School of Psychology
Ysgol Seicoleg

Investigating the Influence of Message-frames, Psychological Flexibility, and Distress on COVID-19 Vaccine Hesitancy: A Systematic Review and Online Survey Experiment

Thesis submitted in partial fulfilment of the requirement for the degree of:

Doctorate of Clinical Psychology (DClinPsy)

South Wales Doctoral Programme in Clinical Psychology

Cardiff University

Sarah Howey

Supervised by: Dr James Stroud & Dr Louise Waddington

22nd May 2023

TABLE OF CONTENTS

Acknowledgments

I would like to express my heartfelt gratitude to the following people who have played a significant role in the successful completion of my Doctorate in Clinical Psychology. Their unwavering support, guidance, and encouragement have been invaluable throughout this journey.

First and foremost, I am deeply grateful to Dr James Stroud for his exceptional guidance, expertise, and dedication to this project. His supervision was instrumental in shaping this research and I am indebted to his patience, flexibility, and commitment.

I am also sincerely grateful to Dr Louise Waddington for her valuable time, constructive feedback, and mentorship. Her insightful comments and guidance have greatly enhanced the quality of my work.

I am also indebted to Johnathan Jones, the subject Librarian, for his patient assistance in developing search terms for my systematic review. His kindness and reassurance lightened the burden during the early stages of the process.

I would like to express my heartfelt gratitude to Dr Hannah Carvell, her presence and support throughout our friendship have been a tremendous source of strength. She also dedicated her time as the second reviewer and quality appraiser for my systematic review.

To my fellow cohort members, thank you for the laughter, camaraderie, and friendships we have shared. Your presence has made this journey more enjoyable, and I look forward to our continued growth and friendships beyond this academic endeavour.

A special acknowledgement to my Mum, whose unwavering support and belief in my abilities have been a constant source of motivation. Without her encouragement and assistance throughout my life and education, achieving a Doctorate would not have been possible. I am forever grateful for her love and support.

I would also like to express my deepest appreciation for my partner, Will, for his consistent support, kindness, love, and patience. His understanding of the ups and downs of this journey have been appreciated, and I am grateful for his presence in my life.

To all those mentioned and to everyone who has contributed to my personal and academic growth, thank you. Your support and encouragement have made this achievement possible, and I am eternally grateful.

Thesis Preface

This research was focused on understanding COVID-19 vaccine hesitancy. In March 2020 the respiratory infection COVID-19 led to the declaration of a global pandemic. A worldwide effort began to develop lifesaving vaccines; however, vaccine hesitancy threatened the success of the new vaccines and worldwide public health.

Paper One – Systematic Review

The systematic review explored existing literature on message-framing interventions to increase COVID-19 vaccine take-up and decrease vaccine hesitancy. Message-framing interventions involve varying the information presented, how it is presented, or who presents it. Emphasis frames vary the content of messages, while equivalence frames present logically equivalent information in different ways, highlighting gains or losses (e.g., for a disease expected to kill 600 people and, an intervention will either ‘save 400 people’ or ‘mean that 200 people will die’). Source type manipulations vary who presents the message. Vaccine hesitancy has been assessed through participants’ intentions to receive COVID-19 vaccines and their attitudes. This is the first review examining the impact of message-framing on COVID-19 vaccine hesitancy.

Five databases were systematically searched, and fifteen papers were reviewed. While message-frames were supported, methodological issues limited opportunities for meaningful comparisons between studies. None of the studies measured actual vaccine take-up so this aim could not be fulfilled. Many studies used different messages/sources and the overall quality varied.

Some studies used equivalence framing, where logically equivalent information is presented as gains or losses. Gain-frames highlight the positive outcomes of a behaviour, such as being vaccinated reducing the risk of severe outcomes from COVID-19 infection. Loss-frames would highlight equivalent negative outcomes, which in this example would be not getting vaccinated increasing the chances of severe outcomes from COVID-19 infection. Higher quality studies found loss-frames had the most impact on vaccine attitudes/intentions. One study found loss-frames were more effective in younger adults and gain-frames were more effective in older-adults. Lower quality studies supported gain-frames. Some studies found prior attitudes about the vaccines may influence message-framing effects. Future studies should consider the impact of prior attitudes.

Messages emphasising the personal benefits of vaccination were supported. Cultural differences between individualistic/collectivist cultures may play a role, and future research could strengthen these findings. Negatively framed messages and messages highlighting economic benefits of vaccination were also supported. Expert sources were supported, although the sources varied. Future research is needed to determine whether certain frames are more effective, or if any information improves vaccine attitudes/intentions. Addressing the methodological limitations discussed will contribute to the quality of future research.

Paper Two – Empirical paper

The empirical paper was an online survey (*n* = 434) investigating the link between psychological flexibility (PF), psychological distress (PD), and COVID-19 vaccine attitudes and acceptance. PF is a person's ability to do things that are important to them, experience both positive and negative emotions, and change their actions according to their thoughts and feelings. High PF supports effective coping strategies and protects from PD (Dawson & Golijani-Moghaddam, 2020). Psychological inflexibility (PIF) and PD have been linked to vaccine hesitancy (Wang & Zhang, 2021). Participants reported how many COVID-19 vaccines they had received, and their attitudes were measured using a scale assessing: confidence in the COVID-19 vaccines; complacency about the need to receive them; constraints preventing them from being vaccinated; how much calculation they had engaged in; and their feelings of collective responsibility to receive the vaccines.

The results showed an association between PIF and PD, and these factors were also associated with participants reporting more constraints, and less personal and collective need for vaccination. The link between PF and coping may explain this, as individuals may be playing down the severity of COVID-19 and the need for vaccination to avoid distress associated with the pandemic. Distressed individuals also avoided information searching about the vaccine, which may reflect a strategy to manage their distress.

Higher confidence in vaccines predicted vaccine take-up in participants with one and four plus doses of the vaccine, but none of the other factors predicted acceptance. The tool used to measure vaccine hesitancy has varied in its ability to predict vaccine take-up depending on the vaccine being assessed, so future research should be conducted with this measure to confirm its reliability.

Unexpectedly, participants with one/two/three doses were less PF than unvaccinated participants. Only a small amount of vaccine take-up was explained by PIF so future research should consider other contributing variables, like conspiracy beliefs. The timing of the research and the pandemic context is also likely to have impacted the results, and the findings must be considered context specific. The results mean public health campaigns should aim to encourage confidence in vaccines, emphasise the personal and collective benefits of vaccination, and reduce the need for information searching. The results from the systematic review mean that message-framing might be an intervention that could support policy makers to design effective vaccine campaigns.

The impact of message-frames on COVID-19 vaccine hesitancy and acceptance: a systematic review.

Word count of Abstract: 155

Word count of main body (excluding abstract, table figures and references): 5,614

ABSTRACT

Background: Message presentation and content affect vaccine take-up, which is vital for COVID-19 vaccine campaigns. Understanding whether message-frames can improve vaccine hesitancy will support public health communications and impact policy and clinicians.

Methods: PsycInfo, Embase, Medline/PubMed, CINAHL, Scopus, Web of Science and grey literature were searched. Fifteen quantitative papers were included. Papers needed to include a message-framing intervention on adults considering the first dose of a COVID-19 vaccine, with vaccine attitudes/acceptance outcomes.

Results: The quality of the studies significantly varied and affected the findings. Four studies supported gain-framing, three supported loss-framing. One found age group differences of gain-/loss-frames. Five studies supported emphasis framing, but the emphasised aspect varied. Five supported expert sources.

Conclusions: The findings support all message framing types, but methodological issues limit the conclusions. No studies assessed actual vaccine take-up. Message/source variation hindered meaningful comparisons. An operationalised definition of framing would support consistency. Analysing sociodemographic/moderating variables would support future message framing research.

Keywords:

- COVID-19
- Vaccine
- Hesitancy
- Message-framing
- Interventions
- Systematic review

INTRODUCTION

The declaration of the COVID-19 pandemic in March 2020 required strict public safety restrictions to be implemented by governments worldwide (World Health Organisation (WHO), 2020). A universal effort to rapidly develop lifesaving vaccines began, while severe lockdown measures restricted people's ability to socialise, closed businesses, schools, and workplaces (Institute for Government, 2021). Vaccines are considered among the most successful public health strategies (Dubé et al., 2013), annually saving around 2-3 million lives worldwide (Freeman et al., 2022; WHO, 2018), but low uptake rates threaten their success (Xiao & Wong, 2020).

Vaccine hesitancy is defined as a "delay in acceptance or refusal of vaccines despite availability of vaccine services." (Strategic Advisory Group of Experts on Immunisation (SAGE), 2014, p. 8). Vaccine hesitancy describes a range of attitudes towards vaccines between total acceptance and refusal (Freeman et al., 2020). Vaccine hesitancy is in WHO's top ten global health threats (Koslap-Petraco, 2019), and approximately 25% of the UK public are hesitant and about 6% are refusing the COVID-19 vaccine (Machingaidze & Wiysonge, 2021; Murphy et al., 2021; Sallam, 2021). The lowest COVID-19 vaccine acceptance rate in the world is 24% (Sallam, 2021), so it is important to understand how to encourage positive attitudes towards the vaccine to reduce hesitancy (Goldenberg, 2021).

Various theories have been proposed to explain vaccine hesitancy. The Health Belief Model (HBM) (Rosenstock, 1966) posits that individuals' beliefs about the severity and susceptibility of a disease, as well as the perceived benefits and risks of vaccination (Carpenter, 2010; Harrison et al., 1992), influence vaccine uptake.

Research indicates that groups who perceive a higher personal risk of contracting COVID-19 and/or a greater risk to members of the public are more likely to accept the vaccine (Karlsson et al., 2021; Malik et al., 2020). Additionally, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) incorporates similar concepts, suggesting that an individual's decision to receive a vaccine is influenced by their belief in the positive consequences of vaccination, perception of familial and societal pressure to get vaccinated, and the sense of control over the behaviour (Chu et al., 2021).

Governments used communication strategies, expert/media sources, and emotional appeals to generate support for COVID-19 public safety measures and vaccines (Mheidly & Fares, 2020). The effectiveness of health messages on the public's behaviour has been widely researched in the context of Framing Theory (Abhyankar et al., 2008; Detweiler et al., 1999; Kahneman & Tversky, 1979; Kim et al., 2020; Nan, 2012a, 2012b; Rivers et al., 2005; Tversky & Kahneman, 1981; Xiao & Borah, 2021). Understanding how framing theory impacts on vaccine decision making could have wide reaching implications for public health strategists in designing effective vaccine campaigns that increase the number of vaccines received and consequently lives saved.

The impact of message framing may also have direct implications for Clinical Psychologists, who support behaviour change through communication. Clinical Psychologists support professionals and service users with issues directly linked to vaccines. Needle phobia is psychological in nature, and often has links to trauma (American Psychiatric Association & Association, 2013; Jenkins, 2014). Maintaining service user engagement in psychological treatment can also be a challenge for Clinical Psychologists in health settings (Farooq & Naeem, 2014). Understanding the

relationship between message framing, engagement in health treatment recommendations would potentially help Psychologists to overcome these treatment barriers and support the therapeutic relationship between service user and therapist. Clinical Psychologists are also required to demonstrate leadership qualities throughout their career, and are placed at consultant, and clinical director levels within the NHS (Skinner et al., 2010). They are required to present data to funding bodies to support the ongoing funding of services in line with current policy, and best practice guidelines (Skinner et al., 2010). Therefore, it is important for Clinical Psychologists to know the impact of message-framing on decision making to support them in presenting information that promotes the wellbeing of service users and staff within the NHS.

Framing Theory

Equivalence framing

Tversky and Kahneman (1981) showed message-framing's impact on health decisions with a fictional deadly Asian disease that was expected to kill 600 people. The participants had to choose between interventions. In one condition participants read how many lives would be lost ('loss-frame', e.g., 400 people will die). In the other condition participants read how many lives would be saved ('gain-frame' e.g., 200 people will be saved). In both conditions the other intervention option presented next to the framed messages had a chance of saving more people and a chance of saving no one. The authors demonstrated that they could predict choice outcomes based on the way information was presented (gains/losses), as opposed to the utility of the outcomes (more lives saved). Gain-framed information promoted risk-avoidance (opting for the intervention guaranteed to save lives), while loss-framed information

promotes riskier choices (opting for the intervention with a chance of saving some people, and a chance of saving none). This phenomenon was coined Prospect Theory and studies using 'equivalence framing' have consistently upheld these effects in various scenarios (Kahneman, 2011; Kahneman & Tversky, 1979; Tversky & Kahneman, 1981), including health behaviours such as substance use (Quick & Bates, 2010; Toll et al., 2007), pap smear testing (Rivers et al., 2005), sunscreen use (Detweiler et al., 1999), and vaccinations (Abhyankar et al., 2008; Kim et al., 2020; Nan, 2012a, 2012b; Xiao & Borah, 2021). Despite not having a clear definition, studies using equivalence framing (presenting logically equivalent information as gains or losses) are underpinned by Prospect Theory's assumption that it is how the message is presented which produces the effect.

Gain-framed messages are better at promoting preventative health behaviours (e.g., physical activity/smoking cessation) than loss-framed messages, but there is no advantage of message-frame in illness detection (e.g., breast cancer/HIV screening) (Gallagher & Updegraff, 2012; Updegraff & Rothman, 2013). Loss-frames were better at improving attitudes/intentions towards the HPV vaccine (Kim et al., 2020; Nan, 2012a, 2012b; Nan et al., 2016; Park, 2012). There is limited research assessing real vaccine take-up, but one study found no effect of framing (O'Keefe & Jensen, 2009).

Rothman and Salovey (1997) proposed that the effect of equivalence framing on health behaviours depends on the level of risk involved. When behaviours have high risk/uncertainty (e.g., disease detection/testing behaviours), loss-framed messages are more effective, whereas gain-framed messages are more effective for low-risk behaviours (e.g., eating a balanced diet). This has been demonstrated in studies on

women who perceive themselves high/low risk of breast cancer and HIV (Apanovitch et al., 2003; Gallagher et al., 2011).

Emphasis framing

Emphasis framing is distinct from equivalence framing as it is concerned with what information is presented, rather than how it is presented (De Vreese, 2005; Gamson & Modigliani, 1987). To alter responsibility attributions, health messages during public health crises may emphasise the problem as an individual or collective issue (Bullock & Shulman, 2021; Everett et al., 2020). Cultural differences impact how these message-frames are processed (Oyserman & Lee, 2008), and moderate vaccination behaviour (Briley et al., 2017). Individual frames are more effective in promoting flu vaccinations in individualistic cultures like the USA (Hofstede, 1980; Pittman, 2020).

This review aims to provide a greater understanding of the impact of gain-/loss-framed messages and emphasis framing on COVID-19 vaccine attitudes and acceptance.

Source Type

The source presenting the message-frame impacts how messages are perceived (Chaiken, 1980; Chen et al., 2018; De Meulenaer et al., 2018; Eastin, 2001; Erku et al., 2021; Hancher-Rauch et al., 2019; Huang & Sundar, 2022; Kumkale et al., 2010; Phua et al., 2018). Sources with credibility and expertise are important, and doctors and government agencies are considered trustworthy sources in health communication (Avery, 2010; Dong, 2015; Dutta-Bergman, 2003; Hovland & Weiss, 1951; Jucks & Thon, 2017; Major & Coleman, 2012).

Celebrity sources also influence health behaviours (Brown et al., 2003; Phua et al., 2018) and many shared their attitudes on the COVID-19 vaccine via social media. Reliance on social media for health information increased during the pandemic (Lee & Jin, 2019), where regulated and unregulated sources shared information. This caused confusion over source credibility and there was a rapid spread of misinformation online (Mian & Khan, 2020). Social media has more false information shared on it than evidence-based information (Del Vicario et al., 2016; Lazer et al., 2018; Lewandowsky et al., 2012; Pulido et al., 2020), and the worldwide politicisation of the pandemic highlights the need to understand the impact of sources on vaccine attitudes/uptake (Bokemper et al., 2021; Kerr et al., 2021; Kreps & Kriner, 2021; Lazarus et al., 2021).

Methodological limitations of existing research

Message-framing effects are not upheld in meta-analyses (O'Keefe & Jensen, 2009; O'Keefe & Nan, 2012) and methodological concerns have been noted. In health research, authors have failed to treat specific health behaviours as distinct (O'Keefe & Jensen, 2009) and unclear definitions of risk, outcome uncertainty/severity have limited the findings (Harrington & Kerr, 2017; Van't Riet et al., 2014). Other studies are criticised for not distinguishing between equivalence and emphasis framing (Cacciatore et al., 2016).

Aims of the review

The severity of COVID-19 and vaccine hesitancy threatens global health. Clinical Psychology may help public health bodies to encourage positive attitudes towards vaccine take-up. There is no systematic review of the research on message-framings influence on COVID-19 vaccine attitudes and uptake. The review specifically aims to:

- Review the quality of the available research.
- Understand whether message framing interventions influence COVID-19 vaccine attitudes/acceptance.
- Understand whether sources influence COVID-19 vaccine attitudes/ acceptance.
- Consider how these findings compliment current research and advance the current literature.
- Make recommendations for further research.

METHOD

Search strategy

The review protocol was pre-registered with the international database of prospectively registered systematic reviews in health and social care (PROSPERO – registration number CRD42022309318) The following peer-reviewed journal databases were searched: PsycInfo, Embase, Medline/PubMed, CINAHL, Scopus, and Web of Science. To reduce the impact of publication bias, grey literature was searched via ProQuest, emails were sent to researchers in the field, and references in relevant papers were considered. The emails and reference lists returned no articles (d). The search was conducted in December 2022. See Appendix A for a full list of search terms used.

Study selection

The inclusion criteria are displayed in Table 1.1. Studies conducted prior to 2020 were excluded. A coexisting spreadsheet was used to detail excluded references and the primary reason for exclusion. To ensure consistency, a second reviewer was involved in screening at both the title and abstract, and full text stages. During the title and abstract and full text phase there were two disputes (99.7% agreement, k = 0.95), which were resolved via discussion. During quality assessment 25% of papers were assessed by an independent reviewer and consensus scores were used.

Table 1.1. Inclusion/exclusion criteria

	Inclusion	Exclusion
Population	Adults Aged 18+ Displaying vaccine hesitancy (or no hesitancy) towards COVID-19 vaccines.	Under 18 Those deciding to vaccinate others (e.g., children). Studies conducted prior to the COVID-19 pandemic (e.g., before 2020)
Interventions	Message framing interventions (e.g., emphasis or equivalence framing). Interventions aimed at increasing first dose COVID-19 vaccination intentions or rates and/or vaccine attitudes. Sufficient detail to determine the message framing intervention used.	Studies that do not include an intervention. Interventions which are not message framing interventions. Interventions not aimed at COVID-19 vaccines. Interventions aimed at booster doses of COVID-19 vaccines. Insufficient detail to determine the message framing used.
Comparators	No comparison groups. Comparison with baseline. Comparison with control group.	
Outcome	Vaccine take-up/intention, or knowledge/attitudes/awareness of vaccines.	No outcomes. Outcomes not related to vaccine take-up/intention, or knowledge/attitudes/awareness of vaccines.
Study Design	Quantitative studies only. English language papers only.	Qualitative studies Single case studies. Non-English language papers.

The search yielded 1,471 articles. After removing duplications, 851 titles and abstracts were screened against the inclusion criteria. Of these, 816 articles were excluded, and 35 full-text articles were reviewed. Twenty of these were excluded for not meeting the inclusion/exclusion criteria (Figure 1.1).

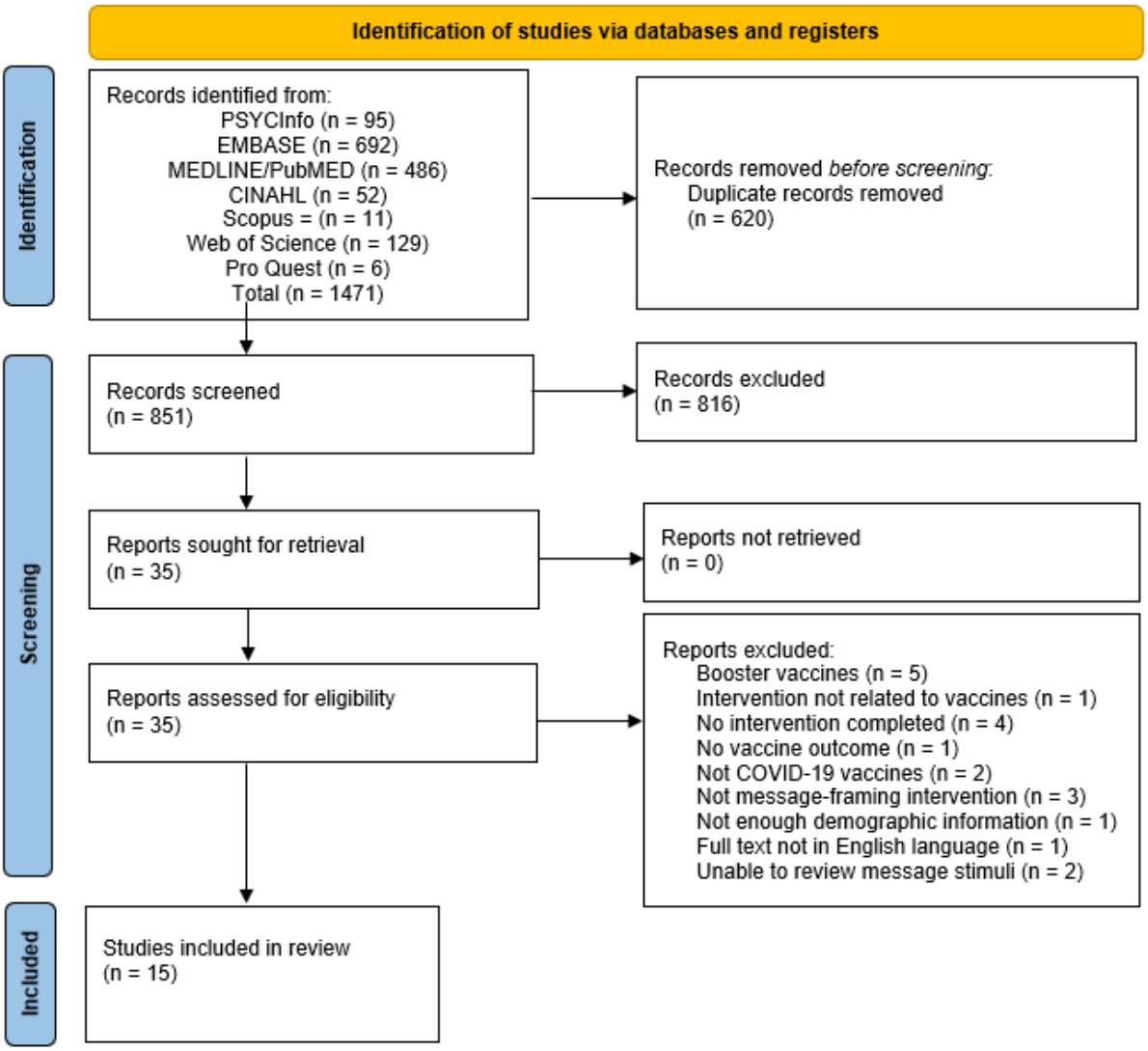


Figure 1.1. PRISMA diagram

Data extraction & synthesis

A meta-analysis was not conducted on the data due to large amounts of heterogeneity within the studies. Synthesis without meta-analysis (SWiM) guidelines were followed (Campbell et al., 2020). All data were extracted into Microsoft Word documents. Data extracted included study characteristics, inclusion/exclusion criteria, participant characteristics, message framing intervention/description, outcome measures, results pertaining to the message framing intervention and outcomes of interest.

Quality Assessment

The review assessed the risk of bias using the quality assessment with diverse studies (Quads) tool (Harrison et al., 2021) (Appendix B). This tool was selected as it allows for meaningful comparison between quantitative studies with different designs. Reviewers scored the quality of each study on thirteen domains from zero to three. Domains assessed included the theoretical underpinning of the research, study setting and design, data collection, analysis, and strengths and limitations. Zero scores in any domain highlights no mention of the specified criteria, whereas scores of three indicate in depth discussion and justification at each level. The tool does not provide cut-off scores for high/low risk of bias; therefore, no studies were excluded based on subjective cut-offs.

Grouping studies for synthesis

In line with SWiM guidance (Campbell et al., 2020), the studies were grouped by message-framing intervention used. Research has been criticised for unclear

definitions of message framing and combining framing types (Cacciatore et al., 2016), so this review clearly defines the message-frames used (equivalence/emphasis framing). Vaccine outcomes were grouped into domains of COVID-19 vaccine intentions and attitudes.

Standardised metrics & synthesis methods

Informal tests of heterogeneity were used, and the methodological characteristics of the studies were inspected. Heterogeneity in the interventions, outcomes, statistical analyses and reported effects meant it was not possible to statistically synthesize or meta-analyse the data. Vote counting based on direction of effect was used (Higgins et al., 2019). A sign test was not possible due to the limited number of studies in each group. Study's findings were considered significant if they reported a significance value of $p<.05$.

RESULTS

Demographic information

Fifteen papers were included in the final review involving 37,973 participants (demographic information in Table 1.2). Sample sizes varied between studies (range = 103 - 24,682). Most studies were conducted in the USA (*n* = 6) and China (*n* = 3). Others were in Italy (*n* = 2), Germany (*n* = 1), India (*n* = 1), Pakistan (*n* = 1), and Malaysia (*n* = 1). Six recruited unvaccinated adults (Betta et al., 2022; Gong et al., 2022; Green et al., 2022; Hines, 2022; Hing et al., 2022; Li et al., 2022; Prakash et al., 2022). The others did not specify.

One study only recruited university students (Hines, 2022), one only recruited younger adults (Betta et al., 2022), one recruited “millennials” (Prakash et al., 2022). One compared younger and older adults (Reinhardt and Rossmann, 2021). One did not report any demographic information (Green et al., 2022).

The prevalence of female participants ranged between 44.1%-70.7%. Four studies reported on participant ethnicity and most participants were White (Borah et al., 2021; Diament et al., 2022; Hines, 2022; Strickland et al., 2022).

Table 1.2. Demographic details for the included studies

						Relevant demographic information			
Author	*Year of publication*	*Country*	*Target population*	*Sampling method*	*Sample size in analysis*	*Age*	*Gender*	*Ethnicity*	*Other*
Betta, Castellini, Acampora & Barello	2022	Italy	Unvaccinated, Italian adults, aged 18-50	Online convenience sampling	405	Range = 19-42 19-30 = 88.3% 31-42 = 11.7% Mean (SD) = 26.75 (4.62)	Female = 70.7% Male = 29.3%	Not reported	*Profession* Student = 51.9% Professional = 48.1% *Education* Before graduation = 27.9% After graduation = 72.1% *Marital status* Single = 83.7% Married/cohabitant = 16.3%

Borah	2022	United States of America	American adults	Online volunteer response sampling (Amazon MTurk)	387	Range = 21 – 73 Mean = 37	Female = 43%	Not reported	This volunteer response sample is considered more diverse than student samples (Berinsky et al., 2012; Buhrmester et al., 2016)
Borah, Hwang, & Hsu	2021	United States of America	American adults	Online volunteer response sampling (Amazon MTurk)	387	Range = 21 – 73 Mean (SD) = 37.1 (10.99)	Female = 42.9% Male = 57.1%	Caucasian = 66.7% African American = 12.4% Hispanic/Latino = 9% Others = 11.9%	
Chen, Dai, Xia, & Zhou	2021	China	Chinese adults	Snowball sampling via non-profit health organisation	413	Range = 18 – 60 Mean (SD) = 24.70 (9.55)	Female = 44.1% Male = 55.2% Other = 0.7%	Not reported	59.3% (n= 245) lived in the city, 38% (n=157) lived in rural areas, or others (2.7% n=11).

									75.5% (n=312) reported a monthly income of 5,000 Yuan (~$715) or less 63.4% (n= 262) received a bachelor's degree or higher
Diament, Kaya & Magenehim	2022	United States of America	American adults	Volunteer response sampling	1,642	Range = 18- 65+* 18-34 = 32.5%-35.3%* 50-64 = 16.8% - 23.9%* 65+ = 12.7%-18.8%*	Female = 50%-53.7% Male = 46.3%-49% Other = 0% - 1%	White = 60.7% - 64.9% Black = 10.7% - 13% Hispanic = 15.9% - 18.6% Asian = 5.3% - 6.3% Mixed = 0.5% - 2.4% Other = 0% - 2%	*Political affiliation:* Democrat = 31.7% - 33.3% Independent/other = 37.1%-39.2% Republican = 27.4%-30.9%
Gong, Tang & Li	2021	China	Unvaccinated, Chinese adults	Volunteer response & snowball sampling	1,404	Range = 18 - >50 18-30 = 35.41% 31-40 = 22.64%	Female = 51.14% Male = 48.86%	Not reported	90.35% of participants had completed high school level

						41-50 = 33.51% >50 = 8.43%			education or higher.
Green, et al.	2022	United States of America	Unvaccinated, American adults	Volunteer response sampling	24,682	Not reported	Not reported	Not reported	
Hines	2022	United States of America	Unvaccinated, American adults at university	Convenience & snowball sampling	103	Range = 18-26 Mean = 20	Female = 70.19% Males = 25.96% Prefer not to say (n=4)	White = 95.19% African American = 0.96% Other = 0.96%	*Political affiliation:* Republican (N = 78, 75.7%) Independent (N =13) Other = 8.7 % (N = 9) Democrats = 2.9% (N=3)
Hing, et al.	2022	Malaysia	Unvaccinated, Malaysian adults	Volunteer response sampling	5,784	Range = 18-60+ 19-39 = 62.9%	Male = 50.3%	Not reported	

Jin, Raza, Yousaf, Zaman & Siang	2021	Pakistan	Pakistani adults	Convenience & random sampling	320	18-29 = 21.2% 30-44 = 39.7% 45-59 = 29.4% 60+ = 9.7%	Female = 44.1% Male = 55.9%	Not reported	Not contracted COVID = 80.3% *Education:* University degree = 28.4%
Li, Tang & Gong	2022	China	Unvaccinated, Chinese adults	Volunteer response & snowball sampling	981	18-30 = 35.27% 31-40 = 23.45% 41-50 = 32.11% >50 = 9.17%	Female = 51.07% Male = 48.93%	Not reported	University degree = 43.93%
Masiero, et al.	2022	Italy	Italian adults	Volunteer response & network sampling	634	Mean (SD) = 22.59 (16.12)	Female = 68.5% Male = 31.5%	Not reported	Mean (SD) age reported as 22.59 (16.12) in main text, and 39.59 (16.12) in Table 2.
Prakash, Nathan, Kini & Victor	2022	India	Unvaccinated, Indian millennials	Judgement sampling	228	18-25 = 92.98% 26-35 = 3.95% 36-45 = 3.07%	Female = 58.77% Male = 41.23%	Not reported	

Reinhardt & Rossmann	2021	Germany	Adults aged 18-29 vs 60+	Volunteer response sampling	281	Mean (SD) = 50.1 (23.5) Older adults: Mean (SD) = 71.1 (6.9) Younger adults: Mean (SD) = 25.5 (3.6)	Female = 50.9%	Not reported
Strickland, et al.	2021	United States of America	American adults	Online volunteer response sampling (Amazon MTurk)	322	Mean (SD) = 38.8 (11.6)	Female = 44.5%	White = 76.7%

**Demographic data presented as percentage ranges across treatment and control groups*

Risk of Bias & Certainty of Evidence

The QuADS quality rating scores (Harrison et al., 2021) varied considerably (range = 15 – 31) (Figure 1.2) (Appendix C for domain scores). The mean and median quality score was 26. The studies scoring below the mean have a higher risk of bias (Chen et al., 2022; Diament et al., 2022; Green et al., 2022; Masiero et al., 2022; Strickland et al., 2022). The use of volunteer response sampling, convenience sampling, or snowball sampling may bias the findings. Sample sizes varied significantly. Six studies justified their sample size with a power analysis (Borah, 2022; Borah et al., 2021; Diament et al., 2022; Hing et al., 2022; Prakash et al., 2022; Reinhardt & Rossmann, 2021).

The term ‘emphasis framing’ was not used to describe the message intervention in any of the included studies. The researchers reviewed the message stimuli and concluded emphasis framing was used where messages emphasised positive/negative aspects of the pandemic and did not use equivalence framing. Nine described equivalence framing as gain vs loss framing (Borah, 2022; Borah et al., 2021; Chen et al., 2022; Gong et al., 2022; Hines, 2022; Li et al., 2022; Masiero et al., 2022; Prakash et al., 2022; Reinhardt & Rossmann, 2021). Studies using emphasis framing could not be meaningfully compared to studies using equivalence framing because they did not compare the effect of presenting logically equivalent messages and comparing the effects. Rather studies using emphasis framing presented multiple messages with varied content. Research using emphasis framing has been criticised for not contributing to our understanding of the underlying mechanism involved in framing effects. Equivalence framing demonstrates the ideas of Prospect Theory by

showing that the context of the messages (describing outcomes as gains or losses) can produce different results (risk seeking/risk taking), despite being logically the same (Cacciatore et al., 2016). Emphasis framing conceptually overlaps with several persuasive concepts and make limited theoretical contributions to the evidence base. One study combined equivalence and emphasis framing by manipulating the vaccine's effectiveness and using gain vs loss framing (Chen et al., 2022). The message stimuli were reviewed to group the studies and define the frames (Table 1.3).

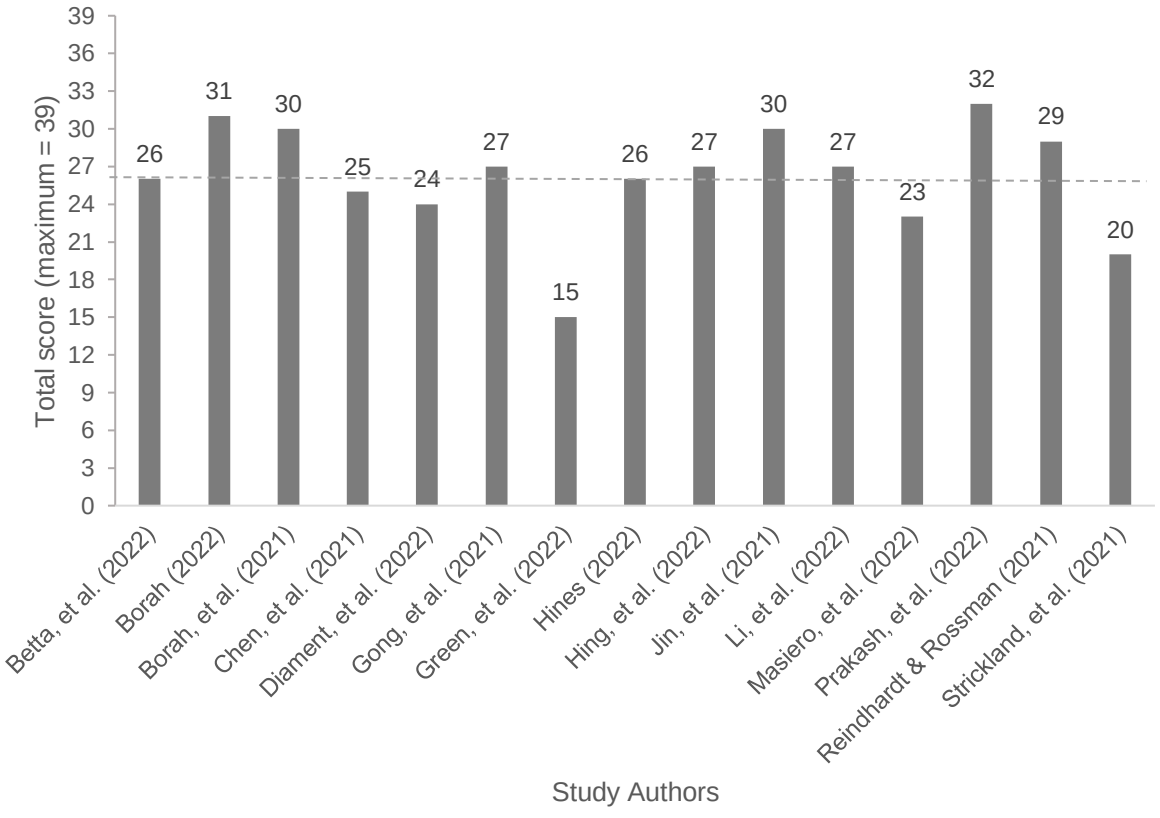


Figure 1.2. Total QuADS scores for the included studies.

