intention to embrace COVID-19 vaccination for their children (see Table 4). Among those who identified as males, 39.5% had the intention to embrace COVID-19 vaccination for their children. For both gender, respondents aged 25-34 had the greatest intention to vaccinate their children against COVID-19 (37.8%). For both gender, those with a doctorate degree had the least intention to embrace COVID-19 vaccination for their children (6.5%).

Table 4: Summary of Chi-square analysis of the association between gender, age, and level of education on COVID-19 vaccination intention

Items and Response	Total sample n (%)	Intention to vaccinate the child	No intention or were unsure about vaccinating the child	P-value
Gender				
Female	379 (49.5)	233 (49.5)	146 (49.5)	0.307[f]
Male	291 (38.0)	186 (39.5)	105 (35.6)	
Non-binary/third gender	51 (6.7)	24 (5.1)	27 (9.1)	
Prefer not to say	44 (5.7)	27 (5.7)	17 (5.8)	
Age				
18-24	129 (16.7)	76 (16.0)	53 (17.8)	0.050[f]
25-34	292 (37.8)	163 (34.8)	129 (43.4)	
35-44	216 (28.0)	141 (29.7)	75 (25.3)	
45-54	84 (10.9)	58 (12.2)	26 (8.8)	
55-64	38 (4.9)	26 (5.5)	12 (4.0)	
Greater than 64	13(1.7)	11 (2.3)	2(0.7)	
Education Level				
GCE	80 (10.4)	46 (9.7)	34 (11.4)	0.354
Some college, but not a graduate	85 (11.0)	50 (10.6)	35 (11.8)	
Certificate of Higher Education	119 (15.5)	72 (15.2)	47 (15.8)	
Diploma of Higher Education	130 (16.9)	75 (15.9)	55 (18.5)	
Bachelor's Degree	199 (25.8)	129 (27.3)	70 (23.6)	
Master's Degree	107 (13.9)	73 (15.4)	34 (311.4)	
Doctorate Degree	50 (6.5)	28 (5.9)	22 (7.4)	

Note: f = Fishers exact test as a remedy to Chi-square inappropriateness

Chi-square analysis of the association between sociodemographic characteristics of participants, including age, gender, and educational level, did not reveal any significant connection with vaccination intention ($P<0.05$) (see Table 4 above).

Factors Associated with Vaccine Hesitancy

To identify the variables linked to vaccine hesitancy, a hierarchical logistic regression analysis was performed (Table 4). Sociodemographic factors like gender, age, and educational level were the first group of independent variables entered into block 1, which explained 18% of the total variation in the level of vaccine hesitancy, $R^2=0.11$, $F(3,756)=4.747$, $P<0.05$. Age was the only factor that strongly influenced the model in which an increase in the age of a participant increases the likelihood of being hesitant to childhood vaccinations. Inclusion of the PMT variables in block 2 yielded a further explained variation in the level of COVID-19 vaccine hesitancy ($\Delta R^2=0.43$, $F(7,749)=274.906$, $P<0.05$). From the PMT variables, self-efficacy, response cost and intrapersonal characteristics most strongly influenced COVID-19 vaccine hesitancy. Gender remained a significant predictor even after adding the PMT variables to block 2. The final hierarchical regression model explained 61% of the total variation in COVID-19 vaccine hesitancy levels ($R^2=0.61$, $F(10,749) = 4.824$, $P<0.05$). The final outcomes of the regression analysis indicated that age, self-efficacy, and response-cost most strongly influenced higher

levels of COVID-19 vaccine hesitancy, while intrapersonal characteristics most strongly influenced lower level of COVID-19 vaccine hesitancy. The likelihood of COVID-19 vaccine hesitancy was most strongly influenced by self-efficacy, intrapersonal characteristics, and response-costs (Table 5).

Table 5: Summary of Hierarchical Regression Analysis predicting Vaccine Hesitancy by PMT Constructs

	Model	B	SE	β	B	SE	β
1.	Gender	0.265	0.406	0.024			
	Age	1.835	0.505	0.131***			
	Level of Education	-0.087	0.270	-0.012			
2.	Gender				0.257	0.400	0.023
	Age				1.813	0.499	0.130***
	Level of Education				-0.109	0.266	-0.015
	Severity				-1.302	1.282	-0.038
	Susceptibility				2.199	1.236	0.069
	Self-efficacy				5.069	1.266	0.156***
	Response-efficacy				-0.922	0.713	-0.056
	Response-cost				1.856	0.750	0.111**
	Intrapersonal Characteristics				-1.311	0.593	-0.091**
	Past experience				0.453	0.596	0.030

Model 1 $R^2 = 0.18$**. Model 2 $R^2 = 0.61$***. ***P < 0.05.* ****P < 0.001.*

Factors Associated with Vaccination Intention

To identify the variables linked to vaccination intention, a hierarchical logistic regression analysis was performed. Gender, age, and educational level were the first group of independent variables entered into block 1, which insignificantly explained 1.6% of the total variation in the likelihood of COVID-19 vaccination intention (Nagelkerke R^2=0.016, χ^2 (8) = 8.64, p =0.373), even though age was a significant predictor in the model, such that an increase in the age of a participant increases the likelihood that a participant will vaccinate their child(ren) against COVID-19. Inclusion of the PMT variables in block 2 yielded a further explained variation in the level of COVID-19 vaccination intention (ΔNagelkerke R^2 =0.339, F(7,749) = 123.3137, P<0.05). Among the PMT variables, severity, intrapersonal characteristics, response efficacy, response costs, and prior experience emerged as the strongest predictors of COVID-19 vaccination intention. Even after the inclusion of PMT variables in the regression model, gender remained a significant predictor. The final hierarchical regression model accounted for 35.5% of the total variance in COVID-19 vaccination intention (Nagelkerke R^2 = 0.355, $\chi^2(8)$ = 19.8, P < 0.05). Ultimately, the analysis revealed that age, severity, response efficacy, intrapersonal characteristics, response costs, and past experience were the most significant factors associated with an increased likelihood of COVID-19 vaccination intention. Of these, severity, intrapersonal characteristics, past experience, response efficacy, and response costs had the strongest influence (Table 6).

Table 6: Summary of Hierarchical Logistic Regression Analysis Predicting COVID-19 Vaccination Intention

	Model	**B**	**SE**	**OR**	**(95% CI)**	**B**	**SE**	**OR**	
1.	Gender	-0.03	0.05	0.97	(0.88-1.08)				
	Age	0.20	0.07	1.22**	(1.07-1.39)				
	Level of Education	-0.02	0.04	0.98	(0.92-1.05)				
2.	Gender					-0.03	0.06	0.97	(0.86-1.09)
	Age					0.27	0.08	1.31**	(1.12-1.54)
	Level of Education					-0.01	0.04	0.99	(0.91-1.07)
	Severity					1.70	0.19	5.47***	(3.74-7.99)
	Susceptibility					0.04	1.19	1.04	(0.72-1.50)
	Self-efficacy					0.19	0.19	1.21	(0.84-1.76)
	Response-efficacy					0.29	0.11	1.33**	(1.08-1.65)

Response-cost	0.24	0.11	1.28**	(1.02-1.59)
Intrapersonal Characteristics	0.38	0.09	1.46***	(1.22-1.73)
Past experience	0.37	0.09	1.44***	(1.19-1.74)

Model 1 χ^2 (8) = 8.64, p =0.373, Nagelkerke R^2 = 0.016. Model 2 χ^2 (8) = 19.8, p <0.05, Nagelkerke R^2 = 0.355. ***P < 0.05. ***P < 0.001.*

PMT Constructs and Vaccination Intention

A univariate analysis was conducted to determine whether a significant association exists between PMT constructs and vaccination intention. All PMT constructs were significantly associated with vaccination intention among the study participants (Table 7).

