

**PREDICTORS OF COVID-19
VACCINE ACCEPTANCE, DELAY
AND REFUSAL:**

**Who accepts, delays, or refuses
COVID-19 vaccines?**

A Rapid Evidence Assessment

April 2023

UNICEF Innocenti – Global Office of Research and Foresight

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London Metropolitan University Performance with Purpose Research Centre

London Metropolitan University's Performance with Purpose Research Centre is located within the Guildhall School of Business and Law. The Centre focuses on research that addresses real societal challenges, such as inclusion, social value and equity, and applies business and management techniques to support effective organizational performance in tackling social problems. The research team was led by Dr. Stephen Hills and included Dr. Justin Webb, Dr. Anna Baker, Dr. Somayeh Pouransari and Alexandros Semertzi. For more information please visit: www.londonmet.ac.uk/research/centres-groups-and-units/performance-with-purpose-research-centre

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CONTENTS

01 EXECUTIVE SUMMARY	4
02 INTRODUCTION	9
03 METHODOLOGY	11
04 EVIDENCE	17
05 WHO IS MORE LIKELY TO DELAY OR REFUSE VACCINATION AND IN WHAT CONTEXT?	23
5.1 Demographics	24
5.1.1 Age	24
5.1.2 Sex/gender	43
5.1.3 Education	59
5.1.4 Income	74
5.1.5 Race/ethnicity	85
5.1.6 Marital status	94
5.1.7 Living area	100
5.1.8 Having children	106
5.1.9 COVID-19 infection	112
06 WHY ARE PEOPLE MORE LIKELY TO DELAY OR REFUSE VACCINATION AND IN WHAT CONTEXT?	117
6.1 Psychological capability	118
6.1.1 COVID-19 knowledge	118
6.1.2 Social media	125
6.2 Social opportunity	132
6.2.1 Political ideology	132
6.3 Reflective motivation	138
6.3.1 Perceived vaccine safety	138
6.3.2 Perceived vaccine efficacy	145
6.3.3 Perceived vulnerability to COVID-19	151
6.3.4 Perceived susceptibility to COVID-19	159
6.3.5 Trust in healthcare professionals	168
6.3.6 Trust in government	174
07 CONCLUSIONS	180
7.1 Who is more likely to delay or refuse vaccination and in what context?	181
7.2 Why are people more likely to delay or refuse vaccination and in what context?	184
08 POLICY IMPLICATIONS	188
8.1 Targeting those more likely to be vaccine hesitant	189
8.2 Improving psychological capability	193
8.3 Improving social opportunity	195
8.4 Improving reflective motivation	197
09 REFERENCES	201

EXECUTIVE SUMMARY

01

Background

The arrival of effective COVID-19 vaccines was expected to be the beginning of the end of the COVID-19 pandemic. However, as vaccine availability has increased in much of the world, challenges remain related to acceptance and uptake of COVID-19 vaccines. This rapid evidence assessment (REA) seeks to understand the existing evidence about who delays or refuses COVID-19 vaccination, why and in what contexts, to inform tailored policies and interventions that support vaccination acceptance and uptake wherever the COVID-19 vaccine is available.

Research questions

1. Who is more likely to delay or refuse vaccination?
2. Why are people more likely to delay or refuse vaccination?
3. In what contexts are people more likely to delay or refuse vaccination?

Conceptual framework

The COM-B model proposes that there are three components that play a pivotal role in producing behaviour and which, therefore, can be modified to change behaviour. According to the model, in order to perform a behaviour, an individual must feel that they are physically and psychologically capable of performing the behaviour, have the physical and social opportunity to perform the behaviour and the motivation to perform the behaviour such that they want to or need to carry out the behaviour more than competing behaviours.

Methodology

A systematic search of the literature was undertaken to identify empirical research in journal articles written in English, published up to and including 30 June 2021, which investigated factors associated with COVID-19 vaccine hesitancy or resistance. Keywords and search strings were designed and tested to capture this focus and a systematic search was undertaken in PubMed Central, Web of Science and Google Scholar, which returned 1,394 studies about vaccine hesitancy. The returned articles underwent title, abstract and full text screening against the inclusion and exclusion criteria before a quality appraisal determined the final list of 56 unique studies to be included in this REA. These studies underwent thematic analysis to establish factors associated with vaccine hesitancy before evidence was segmented by region, cultural groups and income of countries to establish the contexts in which factors were predictive of vaccine hesitancy, using the COM-B model as a theoretical framework.

Who is more likely to delay or refuse vaccination and in what context?

Age: Younger age groups are more likely to be vaccine hesitant [55 per cent of studies; 26 out of 47], as particularly evident in European [71 per cent of studies, 17 out of 24] and the Germanic Europe cultural group [100 per cent of studies, 4 out of 4] countries.

Sex/gender: Females are more likely to be vaccine hesitant [69 per cent of studies, 31 out of 45], as particularly evident in Middle East cultural group countries [100 per cent of studies, 7 out of 7].

Education: The relationship between education and vaccine hesitancy is inconclusive [47 per cent of studies, 16 out of 34 found that education is not predictive; 41 per cent of studies, 14 out of 34 found that as education level increases, vaccine hesitancy decreases].

Income: People with lower income are more likely to be vaccine hesitant [57 per cent of studies, 12 out of 21], as particularly evident in European [71 per cent of studies, 5 out of 7] and Anglo cultural group [77 per cent of studies, 10 out of 13] countries.

Race/ethnicity: Members of Black ethnic groups are most likely to be vaccine hesitant [65 per cent of studies, 11 out of 17].

Marital status: Unmarried people are more likely to be vaccine hesitant [63 per cent of studies, 5 out of 8].

Living area: Whether someone is a rural or urban dweller is not associated with vaccine hesitancy [62 per cent of studies, 5 out of 8], as particularly evident in European [75 per cent of studies, 3 out of 4], Anglo cultural group [100 per cent of studies, 4 out of 4] and high income [80 per cent of studies, 4 out of 5] countries.

Having children: Whether someone has children or not is not associated with vaccine hesitancy [50 per cent of studies, 5 out of 10].

COVID-19 Infection: Previously having had COVID-19 is not associated with vaccine hesitancy [83 per cent of studies, 5 out of 6], as particularly evident in European [100 per cent of studies, 4 out of 4], Anglo cultural group [100 per cent of studies, 4 out of 4] and high income [83 per cent of studies, 5 out of 6] countries.

Why are people more likely to delay or refuse vaccination and in what contexts?

Psychological capability: Our psychological capability to perform a behaviour.

COVID-19 knowledge: People with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more likely to be vaccine hesitant [73 per cent of studies, 8 out of 11].

Social media: Users of social media for COVID-19 information are most likely to be vaccine hesitant [83 per cent of studies, 5 out of 6].

Social opportunity: External social opportunities required to make performing a behaviour possible, such as social pressures, cultural rules and expectations, and cultural perceptions.

Political ideology: Right-wing or conservative voters are more likely to be vaccine hesitant [70 per cent of studies, 7 out of 10].

Reflective motivation: The reflective and internal processes by which we evaluate existing situations, influencing our decision-making and thus behaviours.

Perceived vaccine safety: People who perceive the vaccine to be less safe or to cause side effects are more likely to be vaccine hesitant [100 per cent of studies, 16 out of 16], as particularly evident in North American [100 per cent of studies, 6 out of 6], Asian [100 per cent of studies, 5 out of 5] European [100% of studies, 4 out of 4], Anglo cultural group [100 per cent of studies, 7 out of 7] and high income [100 per cent of studies, 13 out of 13] countries.

Perceived vaccine efficacy: People who perceive the vaccine to be less effective are more likely to be vaccine hesitant [80% of studies, 4 out of 5], as particularly evident in high income countries [75% of studies, 3 out of 4].

Perceived vulnerability: People who perceive themselves to be less vulnerable to COVID-19 are more likely to be vaccine hesitant [79 per cent of studies, 11 out of 14], as particularly evident in North American [100 per cent of studies, 4 out of 4], European [75 per cent of studies, 3 out of 4], Anglo cultural group [80 per cent of studies, 4 out of 5 studies] and high income [73 per cent of studies, 8 out of 11] countries.

Perceived susceptibility: People who perceive themselves to be less susceptible to catching COVID-19 are more likely to be vaccine hesitant [54 per cent of studies, 7 out of 13].

Trust in healthcare professionals: People who have less trust in healthcare professionals are more likely to be vaccine hesitant [100 per cent of studies, 6 out of 6], as particularly evident in European [100 per cent of studies, 5 out of 5], Anglo cultural group [100 per cent of studies, 5 out of 5] and high income [100 per cent of studies, 6 out of 6] countries.

Trust in government: People who have less trust in the government are more likely to be vaccine hesitant [83 per cent of studies, 5 out of 6].

Policy implications

Support younger age groups to receive the COVID-19 vaccine: Health services should present easy and convenient opportunities to receive a COVID-19 vaccine. For example, the NHS in the UK is using pop-up vaccination sites near young people's most common work, study and leisure locations. Also, smoothing out the registration process for an appointment makes it easier to

get a vaccine. For example, the NHS in the UK is making it easier to book and cancel appointments online.

Support females to receive the COVID-19 vaccine: Females may be concerned that the COVID-19 vaccine poses a threat to fertility or that the vaccine should not be taken during pregnancy or when breastfeeding, related to uncertainty at the start of the vaccine rollout when there was not enough data to be as conclusive about the safety of the vaccine for pregnant women and breastfeeding women. Doctors and midwives should assure pregnant and breastfeeding women of the safety of the vaccine based upon the extensive data that is now available, communicating that having COVID-19 during pregnancy carries a far higher risk than having the vaccine, whereby pre-term births, stillbirths and newborn deaths are more common among women who recently had COVID-19.

Support low income people and households to receive the COVID-19 vaccine: Low income people may not have the resources (e.g., time, transport, childcare) to access the vaccine, thus the vaccine should be taken to them, such as pop-up vaccination centres in areas of greater deprivation.

Increase COVID-19 knowledge and reduce acceptance of COVID-19 conspiracy theories: Continued regulation of COVID-19 conspiracy theories on social media and other channels can help to limit the spread of information that is eroding COVID-19 knowledge. However, a more sustainable approach is empowering people to be able to think critically about information, to be able to distinguish fact from fiction. Schools should place an emphasis on teaching critical thinking, rather than attempting the futile task of converting vaccine-resistant people who are invested in conspiracy theories. Changing highly engrained beliefs in the short term is unlikely. Rather, there is a need to engage with the themes of power, personal freedom, agency, citizen against state and loss of traditional lifestyle, which anti-vax conspiracy theories revolve around and are now being extended to the climate change challenge. Such engagement can be undertaken in schools and universities, and town hall meetings.

Reduce reliance on social media for COVID-19 information: Continued regulation of fake COVID-19 news on social media can help to limit the broadcasting of COVID-19 conspiracy theories. However, mega media corporations labelling pseudoscience as misleading may only support the beliefs of conspiracy theorists. Also, regulating the information shared in groups, such as WhatsApp groups, is much more of a challenge and is where most fake news and conspiracy theories are spread.