The dashed line represents the mean and median scores for all the included studies.

Table 1.3. Definition of message framing intervention used

Author	*Year of publication*	*Sample size*	*Message framing intervention*		
			Equivalence	*Emphasis*	*Source type*
Betta, *et al.*	2022	405	-	√	√
Borah	2022	387	√	√	-
Borah, *et al.*	2021	387	√	√	-
Chen, *et al.*	2021	413	√	√	-
Diament, *et al.**	2022	1,642	-	√	√
Gong, *et al.*	2021	1,404	√	√	-
Green, et al.	2022	24,682	-	√	√
Hines	2022	103	√	-	√
Hing, *et al.*	2022	5,784	√	√	√
Jin, *et al.*	2021	320	-	√	√
Li, *et al.*	2022	981	√	-	-
Masiero, et al.	2022	634	√	-	-
Prakash, *et al.*	2022	228	-	√	-
Reinhardt & Rossmann	2021	281	√	-	-
Strickland, et al.	2021	322	√	-	-

Message Framing Interventions

The message-frames varied (Appendix D). The same stimuli were used in two groups of two studies (Borah, 2022; Borah et al., 2021; Gong et al., 2022; Li et al., 2022). One compared an emphasis frame (altruism) to an individualistic equivalence frame (gain vs loss) so was in a different group (Gong et al., 2022). Four used equivalence framing (Li et al., 2022; Masiero et al., 2022; Reinhardt & Rossmann, 2021; Strickland et al., 2022); one combined equivalence and source manipulations (Hines, 2022); one used emphasis framing (Prakash et al., 2022); four used emphasis and source manipulations (Betta et al., 2022; Diament et al., 2022; Green et al., 2022; Jin et al., 2021); four used equivalence and emphasis framing (Borah, 2022; Borah et al., 2021; Gong et al., 2022; Li et al., 2022). One compared four emphasis frames, two equivalence (gain vs loss) frames, and one emphasis/source type frame to a control (Hing et al., 2022).

Study characteristics

Study design and outcomes varied (Table 1.4). No studies measured vaccine take-up. All studies measured vaccine intentions/willingness. Two measured vaccine hesitancy (Gong et al., 2022; Hines, 2022); eleven measured vaccine attitudes and/or related constructs (Betta et al., 2022; Borah, 2022; Borah et al., 2021; Chen et al., 2022; Gong et al., 2022; Hines, 2022; Hing et al., 2022; Jin et al., 2021; Masiero et al., 2022; Prakash et al., 2022; Reinhardt & Rossmann, 2021). The review defined the outcome domains as vaccine attitudes and intention as vaccine hesitancy is an attitude driven phenomenon (Goldenberg, 2021).

The influence of message framing on vaccine attitudes

There was insufficient data to calculate a standardised effect size (available data and summaries of the results for all studies displayed in Table 1.5), so a direction of effect plot was created for each framing group.

Table 1.4. Study characteristics

Author	*Year of publication*	*Design*	*Message framing definition*	*Outcomes of interest*	*Measurement of vaccine attitudes / intentions / uptake*	*Moderation / mediation analysis*	*Statistical methods*
Betta, *et al.*	2022	Repeated measures, factorial design	EMF & ST	1. Vaccine intention 2. Trust in vaccines 3. Attitudes towards vaccines	1. Single item, Likert scale 2. Single item, Likert scale 3. 5C scale[1] (Cornelia Betsch et al., 2018)	N/A	Repeated measures ANOVA
Borah	2022	Randomised control trial	EQF & EMF	1. Vaccine intention 2. Pre exposure attitudes towards vaccination (as a ***moderator*** between message-frame and vaccine intention)	1. Three item, Likert scale (Nan, 2012a) 2. Single item, Likert scale	Moderating role of partisan media use & pre-attitudes about vaccination	Moderation analysis (Hayes process model)
Borah, *et al.*	2021	Randomised control trial	EQF & EMF	1. Vaccine intention 2. Vaccine attitude 3. Pre exposure attitudes towards vaccination (as a ***moderator*** between message-frame and vaccine intention)	1. Three item, Likert scale (Nan, 2012a, 2012b) 2. Two item, Likert scale (Chanel et al., 2011) 3. Two item, Likert scale (Nan et al., 2012)	Moderating role of perceived vaccine benefits	Hierarchical linear regression

Chen, *et al.*	2021	Randomised control trial	EQF & EMF	1. Vaccine intention 2. Vaccine attitudes	1. Three item, seven-point Likert scale 2. Five item, seven-point, semantic differential scale	Numeracy skills & outcome uncertainty	MANCOVA
Diament, *et al.**	2022	Randomised control trial	EMF & ST	1. Willingness to vaccine (at time intervals to indicate hesitancy)	1. Multiple choice question	Socio-political values, general political trust, media index, impact of own health, societal impact of COVID-19	T-test & ordered logit models
Gong, *et al.*	2021	Experimental design	EQF & EMF	1. Vaccine hesitancy 2. Perceived vaccine effectiveness	1. Single item, Likert scale 2. Single item, Likert scale	N/A	ANOVA & ordered logistic regression.

Green, et al.	2022	Randomised control trial	EMF & ST	1. Likelihood of taking the vaccine	1. Single item, Likert scale	Political ideology & partisan membership	Random forest algorithm
Hines	2022	Experimental design	EQF & ST	1. Vaccine intentions 2. Vaccine hesitancy 3. Attitudes towards receiving a vaccine	1. Multiple choice question (Rothman et al., 1999) 2. Three item, Likert scale 3. Seven item, Likert scale (Dillard & Shen, 2005)	Social media engagement	MANOVA
Hing, *et al.*	2022	Randomised control trial with a parallel design	EQF, EMF & ST	1. Vaccine intention 2. Vaccine attitude	1. Single-item, Likert scale 2. Two item, Likert scale	N/A	Ordered logistic regression, generated regression models.
Jin, *et al.*	2021	Cross-sectional, experimental, factorial design	EMF & ST	1. Self-efficacy towards vaccination 2. Perceived benefit of vaccine 3. Scepticism towards vaccine 4. Willingness to be vaccinated	1. Three item, Likert scale 2. Two item, Likert scale (Shafer et al., 2018) 3. Five item, Likert scale 4. Three item, Likert scale	Perceived threat of COVID, perceived benefits of vaccination, self-efficacy towards vaccination, scepticism towards vaccines	Confirmatory factor analysis

Li, *et al.*	2022	Experimental design	EQF	1. Willingness to be vaccinated	1. Single item, Likert scale	Worry about side effects	Regression analyses
Masiero, *et al.*	2022	Cross-sectional	EQF	1. Vaccine intention 2. Vaccine attitudes	1. Single item, visual analogue scale 2. VAX scale[2] (Martin & Petrie, 2017)	Investigating relationship between trust in information sources and vaccine intention, with moderating variables of message framing and vaccine attitudes and perceived health status	Moderated mediation analysis
Prakash, *et al.*	2022	Experimental design	EMF	1. Vaccine intention 2. Vaccine attitudes 3. Direct social norms regarding vaccines	1. Three item, Likert scale (Ogilvie et al., 2021) 2. Eight item, Likert scale (Ogilvie et al., 2021)		T-test

				4. Indirect social norms 5. Perceived behavioural control	3. Four item, Likert scale (Ogilvie et al., 2021) 4. Eight item, Likert scale (Ogilvie et al., 2021) 5. Three item, Likert scale (Ogilvie et al., 2021)		
Reinhardt & Rossmann	2021	Factorial design	EQF	1. Vaccine intentions 2. Vaccines attitudes	1. Three item, Likert scale (Austvoll-Dahlgren et al., 2012) 2. Four item, Likert scale (Askelson et al., 2010; Ofstead et al., 2008)	Age, reactance	ANOVA, MANCOVA, moderated mediation analysis
Strickland, et al.	2021	Randomised controlled trial	EQF	1. Vaccine intention	2. Binary choice (yes/no) on a 0%-100% chance of symptom reduction following vaccine	Binary choice (yes/no) on a 0%-100% chance of symptom reduction following vaccine	Linear mixed effects model with development timeline

EQF = equivalence framing, EMF = emphasis framing, ST = source type

Table 1.5. Summary of results

Author	*Year of publication*	*Sample size in analysis*	*Message framing intervention used*	*Outcomes of interest*	*Available data*	*Summary of results*
Betta, *et al.*	2022	405	EMF & ST	1. Vaccine intention 2. Trust in vaccines 3. Attitudes towards vaccines	1. Vaccine intention (MD = 0.97 in favour of economic costs, MD = 0 .74 in favour of personal health risks, MD = 0 78 in favour of virologist, MD = 1.42 in favour of virologist x personal health risks, MD = 1.27 in favour of virologist x economic costs) 2. Trust in vaccines (MD = 0.02 in favour of personal health risks condition & MD = 0.01 in favour of virologist) 3. Attitudes towards vaccines (MD = 0.01 in favour of economic costs condition and MD = 0.0 in favour of source type)	***Vaccine intentions:*** ***There was not a significant main effect of message frames*** (F [1.71, 353.72] = 2.200, p > 0.05, ηp2 = 0.011)***, nor source type (***F [1, 207] = 3.265, p > 0.05, ηp2 = 0.016) ***on vaccine intentions.*** However, there was a significant interaction (p < 0.05) between frame and source (F [2, 414] = 3.204, p = 0.042, *ηp2 = 0.015*). ***When a virologist emphasised the personal risks of not being vaccinated and the economic costs of the pandemic, participants were more willing to be vaccinated*** (*p* = 0.039). ***Trust in vaccines:*** There was no significant main effect of message frame (F [1.85, 382.99] = 1.283, p = 0.277, ηp2 = 0.006) or source type on trust in vaccines (F [1, 207] = 0.332, p = 0.565) and there was no significant interaction (F [2, 414] = 1.064, p = 0.346, ηp2 = 0.005). ***Vaccine attitudes:*** There was no main effect of message frame (F [2, 414] = 0.066, p = 0.936, ηp2 = 0.000) or source type on vaccine attitudes (F [1, 207] = 0.143, p = 0.706, ηp2 = 0.001)

						and there was no significant interaction (F [1.91, 396.01] = 1.785, p = 0.171, ηp2 = 0.009)
Borah	2022	387	EQF & EMF	1. Vaccine intention 2. Pre exposure attitudes towards vaccination (as a ***moderator*** between message-frame and vaccine intention)	In favour of individual frames	***Message-frame had no effect on intention to vaccinate***. However, participants who initially reported ***more negative attitudes towards vaccines*** (+1 standard deviation above the mean) ***were more willing to be vaccinated after viewing the individual frame*** (b = -0.54, t [377] = -2.98, p < 0.001), than those with average attitudes (b=-0.23, t [377]) =-1.82, p. <0.07) and below average attitudes (b=0.07, t [377] =0.40, p=0.68).
Borah, *et al.*	2021	387	EQF & EMF	1. Vaccine intention 2. Vaccine attitude 3. Pre exposure perceived personal benefits of vaccination (as a ***moderator*** between message-frame and vaccine intention /attitudes	In favour of loss/individual frames	***There was no significant effect of message framing.*** However, there was a positive direction of effect in the loss-frame condition on vaccine attitudes (β =.014 – NS). There was a negative direction of effect for the loss-frame on vaccine intentions (β = -.015 - NS). There was a positive effect direction in the individual frame condition (β = .045 - NS) on vaccine attitudes and a negative effect direction on vaccine intentions (β = - .062 - NS) However, ***participants who perceived more benefits to being vaccinated in the loss/individual frame conditions***, ***held more positive attitudes toward the vaccine*** (loss-frame: β = .286, p < .05; individual frame: β = −.406, *p* < .01), ***and had higher intentions to receive it*** (loss-

							frame: β = .278, p < .05; individual frame: β = −.432, *p* < .01).
Chen, *et al.*	2021	413	EQF & EMF	1. Vaccine intention 2. Vaccine attitudes	NS		***There was no statistically significant effect of message-frame on vaccine attitudes*** (F [3, 413] = 0.46, p = .71) ***or intentions*** (F [3, 413] = 0.44, p = .77)***.***
Diament, *et al.**	2022	1,642	EMF & ST	1. Willingness to vaccine (measured temporally)	In favour of expert source (Food & Drug Administration: OR = 1.420, SE = 0.273, *p* = 0.068). In favour of economic costs frame (OR = 1.461, SE = 0.295, p = 0.060)		The mean intention to receive a vaccine increased in all conditions except those using Dr Fauci as the source. None of the conditions significantly differed from the control group, however when the message was conveyed by the ***Food and Drug Administration (FDA) participants were 1.42 times more willing to be vaccinated*** (OR = 1.420, SE = 0.273, *p* = 0.068) but this result was not statistically significant. Participants were also ***more willing to be vaccinated when the economic costs of the pandemic were emphasised to them (OR = 1.461, SE = 0.295, p = 0.060).***
Gong, *et al.*	2021	1,404	EQF & EMF	1. Vaccine willingness 2. Perceived vaccine effectiveness	OR = 2.93, CI 95% = 2.16,3.96 in favour of loss-frame		***All message frames increased vaccination willingness. Loss framing significantly increased participants willingness to be vaccinated compared to the control, gain framing and altruism groups*** (OR = 2.93, CI 95% = 2.16,3.96). An adjusted model controlling for sociodemographic variables increased this effect (OR = 3.03, 95%CI = [2.22, 4.16]). The gain-frame (OR = 1.90, CI 95% = 1.42, 2.54), and altruism frame (OR = 1.93, CI 95% = 1.44, 2.57) conditions increased vaccine intentions.

Green, *et al.*	2022	24,682	EMF & ST	1.	Likelihood of taking the vaccine	Effect of all message frame conditions and source type conditions except patriotism significantly increased vaccine intentions (*p<.05). Vaccine intention increase in the patriotism condition (NS)*	All the messages increased vaccination willingness compared to the control. These differences were significant (p<.05) in all conditions except the patriotism condition. Participants were significantly ***more likely to take the vaccine when they read the harm prevention, descriptive norm, scientist endorsement, and personal doctor endorsement messages*** (adjusted *p* <.01).
Hines	2022	103	EQF & ST	1. 2. 2.	Vaccine intentions Vaccine hesitancy Attitudes towards receiving a vaccine	*Message frame:* Intentions MD = 0.10 (NS - in favour of gain-frame) Hesitancy MD = 0.34 (NS - in favour of gain-frame) Attitudes MD = 0.15 (NS - in favour of gain-frame) *Source Type:* Intention MD = 0.35 (NS - in favour of expert frame) Hesitancy MD = 0.23 (NS - in favour of expert frame) Attitudes MD = 0.27 (NS - in favour of expert frame)	There was ***no significant effect of message frame or source type on vaccine intentions, hesitancy, or attitudes to receiving a vaccine. Positive direction of effect for gain-frame condition on vaccine intentions*** (mean score increased compared to loss frame)***. Positive effect direction as mean increased in the gain framed condition compared to the loss frame on vaccine attitude measures.***
Hing, *et al.*	2022	5,784	EQF, EMF, & ST	1. 2.	Vaccine intention Vaccine attitude	In favour of control	***Message frame and source type had no significant effect on participants' intentions to vaccinate.*** Compared to the control group, ***participants were***

						significantly less likely to want the vaccine after viewing the loss frame (3.3 percentage points, CI 95% = -6.3, -.02, *p* <.05) compared to the control group. ***Participants who viewed the loss-frame and the message that emphasised that 70% of Malaysian people have indicated they wish to receive the vaccine were also significantly less likely to want the vaccine*** (3.5 percentage points, CI 95% = -6.6, .05)
Jin, *et al.*	2021	320	EMF	1. Self-efficacy towards vaccination 2. Perceived benefit of vaccine 3. Scepticism towards vaccine 4. Willingness to be vaccinated	In favour of negative framing and traditional media	***All of the messages increased participants willingness to be vaccinated***; (1) traditional media – safety benefit frame (β = 0.39 and p = 0.01), (2) digital media – safety benefit frame (β = 0.31 and p = 0.01), (3) traditional media – risk frame (β = 0.51 and p = 0.01), and (4) digital media – risk frame (β = 0.43 and p = 0.01). ***The messages emphasising the risks associated with not being vaccinated were more effective than the safety benefits frame and strengthened the relationship between each variable and participants willingness to be vaccinated***. ***Newspaper articles were more effective at increasing willingness to vaccinate than digital articles.*** 1. Self-efficacy towards receiving a vaccination, and willingness to vaccinate: (1) β = .19, *p* = .01, (2) β = .13, *p* = .01), (3) β = .24, *p* = .05), (4) β = .27, *p* = .01). 2. Perceived benefits of the vaccine and willingness to vaccinate: (1) β = .16, *p*

							= .05, (2) β = .22, *p* = .01), (3) β = .32, *p* = .01), (4) β = .29, *p* = .01) 3. Scepticism towards vaccine: (1) group one (β = −0. 23), (2) group two (β = −0. 20), (3) group three (β = −0. 17), and (4) group four (β = −0. 09).
Li, *et al.*	2022	981	EQF	1.	Willingness to be vaccinated	MD = 0.50 in favour of loss-frame compared to control MD = 0.33 in favour of gain-frame compared to control MD = 0.17 between loss and gain frame	***Both message-frames positively influenced participants willingness to vaccinate*** (gain-frame: β = 0.28, SE = .06, *p*<.001; loss-frame: β = 0.41, SE = .06, *p*< .001). ***Participants in the loss-frame condition were significantly more willing to receive a vaccine*** (*p* = .039). Message-frame moderated the association between worry about side effects and the willingness to receive a vaccine (gain-frame: β = .18, SE = .06, *p* = .005; loss-frame: β = .22, SE .06, *p*<.001)
Masiero, et al.	2022	634	EQF	1. 2.	Vaccine intention Trust in vaccine benefit	Main effects - NS Interaction effects - in favour of gain-frame	There was ***no direct effect of message-frame on intention to receive a vaccine***. However, there was a significant interaction between message-frame and trust in vaccines on the intention to receive a vaccine; ***gain-framed messages strengthened the relationship between trust in vaccine benefit and intention to receive the vaccine*** (b = 3.56; 95% CI: 0.05, 7.08).
Prakash, *et al.*	2022	228	EMF	1. 2. 3. 4.	Vaccine intention Vaccine attitudes Direct social norms regarding vaccines Indirect social norms	In favour of negative frame	***Negatively framed messages increased the mean scores of participants direct social norms, indirect social norms, and perceived behavioural control***

				5. Perceived behavioural control		***conditions.*** The mean attitude scores decreased in the negative frame condition.
Reinhardt & Rossman	2021	281	EQF	1. Vaccine intentions 2. Vaccines attitudes	*Total sample*: Attitudes MD = 0.04 (in favour of loss frame) Intentions MD = 0 *Young adults:* Attitude MD = 0.21 (in favour of loss frame) Intention MD = 0.16 (in favour of loss frame) *Older adults:* Attitude MD = 0.04 (in favour of gain-frame) Intention MD = 0.19	***There was a significant effect of framing on vaccine attitudes and intentions*** (F [3, 271] = 1209.93, p < .001, Wilks Λ = .30, η_p^2 = .70). There was a significant interaction between age and framing on vaccine attitudes (F [1, 273] = 4.59, p = .03, η_p^2 = .02). ***Older adults showed more positive attitudes towards vaccines in the gain frame condition (***M_{adj} = 4.08; SE = 0.07, 95% CI [3.95, 4.20]) than younger adults (M_{adj} = 3.68; SE = 0.07; 95% CI [3.55, 3.82])***. There was no significant interaction between age and framing on vaccine intentions.*** A moderated mediation analysis showed that ***younger participants had more positive attitudes and stronger intentions to receive a vaccine in the loss frame condition*** (b = .14, SE = .07; 95% CI [.02, .28]). ***This indirect effect was not present in participants aged over 60.*** *Bidirectional arrows used because the groups differed in frame preference based on age.*
Strickland, et al.	2021	322	EQF	Vaccine intention	In favour of gain-frame (*p*<.001)	***More participants intended to receive the vaccine after viewing the gain-framed message*** (F [1,320] = 14.86, p < .001).

EQF = equivalence framing, EMF = emphasis framing, ST = source type, NS = Not significant, MD = mean difference

Equivalence framing

Message stimuli between studies varied with gain-frame conditions describing positive effects of the COVID-19 vaccines, including antibody production (Li et al., 2022); reduced risk of contracting the virus (Hines, 2022; Reinhardt & Rossmann, 2021); reduced social restrictions (Hines, 2022; Reinhardt & Rossmann, 2021); increased health benefits (Hines, 2022; Reinhardt & Rossmann, 2021); more lives saved (Masiero et al., 2022); and vaccine safety (Strickland et al., 2022). Within the studies, loss-frame conditions described the opposite of the gain-frame scenario used in that study to produce logically equivalent message conditions. Loss-frames described the opposite (Appendix D). One also study presented the messages from the Centre for Disease Control, or Simone Biles (celebrity gymnast) (Hines, 2022).

There were insufficient studies for a sign test (Table 1.6). The results are reported from highest to lowest quality rating.

Reinhardt and Rossmann (2021) found no effect of message framing on vaccine intentions (mean difference [MD] = 0). The loss-frame produced a small attitude change (MD = 0.04). Splitting the data by age group produced a significant interaction on vaccine attitudes ($F [1, 273] = 4.59$, $p = .03$, $\eta_p^2 = .02$). Younger adults favoured the loss-frame (MD = 0.21), older adults favoured the gain-frame (MD = 0.04). The effect was not significant for vaccine intentions, but the MD supports the previous finding.

Li et al. (2022) found both messages significantly increased vaccine willingness (p<.001). The loss-frame had the largest effect (MD = 0.5, p=0.39) compared to the control. Both messages strengthened the relationship between worry about side effects and vaccine willingness (gain-frame, p = .005; loss-frame, p<.001), and the loss-frame was more effective.

Hines (2022) found no significant effect of message-frame on university students. Gain-frames increased vaccine intentions (MD = 0.10) and attitudes (MD = 0.15), and reduced vaccine hesitancy (MD = 0.34) more than loss-frames. This contradicts findings that younger adults prefer loss-frames (Reinhardt & Rossmann, 2021), but this study had less participants and was of lower quality. Source had no significant effect, but the expert (Centre for Disease Control) increased vaccine intention (MD = 0.35) and attitudes (MD = 0.27), and reduced hesitancy most (MD = 0.23).

Masiero et al. (2022) found no main effect of message-frame on vaccine intentions. Gain-framed messages strengthened the relationship between trust in vaccine benefit and vaccine intention (b = 3.56; 95% CI: 0.05, 7.08). Strickland et al. (2022) showed gain-frame messages increased vaccine intentions. These studies' quality ratings warrant cautious consideration of the results.

High quality studies highlighted age differences in framing (Reinhardt & Rossmann, 2021) and loss-frame support (Li et al., 2022). Lower quality studies supported gain-framing and expert sources (Hines, 2022; Masiero et al., 2022; Strickland et al., 2022).

Table 1.6. Effect direction plot for studies using equivalence framing (and source type)

Author	*Year of publication*	*Sample size in analysis*	*Message framing intervention used*	*Directions of effect*	
				Vaccine intention	*Vaccine attitudes*
Li, et al.	2022	981	EQF	▼	-
Masiero, et al.	2022	634	EQF	▲▼	▲
Reinhardt & Rossmann	2021	281	EQF	▲▼	▲▼
Strickland, et al.	2021	322	EQF	▲	-
Hines	2022	103	EQF & ST	▲	▲2

Superscript numbers indicate the number of outcome measures used to determine direction of effect in that domain. ▼ indicates that the results are in favour of the loss-frame condition. ▲ indicated that results are in favour of the gain-frame condition. ▲▼ indicates that there were mixed findings supporting gain- & loss-frames. ◄► indicates no effect or unclear results. – indicates that a study did not report effect directions/outcomes for this domain.

Emphasis framing

Message content in the studies using emphasis framing varied significantly. Including emphasising personal/collective health risks of being (un)vaccinated (Betta et al., 2022; Green et al., 2022; Prakash et al., 2022); economic impact of the pandemic (Betta et al., 2022; Diament et al., 2022); vaccination as patriotic (Diament et al., 2022); descriptive norms (Green et al., 2022); safety benefits (Jin et al., 2021); fear appraisals (Jin et al., 2021).

Four of the five studies also manipulated source, including virologists (Betta et al., 2022); scientists (Green et al., 2022); personal doctors (Green et al., 2022); the Food and Drug Administration (FDA) (Diament et al., 2022); political figures (Diament et al., 2022); a Black nurse (Diament et al., 2022); celebrities (Betta et al., 2022); a newspaper (Jin et al., 2021); digital media (Jin et al., 2021); photo and textual endorsements (Diament et al., 2022).

The study's results will be reported in order from highest to lowest quality. Message framing was effective in all studies (Table 1.7). There were insufficient studies for a sign test.

Prakash et al. (2022) found negative frames increased vaccine intention (MD = 0.19), direct social norms (MD = 0.18), indirect social norms (MD = 0.10), and perceived behavioural control scores (MD = 0.08). Significance was set at $p = 0.1$, and two significant results were reported, but they are not considered significant in this review.

Jin et al. (2021) reported safety-benefits and fear-appraisal frames significantly increased vaccine intentions, in favour of fear appraisal frames. Newspaper and digital media sources significantly increased vaccine intentions, and newspapers were most effective. Fear-appraisal messages strengthened the relationship between vaccine attitudes and intentions.

Betta et al. (2022) found a virologist (MD = 0.78), personal health risks (MD = 0.74) and economic frames (MD = 0.97) increased vaccine intention. Virologists delivering messages on personal health risks/economic costs produced higher vaccine intentions and the interaction was significant. The study was rated average quality due to the within-subjects design's potential to cause cumulative effects.

Diament et al. (2022) found economic frames increased vaccine intentions (OR = 1.461, SE = 0.295, p = 0.06). Expert endorsement (FDA) increased vaccine intentions (OR = 1.420, SE = 0.273, p = 0.07). The results should be interpreted with caution because the study quality was below average.

Green et al. (2022) received the lowest quality rating in the review. All the messages (individual frame, descriptive norm, scientist/doctor endorsement) increased vaccine intentions. Exact figures were not reported but visually represented in a graph. All the results were significant except the patriotism condition. The differences between the two expert and the patriotism frames were significant. This supports that individualistic frames are beneficial (Betta et al., 2022) but study limitations impact the credibility of the findings compared to other studies.

Table 1.7. Effect direction plot for studies using emphasis framing & source type manipulations

Author	*Year of publication*	*Sample size in analysis*	*Message framing intervention used*	*Directions of effect*	
				Vaccine intention	*Vaccine attitudes*
Betta, *et al.*	2022	405	EMF & ST	▲	◄►$_2$
Diament, *et al.**	2022	1,642	EMF & ST	▲	-
Green, *et al.*	2022	24,682	EMF & ST	▲	-
Jin, *et al.*	2021	320	EMF & ST	▲	▲
Prakash, *et al.*	2022	228	EMF	▲	▲$_4$

Superscript numbers indicate the number of outcome measures used to determine direction of effect in that domain. *The table compares the intervention to the control group. ▲ indicates that the results are in favour of the message-frame. ▼ indicated that results are not in favour of the message-frame. ◄► indicates no effect or unclear results. – indicated that a study did not report outcomes for this domain.

The results show support for emphasis-framing. Higher quality studies supported negative frames (Jin et al., 2021; Prakash et al., 2022). Lower quality studies supported economic frames, negative effects of the pandemic and personal vaccine benefits (individual frames) (Betta et al., 2022; Diament et al., 2022; Green et al., 2022). Various expert sources improve vaccine attitudes/intentions (Diament et al., 2022; Green et al., 2022; Hines, 2022; Jin et al., 2021).

Equivalence & emphasis framing

Four studies combined equivalence (gain vs loss) with various emphasis frames (Borah, 2022; Borah et al., 2021; Chen et al., 2022; Gong et al., 2022). Three studies used individual vs collective frames (Borah, 2022; Borah et al., 2021; Gong et al., 2022). Chen et al. (2022) varied vaccine effectiveness and number format. There were insufficient studies for a sign test (Table 1.8). The results are reported from highest to lowest quality.

Borah (2022) found individual frames increased vaccine intentions but not significantly. There was no vaccine attitude measure. Individual frames significantly increase vaccine intentions when participants had prior negative attitudes (p<.001).

Borah et al. (2021) reported individual (β = .045 – not significant [NS]) and loss-frames (β =.014 – NS) improved vaccine attitudes but decreased vaccine intentions. The individual/loss-frame increased vaccine intentions in participants who previously perceived more vaccine benefits (p<.01).

Gong et al. (2022) found all messages increase vaccine intentions (gain-/loss-/altruism) and supported higher quality findings that loss-frames significantly improved vaccine intentions.

The lowest quality study in this group did not report sufficient detail to determine the direction of the effects and did not report any significant message-frame effects (Chen et al., 2022).

The results show individual, and loss-frames improve vaccine attitudes/intentions most (Borah, 2022; Borah et al., 2021; Gong et al., 2022). Moderation analyses strengthened these effects.

Table 1.8. Effect direction plot for studies using equivalence framing & emphasis framing.

Author	*Year of publication*	*Sample size in analysis*	*Message framing intervention used*	*Directions of effect*	
				Vaccine intention	*Vaccine attitudes*
Borah	2022	387	EQF & EMF	▼	-
Borah, *et al.*	2021	387	EQF & EMF	▲▼	▼
Chen, *et al.*	2021	413	EQF & EMF	-	-
Gong, *et al.*	2022	1,404	EQF & EMF	▼	-

Superscript numbers indicate the number of outcome measures used to determine direction of effect in that domain. *The table compares the intervention to the control group. ▲ indicates that the results are in favour of the gain/collective frame. ▼ indicated that results are in favour of the loss/individual-frame. ▲▼ indicates that there were mixed findings supporting gain-/loss-/individual/collective frames. ◄► indicates no effect or unclear results. – indicates that a study did not report effect directions/outcomes for this domain.

Combination of message framing manipulations

Hing et al. (2022) scored one point above the average quality. This study included all framing types in different messages. Source had no effect on vaccine intentions. Many frames decreased vaccination intentions, significantly in the loss-frame condition which contradicts the previous findings (Table 1.9).

Results were only presented graphically, making interpretation difficult. Gain-frames increased vaccine intentions compared to the control/loss-frame. Multiple messages (loss-frame plus descriptive norm) significantly reduced vaccine intentions.

Study limitations impact reporting the findings alongside the other studies. Gain-frames are supported, and emphasis and loss-frames are harmful. This study contradicts higher-quality support for loss-frames (Borah, 2022; Borah et al., 2021; Gong et al., 2022; Li et al., 2022; Reinhardt & Rossmann, 2021) and contradicts other studies showing support for emphasis and source frames (Betta et al., 2022; Jin et al., 2021; Prakash et al., 2022).

Table 1.9. Direction of effect tables for studies using all message framing types.

Author	*Year of publication*	*Sample size in analysis*	*Message framing intervention used*	*Directions of effect*	
				Vaccine intention	*Vaccine attitudes*
Hing, *et al.*	2022	5,784	EQF, EMF, & ST	▼	-

Superscript numbers indicate the number of outcome measures used to determine direction of effect in that domain. *The table compares the intervention to the control group. ▲ indicates that the results are in favour of the message frames. ▼ indicated that results are in favour of the control. ▲▼ indicates that there were mixed findings. ◄► indicates no effect or unclear results. – indicates that a study did not report effect directions/outcomes for this domain.

DISCUSSION

The review aimed to examine message and source framing effects on COVID-19 vaccine attitudes and acceptance, but this could only be partially fulfilled as none of the studies assessed vaccine take-up. It also aimed to differentiate between message framing types in response to prior criticisms (Cacciatore et al., 2016).

Summary of the findings

Ten studies used equivalence framing. Three higher quality studies supported loss-frames improving COVID-19 vaccine outcomes (Borah et al., 2021; Gong et al., 2022; Li et al., 2022). Framing may be age dependent, with higher quality support for older adults preferring gain-frames and younger adults preferring loss-frames (Reinhardt & Rossmann, 2021). Average or lower quality studies supported gain-framed messages (Hines, 2022; Hing et al., 2022; Masiero et al., 2022; Strickland et al., 2022). Two studies (one higher quality, one lower quality) reported no support for gain- or loss-frames (Borah, 2022; Chen et al., 2022).

Emphasis-framing was supported. Three higher quality studies supported individual frames (Borah, 2022; Borah et al., 2021; Gong et al., 2022). Two higher quality studies supported negative frames (Jin et al., 2021; Prakash et al., 2022). Lower quality studies supported economic frames improving vaccine intentions (Betta et al., 2022; Diament et al., 2022; Green et al., 2022). Expert sources were supported by four average or lower quality studies (Betta et al., 2022; Diament et al., 2022; Green et al., 2022; Hines, 2022; Jin et al., 2021).

Methodological limitations

Meaningfully interpreting the results requires a review of the methodological limitations. Studies lacked a measure of actual vaccine take-up, thus, no conclusions about vaccine take-up could be made. A common limitation in health research is that it rarely includes actual clinicians/patients making real treatment decisions (Glare et al., 2018).

Message and source variation across the studies limited the ability to compare them and draw conclusions. Framing type was not always defined so the experimental stimuli were reviewed to define the frame. Ambiguity in the definition of framing, and use of non-standardised stimuli further complicated the synthesis. Unclear operationalised definitions and conceptualisations of frames have left message framing open to criticism for unclear effects (Cacciatore et al., 2016; Cappella & Jamieson, 1997; Druckman, 2001; Goffman, 1974; Sweetser & Fauconnier, 1996). This made isolating the observed effects difficult, as fourteen studies showed effects of presenting varied information to participants. For example, emphasis framing effects may show the persuasive power of the message rather than the frame (Cacciatore et al., 2016) and feelings towards a source may impact the effects. Results must be interpreted with caution due to these challenges.