Table 7: Summary of Chi-square analysis of the correlation between PMT construct and COVID-19 vaccination intention

Items and Response	Total sample n (%)	Intention to Vaccinate		P-value
		Intended to vaccinate	Not intended to or unsure	
Severity				
Agree	535 (69.1)	398 (83.4)	137 (46.3)	<0.001
Disagree or sure	239 (30.9)	79 (16.6)	159 (53.7)	
Susceptibility				
Agree	426 (55.1)	296 (62.1)	130 (43.9)	<0.001
Disagree or unsure	348 (44.9)	181 (37.9)	166 (56.1)	
Self-efficacy				
Agree	472 (61.1)	323 (67.7)	149 (50.3)	<0.001
Disagree or unsure	302 (38.9)	154 (32.3)	147 (49.7)	
Response-efficacy1				
Agree	430 (55.6)	303 (63.5)	127 (42.9)	<0.001
Disagree or unsure	344 (44.4)	174 (36.5)	169 (57.1)	
Response-efficacy2				
Agree	427 (55.2)	310 (65.0)	117 (39.5)	<0.001
Disagree or unsure	347 (44.1)	167 (35.0)	179 (60.5)	
Response-efficacy3				
Agree	411 (53.1)	293 (61.4)	118 (39.9)	<0.001
Disagree or unsure	363 (46.9)	184 (38.6)	178 (60.1)	
Response cost1				
Agree	437 (56.6)	312 (65.4)	125 (42.2)	<0.001
Disagree or unsure	337 (43.4)	165 (34.6)	171 (57.8)	
Response cost2				
Agree	437 (56.6)	309 (64.8)	128 (43.2)	<0.001
Disagree or unsure	337 (43.4)	168 (35.2)	168 (56.8)	
Response cost3				
Agree	392 (50.6)	283 (59.3)	109 (36.8)	<0.001
Disagree or unsure	382 (49.4)	194 (40.7)	187 (63.2)	
Intrapersonal Characteristics1				
Agree	443 (57.2)	331 (69.4)	112 (37.8)	<0.001
Disagree or unsure	331 (42.8)	146 (30.6)	184 (62.2)	
Intrapersonal Characteristics2				
Agree	411 (53.1)	299 (62.7)	112 (37.8)	<0.001
Disagree or unsure	363 (46.9)	178 (37.3)	184 (62.2)	
Past experience1				
Agree	387 (50.0)	265 (55.6)	122 (41.2)	<0.001
Disagree or unsure	387 (50.0)	212 (44.4)	174 (58.8)	
Past experience2				
Agree	420 (54.3)	301 (63.1)	119 (40.2)	<0.001
Disagree or unsure	353 (45.7)	176 (36.9)	177 (59.8)	

Past experience3				
Agree	438 (56.7)	311 (65.2)	127 (42.9)	<0.001
Disagree or unsure	339 (43.3)	166 (34.8)	169 (57.1)	

Note: 1 = agreed, 2 = disagreed or unsure

Vaccines That Prompted Doubt

Participants were asked which vaccines they were most worried about. COVID-19 vaccine topped the list, with over half of the participants ticking this option (Table 8). About one-fifth of participants were not worried about any specific vaccine. Varicella and MMR vaccines were also mentioned. Participants who identified 'Others' were asked to specify the vaccines, and they mentioned influenza and DTaP.

Table 8: Summary Analysis of Vaccines that Participants were most worried about

Vaccines of Concern	Frequency	Percentage
COVID-19	397	51.6
Measles, Mumps, Rubella (MMR)	71	9.2
No specific vaccine	151	19.6
Others (please specify)	20	2.6
Varicella	131	17.0
Total	770	100.0%

Summary of Findings

Most of the survey respondents were unsure about openly discussing their reservations regarding vaccines with their paediatricians. About a quarter of the parents had less than 50% trust in their paediatricians. Most could not rely on the vaccination information they were given and prefer to seek for information from sources other than their paediatrician. Most parents decide whether to follow vaccination guidelines or not after reading media stories.

All the core components of PMT (threat and coping appraisal) were found to be relevant indicators of vaccination intentions. However, disease severity, response efficacy and self-efficacy were superior indicators compared to other constructs. Thus, the research validates the hypotheses that the intention to obtain a COVID-19 vaccination will have significant positive relationship with the perceived severity of COVID-19, the perceived susceptibility to COVID-19, the perceived efficacy of the vaccine (response efficacy), and the confidence in one's ability to obtain a vaccination (self-efficacy). The research also validates the hypotheses that the intention to obtain a coronavirus vaccination will have significant negative relationship with maladaptive response rewards and the perceived severity of and perceived susceptibility to coronavirus vaccine side effects.

DISCUSSION

Determinants of Vaccination Intention

This study identifies several key factors associated with vaccine hesitancy and vaccination intention. Among the most influential were parental beliefs that vaccinations are ineffective or irrelevant for their

children's health, and that they fail to provide adequate disease protection. Additionally, distrust in the NHS's capacity to deliver effective vaccinations was found to intensify hesitancy. Similar patterns have been documented in other research, which highlights the role of public distrust—not a lack of knowledge—in driving vaccine reluctance (Yaqub et al., 2014; Paterson, Chantler & Larson, 2018; Idowu et al., 2024).

Parental mistrust of pharmaceutical companies also emerged as a significant concern, with some participants viewing childhood immunisations as motivated by corporate profit rather than public health benefits (Kata, 2012; Bianco et al., 2019; Dinga, Sinda & Titanji, 2021). This distrust extended to healthcare providers, with parents who refused vaccinations often reporting that their paediatrician had provided misleading information. Such findings emphasize the urgent need for health organizations to improve transparency and ensure that accurate, accessible information reaches families.

The study further reveals that higher levels of anxiety, concern, and perceived vulnerability are positively associated with vaccination intentions, a pattern consistent with research from the UK, Australia, and the Netherlands (Rubin et al., 2009; Goodwin et al., 2010; Bults et al., 2011). Trust plays a critical role in fostering vaccine uptake. The research underscores the importance of relying on official, credible sources of information and maintaining a commitment to following their recommendations (Bults et al., 2011). Historical examples, such as increased vaccination acceptance during the H1N1 pandemic in the United States, illustrate how confidence in government can enhance vaccine uptake (Quinn et al., 2009).