Depoliticise the vaccine, avoid mandates and diversify pro-vaccine messengers: Governments mandating vaccines serves to strengthen the political divide on vaccines

and should be avoided wherever possible, with focus instead being on building trust and addressing concerns with receiving the vaccine. Diversifying the messengers, and using non-political figures to promote pro-vaccine messages will further depoliticise the vaccine. Right-wing and conservative leaders (especially when not in government) should be involved in promoting pro-vaccine messages to encourage vaccine uptake among right-wing and conservative voters.

Communicate real-world safety data in a meaningful context: Transparent communication of trial and real-world data, focusing not just on the efficacy data, but also the safety data, is required for confidence in vaccine safety. Safety data should be put into context so that it can be more meaningful, such as providing comparable data on blood clot risk from the vaccine, versus COVID-19 itself and birth control pills, or even calculating the risk of hospitalization and death from a COVID-19 vaccine and comparing this with the risk of hospitalization and death from undertaking a car journey.

Communicate real-world efficacy data for transmission, hospitalizations and deaths when adhering to an appropriate vaccine schedule: Timely communication about the effectiveness of vaccines against new COVID-19 variants is critical to maintain confidence in the efficacy of vaccines so that, even where efficacy in transmission drops, the efficacy of the vaccines in limiting transmission and the spread of the virus is understood and that, even where efficacy in limiting transmission decreases, that efficacy in limiting hospitalizations and deaths remains very high. Furthermore, communication of efficacy data should also consider efficacy of number of doses and boosters, and how long protection can be expected to last for before it starts to wane, to build confidence in the vaccines when an appropriate vaccine schedule is followed. Real-world data, rather than trial data, should be used wherever possible to ensure communications are more meaningful.

Challenge beliefs of invulnerability: Communicate risks for groups who do not perceive themselves to be vulnerable to COVID-19, with a focus on different risk profiles dependent upon vaccination status. For example, hospital occupancy rates for different age groups segmented by vaccination status, so to reframe personal risk assessment to be about the risk of not receiving the vaccine, rather than about the risk of catching COVID-19. For example, in the first half of 2021 in the United Kingdom for every one death from COVID-19 in the vaccinated population, there were nearly 200 deaths from COVID-19 in the unvaccinated population. Deliver messages via age-appropriate and relevant people who previously considered themselves to be invulnerable until they were infected.

Understand historical reasons for lack of trust in medical professionals and diversify messengers: Research is required to understand why different groups have a lack of trust in healthcare professionals as a foundation from which trust can be rebuilt. For example, do certain groups face or have faced unethical and medical treatment in the past from healthcare professionals (e.g., the Tuskegee Syphilis Study)? History may lead groups who are being prioritised to receive a vaccine due to age, health conditions and occupation to believe that they are again being used as guinea pigs for experimental drugs. Also, policymakers should seek to understand community hierarchies and local patterns of trust and deliver messages via age-appropriate, relevant and trusted people known to each target group.

Model COVID-19 protective behaviours and be transparent: State-level research is required to understand if and why trust in a government is a barrier to vaccine acceptance to serve as a foundation from which to rebuild trust. Governments should model the behaviour, including receiving vaccines and engaging in other protective behaviours, that they ask their public to engage in, in order to maintain trust. Also, if a government is perceived to not accurately be reporting cases and deaths of COVID-19, it may be difficult to trust them with regard to a vaccine. Governments should be transparent and honest during a public health emergency to maintain trust.

INTRODUCTION

02

Background

The arrival of effective COVID-19 vaccines was expected to be the key intervention to bring about the end of the COVID-19 pandemic (1, 2). However, as vaccine availability has increased in much of the world since vaccines first became available in December 2020, pockets of unvaccinated people continue to put health systems under pressure in the face of more contagious variants that have resulted in record numbers of infections. For example, in January 2021 when the United Kingdom experienced the peak of a wave of omicron variant infections, unvaccinated people represented only 9% of the United Kingdom's over-12 -years-old population (3), but accounted for an estimated 70% of the nearly 35,000 people hospitalized with COVID-19 in England (4).

As issues with COVID-19 vaccine supply and availability are increasingly resolved, the challenge now is supporting populations to get vaccinated. This requires encouraging people to accept and seek out COVID-19 vaccination services. This REA seeks to understand the existing evidence about who delays or refuses COVID-19 vaccination, why and in what contexts. The World Health Organization (WHO) uses the term 'vaccine hesitancy' to refer to the delay in acceptance or refusal of vaccination despite availability of vaccination services (5). Recognizing that the terminology of vaccine hesitancy is contested, this review uses the term in its broadest sense without presuppositions about why people might delay or refuse vaccination. The objective of the REA is to synthesize existing evidence to inform policies and interventions to support people to accept the vaccine when and where it is available.

This report forms part of a larger evidence assessment to investigate non-pharmacological interventions (NPIs) or behavioural interventions to prevent the community spread of SARS-CoV-2, namely social distancing, mask wearing and self-isolation.

Research questions

1. Who is more likely to delay or refuse vaccination?

2. Why are people more likely to delay or refuse vaccination?

3. In what contexts are people more likely to delay or refuse vaccination?

Conceptual framework

The COM-B model (6) was used as a conceptual framework for this REA. It proposes that there are three components that play a pivotal role in producing behaviour and which, therefore, can be modified to change behaviour. According to the model, in order to perform a behaviour, such as the behaviour of receiving a vaccine, an individual must feel that they are physically and psychologically capable of performing the behaviour, have the physical and social opportunity to perform the behaviour and the motivation to perform the behaviour such that they want to or need to carry out the behaviour more than competing behaviours, such as not receiving a vaccine or violating social distancing rules.

- **Capability:** Our abilities to perform a behaviour, including psychological capability, such as knowledge, and physical capability.
- **Opportunity:** External factors required to make performing a behaviour possible, including physical opportunities, such as being able to access a location, having the time and the resources, and social opportunities, such as social pressures, cultural rules and expectations, and cultural perceptions. Furthermore, opportunities may include campaigns or interventions (e.g., advertising campaigns) designed to encourage adherence.
- **Motivation:** Internal processes that influence our decision-making and thus behaviours, including reflective motivation, which covers the reflective processes whereby we evaluate existing situations, such as perceptions of the impact of the behaviour on oneself, and automatic motivation, such as desires and impulses.

03

Systematic search

Inclusion criteria: The inclusion criteria are presented in Table 1 below. Only published academic journal articles are included in this REA, so that the evidence being rapidly assessed has first passed through the peer review process so as to pass an initial quality threshold. Only studies written in English are included, such that there may be relevant evidence published in non-English that are excluded in this review. Collection of evidence commenced on 30 June 2021, so any studies published after this date are excluded. This REA includes factors (e.g., demographics, capabilities, opportunities, motivations, campaigns) associated with the hesitancy or resistance (or

conversely the acceptance or uptake) of COVID-19 vaccines. Studies about efficacy of vaccines (i.e., clinical trials) are excluded, but studies about the efficacy of campaigns to increase vaccine uptake are included, if available. Although there are pre-COVID-19 studies (e.g., SARS, Ebola, swine flu), studies in these contexts are excluded and only studies in the context of COVID-19 are included. Study designs that are included are empirical research, whether quantitative or qualitative. Theoretical or conceptual studies are excluded, as are studies that are lacking explanation of the methodology used or which are secondary literature reviews. Systematic reviews or REAs are also excluded, to avoid double review of studies included in the review as independent studies.

Table 1: Inclusion criteria

	Inclusion criteria	Exclusion criteria
Publication format	Journal articles	Not journal articles Pre-Prints
Language	English	Not in English
Publication date	Up to and including 30 June 2021	Post 30 June 2021
Aim of study	Investigating factors associated with vaccine hesitancy or resistance (or conversely, vaccine acceptance or uptake)	Not investigating factors associated with vaccine hesitancy or resistance (or conversely, vaccine acceptance or uptake) Efficacy of vaccines (i.e., clinical trials)
Protective measure	Vaccine	Not vaccine

Virus	COVID-19	SARS Ebola Swine flu Not COVID-19
Study population	General population for a given territory Specific populations defined by demographic factors of ethnicity, gender OR age	Specific populations defined by factors other than demographic factors of ethnicity, gender OR age (e.g., hospital populations).
Study design	Empirical research (quantitative OR qualitative)	EITHER theoretical/conceptual OR lacking explanation of methodology OR secondary literature review OR systematic reviews OR rapid evidence assessments

Keywords and search strings: The following table provides a list of the keywords for the systematic search of studies via the study's title, abstract and key words. Three layers of keywords are used to reflect the inclusion criteria.

Table 2: Covid vaccine hesitancy keywords

Keywords 1	Covid; coronavirus
Keywords 2	Vaccin* [vaccine/vaccination/vaccinating]
Keywords 3	Hesitan* [hesitancy/hesitant]; uptake; sentiment; resist* [resistance/resisting/resisted]; avoid* [avoidance/avoiding/avoided]; reason* [reasons]; associat* [associated/associations]; predict* [predictors/predicted]; expla* [explanatory/explained]; campaign* [campaigns]

The research team tested the keywords and search strings across the databases and found that they were effective at returning relevant evidence ahead of the full search commencing.

Databases: The research team undertook a comprehensive search of academic and open source databases, as listed in Table 3.

Table 3: List of databases searched

PubMed Central
Web of Science
Google Scholar

Screening

The following three-stage screening process was undertaken to determine the evidence to be included in the REA.

Title screening stage: The titles of studies returned by the systematic searches were screened for relevance using the inclusion criteria and studies clearly not meeting the inclusion criteria, based upon the limited information available from a title, were excluded. Where a member of the research team was unsure about a study, it was discussed with a second member of the team to decide on inclusion (or not) in the next stage of screening.

Abstract screening stage: Of the remaining studies, their abstracts were next screened for relevance against the inclusion criteria, using the greater information available. Studies deemed not to meet the inclusion criteria were excluded. Again, where a member of the research team was unsure about a study, it was discussed with a second member of the team to decide on inclusion (or not) in the next stage of screening.

Full text screening stage: Of the remaining studies, studies were read in full to determine if all inclusion criteria had been met and excluded if not. Where a member of the research team was unsure, a second member of the research team also read the full text. Both then discussed the study and came to a decision together on whether the study should be included or excluded. The quality of a study was also appraised when reading the full text, considering guidance from the UK's Department for International Development (DFID) (7). on assessing the strengths of evidence.

Quality appraisal

The quality of a study was also appraised when reading the full text, considering guidance from the UK's Department for International Development (DFID, 7). Judgment about a study's quality should be based upon a combination of criteria covering conceptual framing, transparency, appropriateness, cultural sensitivity, validity, reliability and cogency, as summarised and applied to this REA as follows:

Conceptual framing: The study should acknowledge existing research or theory, construct a conceptual or theoretical framework setting out the study's assumptions and pose specific research questions or hypotheses.

Transparency: The study should be transparent about its design and methods, including data collection and analysis and research setting, such that results can be reproduced. Studies receiving funding from a party with vested interests are considered fatally flawed and should be excluded from this REA.