Discussion of the findings

The higher quality studies using equivalence framing favoured loss-framing (Borah et al., 2021; Gong et al., 2022; Li et al., 2022), which was partially supported by results showing framing effects are age dependent (Reinhardt & Rossmann, 2021). This supports previous research on the HPV vaccine (Kim et al., 2020; Nan, 2012a, 2012b; Nan et al., 2016; Park, 2012). Support for loss-framing supports the HBM which suggests that individuals' beliefs about the severity and susceptibility of a disease (Rosenstock, 1966), as well as the perceived benefits and risks of vaccination (Carpenter, 2010; Harrison et al., 1992), influence vaccine uptake. Loss-frames highlight the potential risks of not receiving a vaccine, which could increase participants perception of risk or severity of COVID-19.

Other studies supported gain-framed messages improving vaccine intentions/attitudes (Hines, 2022; Hing et al., 2022; Masiero et al., 2022; Strickland et al., 2022), but two were lower quality (Masiero et al., 2022; Strickland et al., 2022) so should be considered cautiously. Higher-quality and below average quality studies found no support for combined equivalence and emphasis framing (Borah, 2022; Chen et al., 2022).

Gain-frames improving vaccine intentions/attitude supports Prospect Theory (Kahneman, 2011; Kahneman & Tversky, 1979; Tversky & Kahneman, 1981) and previous research which demonstrates that gain-frames promote risk avoidance in a health context (Gallagher & Updegraff, 2012). The HBM and TPB (Rosenstock, 1966; Ajzen, 1991) also suggest that perceived benefits of a vaccination are important in vaccine decision making, which could have produced the gain-frame results.

The research quality may have impacted the results, but vaccine decision-making is complex and embedded in socio-political, cultural, and historic contexts (Dubé et al., 2013; Goldenberg, 2021). Rapid COVID-19 vaccine development and prevalent misinformation may also contribute to a lack of clear support for either framing type. Termed an 'infodemic' (Gabarron et al., 2021; WHO, 2021), misinformation about the COVID-19 vaccine was prevalent online (Fisher et al., 2020; Sear et al., 2020). Infodemic is defined as too much, false, or misleading information in digital and physical environments during a disease outbreak (Rothkopf, 2003). Participants attitudes may have been influenced by prior exposure to various messages, which is supported by the findings that prior attitudes impacted framing effects (Borah, 2022; Borah et al., 2021; Jin et al., 2021; Li et al., 2022; Masiero et al., 2022).

More widespread concern about vaccine safety post COVID-19 (Suran, 2022) has coincided with significant decreases in HPV vaccination (Gilkey et al., 2020). Perceptions of risk/uncertainty were not assessed in many studies, despite the impact on message-framing effects (Apanovitch et al., 2003; Gallagher et al., 2011; Rothman et al., 1999). Understanding participants perceptions of risk/uncertainty towards COVID-19 vaccines/the virus may have supported the findings and explained the varied results and provided clearer support for theories of vaccine hesitancy (e.g., HBM and TPB). Repeating previous vaccine research to assess changes post COVID-19 would update our understanding of vaccine attitudes.

Emphasis-framing was supported. There was good quality support for individual frames (Borah, 2022; Borah et al., 2021; Gong et al., 2022). Two lower quality studies also supported individual frames (Betta et al., 2022; Green et al., 2022). Gong et al. (2022) supported collective frames. This supports findings showing culture specific

factors impact framing effects (Bullock & Shulman, 2021; Everett et al., 2020; Oyserman & Lee, 2008). The studies supporting individual frames were conducted in individualistic cultures (Betta et al., 2022; Borah, 2022; Borah et al., 2021; Green et al., 2022). Gong et al. (2022) supported this finding by using a collective frame in a collectivist culture. However, Gong et al. (2022) also found effects of individualised loss-frames in a collectivist culture. The limited number of studies and the conflicting effect requires future research to strengthen the findings. Support for individual frames could also be considered as evidence for the HBM, as these messages highlight the benefits/risks of vaccination to individual participants.

There was also good quality support for negatively framed messages (Jin et al., 2021; Prakash et al., 2022) which could also support HBM as the perceived severity of not receiving the vaccine could have been more salient to participants. Two lower quality studies supported economic frames (Betta et al., 2022; Diament et al., 2022), however these were the only two studies in the review that used economic frames and should be interpreted with caution. Green et al. (2022) found all their messages increased vaccine intentions except for the patriotic frame, however this was the lowest quality study included in the review. The finding that various emphasis frames increased vaccine attitudes/intentions could be due to societal pressure surrounding COVID-19 vaccines, as suggested by the TPB. The sociopolitical context surrounding COVID-19 vaccines meant that pressure to receive vaccines was high due to restrictions on people's freedoms and this may have influenced the results of the studies.

Six studies investigated whether the source impacts vaccine attitudes/intentions (Betta et al., 2022; Diament et al., 2022; Green et al., 2022; Hines, 2022; Hing et al., 2022; Jin et al., 2021). Expert sources improved vaccine attitudes/intentions, supporting previous health research (Avery, 2010; Chen et al., 2018; Dong, 2015; Dutta-Bergman, 2003; Hovland & Weiss, 1951; Jucks & Thon, 2017; Major & Coleman, 2012). Four of the studies were average or below average quality (Betta et al., 2022; Diament et al., 2022; Green et al., 2022; Hines, 2022), so there is scope for further good quality research using consistent source types.

One study contradicted the review and the previous research, showing message-frames decreased vaccine intentions, particularly loss-frames, and multiple messages. This study had a large sample size and slightly above average quality. It was conducted on Malaysian adults and the sociopolitical context in Malaysia surrounding COVID-19 may have influenced the findings. Further research on non-White populations would enhance the literature on culture and country specific effects.

Limitations of the review & recommendations for future research

The review must be considered alongside its own limitations. The conclusions are limited by the lack of consistency within the studies meaning it was impossible to conduct a meta-analysis or statistically synthesise the data. The study groups meant the recommended sign tests were not possible (Higgins et al., 2019), but comparing all the studies would have lacked utility for the reasons discussed. Including only English language papers and those with accessible message stimuli may further limit the conclusions.

Despite the variation, no studies were excluded based on quality, limiting the results. The QuADS (Harrison et al., 2021) does not provide cut-off scores for high/low quality papers, and the scoring of each item is subjective despite including a second reviewer. Five studies scored below the group mean quality score and were included in the synthesis (Chen et al., 2022; Diament et al., 2022; Green et al., 2022; Masiero et al., 2022; Strickland et al., 2022). Future reviews should consider a quality assessment measure that accounts for mixed study design and provides cut off scores to allow for exclusion of papers at high risk of bias.

Considering these limitations, future studies must work towards a clear definition of framing effects to produce replicable, consistent findings. Focusing on equivalence framing would prevent criticism of emphasis-frames which conceptually overlap with other theories and effects (Cacciatore et al., 2016). Emphasis framing also has a wide scope of topics that could be emphasised, meaning the effects are hard to recreate. Within this field, researchers should continue to investigate the cognitive mechanism behind the effect to aid our understanding and the validity of the research.

The studies included in this review, and elsewhere in medical literature, suggest that framing effects may moderate/be moderated by other factors (Rothman et al., 1999). Most of the reviewed studies collected data from the general, adult population. Reinhardt and Rossmann (2021) was the only study to assess for age differences in framing effects. The pandemic disproportionately affected vulnerable members of society, such as the elderly, black and minority ethnic groups, those with a low-income and chronic illnesses (De Angelis et al., 2021; Li et al., 2021; Ogbondah et al., 2022; Ribeiro et al., 2021). Perceived risk/severity of contracting an illness is an important moderator of framing effects (Apanovitch et al., 2003; Gallagher et al., 2011; Rothman

& Salovey, 1997), and in the context of COVID-19, sociodemographic risk factors may play an important role. Future research should consider the impact of these demographic and moderating variables. Researchers should also account for the highlighted methodological limitations, and clearly define the health behaviour, risk, and outcome uncertainty/severity (Harrington & Kerr, 2017; O'Keefe & Jensen, 2009; Van't Riet et al., 2014).

Other moderation effects were also found. Prior attitudes towards COVID-19 vaccines improved framing effects (Borah, 2022; Borah et al., 2021; Jin et al., 2021; Masiero et al., 2022). Li et al. (2022) found message-frames decreased the impact of worry about side effects on vaccine intentions. Other studies within the review sought to understand the relationship between political attitudes, source type, and vaccine attitudes (Borah, 2022; Diament et al., 2022; Green et al., 2022). Affect may also play an important role in framing (Druckman & McDermott, 2008). It was beyond the scope of this review to examine the moderating effects, and the methodological differences mean comparisons between studies would not be beneficial. Future research should aim to use comparable framing interventions and investigate moderating effects.

Clinical implications

The review also has implications for practice. The findings could support the ideas from HBM and TPB (Rosenstock, 1966; Ajzen, 1991) as the messages presented could have increased participants perceptions of the severity/risks of not receiving COVID-19 vaccines. There is evidence that message-frames can produce emotional responses that influence how information is appraised (Druckman & McDermott, 2008). Gain-framed messages induce positive emotions (e.g., hope) and loss-frames

induce negative emotions (e.g., fear) (Gross & D'ambrosio, 2004). Messages that emphasise the risks of not receiving a vaccine could also induce negative emotions. Fear may explain why loss-frames/negative messages encourage preventative health behaviours, as the risk/uncertainty of not engaging in the behaviour becomes salient, which supports the HBM (Rosenstock, 1966). Analysis of media sources during health crises show that, alongside main events they often use sensationalism, strong language emphasising risks, and worst-case scenarios from credible sources (Berry et al., 2007; Dudo et al., 2007). Consistent exposure to messages about COVID-19 and the vaccine may have evoked negative emotions (e.g., sadness-depression, anxiety, anger-hostility) which have been shown to impact how threatened individuals feel by COVID-19 (Pérez-Fuentes et al., 2020). This has direct implications for public health strategists when designing messages about vaccines in the future, as messages that increase the perceived risks/severity of the disease both individually and collectively appear to promote vaccination. This also has implications for health professionals when communicating with individuals about health treatments, and using messages that convey the severity/risk of not engaging in a treatment may be beneficial. The finding that experts increase vaccine intentions may also support clinicians' confidence in relaying such messages. Public health strategists and health professionals would benefit from future research into the role of emotions/message-frames and on COVID-19 vaccine attitudes/intentions. This research would help professionals guide the public in making healthier choices in areas beyond vaccines.

Conclusion

Models of health behaviours suggest that vaccine intentions will increase after receiving messages that highlight the perceived benefits/risks of vaccines; increase feelings of severity/risks to self and others; and increase the sense of familial and societal pressure (Rosenstock, 1966; Ajzen, 1991). Studies on message-framing and vaccine hesitancy suggest that loss-frames are more effective (Kim et al., 2020; Nan, 2012a, 2012b; Nan et al., 2016; Park, 2012) which fits with the ideas of Prospect Theory, HBM and TPB which all suggest that perceptions of risk and severity are important in health decision making (Tversky & Kahneman, 1981; Rosenstock, 1966; Ajzen, 1991). This also applies to messages emphasising aspects of the pandemic which highlight the personal/collective risks of vaccination (De Vreese, 2005; Gamson & Modigliani, 1987). The findings of this review could support these models of health decision making and provide support for public health strategists/health professionals in communicating the risks/severity of not engaging in health behaviours. Previous studies showing that expert sources increase vaccine intentions have been supported by the present review. Further research into this effect, and the inclusion of a measure of actual vaccine behaviour would further strengthen the results. Overall, the review suggests a need for further, good quality research which accounts for methodological limitations in the field of faming research. Further, good quality research which includes measures of participants perceptions of risks/severity of the disease being vaccinated against would provide further support.

REFERENCES

Abhyankar, P., O'connor, D. B., & Lawton, R. (2008). The role of message framing in promoting MMR vaccination: Evidence of a loss-frame advantage. *Psychology, Health and Medicine*, *13*(1), 1-16. doi: 10.1080/13548500701235732

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211. https://psycnet.apa.org/doi/10.1016/0749-5978(91)90020-T

Apanovitch, A. M., McCarthy, D., & Salovey, P. (2003). Using message framing to motivate HIV testing among low-income, ethnic minority women. *Health psychology*, *22*(1), 60. https://doi.org/10.1037/0278-6133.22.1.60

Askelson, N. M., Campo, S., Lowe, J. B., Smith, S., Dennis, L. K., & Andsager, J. (2010). Using the theory of planned behavior to predict mothers' intentions to vaccinate their daughters against HPV. *The Journal of School Nursing*, *26*(3), 194-202. doi: 10.1177/1059840510366022

Austvoll-Dahlgren, A., Falk, R. S., & Helseth, S. (2012). Cognitive factors predicting intentions to search for health information: an application of the theory of planned behaviour. *Health Information & Libraries Journal*, *29*(4), 296-308. https://doi.org/10.1111/hir.12006. Epub 2012 Oct 11. PMID: 23176026.

Avery, E. J. (2010). The role of source and the factors audiences rely on in evaluating credibility of health information. *Public Relations Review*, *36*(1), 81-83. https://doi.org/10.1016/j.pubrev.2009.10.015.

Berinsky, A. J., Huber, G. A., & Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon. com's Mechanical Turk. *Political analysis*, *20*(3), 351-368. doi:10.1093/pan/mpr057

Berry, T. R., Wharf-Higgins, J., & Naylor, P. (2007). SARS wars: an examination of the quantity and construction of health information in the news media. *Health Communication*, *21*(1), 35-44. doi: 10.1080/10410230701283322.

Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PLoS ONE*, *13*(12), e0208601. https://doi.org/10.1371/journal.pone.0208601

Betta, S., Castellini, G., Acampora, M., & Barello, S. (2022). The Effect of Message Framing on COVID-19 Vaccination Intentions among the Younger Age Population Groups: Results from an Experimental Study in the Italian Context. *Vaccines*, *10(4) (no pagination)*, Article 559. https://doi.org/https://dx.doi.org/10.3390/vaccines10040559

Bokemper, S. E., Huber, G. A., Gerber, A. S., James, E. K., & Omer, S. B. (2021). Timing of COVID-19 vaccine approval and endorsement by public figures. *Vaccine*, *39*(5), 825-829. doi: 10.1016/j.vaccine.2020.12.048.

Borah, P. (2022). Message framing and COVID-19 vaccination intention: Moderating roles of partisan media use and pre-attitudes about vaccination [Article]. *Current Psychology*. https://doi.org/10.1007/s12144-022-02851-3

Borah, P., Hwang, J., & Hsu, Y. C. (2021). COVID-19 Vaccination Attitudes and Intention: Message Framing and the Moderating Role of Perceived Vaccine Benefits [Article]. *Journal of Health Communication*, *26*(8), 523-533. https://doi.org/10.1080/10810730.2021.1966687

Briley, D. A., Rudd, M., & Aaker, J. (2017). Cultivating optimism: How to frame your future during a health challenge. *Journal of Consumer Research*, *44*(4), 895-915. doi: 10.1093/jcr/ucx075

Brown, W. J., Basil, M. D., & Bocarnea, M. C. (2003). The influence of famous athletes on health beliefs and practices: Mark McGwire, child abuse prevention, and androstenedione. *Journal of Health Communication*, *8*(1), 41-57. https://doi.org/10.1080/10810730305733

Buhrmester, M., Kwang, T., & Gosling, S. D. (2016). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality data? https://doi.org/10.1177/1745691610393980

Bullock, O. M., & Shulman, H. C. (2021). Utilizing framing theory to design more effective health messages about tanning behavior among college women. *Communication Studies*, *72*(3), 319-332. http://dx.doi.org/10.1080/10510974.2021.1899007

Cacciatore, M. A., Scheufele, D. A., & Iyengar, S. (2016). The end of framing as we know it… and the future of media effects. *Mass communication and society*, *19*(1), 7-23. http://dx.doi.org/10.1080/15205436.2015.1068811

Campbell, M., McKenzie, J. E., Sowden, A., Katikireddi, S. V., Brennan, S. E., Ellis, S., Hartmann-Boyce, J., Ryan, R., Shepperd, S., & Thomas, J. (2020). Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. *bmj*, *368*. https://doi.org/10.1136/bmj.l6890

Cappella, J. N., & Jamieson, K. H. (1997). *Spiral of cynicism: The press and the public good*. Oxford University Press. ISBN: 9780195090635, 9780195090642, 0195090632, 0195090640

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of personality and social psychology*, *39*(5), 752. https://doi.org/10.1037/0022-3514.39.5.752

Chanel, O., Luchini, S., Massoni, S., & Vergnaud, J.-C. (2011). Impact of information on intentions to vaccinate in a potential epidemic: Swine-origin Influenza A (H1N1). *Social Science & Medicine*, *72*(2), 142-148. https://doi.org/10.1016/j.socscimed.2010.11.018

Chen, T., Dai, M., Xia, S., & Zhou, Y. (2022). Do Messages Matter? Investigating the Combined Effects of Framing, Outcome Uncertainty, and Number Format on COVID-19 Vaccination Attitudes and Intention. *Health Communication*, *37*(8), 944-951. https://doi.org/10.1080/10410236.2021.1876814

Chen, X., Hay, J. L., Waters, E. A., Kiviniemi, M. T., Biddle, C., Schofield, E., Li, Y., Kaphingst, K., & Orom, H. (2018). Health literacy and use and trust in health information. *Journal of Health Communication*, *23*(8), 724-734. https://doi.org/10.1080/10810730.2018.1511658

De Angelis, E., Renzetti, S., Volta, M., Donato, F., Calza, S., Placidi, D., Lucchini, R. G., & Rota, M. (2021). COVID-19 incidence and mortality in Lombardy, Italy: an ecological study on the role of air pollution, meteorological factors, demographic and socioeconomic variables. *Environmental research*, *195*, 110777. https://doi.org/10.1016/j.envres.2021.110777

De Meulenaer, S., De Pelsmacker, P., & Dens, N. (2018). Power distance, uncertainty avoidance, and the effects of source credibility on health risk message compliance. *Health Communication*, *33*(3), 291-298. https://doi.org/10.1080/10410236.2016.1266573

De Vreese, C. H. (2005). News framing: Theory and typology. *Information design journal+ document design*, *13*(1), 51-62. http://dx.doi.org/10.1075/idjdd.13.1.06vre

Del Vicario, M., Bessi, A., Zollo, F., Petroni, F., Scala, A., Caldarelli, G., Stanley, H. E., & Quattrociocchi, W. (2016). The spreading of misinformation online. *Proceedings of the National Academy of Sciences*, *113*(3), 554-559. https://doi.org/10.1073/pnas.1517441113

Detweiler, J. B., Bedell, B. T., Salovey, P., Pronin, E., & Rothman, A. J. (1999). Message framing and sunscreen use: gain-framed messages motivate beach-goers. *Health Psychology*, *18*(2), 189. https://doi.org/10.1037/0278-6133.18.2.189

Diament, S. M., Kaya, A., & Magenheim, E. B. (2022). Frames that matter: Increasing the willingness to get the Covid-19 vaccines. *Social Science & Medicine*, *292*, N.PAG-N.PAG. https://doi.org/10.1016/j.socscimed.2021.114562

Dillard, J. P., & Shen, L. (2005). On the nature of reactance and its role in persuasive health communication. *Communication monographs*, *72*(2), 144-168. https://doi.org/10.1080/03637750500111815

Dong, Z. (2015). How to persuade adolescents to use nutrition labels: effects of health consciousness, argument quality, and source credibility. *Asian Journal of Communication*, *25*(1), 84-101. http://dx.doi.org/10.1080/01292986.2014.989241

Druckman, J. N. (2001). The implications of framing effects for citizen competence. *Political behavior*, *23*, 225-256. https://doi.org/10.1023/a:1015006907312

Druckman, J. N., & McDermott, R. (2008). Emotion and the framing of risky choice. *Political behavior*, *30*, 297-321. https://doi.org/10.1007/S11109-008-9056-Y

Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., & Bettinger, J. A. (2013). Vaccine hesitancy: an overview. *Human vaccines & immunotherapeutics*, *9*(8), 1763-1773. https://doi.org/10.4161/hv.24657

Dudo, A. D., Dahlstrom, M. F., & Brossard, D. (2007). Reporting a potential pandemic: A risk-related assessment of avian influenza coverage in US newspapers. *Science communication*, *28*(4), 429-454. http://dx.doi.org/10.1177/1075547007302211

Dutta-Bergman, M. (2003). Trusted online sources of health information: differences in demographics, health beliefs, and health-information orientation. *Journal of Medical Internet Research*, *5*(3), e893. https://doi.org/10.2196/jmir.5.3.e21

Eastin, M. S. (2001). Credibility assessments of online health information: The effects of source expertise and knowledge of content. *Journal of Computer-Mediated Communication*, *6*(4), JCMC643. http://dx.doi.org/10.1111/j.1083-6101.2001.tb00126.x

Erku, D. A., Bauld, L., Dawkins, L., Gartner, C. E., Steadman, K. J., Noar, S. M., Shrestha, S., & Morphett, K. (2021). Does the content and source credibility of health and risk messages related to nicotine vaping products have an impact on harm perception and behavioural intentions? A systematic review. *Addiction*, *116*(12), 3290-3303. https://doi.org/10.1111/add.15473

Everett, J. A., Colombatto, C., Chituc, V., Brady, W. J., & Crockett, M. (2020). The effectiveness of moral messages on public health behavioral intentions during the COVID-19 pandemic. https://doi.org/10.31234/osf.io/9yqs8

Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., & Mazor, K. M. (2020). Attitudes toward a potential SARS-CoV-2 vaccine: a survey of US adults. *Annals of internal medicine*, *173*(12), 964-973. https://doi.org/10.7326/m20-3569

Freeman, D., Loe, B. S., Chadwick, A., Vaccari, C., Waite, F., Rosebrock, L., ..., & Lambe, S. (2020). COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. *Psychological medicine*, 1-15. https://doi.org/10.1017/s0033291720005188

Freeman, D., Loe, B. S., Chadwick, A., Vaccari, C., Waite, F., Rosebrock, L., Jenner, L., Petit, A., Lewandowsky, S., & Vanderslott, S. (2022). COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. *Psychological medicine*, *52*(14), 3127-3141. https://doi.org/10.1017/s0033291720005188

Gallagher, K. M., & Updegraff, J. A. (2012). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of Behavioral Medicine*, *43*(1), 101-116. https://doi.org/10.1007/s12160-011-9308-7

Gallagher, K. M., Updegraff, J. A., Rothman, A. J., & Sims, L. (2011). Perceived susceptibility to breast cancer moderates the effect of gain-and loss-framed messages on use of screening mammography. *Health psychology*, *30*(2), 145. http://dx.doi.org/10.1037/a0022264

Gamson, W. A., & Modigliani, A. (1987). The changing culture of affirmative action. *Research in political sociology*, *3*(1), 137-177.

Gilkey, M. B., Bednarczyk, R. A., Gerend, M. A., Kornides, M. L., Perkins, R. B., Saslow, D., Sienko, J., Zimet, G. D., & Brewer, N. T. (2020). Getting human

papillomavirus vaccination back on track: protecting our national investment in human papillomavirus vaccination in the COVID-19 era. *Journal of Adolescent Health*, *67*(5), 633-634. https://doi.org/10.1016%2Fj.jadohealth.2020.08.013

Glare, P., Fridman, I., & Ashton-James, C. E. (2018). Choose your words wisely: the impact of message framing on patients' responses to treatment advice. *International review of neurobiology*, *139*, 159-190. https://doi.org/10.1016/bs.irn.2018.07.020

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press. ISBN: 0674316568, 9780674316560

Goldenberg, M. J. (2021). *Vaccine hesitancy: public trust, expertise, and the war on science*. University of Pittsburgh Press. https://doi.org/10.28968/cftt.v5i1.29607

Gong, Z., Tang, Z., & Li, J. (2022). What Strategy Is Better for Promoting COVID-19 Vaccination? A Comparison Between Gain-Framed, Loss-Framed, and Altruistic Messages. *Annals of Behavioral Medicine*, *56*(4), 325-331. https://doi.org/10.1093/abm/kaab070

Green, J., Druckman, J. N., Baum, M. A., Lazer, D., Ognyanova, K., Simonson, M. D., Lin, J., Santillana, M., & Perlis, R. H. (2022). Using General Messages to Persuade on a Politicized Scientific Issue [Article; Early Access]. *British Journal of Political Science*, 9, Article Pii s0007123422000424. https://doi.org/10.1017/s0007123422000424

Gross, K., & D'ambrosio, L. (2004). Framing emotional response. *Political psychology*, *25*(1), 1-29. http://dx.doi.org/10.1111/j.1467-9221.2004.00354.x

Hancher-Rauch, H. L., Britt-Spells, A., Wojtyna, A., & Standish, M. (2019). Health Information Seeking Behavior and Perceived Source Trustworthiness in

Public Health Students: A Pilot Study for Improving the Curriculum. *Journal of Health Education Teaching*, *10*(1), 34-43.

Harrington, N. G., & Kerr, A. M. (2017). Rethinking risk: Prospect theory application in health message framing research. *Health Communication*, *32*(2), 131-141. https://doi.org/10.1080/10410236.2015.1110004

Harrison, R., Jones, B., Gardner, P., & Lawton, R. (2021). Quality assessment with diverse studies (QuADS): an appraisal tool for methodological and reporting quality in systematic reviews of mixed-or multi-method studies. *BMC Health Services Research*, *21*(1), 1-20. https://doi.org/10.1186/s12913-021-06122-y

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2019). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons. http://dx.doi.org/10.1002/9781119536604

Hines, K. (2022). *"Who Said What?": Effects of Message Framing and Source Type Toward COVID-19 Vaccinations Intentions among College Students* (Publication Number 29288815) [M.A., Auburn University]. ProQuest Dissertations & Theses Global. Ann Arbor. https://etd.auburn.edu//handle/10415/8165

Hing, N. Y. L., Woon, Y. L., Lee, Y. K., Kim, H. J., Lothfi, N. M., Wong, E., Perialathan, K., Ahmad Sanusi, N. H., Isa, A., Leong, C. T., & Costa-Font, J. (2022). When do persuasive messages on vaccine safety steer COVID-19 vaccine acceptance and recommendations? Behavioural insights from a randomised controlled experiment in Malaysia. *BMJ Global Health*, *7(7) (no pagination)*, Article e009250. https://doi.org/10.1136/bmjgh-2022-009250

Hofstede, G. (1980). Motivation, leadership, and organization: do American theories apply abroad? *Organizational dynamics*, *9*(1), 42-63. https://doi.org/10.1016/0090-2616(80)90013-3

Hovland, C. I., & Weiss, W. (1951). The influence of source credibility on communication effectiveness. *Public opinion quarterly*, *15*(4), 635-650. https://doi.org/10.1007/BF02716996

Huang, Y., & Sundar, S. S. (2022). Do we trust the crowd? Effects of crowdsourcing on perceived credibility of online health information. *Health Communication*, *37*(1), 93-102. https://doi.org/10.1080/10410236.2020.1824662

Institute for Government. (2021). Timeline of UK Government Coronavirus Lockdowns and Measures, March 2020 to December 2021.

Jin, Q., Raza, S. H., Yousaf, M., Zaman, U., & Siang, J. M. L. D. (2021). Can communication strategies combat covid-19 vaccine hesitancy with trade-off between public service messages and public skepticism? Experimental evidence from Pakistan. *Vaccines*, *9(7) (no pagination)*, Article 757. https://doi.org/https://dx.doi.org/10.3390/vaccines9070757

Jucks, R., & Thon, F. M. (2017). Better to have many opinions than one from an expert? Social validation by one trustworthy source versus the masses in online health forums. *Computers in Human Behavior*, *70*, 375-381. http://dx.doi.org/10.1016/j.chb.2017.01.019

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux. .

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 363-391. https://doi.org/0012-9682(197903)47:2%3C263:PTAAOD%3E2.0.CO;2-3

Kerr, J. R., Freeman, A. L., Marteau, T. M., & van der Linden, S. (2021). Effect of information about COVID-19 vaccine effectiveness and side effects on behavioural intentions: two online experiments. *Vaccines*, *9*(4), 379. https://doi.org/10.3390/vaccines9040379

Kim, H. K., Lee, T. K., & Kong, W. Y. (2020). The interplay between framing and regulatory focus in processing narratives about HPV vaccination in Singapore. *Health Communication*, *35*(2), 222-232. https://doi.org/10.1080/10410236.2018.1553022

Koslap-Petraco, M. (2019). Vaccine hesitancy: not a new phenomenon, but a new threat. *Journal of the American Association of Nurse Practitioners, 31(11)*, 624-626. https://doi.org/10.1097/jxx.0000000000000342

Kreps, S., & Kriner, D. (2021). Factors influencing Covid-19 vaccine acceptance across subgroups in the United States: Evidence from a conjoint experiment. *Vaccine*, *39*(24), 3250-3258. https://doi.org/10.1016/j.vaccine.2021.04.044

Kumkale, G. T., Albarracín, D., & Seignourel, P. J. (2010). The effects of source credibility in the presence or absence of prior attitudes: Implications for the design of persuasive communication campaigns. *Journal of applied social psychology*, *40*(6), 1325-1356. https://doi.org/10.1111/j.1559-1816.2010.00620.x

Lazarus, J. V., Ratzan, S. C., Palayew, A., Gostin, L. O., Larson, H. J., Rabin, K., Kimball, S., & El-Mohandes, A. (2021). A global survey of potential acceptance of a COVID-19 vaccine. *Nature Medicine*, *27*(2), 225-228. https://doi.org/10.1038/s41591-020-1124-9

Lazer, D. M., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F., Metzger, M. J., Nyhan, B., Pennycook, G., & Rothschild, D. (2018). The science of fake news. *Science*, *359*(6380), 1094-1096. https://doi.org/10.1126/science.aao2998

Lee, Y.-I., & Jin, Y. (2019). Crisis information seeking and sharing (CISS): scale development for measuring publics' communicative behavior in social-mediated public health crises. *Journal of International Crisis and Risk Communication Research*, *2*(1), 13-38. http://dx.doi.org/10.30658/jicrcr.2.1.2

Lewandowsky, S., Ecker, U. K., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and its correction: Continued influence and successful debiasing. *Psychological science in the public interest*, *13*(3), 106-131. https://doi.org/10.1177/1529100612451018

Li, J., Tang, Z., & Gong, Z. (2022). Does the Message Frame Promote People's Willingness to Vaccinate when they Worry about Side Effects from the COVID-19 Vaccine? Evidence from an Online Survey Experiment in China [Article]. *Health Communication*. https://doi.org/10.1080/10410236.2022.2028469

Li, S. L., Pereira, R. H., Prete Jr, C. A., Zarebski, A. E., Emanuel, L., Alves, P. J., Peixoto, P. S., Braga, C. K., de Souza Santos, A. A., & de Souza, W. M. (2021). Higher risk of death from COVID-19 in low-income and non-White populations of São Paulo, Brazil. *BMJ Global Health*, *6*(4), e004959. https://doi.org/10.1136/bmjgh-2021-004959

Machingaidze, S., & Wiysonge, C. S. (2021). Understanding COVID-19 vaccine hesitancy. *Medicine, 27(8)*, 1338-1339. https://doi.org/10.1038/s41591-021-01459-7

Major, L. H., & Coleman, R. (2012). Source credibility and evidence format: Examining the effectiveness of HIV/AIDS messages for young African Americans. *Journal of Health Communication*, *17*(5), 515-531. https://doi.org/10.1080/10810730.2011.635771

Martin, L. R., & Petrie, K. J. (2017). Understanding the dimensions of anti-vaccination attitudes: The vaccination attitudes examination (VAX) scale. *Annals of Behavioral Medicine*, *51*(5), 652-660. https://doi.org/10.1007/s12160-017-9888-y

Masiero, M., Mazzoni, D., Pizzoli, S. F. M., Gargenti, S., Grasso, R., Mazzocco, K., & Pravettoni, G. (2022). The Individuals' Willingness to Get the Vaccine for COVID-19 during the Third Wave: A Study on Trust in Mainstream Information

Sources, Attitudes and Framing Effect [Article]. *Behavioral Sciences*, *12*(10), 12, Article 399. https://doi.org/10.3390/bs12100399

Mheidly, N., & Fares, J. (2020). Leveraging media and health communication strategies to overcome the COVID-19 infodemic. *Journal of public health policy*, *41*(4), 410-420. https://doi.org/10.1057/s41271-020-00247-w

Mian, A., & Khan, S. (2020). Coronavirus: the spread of misinformation. *BMC Medicine*, *18*, 1-2. https://doi.org/10.1186/s12916-020-01556-3

Murphy, J., Vallières, F., Bentall, R. P., Shevlin, M., McBride, O., Hartman, T. K., ..., & Hyland, P. (2021). Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nature comunications*, 1-15. https://doi.org/10.1038/s41467-020-20226-9

Nan, X. (2012a). Communicating to young adults about HPV vaccination: Consideration of message framing, motivation, and gender. *Health Communication*, *27*(1), 10-18. https://doi.org/10.1080/10410236.2011.567447

Nan, X. (2012b). Relative persuasiveness of gain-versus loss-framed human papillomavirus vaccination messages for the present-and future-minded. *Human Communication Research*, *38*(1), 72-94. https://doi.org/10.1111/j.1468-2958.2011.01419.x

Nan, X., Madden, K., Richards, A., Holt, C., Wang, M. Q., & Tracy, K. (2016). Message framing, perceived susceptibility, and intentions to vaccinate children against HPV among African American parents. *Health Communication*, *31*(7), 798-805. https://doi.org/10.1080/10410236.2015.1005280

Nan, X., Xie, B., & Madden, K. (2012). Acceptability of the H1N1 vaccine among older adults: The interplay of message framing and perceived vaccine safety

and efficacy. *Health Communication*, *27*(6), 559-568. https://doi.org/10.1080/10410236.2011.617243

O'Keefe, D. J., & Jensen, J. D. (2009). The relative persuasiveness of gain-framed and loss-framed messages for encouraging disease detection behaviors: A meta-analytic review. *Journal of Communication*, *59*(2), 296-316. https://doi.org/10.1080/10810730701615198

O'Keefe, D. J., & Nan, X. (2012). The relative persuasiveness of gain-and loss-framed messages for promoting vaccination: A meta-analytic review. *Health Communication*, *27*(8), 776-783. https://doi.org/10.1080/10410236.2011.640974

Ofstead, C. L., Tucker, S. J., Beebe, T. J., & Poland, G. A. (2008). Influenza vaccination among registered nurses: information receipt, knowledge, and decision-making at an institution with a multifaceted educational program. *Infection Control & Hospital Epidemiology*, *29*(2), 99-106. https://doi.org/10.1086/526431

Ogbondah, B., Owhonda, G., Jaja, I., Luke, A., Green, P., & Mberekpe, P. (2022). COVID-19: Socio-demographic determinants of knowledge. *Ibom Medical Journal*, *15*(3), 236-244.