Trust influences not only how risks are perceived but also how the public responds to proposed health interventions (Khosravi, 2020; Siegrist et al., 2021). High levels of institutional trust correlate with greater likelihood of adopting recommended protective measures (Paek et al., 2008; Baumgaertner et al., 2018; Khosravi, 2020). This relationship underscores the importance of consistent and transparent communication during public health crises. Conversely, mixed messages can erode trust, ultimately reducing adherence to public health strategies (Vaughan & Tinker, 2009; Baumgaertner et al., 2018; Zheng et al., 2022).

Vaccine Side Effects

A significant proportion of parents in the study expressed concerns about the potential adverse effects of vaccinations. Over one-third worried that vaccines could severely harm their children, and approximately two-fifths raised safety concerns about routine childhood immunizations. Furthermore, more than a third of respondents preferred administering fewer vaccines at a time. These safety-related apprehensions are consistently linked to vaccine hesitancy, as previously documented (Gilkey et al., 2013; Marti et al., 2017). Research has shown that parents who believe their children have experienced vaccine-related side effects are more likely to harbour safety concerns (Chow et al., 2017). Indeed, these concerns can deter adherence to standard childhood vaccination schedules (Dube et al., 2016).

Media Influences

While social media plays an important role in disseminating information about the benefits of childhood vaccinations, it is also a significant channel for spreading misinformation. The pervasive presence of false information about vaccines on social media platforms has become a well-documented driver of vaccine refusal (Tran et al., 2018; Özceylan, Toprak & Esen, 2021). This study corroborates these findings, demonstrating that parents who rely on social media for vaccine information tend to exhibit higher levels of hesitancy. Although the internet offers easily accessible data, it also facilitates the rapid circulation of false narratives, which can breed mistrust and misperceptions. These findings underscore the critical need for health organizations to counter misinformation by providing accurate, evidence-based vaccine information through online and social media channels.

Approximately 61.8% of parents in the study were hesitant or unwilling to discuss their vaccine-related concerns with their child's paediatrician. Additionally, 26.6% reported having less than 50% trust in their paediatrician, and 62.1% sought vaccine information from other sources because they did not find the paediatrician's information credible. This pattern aligns with prior research showing that many

parents base their vaccination decisions on information from media rather than healthcare professionals. Various studies highlight how pervasive misinformation on the internet complicates the ability to distinguish credible content from falsehoods, often amplifying anti-vaccine rhetoric in ways that are difficult to refute (Zucco et al., 2018; Bianco et al., 2019; Al-Regaiey et al., 2022).

Thus, while digital platforms can be valuable tools for education, they also pose significant risks by allowing false information to flourish. The straightforward, emotionally appealing language of anti-vaccine arguments often resonates with concerned parents, making it more challenging for experts to provide convincing counter-narratives (Bianco et al., 2019). Health authorities must therefore intensify efforts to disseminate accurate, trustworthy information through the same channels to rebuild public confidence in vaccines.

PMT Constructs

The present study demonstrates that the fundamental constructs of Protection Motivation Theory (PMT) play a significant role in predicting vaccination intentions. However, the constructs of disease severity, response efficacy, and self-efficacy emerged as the most influential. This finding aligns with prior research showing that not all PMT constructs hold equal predictive power for specific behaviours. For example, Eberhardt & Ling (2021a) assessed psychological determinants of COVID-19 vaccination intentions among BAME communities in the UK and found perceived vulnerability to be a strong predictor of vaccination intention. Similarly, Ling et al. (2019) identified response efficacy as the most reliable predictor of influenza vaccination intention in the US. Camerini et al. (2019) found that perceptions of MMR vaccine efficacy were the strongest direct predictors of vaccine adherence in Switzerland.

Coping appraisal constructs, as opposed to threat appraisal constructs, generally demonstrate stronger associations with adaptive health behaviours (Ling et al., 2019; Eberhardt & Ling, 2021a; Eberhardt & Ling, 2021b; Eberhardt & Ling, 2022). Although the current study did not find a direct relationship between threat appraisal and the intention to follow official COVID-19 vaccination guidelines, the findings confirm the interconnectedness of threat and coping appraisals under the PMT model. This interrelationship emphasizes the importance of how individuals weigh the potential benefits and risks of vaccination (Ho et al., 1998; Floyd et al., 2000; Milne et al., 2000; Heininger, 2009; Chen, 2015). Public health organizations and healthcare professionals play a crucial role in shaping these perceptions by highlighting the efficacy of vaccines and the severity of diseases like COVID-19. Mixed messages from media sources further complicate this landscape, making it vital for trusted institutions to provide clear and accurate information (Bell et al., 2020; Goldman et al., 2020; Wang et al., 2021; Zhang et al., 2021; Khatatbeh et al., 2022).

This study underlines the necessity of reliable communication from healthcare professionals and institutions. By delivering accurate messages about vaccine efficacy, these entities can effectively increase both vaccination intentions and behaviours. The consequences of some healthcare professionals advising against immunization also underscore the importance of verifying information sources (Verger et al., 2015; Collange et al., 2016; Paterson et al., 2016). This highlights the critical role of health authorities and providers in fostering trust and guiding parents towards evidence-based decisions.

Research and Innovations

Expanding access to vaccination requires ongoing research into vaccine development and distribution technologies. Equitable vaccine delivery hinges on innovative approaches that improve accessibility. Future research should leverage theoretical frameworks like PMT to identify patterns and variations in the factors influencing parental intentions to follow official immunization guidelines. For instance, comparing the behavioural intentions of caregivers of younger children (0–6 years) with those of older children may reveal distinct predictive indicators that can inform targeted interventions.

Exploring additional factors, such as sociocultural and socioeconomic disparities, is crucial in understanding vaccine hesitancy in a culturally diverse context (Obohwemu et al., 2025a; Obohwemu

et al., 2025b). Qualitative studies could provide deeper insights into the unique barriers faced by multi-ethnic populations. Given that vaccine intentions are dynamic, longitudinal studies are needed to track changes over time and across different demographic groups. Such research could examine how parental attitudes and intentions evolve in response to shifting media narratives and regional disparities in vaccine access. A longitudinal approach may also shed light on how vaccine hesitancy changes as children grow older, enabling the development of tailored interventions that address parents' evolving concerns and encourage sustained vaccination uptake.

Study Strengths and Limitations

This cross-sectional study explored the influence of various factors—such as parental attitudes, structural and contextual barriers, and socioeconomic concerns—on vaccination intentions. The large sample size provided sufficient power to detect even minor differences in immunisation rates between groups. By encompassing diverse demographic characteristics, the study offered a robust dataset for assessing vaccine hesitancy and related confidence and trust measures. However, the cross-sectional design imposes certain constraints on generalizability and causation. For instance, the correlations observed between vaccine hesitancy and its determinants, while insightful, cannot establish causal relationships. Moreover, the cross-sectional nature limited the exploration of deeper reasons behind vaccine hesitancy and prevented tracking changes over time. The reliance on self-reported data introduced potential recall bias, and the online survey format may have inadvertently excluded individuals with limited digital literacy, such as first-generation immigrants or older adults. Additionally, while the survey attempted to reflect UK demographics, some subpopulations, notably Asian respondents, were underrepresented. These limitations highlight the need for longitudinal research to better understand how vaccine attitudes evolve, particularly in response to shifting media narratives and regional disparities. Despite these challenges, the findings enrich our understanding of vaccine hesitancy and provide a foundation for improving health promotion programs.