Appropriateness: The study should use an appropriate research design to answer its research question or achieve its aim or objectives. The screening process will have included only studies investigating factors associated with decisions to delay or refuse vaccination (vaccine hesitancy). Experimental designs are most appropriate for establishing causal linkages between a treatment (e.g., campaign) and a dependent variable (e.g., hesitancy), but, other than campaigns, most factors (e.g., demographics, capabilities, opportunities and motivations) can only be measured and observed as independent variables, rather than manipulated or randomly assigned. As such, associations are most appropriately measured using observational designs, such as regression designs, these measure the association between factors and behaviours whilst controlling for confounding variables. This protects against bias whereby an unmeasured and uncontrolled variable can result in a distortion in the measurement of an association between a factor and a behavioural outcome. Qualitative studies are not appropriate for measuring associations but they are included in this REA because rich qualitative data can provide valuable evidence in terms of detailing the mechanisms and processes by which a factor is associated with decisions to delay or refuse vaccination. Studies considered to be using an inappropriate design were excluded from this REA.

Cultural sensitivity: The study should take steps to consider the local, socio-cultural factors that might affect the association between factors and decisions to delay or refuse vaccination (i.e., are confounding variables). This is particularly important in the context of campaigns as treatment variables, where a control condition, in which the setting (i.e., socio-cultural factors) is held constant, should be included as part of the design, to isolate the

effect of a campaign from the setting in which it was implemented. Such measures are not possible when observing independent variables, but a study could theoretically consider socio-cultural factors when they represent a potential bias.

Validity: The study should take steps to ensure measurement validity, internal validity, external validity and ecological validity.

Measurement validity: The study should use indicators that are well suited to measure the target concept and which are valid in the research setting of the study. For example, using statements that measure the construct or variable of interest and using concrete facts (e.g., qualifications obtained to measure education) rather than abstract concepts where available.

Internal validity: The study should correctly interpret the extent to which its evidence establishes a cause and effect relationship. As described above, the study should take steps to control for confounding variables, which is possible in both experimental and observational designs. Furthermore, the study should take steps to consider reverse causality; the possibility that the supposed independent variable and supposed dependent variable are operating in reverse such that the supposed dependent variable is causing the supposed independent variable. For example, perceived susceptibility has been conceived as an independent variable in relation to the dependent variable of compliance with social distancing rules, but equally, an individual's compliance with social distancing rules can just as plausibly be an independent variable in relation to perceived susceptibility to COVID-19, i.e., I am not complying with social distancing rules so I am more susceptible to infection. An experimental design removes the possibility of reverse causality because the sequence of cause and effect can be observed following implementation of a treatment. However, reverse causality is a potential problem in observational research and where this is a risk it should be considered theoretically, i.e., provide an explanation based upon what we know about the variables to make a claim that one is causing the other.

External validity: The study should correctly interpret the extent to which its findings are likely to be generalisable and replicable across other contexts. Quantitative studies should take steps to construct a representative sample of the population of interest, such as using a sampling frame, randomly selecting responsive units from that sampling frame so that no units are systematically excluded and collecting a sufficient sample size for appropriate margin of error and confidence level.

Ecological validity: The study should take steps to capture or accurately represent the real world by undertaking

reflexivity to consider how much the activity of doing the research biased the research findings. For example, asking questions about legal compliance with rules in a way and in a context that captures the truth, rather than the socially desirable response.

Reliability: The study should take steps to ensure stability, internal reliability and analytical reliability.

Stability: The study should take steps to ensure that measures being used work consistently (i.e., results are stable under the same conditions), for example, by ensuring researchers are consistent in the way questions are asked and data gathered.

Internal reliability: The study should take steps to ensure internal consistency between different components of a measure. For example, Cronbach's Alpha can be used to measure the internal consistency of items comprising a scale and items from scales or variables removed from studies where internal consistency thresholds are not met.

Analytical reliability: The study should take steps to ensure that dramatically different results from the same set of data by different researchers or analytical steps being used are avoided. For example, using multiple researchers and using a coding scheme in thematic analysis.

Cogency: The study should provide a clear, logical thread that runs throughout the manuscript, linking conceptual frameworks to data collection, data analysis and conclusions, only making claims supported by the data and findings. Furthermore, the study should consider alternative explanations and interpretations of the data and findings and be self-critical such that limitations of the study are identified.

Where a member of the research team was unsure whether to include or exclude on the basis of quality, a second member of the research team undertook a quality appraisal of the study before both discussed to jointly reach a decision on inclusion or exclusion.

Data analysis and synthesis

Predictors: Using NVivo software, open coding was undertaken to identify predictors of hesitancy. Once all studies had been coded for predictors, lists of studies containing each predictor were established. At this point, predictors were reviewed to identify predictors of equivalent meaning but different labelling and these collapsed to form a single predictor. For example, it was decided that knowledge and belief in conspiracy theories were equivalent predictors, as were perceived vaccine safety and side effects concern.

Predictor-specific study summaries: Next, predictor-specific summaries of each study were written, identifying the study's context (e.g., United Kingdom residents), sampling method (e.g., convenience sample), how it defined and measured the predictor, how it defined (e.g., vaccine hesitancy, vaccine acceptance or vaccine intention) and measured (e.g., binary variable; hesitant or not) the protective measure outcome variable, the study design (e.g., cross-sectional survey design) and data analysis method (e.g., logistic regression). Next, a summary of the evidence relevant to the predictor of interest was written, which may have been quantitative or qualitative. Where the quantitative analysis was simple (e.g., Chi-square with a single independent variable), the summary described the relationship between the predictor and the outcome variable (e.g., percentage differences and statistical significance), but where it was multiple (e.g., multiple logistic regression), the summary described the relationship between the predictor and the outcome variable (e.g., odds ratio (OR) and statistical significance) when holding other variables constant. Finally, a conclusion was drawn as to the overall finding of the study in terms of the relationship between the predictor and the outcome variable. This may have been identifying a category (e.g., Black respondents were most likely to be vaccine hesitant) where the outcome variable was most prevalent, whether a numerical association was positive (e.g., as age increases, vaccine hesitancy increases), negative (e.g., as age increases, vaccine hesitance decreases), non-linear or non-significant (e.g., there was no association between age and vaccine hesitancy). Where there was conflicting evidence within a single study, the strength of the conflicting evidence was weighed up to determine an overall finding. For example, if the vast majority of categories of a predictor were not significantly associated with an outcome variable then that study would be deemed to evidence that the predictor was not associated with the outcome variable.

Themes by finding: Next, the predictor-specific study summaries were thematically analysed on the basis of their findings. For example, studies were grouped on the basis of a positive association, negative association, non-linear association or no association.

Data synthesis: To draw conclusions for each predictor, frequencies of studies for each theme were counted and percentages calculated, first at the level of predictive vs. non-predictive whereby, for example, studies finding statistically significant associations, regardless of direction of the association, were grouped and counted and compared against all studies that did not find a statistically significant association between a predictor and outcome variable. Next, this synthesis was undertaken at the

granular level of themes, breaking predictive studies down into their different findings (e.g., positive association, negative association, non-linear association and no association). Where a category made up 70% or above of the evidence it was deemed to yield a conclusion of high confidence about the relationship; where a category made up 60% to 69% of the evidence it was deemed to yield a confident conclusion about the relationship; where a category made up 50% to 59% of the evidence it was deemed to yield a conclusion of some confidence about the relationship, unless another category also made up 50% of the evidence, in which case the evidence was deemed inconclusive. Equally, if no categories made up at least 50% of the evidence it was deemed inconclusive.

Context segmentation: To address the question of 'in what contexts are people more likely to delay or refuse vaccination?' evidence was segmented on the basis of (i) region, (ii) cultural group and (iii) income, as determined by the country in which the study was conducted. Region segments used were Europe, North America, Asia, Oceania, South America and Africa. Cultural group segments used were Anglo, Germanic Europe, Nordic Europe, Eastern Europe, Latin Europe, Latin America, Southern Asia, Confucian Asia, Sub-Saharan Africa and the Middle East, as defined by House et al. (8). Income segments used were high income, upper middle income, lower middle income and low income, as defined by the World Bank. The above data synthesis approach was followed at the level of each segment. Where there were less than four studies in a segment, it was deemed that this was insufficient evidence by which to draw conclusions about the relationship between a predictor and outcome variable.

Themes by conceptual framework: Demographic predictors were identified to answer the 'who are more likely to delay or refuse vaccination' question. The remaining predictors were then organised within the COM-B model conceptual framework in terms of psychological capability (e.g., knowledge), physical capability (e.g., physical strength), physical opportunity (e.g., time, location and resources), social opportunity (e.g., cultural norms and social cues), reflective motivation (e.g., reflections and motivations) and automatic motivation (e.g., desires, impulses and inhibitions) to answer the 'why are people more likely to delay or refuse vaccination?' question.

04

Systematic search and screening results

The systematic search returned 1,394 studies about vaccine hesitancy (625 from Web of Science, 420 from Google Scholar and 349 from PubMed). After duplicates were removed on Zotero software, the number of studies decreased to 634.

Title screening stage: Of the 634 unique studies returned from the systematic search, 550 studies were excluded at the title screening stage:

- 550 studies were excluded for not being relevant: not measuring factors associated with COVID-19 vaccine hesitancy.

Abstract screening stage: Of the 84 studies remaining after the title screening stage, 14 studies were excluded at the abstract screening stage:

- 8 studies were excluded for being about too specific a population.
- 3 studies were excluded for not being relevant: one measured vaccine hesitancy, but did not consider factors associated with vaccine hesitancy, one considered non-COVID-19 vaccines and one considered vaccine efficacy (not hesitancy).
- 2 studies were excluded for being commentaries, rather than empirical research.
- 1 study was excluded for not being published in a peer-reviewed academic journal.

Full text screening and quality appraisal stage: Of the 70 studies remaining after the abstract screening stage, 14 studies were excluded at the full text screening and quality appraisal stage:

- 7 studies were excluded for being pre-prints, not having gone through the peer review process at the point of the systematic search.
- 3 studies were excluded for not being relevant: not using vaccine hesitancy as an outcome variable.
- 1 study was excluded for not being in English (although the title and abstract was in English, the full text was only available in Portuguese).
- 1 study was excluded for not being published in a peer-reviewed academic journal.
- 2 studies were excluded for quality issues: one used a highly biased sample, one used an inappropriate research design to measure associations.