Ogilvie, G. S., Gordon, S., Smith, L. W., Albert, A., Racey, C. S., Booth, A., Gottschlich, A., Goldfarb, D., Murray, M., & Galea, L. A. (2021). Intention to receive a COVID-19 vaccine: results from a population-based survey in Canada. *BMC Public Health*, *21*(1), 1-14. https://doi.org/10.1186/s12889-021-11098-9

Oyserman, D., & Lee, S. W. (2008). Does culture influence what and how we think? Effects of priming individualism and collectivism. *Psychological bulletin*, *134*(2), 311. https://doi.org/10.1037/0033-2909.134.2.311

Park, S.-Y. (2012). The effects of message framing and risk perceptions for HPV vaccine campaigns: focus on the role of regulatory fit. *Health marketing quarterly*, *29*(4), 283-302. https://doi.org/10.1080/07359683.2012.732847

Pérez-Fuentes, M. d. C., Molero Jurado, M. d. M., Martos Martínez, Á., & Gázquez Linares, J. J. (2020). Threat of COVID-19 and emotional state during quarantine: Positive and negative affect as mediators in a cross-sectional study of the Spanish population. *PLoS ONE*, *15*(6), e0235305. https://doi.org/10.1371/journal.pone.0235305

Phua, J., Jin, S. V., & Hahm, J. M. (2018). Celebrity-endorsed e-cigarette brand Instagram advertisements: Effects on young adults' attitudes towards e-cigarettes and smoking intentions. *Journal of health psychology*, *23*(4), 550-560. https://doi.org/10.1177/1359105317693912

Pittman, M. (2020). Accountability moderates the effects of egoistic and altruistic appeals in prosocial messages. *Journal of Consumer Marketing*, *37*(7), 807-820. http://dx.doi.org/10.1108/JCM-07-2018-2751

Prakash, A., Nathan, R. J., Kini, S., & Victor, V. (2022). Message framing and COVID-19 vaccine acceptance among millennials in South India [Article].

PLoS ONE, *17*(7 July), Article e0269487. https://doi.org/10.1371/journal.pone.0269487

Pulido, C. M., Villarejo-Carballido, B., Redondo-Sama, G., & Gómez, A. (2020). COVID-19 infodemic: More retweets for science-based information on coronavirus than for false information. *International sociology*, *35*(4), 377-392. https://doi.org/10.1177/0268580920914755

Quick, B. L., & Bates, B. R. (2010). The use of gain-or loss-frame messages and efficacy appeals to dissuade excessive alcohol consumption among college students: A test of psychological reactance theory. *Journal of Health Communication*, *15*(6), 603-628. https://doi.org/10.1080/10810730.2010.499593

Reinhardt, A., & Rossmann, C. (2021). Age-Related Framing Effects: Why Vaccination Against COVID-19 Should Be Promoted Differently in Younger and Older Adults [Article]. *Journal of Experimental Psychology: Applied*, *27*(4), 669-678. https://doi.org/10.1037/xap0000378

Ribeiro, K. B., Ribeiro, A. F., Veras, M. A. d. S. M., & de Castro, M. C. (2021). Social inequalities and COVID-19 mortality in the city of São Paulo, Brazil. *International Journal of Epidemiology*, *50*(3), 732-742. https://doi.org/10.1093/ije/dyab022

Rivers, S. E., Salovey, P., Pizarro, D. A., Pizarro, J., & Schneider, T. R. (2005). Message framing and pap test utilization among women attending a community health clinic. *Journal of health psychology*, *10*(1), 65-77. https://doi.org/10.1177/1359105305048556

Rothkopf, D. J. (2003). When the buzz bites back. *The Washington Post*, *11*, B1-B5. https://www.washingtonpost.com/archive/opinions/2003/05/11/when-the-buzz-bites-back/bc8cd84f-cab6-4648-bf58-0277261af6cd/

Rothman, A. J., Martino, S. C., Bedell, B. T., Detweiler, J. B., & Salovey, P. (1999). The systematic influence of gain-and loss-framed messages on interest in and use of different types of health behavior. *Personality and Social Psychology Bulletin*, *25*(11), 1355-1369. https://doi.org/10.1177/0146167299259003

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: the role of message framing. *Psychological bulletin*, *121*(1), 3. https://doi.org/10.1037/0033-2909.121.1.3

Rosenstock, I. M. (1966). Why people use health services. The Milbank Memorial Fund Quarterly, 44, 94-127. doi: 10.1111/j.1468-0009.2005.00425.x

Sallam, M. (2021). COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines, 9(2)*, 160. https://doi-org.abc.cardiff.ac.uk/10.3390%2Fvaccines9020160

Sear, R. F., Velásquez, N., Leahy, R., Restrepo, N. J., El Oud, S., Gabriel, N., Lupu, Y., & Johnson, N. F. (2020). Quantifying COVID-19 content in the online health opinion war using machine learning. *Ieee Access*, *8*, 91886-91893. https://doi.org/10.1109/access.2020.2993967

Shafer, A., Kaufhold, K., & Luo, Y. (2018). Applying the health belief model and an integrated behavioral model to promote breast tissue donation among Asian Americans. *Health Communication*, *33*(7), 833-841. https://doi.org/10.1080/10410236.2017.1315678

Strategic Advisory Group of Experts in Immunization (SAGE). (2014). *Report of the SAGE working group on vaccine hesitancy*. https://www.asset-scienceinsociety.eu/sites/default/files/sage_working_group_revised_report_vaccine_hesitancy.pdf

Strickland, J. C., Reed, D. D., Hursh, S. R., Schwartz, L. P., Foster, R. N., Gelino, B. W., LeComte, R. S., Oda, F. S., Salzer, A. R., Schneider, T. D., Dayton, L., Latkin, C., & Johnson, M. W. (2022). Behavioral economic methods to inform infectious disease response: Prevention, testing, and vaccination in the COVID-19 pandemic. *PLoS ONE Vol 17(1), 2022, ArtID e0258828*, *17*(1). https://doi.org/10.1371/journal.pone.0258828

Suran, M. (2022). Why parents still hesitate to vaccinate their children against COVID-19. *Jama*, *327*(1), 23-25. https://doi.org/10.1001/jama.2021.21625

Sweetser, E., & Fauconnier, G. (1996). Cognitive links and domains: Basic aspects of mental space theory. *Spaces, worlds, and grammar*, *1228*.

Toll, B. A., O'Malley, S. S., Katulak, N. A., Wu, R., Dubin, J. A., Latimer, A., Meandzija, B., George, T. P., Jatlow, P., & Cooney, J. L. (2007). Comparing gain-and loss-framed messages for smoking cessation with sustained-release bupropion: a randomized controlled trial. *Psychology of Addictive Behaviors*, *21*(4), 534. https://doi.org/10.1037/0893-164x.21.4.534

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *science*, *211*(4481), 453-458. https://doi.org/10.1126/science.7455683

Updegraff, J. A., & Rothman, A. J. (2013). Health message framing: Moderators, mediators, and mysteries. *Social and Personality Psychology Compass*, *7*(9), 668-679. https://doi.org/10.1111/spc3.12056

Van't Riet, J., Cox, A. D., Cox, D., Zimet, G. D., De Bruijn, G.-J., Van den Putte, B., De Vries, H., Werrij, M. Q., & Ruiter, R. A. (2014). Does perceived risk influence the effects of message framing? A new investigation of a widely held notion. *Psychology & Health*, *29*(8), 933-949. https://doi.org/10.1080/08870446.2014.896916

World Health Organisation (WHO). (2020). *Coronavirus disease (COVID-19)*. https://www-who-int.abc.cardiff.ac.uk/health-topics/coronavirus#tab=tab_1

World Health Organization. (2018). *2018 assessment report of the Global Vaccine Action Plan: strategic advisory group of experts on immunization*. https://apps.who.int/iris/bitstream/handle/10665/276967/WHO-IVB-18.11-eng.pdf

Xiao, X., & Borah, P. (2021). Do norms matter? Examining norm-based messages in HPV vaccination promotion. *Health Communication*, *36*(12), 1476-1484. https://doi.org/10.1080/10410236.2020.1770506

Xiao, X., & Wong, R. M. (2020). Vaccine hesitancy and perceived behavioral control: a meta-analysis. *Vaccine, 38(33)*, 5131-5138. https://doi.org/10.1016/j.vaccine.2020.04.076

Psychological flexibility and psychological distress and their relationship with COVID-19 vaccine attitudes and acceptance (a).

Word count of Abstract: 172

Word count of main body (excluding abstract, table figures and references): 4,897

ABSTRACT

Background: Vaccine hesitancy threatens the success of COVID-19 vaccines. Psychological distress (PD), psychological inflexibility (PIF) and vaccine attitudes are linked to vaccine take-up. This study explores the predictive validity of PD, PF, and vaccine attitudes on COVID-19 vaccine take-up.

Methods: An online survey (n = 434) was conducted between August – November 2022 using the 5C scale (vaccine attitudes), CompACT-8 (PF) and CORE-OM (PD). Analyses included correlation analyses, multiple linear, logistic, and binomial regressions.

Results: PF and PD positively predicted vaccine complacency, constraints, calculation, and collective responsibility. PD/PF did not predict confidence. Confidence predicted vaccine take-up in one-dose and four-plus dose groups. Those with one/two/three doses were less PF than zero/four-plus doses. PD did not predict vaccine take-up. PF predicted PD.

Conclusions: Coping strategies may link vaccine hesitancy and PIF, as avoidance strategies may protect against distress. PD predicting less calculation supports this. PIF predicting vaccine take-up may reflect the research/pandemic context. Public health strategies should foster confidence in COVID-19 vaccines and emphasise the collective/individual benefits and reduce the need for deliberation.

Keywords:

- COVID-19
- Vaccine
- Hesitancy
- Psychological flexibility
- Psychological distress
- Survey experiment

INTRODUCTION

COVID-19 led to the declaration of a global pandemic in March 2020 (World Health Organisation (WHO), 2020) causing a rush to develop lifesaving vaccines. Vaccines are one of the most successful public health strategies (Dubé et al., 2013), saving 2-3 million lives per year (Freeman et al., 2020; World Health Organization, 2018), but low uptake rates threaten their success (Xiao & Wong, 2020). Vaccine hesitancy describes individuals who are delaying or refusing some but not all vaccines, distinguishing them from those that accept/refuse all vaccines (Freeman et al., 2020; Strategic Advisory Group of Experts in Immunization (SAGE), 2014).

Vaccine hesitancy is common with new vaccines (Aide et al., 2007; Fatima & Syed, 2018; Mesch & Schwirian, 2019; Morgan & Poland, 2011; Sallam, 2021; Sallam et al., 2022), and WHO listed it as one of the top ten global health threats in 2019 (Koslap-Petraco, 2019). Compared to other health threats listed (e.g., treatment resistant/non-communicable diseases, climate/humanitarian crises, and air pollution), vaccine hesitancy is the only attitude-driven threat (Goldenberg, 2021).

The decision to accept a vaccine is complex and embedded in socio-political, cultural, and historic contexts (Dubé et al., 2013; Goldenberg, 2021). In May 2023, 30% of the UK population had not received all the recommended doses of the COVID-19 vaccines and 6.4% have outright refused any doses (UK Government, 2023). The lowest acceptance rate in the world is 24% (Sallam, 2021).

Several theories of vaccine hesitancy have been proposed in the literature. Mistrust in vaccines and the government, and conspiracy beliefs are widely cited as predictors of vaccine hesitancy (Bertin et al., 2020; Freeman et al., 2022; Jennings et al., 2021; Sallam et al., 2021). The Health Belief Model (HBM) (Rosenstock, 1966) suggests vaccine uptake is predicted by individual beliefs about perceived severity and susceptibility of a disease, and the perceived benefits and risks (Carpenter, 2010; Harrison et al., 1992). Studies have shown that groups who perceived higher personal risk of getting COVID-19 and/or greater risk to the general public were more likely to accept the vaccine (Karlsson et al., 2021; Malik et al., 2020). The Theory of Planned Behaviour (TPB) (Ajzen, 1991) also incorporates these concepts, suggesting that to receive a vaccine an individual must believe in the positive consequences of vaccines, perceive familial and societal pressure to get vaccinated, and believe the behaviour is in their control (Chu et al., 2021)(b).

The 3C model (MacDonald, 2015) and describes vaccine hesitancy as occurring from a combination of convenience (lack of practical barriers), confidence (trusting the safety/effectiveness of vaccines), and complacency (not perceiving the target disease as high risk, therefore vaccines are unnecessary). This model incorporates the HBM and TPB (b) and was developed from prior research to be globally applicable, and helpful for measuring outcomes. An updated 5C model (Betsch et al., 2018) added calculation (an individual's engagement in information searching and consideration of the vaccine) and collective responsibility (the willingness to protect others by receiving a vaccination). 'Constraints' replaced convenience to acknowledge barriers in availability, affordability, and accessibility. The 5C 'antecedents to vaccine acceptance' scale (Betsch et al., 2018) predicts vaccine take-up in influenza, MMR, HPV, and COVID-19 vaccines (Betsch et al., 2018; Ghazy et al., 2021; Hossain et al., 2021). To

reflect research, this measure improves on others by assessing more than just vaccine confidence (Betsch et al., 2018; Gilkey et al., 2014; Gilkey et al., 2016; Larson et al., 2016; Larson et al., 2015; Sarathchandra et al., 2018; Shapiro et al., 2018). This is the first study to examine the relationship between the 5C scale and the COVID-19 vaccines in the UK in 2022/3 after initial and booster vaccines had been offered. The findings of this study will contribute to our understanding of the how vaccine attitudes influence vaccine decisions in the pandemic (b).

Emotions have also been studied in relation to vaccine hesitancy. Depression negatively correlates with vaccine take-up for influenza, measles, hepatitis B, and herpes zoster vaccines (Krishnamoorthy et al., 2020; Madison et al., 2021; Mazereel et al., 2021). COVID-19 related anxiety increases vaccine take-up (Salali & Uysal, 2022; Ward et al., 2020). Unremitting news updates and politicisation caused underestimation of COVID-19 severity, leading to emotional detachment and passivity (Jamieson & Albarracin, 2020; Morgul et al., 2021; NORC, 2020; Tyson, 2020). The pandemic caused worldwide increases in psychological distress (PD), depression, anxiety, loneliness, and suicidal ideation (Bakshi et al., 2021; Davillas & Jones, 2020; Killgore et al., 2020; McGinty et al., 2020; Nicola et al., 2020; Reger et al., 2020; Rossell et al., 2021; Serafini et al., 2020; Tindle et al., 2022; Zhang et al., 2020). These emotions reduce motivation to engage in preventative health behaviours like vaccination (Morgul et al., 2021; Qiu et al., 2020; Wang et al., 2020). Emotional vulnerability increases endorsement of COVID-19 misinformation and vaccine hesitancy (Dubé et al., 2013; Fisher et al., 2020; Jolley & Douglas, 2014; MacFarlane et al., 2020; Sear et al., 2020). The current study examines the link between PD and vaccine hesitancy.

Psychological flexibility (PF) has also been linked to vaccine hesitancy. PF has three constructs: openness to experience (OE), behavioural awareness (BA), and valued action (VA) (Francis et al., 2016). OE is about accepting and experiencing emotions related to current experiences. BA is about being aware of one's actions and aligning them with thoughts and feelings. VA is about acting on one's deeply held values. PF scores are lower in adults refusing the flu vaccine (Cheung & Mak, 2016) and parents refusing their children's COVID-19 vaccines (Wang & Zhang, 2021). PF protects from PD by improving coping with/adjusting to challenges, regulating emotions and prioritisation (Burton & Bonanno, 2016; Hayes et al., 2011; Kashdan et al., 2006; Kashdan & Rottenberg, 2010b). PF is associated with better wellbeing, lower levels of depression, anxiety, and COVID-19 related distress (Crasta et al., 2020; Daks et al., 2020; Dawson & Golijani-Moghaddam, 2020; Francis et al., 2016; Kroska et al., 2020; Mallett et al., 2021; McCracken et al., 2021; Pakenham et al., 2020; Peltz et al., 2020; Smith et al., 2020; Strosahl et al., 2012).

Psychological inflexibility (PIF) is related to rigid and avoidant coping strategies, such as denial, disengagement, distraction, substance use, rumination/avoidance in depression/anxiety disorders (Abramson et al., 1989; Bardeen et al., 2013; Bonanno et al., 2004; Chawla & Ostafin, 2007; Cheng, 2001; Hayes et al., 1996; Kabat-Zinn, 2013; Karekla & Panayiotou, 2011; Kashdan et al., 2006; Kashdan & Rottenberg, 2010a; Kashdan & Steger, 2006; McLaughlin et al., 2007; Nielsen et al., 2016; Nolen-Hoeksema et al., 2008; Paul, 2002; Zvolensky & Eifert, 2001). Complacency about COVID-19 severity and required collective responsibility; reduced vaccine confidence, constraints and calculation could be considered avoidant coping strategies. This study predicts a relationship between PF, PD, and vaccine attitudes on the 5C scale.

The researchers hypothesise:

- H1: Individuals showing low PF (lower scores on the Comp-ACT 8) and high PD (higher scores on the CORE-OM) will show less favourable attitudes towards vaccines on the 5C scale (lower confidence, calculation, and collective responsibility, and higher complacency and constraints).
- H2: Individuals showing low PF will score high in PD (d).
- H3: The variance in vaccine take-up will be related to participants' vaccine attitudes, PF scores and PD scores (d).

METHOD

Design

The study used a quasi-experimental quantitative questionnaire design. The dependent variable (DV) was vaccine hesitancy (5Cs measure of antecedents to vaccination) and questions about the number of COVID-19 vaccines received. The independent variables (IV) were PD (measured using the CORE-OM) and PF (measured using the CompACT-8).

Participants

Four-hundred and thirty-four participants were included in the analysis. G*Power (Faul, Erdfelder, Lang and Buchner, 2007) determined that a minimum of 119 participants were required to achieve a power of 0.95 with a medium effect size (0.15) so the sample size was sufficient. Slightly more than half of the final sample identified as female (51%), and just under half were aged 25-34 (47.5%). The sociodemographic details are in Table 2.1. One hundred and twenty-one participants were excluded. Eighty-four had their participation terminated after not consenting to all the specified criteria (Appendix E for consent form). Thirty-seven were excluded after failing to complete the minimum percentage of data completion required (Kang, 2013). Three participants missed one question from the CompACT-8, so the responses were prorated. Eight participants omitted two questions from the CORE-OM, and forty-three omitted one question. In line with the CORE-OM guidance, the same procedure was taken (Morris, 2019).

Table 2.1. Sociodemographic characteristics of participants

Characteristic		*N (%)*
Gender	Female	222 (51.2)
	Male	200 (46.1)
	Nonbinary	7 (1.6)
	Prefer not to say	5 (1.2)
Age	18-24	101 (23.3)
	25-34	206 (47.5)
	35-44	63 (14.5)
	45-54	30 (6.9)
	55-64	24 (5.5)
	65+	10 (2.3)
Ethnicity	Asian not specified	18 (4.1)
	Pakistani	2 (.5)
	Asian other	1 (.2)
	Black not specified	9 (2.1)
	African	3 (.7)
	Caribbean	9 (2.1)
	Mixed not specified	2 (.5)
	White & Asian	51 (11.8)
	White & Black African	7 (1.6)
	White & Black Caribbean	4 (.9)
	Mixed other	5 (1.2)
	White not specified	118 (27.2)
	British - English	79 (18.2)
	British - Scottish	13 (3)
	British - Welsh	45 (10.4)
	White other	30 (6.9)

	Chinese	1 (.2)
	Middle Eastern/North African	2 (.5)
	Prefer not to say	35 (8.1)
Vaccine status	None	45 (10.4)
	1 dose	37 (8.5)
	2 doses	100 (23)
	3 doses	158 (36.4)
	4+ doses	94 (21.7)

Six current undergraduate Psychology scholars were recruited via Cardiff University's Experimental Management System for mandatory course credits. Five members of the public were recruited via Survey Circle, a free online survey exchange platform where studies are advertised by researchers who mutually agree to participate in each other's research. All members of the general public (including Survey Circle) were directed to the Qualtrics survey and had the opportunity to enter the prize draw. A prize draw to win one of three high street vouchers (1x £10, 1x £20, 1x £50) was offered. The researchers used social media platforms (WhatsApp, Facebook, Twitter, and Reddit) to recruit contacts and the public through groups/threads (Appendix F). All adults aged 18 and above who understand written and spoken English were eligible to participate. The study was aimed at UK residents but the nature of distributing the survey link meant this was not guaranteed.

Materials

Antecedents to vaccination

Participants attitudes towards vaccines were measured using an adapted version of the 15-item 5Cs vaccine hesitancy scale (Betsch et al., 2018) (Appendix G). The measure was adapted in line with the author's guidance and related each question to COVID-19 vaccines. The 5Cs scale asks participants to state their level of agreement with statements about COVID-19 vaccines on a 7-point Likert scale (1= strongly disagree to 7= strongly agree). The measure is made up of 5 subscales (Table 2.2). Each antecedent is distinct, so a total score is not recommended. The measure was validated across different populations and vaccines and has good convergent validity with other validated measures (Gilkey et al., 2014; Gilkey et al., 2016; Larson et al., 2016; Larson et al., 2015; Sarathchandra et al., 2018; Shapiro et al., 2018).

Table 2.2. 5C subscales and definitions

5C subscale	*Definition*
Confidence	The degree to which the safety and efficacy of the vaccine is trusted
Complacency	The perceived level of risk associated with COVID-19 disease and the necessity of the vaccines
Constraints	Barriers beyond a person's control, including physical availability, affordability, and accessibility
Calculation	The degree to which an individual engages in information searching and consideration of the vaccines
Collective responsibility	The willingness to protect others through herd immunity by receiving a vaccination

Lower confidence scores indicate lower vaccine confidence. Higher complacency scores indicate lower perceived threat from COVID-19 and less need for vaccination. Higher constraints suggest more physical/psychological barriers preventing vaccination. Higher calculation suggests more information searching, indicating vaccine hesitancy. It suggests individuals are more risk-averse and may be more likely to engage with vaccine-critical sources. High collective responsibility scores suggest perceived value in the collective benefits of vaccination. The internal consistency on this measure was good (α = 0.70-0.91, Table 2.3).

Table 2.3: Cronbach's alpha co-efficient for the 5Cs subscales

Subscale	***Cronbach's α***	***Original paper Cronbach's α***
Confidence	α = 0.91	α = 0.85
Complacency	α = 0.72	α = 0.76
Constraints	α = 0.88	α = 0.85
Calculation	α = 0.81	α = 0.78
Collective Responsibility	α = 0.70	α = 0.71

Vaccine hesitancy

To determine levels of vaccine hesitancy, participants reported how many COVID-19 vaccines they had received in the demographic questionnaire (Appendix H). Participants who have received some but not all vaccines can be considered vaccine hesitant.

Psychological Flexibility

PF was measured using the CompACT-8 (Morris, 2019) (Appendix I), an eight-item abbreviated version of the Comprehensive Assessment of Acceptance and Commitment Therapy Processes (CompACT-8) (Francis et al., 2016). The CompACT-8 measures the core features of PF; OE, BA, VA. Participants rate their responses on a 7-point Likert scale from 0 (strongly disagree) to 6 (strongly agree). Higher scores

indicate greater PF with a maximum score of 48. Participants showed an acceptable level of internal consistency on this measure (α = 0.76, Table 2.4 for subscale α coefficients). The original paper reported the α = 0.7. The scale demonstrates good convergent validity with evidence of significant correlations with the Acceptance and Action Questionnaire (AAQ-II) (Bond et al., 2011) and measures of distress and wellbeing (Morris, 2019).

Table 2.4. Cronbach's alpha co-efficient for the CompACT-8

Subscale	***Cronbach's α***
Openness to experience	α = 0.70
Valued Action	α = 0.76
Behavioural Awareness	α = 0.77

Psychological Distress (PD)

PD was measured using the CORE-OM (Clinical Outcomes in Routine Evaluation - Outcome Measure) (Evans et al., 2002), a 34-item questionnaire using a 5-point Likert scale from 0 (not at all) to 4 (most of the time) (Appendix J). The CORE-OM is a widely used outcome measures in mental health settings for monitoring clinical symptoms of distress within adults. Higher scores indicate higher distress. Some items are positively framed, and others are negatively framed, and reverse scored. The CORE-OM has four domains (Table 2.5)

Table 2.5. CORE-OM domains and definitions

Subscale	*Definition*
Subjective wellbeing	A person's sense of life quality and emotional health (four items)
Problems/symptoms	Psychological health issues, such as symptoms of anxiety or depression, reactions to trauma, and physical complaints (twelve items)
Life functioning	Interpersonal, social, and general functioning in daily life (twelve items)
Risk	Items considering self-harm and suicidal ideation, and violent behaviour and threats towards others. The risk items include questions about risk to self (four items) and others (two items).

Domain scores can be reported separately, but they were never intended to form separate factors (Evans et al., 2000), so clinical scores were used in the analysis (participant mean score is multiplied by 10). Higher scores indicate higher distress. The maximum score is 40. Participants showed a very good level of internal consistency ($\alpha = 0.96$). The original paper reports Cronbach's alpha coefficients ranging from $\alpha > 0.75$ - < 0.95 (Evans et al., 2000). The CORE-OM shows good convergent validity compared to other validated scales of PD (Beck et al., 1988; Beck et al., 1987; Derogatis & Melisaratos, 1983; Goldberg & Hillier, 1979).

Procedure

Ethical approval was granted by Cardiff University's ethics committee (5th July 2022 – Appendix K). Data collection began on 1st August 2022 when the UK population had been offered the initial two doses of COVID-19 vaccines, plus the first booster dose (3 doses). Those in vulnerable categories or working in healthcare settings had been offered additional follow-up booster vaccines (4+ doses). Participants completed the survey using online Qualtrics software. Participants read an information sheet (Appendix L) explaining the right to withdraw any time. Participants could omit questions regarding suicide on CORE-OM. Data collection ended on 18th November 2022. Participants followed a survey link and completed a consent form. Eligible participants continued to the demographic questionnaire. Participants followed a survey link and completed a consent form and eligible participants continued to the demographic questionnaire. Participants then completed the 5Cs scale, followed by the CompACT-8, and the CORE-OM. A debrief sheet was then displayed, and they were given a link to a separate survey to enter details for the prize draw. University students were awarded participation credits automatically.

Analysis Strategy

The relationship between participant scores on the CompACT-8, CORE-OM, and 5C scale (H1) was explored using a correlation analysis. The relationships between the CompACT-8, CORE-OM, and 5C scales (H1 and H2) was analysed using a standard linear regression. An ordinal regression analysis explored how much of the variance in the number of vaccine doses received (DV) was predicted by the 5C subscales, CompACT-8, and CORE-OM scores (IVs) (H3). However, the test of parallel lines was significant (Appendix M), so a multinomial regression was conducted. A logistical regression analysed whether there were significant differences between unvaccinated (0 doses, n = 45) and vaccinated participants (1-3+ doses, n = 389).

Data were analysed in IBM SPSS Statistics 27. Tests of normality indicated that participants responses on all the outcome measures were not normally distributed. Transformations using Blom's formula and mathematical transformations did not correct the distributions. Given the large sample size assumptions of normality could be relaxed because of central limit theorem (Pek et al., 2018) and non-parametric statistics were performed where necessary.

RESULTS

Descriptive data for the outcome variables are displayed in Table 2.6.

Correlation analyses exploring the relationships between PF, PD, and vaccine attitudes (H1).

Non-parametric correlations tested the relationships between PF and PD, and the 5C subscales (Table 2.7). The hypothesis predicted that participants low in PF and high in PD would score lower on confidence, calculation, and collective responsibility, and higher in complacency and constraints.

As predicted, PF was significantly negatively correlated to PD. PF showed no relationship to confidence, or calculation, contrary to the hypothesis. PF significantly negatively correlated to complacency and constraints, and positively correlated with collective responsibility, supporting H1. PD showed no significant relationship to confidence in vaccines contrary to the hypothesis. PD was significantly positively correlated to complacency and constraints which supports H1. As predicted, PD significantly negatively correlated to calculation and collective responsibility.

Table 2.6. Descriptive data for the outcome measures

Vaccine Status		*Confidence* [a]	*Complacency* [a]	*Constraints* [a]	*Calculation* [a]	*Collective Responsibility* [a]	*Psychological flexibility* [b]	*Psychological distress* [c]
Total	Mean (SD)	16.00 (4.71)	11.43 (4.56)	8.73 (4.70)	16.50 (3.45)	15.30 (4.37)	28.36 (7.07)	11.88 (6.80)
(n = 434)								
0 doses	Mean (SD)	14.47 (6.41)	9.53 (4.70)	6.38 (4.14)	16.69 (4.46)	15.69 (5.30)	32.91 (8.12)	8.95 (7.36)
(n = 45)								
1 dose	Mean (SD)	16.86 (3.32)	11.08 (3.16)	9.86 (4.20)	16.89 (2.79)	15.30 (3.60)	26.76 (4.80)	11.26 (6.11)
(n = 37)								
2 doses	Mean (SD)	15.93 (4.25)	12.60 (4.37)	9.86 (4.60)	16.39 (3.14)	14.58 (4.04)	25.89 (6.12)	13.83 (5.80)
(n = 100)								
3 doses	Mean (SD)	15.91 (4.82)	11.03 (4.59)	8.37 (4.78)	16.54 (3.48)	15.68 (4.35)	29.05 (6.91)	10.67 (5.92)
(n = 158)								
4+ doses	Mean (SD)	16.61 (4.38)	11.89 (4.78)	8.80 (4.69)	16.28 (3.44)	15.27 (4.53)	28.28 (7.35)	13.50 (8.17)
(n = 94)								

[a]5C subscale scores, [b]CompACT-8 total score, [b]CompACT-8 subscale scores, [c]CORE-OM scores

Table 2.7. Spearman's rho(non-parametric) correlations among primary study variables

Study variables	1	2	3	4	5	6	7	8	9	10
1. *Confidence* [a]	-	-.199**	-.339**	.125**	.703**	.031	.050	.016	.007	-.039
2. *Complacency* [a]	-.199**	-	.650**	-.008	-.510**	-.261**	-.172**	-.180**	-.227**	.270**
3. *Constraints* [a]	-.339**	.650**	-	-.260**	-.507**	-.330**	-.232**	-.269**	-.279**	.312**
4. *Calculation* [a]	.125**	-.008	-.260**	-	.192**	.083	.185**	.055	-.021	-.183**
5. *Collective Responsibility* [a]	.703**	-.510**	-.507**	.192**	-	.213**	.099*	.186**	.171**	-.210**
6. *Psychological flexibility* [b]	.031	-.261**	-.330**	.083	.213**	-	.557**	.823**	.781**	-.741**
7. *Valued Action* [c]	.050	-.172**	-.232**	.185**	.099*	.557**	-	.270**	.122*	-.520**
8. *Behavioural Awareness* [b]	.016	-.180**	-.269**	.055	.186**	.823**	.270**	-	.569**	-.611**
9. *Openness to experience* [b]	.007	-.227**	-.279**	-.021	.171**	.781**	.122*	.569**	-	-.510**
10. *Psychological distress* [c]	-.039	.270**	.312**	-.183**	-.210**	-.741**	-.520**	-.611**	-.510**	-

**p<.01, *p<.05, [a]5C subscale scores, [b]CompACT-8 total score, [b]CompACT-8 subscale scores, [c]CORE-OM scores

Regression analyses exploring how much of the variance in vaccine attitudes is explained by PF and PD (H1).

The model predicted 7.5% of the variance in complacency (r^2= .075, F (2, 431) = 17.56, *p* = <.001) (Table 2.8) in the expected directions. PF significantly uniquely explained 0.85% of the variance and PD explained 1.25% of the variance supporting the hypothesis.

The model predicted 12.6% of the variance in constraints (r^2=.126, F (2, 431) = 30.99, *p*<.001). PF uniquely contributed 4.08% of the variance. There was no unique contribution of PD, but the results were in the expected directions.

The model contributed to 2.1% of the variance in calculation, with 1.59% being uniquely explained by PD in the expected direction.

Finally, 3.5% of the variance in collective responsibility was explained by the model (r^2= .035, F (2, 431) = 7.75, *p*<.001), however neither PD nor PF significantly uniquely explained the variance. The direction of the relationship between PF and collective responsibility was as expected, PD was in the opposite direction.

The hypothesis was partially supported with the model predicting the variance in all the anticipated variables, except confidence. The model varied in predictive validity, with varying unique contributions of PF and PD. The relationships between the variables were as expected except for confidence.

Table 2.8. Multiple Linear Regression Coefficients

		Unstandardized Coefficients		*Standardized Coefficients*	*t*	*Sig.*	*Correlations*			*Collinearity Statistics*	
Dependent variable	*Predictor variables*	*B*	*Std. Error*	*Beta*			*Zero-order*	*Partial*	*Part*	*Tolerance*	*VIF*
Confidence [a]	(Constant)	17.040	1.787		9.534	.000					
	Psychological flexibility [b]	-.038	.046	-.057	-.821	.412	-.060	-.040	-.039	.477	2.098
	Psychological distress [c]	.003	.048	.004	.063	.950	.046	.003	.003	.477	2.098
Complacency [a]	(Constant)	12.581	1.669		7.538	.000					
	Psychological flexibility [b]	-.086	.043	-.134	-1.991	.047*	-.251	-.095	-.092	.477	2.098
	Psychological distress [c]	.109	.045	.162	2.413	.016*	.259	.115	.112	.477	2.098
Constraints [a]	(Constant)	13.580	1.672		8.124	.000					
	Psychological flexibility [b]	-.194	.043	-.293	-4.484	.000**	-.350	-.211	-.202	.477	2.098
	Psychological distress [c]	.055	.045	.080	1.223	.222	.291	.059	.055	.477	2.098

Calculation [a]	(Constant)	18.436	1.298		14.207	.000					
	Psychological flexibility [b]	-.030	.034	-.061	-.883	.378	.071	-.042	-.042	.477	2.098
	Psychological distress [c]	-.092	.035	-.182	-2.640	.009*	-.138	-.126	-.126	.477	2.098
Collective Responsibility [a]	(Constant)	14.289	1.634		8.743	.000					
	Psychological flexibility [b]	.063	.042	.101	1.478	.140	.173	.071	.070	.477	2.098
	Psychological distress [c]	-.064	.044	-.099	-1.450	.148	-.173	-.070	-.069	.477	2.098
Psychological flexibility [b]	(Constant)	31.603	.933		33.869	.000					
	Psychological distress [c]	-.695	.032	-.723	-21.780	.000**	-.723	-.723	-.723	1.000	1.000

*p<.05, **p<.001, [a]5C subscale scores, [b]CompACT-8 total score, [c]CORE-OM scores

Regression analyses exploring the relationship between PF and PD (H2)

The multiple linear regression indicated that 52.3% of the variance in PD was significantly predicted by PF (r^2= .523, F (1, 432) = 474.35, *p*<.001), therefore H2 was supported (Table 2.8).

Regression analyses exploring how much of the variance in vaccine take-up is predicted by PF, PD and vaccine attitudes (H3).