Implications for Policy and Practice

Parental concerns about adverse vaccine effects and unfamiliar immunisations reflect broader worries that also extend to healthcare professionals, who may harbour doubts about new vaccines and vaccine schedules (Chukwuyem et al., 2024). Addressing vaccine hesitancy requires a sociocultural approach that equips vaccine providers with effective communication skills and comprehensive knowledge of vaccine benefits (Ren et al., 2018). Doctors and healthcare workers, as trusted sources of health information, must clearly convey vaccine safety, openly address questions, and attentively respond to parental concerns (Smith et al., 2017; Napolitano et al., 2018). Discussions with parents should also emphasize how vaccination not only protects their own children but also contributes to the health of the broader community. By fostering trust through transparent and empathetic communication, healthcare providers can enhance vaccine acceptance.

Key cognitive factors—such as perceived disease severity, response efficacy, and self-efficacy—strongly influence vaccination intentions. Control variables like age, education, income, and access to healthcare also play a critical role. Targeted educational campaigns should focus on raising vaccine awareness, particularly among older adults, individuals with lower educational attainment, and those in lower socioeconomic brackets. By increasing understanding of disease severity and improving self-efficacy, these initiatives can bolster vaccination rates, especially among previously unvaccinated UK residents who may be hesitant or unaware of the benefits. In this way, educational strategies can help bridge gaps in vaccine knowledge, ultimately fostering a more informed and immunized population.

CONCLUSION

Given the relatively low proportion of parents who intend to vaccinate their children against COVID-19, future research should evaluate prior UK vaccination campaigns by examining the presence and application of PMT constructs within these programs. To improve immunisation rates, it is crucial to

identify and address the factors underlying parental reluctance. Emphasizing the importance of new vaccines and addressing concerns about their potential risks among less educated groups may enhance the effectiveness of vaccination messages. Tailoring communication to align with the audience's educational levels, alongside providing healthcare professionals with enhanced counselling and interpersonal skills, can lead to more impactful interactions.

Efforts to promote vaccine uptake are likely to be more effective if they simultaneously increase individuals' perceptions of COVID-19's severity and their vulnerability to the disease, while also strengthening their confidence in the vaccine's effectiveness. At the same time, these initiatives should work to reduce perceptions of the benefits associated with forgoing vaccination. Additionally, conspiracy theories and misinformation must be openly addressed, as they often contribute to vaccine hesitancy. A comprehensive approach that incorporates a variety of tailored strategies—rather than relying on a single intervention—may be necessary to meaningfully reduce COVID-19 vaccine hesitancy.

CONFLICTS OF INTEREST

The author declares no conflicts of interest.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ACKNOWLEDGEMENT

The author would like to acknowledge Floor Christie-de Jong and Jonathan Ling for their expert advice. Gratitude is extended to the management and technical staff of PENKUP Research Institute, Birmingham, United Kingdom for their excellent assistance and for providing medical writing/editorial support in accordance with Good Publication Practice (GPP3) guidelines.

REFERENCES

Abdelamir, A.S. & Hafidh, R.R., (2020). *The Possible Immunological Pathways for the Variable Immunopathogenesis of COVID-19 Infections among Healthy Adults, Elderly and Children*. Electronic Journal of General Medicine, 17(4), em202.

Abedin, M., Islam, M.A., Rahman, F.N., et al., (2021). *COVID-19 vaccine hesitancy and related factors among Bangladeshi adults: a cross-sectional survey*. PLOS ONE, 16(8), e0257096.

Abejegah, C., Obohwemu, K.O. and Mdegela, M., (2024). Clinical manifestations and outcome of human mpox infection from 1970 to 2023. A systematic literature review. *Clinical Infection in Practice*, p.100397.

Al-Regaiey, K., et al., (2022). *Social media misinformation and vaccine hesitancy: The spread and influence of misinformation during the COVID-19 pandemic*. Journal of Infection and Public Health, 15(5), pp.585–591.

Alwreikat, A., Shehata, A. & Edakar, M., (2021). *Parental acceptance of COVID-19 vaccines for children: a Protection Motivation Theory-based study*. Journal of Pediatric Health Care, 35(5), pp.452–459.

Anderson, R.M., Heesterbeek, H., Klinkenberg, D. & Hollingsworth, T.D., (2020). *How will country-based mitigation measures influence the course of the COVID-19 epidemic?*. The Lancet, 395(10228), pp.931–934.

Andersson, O., Campos-Mercade, P., Meier, A.N. & Wengström, E., (2022). *Anticipation of COVID-19 vaccines reduces willingness to socially distance*. Journal of Health Economics, 82, 102581.

Azizi, S.M., et al., (2017). *Application of the protection motivation theory to predict COVID-19 preventive behaviours in the Iranian population*. BMC Public Health, 21(1), pp.1–9.

Baumgaertner, B., Carlisle, J.E. & Justwan, F. (2018) *The influence of political ideology and trust on willingness to vaccinate*. PLOS ONE, 13(1), e0191728.

Bell, S., Clarke, R., Mounier-Jack, S., et al. (2020) *Parents' and guardians' views on the acceptability of a future COVID-19 vaccine: a multi-methods study in England*. Vaccine, 38(49), pp.7789–7798.

Betsch, C., Renkewitz, F., Betsch, T. & Ulshöfer, C. (2015) *The influence of vaccine-critical websites on perceiving vaccination risks*. Journal of Health Psychology, 15(3), pp.446–455.

Bianco, A., Mascaro, V., Zucco, R. & Pavia, M. (2014) *Parent perspectives on childhood vaccination: How to deal with vaccine hesitancy and refusal?* Italian Journal of Pediatrics, 40(1), pp.1–7.

Bianco, A., Zucco, R., Pileggi, C., et al. (2019) *Analyzing public health communication: The vaccine hesitancy phenomenon*. Human Vaccines & Immunotherapeutics, 15(7–8), pp.1636–1643.

Bish, A. & Michie, S. (2010) *Demographic and attitudinal determinants of protective behaviours during a pandemic: A review*. British Journal of Health Psychology, 15(4), pp.797–824.

Bish, A., Yardley, L., Nicoll, A. & Michie, S. (2011) *Factors associated with uptake of vaccination against pandemic influenza: A systematic review*. Vaccine, 29(38), pp.6472–6484.

Britt, R.K., Hatten, K.N., Chappuis, S.O., et al. (2014) *Using protection motivation theory and health literacy to communicate effective COVID-19 preventive measures in social media*. Health Communication Research, 29(4), pp.335–348.

Bults, M., Beaujean, D.J.M.A., Richardus, J.H. & Voeten, H.A.C.M. (2011) *Perceived risk, anxiety, and behavioural responses of the general public during the early phase of the Influenza A (H1N1) pandemic in the Netherlands: results of three consecutive online surveys*. BMC Public Health, 11, p.2.