Overview of vaccine hesitancy evidence

The final list of vaccine hesitancy evidence to be reviewed consisted of 56 studies, a summary of which follows:

Table 4: Summary of studies included in REA

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
4	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
5	Lockyer et al. (2021)	United Kingdom	Europe	Anglo	High Income
6	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income
7	Wakefield et al. (2021)	United Kingdom	Europe	Anglo	High Income
8	Murphy et al. (2021)	United Kingdom and Ireland	Europe	Anglo	High Income
9	Salali and Uysal (2021)	United Kingdom and Turkey	Europe and Asia	Anglo and Middle East	High Income and Upper Middle Income
10	Agley et al. (2021)	United States	North America	Anglo	High Income
11	Allen et al. (2021)	United States	North America	Anglo	High Income
12	Benis et al. (2021)	United States	North America	Anglo	High Income
13	Chu and Liu (2021)	United States	North America	Anglo	High Income
14	Coe et al. (2021)	United States	North America	Anglo	High Income
15	Dorman et al. (2021)	United States	North America	Anglo	High Income
16	Huynh and Senger (2021)	United States	North America	Anglo	High Income
17	Johnson et al. (2021)	United States	North America	Anglo	High Income
18	Kreps et al. (2021)	United States	North America	Anglo	High Income
19	Park et al. (2021)	United States	North America	Anglo	High Income
20	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
21	Savoia et al. (2021)	United States	North America	Anglo	High Income

22	Shih et al. (2021)	United States	North America	Anglo	High Income
23	Willis et al. (2021)	United States	North America	Anglo	High Income
24	Edwards et al. (2021)	Australia	Oceania	Anglo	High Income
25	Bendau et al. (2021)	Germany	Europe	Germanic Europe	High Income
26	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
27	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
28	Lamot et al. (2020)	Slovenia	Europe	Eastern Europe	High Income
29	Montagni et al. (2021)	France	Europe	Latin Europe	High Income
30	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
31	Caserotti et al. (2021)	Italy	Europe	Latin Europe	High Income
32	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
33	Zampetakis et al. (2021)	Greece	Europe	Latin Europe	High Income
34	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
35	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
36	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income
37	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income
38	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income
39	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
40	Nazli et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
41	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
42	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income

43	Mir et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
44	Sharun et al. (2020)	India	Asia	Southern Asia	Lower Middle Income
45	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income
46	Tao et al. (2021)	China	Asia	Confucian Asia	High Income
47	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
48	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
49	Urrunaga-Pastor et al. (2021)	Multiple Countries	South America	Latin America	Varies
50	Mesele (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
51	Mose and Yesshaneh (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
52	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income
53	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income
54	Lazarus et al. (2021)	Multiple countries non-aggregated			
55	Lindholt et al. (2020)	Multiple countries aggregated			
56	Rozek et al. (2021)	Multiple countries aggregated			

Region: Evidence was reviewed from all regions of the world, but the vast majority of research [82%] was limited to three regions: Europe [34%], North America [25%] and Asia [23%].

Cultural group: Evidence was reviewed from all cultural groups of the world, but considerably more from the Anglo cultural group [41%] than any other cultural group, followed by the Latin Europe cultural group [11%].

Income: The majority of evidence reviewed was from high income countries [66%]. Only two studies [4%] were conducted in the context of low income countries.

Study design: The vast majority of studies [91%] followed a cross-sectional survey research design, which lends itself well to measuring factors associated with vaccine hesitancy.

Table 5: Studies by region, cultural group, income category and study design

	Number	%
Region		
Europe	19	34%
North America	14	25%

Asia	13	23%
Oceania	1	2%
South America	1	2%
Africa	4	7%
Multi-regional	4	7%
Cultural group		
Anglo	23	41%
Germanic Europe	3	5%
Nordic Europe	1	2%
Eastern Europe	1	2%
Latin Europe	6	11%
Latin America	1	2%
Southern Asia	4	7%
Confucian Asia	4	7%
Sub-Saharan Africa	4	7%
Middle East	5	9%
Multi-cultural group	4	7%
Income		
High Income	37	66%
Upper Middle Income	4	7%
Lower Middle Income	8	14%
Low Income	2	4%
Multi-incomes	5	9%
Study design		
Cross-sectional	51	91%
Conjoint experiment	4	7%
Qualitative	1	2%
Total	56	100%

**WHO IS MORE LIKELY TO DELAY OR
REFUSE VACCINATION AND IN
WHAT CONTEXT?**

05

DEMOGRAPHICS
AGE

5.1.1

Age is the number of years since an individual was born. The evidence reviewed measured it as either discrete numerical data (i.e., the exact age in years of a respondent) or as a categorical variable (i.e., the age range group that a respondent's age corresponds to).

In total, 48 studies considered the association between age and vaccine hesitancy. Of these, 33 found that age was predictive of vaccine hesitancy, 14 found that age was not predictive of vaccine hesitancy and one had mixed findings. Of the 33 studies that found age was predictive of vaccine hesitancy, 26 found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more vaccine hesitant), four found that as age increases, vaccine hesitancy increases (i.e., older age groups are more vaccine hesitant) and three found that the relationship between age and vaccine hesitancy is non-linear.

As age increases, vaccine hesitancy decreases

Table 6: Studies evidencing that as age increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
4	Wakefield et al. (2021)	United Kingdom	Europe	Anglo	High Income
5	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
6	Coe et al. (2021)	United States	North America	Anglo	High Income
7	Willis et al. (2021)	United States	North America	Anglo	High Income
8	Dorman et al. (2021)	United States	North America	Anglo	High Income

9	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
10	Shih et al. (2021)	United States	North America	Anglo	High Income
11	Edwards et al. (2021)	Australia	Oceania	Anglo	High Income
12	Bendau et al. (2021)	Germany	Europe	Germanic Europe	High Income
13	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
14	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
15	Caserotti et al. (2021)	Italy	Europe	Latin Europe	High Income
16	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
17	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
18	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
19	Nazli et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
20	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
21	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
22	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
23	Mose and Yesshaneh (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
24	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income
25	Lazarus et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Germany	Europe	Germanic Europe	High Income
		France	Europe	Latin Europe	High Income
		Sweden	Europe	Nordic Europe	High Income
		Poland	Europe	Eastern Europe	High Income
		Canada	North America	Anglo	High Income
		Brazil	South America	Latin America	Upper Middle Income

26	Lindholt et al. (2021)	Multiple countries aggregated
27	Rozek et al. (2021)	Multiple countries aggregated

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine hesitancy, measured from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that age was negatively associated with vaccine hesitancy [$R_s = -0.3$], whereby as age increases, vaccine hesitancy decreases such that younger respondents are more vaccine hesitant. Age was found to be the most predictive of demographic variables, although less predictive than general vaccine attitude, COVID-19 conspiracy suspicions, trust in scientists working at universities, trust in doctors and nurses and trust in scientists working for private companies, such that age was the sixth most important predictor in the rank-order correlations analysis. In terms of mechanisms, age was negatively associated with informational use of social media, which, in turn, was positively associated with conspiracy suspicions.

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant other demographic factors (gender, ethnicity, education, household income), age was negatively associated with vaccine hesitancy [$R_s = -0.29$, $p < 0.001$], whereby as age increases, vaccine hesitancy decreases such that younger respondents are more vaccine hesitant. Age remained predictive, but less so, when holding other factors constant. When also holding constant reliance on legacy media and reliance on social media for COVID-19 knowledge, age was still negatively associated with vaccine hesitancy [$R_s = -0.25$, $p < 0.001$]. When holding constant perceived risk of COVID-19 to oneself, the UK and the world, as well as other demographic factors, age was still negatively associated with vaccine hesitancy [$R_s = -0.26$, $p < 0.001$]. When holding constant trust in the government, scientists working at universities, scientists working at private companies, and doctors and nurses, as well as other demographic factors, age was still negatively associated with vaccine hesitancy [$R_s = -0.24$, $p < 0.001$]. When holding constant general vaccine attitude and COVID-19 conspiracy suspicions, as well as other demographic factors, age was still negatively associated with vaccine hesitancy [$R_s = -0.24$, $p < 0.001$]. When holding constant all factors studied in a single model, age was still negatively associated with vaccine hesitancy [$R_s = -0.21$, $p < 0.001$]. In this full model, age was the third most predictive factor of vaccine hesitancy after general vaccine hesitancy and COVID-19 conspiracy suspicions.

United Kingdom, Jennings et al. (2021): In a nationally representative (quota) sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 29%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, social media platforms use, gender, posting political content online, fact-checking, having had COVID-19, sources of information, education, trust in the media, voting Conservative, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations, and evaluation of government's handling of COVID-19, age was positively associated with vaccine acceptance, whereby the OR of just over 20 means that the oldest respondents were more than 20 times more likely to receive the vaccine compared with the youngest [age range of 18 to 87 was rescaled to a range of 0 to 1], this establishes a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant. Indeed, out of all predictors measured, age was the strongest predictor of vaccine acceptance.

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine hesitancy, measured on a scale from 1 (definitely) to 5 (definitely not) plus an option for don't know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that age was negatively associated with vaccine hesitancy [$B = -0.031$, $p < 0.001$] whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Age was found to be the strongest predictor of vaccine hesitancy [$R^2 = 0.038$] amongst demographic factors, including gender, education, religion, politics, income, ethnicity, relationship status, English region, housing situation, employment status, employment change due to COVID-19, child at school and risk of severe COVID-19.

United Kingdom, Wakefield et al. (2021): In a convenience sample of 130 UK residents, Wakefield et al. (2021) examined the relationship between age, measured as a discrete numerical variable in years, and vaccine willingness, measured on a scale of 1 (definitely not) to 5 (yes, definitely), using linear regression.

Wakefield et al. (2021) found that, when holding constant community identification, duty to community to get vaccinated and subjective neighbourhood socio-economic status, age was positively associated with vaccine acceptance [B = 0.01, p = 0.02], evidencing a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

United Kingdom, Murphy et al. (2021): In nationally representative (quota) samples of 2025 UK residents, Murphy et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable with a hesitancy rate of 31%, using a cross-sectional survey design and multinomial logistic regression.

Murphy et al. (2020) found that, when holding constant sex, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, respondents aged 18–24 years old [AOR = 1.9, p < 0.05], respondents aged 25–34 years old [AOR = 2.33, p < 0.05], respondents aged 35–44 years old [AOR = 2.53, p < 0.05], respondents aged 45–54 years old [AOR = 2.27, p < 0.05] and respondents aged 55–64 years old [AOR = 2.48, p < 0.05] were more likely to be vaccine hesitant (compared with vaccine accepting) than respondents aged 65 years and older. Respondents aged 18–24 years old [AOR = 13.9, p < 0.05], respondents aged 25–34 years old [AOR = 10.11, p < 0.05], respondents aged 35–44 years old [AOR = 11.83, p < 0.05], respondents aged 45–54 years old [AOR = 4.91, p < 0.05] and respondents aged 55–64 years old [AOR = 4.36, p < 0.05] were more likely to be vaccine resistant (compared with vaccine accepting) than respondents aged 65 years and older. Respondents aged 18–24 years old [AOR = 7.3, p < 0.05], respondents aged 25–34 years old [AOR = 4.34, p < 0.05] and respondents aged 35–44 years old [AOR = 4.67, p < 0.05] were more likely to be vaccine resistant (compared with vaccine hesitant) than respondents aged 65 years and older. Respondents aged 45–54 years old and respondents aged 55–64 years old were not more or less likely to be vaccine resistant (compared with vaccine accepting) than respondents aged 65 years and older [p > 0.05].

Overall, there is a negative association between age and both vaccine hesitancy and resistance whereby as age increases, vaccine hesitancy and resistance decrease, such

that younger respondents are more vaccine hesitant and resistant. This relationship was much stronger for vaccine resistance than hesitancy.

United States, Coe et al. (2021): In a nationally representative (quota) sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between gender, measured as a binary variable, and intention to receive the COVID-19 vaccine, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that, respondents aged 65 years and older were more likely to receive the vaccine than respondents aged under 65 years old [COR = 1.71, 95% CI: 1.18–2.47].

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant gender, race, region, ethnicity, education, annual household income, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, age was not associated with vaccine acceptance [AOR = 1.05, 95% CI: 0.58–1.9], which suggests that other factors modelled better accounted for variance in vaccine hesitancy.