A binary logistic regression explored how much of the variance in vaccine take-up was predicted by the 5C scale, PF and PD scores (Table 2.9). The binary dependent variables were unvaccinated (zero doses, n = 45) and vaccinated participants (one or more reported doses, n = 389). The independent variables were the 5C subscales, CompACT-8, and the CORE-OM. The results are not as predicted except in vaccine confidence for some groups. No other subscale on the 5C significantly predicted the variance vaccine take-up. Vaccinated participants were less PF than unvaccinated participants, and PD did not predict the variance in vaccine take-up.

Table 2.9. Binary logistic regression output exploring the variance predicted by the 5C, CompACT-8, & CORE-OM when comparing vaccinated to unvaccinated participants

	B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*
Confidence [a]	.097	.045	4.549	1	.033	1.102
Complacency [a]	.048	.053	.836	1	.361	1.049
Constraints [a]	.072	.053	1.816	1	.178	1.075
Calculation [a]	.015	.048	.095	1	.758	1.015
Collective Responsibility [a]	-.036	.061	.343	1	.558	.965
Psychological flexibility [b]	-.069	.031	4.826	1	.028	.933
Psychological distress [c]	-.010	.036	.076	1	.782	.990
Constant	2.118	1.813	1.365	1	.243	8.312

a. Variable(s) entered on step 1: 5C Confidence [a], 5C Complacency [a], 5C Constraints [a], 5C Calculation [a], 5C Collective Responsibility [a], CompACT-8 Total [b], CORE Total [c].

A multinomial regression was conducted where the dependent variables were the number of vaccines received (zero doses, one dose, two doses, three doses, four plus doses). The reference category was zero vaccines. The predictor variables were the 5C scale, CompACT-8, and the CORE-OM (Table 2.10).

Compared to unvaccinated participants, individuals with one or four plus doses were significantly more confident in vaccines. Individuals with one dose reported more constraints than unvaccinated participants. No other 5C constructs predicted the variance in the number of vaccines received. Individuals with one, two or three doses were significantly less PF than unvaccinated participants.

Table 2.10. Multinomial regression analysis investigating differences between vaccine groups following parallel lines assumption not being met.

							95% Confidence Interval for Exp(B)	
Vaccine Status		*B*	*Std. Error*	*Wald*	*df*	*Sig.*	*Exp(B)*	*Lower Bound*	*Upper Bound*
1 dose	Intercept	1.773	2.724	.424	1	.515			
	Confidence	.217	.081	7.195	1	.007*	1.242	1.060	1.456
	Complacency	-.082	.076	1.178	1	.278	.921	.794	1.069
	Constraints	.185	.074	6.279	1	.012*	1.203	1.041	1.390
	Calculation	.081	.074	1.190	1	.275	1.085	.937	1.255
	Collective Responsibility	-.142	.094	2.263	1	.133	.868	.721	1.044
	Psychological flexibility	-.145	.051	8.091	1	.004**	.865	.783	.956
	Psychological distress	-.094	.054	2.993	1	.084	.910	.818	1.013
2 doses	Intercept	1.774	2.142	.686	1	.407			
	Confidence	.092	.056	2.769	1	.096	1.097	.984	1.223
	Complacency	.080	.062	1.696	1	.193	1.083	.960	1.222
	Constraints	.072	.060	1.401	1	.237	1.074	.954	1.209
	Calculation	.015	.057	.071	1	.789	1.015	.907	1.136
	Collective Responsibility	-.046	.072	.410	1	.522	.955	.829	1.100
	Psychological flexibility	-.114	.040	8.272	1	.004**	.892	.826	.964
	Psychological distress	-.008	.042	.035	1	.851	.992	.914	1.077

3 doses	Intercept	2.006	1.938	1.071	1	.301			
	Confidence	.061	.049	1.575	1	.210	1.063	.966	1.170
	Complacency	.044	.056	.628	1	.428	1.045	.937	1.166
	Constraints	.066	.056	1.379	1	.240	1.068	.957	1.193
	Calculation	.006	.051	.014	1	.907	1.006	.911	1.111
	Collective Responsibility	.000	.065	.000	1	.996	1.000	.880	1.137
	Psychological flexibility	-.075	.034	4.778	1	.029*	.928	.868	.992
	Psychological distress	-.043	.039	1.199	1	.274	.958	.888	1.034
4+ doses	Intercept	-1.932	2.134	.819	1	.365			
	Confidence	.140	.056	6.171	1	.013*	1.150	1.030	1.285
	Complacency	.066	.061	1.186	1	.276	1.068	.948	1.204
	Constraints	.049	.061	.636	1	.425	1.050	.932	1.183
	Calculation	.008	.055	.020	1	.886	1.008	.904	1.124
	Collective Responsibility	-.069	.072	.919	1	.338	.933	.811	1.075
	Psychological flexibility	-.010	.037	.068	1	.795	.990	.921	1.065
	Psychological distress	.058	.041	1.985	1	.159	1.060	.978	1.148

a. The reference category is: 0 vaccines.

*p<.05, **p<.005

DISCUSSION

This study investigated the relationships between PF, PD, vaccine attitudes and vaccine take-up. The study aimed to understand the predictive validity of each variable on vaccine attitudes and take-up.

Vaccine attitudes

The results confirmed an association between PIF and PD (H2), supporting previous literature (Crasta et al., 2020; Daks et al., 2020; Dawson & Golijani-Moghaddam, 2020; Francis et al., 2016; Kroska et al., 2020; Mallett et al., 2021; McCracken et al., 2021; Pakenham et al., 2020; Peltz et al., 2020; Smith et al., 2020; Strosahl et al., 2012). PIF individuals may cope with PD by acting in ways that are incongruent with their emotions, or supressing negative feelings which could amplify or reinforce their distress (Bardeen et al., 2013; Bonanno et al., 2004; Burton & Bonanno, 2016; Chawla & Ostafin, 2007; Cheng, 2001; Hayes et al., 1996; Karekla & Panayiotou, 2011; Kashdan et al., 2006; Kashdan & Rottenberg, 2010b; Nielsen et al., 2016). This is supported by the findings that PIF and high PD is associated with more reporting of constraints, and less reporting of personal and collective need for vaccination (partially supporting H1). Reporting less personal and collective need for vaccines may reflect attempts to avoid distress about the pandemic and/or the barriers preventing individuals from vaccination.

PD was also associated with lower calculation (partially supporting H1), indicating distress is associated with less information searching. PF and PD are distinct concepts. Coping with distress involved employing various strategies, including avoidance (Dawson & Golijani-Moghaddam, 2020). The relationship between PIF and distress only occurs when coping strategies reinforce or perpetuate distress. Distressed individuals avoiding information about COVID-19 vaccines could be protecting themselves from further distress, indicating PF, as individuals are aligning their actions with their thoughts and feelings (Dawson & Golijani-Moghaddam, 2020). Future research should consider if the observed relationships between PF, PD and the 5C constructs is moderated/mediated by coping.

Contrary to the hypothesis and prior literature, PF and PD were not associated with confidence in COVID-19 vaccines. Vaccine hesitancy is complex, and the unique context of the pandemic may have influenced these findings (Dubé et al., 2013; Goldenberg, 2021). The rapid development and extensive discussion surrounding the COVID-19 vaccine may have uniquely affected the public's confidence in the vaccines.

Vaccine take-up

Confidence in vaccines was associated with vaccine take-up in those with one or four plus doses. However, this relationship was not consistently observed across all doses, contrary to previous research (Betsch et al., 2018; Ghazy et al., 2021; Hossain et al., 2021; MacDonald, 2015). Moreover, none of the other 5C subscales were associated with vaccine take-up. The 5C scale's ability to predict variance in vaccine take-up varies across vaccines (Betsch et al., 2018), and previous research identified

only three constructs (confidence, collective responsibility, and calculation) were associated with COVID-19 vaccine take-up (Barello et al., 2023). If the 5C scale is used in future COVID-19 vaccine research, it is important to consider that there can be differences in the 5C variables associated with vaccine take-up. Further research may be necessary to understand this.

Unexpectedly, individuals who received one, two, or three doses of the COVID-19 vaccines were less PF than unvaccinated participants (H3). Additionally, individuals who received additional doses (four plus) did not differ in PF to unvaccinated participants. However, PF only predicted relatively small amounts of variance in vaccine take-up associated with, meaning that future research aiming to understand why individuals accept/refuse COVID-19 vaccines may need to consider variables other than PF.

Conspiracy beliefs is one variable that impacts PF, and vaccine hesitancy/acceptance in several vaccines and populations (Allington et al., 2023; Farhart et al., 2022; Hornsey et al., 2018; Jennings et al., 2021; Karekla & Panayiotou, 2011; Kashdan et al., 2006; Ognyanova et al., 2021; Swami et al., 2014; van Prooijen & Douglas, 2018; Vitriol & Marsh, 2021; Zhang et al., 2021). Conspiratorial beliefs are thought to provide a sense of control or meaning (Newheiser et al., 2011) or an outlet for intense negative emotions (Abalakina-Paap et al., 1999) which can be viewed as coping strategies aimed to control or reduce distress (Karekla & Panayiotou, 2011; Kashdan et al., 2006). PF mediates the relationship between conspiracy beliefs and vaccine hesitancy (Constantinou et al., 2021), suggesting PF is protective. This may explain why unvaccinated participants more PF were, as individuals who believe

COVID-19 vaccines are dangerous are acting in accordance with their values, thoughts, and feelings by refusing vaccines.

During the pandemic, individuals with stronger conspiracy theory beliefs showed lower adherence to government restrictions and public health measures (Constantinou et al., 2020). This may have impacted the PD findings as these individuals experienced less isolation and distress related to restrictions in the short-term. However, in the longer-term, belief in conspiracy theories is associated with anxiety, higher stress, uncertainty, and feeling out of control/powerless (Bruder et al., 2013; Marchlewska et al., 2018; Radnitz & Underwood, 2017; Swami et al., 2016; Zarefsky, 2014). Incorporating a measure of conspiracy beliefs could have improved our understanding of the impact of these beliefs on COVID-19 vaccine hesitancy, PF and PD.

The unexpected association between PF and vaccine take-up could also be due to this study measuring real vaccine take-up, compared to previous studies using hypothetical vaccine decisions, different vaccines, and/or being conducted before COVID-19 vaccines were available (Barello et al., 2023; Ghazy et al., 2021; Hossain et al., 2021; Kwok et al., 2021). Attitudes and behaviour towards hypothetical or novel vaccines are likely to be different to attitudes/behaviour towards an established vaccine. Additionally, the exceptional circumstances and rapid development of the COVID-19 vaccines will have uniquely affected participants attitudes and acceptance (Dror et al., 2020; Fadda et al., 2020).

The findings may also reflect the timing of the research, as data were collected two years into the pandemic and most responses were collected during summer (2022), when restrictions were lower than in the winter (Cabinet Office, 2022). The timing of the research means many participants will have experienced COVID-19 infection or would have known people who had been infected (UK Government, 2023), which may have influenced their motivation to receive the vaccines. Individuals who received at least one dose of the COVID-19 vaccine may have felt it was necessary at the time they received it. However, this perception of necessity may conflict with their current values and risk perceptions. They may experience less PF as socialising and activities resume, as this is incongruent with their earlier cautious approach. To cope with this conflict individuals may adopt coping strategies such as perceiving COVID-19 as less severe and reporting more barriers to vaccination. The avoidant strategies may be effective in reducing distress and explaining why PD was not associated with vaccine take-up in this context.

There is also likely to have been individual differences in vaccine attitudes/acceptance depending on when the vaccine was offered. Clinically vulnerable people and healthcare staff were offered COVID-19 vaccines first (NHS England, 2023), meaning some participants will have had differing experiences/information about the vaccines at the time of their decision.

The unexpected relationship between PF and vaccine take-up could also have been impacted by the CompACT-8 lacking temporal/context cues (Hayes et al., 2012; Sudman et al., 1996). Measures that do not explicitly cue respondents to a situational context assume that the concept being measured is a fixed trait (Gloster et al., 2021),

whereas PF can fluctuate. Whether participants consider themselves across their lifespan, or within certain timeframes is beyond the researchers' control, affecting the validity of the measure (Fernandez-Ballesteros, 2004; Menon, 1994; Ong et al., 2019; Walentynowicz et al., 2018). Participants' responses on the CompACT-8, which assess their ability to engage in meaningful activities, act according to their values, and avoid negative experiences, may have been influenced by their compliance with mandatory self-isolation and compulsory mask wearing rules that were still in place in January 2022, six months before data collection (UK, 2021a, 2021b).

The CORE-OM assessing feelings over the last week may explain why the PD findings were not as predicted. The mean PD score for the sample was relatively low and may be reduced compared to the pandemic's peak or when participants made their initial vaccine decisions. The emotions caused by the pandemic will have also varied significantly over time (Bakshi et al., 2021; Davillas & Jones, 2020; Killgore et al., 2020; McGinty et al., 2020; Nicola et al., 2020; Reger et al., 2020; Rossell et al., 2021; Serafini et al., 2020; Tindle et al., 2022; Zhang et al., 2020). Using additional measures of distress, such as Generalised Anxiety Disorder Scale (GADS-7) (Spitzer et al., 2006) and Beck Depression Inventory-Second Edition (BDI-II) (Beck et al., 1987) would have allowed the researchers to distinguish between distinct types of distress and potentially strengthened the findings.

Limitations & areas for future research

The present findings should be considered alongside the study's limitations. A larger sample size in all vaccine dose groups would have increased the statistical power. Furthermore, since the researchers had no control over where social media adverts were displayed, participants from other countries may have participated. The reliance on self-reported information raises concerns about response reliability. COVID-19 vaccine hesitancy is a complex and emotional charged issue, and participants who delay or refuse vaccines are may have experienced judgement and negative reactions, potentially influencing their responses. The study was cross-sectional, therefore cause and effect cannot be examined and relationships between variables can be bidirectional. Additionally, replacing the ordinal regression with the multinomial regressions due to the violation of the test of parallel lines assumption is a limitation, as changing variables from ordinal to nominal reduces the nuance in the data.

Caution is needed when interpreting the results due to the everchanging pandemic context and fluctuating restrictions. The findings should be considered specific to the given context. Moreover, the predictive validity of the 5C scale has been shown to vary depending on the vaccine being considered (Betsch et al., 2018), indicating the need for further research on its applicability to different vaccines.

Participants chronic health problems and their perception of the risks for others was not assessed, which could have provided valuable insights into their vaccine attitudes/behaviour as risk perceptions influence vaccine take-up (Apanovitch et al.,

2003; Gallagher et al., 2011; Rothman & Salovey, 1997). The number of doses participants were offered was also not measured. The results must be tentatively considered as these factors could impact the validity of the conclusions about participants in different dose categories.

Implications

The finding that confidence was the only variable associated with vaccine take-up means that public health strategists need to consider how they foster confidence in COVID-19 vaccines. The way public health messages are written has been shown to impact decision making for a variety of behaviours, including vaccination (Abhyankar et al., 2008; Detweiler et al., 1999; Kahneman, 2011; Kahneman & Tversky, 1979; Kim et al., 2020; Nan, 2012a, 2012b; Quick & Bates, 2010; Rivers et al., 2005; Toll et al., 2007; Tversky & Kahneman, 1981; Xiao & Borah, 2021). Public health strategists should consider the current study alongside these findings to produce effective vaccination campaigns.

In addition to how messages are framed, there is evidence that the source presenting a health message can moderate the effects on decision making (Chaiken, 1980; Chen et al., 2018; De Meulenaer et al., 2018; Eastin, 2001; Erku et al., 2021; Hancher-Rauch et al., 2019; Huang & Sundar, 2022; Kumkale et al., 2010; Phua et al., 2018). The credibility of the source, and perceptions of trustworthiness has also been found to impact behaviour (Avery, 2010; Dong, 2015; Hovland & Weiss, 1951; Jucks & Thon, 2017; Major & Coleman, 2012). Additionally, public health messages regarding COVID-19 vaccinations should account for distressed individuals engaging

in less deliberation, therefore their messages need to be strategically targeted, so they are easy to access and digest (e.g., via credible sources on social media/television advertising). These findings, alongside the current research could aid policy makers in designing effective messages, that encourage vaccination by boosting confidence in COVID-19 vaccines and using targeted messages from credible sources that reduce the need for deliberative decision making.

This study highlighted that PIF is associated with vaccine take-up in some cases, along with lower perceptions of personal and collective need for vaccination and more constraints. Future research is needed to understand why some individuals are refusing COVID-19 vaccines. Developing messages that emphasise the personal and collective benefits of COVID-19 vaccines may encourage individuals who have accepted some but not all the recommended doses. Additionally, vaccination campaigns should focus on improving accessibility to information and vaccines, particularly for individuals expressing more barriers to vaccination.

REFERENCES

Abalakina-Paap, M., Stephan, W. G., Craig, T., & Gregory, W. L. (1999). Beliefs in conspiracies. *Political psychology*, *20*(3), 637-647. https://doi.org/10.1111/0162-895X.00160

Abhyankar, P., O'connor, D. B., & Lawton, R. (2008). The role of message framing in promoting MMR vaccination: Evidence of a loss-frame advantage. *Psychology, Health and Medicine*, *13*(1), 1-16. https://doi.org/10.1080/13548500701235732

Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological review*, *96*(2), 358. http://dx.doi.org/10.1037/0033-295X.96.2.358

Aide, P., Bassat, Q., & Alonso, P. L. (2007). Towards an effective malaria vaccine. *Archives of disease in childhood*, *92*(6), 476-479. https://doi-org/10.1136%2Fadc.2005.092551

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211. https://doi-org.abc.cardiff.ac.uk/10.1016/0749-5978(91)90020-T

Allington, D., McAndrew, S., Moxham-Hall, V., & Duffy, B. (2023). Coronavirus conspiracy suspicions, general vaccine attitudes, trust and coronavirus information source as predictors of vaccine hesitancy among UK residents during the COVID-19 pandemic. *Psychological medicine*, *53*(1), 236-247. https://doi.org/10.1017/s0033291721001434

Apanovitch, A. M., McCarthy, D., & Salovey, P. (2003). Using message framing to motivate HIV testing among low-income, ethnic minority women. *Health psychology*, *22*(1), 60. https://doi.org/10.1037//0278-6133.22.1.60

Bakshi, A. J., Deshmukh, J., & Kumar, S. (2021). The psychology of pandemics: preparing for the next global outbreak of infectious disease: by Steven Taylor, Newcastle upon Tyne, Cambridge Scholars Publishing, 2019, 178 pp.,£ 58.99 (hardback), ISBN 9781527539594. In: Taylor & Francis.

Bardeen, J. R., Fergus, T. A., & Orcutt, H. K. (2013). Experiential avoidance as a moderator of the relationship between anxiety sensitivity and perceived stress. *Behavior therapy*, *44*(3), 459-469. https://doi.org/10.1016/j.beth.2013.04.001

Barello, S., Palamenghi, L., & Graffigna, G. (2023). Looking inside the 'black box'of vaccine hesitancy: Unlocking the effect of psychological attitudes and beliefs on COVID-19 vaccine acceptance and implications for public health communication. *Psychological medicine*, *53*(3), 1120-1121. https://doi.org/10.1017/s003329172100101x

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: psychometric properties. *Journal of consulting and clinical psychology*, *56*(6), 893. https://doi.org/10.1037//0022-006x.56.6.893

Beck, A. T., Steer, R. A., & Brown, G. K. (1987). *Beck depression inventory*. Harcourt Brace Jovanovich New York:. https://doi-org.abc.cardiff.ac.uk/10.1080%2F00223890802248919

Bertin, P., Nera, K., & Delouvée, S. (2020). Conspiracy beliefs, rejection of vaccination, and support for hydroxychloroquine: A conceptual replication-extension in the COVID-19 pandemic context. *Frontiers in psychology*, 2471. https://doi.org/10.3389/fpsyg.2020.565128

Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PloS one, 13(12)*, e0208601. https://doi.org/10.1371/journal.pone.0208601

Bonanno, G. A., Papa, A., Lalande, K., Westphal, M., & Coifman, K. (2004). The importance of being flexible: The ability to both enhance and suppress emotional expression predicts long-term adjustment. *Psychological Science*, *15*(7), 482-487. https://doi.org/10.1111/j.0956-7976.2004.00705.x

Bond, F. W., Hayes, S. C., Baer, R. A., Carpenter, K. M., Guenole, N., Orcutt, H. K., Waltz, T., & Zettle, R. D. (2011). Preliminary psychometric properties of the Acceptance and Action Questionnaire–II: A revised measure of psychological inflexibility and experiential avoidance. *Behavior therapy*, *42*(4), 676-688. https://doi.org/10.1016/j.beth.2011.03.007

Bruder, M., Haffke, P., Neave, N., Nouripanah, N., & Imhoff, R. (2013). Measuring individual differences in generic beliefs in conspiracy theories across cultures: Conspiracy Mentality Questionnaire. *Frontiers in psychology*, *4*, 225. https://doi.org/10.3389%2Ffpsyg.2013.00225

Burton, C. L., & Bonanno, G. A. (2016). Measuring ability to enhance and suppress emotional expression: The Flexible Regulation of Emotional Expression

(FREE) Scale. *Psychological assessment*, *28*(8), 929. https://doi.org/10.1037/pas0000231

Cabinet Office. (2022). *COVID-19 Response: Living with COVID-19*. Retrieved 11/05/2023 from https://www.gov.uk/government/publications/covid-19-response-living-with-covid-19/covid-19-response-living-with-covid-19#living-with-covid-19

Carpenter, C. J. (2010). A meta-analysis of the effectiveness of health belief model variables in predicting behavior. *Health communication, 25(8)*, 661-669. https://doi.org/10.1080/10410236.2010.521906

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of personality and social psychology*, *39*(5), 752. https://doi.org/10.1037/0022-3514.39.5.752

Chawla, N., & Ostafin, B. (2007). Experiential avoidance as a functional dimensional approach to psychopathology: An empirical review. *Journal of clinical psychology*, *63*(9), 871-890. https://doi.org/10.1002/jclp.20400

Chen, X., Hay, J. L., Waters, E. A., Kiviniemi, M. T., Biddle, C., Schofield, E., Li, Y., Kaphingst, K., & Orom, H. (2018). Health literacy and use and trust in health information. *Journal of Health Communication*, *23*(8), 724-734. https://doi.org/10.1080/10810730.2018.1511658

Cheng, C. (2001). Assessing coping flexibility in real-life and laboratory settings: a multimethod approach. *Journal of personality and social psychology*, *80*(5), 814. https://doi.org/10.1037//0022-3514.80.5.814

Cheung, K. W., & Mak, Y. W. (2016). Association between psychological flexibility and health beliefs in the uptake of influenza vaccination among people with chronic respiratory diseases in Hong Kong. *International journal of environmental research and public health, 13(2)*, 155. https://doi.org/10.3390/ijerph13020155

Chu, A., Gupta, V., & Unni, E. J. (2021). Utilizing the Theory of Planned Behavior to determine the intentions to receive the influenza vaccine during COVID-19: A cross-sectional survey of US adults. *Preventive medicine reports*, 101417. https://doi.org/10.1016/j.pmedr.2021.101417

Constantinou, M., Gloster, A. T., & Karekla, M. (2021). I won't comply because it is a hoax: Conspiracy beliefs, lockdown compliance, and the importance of psychological flexibility. *Journal of contextual behavioral science*, *20*, 46-51. https://doi.org/10.1016/j.jcbs.2021.03.001

Constantinou, M., Kagialis, A., & Karekla, M. (2020). COVID-19 scientific facts vs. conspiracy theories: 0–1: science fails to convince even highly educated individuals. https://doi.org/10.3390%2Fijerph18126343

Crasta, D., Daks, J. S., & Rogge, R. D. (2020). Modeling suicide risk among parents during the COVID-19 pandemic: Psychological inflexibility exacerbates the impact of COVID-19 stressors on interpersonal risk factors for suicide. *Journal of contextual behavioral science*, *18*, 117-127. https://doi.org/10.1016%2Fj.jcbs.2020.09.003

Daks, J. S., Peltz, J. S., & Rogge, R. D. (2020). Psychological flexibility and inflexibility as sources of resiliency and risk during a pandemic: Modeling the

cascade of COVID-19 stress on family systems with a contextual behavioral science lens. *Journal of contextual behavioral science*, *18*, 16-27. https://doi.org/10.1016/j.jcbs.2020.08.003

Davillas, A., & Jones, A. M. (2020). The COVID-19 pandemic and its impact on inequality of opportunity in psychological distress in the UK. *Available at SSRN 3614940*. https://dx.doi.org/10.2139/ssrn.3614940

Dawson, D. L., & Golijani-Moghaddam, N. (2020). COVID-19: Psychological flexibility, coping, mental health, and wellbeing in the UK during the pandemic. *Journal of contextual behavioral science*, *17*, 126-134. https://doi.org/10.1016%2Fj.jcbs.2020.07.010

De Meulenaer, S., De Pelsmacker, P., & Dens, N. (2018). Power distance, uncertainty avoidance, and the effects of source credibility on health risk message compliance. *Health Communication*, *33*(3), 291-298. https://doi.org/10.1080/10410236.2016.1266573

Derogatis, L. R., & Melisaratos, N. (1983). The brief symptom inventory: an introductory report. *Psychological medicine*, *13*(3), 595-605. https://psycnet-apa-org.abc.cardiff.ac.uk/doi/10.1017/S0033291700048017

Detweiler, J. B., Bedell, B. T., Salovey, P., Pronin, E., & Rothman, A. J. (1999). Message framing and sunscreen use: gain-framed messages motivate beach-goers. *Health Psychology*, *18*(2), 189. https://doi-org.abc.cardiff.ac.uk/10.1037/0278-6133.18.2.189

Dror, A. A., Eisenbach, N., Taiber, S., Morozov, N. G., Mizrachi, M., Zigron, A., Srouji, S., & Sela, E. (2020). Vaccine hesitancy: the next challenge in the fight

against COVID-19. *European journal of epidemiology*, *35*, 775-779. https://doi.org/10.1007/s10654-020-00671-y

Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., & Bettinger, J. A. (2013). Vaccine hesitancy: an overview. *Human vaccines & immunotherapeutics*, *9*(8), 1763-1773. https://doi.org/10.4161/hv.24657

Eastin, M. S. (2001). Credibility assessments of online health information: The effects of source expertise and knowledge of content. *Journal of Computer-Mediated Communication*, *6*(4), JCMC643. https://doi.org/10.1111/j.1083-6101.2001.tb00126.x

Erku, D. A., Bauld, L., Dawkins, L., Gartner, C. E., Steadman, K. J., Noar, S. M., Shrestha, S., & Morphett, K. (2021). Does the content and source credibility of health and risk messages related to nicotine vaping products have an impact on harm perception and behavioural intentions? A systematic review. *Addiction*, *116*(12), 3290-3303. https://doi.org/10.1111/add.15473

Evans, C., Connell, J., Barkham, M., Margison, F., McGrath, G., Mellor-Clark, J., & Audin, K. (2002). Towards a standardised brief outcome measure: Psychometric properties and utility of the CORE–OM. *The British Journal of Psychiatry*, *180*(1), 51-60. https://doi.org/10.1192/bjp.180.1.51

Evans, C., Mellor-Clark, J., Margison, F., Barkham, M., Audin, K., Connell, J., & McGrath, G. (2000). CORE: clinical outcomes in routine evaluation. *Journal of mental health*, *9*(3), 247-255. https://doi.org/10.1080/713680250

Fadda, M., Albanese, E., & Suggs, L. S. (2020). When a COVID-19 vaccine is ready, will we all be ready for it? In (Vol. 65, pp. 711-712): Springer. https://doi.org/10.1007/s00038-020-01404-4

Farhart, C. E., Douglas-Durham, E., Trujillo, K. L., & Vitriol, J. A. (2022). Vax attacks: How conspiracy theory belief undermines vaccine support. *Progress in Molecular Biology and Translational Science*, *188*(1), 135-169. https://doi.org/10.1016/bs.pmbts.2021.11.001

Fatima, K., & Syed, N. I. (2018). Dengvaxia controversy: impact on vaccine hesitancy. *Journal of global health*, *8*(2). https://doi.org/10.7189%2Fjogh.08-020312

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175-191. https://doi.org/10.3758/bf03193146

Fernandez-Ballesteros, R. (2004). Self-report questionnaires. In S. N. Haynes & E. M. Heiby (Eds.), *Comprehensive handbook of psychological assessment, Vol. 3. Behavioral assessment* (pp. 194–221). John Wiley & Sons, Inc. https://doi.org/10.1093/med:psych/9780195304633.003.0005

Fisher, K. A., Bloomstone, S. J., Walder, J., Crawford, S., Fouayzi, H., & Mazor, K. M. (2020). Attitudes toward a potential SARS-CoV-2 vaccine: a survey of US adults. *Annals of internal medicine*, *173*(12), 964-973. https://doi.org/10.7326/m20-3569

Francis, A. W., Dawson, D. L., & Golijani-Moghaddam, N. (2016). The development and validation of the Comprehensive assessment of Acceptance and Commitment Therapy processes (CompACT). *Journal of contextual behavioral science*, *5*(3), 134-145. https://doi.org/10.1016/j.jcbs.2016.05.003

Freeman, D., Loe, B. S., Chadwick, A., Vaccari, C., Waite, F., Rosebrock, L., ..., & Lambe, S. (2020). COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. *Psychological medicine*, 1-15. https://doi.org/10.1017/s0033291720005188

Freeman, D., Loe, B. S., Chadwick, A., Vaccari, C., Waite, F., Rosebrock, L., Jenner, L., Petit, A., Lewandowsky, S., & Vanderslott, S. (2022). COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. *Psychological medicine*, *52*(14), 3127-3141. https://doi.org/10.1017/s0033291720005188

Gallagher, K. M., Updegraff, J. A., Rothman, A. J., & Sims, L. (2011). Perceived susceptibility to breast cancer moderates the effect of gain-and loss-framed messages on use of screening mammography. *Health psychology*, *30*(2), 145. https://doi.org/10.1037%2Fa0022264

Ghazy, R. M., Abd ElHafeez, S., Shaaban, R., Elbarazi, I., Abdou, M. S., Ramadan, A., & Kheirallah, K. A. (2021). Determining the cutoff points of the 5C scale for assessment of COVID-19 vaccines psychological antecedents among the Arab population: a multinational study. *Journal of Primary Care & Community Health*, *12*, 21501327211018568. https://doi.org/10.1177/21501327211018568

Gilkey, M. B., Magnus, B. E., Reiter, P. L., McRee, A.-L., Dempsey, A. F., & Brewer, N. T. (2014). The Vaccination Confidence Scale: a brief measure of parents' vaccination beliefs. *Vaccine*, *32*(47), 6259-6265. https://doi.org/10.1016/j.vaccine.2014.09.007

Gilkey, M. B., Reiter, P. L., Magnus, B. E., McRee, A.-L., Dempsey, A. F., & Brewer, N. T. (2016). Validation of the vaccination confidence scale: a brief measure to identify parents at risk for refusing adolescent vaccines. *Academic pediatrics*, *16*(1), 42-49. https://doi.org/10.1016%2Fj.acap.2015.06.007

Gloster, A. T., Block, V. J., Klotsche, J., Villanueva, J., Rinner, M. T., Benoy, C., Walter, M., Karekla, M., & Bader, K. (2021). Psy-Flex: A contextually sensitive measure of psychological flexibility. *Journal of contextual behavioral science*, *22*, 13-23. https://doi.org/10.1016/j.jcbs.2021.09.001

Goldberg, D. P., & Hillier, V. F. (1979). A scaled version of the General Health Questionnaire. *Psychological medicine*, *9*(1), 139-145. https://doi.org/10.1017/s0033291700021644

Goldenberg, M. J. (2021). *Vaccine hesitancy: public trust, expertise, and the war on science*. University of Pittsburgh Press. ISBN : 9780822966906

Hancher-Rauch, H. L., Britt-Spells, A., Wojtyna, A., & Standish, M. (2019). Health Information Seeking Behavior and Perceived Source Trustworthiness in Public Health Students: A Pilot Study for Improving the Curriculum. *Journal of Health Education Teaching*, *10*(1), 34-43. https://doi.org/10.2105/ajph.2009.180521

Harrison, J. A., Mullen, P. D., & Green, L. W. (1992). A meta-analysis of studies of the health belief model with adults. *Health Education Research, 7(1)*, 107-116. https://doi.org/10.1093/her/7.1.107

Hayes, S. C., Barnes-Holmes, D., & Wilson, K. G. (2012). Contextual behavioral science: Creating a science more adequate to the challenge of the human condition. *Journal of contextual behavioral science*, *1*(1-2), 1-16. https://doi.org/10.1016/j.jcbs.2012.09.004

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2011). *Acceptance and commitment therapy: The process and practice of mindful change*. Guilford press. ISBN 9781462528943

Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of consulting and clinical psychology*, *64*(6), 1152. https://doi.org/10.1037//0022-006x.64.6.1152

Hornsey, M. J., Harris, E. A., & Fielding, K. S. (2018). The psychological roots of anti-vaccination attitudes: A 24-nation investigation. *Health psychology*, *37*(4), 307. https://doi.org/10.1037/hea0000586

Hossain, M. B., Alam, M. Z., Islam, M. S., Sultan, S., Faysal, M. M., Rima, S., Hossain, M. A., & Al Mamun, A. (2021). Health belief, planned behavior, or psychological antecedents: What predicts COVID-19 Vaccine Hesitancy better among the Bangladeshi Adults? *MedRxiv*, 2021.2004. 2019.21255578. https://doi.org/10.3389/fpubh.2021.711066

Huang, Y., & Sundar, S. S. (2022). Do we trust the crowd? Effects of crowdsourcing on perceived credibility of online health information. *Health Communication*, *37*(1), 93-102. https://doi.org/10.1080/10410236.2020.1824662

Jamieson, K. H., & Albarracin, D. (2020). The Relation between Media Consumption and Misinformation at the Outset of the SARS-CoV-2 Pandemic in the US. *The Harvard Kennedy School Misinformation Review*. https://doi.org/10.1177%2F00027642231164047

Jennings, W., Stoker, G., Bunting, H., Valgarðsson, V. O., Gaskell, J., Devine, D., McKay, L., & Mills, M. C. (2021). Lack of trust, conspiracy beliefs, and social media use predict COVID-19 vaccine hesitancy. *Vaccines*, *9*(6), 593. https://doi.org/10.3390/vaccines9060593

Jolley, D., & Douglas, K. M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *PloS one*, *9*(2), e89177. https://doi.org/10.1371/journal.pone.0089177

Kabat-Zinn, J. (2013). *Full catastrophe living, revised edition: how to cope with stress, pain and illness using mindfulness meditation*. Hachette UK. ISBN-13: 9780749958411

Kahneman, D. (2011). *Thinking, fast and slow.* Farrar, Straus and Giroux. ISBN-10 : 0141033576

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 363-391. https://doi.org/0012-9682(197903)47:2%3C263:PTAAOD%3E2.0.CO;2-3

Kang, H. (2013). The prevention and handling of the missing data. *Korean journal of anesthesiology*, *64*(5), 402-406. https://doi.org/10.4097%2Fkjae.2013.64.5.402