Camerini, A.L., Diviani, N., Fadda, M. & Schulz, P.J. (2019) *Using protection motivation theory to predict intention to adhere to official MMR vaccination recommendations in Switzerland*. SSM - Population Health, 7, 100321.

Casiday, R.E. (2007) *Children's health and the social theory of risk: exploring the implications of parents' involvement in health research*. Health, Risk & Society, 9(1), pp.47–63.

CDC (2010) *Recommended Immunization Schedule for Children and Adolescents Aged 18 Years or Younger, United States*. [online] Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html [Accessed 17 Apr. 2025].

Chen, X., et al. (2021) *COVID-19 vaccine hesitancy among parents in Hong Kong*. Human Vaccines & Immunotherapeutics, 17(11), pp.3993–3998.

Chinazzi, M., Davis, J.T., Ajelli, M., et al. (2020) *The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak*. Science, 368(6489), pp.395–400.

Chow, M.Y.K., Danchin, M., Willaby, H.W., et al. (2017) *Parental attitudes, beliefs, behaviours and concerns towards childhood vaccinations in Australia: a national online survey*. Australian Family Physician, 46(3), pp.145–151.

Collange, F., Verger, P., Launay, O., et al. (2016) *Determinants of parental acceptance of H1N1 vaccination: a qualitative approach*. Vaccine, 34(5), pp.642–648.

Cordina, M. & Lauri, M.A. (2021) *COVID-19 vaccine hesitancy and the role of pharmacotherapy education: A cross-sectional study in Malta*. Pharmacy Practice, 19(2), 2252.

D'Alessandro, A., Napolitano, F. and Angelillo, I.F. (2018) *Vaccine hesitancy among parents of children with and without chronic conditions*. Health Education & Behaviour, 45(5), pp.768–776.

Desmond, H. and Dierickx, K. (2021) *Ethical issues in public health research*. Bioethics, 35(2), pp.142–149.

Dinga, J.N., Sinda, L.K. and Titanji, V.P.K. (2021) *Assessment of vaccine hesitancy in Cameroon: a national survey*. The Pan African Medical Journal, 38, p.403.

Dong, E., Du, H. and Gardner, L. (2020) *An interactive web-based dashboard to track COVID-19 in real time*. The Lancet Infectious Diseases, 20(5), pp.533–534.

Dror, A.A., Eisenbach, N., Taiber, S., Morozov, N.G., Mizrachi, M., Zigron, A., Srouji, S. and Sela, E. (2020) *Vaccine hesitancy: the next challenge in the fight against COVID-19*. European Journal of Epidemiology, 35(8), pp.775–779.

Dubé, E., Gagnon, D., MacDonald, N.E. and the SAGE Working Group on Vaccine Hesitancy (2018) *Strategies intended to address vaccine hesitancy: Review of published reviews*. Vaccine, 33(34), pp.4191–4203.

Dubé, E., MacDonald, N.E., Guay, M. and Gagnon, D. (2021) *Mapping vaccine hesitancy—Country-specific characteristics of a global phenomenon*. Vaccine, 39(42), pp.6392–6399.

Dubé, E., Vivion, M. and MacDonald, N.E. (2016) *Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: influence, impact and implications*. Expert Review of Vaccines, 14(1), pp.99–117.

Eberhardt, J. and Ling, J. (2021a) *Predicting COVID-19 vaccination intention using protection motivation theory and conspiracy beliefs*. Vaccine, 39(42), pp.6269–6275.

Eberhardt, J. and Ling, J. (2021b) *The role of cognitive appraisals and cultural values in predicting COVID-19 vaccine hesitancy*. Journal of Health Psychology. Advance online publication.

Eberhardt, J. and Ling, J. (2022) *Health belief model and COVID-19 vaccination: A longitudinal study*. Journal of Public Health, 44(1), pp.e45–e53.

Ernsting, C., Gellert, P., Oedekoven, M., O'Sullivan, J.L., Kanzler, M., Kuhlmey, A. and Schnitzer, S. (2011) *Using the Protection Motivation Theory to predict intentions to receive the seasonal influenza vaccination*. Medical Decision Making, 31(5), pp.650–662.

Etikan, I., Alkassim, R.S. and Abubakar, S. (2016) *Comparisons of convenience sampling and purposive sampling*. American Journal of Theoretical and Applied Statistics, 5(1), pp.1–4.

Etikan, I., Musa, S.A. and Alkassim, R.S. (2016) *Comparison of convenience sampling and purposive sampling*. American Journal of Theoretical and Applied Statistics, 5(1), pp.1–4.

Faasse, K. and Newby, J.M. (2020) *Public perceptions of COVID-19 in Australia: perceived risk, knowledge, health-protective behaviours, and vaccine intentions*. Frontiers in Psychology, 11, p.551004.

Floyd, D.L., Prentice-Dunn, S. and Rogers, R.W. (2000) *A meta-analysis of research on Protection Motivation Theory*. Journal of Applied Social Psychology, 30(2), pp.407–429.

Freimuth, V.S., Jamison, A.M., An, J., Hancock, G.R. and Quinn, S.C. (2017) *Determinants of trust in the flu vaccine for African Americans and Whites*. Social Science & Medicine, 193, pp.70–79.

Fuchs, C. (2018) *Digital Demagogue: Authoritarian Capitalism in the Age of Trump and Twitter*. London: Pluto Press.

Gilkey, M.B., Calo, W.A., Marciniak, M.W. and Brewer, N.T. (2013) *Parents who refuse or delay HPV vaccine: differences in vaccination behaviour, beliefs, and clinical communication preferences*. Human Vaccines & Immunotherapeutics, 9(11), pp.2529–2536.

Goldman, R.D., Yan, T.D., Seiler, M., Cotanda, C.P., Brown, J.C., Klein, E.J., Hoeffe, J., Gelernter, R., Hall, J.E. and Griffiths, M.A. (2020) *Caregiver willingness to vaccinate their children against COVID-19: Cross sectional survey*. Vaccine, 38(48), pp.7668–7673.

Goodwin, R., Haque, S., Neto, F. and Myers, L.B. (2010) *Initial psychological responses to Influenza A, H1N1 ('Swine flu')*. BMC Infectious Diseases, 10(1), p.166.

Grano, C., Singh, D. and Di Pucchio, A. (2022) *Psychological predictors of COVID-19 vaccination intentions in the UK population*. Vaccines, 10(1), p.14.

Han, P.K.J., Moser, R.P. and Klein, W.M. (2016) *Perceived ambiguity about cancer prevention recommendations: Associations with cancer-related perceptions and behaviours in a US population survey*. Health Expectations, 19(1), pp.3–15.

Heininger, U. (2006) *An internet-based survey on parental attitudes towards immunization*. Vaccine, 24(37–39), pp.6351–6355.

Heininger, U. (2009) *Understanding parents' fears: the key to successful immunization*. Pediatric Infectious Disease Journal, 28(8 Suppl), pp.S80–S82.