Overall, there is some evidence of a positive association between age and vaccine acceptance whereby as age increases, vaccine acceptance increases, such that younger respondents are more vaccine hesitant.

United States, Willis et al. (2021): In a convenience sample of 1,205 Arkansas residents, Willis et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine hesitancy, measured as a binary variable at a hesitancy rate of 78.14%, using a cross-sectional survey design, t-test and a logistic regression model.

Using t-test, Willis et al. (2021) found that there was a significant difference [p = 0.002] between the average age of those who reported hesitancy [45.36 years old] and those who were likely to get the vaccine [49.02 years old], whereby hesitant respondents were, on average, younger.

Using logistic regression, Willis et al. (2021) found that when holding constant sex, race/ethnicity, income, education, COVID-19 health literacy, fear of COVID-19 infection and general vaccine trust, age was negatively associated with vaccine hesitance [OR = 0.98, p = 0.026].

Overall, there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Dorman et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional research design and Chi-square.

Using Chi-square, Dorman et al. (2021) found that vaccine intention differed by age group [$p < 0.001$]. Respondents aged 75+ were most willing to receive the vaccine [5.48 out of 7], followed by 55-74-year-olds [4.99 out of 7], 18-34-year-olds [4.7 out of 7] and least willing were 35-54 year-olds [4.31 out of 7]. Using t-tests, Dorman et al. (2021) found that differences between each category were all significant [$p < 0.001$], which, with the exception of the 35-54-year-old age group, establishes a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between age, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found significant differences in vaccine uptake intention between age groups [$p = 0.005$]. Respondents aged 65 years old and over [74.5%] were most likely to get the vaccine followed by respondents aged 55-64 years old [64%], respondents aged 35-44 years old [64%], 25-34 years old [61%] and 45-54 years old [55.6%]. Respondents aged 18-24 years old [52.5%] were least likely to get the vaccine [52.5%], evidencing a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, gender, of White race, of Hispanic cultural identity, total household income, education, political party identity, marital status and preferred media for virus news, age was not associated with vaccine hesitancy [$p = 0.148$], which suggests that other factors modelled better accounted for variance in vaccine hesitancy.

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between age (generation), measured as a categorical

variable, and vaccine hesitancy, measured using an adapted version of the World Health Organization (WHO) Strategic Advisory Group of Experts on Immunizations (SAGEs) 10-item scale, which was then recoded as two binary variables (vaccine rejection and vaccine resistance), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant residence, generation race/ethnicity, monthly family income and political affiliation, age was not associated with vaccine resistance, but it was with vaccine hesitancy. Baby Boomers (56 years old +) [OR = 0.4, 95% CI 0.25-0.65] and GenX (40-55 years old) [OR = 0.54, 95% CI 0.34-0.85] were less likely to be vaccine hesitant than Millennials (24-39 years old). However, there was no significant difference between Millennials (24-39 years old) and GenZ (18-23 years old [95% CI 0.71-2.51]).

Overall, there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant, but no association between age and vaccine resistance.

Australia, Edwards et al. (2021): In a nationally representative (quota) sample of 3,000 Australia residents, Edwards et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured on a scale of 1 (definitely not get the vaccine) to 4 (definitely get the vaccine) at a hesitancy rate of 58.6%, using a cross-sectional survey design and ordinal probit regression, presenting average marginal effects (AME).

Edwards et al. (2021) found that, when holding constant location in Australia, gender, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment and income, 55-64-year-olds [AME = -0.021, $p < 0.05$], 65-74-year-olds [AME = -0.03, $p < 0.01$] and 75+ year-olds [AME = -0.038, $p < 0.001$] were less likely to definitely not get the vaccine than 35-44-year-olds. When holding constant location in Australia, gender, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment and income, 55-64-year-olds [AME = 0.089, $p < 0.05$], 65-74-year olds [AME = 0.134, $p < 0.01$] and 75+ year olds [AME = 0.191, $p < 0.01$] were more likely to definitely get the vaccine than 35-44-year-olds. 18-24-year-olds and 25-34 year olds were not more or less likely to definitely not get the vaccine or definitely get the vaccine than 35-44-year-olds.

Edwards et al. (2021) found that, when holding constant location in Australia, gender, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment, income, belief that too much fuss is being made about COVID-19, social distancing

behaviour, having downloaded the COVID-19 Safe App, voting intention, confidence in government, confidence in hospitals and health system, support for migration, populism and religiosity, 55-64-year-olds [AME = -0.03, $p < 0.05$], 65-74-year-olds [AME = -0.039, $p < 0.05$] and 75+ year-olds [AME = -0.049, $p < 0.05$] were less likely to definitely not get the vaccine than 35-44-year-olds. When holding constant location in Australia, gender, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment, income, belief that too much fuss is being made about COVID-19, social distancing behaviour, having downloaded the COVID-19 Safe App, voting intention, confidence in government, confidence in hospitals and health system, support for migration, populism and religiosity, 55-64-year-olds [AME = 0.11, $p < 0.05$], 65-74-year-olds [AME = 0.153, $p < 0.01$] and 75+ year-olds [AME = 0.216, $p < 0.01$] were more likely to definitely get the vaccine than 35-44-year-olds. 18-24-year-olds and 25-34-year-olds were not more or less likely to definitely not get the vaccine or definitely get the vaccine than 35-44-year-olds.

Overall, this study establishes a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Germany, Bendau et al. (2021): In a convenience sample of 1,779 Germany residents, Bendau et al., (2021) examined the relationship between gender, measured as a numerical discrete variable in years, and vaccine willingness, measured on a scale of -2 (absolutely not) to +2 (absolutely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and Spearman rank correlations.

Bendau et al. (2021) found that age was positively associated with vaccine willingness [$r_s = 0.7$, $p = 0.003$] whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Austria, Paul et al. (2021): In a nationally representative (quota) sample of 1,301 Austrian residents, Paul et al. (2021) examined the relationship between gender, measured as a categorical variable, and readiness to get vaccinated, measured on a scale from 1 (completely disagree) to 5 (completely agree), using a cross-sectional survey design, descriptive statistics and ordinary least squares (OLS) regression.

Using descriptive statistics, Paul et al. (2021) found that more respondents aged over 65 years old [66%] completely or somewhat agreed that they intended to receive the vaccine as soon as possible than respondents aged 30-65 [46%] and respondents aged 30 years old and younger [44%].

Using (OLS) regression, Paul et al. (2021) found that, when holding constant gender, education, income situation,

pre-existing condition, subjective health risk, sense of community, conspiracy belief and party voted for, respondents aged over 65 years old were more likely to accept the vaccine as soon as possible than respondents aged 31-65, such that age is negatively associated vaccine hesitancy whereby as age increases vaccine hesitancy decreases and younger respondents are more vaccine hesitant.

Austria, Schernhammer et al. (2021): In a quota sample of 1,007 Austria residents, Schernhammer et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy rate of 41.1% (intermediate or severe), using a cross-sectional survey design and logistic regression.

Schernhammer et al. (2021) found that, when holding constant gender, area of residence, education, politics, optimism, resilience, need for cognitive closure, main source of information and health status, respondents aged 55-59 years [OR = 0.48, 95% CI 0.28-0.84] and respondents aged 60+ years [OR = 0.37, 95% CI 0.21-0.66] were less likely to be intermediate or high vaccine hesitant than respondents aged under 35 years old.

Schernhammer et al. (2021) also found that when holding constant the same factors, respondents aged 55-59 years [OR = 0.4, CI 0.22-0.76] and respondents aged 60+ years [OR = 0.4, CI 0.14-0.54] were less likely to be undecided about the vaccine than respondents aged under 35 years old.

Overall, there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Italy, Caserotti et al. (2021): In a convenience sample of 2,267 Italy residents, Caserotti et al. (2021) examined the relationship between age, measured as a categorical variable, and (i) vaccine acceptance, measured on a scale from 0 (not at all likely) to 100 (very likely), using a logistic regression model (from which ORs were presented) and (ii) vaccine hesitancy, measured as a binary variable (no hesitancy vs. hesitancy > 0), using a negative binomial (from which incidence rate ratios (IRR) were presented).

In modelling vaccine acceptance, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, gender, deprivation and area in Italy, respondents aged 25 and under [OR = 1.65, $p < 0.001$] and aged 46-65 [OR = 1.47, $p = 0.003$] were more likely to accept the vaccine than respondents aged 26-45, but there

was no difference between respondents aged 45-65 and respondents aged 26-45 [$p = 0.413$].

In modelling vaccine hesitancy, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, gender, deprivation and area in Italy, respondents aged 25 and under [IRR = 1.65, $p < 0.001$] were less likely to be vaccine hesitant than respondents aged 26-45, but there was no difference between respondents aged 45-65 and respondents aged 26-45 [$p = 0.764$] or between respondents aged over 65 and respondents aged 26-45 [$p = 0.897$].

On balance, Caserotti et al. (2021) found a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Portugal, Soares et al. (2021): In a convenience sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between age, measured as a discrete numerical variable, and vaccine intention, measured as a categorical variable (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design, descriptive statistics and multinomial logistic regression.

Using descriptive statistics, Soares et al. (2021) found that respondents who would take the vaccine as soon as possible were, on average, older [47.7 years old] than respondents who would wait [45.4 years old] and would not take the vaccine [44.9 years old].

Using multinomial logistic regression, Soares et al. (2021) found that, when holding constant gender, education, monthly household income, lost income during pandemic and occupation, older respondents were more likely to take the vaccine as soon as possible [wait vs. yes OR = 0.99, 95% CI 0.98 - 0.99; no vs. yes, OR: 0.98, 95% CI 0.97, 0.99].

Overall, there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Malta, Cordina et al. (2021): In a convenience sample of 2,529 Malta residents, Coe et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (definitely no) to 10 (definitely yes), using a cross-sectional survey design, ANOVA and linear regression.

In simple ANOVA analysis, Cordina et al. (2021) found that vaccine acceptance differed by age group [$p = 0.005$]. Post-hoc analysis found respondents over the age of 60 were more willing to take the vaccine than respondents

aged 40-49 years old [$p < 0.01$] and respondents aged 30-39 years old [$p < 0.02$], which establishes a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

In multiple regression analysis, Cordina et al. (2021) found that, when holding constant COVID-19 knowledge, accessing COVID-19 news and information, engaging in preventative behaviour, vaccine efficacy, importance of family and friends. Opinion of the vaccine, importance of healthcare professionals. Advice, health worker status, chronic health condition status, gender, education, flu jab status, opinion on giving the vaccine to children and opinion on encouraging elderly patients to take the vaccine, there was no association between age and vaccine hesitancy [$p > 0.05$], which suggests that other factors modelled better accounted for variance in vaccine hesitancy.

Finland, Hammer et al. (2021): In a nationally representative (quota) sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 8 (strongly agree), using descriptive statistics and a stratified linear regression model.