Karekla, M., & Panayiotou, G. (2011). Coping and experiential avoidance: Unique or overlapping constructs? *Journal of behavior therapy and experimental psychiatry*, *42*(2), 163-170. https://doi.org/10.1016/j.jbtep.2010.10.002

Karlsson, L. C., Soveri, A., Lewandowsky, S., Karlsson, L., Karlsson, H., Nolvi, S., Karukivi, M., Lindfelt, M., & Antfolk, J. (2021). Fearing the disease or the vaccine: The case of COVID-19. *Personality and individual differences*, *172*, 110590. https://doi.org/10.1016/j.paid.2020.110590

Kashdan, T. B., Barrios, V., Forsyth, J. P., & Steger, M. F. (2006). Experiential avoidance as a generalized psychological vulnerability: Comparisons with coping and emotion regulation strategies. *Behaviour research and therapy*, *44*(9), 1301-1320. https://doi.org/10.1016/j.brat.2005.10.003

Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical psychology review, 30(7)*, 865-878. https://doi.org/10.1016%2Fj.cpr.2010.03.001

Kashdan, T. B., & Steger, M. F. (2006). Expanding the topography of social anxiety: An experience-sampling assessment of positive emotions, positive events, and emotion suppression. *Psychological Science*, *17*(2), 120-128. https://doi.org/10.1111/j.1467-9280.2006.01674.x

Killgore, W. D., Cloonan, S. A., Taylor, E. C., & Dailey, N. S. (2020). Loneliness: A signature mental health concern in the era of COVID-19. *Psychiatry research*, *290*, 113117. https://doi.org/10.1016%2Fj.psychres.2020.113117

Kim, H. K., Lee, T. K., & Kong, W. Y. (2020). The interplay between framing and regulatory focus in processing narratives about HPV vaccination in Singapore. *Health Communication*, *35*(2), 222-232. https://doi.org/10.1080/10410236.2018.1553022

Koslap-Petraco, M. (2019). Vaccine hesitancy: not a new phenomenon, but a new threat. *Journal of the American Association of Nurse Practitioners, 31(11)*, 624-626. https://doi.org/10.1097/jxx.0000000000000342

Krishnamoorthy, Y., Nagarajan, R., Saya, G. K., & Menon, V. (2020). Prevalence of psychological morbidities among general population, healthcare workers and COVID-19 patients amidst the COVID-19 pandemic: A systematic review and meta-analysis. *Psychiatry research*, *293*, 113382. https://doi.org/10.1016%2Fj.psychres.2020.113382

Kroska, E. B., Roche, A. I., Adamowicz, J. L., & Stegall, M. S. (2020). Psychological flexibility in the context of COVID-19 adversity: Associations with distress. *Journal of contextual behavioral science*, *18*, 28-33. https://doi.org/10.1016/j.jcbs.2020.07.011

Kumkale, G. T., Albarracín, D., & Seignourel, P. J. (2010). The effects of source credibility in the presence or absence of prior attitudes: Implications for the design of persuasive communication campaigns. *Journal of applied social*

psychology, *40*(6), 1325-1356. https://doi.org/10.1111/j.1559-1816.2010.00620.x

Kwok, K. O., Li, K.-K., Wei, W. I., Tang, A., Wong, S. Y. S., & Lee, S. S. (2021). Influenza vaccine uptake, COVID-19 vaccination intention and vaccine hesitancy among nurses: A survey. *International journal of nursing studies*, *114*, 103854. https://doi.org/10.1016%2Fj.ijnurstu.2020.103854

Larson, H. J., De Figueiredo, A., Xiahong, Z., Schulz, W. S., Verger, P., Johnston, I. G., Cook, A. R., & Jones, N. S. (2016). The state of vaccine confidence 2016: global insights through a 67-country survey. *EBioMedicine*, *12*, 295-301. https://doi.org/10.1016/j.ebiom.2016.08.042

Larson, H. J., Jarrett, C., Schulz, W. S., Chaudhuri, M., Zhou, Y., Dube, E., Schuster, M., MacDonald, N. E., & Wilson, R. (2015). Measuring vaccine hesitancy: the development of a survey tool. *Vaccine*, *33*(34), 4165-4175. https://doi.org/10.1016/j.vaccine.2015.04.037

MacDonald, N. E. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, *33*(34), 4161-4164. https://doi.org/10.1016/j.vaccine.2015.04.036

MacFarlane, D., Hurlstone, M. J., & Ecker, U. K. (2020). Protecting consumers from fraudulent health claims: A taxonomy of psychological drivers, interventions, barriers, and treatments. *Social Science & Medicine*, *259*, 112790. https://doi.org/10.1016/j.socscimed.2020.112790

Machingaidze, S., & Wiysonge, C. S. (2021). Understanding COVID-19 vaccine hesitancy. *Medicine, 27(8)*, 1338-1339. https://doi.org/10.1038/s41591-021-01459-7

Madison, A. A., Shrout, M. R., Renna, M. E., & Kiecolt-Glaser, J. K. (2021). Psychological and behavioral predictors of vaccine efficacy: considerations for COVID-19. *Perspectives on Psychological Science*, *16*(2), 191-203. https://doi.org/10.1177/1745691621989243

Malik, A. A., McFadden, S. M., Elharake, J., & Omer, S. B. (2020). Determinants of COVID-19 vaccine acceptance in the US. *EClinicalMedicine*, *26*, 100495. https://doi.org/10.1016/j.eclinm.2020.100495

Marchlewska, M., Cichocka, A., & Kossowska, M. (2018). Addicted to answers: Need for cognitive closure and the endorsement of conspiracy beliefs. *European journal of social psychology*, *48*(2), 109-117. https://doi-org.abc.cardiff.ac.uk/10.1002/ejsp.2308

Mazereel, V., Van Assche, K., Detraux, J., & De Hert, M. (2021). COVID-19 vaccination for people with severe mental illness: why, what, and how? *The Lancet Psychiatry*, *8*(5), 444-450. https://doi.org/10.1016/s2215-0366(20)30564-2

McCracken, L. M., Badinlou, F., Buhrman, M., & Brocki, K. C. (2021). The role of psychological flexibility in the context of COVID-19: Associations with depression, anxiety, and insomnia. *Journal of contextual behavioral science*, *19*, 28-35. https://doi.org/10.1016/j.jcbs.2020.11.003

McGinty, E. E., Presskreischer, R., Han, H., & Barry, C. L. (2020). Psychological distress and loneliness reported by US adults in 2018 and April 2020. *jama*, *324*(1), 93-94. https://doi.org/10.1001/jama.2020.9740

McLaughlin, K. A., Mennin, D. S., & Farach, F. J. (2007). The contributory role of worry in emotion generation and dysregulation in generalized anxiety disorder. *Behaviour research and therapy*, *45*(8), 1735-1752. https://doi.org/10.1016/j.brat.2006.12.004

Menon, G. (1994). Judgments of behavioral frequencies: Memory search and retrieval strategies. *Autobiographical memory and the validity of retrospective reports*, 161-172. doi: 9210916

Mesch, G. S., & Schwirian, K. P. (2019). Vaccination hesitancy: fear, trust, and exposure expectancy of an Ebola outbreak. *Heliyon*, *5*(7), e02016. https://doi.org/10.1016%2Fj.heliyon.2019.e02016

Morgan, A., & Poland, G. A. (2011). The Jenner Society and the Edward Jenner Museum: tributes to a physician-scientist. *Vaccine*, *29*, D152-D154. https://doi.org/10.1016/j.vaccine.2011.08.128

Morgul, E., Bener, A., Atak, M., Akyel, S., Aktaş, S., Bhugra, D., Ventriglio, A., & Jordan, T. R. (2021). COVID-19 pandemic and psychological fatigue in Turkey. *International Journal of Social Psychiatry*, *67*(2), 128-135. https://doi.org/10.1177/0020764020941889

Morris, J. (2019). *Development and validation of a short form of the Comprehensive assessment of Acceptance and Commitment Therapy processes (CompACT-SF)* University of Nottingham]. http://dx.doi.org/10.1016/j.jcbs.2016.05.003

Murphy, J., Vallières, F., Bentall, R. P., Shevlin, M., McBride, O., Hartman, T. K., ..., & Hyland, P. (2021). Psychological characteristics associated with COVID-19

vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nature comunications*, 1-15. DOI:10.1038/s41467-020-20226-9

Nan, X. (2012a). Communicating to young adults about HPV vaccination: Consideration of message framing, motivation, and gender. *Health Communication*, *27*(1), 10-18. https://doi.org/10.1080/10410236.2011.567447

Nan, X. (2012b). Relative persuasiveness of gain-versus loss-framed human papillomavirus vaccination messages for the present-and future-minded. *Human Communication Research*, *38*(1), 72-94. https://doi.org/10.1111/j.1468-2958.2011.01419.x

Newheiser, A.-K., Farias, M., & Tausch, N. (2011). The functional nature of conspiracy beliefs: Examining the underpinnings of belief in the Da Vinci Code conspiracy. *Personality and individual differences*, *51*(8), 1007-1011. https://doi.org/10.1016/j.paid.2011.08.011

NHS England. (2023). *Getting an additional primary dose of the COVID-19 vaccine*. Retrieved 08/05/2023 from https://www.nhs.uk/conditions/covid-19/covid-19-vaccination/getting-an-additional-primary-dose-of-the-covid-19-vaccine/

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International journal of surgery*, *78*, 185-193. https://doi.org/10.1016%2Fj.ijsu.2020.04.018

Nielsen, E., Sayal, K., & Townsend, E. (2016). Exploring the relationship between experiential avoidance, coping functions and the recency and frequency of

self-harm. *PloS one*, *11*(7), e0159854. https://doi.org/10.1371/journal.pone.0159854

Nolen-Hoeksema, S., Blair, E., & Sonja, L. (2008). Rethinking Rumination. Perspectives of Psychological Science, 3, 400-424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

NORC, A. (2020). Expectations for a COVID-19 Vaccine. In: Associated Press-University of Chicago National Opinion Research Center. https://www.hhs.gov/sites/default/files/nvac_june2020_panel2.pdf

Ognyanova, K., Lazer, D., Baum, M., Druckman, J., Green, J., Perlis, R., Santillana, M., Simonson, M. D., Lin, J., & Uslu, A. (2021). The COVID States Project# 60: COVID-19 vaccine misinformation: from uncertainty to resistance. https://doi.org/10.31219/osf.io/xtjad

Ong, C. W., Lee, E. B., Levin, M. E., & Twohig, M. P. (2019). A review of AAQ variants and other context-specific measures of psychological flexibility. *Journal of contextual behavioral science*, *12*, 329-346. https://doi.org/10.1016/j.jcbs.2019.02.007

Pakenham, K. I., Landi, G., Boccolini, G., Furlani, A., Grandi, S., & Tossani, E. (2020). The moderating roles of psychological flexibility and inflexibility on the mental health impacts of COVID-19 pandemic and lockdown in Italy. *Journal of contextual behavioral science*, *17*, 109-118. https://doi.org/10.1016%2Fj.jcbs.2020.07.003

Paul, H. (2002). Acceptance and commitment therapy: An experimental approach to behavior change. In: HAWORTH PRESS INC 10 ALICE ST, BINGHAMTON, NY 13904-1580 USA. ISBN: 1572309555, 9781572309555

Pek, J., Wong, O., & Wong, A. C. (2018). How to address non-normality: A taxonomy of approaches, reviewed, and illustrated. *Frontiers in psychology*, *9*, 2104. https://doi.org/10.3389%2Ffpsyg.2018.02104

Peltz, J. S., Daks, J. S., & Rogge, R. D. (2020). Mediators of the association between COVID-19-related stressors and parents' psychological flexibility and inflexibility: The roles of perceived sleep quality and energy. *Journal of contextual behavioral science*, *17*, 168-176. https://doi.org/10.1016%2Fj.jcbs.2020.07.001

Phua, J., Jin, S. V., & Hahm, J. M. (2018). Celebrity-endorsed e-cigarette brand Instagram advertisements: Effects on young adults' attitudes towards e-cigarettes and smoking intentions. *Journal of health psychology*, *23*(4), 550-560. https://doi.org/10.1177/1359105317693912

Qiu, J., Shen, B., Zhao, M., Wang, Z., Xie, B., & Xu, Y. (2020). A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations. *General psychiatry*, *33*(2). http://dx.doi.org/10.1136/gpsych-2020-100213

Quick, B. L., & Bates, B. R. (2010). The use of gain-or loss-frame messages and efficacy appeals to dissuade excessive alcohol consumption among college students: A test of psychological reactance theory. *Journal of Health*

Communication, *15*(6), 603-628. https://doi.org/10.1080/10810730.2010.499593

Radnitz, S., & Underwood, P. (2017). Is belief in conspiracy theories pathological? A survey experiment on the cognitive roots of extreme suspicion. *British Journal of Political Science*, *47*(1), 113-129. https://ideas.repec.org/a/cup/bjposi/v47y2017i01p113-129_00.html

Reger, M. A., Stanley, I. H., & Joiner, T. E. (2020). Suicide mortality and coronavirus disease 2019—a perfect storm? *JAMA psychiatry*, *77*(11), 1093-1094. https://doi.org/10.1001/jamapsychiatry.2020.1060

Rivers, S. E., Salovey, P., Pizarro, D. A., Pizarro, J., & Schneider, T. R. (2005). Message framing and pap test utilization among women attending a community health clinic. *Journal of health psychology*, *10*(1), 65-77. https://doi.org/10.1177/1359105305048556

Rosenstock, I. M. (1966). Why people use health services. *The Milbank Memorial Fund Quarterly*, *44*(3), 94-127. https://doi.org/10.1111%2Fj.1468-0009.2005.00425.x

Rossell, S. L., Neill, E., Phillipou, A., Tan, E. J., Toh, W. L., Van Rheenen, T. E., & Meyer, D. (2021). An overview of current mental health in the general population of Australia during the COVID-19 pandemic: Results from the COLLATE project. *Psychiatry research*, *296*, 113660. https://doi.org/10.1016%2Fj.psychres.2020.113660

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: the role of message framing. *Psychological bulletin*, *121*(1), 3. https://doi.org/10.1037/0033-2909.121.1.3

Salali, G. D., & Uysal, M. S. (2022). COVID-19 vaccine hesitancy is associated with beliefs on the origin of the novel coronavirus in the UK and Turkey. *Psychological medicine*, *52*(15), 3750-3752. https://doi.org/10.1017/s0033291720004067

Sallam, M. (2021). COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines, 9(2)*, 160. https://doi.org/10.3390%2Fvaccines9020160

Sallam, M., Al-Sanafi, M., & Sallam, M. (2022). A global map of COVID-19 vaccine acceptance rates per country: an updated concise narrative review. *Journal of Multidisciplinary Healthcare*, 21-45. https://doi.org/10.2147/jmdh.s347669

Sallam, M., Dababseh, D., Eid, H., Al-Mahzoum, K., Al-Haidar, A., Taim, D., Yaseen, A., Ababneh, N. A., Bakri, F. G., & Mahafzah, A. (2021). High rates of COVID-19 vaccine hesitancy and its association with conspiracy beliefs: a study in Jordan and Kuwait among other Arab countries. *Vaccines*, *9*(1), 42. https://doi.org/10.3390/vaccines9010042

Sarathchandra, D., Navin, M. C., Largent, M. A., & McCright, A. M. (2018). A survey instrument for measuring vaccine acceptance. *Preventive medicine*, *109*, 1-7. https://doi.org/10.1016/j.ypmed.2018.01.006

Sear, R. F., Velásquez, N., Leahy, R., Restrepo, N. J., El Oud, S., Gabriel, N., Lupu, Y., & Johnson, N. F. (2020). Quantifying COVID-19 content in the online

health opinion war using machine learning. *Ieee Access*, *8*, 91886-91893. https://doi.org/10.1109/access.2020.2993967

Serafini, G., Parmigiani, B., Amerio, A., Aguglia, A., Sher, L., & Amore, M. (2020). The psychological impact of COVID-19 on the mental health in the general population. In: Oxford University Press. https://doi.org/10.1093/qjmed/hcaa201

Shapiro, G. K., Tatar, O., Dube, E., Amsel, R., Knauper, B., Naz, A., Perez, S., & Rosberger, Z. (2018). The vaccine hesitancy scale: Psychometric properties and validation. *Vaccine*, *36*(5), 660-667. https://doi.org/10.1016/j.vaccine.2017.12.043

Smith, B. M., Twohy, A. J., & Smith, G. S. (2020). Psychological inflexibility and intolerance of uncertainty moderate the relationship between social isolation and mental health outcomes during COVID-19. *Journal of contextual behavioral science*, *18*, 162-174. https://doi.org/10.1016%2Fj.jcbs.2020.09.005

Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*, *166*(10), 1092-1097. https://doi.org/10.1001/archinte.166.10.1092

Strategic Advisory Group of Experts in Immunization (SAGE). (2014). *Report of the SAGE working group on vaccine hesitancy*. https://www.asset-scienceinsociety.eu/sites/default/files/sage_working_group_revised_report_vaccine_hesitancy.pdf

Strosahl, K. D., Robinson, P. J., & Gustavsson, T. (2012). *Brief interventions for radical change: Principles and practice of focused acceptance and commitment therapy*. New Harbinger Publications. ISBN-10: 1608823458

Sudman, S., Bradburn, N. M., & Schwarz, N. (1996). *Thinking about answers: The application of cognitive processes to survey methodology*. Jossey-Bass.

Swami, V., Furnham, A., Smyth, N., Weis, L., Lay, A., & Clow, A. (2016). Putting the stress on conspiracy theories: Examining associations between psychological stress, anxiety, and belief in conspiracy theories. *Personality and individual differences*, *99*, 72-76. https://doi.org/10.1016/j.paid.2016.04.084

Swami, V., Voracek, M., Stieger, S., Tran, U. S., & Furnham, A. (2014). Analytic thinking reduces belief in conspiracy theories. *Cognition*, *133*(3), 572-585. https://doi.org/10.1016/j.cognition.2014.08.006

Tindle, R., Hemi, A., & Moustafa, A. A. (2022). Social support, psychological flexibility and coping mediate the association between COVID-19 related stress exposure and psychological distress. *Scientific Reports*, *12*(1), 8688. https://doi.org/10.1038/s41598-022-12262-w

Toll, B. A., O'Malley, S. S., Katulak, N. A., Wu, R., Dubin, J. A., Latimer, A., Meandzija, B., George, T. P., Jatlow, P., & Cooney, J. L. (2007). Comparing gain-and loss-framed messages for smoking cessation with sustained-release bupropion: a randomized controlled trial. *Psychology of Addictive Behaviors*, *21*(4), 534. https://doi.org/10.1037/0893-164x.21.4.534

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *science*, *211*(4481), 453-458. https://doi.org/10.1126/science.7455683

Tyson, A. (2020). Republicans remain far less likely than Democrats to view COVID-19 as a major threat to public health. Retrieved on 16/05/23 from https://www.pewresearch.org/short-reads/2020/07/22/republicans-remain-far-less-likely-than-democrats-to-view-covid-19-as-a-major-threat-to-public-health/

UK, G. (2021a). Face coverings: When to wear one, exemptions, and how to make your own. Retrieved on 8/05/23 form https://www.gov.uk/government/publications/face-coverings-when-to-wear-one-and-how-to-make-your-own/face-coverings-when-to-wear-one-and-how-to-make-your-own

UK Government. (2021b). Stay at home: guidance for households with possible or confirmed coronavirus (COVID-19) infection. Retrieved on 8/05/23 from*:* https://www.gov.uk/government/publications/covid-19-stay-at-home-guidance/stay-at-home-guidance-for-households-with-possible-coronavirus-covid-19-infection

UK Government. (2023) *COVID-19 Infection rates in England*. Retrieved 11/05/2023 from https://coronavirus.data.gov.uk/details/vaccinations

van Prooijen, J. W., & Douglas, K. M. (2018). Belief in conspiracy theories: Basic principles of an emerging research domain. *European journal of social psychology*, *48*(7), 897-908. https://doi.org/10.1002/ejsp.2530

Vitriol, J. A., & Marsh, J. K. (2021). A pandemic of misbelief: How beliefs promote or undermine COVID-19 mitigation. *Frontiers in Political Science*, *3*, 648082. http://dx.doi.org/10.3389/fpos.2021.648082

Walentynowicz, M., Schneider, S., & Stone, A. A. (2018). The effects of time frames on self-report. *PLoS ONE*, *13*(8), e0201655. https://doi.org/10.1371/journal.pone.0201655

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *International journal of environmental research and public health*, *17*(5), 1729. https://doi.org/10.3390/ijerph17051729

Wang, Y., & Zhang, X. (2021). Influence of parental psychological flexibility on pediatric COVID-19 vaccine hesitancy: mediating role of self-efficacy and coping style. *Frontiers in psychology*, 5619. https://doi.org/10.3389/fpsyg.2021.783401

Ward, J. K., Alleaume, C., Peretti-Watel, P., Seror, V., Cortaredona, S., Launay, O., Raude, J., Verger, P., Beck, F., & Legleye, S. (2020). The French public's attitudes to a future COVID-19 vaccine: The politicization of a public health issue. *Social Science & Medicine*, *265*, 113414. https://doi.org/10.1016/j.socscimed.2020.113414

World Health Organisation (WHO). (2020). *Coronavirus disease (COVID-19)*. https://www-who-int.abc.cardiff.ac.uk/health-topics/coronavirus#tab=tab_1

World Health Organization. (2018). *2018 assessment report of the Global Vaccine Action Plan: strategic advisory group of experts on immunization*. https://www-who-int.abc.cardiff.ac.uk/publications/i/item/2018-assessment-report-of-the-global-vaccine-action-plan

Xiao, X., & Borah, P. (2021). Do norms matter? Examining norm-based messages in HPV vaccination promotion. *Health Communication*, *36*(12), 1476-1484. https://doi.org/10.1080/10410236.2020.1770506

Xiao, X., & Wong, R. M. (2020). Vaccine hesitancy and perceived behavioral control: a meta-analysis. *Vaccine, 38(33)*, 5131-5138. https://doi.org/10.1016/j.vaccine.2020.04.076

Zarefsky, D. (2014). *Rhetorical perspectives on argumentation: Selected essays by David Zarefsky* (Vol. 24). Springer. ISBN-10: 3319379380

Zhang, J., Lu, H., Zeng, H., Zhang, S., Du, Q., Jiang, T., & Du, B. (2020). The differential psychological distress of populations affected by the COVID-19 pandemic. *Brain, behavior, and immunity*, *87*, 49. https://doi.org/10.1016/j.bbi.2020.04.031

Zhang, X., Guo, Y., Zhou, Q., Tan, Z., & Cao, J. (2021). The mediating roles of medical mistrust, knowledge, confidence and complacency of vaccines in the pathways from conspiracy beliefs to vaccine hesitancy. *Vaccines*, *9*(11), 1342. https://doi.org/10.3390/vaccines9111342

Zvolensky, M. J., & Eifert, G. H. (2001). A review of psychological factors/processes affecting anxious responding during voluntary hyperventilation and inhalations of carbon dioxide-enriched air. *Clinical Psychology Review*, *21*(3), 375-400. https://doi.org/10.1016/s0272-7358(99)00053-7

APPENDIX A – SEARCH TERMS

Search terms by database

OVID

(Immunization OR Immunisation OR Vaccin* OR shot OR shots OR Jab OR jabs OR Injections OR Inject* OR Immun* OR Inoculat*) adj3 ("vaccine hesitancy" OR Hesitan* OR Reluctan* OR Ambival* OR Uncertain* OR Resist* or Unwill* OR Refus* OR Undecid* OR Concern OR Rate* OR uptake OR take up OR accept* OR willing*) AND Coronavirus OR COVID* AND Framing effects OR messag* fram* OR (gain* adj3 loss*) OR individual* adj3 collect*) OR framing OR frame OR frames

CINAHL

(Immunization OR Immunisation OR Vaccin* OR shot OR shots OR Jab OR jabs OR Injections OR Inject* OR Immun* OR Inoculat*) N3 ("vaccine hesitancy" OR Hesitan* OR Reluctan* OR Ambival* OR Uncertain* OR Resist* or Unwill* OR Refus* OR Undecid* OR Concern OR Rate* OR uptake OR “take up” OR accept* OR willing*) AND (Coronavirus OR COVID*) AND (Framing effect* OR messag* fram* OR gain* N3 loss* OR individual* N3 collect* OR framing OR frame OR frames)

Scopus

(Immunization OR Immunisation OR Vaccin* OR shot OR shots OR Jab OR jabs OR Injections OR Inject* OR Immun* OR Inoculat*) W/3 ("vaccine hesitancy" OR Hesitan* OR Reluctan* OR Ambival* OR Uncertain* OR Resist* or Unwill* OR Refus* OR Undecid* OR Concern OR Rate* OR uptake OR “take up” OR accept* OR willing*) AND (Coronavirus OR COVID*) AND (“Framing effect*” OR “messag* fram*” OR gain* W/3 loss* OR individual* N3 collect* OR framing OR frame OR frames)

Web of Science

Immunization OR Immunisation OR Vaccin* OR shot OR shots OR Jab OR jabs OR Injections OR Inject* OR Immun* OR Inoculat*) Near/3 ("vaccine hesitancy" OR Hesitan* OR Reluctan* OR Ambival* OR Uncertain* OR Resist* or Unwill* OR Refus* OR Undecid* OR Concern OR Rate* OR uptake OR “take up” OR accept* OR willing*) AND (Coronavirus OR COVID*) AND (“Framing effect*” OR “messag* fram*” OR gain* Near/3 loss* OR individual* Near/3 collect* OR framing OR frame OR frames)

ProQuest

noft((immunization OR immunisation OR vaccin* OR shot OR shots OR jab OR jabs OR injections OR inject* OR immun* OR inoculat*) NEAR/3 ("vaccine hesitancy" OR hesitan* OR reluctan* OR ambival* OR uncertain* OR resist* OR unwill* OR refus* OR undecid* OR concern OR rate* OR uptake OR "take up" OR accept* OR willing*)) AND noft((coronavirus OR covid*)) AND noft(("Framing effect*" OR "messag* fram*" OR gain* NEAR/3 loss* OR individual* NEAR/3 collect* OR framing OR frame OR frames))

APPENDIX B – QuADS SCORING CRITERIA

QuADS Criteria	0	1	2	3
1. Theoretical or conceptual underpinning to the research	No mention at all.	General reference to broad theories or concepts that frame the study. e.g. key concepts were identified in the introduction section.	Identification of specific theories or concepts that frame the study and how these informed the work undertaken. e.g. key concepts were identified in the introduction section and applied to the study.	Explicit discussion of the theories or concepts that inform the study, with application of the theory or concept evident through the design, materials and outcomes explored. e.g. key concepts were identified in the introduction section and the application apparent in each element of the study design.
2. Statement of research aim/s	No mention at all.	Reference to what the sought to achieve embedded within the report but no explicit aims statement.	Aims statement made but may only appear in the abstract or be lacking detail.	Explicit and detailed statement of aim/s in the main body of report.
3. Clear description of research setting and target population	No mention at all.	General description of research area but not of the specific research environment e.g. 'in primary care.'	Description of research setting is made but is lacking detail e.g. 'in primary care practices in region [x]'.	Specific description of the research setting and target population of study e.g. 'nurses and doctors from GP practices in [x] part of [x] city in [x] country.'
4. The study design is appropriate to address the stated research aim/s	No research aim/s stated or the design is entirely unsuitable e.g. a Y/N item survey for a study seeking to undertake exploratory work of lived experiences. .	The study design can only address some aspects of the stated research aim/s e.g. use of focus groups to capture data regarding the frequency and experience of a disease.	The study design can address the stated research aim/s but there is a more suitable alternative that could have been used or used in addition e.g. addition of a qualitative or	The study design selected appears to be the most suitable approach to attempt to answer the stated research aim/s.

			quantitative component could strengthen the design.	
5. Appropriate sampling to address the research aim/s	No mention of the sampling approach.	Evidence of consideration of the sample required e.g. the sample characteristics are described and appear appropriate to address the research aim/s.	Evidence of consideration of sample required to address the aim. e.g. the sample characteristics are described with reference to the aim/s.	Detailed evidence of consideration of the sample required to address the research aim/s. e.g. sample size calculation or discussion of an iterative sampling process with reference to the research aims or the case selected for study.
6. Rationale for choice of data collection tool/s	No mention of rationale for data collection tool used.	Very limited explanation for choice of data collection tool/s. e.g. based on availability of tool.	Basic explanation of rationale for choice of data collection tool/s. e.g. based on use in a prior similar study.	Detailed explanation of rationale for choice of data collection tool/s. e.g. relevance to the study aim/s, co-designed with the target population or assessments of tool quality.
7. The format and content of data collection tool is appropriate to address the stated research aim/s	No research aim/s stated and/or data collection tool not detailed.	Structure and/or content of tool/s suitable to address some aspects of the research aim/s or to address the aim/s superficially e.g. single item response that is very general or an open-response item to capture content which requires probing.	Structure and/or content of tool/s allow for data to be gathered broadly addressing the stated aim/s but could benefit from refinement. e.g. the framing of survey or interview questions are too broad or focused to one element of the research aim/s.	Structure and content of tool/s allow for detailed data to be gathered around all relevant issues required to address the stated research aim/s.
8. Description of data collection procedure	No mention of the data collection procedure.	Basic and brief outline of data collection procedure e.g. 'using a questionnaire distributed to staff'.	States each stage of data collection procedure but with limited detail or states some stages in detail but	Detailed description of each stage of the data collection procedure, including when, where and how

			omits others e.g. the recruitment process is mentioned but lacks important details.	data was gathered such that the procedure could be replicated.
9. Recruitment data provided	No mention of recruitment data.	Minimal and basic recruitment data e.g. number of people invited who agreed to take part.	Some recruitment data but not a complete account e.g. number of people who were invited and agreed.	Complete data allowing for full picture of recruitment outcomes e.g. number of people approached, recruited, and who completed with attrition data explained where relevant.
10. Justification for analytic method selected	No mention of the rationale for the analytic method chosen.	Very limited justification for choice of analytic method selected. e.g. previous use by the research team.	Basic justification for choice of analytic method selected e.g. method used in prior similar research.	Detailed justification for choice of analytic method selected e.g. relevance to the study aim/s or comment around of the strengths of the method selected.
11. The method of analysis was appropriate to answer the research aim/s	No mention at all.	Method of analysis can only address the research aim/s basically or broadly.	Method of analysis can address the research aim/s but there is a more suitable alternative that could have been used or used in addition to offer a stronger analysis.	Method of analysis selected is the most suitable approach to attempt answer the research aim/s in detail e.g. for qualitative interpretative phenomenological analysis might be considered preferable for experiences vs. content analysis to elicit frequency of occurrence of events.
12. Evidence that the research stakeholders have been considered in research design or conduct.	No mention at all.	Consideration of some the research stakeholders e.g. use of pilot study with target sample but no	Evidence of stakeholder input informing the research. e.g. use of pilot study with feedback influencing the study	Substantial consultation with stakeholders identifiable in planning of study design and in preliminary work e.g. consultation in the

		stakeholder involvement in planning stages of study design.	design/conduct or reference to a project reference group established to guide the research.	conceptualisation of the research, a project advisory group or evidence of stakeholder input informing the work.
13. Strengths and limitations critically discussed	No mention at all.	Very limited mention of strengths and limitations with omissions of many key issues. e.g. one or two strengths/limitations mentioned with limited detail.	Discussion of some of the key strengths and weaknesses of the study but not complete. e.g. several strengths/limitations explored but with notable omissions or lack of depth of explanation.	Thorough discussion of strengths and limitations of all aspects of study including design, methods, data collection tools, sample & analytic approach.

APPENDIX C – QUALITY RATINGS OF INCLUDED STUDIES

Paper	*Item on QuADS*													*Total score (Maximum = 39)*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	
Betta, Castellini, Acampora & Barello (2022)	2	2	3	1	2	2	3	3	3	0	3	0	2	26
Borah (2022)	3	3	3	3	3	2	2	3	3	0	3	0	3	31
Borah, Hwang, & Hsu (2021)	3	3	3	3	3	2	2	3	3	0	3	0	2	30
Chen, Dai, Xia, & Zhou (2021)	3	3	2	3	2	1	1	2	3	0	3	0	2	25
Diament, Kaya & Magenehim (2022)	1	2	1	3	3	0	1	2	3	3	3	0	2	24
Gong, Tang & Li (2021)	3	3	3	3	2	1	1	3	3	0	3	0	2	27
Green, et al. (2022)	2	1	2	3	2	0	1	3	1	0	0	0	0	15
Hines (2022)	3	3	3	3	1	2	2	3	2	0	2	0	2	26
Hing, et al. (2022)	1	1	2	3	3	2	2	3	2	3	3	0	2	27
Jin, Raza, Yousaf, Zaman & Siang (2021)	3	3	2	3	1	2	2	3	3	2	3	0	3	30
Li, Tang & Gong (2022)	3	3	3	3	2	0	2	3	3	0	3	0	2	27

Masiero, et al. (2022)	3	2	1	3	1	2	2	2	2	0	3	0	2	23
Prakash, Nathan, Kini & Victor (2022)	3	3	3	3	3	2	3	2	3	3	3	0	2	32
Reinhardt & Rossmann (2021)	3	3	1	3	3	2	2	3	3	0	3	0	3	29
Strickland, et al. (2021)	2	1	3	3	2	0	1	2	1	0	3	0	2	20

APPENDIX D –MESSAGE STIMULI

Message framing description and definition

Author	*Year of publication*	*Message framing description*	*Message framing definition*
Betta, *et al.*	2022	(Personal health risks vs collective health risks vs economic costs) x (virologist vs influencer) (Below table for full details).	EMF & ST
Borah	2022	(Gain vs loss-frame) x (individual vs collective frame) x control Getting vaccinated will decrease your chances of contracting coronavirus (gain-frame) Not getting vaccinated will increase your chances of contracting coronavirus (loss-frame) Thinking about your health is important. This precaution could save your life (individual frame) Thinking about your community's health is important. This precaution will save your community (collective frame)	EQF & EMF

Borah, *et al.*	2021	(Gain vs loss-frame) x (individual vs collective frame) x control Getting vaccinated will decrease your chances of contracting coronavirus (gain-frame) Not getting vaccinated will increase your chances of contracting coronavirus (loss-frame) Thinking about your health is important. This precaution could save your life (individual frame) Thinking about your community's health is important. This precaution will save your community (collective frame)	EQF & EMF
Chen, *et al.*	2021	By [not] getting vaccinated, people will be [un]able to protect themselves from a potentially deadly infection. If you are [fail to get] vaccinated against the virus, you can [not] decrease your risk of getting infected (Gain vs [loss]) x (certainty of vaccine effectiveness [80% effective] vs uncertainty [20% effective]) x (number format [86 out of 108; 22 out of 108] vs percentage [80%:20%)	EQF & EMF
Diament, *et al.*	2022	Pro vaccine message (control) vs photo demonstrations (Black nurse receiving vaccine vs Dr Fauci) vs political source text	EMF & ST

endorsement (President Biden vs President Trump vs Dr Fauci) vs Food & Drug Administration (FDA) text endorsement vs Economic impact. (Below table for full details).