Henrikson, N.B., Opel, D.J., Grothaus, L., Nelson, J., Scrol, A., Dunn, J. and Grossman, D.C. (2017) *Physician communication training and parental vaccine hesitancy: a randomized trial*. Pediatrics, 139(1), p.e20162103.

Idowu, T.O., Obohwemu, K.O. and Iyevhobu, K.O., (2024). Knowledge, attitudes and practices of mothers towards childhood vaccination in Lagos State, Nigeria. *International Journal of Medical Science and Public Health Research*, *5*(09), pp.69-100.

Institute of Medicine (IOM). (2004) *Immunization safety review: Vaccines and autism*. Washington, DC: The National Academies Press.

Kata, A. (2012) 'Anti-vaccine activists, Web 2.0, and the postmodern paradigm—An overview of tactics and tropes used online by the anti-vaccination movement', *Vaccine*, 30(25), pp. 3778–3789. https://doi.org/10.1016/j.vaccine.2011.11.112

Kayode, M., Ajisegiri, S. W., Ogbonna, C. U., and Adepoju, K. A. (2022) 'Information sources and COVID-19 vaccine hesitancy in sub-Saharan Africa: The Nigerian perspective', *BMC Public Health*, 22, 843. https://doi.org/10.1186/s12889-022-13310-z

Khatatbeh, M., Khasawneh, A. I., Alhalaiqa, F., et al. (2022) 'Factors associated with COVID-19 vaccine acceptance among healthcare providers in Jordan', *PLOS ONE*, 17(5), e0269254. https://doi.org/10.1371/journal.pone.0269254

Khosravi, M. (2020) 'Perceived risk of COVID-19 pandemic: The role of public worry and trust', *Electronic Journal of General Medicine*, 17(4), em203. https://doi.org/10.29333/ejgm/7856

Ko, N. Y., Lu, W. H., Chen, Y. L., et al. (2020) 'COVID-19-related information sources and the relationship with confidence in people coping with COVID-19: Facebook survey study in Taiwan', *Journal of Medical Internet Research*, 22(6), e20021. https://doi.org/10.2196/20021

Kreps, S. and Kriner, D. L. (2021) 'Model uncertainty, political contestation, and public trust in science: Evidence from the COVID-19 pandemic', *Science Advances*, 7(1), eabd4563. https://doi.org/10.1126/sciadv.abd4563

Lai, C. C., Shih, T. P., Ko, W. C., Tang, H. J. and Hsueh, P. R. (2020) 'Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges', *International Journal of Antimicrobial Agents*, 55(3), 105924. https://doi.org/10.1016/j.ijantimicag.2020.105924

Le, T. T., Andreadakis, Z., Kumar, A., et al. (2020) 'The COVID-19 vaccine development landscape', *Nature Reviews Drug Discovery*, 19(5), pp. 305–306. https://doi.org/10.1038/d41573-020-00073-5

Lee, B. Y., Bartsch, S. M., Wong, K. F., et al. (2020) 'Simulation shows that early vaccination of children against COVID-19 can decrease cases, hospitalizations, and deaths across all age groups', *Health Affairs*, 40(2), pp. 302–310. https://doi.org/10.1377/hlthaff.2020.01530

Leventhal, H. (1970) 'Findings and theory in the study of fear communications', *Advances in Experimental Social Psychology*, 5, pp. 119–186. https://doi.org/10.1016/S0065-2601(08)60091-X

Li, H. O., Bailey, A., Huynh, D. and Chan, J. (2020) 'YouTube as a source of information on COVID-19: A pandemic of misinformation?', *BMJ Global Health*, 5(5), e002604. https://doi.org/10.1136/bmjgh-2020-002604

Limaye, R. J., Sauer, M., Ali, J., et al. (2021) 'Building trust while influencing online COVID-19 content in the social media world', *The Lancet Digital Health*, 3(6), pp. e359–e360. https://doi.org/10.1016/S2589-7500(21)00082-7

Ling, J., Eberhardt, J. and Sanderson, M. (2019) 'Predicting intention to receive influenza vaccination using Protection Motivation Theory', *Health Promotion Perspectives*, 9(1), pp. 1–8. https://doi.org/10.15171/hpp.2019.01

Lippke, S. and Ziegelmann, J. P. (2008) 'Theory-based health behaviour change: Developing, testing, and applying theories for evidence-based interventions', *Applied Psychology: An International Review*, 57(4), pp. 698–716. https://doi.org/10.1111/j.1464-0597.2008.00339.x

Liu, P. L., Liang, J. and Hsieh, C. H. (2016) 'Applying protection motivation theory to understand hepatitis B vaccination intentions among migrant workers', *BMC Public Health*, 16, 1243. https://doi.org/10.1186/s12889-016-3880-6

Lourenco, J., Paton, R., Ghafari, M., et al. (2020) 'Fundamental principles of epidemic spread highlight the immediate need for large-scale serological surveys to assess the stage of the SARS-CoV-2 epidemic', *medRxiv*. https://doi.org/10.1101/2020.03.24.20042291

Napolitano, F., D'Alessandro, A., Angelillo, I. F. (2016) 'Knowledge, attitudes, and practices of parents towards varicella and its vaccination', *BMC Infectious Diseases*, 16, 356. https://doi.org/10.1186/s12879-016-1703-y

Napolitano, F., D'Alessandro, A., Angelillo, I. F. (2018) 'Investigating Italian parents' vaccine hesitancy: A cross-sectional survey on childhood immunizations', *Human Vaccines & Immunotherapeutics*, 14(7), pp. 1558–1565. https://doi.org/10.1080/21645515.2018.1458505

Obohwemu, K., Christie-de Jong, F. and Ling, J., (2022). Parental childhood vaccine hesitancy and predicting uptake of vaccinations: a systematic review. *Primary Health Care Research & Development*, *23*, p.e68.

Obohwemu, K.O., (2024a). Improving maternal awareness and childhood vaccination uptake in Delta State, Nigeria. *International Journal of Medical Science and Public Health Research*, *5*(12), pp.37-57.

Obohwemu, K.O., (2024b). Maternal attitudes towards childhood vaccination in Delta State, Nigeria. *Frontline Medical Sciences and Pharmaceutical Journal*, *4*(12), pp.43-66.

Obohwemu, K.O., Idomeh, J.E. and Chauhan, R., (2025b). Sociodemographic Factors and Maternal Knowledge of Childhood Vaccination in Nigeria. International Journal of Medical Science and Public Health Research, 6(01), pp.7-21.

Obohwemu, K.O., Owusuaa-Asante, A.M., Ibiangake, N.F., Abayomi, G.O., Idomeh, J.E., Chauhan, R. and Sharma, S., (2025a). The Interplay of Ethnicity, Education, and Employment on Maternal Attitudes Toward Childhood Vaccination in Nigeria. *The American Journal of Medical Sciences and Pharmaceutical Research*, *7*(01), pp.65-77.