Hammer et al. (2021) found that strongly agreeing that a respondent would get the vaccine when it becomes available increased with age; 64+ year-olds [58%], 50-64-year-olds [41%], 30-49-year-olds [24%] and 18-29-year-olds [21%], evidencing a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

To understand mechanisms behind the association between age and vaccine hesitancy, Hammer et al. (2021) used a linear regression model stratified by age group (under 50 years old vs. 50 years old and over). They found that factors that were uniquely predictive of vaccine acceptance for the younger age group were having previously been infected [$B = -0.12$, $p = 0.016$], more likely to accept the vaccine with a recommendation from a healthcare professional [$B = 0.22$, $p = 0.005$] and require it to be easy it to get a vaccine [$B = 0.12$, $p = 0.001$]. They also found that factors that were uniquely predictive of vaccine acceptance in respondents 50 and over perceived vaccine efficacy and safety [$B = 0.2$, $p = 0.001$] and being female [$B = -0.22$, $p = 0.019$] vs. male.

Turkey, Nazli et al. (2021): In a convenience sample of 467 of Turkey residents, Nazli et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine attitude, measured as a categorical variable (trust and want to get vaccinated, undecided about positive effects of vaccine but want to get vaccinated, undecided about positive effects of vaccine and

do not want to get vaccinated, think vaccine has negative effects and is ineffective and do not want to get vaccinated) at a hesitancy rate of 15%, using a cross-sectional survey design, descriptive statistics and ANOVA.

Nazli et al. (2021) found a significant difference [$p < 0.003$] in mean age between respondents who trust and want to get vaccinated [36.9 years old] and respondents who think vaccine has negative effects and is ineffective and do not want to get vaccinated [32 years old], such that age is negatively associated vaccine hesitancy whereby as age increases vaccine hesitancy decreases and younger respondents are more vaccine hesitant.

India, Goruntla et al. (2021): In a convenience sample of 2,451 of India residents, Goruntla et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 10.73%, using a cross-sectional survey design, ANOVA and multiple logistic regression.

Using ANOVA, Goruntla et al. (2021) found that vaccine acceptance differed by age group [$p < 0.001$]. Vaccine acceptance was highest in 40-49-year-olds [96.84%], 50-59-year-olds [96.43%] and 60+ year-olds [96%], lower in 30-39-years [91.93%] and lowest in under 20-year-olds [87.5%] and 20-29-year-olds [86.24%].

Goruntla et al. (2021) found that when holding constant marital status, area of location, education, occupation, income, healthcare profession, chronic disorders and overall health, respondents aged 40-49, [OR = 4.38, $p < 0.001$], aged 50-59 [OR = 3.86, $p < 0.05$] or aged 60+ [OR = 3.43, $p < 0.01$] were more likely to be accept the vaccine than respondents aged under 20.

Across all data a negative association between age and vaccine hesitancy was evident whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitance, measured as a binary variable (unwilling vs. willing) at a rate of 47.3%, using simple and multiple logistic regression.

Using simple logistic regression, Tsai et al. (2021) found that age was not associated with vaccine hesitancy [$p > 0.05$].

Using multiple logistic regression, Tsai et al. (2021) found that when holding constant sex, education, occupational status, experience of vaccine refusal, severity of the pandemic in Taiwan and worry about contracting COVID-19, health and political orientation, respondents aged 60 and above, [AOR = -1.967, $p = 0.003$] and respondents aged

40-59 [AOR = 1.667, $p = 0.008$] were more vaccine hesitant than respondents aged 20-39.

Overall, there is a negative association between age and vaccine hesitancy, but only when holding other factors constant, suggesting that age groups differ by other factors that are associated with vaccine hesitancy.

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between gender, as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

In all nine scenarios in the conjoint experimental design, respondents aged over 65 years old were most likely (likely/definitely yes) to accept the vaccine than males were more likely to accept the vaccine than respondents aged 36-65 years old and respondents aged 18-35 years old.

Overall, there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Ethiopia, Mose and Yeshaneh (2021): In a random sample of 396 Ethiopia pregnant women, Mose and Yeshaneh (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Mose and Yeshaneh (2021) found that respondents aged 34-41 were more likely to accept the vaccine [COR = 2.545, $p < 0.05$] than respondents aged 18-24. However, there was no significant difference [$p > 0.05$] in vaccine acceptance between respondents aged 25-33 and respondents aged 18-24.

Using multiple logistic regression, Mose and Yeshaneh (2021) found that, when holding constant educational status, occupation, gravidity, parity, African National Congress (ANC) visit, medical illness, knowledge, attitude and practice, respondents aged 34-41 were more likely to accept the vaccine [AOR = 1.464, $p < 0.05$] than respondents aged 18-24. However, there was no significant difference [$p > 0.05$] in vaccine acceptance between respondents aged 25-33 and respondents aged 18-24. That the OR decreases in multiple logistic regression suggests that some of the variance in vaccine acceptance as a result of age group is better accounted for by other variables in the model.

Overall, this study evidences a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more likely to be vaccine hesitant.

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable and at a hesitancy rate of 53.6%, using a cross-sectional research design and logistic regression.

Echoru et al. (2021) found that, when holding constant gender, education, occupation, religion, marital status, income, and rural or urban residence, 21-30-year-olds [OR = 0.14, $p = 0.000$], 31-40-year-olds [OR = 0.27, $p = 0.000$], 41-50-year-olds [OR = 0.31, $p = 0.000$] and 61-70-year-olds [OR = 0.17, $p = 0.000$] were less likely to be vaccine hesitant than 18-20 year olds, which establishes a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

United Kingdom, France, Germany, Sweden, Poland, Canada, Brazil, Lazarus et al. (2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) for descriptive statistics but recoded as a binary variable (completely agree and somewhat agree vs. all other responses) for logistic regression, using a cross-sectional survey design.

Using descriptive statistics and simple logistic regression to test significance, Lazarus et al. (2021) found that older (≥ 50) respondents in Brazil [48.3% vs. 32.1% in < 50 , $p < 0.05$], Canada [74.6% vs. 66% in < 50 , $p < 0.05$], Poland [63.7% vs. 51.6% in < 50 , $p < 0.05$], Sweden [76.2% vs. 51.9% in < 50 , $p < 0.05$], and the UK [79.4% vs. 68.4% in < 50 , $p < 0.05$] were significantly more likely to accept the vaccine than younger (< 50) respondents.

Using logistic regression models, Lazarus et al. (2021) found that, when holding constant gender and education, older (≥ 50) respondents in Canada [OR = 1.4], Poland [OR = 1.63], France [OR = 1.48], Germany [OR = 1.61], Sweden [OR = 2.94], and the UK [OR = 1.65] were significantly more likely to accept the vaccine than younger (< 50) respondents.

For these countries there is a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020): In a nationally representative (quota) sample of 18,231 respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely disagree that I would

take a vaccine) to 5 (completely agree), using a cross-sectional survey design and simple and multiple OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%] the United States [54%], France (47%) and the lowest level of vaccine acceptance was in Hungary [47%].

Using simple OLS regression, Lindholt et al. (2020) found that age was positively associated with vaccine acceptance [B = 0.231, $p < 0.001$], evidencing a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Using multiple OLS regression, Lindholt et al. (2020) found that, when holding constant trust in national health authorities, trust in scientists, trust in the government, democratic rights, support of public protests, conspiracy beliefs, misinformation, political ideology, vote choice (government), fatigue, behaviour change, knowledge, gender, education, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the economy, support for restrictions and interpersonal trust, age was positively associated with vaccine acceptance [B = 0.188, $p < 0.001$], evidencing a negative association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy decreases, such that younger respondents are more vaccine hesitant.

Multiple Countries, Rozek et al. (2021): In nationally representative (quota) samples (except for snowball sample from Russia) of 17 countries (Canada, United States, Germany, Poland, Russia, Sweden, Ukraine, China, Hong Kong, Taiwan, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Turkey) totalling 17,608 responses, Rozek et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (yes, no, maybe) but recoded as a binary variable (yes vs. no/maybe) and at a hesitancy rate of 44% (no and maybe combined), using a cross-sectional survey design and logistic regression.

Rozek et al. (2021) found that, when holding constant confidence in local health department, confidence in the ministry of health, confidence in the WHO, trust in medical practitioners, trust in science, trust in religious leaders, trust in political leaders and gender, respondents over 70 years old were less likely to be vaccine hesitant than respondents below 30 years old [OR = 0.75, $p < 0.001$], such that age is negatively associated vaccine hesitancy whereby as age increases vaccine hesitancy decreases and younger respondents are more vaccine hesitant.

As age increases, vaccine hesitancy increases

Table 7: Studies evidencing that as age increases, vaccine hesitancy increases

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
3	Tao et al. (2021)	China	Asia	Confucian Asia	High Income
4	Lazarus et al. (2021)	China	Asia	Confucian Asia	High Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that there was no statistically significant association between age and vaccine hesitancy in the key worker sample, but age was associated with vaccine hesitancy in the non-key worker sample. When holding constant gender, area lived, education, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and perceived COVID-19 risk, respondents aged 25-34 years old [OR = 2.41, p < 0.001], aged 35-44 years old [OR = 1.96, p < 0.05], aged 45-55 years old [OR = 2.91, p < 0.001] were more likely to be vaccine hesitant than respondents aged 18-24 years old. There was no difference in likelihood to be vaccine hesitant between respondents aged 55 years old and above and respondents aged 18-24 years old [p > 0.05].

Overall, there is a positive association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy increases, such that older respondents are more vaccine hesitant.

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between age, measured as both a categorical variable (Chi-square analysis) and numerical discrete variable in years (multiple linear regression), and vaccine hesitancy, measured as a

categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance), using Chi-square and multiple linear regression. Vaccine hesitancy (refusal and hesitancy categories combined) was at 58.9%.

Using Chi-square, Kuçukkarapinar et al. (2021) found that vaccine acceptance differed by age group [p < 0.001]. Vaccine acceptance was highest in 18-25-year-olds [54.5%], followed by 36-65-year-olds [48.8%], then 26-35-year-olds [44.6%] and lowest in 65+ year-olds [39.7%], overall, establishing a positive association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy increases, such that older respondents are more vaccine hesitant.

Using multiple linear regression, Kuçukkarapinar et al. (2021) found that when holding constant gender, education level, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, risk perception, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, age was negatively associated with vaccine acceptance [B = -0.05, p = 0.004], whereby as age increases, vaccine hesitancy increases, such that older respondents are more vaccine hesitant.

China (Pregnant Women), Tao et al. (2021): In a multi-stage part-random and part-convenience sample of 1,392 pregnant China residents, Tao et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy (intermediate or severe) rate of 41.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Tao et al. (2021) found that vaccine acceptance differed by age group [p = 0.04]. Vaccine acceptance was highest in under-26-year-olds [81.7%],

followed by 26-30 year olds [78.2%], then 31-35-year-olds [77.6%], then 36-40-year-olds [68.6%] and lowest in over 40-year-olds [66.7%].

Using logistic regression, Tao et al. (2021) found that, when holding constant region, education, occupation, income, gravidity, parity, gestational trimester, history of adverse pregnancy outcomes, history of chronic disease, history of influenza vaccination, gestational complications, COVID-19 knowledge, perceived susceptibility, perceived severity, barriers to receiving the vaccine, perceived benefits of the vaccine and cues to action, respondents aged 35 years old and younger were more likely to accept the vaccine than respondents aged over 35 years old [AOR = 1.87, $p = 0.01$].

Overall, there is a positive association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy increases, such that older respondents are more vaccine hesitant.

China, Lazarus et al. (2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) for descriptive statistics but recoded as a binary variable (completely agree and somewhat agree vs. all other responses) for logistic regression, using a cross-sectional survey design.