Gong, *et al.*	2021	Gain vs loss vs altruism (collective benefits) vs control Getting a COVID-19 vaccine can make you produce strong antibodies against COVID-19 so that you will not be infected with COVID-19 (gain) If you do not get a COVID-19 vaccine, you will not produce antibodies against COVID-19. Therefore, you have high probability to get infected with COVID-19 when you accidentally come into contact with the virus (loss) As some people (such as elderly and children) cannot be vaccinated yet, you need to get vaccinated to promote the formation of herd immunity in your community, thereby reducing their possibility of infecting with COVID-19" (altruism)	EQF & EMF
Green, et al.	2022	Control Patriotism frame: "many argue that it is a matter of patriotism and doing what is right for the country. With that in mind, how likely are you to get vaccinated?" Individual frame: "many argue that it is a matter of preventing harm to yourself and others. With that in mind, how likely are you to get vaccinated?"	EMF & ST

		Descriptive norm: “if you learned that most people you know said they were likely to take the vaccine, what would you think? How likely would you be to get vaccinated?” Scientist endorsement: “if you learned that most scientists recommend taking the vaccine, what would you think? How likely would you be to get vaccinated? Personal doctor endorsement: “if you learned that your personal physician recommended taking the vaccine, what would you think? How likely would you be to get vaccinated?”	
Hines	2022	(Gain vs loss) x (Centre for Disease Control vs Celebrity) Gain vs [loss]: “1) [not] getting the vaccine can help you reduce your risk of contracting the virus and limiting the spread of the virus. 2) If you decide [not] to get the vaccine you can shop at some stores without wearing a mask. 3) If you get vaccinated you can attend events and fly without getting tested all the time [not getting the vaccine requires you to get tested all the time if you want to attend a concert of fly].”	EQF & ST
Hing, *et al.*	2022	1. Descriptive norm (70%): Around 70% of Malaysians said that they will get the COVID-19 vaccine.	EQF, EMF & ST

2. Descriptive norm: The COVID-19 vaccine was tested with thousands of people, including the elderly, and people with existing health conditions. Now, millions of people worldwide have received it. When it's your turn, you can be confident that it is safe and effective.

3. Government official and health authority, and descriptive norm (HCW): Malaysia's Health Director General, Dr Noor Hisham Abdullah, and 9 out of 10 healthcare workers in Malaysia have received the COVID-19 vaccine. They recommend that you get it too.

4. Negative attribute (loss) framing: Only 4 out of 100 people who received the COVID-19 vaccine experienced side effects.

5. Positive attribute (gain) framing: 96 out of 100 people who received the COVID-19 vaccine did not experience any side effects.

6. Risky choice framing (safety): There are 0 deaths caused by the COVID-19 vaccines. On the other hand, over 1400 people have died due to COVID-19 infections.

7. Risky choice framing (side effects): Only 4 in 1 million people who received the COVID-19 vaccine experienced blood clots. On the other hand, 200000 in 1 million people

		infected with COVID-19 experienced blood clots. 8. Control message	
Jin, *et al.*	2021	(Newspaper vs social media) x (safety benefits vs fear appraisals) Safety benefits: The World Health Organisation, scientific community, and medical practitioners declared that COVID-19 vaccines are safe and ensure protection against COVID-19 infection. Fear appraisals: The COVID-19 pandemic is spreading sharply, wear a mask, and get your vaccines once available before it's too late. The WHO, the scientific community, and medical practitioners declared that COVID-19 vaccines could protect against deadly COVID-19 infection.	EMF & ST
Li, *et al.*	2022	Control vs gain vs loss-frame Gain: "getting a COVID-19 vaccine can make you produce strong antibodies against COVID-19 so that you will not be infected with COVID-19," Loss: "if you do not get a COVID-19 vaccine, you will not produce antibodies against COVID-19. Therefore, you may get infected	EQF

		with COVID-19 when you accidentally come into contact with the virus."	
Masiero, et al.	2022	(Gain vs loss) x (frequency vs percentage) The gain-framed scenarios were positive and highlighted the number of potential lives saved, while the loss-framed scenarios were negative and highlighted the number of potential lives lost.	EQF
Prakash, *et al.*	2022	Positive vs negative frame Positive: described the vaccines as 80% effective and that vaccines save individuals and their families from getting the virus. This means they will be less anxious and feel safe after being vaccinated. Negative: described the vaccines as 20% effective. Described side effects of the vaccine (pain, fatigue, aches). Described collective benefits of vaccination being at risk of individuals being unwell for a few days. Described how individuals and their families will be more anxious for not getting vaccinated. (Below table for full details).	EMF
Reinhardt & Rossmann	2021	Gain vs loss-frames Gain: described benefits of being vaccinated (e.g., increased chance of healthy life,	EQF

		reduced restrictions, protect for self and community) Loss: described the above as consequences of not being vaccinated (e.g., increased risk of ill health, continued restrictions, no protection for self or community) (Below table for full details).	
Strickland, et al.	2021	Positive safety frame (95% of the scientific community declares the vaccine as safe) vs negative safety frame (5% of the scientific community declares the vaccine unsafe)	EQF

EQF = equivalence framing, EMF = emphasis framing, ST = source type

Betta et al. (2022) message stimuli.

Risk To The Collective Health	"Are you thinking of not getting the COVID-19 vaccine? Prepare for more deaths and hospitalizations "! So declares Professor Miravalle, virologist at the Ripali Hospital. "According to our research- adds the Professor- at least 3 out of 4 Italians must receive the COVID-19 vaccine to reduce the spread of the new coronavirus and bring mortality and hospitalization rates down to pre-pandemic levels. Out of 4 Italians choose not to receive the vaccine, mortality and hospitalizations will continue to increase and this means that we will not be able to achieve herd immunity as many Italians will continue to contract and spread COVID-19. If we want to end this pandemic, we need young people to get vaccinated too. So, for this very reason, it is essential that all young people, for whom there are no medical indications, get the vaccine as soon as it is their turn!"	"Are you thinking of not getting the COVID-19 vaccine? Tell the people who depend on your choice not to get sick "! So declare Chiara Ferragni and Fedez. "In these days, -add the Ferragnez-Sofia, a law student currently undergoing chemotherapy treatments to fight leukemia, wrote to us. Since she cannot get the COVID-19 vaccine and therefore has a higher risk of contracting COVID-19 in severe forms, which is why her health depends largely on the health of others! By vaccinating, we will be able to stop the spread of COVID-19. This reduces the chances that people like Sofia, who cannot develop antibodies to the virus, will get sick. So, it is essential that all young people, who are not against medical indications, get the vaccine as soon as it is their turn!
Economic Risk	"Are you thinking of not getting the COVID-19 vaccine? Get ready for a slower economic recovery "! So declares Professor Rissori, virologist at the Piemmolo Hospital. "According to our research- adds the Professor- to ensure a rapid economic recovery at least 3 out of 4 Italians must receive the COVID-19 vaccine. If more than 1 in 4 Italians choose not to receive the vaccine, Italy will be forced to continue the gradual closure of activities to stop the spread of the virus. This could cause millions of Italians to lose their jobs. If we want to put an end to the economic difficulties that this pandemic has unleashed, we need Italians to get vaccinated. So, for this very reason, it is essential that all young people for whom there are no medical indications, get the vaccine as soon as it is their turn!"	"Are you thinking of not getting the COVID-19 vaccine? Tell someone who lost their job "! So declare Chiara Ferragni and Fedez. This afternoon, the Ferragnezes add, "Luca, 27, a graduate in Economics and Management, wrote to us, who lost his job due to the coronavirus last March. Although his company was able to allow some employees to work from home, he was one of the unfortunates few who lost their jobs due to massive budget cuts as the newcomer. Luca barely has enough money set aside to pay the rent and this situation forced him to return to live at home with his parents asking them for support. Although he is actively looking for a new job, there are simply not many opportunities. If a sufficient number of people decide to get vaccinated, we can stop the spread of COVID-19 and start the economy again and avoid consequences like the one described by Luca. So, for this very reason, it is essential that all young people for whom there are no medical indications, get the vaccine as soon as it is their turn!"

Type of Frame	Virologist	Influencer
Personal Risk	"Are you thinking of not getting the COVID-19 vaccine? You are risking your health"! So declares Professor Benati, a virologist at the Ferravalle Hospital. "According to our research -the professor adds-, people who do not get vaccinated against COVID-19 have a high risk of contracting several long-term health complications. With a disease like COVID-19, the risk should not only be assessed in terms of the number of deaths; in fact, we talk about a multisystem disease, which can cause damage to various organs of the body. moreover, there is no evidence on the long-term scientific effects of COVID. Our research is leading to show that a 30-year-old is more likely to have long-term consequences after COVID (such as chronic fatigue, shortness of breath, gastrointestinal problems, etc.) than the risk of death for a 60-year-old. So, for this reason, it is essential that all young people for whom there are no medical indications, get the vaccine as soon as possible!"	"Are you thinking of not getting the COVID-19 vaccine? Ask someone who has contracted the virus! " So declare, Fedez and Chiara Ferragni. "This afternoon- add the Ferragnez-Marco, a 28-year-old boy, wrote to us and we want to share his experience with all of you. Oh yes, his quarantine began in October, among illness, COVID swab and the hope of being told "it's all over". Marco told us that at the beginning he was sure that everything would last a few days and instead when the classic symptoms disappeared, the indelible signs of COVID showed up: headache, joint pain, exhaustion and cough. Endless days of confinement in which you feel like you're on a swing, between moments of apparent well-being and states of total discomfort. We hope, as the Ferragnez say, that this experience will be a warning to everyone. This is not an ordinary flu but a disease that leaves its marks even in the long term. So, for this very reason, it is essential that all young people for whom there are no medical indications, get the vaccine as soon as it is their turn!

Diament et al. (2022) message stimuli.

Table 1
Survey experiment conditions and response options.

Group	Independent Variable: Question Vignette
Control Template	As you know, the Covid-19 (coronavirus) pandemic is impacting the United States: about 24 million people have been infected with this virus, and over 400 thousand people have died from it. There are now highly effective Covid-19 vaccines. If access is not an issue, are you willing to get the coronavirus (Covid-19) vaccine?
Actor Demonstration Template	As you know, the Covid-19 (coronavirus) pandemic is impacting the United States: about 24 million people have been infected with this virus, and over 400 thousand people have died from it. There are now highly effective Covid-19 vaccines. *The picture below shows* ***[insert actor title, actor name]****, receiving the vaccine in December 2020.* If access is not an issue, are you willing get the coronavirus (Covid-19) vaccine?
Treatment[1]	"a critical care nurse, Sandra Lindsay"
Treatment[2]	"the Director of the National Institute of Allergy and Infectious Diseases, Dr. Anthony S. Fauci"
Actor Textual Endorsement Template	As you know, the Covid-19 (coronavirus) pandemic is impacting the United States: about 24 million people have been infected with this virus, and over 400 thousand people have died from it. There are now highly effective Covid-19 vaccines. ***[Insert actor title and actor name]*** *has publicly endorsed getting vaccinated against Covid-19.* If access is not an issue, are you willing get the coronavirus (Covid-19) vaccine?
Treatment[3]	"The 46th President of the United States, Joseph R. Biden,"
Treatment[4]	"The 45th President of the United States, Donald J. Trump,"
Treatment[5]	"Director of the National Institute of Allergy and Infectious Diseases Dr. Anthony S. Fauci"
Substantive Textual Message Template	As you know, the Covid-19 (coronavirus) pandemic is impacting the United States: about 24 million people have been infected with this virus, and over 400 thousand people have died from it. There are now highly effective Covid-19 vaccines. ***[Insert substantive frame]*** If access is not an issue, are you willing get the coronavirus (Covid-19) vaccine?
Treatment[6]	"The Food and Drug Administration's (FDA) 23-member panel of medical experts including physicians, statisticians, chemists, pharmacologists and other scientists—which evaluates new vaccines before they are released to the public—recently approved Covid-19 vaccines for public use."
Treatment[7]	"The negative economic impact of the pandemic is similar to the worst recessions this country has experienced—widespread unemployment, business closures, and food and housing insecurity."

Prakash et al. (2022) message stimuli.

Table 1. Scenarios of positive and negative frames.

Frames	Message Content
Positive Frame (Ministry of Health and Family Welfare [10])	Ramesh is a 25-year-old living in the city of Bangalore as an IT professional. He hears news about the COVID-19 vaccination being given to the people of his age group. His family, friends and coworkers feel positively about the vaccination.
	While considering whether or not he should take up the vaccination, he reads an article by the Centre for Disease Control and Prevention (CDC) which reads "did you know getting yourself vaccinated will decrease your chances of contracting the virus?".
	The vaccinations being given in India demonstrate a remarkable 80% effectiveness. The side effects are pain at the injection site, fever, fatigue and body aches in some cases. However, the benefits of getting vaccinated against COVID-19 far outweigh the risks. It is on Ramesh to choose wisely.
	Moreover, if Ramesh chooses to vaccinate himself, he will be able to save himself and his family from contracting the virus. He will also feel less anxious and be able to experience the safety that comes with being vaccinated.
Negative Frame (Ministry of Health and Family Welfare [10])	Ramesh is a 25-year-old living in the city of Bangalore as an IT professional. He hears news about the COVID-19 vaccination being given to the people of his age group. His family, friends and co-workers feel positively about the vaccination.
	While considering whether or not he should take up the vaccination, he reads an article by the Centre for Disease Control and Prevention (CDC) which reads "did you know not getting yourself vaccinated will increase your chances of contracting the virus?".
	The vaccinations being given in India are seen to not be effective in a mere 20% of the situations. The side effects are pain at the injection site, fever, fatigue and body aches in some cases. However, if he is given a choice to protect himself, his family and his community from the highly transmissible and deadly coronavirus that results in long term health consequences for a large number of otherwise healthy people; it may cost him a few days of feeling sick. It is on him to choose wisely.
	Moreover, if Ramesh chooses to not vaccinate himself, he will fail to save himself and his family from the virus. He will also be more anxious and will not be able to benefit from the peace of mind after getting vaccinated.

https://doi.org/10.1371/journal.pone.0269487.t001

Reinhardt & Rossmann (2021) message stimuli.

Table 2

Stimulus Manipulation

Loss	Gain
After vaccine rollout, you too will have to decide whether you want to be vaccinated against the novel coronavirus or not. Thereby, you should bear in mind that a decision against the vaccination brings numerous disadvantages for you and your family and friends:	After vaccine rollout, you too will have to decide whether you want to be vaccinated against the novel coronavirus or not. Thereby, you should bear in mind that the decision to be vaccinated brings numerous advantages for you and your family and friends:
First, the past months have demonstrated the consequences of an infection with COVID-19. By not getting vaccinated, you significantly increase your risk of an infection and possible serious health consequences. It's up to you!	First, the past months have demonstrated the consequences of an infection with COVID-19. By getting vaccinated, you will increase your chance of a healthy life without any restrictions caused by the novel coronavirus. It's up to you!
Second, in order to prevent an uncontrolled spread of the novel coronavirus, German citizens had to change their behavior in the past months drastically (e.g., compulsory mask wearing in public; social distancing). If you don't get vaccinated, you are making the immunization of the population more difficult—the currently valid restrictions will thus remain a major issue for a long time to come. For example, travel restrictions or limited leisure and cultural opportunities (e.g., closed clubs, theaters) will remain very likely.	Second, to prevent an uncontrolled spread of the novel coronavirus, the German citizens had to change their behavior in the past months drastically (e.g., compulsory mask wearing in public; social distancing). If you are vaccinated, you contribute to the immunization of the population—the current restrictions will finally come to an end. For example, there is nothing to prevent unrestricted travel or the enjoyment of leisure and cultural activities (e.g., visiting clubs, theaters).
Third, with your decision against the vaccination, you are not only endangering yourself but also the community: If a lot of people do not get vaccinated against SARS-CoV-2, then the health of those who cannot be vaccinated (e.g., due to allergies to components of the vaccine) will also be threatened. Thus, your decision is actively impeding herd immunity.	Third, with your decision to be vaccinated, you protect not only yourself but also the community: If a lot of people get vaccinated against SARS-CoV-2, then the health of those who cannot be vaccinated (e.g., due to allergies to components of the vaccine) is also protected. Thus, your decision is actively contributing to herd immunity.

APPENDIX E – CONSENT FORMS

University students

South Wales Doctoral Programme in Clinical Psychology - Consent Form

I understand that my participation in this project will involve completing a series of questionnaires which will require approximately 15-30 minutes of my time.

I am free to withdraw from the study at any time, without penalty.

I am free to discuss my concerns with Dr XXX.

I understand that the information provided by me will be held totally anonymously, so that it is impossible to trace this information back to me individually.

I understand that this information may be retained indefinitely.

I understand that once I have submitted my responses it will not be possible to withdraw my data as the researchers will not be able to identify my data.

I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study.

You may print a copy of this consent form for your records.

Please confirm that you are eligible to take part by selecting 'Yes' to each of the following statements:

	Yes	No
I am over 18 years old		
I have read and understood the above information		
I understand some of the questions will ask about self-harm and suicide		
I understand that if I do not wish to answer these questions then I am free to omit them		
I understand that I do not have to participate in this research study and can withdraw at any time, without penalty		

Please indicate if you are happy to take part in this study based on the information provided:

√	Please tick
	I am happy to take part
	I do not wish to take part, and would like to withdraw at this point

General Public

South Wales Doctoral Programme in Clinical Psychology - Consent Form

I understand that my participation in this project will involve completing a series of questionnaires which will require approximately 15-30 minutes of my time.

I am free to withdraw from the study at any time, without penalty.

I am free to discuss my concerns with Dr XXX.

I understand that the information provided by me will be held totally anonymously, so that it is impossible to trace this information back to me individually. I understand that this information may be retained indefinitely.

I understand that once I have submitted my responses it will not be possible to withdraw my data as the researchers will not be able to identify my data.

I understand that providing my personal details is required to be entered into the prize draw only and is not in any way connected to the responses provided in the questionnaires. I understand that I do not have to provide any personal information, however this will mean I will not be entered into the prize draw.

I understand that my personal data will be deleted after the prize draw has taken place. I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study.

You may print a copy of this consent form for your records.

Please confirm that you are eligible to take part by selecting 'Yes' to each of the following statements:

	Yes	No
I am over 18 years old		
I have read and understood the above information		
I understand some of the questions will ask about self-harm and suicide		
I understand that if I do not wish to answer these questions then I am free to omit them		
I understand that I do not have to participate in this research study and can withdraw at any time, without penalty		

Please indicate if you are happy to take part in this study based on the information provided:

√	Please tick
	I am happy to take part
	I do not wish to take part, and would like to withdraw at this point

APPENDIX F – SURVEY SHARE LOG

The locations the Qualtrics link to participate in the empirical paper were shared to recruit participants.

Facebook

Date shared	*Location*
19th August	Personal Facebook account (SH & JS)
5th August 2022	Group – Survey Exchange / Survey Group / Survey Participants – Dissertation, Thesis Survey Exchange
	Group – Student Survey Exchange
	Group – Dissertation Survey Exchange
	Group – Survey Sharing
1st August	Group – Anti-Vaccination Group
	Group – AntiVax!!
	Group – Anti-Vax

Survey Circle

Date shared	*Location*
5th August	Survey Circle

Reddit

Date shared	*Location*
5th August	r/antiVaxxers
	r/psychology research
	r/dissertation support
	r/vaccines
	r/psychology
	r/vaccine narrative
	r/samplesize

Other

Date shared	*Location*
2nd August	Shared on articles about COVID-19 posted on BBC/Guardian/Wales Online/Daily Mail/Daily Mirror
	Link sent to staff within an NHS setting and asked to circulate. It is difficult to ascertain how many people would receive this link or how many people it would be circulated to.
	Link sent to trainee clinical psychologists across 3 cohorts to complete / distribute.

APPENDIX G – ADAPTED 5Cs SCALE

Please evaluate how much you disagree or agree with the following statements.

1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neutral, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree

1. I am completely confident that COVID-19 vaccines are safe.
2. COVID-19 vaccinations are effective.
3. Regarding COVID-19 vaccines, I am confident that public authorities decide in the best interest of the community.
4. Vaccination is unnecessary because vaccine-preventable diseases are not common anymore.
5. My immune system is so strong, it also protects me against diseases.
6. Vaccine-preventable diseases are not so severe that I should get vaccinated.
7. Everyday stress prevents me from getting the COVID-19 vaccinations.
8. For me, it is inconvenient to receive the COVID-19 vaccinations.
9. Visiting the doctor's makes me feel uncomfortable; this keeps me from getting the COVID-19 vaccinations.
10. When I think about getting vaccinated, I weigh benefits and risks to make the best decision possible.
11. For each and every vaccination, I closely consider whether it is useful for me.
12. It is important for me to fully understand the topic of vaccination, before I get the COVID-19 vaccinations.

13. When everyone is vaccinated against COVID-19, I don't have to get vaccinated, too.
14. I get vaccinated because I can also protect people with a weaker immune system.
15. COVID-19 vaccination is a collective action to prevent the spread of disease.

APPENDIX H - DEMOGRAPHIC QUESTIONNAIRE

What is you gender?

- Male
- Female
- Non-binary/third gender
- Other: Please specify
- Prefer not to say.

What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 and over
- I'd prefer not to say.

What is your ethnic group? (Select all that apply)

- Asian, Asian British, Asian English, Asian Scottish or Asian Welsh
    - Bangladeshi
    - Indian
    - Pakistani
    - Any other Asian background – please specify:
- Black, Black British, Black English, Black Scottish, or Black Welsh
    - African
    - Caribbean
    - Any other Black background – please specify:
- Mixed
    - White & Asian

    - White & Black African
    - White & Black Caribbean
    - Any other Mixed background – please specify:
- White
    - British – English
    - British – Scottish
    - British – Welsh
    - Any other White background – please specify:
- Chinese/Middle Eastern/Other ethnic background
    - Chinese
    - Middle Eastern/North African
    - Any other background – please specify:
- Prefer not to say.

Are you currently studying at Cardiff University?

- Yes
- No

Are you an undergraduate or a postgraduate student at Cardiff University?

- Undergraduate
- Postgraduate
- Prefer not to say.

Have you received a Covid-19 Vaccination?

- Yes
- No

Please choose the option that best applies to you:

- I have received the first dose of a Covid-19 vaccine.
- I have received the second dose of a Covid-19 vaccine.
- I have received a third dose of a Covid-19 vaccine.

- I have received any additional booster doses that have been offered.

APPENDIX I – COMPACT-8

CompACT®

Name:	Date:

Please rate the following 8 statements using the scale below:

0	1	2	3	4	5	6
Strongly disagree	Moderately disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Moderately agree	Strongly agree

1.	I act in ways that are consistent with how I wish to live my life	0	1	2	3	4	5	6
2.	I get so caught up in my thoughts that I am unable to do the things that I most want to do	0	1	2	3	4	5	6
3.	I rush through meaningful activities without being really attentive to them	0	1	2	3	4	5	6
4.	I go out of my way to avoid situations that might bring difficult thoughts, feelings, or sensations	0	1	2	3	4	5	6
5.	I undertake things that are meaningful to me, even when I find it hard to do so	0	1	2	3	4	5	6
6.	Even when doing the things that matter to me, I find myself doing them without paying attention	0	1	2	3	4	5	6
7.	I work hard to keep out upsetting feelings	0	1	2	3	4	5	6
8.	I can keep going with something when it's important to me	0	1	2	3	4	5	6

Scoring instructions (administrative use only) **REMOVE FOR CLIENTS**

- Scores are derived by summing responses for each of the three subscales (Openness to Experience; Behavioural Awareness; Valued Action) or the scale as a whole (CompACT Total score).
- Five items are ~~reverse-scored~~ before summation (items 2, 3, 4, 6, and 7).

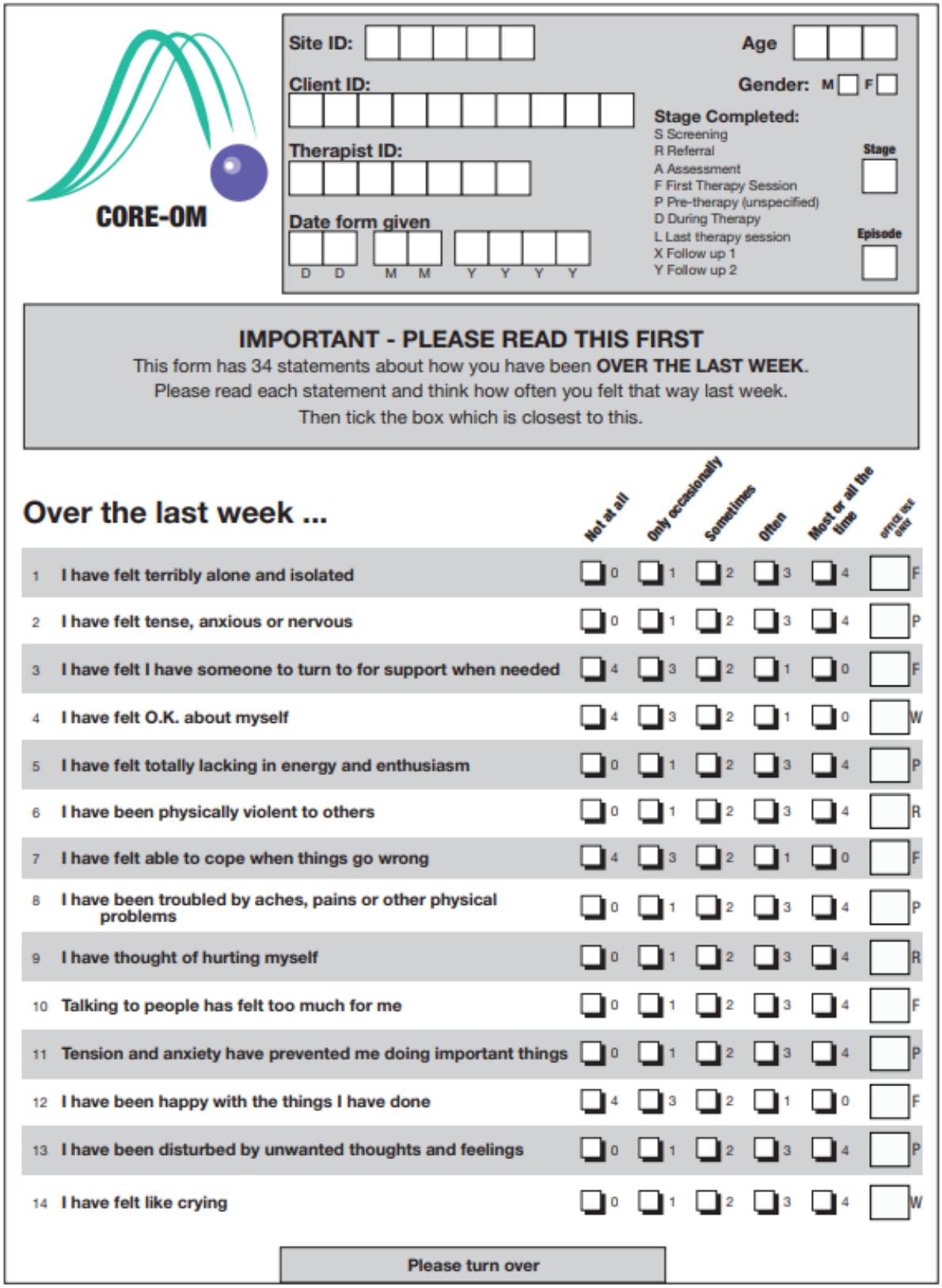
Openness to Experience (OE) subscale
Calculated as the sum of scores for items: 2 (reversed), 4 (reversed), and 7 (reversed).
Subscale scores range from 0-18, with higher scores indicating greater openness to experience (willingness to experience internal events [thoughts, feelings, sensations, etc.] without trying to control or avoid them)

Behavioural Awareness (BA) subscale
Calculated as the sum of scores for items: 3 (reversed) and 6 (reversed).
Subscale scores range from 0–12 with higher scores indicating greater behavioural awareness (mindful attention to current actions)

Valued Action (VA) subscale
Calculated as the sum of scores for items: 1, 5, and 8.
Subscale scores range from 0–18 with higher scores indicating greater engagement in valued actions (meaningful activity)

~~CompACT~~ Total
Calculated as the sum of the three subscale scores, the full-scale ~~CompACT~~ Total score ranges from 0–48, with higher scores indicating greater psychological flexibility: The ability to attend and adapt to situational demands in the pursuit of personally-meaningful longer-term goals.

APPENDIX J – CORE-OM



CORE-OM

Site ID: Age

Client ID: Gender: M F

Therapist ID:

Date form given D D M M Y Y Y Y

Stage Completed:
S Screening
R Referral
A Assessment
F First Therapy Session
P Pre-therapy (unspecified)
D During Therapy
L Last therapy session
X Follow up 1
Y Follow up 2

Stage

Episode

IMPORTANT - PLEASE READ THIS FIRST

This form has 34 statements about how you have been **OVER THE LAST WEEK**.
Please read each statement and think how often you felt that way last week.
Then tick the box which is closest to this.

Over the last week ...

		Not at all	Only occasionally	Sometimes	Often	Most or all the time	
1	I have felt terribly alone and isolated	0	1	2	3	4	F
2	I have felt tense, anxious or nervous	0	1	2	3	4	P
3	I have felt I have someone to turn to for support when needed	4	3	2	1	0	F
4	I have felt O.K. about myself	4	3	2	1	0	W
5	I have felt totally lacking in energy and enthusiasm	0	1	2	3	4	P
6	I have been physically violent to others	0	1	2	3	4	R
7	I have felt able to cope when things go wrong	4	3	2	1	0	F
8	I have been troubled by aches, pains or other physical problems	0	1	2	3	4	P
9	I have thought of hurting myself	0	1	2	3	4	R
10	Talking to people has felt too much for me	0	1	2	3	4	F
11	Tension and anxiety have prevented me doing important things	0	1	2	3	4	P
12	I have been happy with the things I have done	4	3	2	1	0	F
13	I have been disturbed by unwanted thoughts and feelings	0	1	2	3	4	P
14	I have felt like crying	0	1	2	3	4	W

Please turn over

Over the last week ...

		Not at all	Only occasionally	Sometimes	Often	Most or all the time	OFFICE USE ONLY
15	I have felt panic or terror	0	1	2	3	4	P
16	I made plans to end my life	0	1	2	3	4	R
17	I have felt overwhelmed by my problems	0	1	2	3	4	W
18	I have had difficulty getting to sleep or staying asleep	0	1	2	3	4	P
19	I have felt warmth or affection for someone	4	3	2	1	0	F
20	My problems have been impossible to put to one side	0	1	2	3	4	P
21	I have been able to do most things I needed to	4	3	2	1	0	F
22	I have threatened or intimidated another person	0	1	2	3	4	R
23	I have felt despairing or hopeless	0	1	2	3	4	P
24	I have thought it would be better if I were dead	0	1	2	3	4	R
25	I have felt criticised by other people	0	1	2	3	4	F
26	I have thought I have no friends	0	1	2	3	4	F
27	I have felt unhappy	0	1	2	3	4	P
28	Unwanted images or memories have been distressing me	0	1	2	3	4	P
29	I have been irritable when with other people	0	1	2	3	4	F
30	I have thought I am to blame for my problems and difficulties	0	1	2	3	4	P
31	I have felt optimistic about my future	4	3	2	1	0	W
32	I have achieved the things I wanted to	4	3	2	1	0	F
33	I have felt humiliated or shamed by other people	0	1	2	3	4	F
34	I have hurt myself physically or taken dangerous risks with my health	0	1	2	3	4	R

THANK YOU FOR YOUR TIME IN COMPLETING THIS QUESTIONNAIRE

	(W)	(P)	(F)	(R)	All items	All minus R
Total Scores						
Mean Scores (Total score for each dimension divided by number of items completed in that dimension)						

APPENDIX K – ETHICAL APPROVAL

From: psychethics
Sent: Tuesday, July 5, 2022, 3:14 PM
To:
Cc:
Subject: Ethics Feedback - EC.22.06.14.6582R2

Dear,

The Ethics Committee has considered your revised PG project proposal: The psychological influences of vaccine hesitancy (EC.22.06.14.6582R).

Your revised project proposal has received a **Favourable Opinion** based on the information described in the proforma and supporting documentation.

Conditions of the favourable opinion
The favourable opinion is subject to the following conditions being met:

- You must retain a copy of this decision letter with your Research records.
- Please note that if any changes are made to the above project, then you must notify the Ethics Committee.
- Please use the EC reference number on all future correspondence.
- The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project.
- The Committee must be informed when your research project has ended. This notification should be made to [EMAIL] within three months of research project completion.

The Committee reminds you that it is your responsibility to conduct your research project to the highest ethical standards and to keep all ethical issues arising from your research project under regular review.

You are expected to comply with Cardiff University's policies, procedures and guidance at all times, including, but not limited to, its Policy on the Ethical Conduct of Research involving Human Participants, Human Material or Human Data and our Research Integrity and Governance Code of Practice.

Kind regards,

School of Psychology Research Ethics Committee

APPENDIX L – INFORMATION SHEET

PARTICIPANT INFORMATION SHEET

THE PSYCHOLOGICAL INFLUENCES OF VACCINE HESITANCY

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others, if you wish.

Thank you for reading this.

1. What is the purpose of this research project?

We would like you to take part in a study that aims to understand more about why some people are hesitant about taking vaccines.

2. Who can take part?

We are interested in learning about what may influence people's decisions to take vaccines in the general population who are aged 18+. We think everyone's experiences are important and would like to hear from people whatever their opinion is on COVID-19 vaccines. We are recruiting people that have a) had all COVID-19 vaccines they have been offered; b) have had some of the COVID-19 vaccines they have been offered; c) have not had any COVID-19 vaccines they have been offered.

3. What will taking part involve?

The study will involve completing three short questionnaires. We will also ask you about whether you have had any COVID-19 vaccines. One questionnaire will ask you about feelings of distress and will directly ask you whether you have made plans to end your life in the last week.

If you decide to take part, then you will be asked to complete some online questionnaires. To thank you for taking part, you will be awarded participation credits (relevant only to School of Psychology students), or you will be entered into a prize draw for the chance to win one of the following gift cards: 1 x £10 Love2Shop, 1 x £20 Love2Shop, 1 x £25 Love2Shop.

To enter the prize draw you will be asked to complete an unrelated questionnaire that will ask you to provide some personal information (your email address) so that you can be contacted if you win. This is to enter you into a prize draw only and the information you give will be stored separately to the questionnaire data and it will be impossible to link this information with the questionnaire data in any way. This data will be deleted once the prize draw has been done once data collection is complete.

4. What are the possible disadvantages of taking part?

Thinking about vaccines and/or the COVID-19 pandemic may evoke strong emotions for some people. The questionnaires will ask you directly about whether you have had any of the COVID-19 vaccines which some people may not wish to answer. Answering questions about distress and plans to end your life may also be difficult to answer. The information you provide will be kept anonymously and it will not be possible to identify you from the information you provide. This means that we will not be able to offer you any support based on the responses you give on the questionnaires.

5. Will my taking part in this research project be kept confidential?

All information collected from (or about) you during the research project will be kept anonymously and any personal information you provide will be managed in accordance with data protection legislation. Please see 'What will happen to my Personal Data?' (below) for further information.