Opel, D. J., Diekema, D. S., Lee, N. R. and Marcuse, E. K. (2009) 'Social marketing as a strategy to increase immunization rates', *Archives of Pediatrics & Adolescent Medicine*, 163(5), pp. 432–437. https://doi.org/10.1001/archpediatrics.2009.61

Opel, D. J., Mangione-Smith, R., Taylor, J. A., et al. (2011b) 'Development of a survey to identify vaccine-hesitant parents: The parent attitudes about childhood vaccines survey', *Human Vaccines*, 7(4), pp. 419–425. https://doi.org/10.4161/hv.7.4.14120

Opel, D. J., Robinson, J. D., Heritage, J., et al. (2011a) 'Characterizing providers' immunization communication practices during health supervision visits with vaccine-hesitant parents: A pilot study', *Vaccine*, 30(7), pp. 1269–1275. https://doi.org/10.1016/j.vaccine.2011.12.043

Opel, D. J., Taylor, J. A., Zhou, C., et al. (2013) 'The relationship between parent attitudes about childhood vaccines survey scores and future child immunization status: A validation study', *JAMA Pediatrics*, 167(11), pp. 1065–1071. https://doi.org/10.1001/jamapediatrics.2013.2483

Özceylan, G., Toprak, D. and Esen, E. (2021) 'Vaccine rejection and hesitation in Turkey', *Human Vaccines & Immunotherapeutics*, 17(5), pp. 1125–1132. https://doi.org/10.1080/21645515.2020.1821183

Paek, H. J., Hove, T., Jeong, H. J. and Kim, M. (2008) 'Determinants of preventive behaviours in response to the 2009 H1N1 influenza pandemic', *Journal of Health Communication*, 13(8), pp. 761–776. https://doi.org/10.1080/10810730802487445

Parker, C., Scott, S. and Geddes, M. (2019) 'Snowball sampling', in Atkinson, P., Delamont, S., Cernat, A., Sakshaug, J. W. and Williams, R. A. (eds.) *SAGE research methods foundations*. London: SAGE. https://doi.org/10.4135/9781526421036851710

Paterson, P., Chantler, T. and Larson, H. J. (2018) 'Reasons for non-vaccination: Parental vaccine hesitancy and the childhood influenza vaccination school pilot programme in England', *Vaccine*, 36(36), pp. 5397–5401. https://doi.org/10.1016/j.vaccine.2017.08.016

Paterson, P., Meurice, F., Stanberry, L. R., Glismann, S., Rosenthal, S. L. and Larson, H. J. (2016) 'Vaccine hesitancy and healthcare providers', *Vaccine*, 34(52), pp. 6700–6706. https://doi.org/10.1016/j.vaccine.2016.10.042

Petrie, A. and Sabin, C. (2019) *Medical statistics at a glance*, 4th edn. Oxford: Wiley-Blackwell.

Posey, C., Roberts, T. L. and Lowry, P. B. (2015) 'The impact of organizational commitment on insiders' motivation to protect organizational information assets', *Journal of Management Information Systems*, 32(4), pp. 179–214. https://doi.org/10.1080/07421222.2015.1138374

Quinn, S. C., Jamison, A. M., Freimuth, V. S., An, J. and Hancock, G. R. (2017) 'Determinants of influenza vaccination among high-risk Black and White adults', *Vaccine*, 35(51), pp. 7154–7159. https://doi.org/10.1016/j.vaccine.2017.11.019

Quinn, S. C., Kumar, S., Freimuth, V. S., Kidwell, K. and Musa, D. (2009) 'Public willingness to take a vaccine or drug under emergency use authorization during the 2009 H1N1 pandemic', *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, 7(3), pp. 275–290. https://doi.org/10.1089/bsp.2009.0041

Ren, X., Geoffroy, E., Tiako, M. J., et al. (2018) 'Knowledge, attitudes, and behaviours of nurses and physicians towards vaccinations in Cameroon: A cross-sectional study', *Human Vaccines & Immunotherapeutics*, 14(11), pp. 2538–2544. https://doi.org/10.1080/21645515.2018.1483809

Repalust, A., Šević, S., Šepić Golubić, M., et al. (2017) 'Parental refusal of childhood vaccination: Associated socio-demographic factors in Croatia', *Vaccine*, 35(36), pp. 4751–4756. https://doi.org/10.1016/j.vaccine.2017.07.025

Rey, D., Fressard, L., Cortaredona, S., et al. (2018) 'Vaccine hesitancy in the French population in 2016, and its association with vaccine uptake and perceived vaccine risk–benefit balance', *Eurosurveillance*, 23(17), pp. 1–10. https://doi.org/10.2807/1560-7917.ES.2018.23.17.17-00816

Rogers, R. W. (1975) 'A protection motivation theory of fear appeals and attitude change', *The Journal of Psychology*, 91(1), pp. 93–114. https://doi.org/10.1080/00223980.1975.9915803

Rogers, R. W. (1983) 'Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation', in Cacioppo, J. and Petty, R. E. (eds.) *Social psychophysiology: A sourcebook*. New York: Guilford Press, pp. 153–176.

Rogers, R. W. and Prentice-Dunn, S. (1997) 'Protection motivation theory', in Gochman, D. S. (ed.) *Handbook of health behaviour research I: Personal and social determinants*. New York: Springer, pp. 113–132.

Rovetta, A. and Castaldo, L. (2021) 'Influence of COVID-19 infodemic on web users' vaccination attitude: Italian nationwide study', *JMIR Infodemiology,* 1(1), e29929. https://doi.org/10.2196/29929

Rubin, G. J., Amlôt, R., Page, L. and Wessely, S. (2009) 'Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: Cross sectional telephone survey', *BMJ,* 339, b2651. https://doi.org/10.1136/bmj.b2651

Ryu, H. S., Kim, H. S., Kim, H. and Choi, S. (2022) 'Parents' intentions to vaccinate children against COVID-19: A protection motivation theory-based study in South Korea', *BMC Public Health,* 22, 1322. https://doi.org/10.1186/s12889-022-13677-0

Schmid, P., Rauber, D., Betsch, C., Lidolt, G. and Denker, M. L. (2017) 'Barriers of influenza vaccination intention and behaviour – A systematic review of influenza vaccine hesitancy, 2005–2016', *PLoS ONE*, 12(1), e0170550. https://doi.org/10.1371/journal.pone.0170550

Sharifirad, G., Yarmohammadi, P., Sharifabad, M. A. and Rahaei, Z. (2014) 'Determinants of fast food consumption among Iranian high school students based on the theory of planned behaviour', *Journal of Obesity & Weight Loss Therapy*, 4(2), pp. 1–6. https://doi.org/10.4172/2165-7904.1000226

Shiloh, S., Peleg, S. and Nudelman, G. (2021) 'Vaccination intention among adults with chronic conditions: The role of risk perception and health behaviour theories', *Health Psychology and Behavioural Medicine*, 9(1), pp. 674–695. https://doi.org/10.1080/21642850.2021.1942029

Siegrist, M., Luchsinger, L. and Bearth, A. (2021) 'The impact of trust and risk perception on the acceptance of measures to reduce COVID-19 cases', *Risk Analysis*, 41(5), pp. 787–800. https://doi.org/10.1111/risa.13675

Sloan, L. and Quan-Haase, A. (2017) *The SAGE handbook of social media research methods*. London: SAGE Publications.