In the China sample, younger respondents [74.6% vs. 66% in ≥ 50 , $p < 0.05$] were significantly more likely to accept the vaccine [90.3% vs. 85.8% in ≥ 50 , $p < 0.05$]. Using logistic regression models, Lazarus et al. (2021) found that, in the China sample, when holding constant gender and education, older (≥ 50) respondents were significantly less likely to receive the vaccine [OR = 0.71], evidencing a positive association between age and vaccine hesitancy whereby as age increases, vaccine hesitancy increases, such that older respondents are more vaccine hesitant.

Relationship between age and vaccine hesitancy is non-linear

Table 8: Studies evidencing that the relationship between age and vaccine hesitancy is non-linear

	Study	Country	Region	Cultural Group	Income
1	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Lamot et al. (2020)	Slovenia	Europe	Eastern Europe	High Income
3	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income

United Kingdom, Sethi et al. (2021): In a convenience sample of 4,884 United Kingdom residents, Sethi et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intent, measured as a categorical variable (interested, not interested, unsure) at a hesitancy rate of 20.7% (unsure and not interested combined), using a cross-sectional survey design and descriptive statistics.

Sethi et al. (2021) found that of respondents over 18 years of age, respondents aged 70 years and older were least likely to not receive the vaccine (5.34%), followed by respondents aged 60-99 years old (10.78%), respondents aged 18-29 years old (13.95%) and respondents aged 30-39 years old [19.19%]. Most likely to reject the vaccine were respondents aged 40-49 years old [24.73%] and respondents aged 50-59 years old [23.54%].

This study evidences that age is associated with vaccine hesitancy, with the oldest respondents being the least hesitant, suggesting a negative association between age and vaccine hesitancy. However, overall, the relationship is non-linear whereby middle-age respondents were most hesitant.

Slovenia, Lamot et al. (2020): In a snowball sample of 851 Slovenia residents, Lamot et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 0 (not likely at all) to 10 (very likely), using a cross-sectional survey design and ordinal regression.

Lamot et al. (2020) found that, when holding constant education, employment status, health and political orientation, respondents aged 18-29, [B = -1.16, $p = 0.000$] were less likely to be vaccine hesitant than respondents

aged 40+, although respondents aged 30-39, [B = 0.5, p = 0.015] were more likely to be vaccine hesitant than respondents aged 40+.

Overall, the relationship between age and vaccine hesitancy is found to be non-linear in this study, with the middle age group being most hesitant.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, only 246 (24.6%) were willing to receive the COVID-19 vaccine. Allagoa et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine willingness, measured as a binary variable (willing vs. unwilling) at a hesitancy rate of 75.4%, using a cross-sectional survey design and logistic regression.

Allagoa et al., (2021) found that when holding constant COVID-19 diagnosis, marital status, religion, occupation and educational attainment, and the presence of chronic illnesses and gender, respondents aged 26-35, [OR = 0.38, p < 0.001] and aged 36-45 [OR = 0.56, p < 0.05], were less likely to be willing to take the vaccine than respondents aged 25 years old and younger. There was no difference in vaccine willingness between respondents aged 46-55 [p = 0.342], respondents aged 55 years and older [p = 0.36] and respondents aged 25 years old and younger.

Overall, the relationship between age and vaccine hesitancy is found to be non-linear in this study, with the youngest and oldest groups being most vaccine willing and the middle groups most hesitant.

Age is not associated with vaccine hesitancy

Table 9: Studies evidencing that age is not predictive of vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Agley et al. (2021)	United States	North America	Anglo	High Income
2	Benis et al. (2021)	United States	North America	Anglo	High Income
3	Chu and Liu (2021)	United States	North America	Anglo	High Income
4	Huynh and Senger (2021)	United States	North America	Anglo	High Income
5	Johnson et al. (2021)	United States	North America	Anglo	High Income
6	Kreps et al. (2021)	United States	North America	Anglo	High Income
7	Savoia et al. (2021)	United States	North America	Anglo	High Income
8	Murphy et al. (2021)	Ireland	Europe	Anglo	High Income
9	Montagni et al. (2021)	France	Europe	Latin Europe	High Income
10	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income
11	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income

12	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
13	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income
14	Urrunaga-Pastor et al. (2021)	Latin America and the Caribbean	South America	Latin America	Varies
15	Lazarus et al. (2021)	Spain	Europe	Latin Europe	High Income
		Russia	Europe/Asia	Eastern Europe	High Income
		Mexico	South America	Latin America	Upper Middle Income
		Ecuador	South America	Latin America	Upper Middle Income
		South Korea	Asia	Confucian Asia	High Income
		Singapore	Asia	Confucian Asia	High Income
		South Africa	Africa	Anglo/Sub-Saharan Africa	Upper Middle Income
		Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income

United States, Agle et al. (2021): In a nationally representative sample of 1,017 United States residents, Agle et al. (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and linear regression.

Agle et al. (2021) found that, when holding constant COVID-19 diagnosis, gender, race, being Hispanic or Latin, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19 and friends' or family's avoidance of crowded areas, age was not associated with vaccine intention [$p = 0.75$].

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Benis et al. (2021) found that respondents aged 45-54 years old [COR = 1.95, 95% CI: 1.14- 3.41] were more likely to accept the vaccine than

respondents aged 18-24. However, other age groups were not more likely to accept the vaccine than 18-24-year-olds.

Using multiple logistic regression (Model 1), Benis et al. (2021) found that, when holding constant gender, marital status, number of children, education, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19 and opinion on whether vaccines should be free of charge, age was not associated with vaccine acceptance [$p = 0.053$].

Using multiple logistic regression (Model 2), Benis et al. (2021) found that, when holding constant gender, number of children, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19 and opinion on whether vaccines

should be free of charge, age was not associated with vaccine acceptance [$p = 0.053$].

On balance, there was not sufficient evidence to conclude that age is associated with vaccine hesitancy.

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between age, measured as a numerical discrete variable in years, and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant gender, ethnicity, education, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived severity, fear, perceived benefits, perceived barriers and self-efficacy, there was no association between age and vaccine intention [$p > 0.05$].

United States, Huynh and Senger (2021): In a convenience sample of 351 USA residents, Huynh and Senger (2021) examined the relationship between gender, measured as a categorical variable, and vaccination intention, measured on a scale of 1 (not at all) to 7 (extremely likely), using a cross-sectional survey design and hierarchical regression.

Huynh and Senger (2021) found that, when holding constant ethnicity, gender, education, socio-economic situation and political orientation, age was not associated vaccination intention [$p > 0.05$].

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design, Fisher exact test and logistic regression.

Using Fisher exact test, Johnson et al. (2021) found that there were no statistically differences in vaccine intention between age groups [$p = 0.205$].

Using logistic regression, Johnson et al. (2021) found that, when holding constant Black race, Hispanic ethnicity, education, having had the flu or flu vaccine in the last year, flu vaccine intention, income and gender, age was not associated with vaccine intention [$p = 0.211$].

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between age, measured as a numerical discrete variable in decades, and vaccine acceptance, measured (i) as a discrete choice (vaccine A

vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental design and ordinary least squares (OLS) regression.

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), politics, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion and ethnicity, age was negatively associated with vaccine intention measured as individual vaccine evaluation [$B = -0.02$, $p < 0.001$], such that the older a respondent was, the less likely they were to accept the vaccine, but not associated with vaccine intention measured as a discrete choice [$p = 0.09$].

United States, Savoia et al. (2021): In a convenience sample of 2640 United States residents, Savoia et al. (2020) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design and simple logistic regression.

Sallam et al. (2021) found that age was not associated with vaccine hesitancy [$p > 0.05$].

Ireland, Murphy et al. (2021): In nationally representative (quota) samples of 1041 Ireland residents, Murphy et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable at a hesitancy rate of 35%, using a cross-sectional survey design and multinomial logistic regression.

Murphy et al. (2020) found that, when holding constant sex, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, respondents aged between 35 and 44 years [$AOR = 2.00$, $p < 0.05$] were more likely to be vaccine hesitant (compared with vaccine accepting) than respondents aged 65 years and older. Respondents aged 35-44 years [$AOR = 3.33$, $p < 0.05$] were more likely to be vaccine resistant (compared with vaccine hesitant) than respondents 65 years and older. However, other age groups were not more or less likely be vaccine hesitant (compared with vaccine accepting) or resistant (compared with vaccine accepting) than respondents aged 65 years and older [$p > 0.05$].

Overall, for the most part, this study found that there was no association between income and vaccine hesitancy in the context of Ireland.

France, Montagni et al. (2021): In a convenience sample of 2,344 France residents, Montagni et al. (2021) examined the relationship between age, measured as a binary variable (18-34 vs. 35+), and vaccine acceptance, measured as a categorical variable (anti-vaccination = 18.6%, hesitant = 10.9%, pro-vaccination = 70.5%), using Chi-square.

Using Chi-square, Montagni et al. (2021) found that there were no significant differences between age groups in distribution between being anti-vaccination, hesitant and pro-vaccination [$p = 0.1$], evidencing that age is not associated with vaccine hesitancy.

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Using logistic regression, Al-Qerem and Jarab (2021) found that when holding constant sex, education level, marital status, having children, perceived COVID-19 risk, perceived susceptibility to COVID-19 infection, perceived seriousness of COVID-19 and COVID-19 knowledge, age was not associated [$p > 0.05$] with vaccine resistance (no vs. yes) or hesitance (not sure vs. yes).

Jordan, Kuwait, Saudi Arabia, Other Arab Countries, Sallam et al. (2021): In a convenience sample of 3'414 Arab country residents, Sallam et al. (2020) examined the relationship between age, measured as both a categorical variable and a numerical discrete variable in years, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design, Chi-square and multinomial regression.

Using Chi-square, Sallam et al. (2021) found that there was no significant difference [$p = 0.908$] in mean age between respondents who would get the vaccine when available [31.4 years old] and those who would not [30.7 years old], such that age was not associated with vaccine hesitancy.

Using logistic regression, Sallam et al. (2021) found that, when holding constant COVID-19 origin conspiracy belief, implanting microchips conspiracy belief, infertility belief, general vaccine belief, gender, country of residence, education, chronic disease history, and self or family experience of COVID-19, age was not associated with vaccine hesitancy [$p = 0.762$].

India, Kumar et al. (2021): In a convenience sample of 841 India residents, Kumar et al. (2021) examined the relationship between gender, measured as a numerical discrete variable in years, and vaccine interest, measured as a categorical variable (interested, not interested and not sure) at a hesitancy rate of 46.8% (not interested and not

sure combined), using a cross-sectional survey design and ANOVA.

Kumar et al. (2021) found that there was no significant difference [$p = 0.394$] in the mean ages of respondents who intended to have the vaccine [Mean age = 34.39], respondents who did not intend to have the vaccine [Mean age = 32.83] and respondents who were unsure about their intention to have the vaccine [Mean age = 34.18], thus finding no association between age and vaccine hesitancy.

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design and Chi-square.

Wong et al. (2021) found that age was not associated with vaccine hesitancy [$p = 0.304$].