6. What will happen to my Personal Data?

The personal data you provide for the purpose of the prize draw will be deleted once the winners have been selected.

7. What will happen to the results of the research project?

The information you provide as part of this study will be used to inform our understanding of the factors that influence vaccine hesitancy. The results will be submitted as part of Sarah Howey's training in Clinical Psychology. The results may also be written up and published in a journal and presented to people who work in similar research areas. If you wish to receive information about the results of the study, please inform Sarah Howey and the results can be shared with you when they are available.

8. What if there is a problem?

If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached or treated during the course of this research, please contact Dr James Stroud. If your complaint is not managed to your satisfaction, please contact Dr XX Chair of the ENGIN Research Ethics Committee, via XXXX**.**

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

9. Do I have to take part?

No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, we will discuss the research project with you and ask you to sign a consent form. If you decide not to take part, you do not have to explain your reasons and it will not affect your legal rights.

You are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form.

10. Who is sponsoring this research project?

Cardiff & Vale University Health Board is funding the research and Cardiff University is sponsoring the research.

11. Who has reviewed this research project?

This research project has been reviewed and approved by the School of Psychology Research Ethics Committee at Cardiff University.

If you have any concerns or complaints about the research, you can contact the School of Psychology Research Ethics Committee in writing at:

Secretary to the Research Ethics Committee
School of Psychology
Tower Building
70 Park Place

17
Cardiff
CF10 3AT

South Wales Doctoral Programme in Clinical Psychology

Cardiff University

Tower Building

Park Place

Cardiff

CF10 3AT

Tel: XXXXX

Email: XXXXX

Academic Tutor

South Wales Doctoral Programme in Clinical Psychology

Cardiff University

Tower Building

Park Place

Cardiff

CF10 3AT

Tel: XXXXX

Email: XXXXX

12. Further information and contact details.

Should you have any questions relating to this research project, you may contact us during normal working hours:

Thank you for considering taking part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

APPENDIX M – ORDINAL REGRESSION & TEST OF PARALLEL LINES

Ordinal regression investigating whether the variance in vaccine take-up is predicted by vaccine attitudes, PF, & PD

	Log Odds Estimate	S.E.	Wald	p	95% Confidence Interval	
					Lower Bound	Upper Bound
Confidence [a]	.023	.028	.700	.403	-.031	.078
Complacency [a]	.044	.028	2.441	.118	-.011	.099
Constraints [a]	-.019	.026	.520	.471	-.071	.033
Calculation [a]	-.025	.028	.817	.366	-.079	.029
Collective Responsibility [a]	.015	.035	.196	.658	-.053	.084
Psychological flexibility [b]	.048	.030	2.623	.105	-.010	.106
Valued Action [b]	.063	.043	2.198	.138	-.020	.147
Behavioural Awareness [b]	-.111	.058	3.698	.054	-.225	.002
Openness to experience [b]	0[x]	.	.	.	.	.
Psychological distress [c]	.042	.019	4.739	.029*	.004	.080

[x] This parameter is set to zero because it is redundant.

*p<.05

[a]5C subscale scores, [b]CompACT-8 total score, [b]CompACT-8 subscale scores, [c]CORE-OM scores

Test of Parallel Lines assumption violated in ordinal regression model

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	1259.230			
General	1171.998[b]	87.232[c]	42	.000

APPENDIX N – VACCINE SUBMISSION GUIDELINES

ELSEVIER

VACCINE

The official journal of The Japanese Society for Vaccinology.

AUTHOR INFORMATION PACK

TABLE OF CONTENTS

ISSN: 0264-410X

DESCRIPTION

Vaccine has an open access companion journal titled Vaccine: X.

Vaccine is **unique** in publishing the highest quality science across **all disciplines** relevant to the field of vaccinology - all original article submissions across basic and clinical research, vaccine manufacturing, history, public policy, behavioral science and ethics, social sciences, safety, and many other related areas are welcomed. The submission categories as given in the Guide for Authors indicate where we receive the most papers. **Papers outside these major areas are also welcome and authors are encouraged to contact us with specific questions**. We also invite authors **to submit relevant basic science and clinical reviews, methodological articles, opinion and commentary pieces, visual pieces, and letters**. Authors are required to consult the Guide for Authors as the submission guidelines are dynamic and therefore subject to change.

The Editors retain the right to desk reject submissions without peer review when it is clear that the Guide for Authors **and the** submission categories ***have not been consulted***.

AUDIENCE

Research workers, product developers, clinicians and practitioners with interests in virology, bacteriology, parasitology, mycology, immunology, genetics, biotechnology and biochemistry in the medical and veterinary fields.

IMPACT FACTOR

2021: 4.169 © Clarivate Analytics Journal Citation Reports 2022

GUIDE FOR AUTHORS

INTRODUCTION

Vaccine publishes high quality science across all disciplines relevant to the field of vaccinology - all original article submissions across basic and clinical research, vaccine manufacturing, history, public policy, behavioral science and ethics, social sciences, safety, and many other related areas are welcomed.

Types of paper

Vaccine publishes primary research papers, review articles, short communications, conference reports and letters on the following topics:Basic Science ReviewClinical Science ReviewCommentary/ EditorialHistory of Vaccinology Human Fungal/Parasite/Other VaccinesHuman Non-Infectious Disease Vaccines (cancer, allergy, other)Human Viral Vaccines: Basic ResearchLetter to the EditorNovel Pathogen Vaccines (Biodefense/High Consequence Pathogens/Emerging Diseases)Vaccine Acceptance/HesitancyVaccine Basic Science (Immunology/Animal Models)Vaccine EthicsVaccine Manufacturing and BioprocessingVaccine Operational Research (Evaluation/ Epidemiology/Informatics/Models /Big Data and Analytics)Vaccine Policy Legislation/Economics/ Digital Health)Vaccine Regulatory Science (Implementation/Guidelines/Public Health)Vaccine Safety ScienceVaccine Technology (Vectors/Adjuvants/Delivery Systems/Nanotechnology)Veterinary Bacterial VaccinesVeterinary Fungal/Parasite/Other VaccinesVeterinary Viral VaccinesVisual Vaccinology

For more specific guidelines for each article type please go to: Article Type - Guidelines

Vaccine also welcomes **Review articles** thoughtful **Opinion pieces** and **Commentaries** on topics of interest to the readership of the journal. Authors should contact the Editor-in-Chief Dr. Gregory Poland via jvac@elsevier.com, before preparing such a work in order to solicit approval to submit.

Authors who wish to submit a Review article should also seek approval of topic before submission. Please send your enquiry to the Managing Editor of the journal at d.beerens@elsevier.com. However, the resulting submission is still subject to standard peer review, and the solicitation does not guarantee acceptance for publication.

Please note that ALL articles must now carry a single sentence before the article's bibliography stating: "All authors attest they meet the ICMJE criteria for authorship" and all authors must submit written confirmation in their cover letter that "All authors attest they meet the ICMJE criteria for authorship".

Authors must ensure that any documentation submitted to Vaccine for review purposes may be published should their article be accepted. Therefore, confidential and/or proprietary information contained in documentation submitted for review should be redacted or removed prior to submission.

Contact details for submission

Papers should be submitted using the *Vaccine* online submission system at: https://www.editorialmanager.com/jvac

Essentials to ensure fast handling

Manuscript is in accordance with ARTICLE TYPE - GUIDELINES Manuscript-text is saved as a Word-file, line-numbers are added and text is double spaced Clinical trial registry is mentioned at the end of the abstract if applicable Conflict of interest statement is included at the end of the manuscript Figures and tables are prepared as separate files and are clearly labeled Cover letter is prepared, introducing your article and explaining the novelty of the research Keywords are prepared Contact details of 8 suggested reviewers (Name, affiliation and email address) are prepared Highlights are prepared (a birds' eye view of your article in 3-5 points, 85 characters each) The work presented in the article has been carried in line with all relevant ethical guidelines Please note that even though Vaccine is a transformative journal, certain article types are not supported by Open Access. This concerns article types such as Correspondence, Discussion, Conference Reports. If you are in doubt whether your article type can be published as Open Access in the journal please contact the Journal Manager at: jvac@elsevier.com

For any further information please consult this Guide For Authors or visit our Support Center.

Submission checklist

Ensure that the following items are taken care of during submission:

One author has been designated as the corresponding author with contact details:
- E-mail address
- Full postal address

All necessary files have been uploaded:
Manuscript:
- Include keywords
- All figures (include relevant captions)
- All tables (including titles, description, footnotes)
- Ensure all figure and table citations in the text match the files provided
- Indicate clearly if color should be used for any figures in print

Graphical Abstracts / Highlights files (where applicable)
Supplemental files (where applicable)

Further considerations
- Manuscript has been 'spell checked' and 'grammar checked'
- All references mentioned in the Reference List are cited in the text, and vice versa
- Permission has been obtained for use of copyrighted material from other sources (including the Internet)
- A Conflict of Interest statement is provided, even if the authors have no competing interests to declare
- Journal policies detailed in this guide have been reviewed and adhered to
- Suggestions for 8 reviewers and their contact details have been provided

BEFORE YOU BEGIN

Ethics in publishing

Please see our information on Ethics in publishing.

Studies in humans and animals

If the work involves the use of human subjects, the author should ensure that the work described has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The manuscript should be in line with the Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals and aim for the inclusion of representative human populations (sex, age and ethnicity) as per those recommendations. The terms sex and gender should be used correctly.

Authors should include a statement in the manuscript that informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

All animal experiments should comply with the ARRIVE guidelines and should be carried out in accordance with the U.K. Animals (Scientific Procedures) Act, 1986 and associated guidelines, EU Directive 2010/63/EU for animal experiments, or the National Research Council's Guide for the Care and Use of Laboratory Animals and the authors should clearly indicate in the manuscript that such guidelines have been followed. The sex of animals must be indicated, and where appropriate, the influence (or association) of sex on the results of the study.

Policy and ethics (additional information)

Informed consent
Studies on human subjects require ethics committee approval and informed consent, which should be documented in the paper. The statement must indicate that informed consent was obtained after the nature and possible consequences of the study had been fully explained to the subjects.

Appropriate consents, permissions and releases must be obtained where an author wishes to include case details or other personal information or images of patients and any other individuals in an Elsevier publication. Written consents must be retained by the author but copies do not need to be provided

to the journal. Only in exceptional circumstances and when specifically requested by the journal (for example if a legal issue arises) the author must provide copies of the consent forms or evidence that such consent has been obtained.

For more information, please review the Elsevier Policy on the Use of Images or Personal Information of Patients or other Individuals. Unless you have written permission from the patient (or, where applicable, the next of kin), the personal details of any patient included in any part of the article and in any supplementary materials (including all illustrations and videos) must be removed before submission.

Animal welfare
Authors using experimental animals must state that their care was in accordance with institutional guidelines. For animals subjected to invasive procedures, the anesthetic, analgesic and tranquilizing agents used, as well as the amounts and frequency of administration, must be stated.

Availability of Materials
Publication of an article in *Vaccine* is taken to imply that the authors are prepared to freely distribute materials used in the published experiments (e.g. antibodies, cell lines) to academic researchers for their own use.

Declaration of competing interest
All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/ registrations, and grants or other funding. Authors should complete the declaration of competing interest statement using Elsevier's Declaration of Interests form and upload to the submission system at the Attach/Upload Files step. **Note: Please do not convert the .docx template to another file type. Author signatures are not required.** If there are no interests to declare, you will still need to complete the form and confirm. For further guidance on using the declaration tool, please view this short video.

Declaration of generative AI in scientific writing
The below guidance only refers to the writing process, and not to the use of AI tools to analyse and draw insights from data as part of the research process.

Where authors use generative artificial intelligence (AI) and AI-assisted technologies in the writing process, authors should only use these technologies to improve readability and language. Applying the technology should be done with human oversight and control, and authors should carefully review and edit the result, as AI can generate authoritative-sounding output that can be incorrect, incomplete or biased. AI and AI-assisted technologies should not be listed as an author or co-author, or be cited as an author. Authorship implies responsibilities and tasks that can only be attributed to and performed by humans, as outlined in Elsevier's AI policy for authors.

Authors should disclose in their manuscript the use of AI and AI-assisted technologies in the writing process by following the instructions below. A statement will appear in the published work. Please note that authors are ultimately responsible and accountable for the contents of the work.

Disclosure instructions
Authors must disclose the use of generative AI and AI-assisted technologies in the writing process by adding a statement at the end of their manuscript in the core manuscript file, before the References list. The statement should be placed in a new section entitled 'Declaration of Generative AI and AI-assisted technologies in the writing process'.

Statement: During the preparation of this work the author(s) used [NAME TOOL / SERVICE] in order to [REASON]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

This declaration does not apply to the use of basic tools for checking grammar, spelling, references etc. If there is nothing to disclose, there is no need to add a statement.

Submission declaration and verification

Submission of an article implies that the work described has not been published previously (except in the form of an abstract, a published lecture or academic thesis, see 'Multiple, redundant or concurrent publication' for more information), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. To verify compliance, your article may be checked by Crossref Similarity Check and other originality or duplicate checking software.

Preprints

Please note that preprints can be shared anywhere at any time, in line with Elsevier's sharing policy. Sharing your preprints e.g. on a preprint server will not count as prior publication (see 'Multiple, redundant or concurrent publication' for more information).

Preprint posting on SSRN

In support of Open Science, this journal offers its authors a free preprint posting service. Preprints provide early registration and dissemination of your research, which facilitates early citations and collaboration.

During submission to Editorial Manager, you can choose to release your manuscript publicly as a preprint on the preprint server SSRN once it enters peer-review with the journal. Your choice will have no effect on the editorial process or outcome with the journal. Please note that the corresponding author is expected to seek approval from all co-authors before agreeing to release the manuscript publicly on SSRN.

You will be notified via email when your preprint is posted online and a Digital Object Identifier (DOI) is assigned. Your preprint will remain globally available free to read whether the journal accepts or rejects your manuscript.

For more information about posting to SSRN, please consult the SSRN Terms of Use and FAQs.

Use of inclusive language

Inclusive language acknowledges diversity, conveys respect to all people, is sensitive to differences, and promotes equal opportunities. Content should make no assumptions about the beliefs or commitments of any reader; contain nothing which might imply that one individual is superior to another on the grounds of age, gender, race, ethnicity, culture, sexual orientation, disability or health condition; and use inclusive language throughout. Authors should ensure that writing is free from bias, stereotypes, slang, reference to dominant culture and/or cultural assumptions. We advise to seek gender neutrality by using plural nouns ("clinicians, patients/clients") as default/wherever possible to avoid using "he, she," or "he/she." We recommend avoiding the use of descriptors that refer to personal attributes such as age, gender, race, ethnicity, culture, sexual orientation, disability or health condition unless they are relevant and valid. When coding terminology is used, we recommend to avoid offensive or exclusionary terms such as "master", "slave", "blacklist" and "whitelist". We suggest using alternatives that are more appropriate and (self-) explanatory such as "primary", "secondary", "blocklist" and "allowlist". These guidelines are meant as a point of reference to help identify appropriate language but are by no means exhaustive or definitive.

Reporting sex- and gender-based analyses

Reporting guidance

For research involving or pertaining to humans, animals or eukaryotic cells, investigators should integrate sex and gender-based analyses (SGBA) into their research design according to funder/sponsor requirements and best practices within a field. Authors should address the sex and/or gender dimensions of their research in their article. In cases where they cannot, they should discuss this as a limitation to their research's generalizability. Importantly, authors should explicitly state what definitions of sex and/or gender they are applying to enhance the precision, rigor and reproducibility of their research and to avoid ambiguity or conflation of terms and the constructs to which they refer (see Definitions section below). Authors can refer to the Sex and Gender Equity in Research (SAGER) guidelines and the SAGER guidelines checklist. These offer systematic approaches to the use and editorial review of sex and gender information in study design, data analysis, outcome reporting and research interpretation - however, please note there is no single, universally agreed-upon set of guidelines for defining sex and gender.

Definitions

Sex generally refers to a set of biological attributes that are associated with physical and physiological features (e.g., chromosomal genotype, hormonal levels, internal and external anatomy). A binary sex categorization (male/female) is usually designated at birth ("sex assigned at birth"), most often based solely on the visible external anatomy of a newborn. Gender generally refers to socially constructed roles, behaviors, and identities of women, men and gender-diverse people that occur in a historical and cultural context and may vary across societies and over time. Gender influences how people view themselves and each other, how they behave and interact and how power is distributed in society. Sex and gender are often incorrectly portrayed as binary (female/male or woman/man) and unchanging whereas these constructs actually exist along a spectrum and include additional sex categorizations and gender identities such as people who are intersex/have differences of sex development (DSD) or identify as non-binary. Moreover, the terms "sex" and "gender" can be ambiguous—thus it is important for authors to define the manner in which they are used. In addition to this definition guidance and the SAGER guidelines, the resources on this page offer further insight around sex and gender in research studies.

Contributors

Each author is required to declare their individual contribution to the article: all authors must have materially participated in the research and/or article preparation, so roles for all authors should be described. The statement that all authors have approved the final article should be true and included in the disclosure.

Authorship

All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Changes to authorship

Authors are expected to consider carefully the list and order of authors **before** submitting their manuscript and provide the definitive list of authors at the time of the original submission. Any addition, deletion or rearrangement of author names in the authorship list should be made only **before** the manuscript has been accepted and only if approved by the journal Editor. To request such a change, the Editor must receive the following from the **corresponding author**: (a) the reason for the change in author list and (b) written confirmation (e-mail, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed.

Only in exceptional circumstances will the Editor consider the addition, deletion or rearrangement of authors **after** the manuscript has been accepted. While the Editor considers the request, publication of the manuscript will be suspended. If the manuscript has already been published in an online issue, any requests approved by the Editor will result in a corrigendum.

All scientific communications describing immunogenicity, effectiveness, or efficacy of a human or veterinary vaccine must include the following details: Vaccine characteristics: Vaccine lot number, manufacturer, dosing interval and number of doses, vaccine route of administration, if an injection - the anatomic site of injection, technique for vaccine administration (if by injection, specify needle length), concomitant vaccines administered, cold chain or storage effects if relevant, and a specification of what vaccine antigens and adjuvants were administered. Subject characteristics: Age, race, ethnicity, body mass index or body weight, smoking status, gender, medical/immunologic status, and concomitant drug use.

Statistical and analytical reporting

For further information on Vaccine guidelines for statistical and analytical reporting, please visit:

AUTHOR GUIDELINES

To consult the journal's Statistical and Analytical guidelines checklist, please go to:

STATISTICAL AND ANALYTICAL GUIDELINES CHECKLIST

Reporting clinical trials
Randomized controlled trials should be presented according to the CONSORT guidelines. At manuscript submission, authors must provide the CONSORT checklist accompanied by a flow diagram that illustrates the progress of patients through the trial, including recruitment, enrollment, randomization, withdrawal and completion, and a detailed description of the randomization procedure.

All scientific communications describing immunogenicity, effectiveness, or efficacy of a human or veterinary vaccine must include the following details: Vaccine characteristics: Vaccine lot number, manufacturer, dosing interval and number of doses, vaccine route of administration, if an injection - the anatomic site of injection, technique for vaccine administration (if by injection, specify needle length), concomitant vaccines administered, cold chain or storage effects if relevant, and a specification of what vaccine antigens and adjuvants were administered. Subject characteristics: Age, race, ethnicity, body mass index or body weight, smoking status, gender, medical/immunologic status, and concomitant drug use.

Registration of clinical trials
Registration in a public trials registry is a condition for publication of clinical trials in this journal in accordance with International Committee of Medical Journal Editors recommendations. Trials must register at or before the onset of patient enrolment. The clinical trial registration number should be included at the end of the abstract of the article. A clinical trial is defined as any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects of health outcomes. Health-related interventions include any intervention used to modify a biomedical or health-related outcome (for example drugs, surgical procedures, devices, behavioural treatments, dietary interventions, and process-of-care changes). Health outcomes include any biomedical or health-related measures obtained in patients or participants, including pharmacokinetic measures and adverse events. Purely observational studies (those in which the assignment of the medical intervention is not at the discretion of the investigator) will not require registration.

Article transfer service
This journal uses the Elsevier Article Transfer Service to find the best home for your manuscript. This means that if an editor feels your manuscript is more suitable for an alternative journal, you might be asked to consider transferring the manuscript to such a journal. The recommendation might be provided by a Journal Editor, a dedicated Scientific Managing Editor, a tool assisted recommendation, or a combination. If you agree, your manuscript will be transferred, though you will have the opportunity to make changes to the manuscript before the submission is complete. Please note that your manuscript will be independently reviewed by the new journal. More information.

Copyright
Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (see more information on this). An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations. If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Elsevier has preprinted forms for use by authors in these cases.

Elsevier supports responsible sharing
Find out how you can share your research published in Elsevier journals.

Role of the funding source
You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication. If the funding source(s) had no such involvement, it is recommended to state this.

Open access
Please visit our Open Access page for more information.

Language (usage and editing services)
Please write your text in good English (American or British usage is accepted, but not a mixture of these). Authors who feel their English language manuscript may require editing to eliminate possible grammatical or spelling errors and to conform to correct scientific English may wish to use the English Language Editing service available from Elsevier's Author Services.

Submission
Our online submission system guides you stepwise through the process of entering your article details and uploading your files. The system converts your article files to a single PDF file used in the peer-review process. Editable files (e.g., Word, LaTeX) are required to typeset your article for final publication. All correspondence, including notification of the Editor's decision and requests for revision, is sent by e-mail.

Submit your article
Please submit your article via https://www.editorialmanager.com/jvac

Referees
Suggestions for potential reviewers
Authors are requested to provide the names and institutional e-mail addresses of eight potential reviewers upon submission. It would not be appropriate to nominate individuals that have had any input into the manuscripts submitted or any recent collaboration with the authors or from the same department or institute. Please provide the names of suggested reviewers from countries other than that of the authors and include their institutional email addresses. Hotmail, yahoo, gmail and/or similar addresses are not recommended. The Editors may or may not take these suggestions into account during the reviewing process.

Review process
All contributions are read by two or more referees to ensure both accuracy and relevance, and revisions to the script may thus be required. On acceptance, contributions are subject to editorial amendment to suit house style. When a manuscript is returned for revision prior to final acceptance, the revised version must be submitted as soon as possible after the author's receipt of the referee's reports. Revised manuscripts returned after four months will be considered as new submissions subject to full re-review.

PREPARATION

Queries
For questions about the editorial process (including the status of manuscripts under review) or for technical support on submissions, please visit our Support Center.

Peer review
This journal operates a single anonymized review process. All contributions will be initially assessed by the editor for suitability for the journal. Papers deemed suitable are then typically sent to a minimum of two independent expert reviewers to assess the scientific quality of the paper. The Editor is responsible for the final decision regarding acceptance or rejection of articles. The Editor's decision is final. Editors are not involved in decisions about papers which they have written themselves or have been written by family members or colleagues or which relate to products or services in which the editor has an interest. Any such submission is subject to all of the journal's usual procedures, with peer review handled independently of the relevant editor and their research groups. More information on types of peer review.

Use of wordprocessing software
It is important that the file be saved in the native format of the wordprocessor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the wordprocessor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: https://www.elsevier.com/guidepublication). Note that source files of figures, tables and text graphics will be required whether or not you embed your figures in the text. Source files must have "consecutive" line numbering added by authors (this must include tables, captions, references).See also the section on Electronic artwork.

To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your wordprocessor.

Introduction
State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods
Provide sufficient detail to allow the work to be reproduced, with details of supplier and catalogue number when appropriate. Methods already published should be indicated by a reference: only relevant modifications should be described.

Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Essential title page information
• ***Title.*** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• ***Author names and affiliations.*** Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. You can add your name between parentheses in your own script behind the English transliteration. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.
• ***Corresponding author.*** Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. This responsibility includes answering any future queries about Methodology and Materials. **Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.**
• ***Present/permanent address.*** If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Highlights
Highlights are optional yet highly encouraged for this journal, as they increase the discoverability of your article via search engines. They consist of a short collection of bullet points that capture the novel results of your research as well as new methods that were used during the study (if any). Please have a look at the examples here: example Highlights.

Highlights should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point).

Abstract
A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract
Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a

separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site.

Stereochemistry abstract
For each important chiral compound you are requested to supply a stereochemistry abstract detailing structure, name, formula and all available stereochemical information for eventual incorporation into a database. An abstract for only one enantiomer per compound is required.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, using British spelling and avoiding general and plural terms and multiple concepts (avoid, for example, 'and', 'of'). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords will be used for indexing purposes.

Abbreviations
Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements
Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Formatting of funding sources
List funding sources in this standard way to facilitate compliance to funder's requirements:

Funding: This work was supported by the National Institutes of Health [grant numbers xxxx, yyyy]; the Bill & Melinda Gates Foundation, Seattle, WA [grant number zzzz]; and the United States Institutes of Peace [grant number aaaa].

It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

If no funding has been provided for the research, it is recommended to include the following sentence:

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

Units
Follow internationally accepted rules and conventions: use the international system of units (SI). If other units are mentioned, please give their equivalent in SI.

Math formulae
Please submit math equations as editable text and not as images. Present simple formulae in line with normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Footnotes
Footnotes should be used sparingly. Number them consecutively throughout the article. Many word processors can build footnotes into the text, and this feature may be used. Otherwise, please indicate the position of footnotes in the text and list the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.

Artwork

Electronic artwork
General points
- Make sure you use uniform lettering and sizing of your original artwork.
- Embed the used fonts if the application provides that option.

• Aim to use the following fonts in your illustrations: Arial, Courier, Times New Roman, Symbol, or use fonts that look similar.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Provide captions to illustrations separately.
• Size the illustrations close to the desired dimensions of the published version.
• Submit each illustration as a separate file.
• Ensure that color images are accessible to all, including those with impaired color vision.

A detailed guide on electronic artwork is available.
You are urged to visit this site; some excerpts from the detailed information are given here.
Formats
If your electronic artwork is created in a Microsoft Office application (Word, PowerPoint, Excel) then please supply 'as is' in the native document format.
Regardless of the application used other than Microsoft Office, when your electronic artwork is finalized, please 'Save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):
EPS (or PDF): Vector drawings, embed all used fonts.
TIFF (or JPEG): Color or grayscale photographs (halftones), keep to a minimum of 300 dpi.
TIFF (or JPEG): Bitmapped (pure black & white pixels) line drawings, keep to a minimum of 1000 dpi.
TIFF (or JPEG): Combinations bitmapped line/half-tone (color or grayscale), keep to a minimum of 500 dpi.
Please do not:
• Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); these typically have a low number of pixels and limited set of colors;
• Supply files that are too low in resolution;
• Submit graphics that are disproportionately large for the content.

Color artwork
Please make sure that artwork files are in an acceptable format (TIFF (or JPEG), EPS (or PDF), or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no additional charge, that these figures will appear in color online (e.g., ScienceDirect and other sites) regardless of whether or not these illustrations are reproduced in color in the printed version. **For color reproduction in print, you will receive information regarding the costs from Elsevier after receipt of your accepted article**. Please indicate your preference for color: in print or online only. Further information on the preparation of electronic artwork.

Figure captions
Ensure that each illustration has a caption. Supply captions separately, not attached to the figure. A caption should comprise a brief title (**not** on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

Tables

Please submit tables as editable text and not as images. Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. Please avoid using vertical rules and shading in table cells.

References

Citation in text
Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. If these references are included in the reference list they should follow the standard reference style of the journal and should include a substitution of the publication date with either 'Unpublished results' or 'Personal communication'. Citation of a reference as 'in press' implies that the item has been accepted for publication.

Reference links
Increased discoverability of research and high quality peer review are ensured by online links to the sources cited. In order to allow us to create links to abstracting and indexing services, such as Scopus, Crossref and PubMed, please ensure that data provided in the references are correct. Please note that incorrect surnames, journal/book titles, publication year and pagination may prevent link creation. When copying references, please be careful as they may already contain errors. Use of the DOI is highly encouraged.

A DOI is guaranteed never to change, so you can use it as a permanent link to any electronic article. An example of a citation using DOI for an article not yet in an issue is: VanDecar J.C., Russo R.M., James D.E., Ambeh W.B., Franke M. (2003). Aseismic continuation of the Lesser Antilles slab beneath northeastern Venezuela. Journal of Geophysical Research, https://doi.org/10.1029/2001JB000884. Please note the format of such citations should be in the same style as all other references in the paper.

Web references
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

Data references
This journal encourages you to cite underlying or relevant datasets in your manuscript by citing them in your text and including a data reference in your Reference List. Data references should include the following elements: author name(s), dataset title, data repository, version (where available), year, and global persistent identifier. Add [dataset] immediately before the reference so we can properly identify it as a data reference. The [dataset] identifier will not appear in your published article.

Preprint references
Where a preprint has subsequently become available as a peer-reviewed publication, the formal publication should be used as the reference. If there are preprints that are central to your work or that cover crucial developments in the topic, but are not yet formally published, these may be referenced. Preprints should be clearly marked as such, for example by including the word preprint, or the name of the preprint server, as part of the reference. The preprint DOI should also be provided.

Reference management software
Most Elsevier journals have their reference template available in many of the most popular reference management software products. These include all products that support Citation Style Language styles, such as Mendeley. Using citation plug-ins from these products, authors only need to select the appropriate journal template when preparing their article, after which citations and bibliographies will be automatically formatted in the journal's style. If no template is yet available for this journal, please follow the format of the sample references and citations as shown in this Guide. If you use reference management software, please ensure that you remove all field codes before submitting the electronic manuscript. More information on how to remove field codes from different reference management software.

Reference formatting
There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/ book title, chapter title/article title, year of publication, volume number/book chapter and the article number or pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct. If you do wish to format the references yourself they should be arranged according to the following examples:

Reference style
Text: Indicate references by number(s) in square brackets in line with the text. The actual authors can be referred to, but the reference number(s) must always be given.
List: Number the references (numbers in square brackets) in the list in the order in which they appear in the text.
Examples:
Reference to a journal publication:
[1] Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. J Sci Commun 2010;163:51–9. https://doi.org/10.1016/j.Sc.2010.00372.

Reference to a journal publication with an article number:
[2] Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. Heliyon. 2018;19:e00205. https://doi.org/10.1016/j.heliyon.2018.e00205
Reference to a book:
[3] Strunk Jr W, White EB. The elements of style. 4th ed. New York: Longman; 2000.
Reference to a chapter in an edited book:
[4] Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. Introduction to the electronic age, New York: E-Publishing Inc; 2009, p. 281–304.
Reference to a website:
[5] Cancer Research UK. Cancer statistics reports for the UK, http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/; 2003 [accessed 13 March 2003].
Reference to a dataset:
[dataset] [6] Oguro M, Imahiro S, Saito S, Nakashizuka T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. https://doi.org/10.17632/xwj98nb39r.1.
Note shortened form for last page number. e.g., 51–9, and that for more than 6 authors the first 6 should be listed followed by 'et al.' For further details you are referred to 'Uniform Requirements for Manuscripts submitted to Biomedical Journals' (J Am Med Assoc 1997;277:927–34) (see also Samples of Formatted References).

Journal abbreviations source
Journal names should be abbreviated according to the List of Title Word Abbreviations.

Supplementary material

Supplementary material such as applications, images and sound clips, can be published with your article to enhance it. Submitted supplementary items are published exactly as they are received (Excel or PowerPoint files will appear as such online). Please submit your material together with the article and supply a concise, descriptive caption for each supplementary file. If you wish to make changes to supplementary material during any stage of the process, please make sure to provide an updated file. Do not annotate any corrections on a previous version. Please switch off the 'Track Changes' option in Microsoft Office files as these will appear in the published version.

Each supplementary material file should have a short caption which will be placed at the bottom of the article, where it can assist the reader and also be used by search engines.

Research data

This journal requires and enables you to share data that supports your research publication where appropriate, and enables you to interlink the data with your published articles. Research data refers to the results of observations or experimentation that validate research findings. To facilitate reproducibility and data reuse, this journal also encourages you to share your software, code, models, algorithms, protocols, methods and other useful materials related to the project.

Below are a number of ways in which you can associate data with your article or make a statement about the availability of your data when submitting your manuscript. When sharing data in one of these ways, you are expected to cite the data in your manuscript and reference list. Please refer to the "References" section for more information about data citation. For more information on depositing, sharing and using research data and other relevant research materials, visit the research data page.

Data linking
If you have made your research data available in a data repository, you can link your article directly to the dataset. Elsevier collaborates with a number of repositories to link articles on ScienceDirect with relevant repositories, giving readers access to underlying data that gives them a better understanding of the research described.

There are different ways to link your datasets to your article. When available, you can directly link your dataset to your article by providing the relevant information in the submission system. For more information, visit the database linking page.

For supported data repositories a repository banner will automatically appear next to your published article on ScienceDirect.

In addition, you can link to relevant data or entities through identifiers within the text of your manuscript, using the following format: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

Data statement

To foster transparency, we require you to state the availability of your data in your submission if your data is unavailable to access or unsuitable to post. This may also be a requirement of your funding body or institution. You will have the opportunity to provide a data statement during the submission process. The statement will appear with your published article on ScienceDirect. For more information, visit the Data Statement page..

AFTER ACCEPTANCE

News and embargoes

If you think your article would be interesting for a wider audience, we would be happy to hear from you. Please contact the Journal Manager, Stephanie Turner (s.turner.1@elsevier.com) and we'll send you an information form to complete. You must inform the Journal Manager if you are planning publicity for your article through your institution or funding body. Any publicity materials must be approved by Elsevier before release, and must not be distributed before the article has been published.

Uncorrected proofs of articles are published online on ScienceDirect as soon as they are available. As such, information about embargoes is not available. Authors can track the status of their article via the **Track Your Accepted Article service**. Uncorrected articles are normally available online within two working days of you receiving the email to download the proofs.

Online proof correction

To ensure a fast publication process of the article, we kindly ask authors to provide us with their proof corrections within two days. Corresponding authors will receive an e-mail with a link to our online proofing system, allowing annotation and correction of proofs online. The environment is similar to MS Word: in addition to editing text, you can also comment on figures/tables and answer questions from the Copy Editor. Web-based proofing provides a faster and less error-prone process by allowing you to directly type your corrections, eliminating the potential introduction of errors.
If preferred, you can still choose to annotate and upload your edits on the PDF version. All instructions for proofing will be given in the e-mail we send to authors, including alternative methods to the online version and PDF.
We will do everything possible to get your article published quickly and accurately. Please use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor. It is important to ensure that all corrections are sent back to us in one communication. Please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility.

Offprints

The corresponding author will, at no cost, receive a customized Share Link providing 50 days free access to the final published version of the article on ScienceDirect. The Share Link can be used for sharing the article via any communication channel, including email and social media. For an extra charge, paper offprints can be ordered via the offprint order form which is sent once the article is accepted for publication. Corresponding authors who have published their article gold open access do not receive a Share Link as their final published version of the article is available open access on ScienceDirect and can be shared through the article DOI link.

AUTHOR INQUIRIES

Visit the Elsevier Support Center to find the answers you need. Here you will find everything from Frequently Asked Questions to ways to get in touch.
You can also check the status of your submitted article or find out when your accepted article will be published.