Smith, L. E., Amlôt, R., Weinman, J., Yiend, J. and Rubin, G. J. (2017) 'A systematic review of factors affecting vaccine uptake in young children', *Vaccine*, 35(45), pp. 6059–6069. https://doi.org/10.1016/j.vaccine.2017.09.046

Smith, P. J., Humiston, S. G., Parnell, T., et al. (2011) 'The association between intentional delay of vaccine administration and timely childhood vaccination coverage', *Public Health Reports*, 126(Suppl 2), pp. 39–49. https://doi.org/10.1177/00333549111260S207

Strelitz, B., Gritjenko, S., Gritzman, L., et al. (2016) 'Parental vaccine hesitancy and acceptance of seasonal influenza vaccine in children, Colorado, USA', *Preventive Medicine Reports*, 3, pp. 235–240. https://doi.org/10.1016/j.pmedr.2016.02.004

Teasdale, E., Yardley, L., Schlotz, W. and Michie, S. (2012) 'The importance of coping appraisal in behavioural responses to pandemic flu', *British Journal of Health Psychology*, 17(1), pp. 44–59. https://doi.org/10.1111/j.2044-8287.2011.02017.x

Thunstrom, L., Ashworth, M., Finnoff, D. and Newbold, S. (2020) 'Hesitancy towards a COVID-19 vaccine and prospects for herd immunity', *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3593098

Tomietto, M., Simonetti, V., Comparcini, D., et al. (2022a) 'Nursing students' knowledge, attitudes and behaviours on COVID-19 self-protective measures: A multi-centre cross-sectional study', *Nurse Education in Practice*, 56, 103197. https://doi.org/10.1016/j.nepr.2021.103197

Tran, B. X., Vu, G. T., Pham, H. Q., et al. (2018) 'Understanding health literacy and health information-seeking behaviour of Vietnamese undergraduates in the digital age', *International Journal of Environmental Research and Public Health*, 15(4), 660. https://doi.org/10.3390/ijerph15040660

Tsuzuki, S., Saeki, K., Kuroda, M., et al. (2020) 'Determining the target population for coronavirus disease 2019 (COVID-19) vaccination in Japan: A modeling study', *BMC Infectious Diseases*, 20(1), 994. https://doi.org/10.1186/s12879-020-05623-x

Vaughan, E. and Tinker, T. (2009) 'Effective health risk communication about pandemic influenza for vulnerable populations', *American Journal of Public Health*, 99(S2), pp. S324–S332. https://doi.org/10.2105/AJPH.2009.162537

Verger, P., Fressard, L., Collange, F., et al. (2015) 'Vaccine hesitancy among general practitioners and its determinants during controversies: A national cross-sectional survey in France', *EBioMedicine*, 2(8), pp. 891–897. https://doi.org/10.1016/j.ebiom.2015.06.018

Victor, M. (2020) 'The psychology of parental vaccine decision-making: Vaccine decision-making for children's health', *Journal of Health Psychology*, 25(12), pp. 1772–1781. https://doi.org/10.1177/1359105318770971

Wan, M., He, J., Zhou, T. and Liu, Y. (2021) 'Determinants of COVID-19 vaccination intention and behaviour among Chinese adolescents: A protection motivation theory perspective', *Human Vaccines & Immunotherapeutics*, 17(9), pp. 2865–2875. https://doi.org/10.1080/21645515.2021.1921936

Wang, J., Jing, R., Lai, X., et al. (2020) 'Acceptance of COVID-19 vaccination during the COVID-19 pandemic in China', *Vaccines*, 8(3), 482. https://doi.org/10.3390/vaccines8030482

Wang, Y., et al. (2021) 'The impact of vaccine conspiracy beliefs on parental willingness to vaccinate children against COVID-19', *Vaccines*, 9(6), 647. https://doi.org/10.3390/vaccines9060647

Wang, Y., McKee, M., Torbica, A. and Stuckler, D. (2019) 'Systematic literature review on the spread of health-related misinformation on social media', *Social Science & Medicine*, 240, 112552. https://doi.org/10.1016/j.socscimed.2019.112552

Weinstein, N. D., Kwitel, A., McCaul, K. D., et al. (2007) 'Risk perceptions: Assessment and relationship to influenza vaccination', *Health Psychology*, 26(2), pp. 146–151. https://doi.org/10.1037/0278-6133.26.2.146

Wheeler, M. and Buttenheim, A. M. (2013) 'Parental vaccine concerns, information source, and choice of alternative immunization schedules', *Human Vaccines & Immunotherapeutics*, 9(8), pp. 1782–1789. https://doi.org/10.4161/hv.25959

WHO (2020a) 'Coronavirus disease (COVID-19) pandemic'. World Health Organization. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019

Williams, S. E., Rothman, R. L., Offit, P. A., et al. (2015) 'A randomized trial to increase acceptance of childhood vaccines by vaccine-hesitant parents: A pilot study', *Academic Pediatrics*, 15(5), pp. 481–486. https://doi.org/10.1016/j.acap.2015.03.010

Wölfel, R., Corman, V. M., Guggemos, W., et al. (2020) 'Virological assessment of hospitalized patients with COVID-2019', *Nature*, 581(7809), pp. 465–469. https://doi.org/10.1038/s41586-020-2196-x

Wu, J. T., Leung, K., Bushman, M., et al. (2022) 'Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China', *Nature Medicine*, 26(4), pp. 506–510. https://doi.org/10.1038/s41591-020-0822-7

Xu, B., Gutierrez, B., Mekaru, S., et al. (2020) 'Epidemiological data from the COVID-19 outbreak, real-time case information', *Scientific Data*, 7, 106. https://doi.org/10.1038/s41597-020-0448-0

Yaqub, O., Castle-Clarke, S., Sevdalis, N. and Chataway, J. (2014) 'Attitudes to vaccination: A critical review', *Social Science & Medicine*, 112, pp. 1–11. https://doi.org/10.1016/j.socscimed.2014.04.018

Youn, H., Lee, H. and Ha-Brookshire, J. E. (2021) 'Understanding consumer behaviour for sustainable apparel: Applying protection motivation theory', *Sustainability*, 13(4), 1955. https://doi.org/10.3390/su13041955

Zhang, X., Guo, Y., Yu, H. and Li, Y. (2021) 'Online health information seeking in the context of COVID-19: An empirical study of the Chinese population', *Health Information & Libraries Journal*, 38(3), pp. 230–241. https://doi.org/10.1111/hir.12333

Zheng, R., Zhou, Y., Qiu, M. and Yan, Y. (2022) 'Trust in government and health behaviour during the COVID-19 pandemic: Empirical evidence from China', *Journal of Asian Public Policy*, 15(1), pp. 58–77. https://doi.org/10.1080/17516234.2020.1797973

Zucco, R., Lavano, F., Anfosso, R., et al. (2018) 'Internet and social media use as a source of vaccine information and its impact on vaccination intention and confidence in Italy', *Human Vaccines & Immunotherapeutics*, 14(7), pp. 1572–1577. https://doi.org/10.1080/21645515.2018.1463943