Latin America and the Caribbean, Urrunaga-Pastor et al. (2021): In a secondary convenience sample of 472,521 Latin America and the Caribbean residents, Urrunaga-Pastor et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine intention, measured as a categorical variable (definitely yes, probably yes, probably no, definitely yes), recoded as a binary variable at a hesitancy rate of 20%, using a cross-sectional survey design and simple log-linear regression (reporting prevalence ratios).

Urrunaga-Pastor et al. (2021) found that age was not associated with vaccine intention [$p > 0.05$].

Spain, Russia, Mexico, Ecuador, South Korea, Singapore, South Africa, Nigeria, Lazarus et al. (2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) for descriptive statistics but recoded as a binary variable (completely agree and somewhat agree vs. all other responses) for logistic regression, using a cross-sectional survey design.

Differences in vaccine acceptance between older and younger participants were not significant in Spain, Russia, Ecuador, South Korea, Singapore, South Africa and Nigeria. For these countries, age is not associated with vaccine hesitancy.

Conclusions

Table 10: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]			Non-predictive [n, %]	Total
	As age increases, vaccine hesitancy decreases [n, %]	As age increases, vaccine hesitancy increases [n, %]	Relationship between age and vaccine hesitancy is non-linear		
Studies	33 [70%]			14 [30%]	47
Studies	26 [55%]	4 [9%]	3 [6%]	14 [30%]	47
Region					
Europe	17 [71%]	1 [4%]	2 [8%]	4 [17%]	24
North America	6 [46%]	0	0	7 [54%]	13
Asia	4 [29%]	3 [21%]	0	7 [50%]	14
Oceania	1 [100%]	0	0	0	1
South America	1 [33%]	0	0	2 [67%]	3
Africa	2 [40%]	0	1 [20%]	2 [40%]	5
Cultural Group					
Anglo	12 [52%]	1 [4%]	1 [4%]	9 [39%]	23
Germanic Europe	4 [100%]	0	0	0	4
Nordic Europe	1 [100%]	0	0	0	1
Eastern Europe	1 [33%]	0	1 [33%]	1 [33%]	3
Latin Europe	4 [67%]	0	0	2 [33%]	6
Latin America	1 [25%]	0	0	3 [75%]	4
Southern Asia	1 [33%]	0	0	2 [67%]	3
Confucian Asia	2 [33%]	2 [33%]	0	2 [33%]	6
Sub-Saharan Africa	2 [40%]	0	1 [20%]	2 [40%]	5
Middle East	1 [25%]	1 [25%]	0	2 [50%]	4
Income					
High Income	26 [57%]	3 [7%]	2 [4%]	15 [33%]	46

Upper Middle Income	2 [29%]	1 [14%]	0	4 [57%]	7
Lower Middle Income	1 [25%]	0	1 [25%]	2 [50%]	4
Low Income	2 [100%]	0	0	0	2

Key

	Conclusion of high confidence
	Confident conclusion or conclusion of some confidence

Overall: Of the studies that considered the association between age and vaccine hesitancy, 70% [33 out of 47] found age to be predictive, such that it can be concluded with high confidence that age is predictive of vaccine hesitancy. Of the 33 studies that found age to be predictive of vaccine hesitancy, 79% of studies [26 out of 33] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), such that it can be concluded with high confidence that, when age is predictive of vaccine hesitancy, the association is negative. Out of all studies, only 55% [26 out of 47] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), such that, overall, it can only be concluded with some confidence that as age increases, vaccine hesitancy decreases.

NB: Murphy et al. (2021) was not included in the above analysis as it contained two countries for which there were mixed findings in terms of the association between age and vaccine hesitancy.

In looking for patterns by region, cultural group and economies of the countries in the studies, some associations between age and vaccine hesitancy are evident.

Region: Of studies conducted in countries in Europe, 71% [17 out of 24] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), such that it can be concluded with high confidence that in European countries, as age increases, vaccine hesitancy decreases.

A relationship between age and vaccine hesitancy was not evident in a North American context: 54% of studies [7 out of 13] found that age was not associated with vaccine hesitancy; nor in an Asian context: 50% of studies [7 out of 14] found that age was not associated with vaccine hesitancy, such that it can be concluded with some confidence that in countries in North America and Asia, age is not associated with vaccine hesitancy.

The relationship between age and vaccine hesitancy was inconclusive in an African context: 40% of studies

[2 out of 5] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), but equally 40% of studies [2 out of 5] found that age was not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between age and vaccine hesitancy in the contexts of South America [3 studies] and Oceania [1 study].

Cultural group: Of studies conducted in countries in the Germanic Europe cultural group, 100% [4 out of 4] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), such that it can be concluded with high confidence that in countries in the Germanic Europe cultural group, as age increases, vaccine hesitancy decreases.

Of studies conducted in countries in the Latin Europe cultural group, 67% [4 out of 6] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant). As such, it can be confidently concluded that in Latin Europe cultural group countries, as age increases, vaccine hesitancy decreases.

Of studies conducted in countries that are part of the Anglo cultural group, 52% [12 out of 23] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant). As such, it can be concluded with some confidence that in Anglo cultural group countries, as age increases, vaccine hesitancy decreases.

A relationship between age and vaccine hesitancy was not evident in a Latin American cultural group context: 75% of studies [3 out of 4] found that age was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in countries in the Latin American cultural group, age is not associated with vaccine hesitancy.

A relationship between age and vaccine hesitancy was also not evident in a Middle East cultural group context: 50% of studies [2 out of 4] found that age was not associated with vaccine hesitancy, such that it can be concluded with some

confidence that in countries in the Latin America cultural group, age is not associated with vaccine hesitancy.

There is inconclusive evidence of an association between age and vaccine hesitancy in Confucian Asia and Sub-Saharan cultural group contexts. In a Confucian Asia cultural group context, 33% of studies [2 out of 6] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), but equally 33% of studies [2 out of 6] found that as age increases,

vaccine hesitancy increases (i.e., older age groups are more hesitant) and 33% of studies [2 out of 6] found that age was not associated with vaccine hesitancy. In a Sub-Saharan Africa cultural group context, 40% of studies [2 out of 5] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), but equally 40% of studies [2 out of 5] found that age was not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between age and vaccine hesitancy in the contexts of the Eastern Europe [3 studies], Southern Asia [3 studies] and Nordic Europe [1 study] cultural groups.

Income: Of studies conducted in high income countries, 57% of studies [26 out of 46] found that as age increases, vaccine hesitancy decreases (i.e., younger age groups are more hesitant), such that it can be concluded with some confidence that in high income countries, as age increases, vaccine hesitancy decreases.

A relationship between age and vaccine hesitancy was not evident in upper middle income countries: 57% of studies [4 out of 7] found that age was not predictive of vaccine hesitancy, such that it can be concluded with some confidence that in upper middle income countries, age is not associated with vaccine hesitancy.

A relationship between age and vaccine hesitancy was also not evident in lower middle income countries: 50% of studies [2 out of 4] found that age was not predictive of vaccine hesitancy, such that it can be concluded with some confidence that in lower middle income countries, age is not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between age and vaccine hesitancy in the context of low income countries [2 studies].

DEMOGRAPHICS
SEX/GENDER

5.1.2

Sex is the biological characteristics and gender is the socially constructed characteristics of males, females and other categories. In the evidence reviewed sex and gender were most frequently measured as a binary variable (i.e., male vs female), but also as a categorical variable with additional categories (e.g., other).

In total, 47 studies considered the association between sex/gender and vaccine hesitancy. Of these, 35 found that sex/gender was predictive of vaccine hesitancy and 10 found that gender was not predictive of vaccine hesitancy. Of the 35 studies that found sex/gender was predictive of vaccine hesitancy, 31 found that females are more likely to be vaccine hesitant than males and four found that males are more likely to be vaccine hesitant than females.

Females are more likely to be vaccine hesitant

Table 11: Studies evidencing that females are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
4	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income
5	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income
6	Coe et al. (2021)	United States	North America	Anglo	High Income
7	Dorman et al. (2021)	United States	North America	Anglo	High Income
8	Kreps et al. (2020)	United States	North America	Anglo	High Income
9	Ruiz and Bell (2021)	United States	North America	Anglo	High Income
10	Edwards et al. (2021)	Australia	Oceania	Anglo	High Income

11	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
12	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
13	Zampetakis and Melas (2021)	Greece	Europe	Latin Europe	High Income
14	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
15	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
16	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
17	Lamot et al. (2020)	Slovenia	Europe	Eastern Europe	High Income
18	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
19	Mesesle (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
20	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income
21	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Low Income
22	Urrunaga-Pastor et al. (2021)	Latin America and the Caribbean		Latin America	
23	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
24	Salali and Uysal (2021)	Turkey	Asia	Middle East	Upper Middle Income
25	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income
26	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income
27	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income
28	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
29	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
30	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income

31	Lazarus et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
32	Lindholt et al. (2020)	Multiple Countries			
33	Rozek et al. (2021)	Multiple Countries			

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between gender, measured as a male and female, and vaccine hesitancy, measured on a scale from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that female gender was positively correlated with vaccine hesitancy [$r_s = 0.08$], but was less predictive than other demographic factors; age [$r_s = -0.3$], membership of an other than White ethnic group [$r_s = 0.24$] and level of education [$r_s = 0.16$].

Using linear rank-order regression, Allington et al. (2021) found that, when holding constant other demographic factors (age, ethnicity, education, household income), females were more likely to be vaccine hesitant than males [$r_s = 0.07$, $p < 0.001$]. Being female was equally predictive when holding other factors constant. When also holding constant reliance on legacy media and reliance on social media for COVID-19 knowledge, females were still more likely to be vaccine hesitant than males [$r_s = 0.07$, $p < 0.001$]. When holding constant perceived risk of COVID-19 to oneself, the UK and the world, as well as other demographic factors, females were more likely to be vaccine hesitant than males [$r_s = 0.08$, $p < 0.001$]. When holding constant trust in the government, scientists working at universities, scientists working at private companies, and doctors and nurses, as well as other demographic factors, females were still more likely to be vaccine hesitant than males [$r_s = 0.08$, $p < 0.001$]. When holding constant general vaccine attitude and COVID-19 conspiracy suspicions, as well as other demographic factors, females were more likely to be vaccine hesitant than males [$r_s = 0.06$, $p < 0.001$]. When holding constant all factors studied in a single model, females were still more likely to be vaccine hesitant than males [$r_s = 0.06$, $p < 0.001$].

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers ($n = 584$) and non-key workers ($n = 1,021$), Butter et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that there was statistically significant association between gender and vaccine hesitancy in the key worker sample, but gender was not associated with vaccine hesitancy in the non-key worker sample [$p > 0.05$]. When holding constant age, area lived, education, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and perceived COVID-19 risk, female respondents were more likely to be vaccine hesitant than male respondents [OR = 1.96, $p < 0.05$].

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale from 1 (definitely) to 5 (definitely not) plus an option for don't know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that gender was associated with vaccine hesitancy; females were more likely to be vaccine hesitant [$B = 0.224$, $p < 0.001$]. However, gender only accounted for 1% of variance in vaccine hesitancy [$R^2 = 0.010$]. The strongest predictor of vaccine hesitancy was age [$R^2 = 0.038$].

United Kingdom, Sethi et al. (2021): In a convenience sample of 4,884 United Kingdom residents, Sethi et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intent, measured as a categorical variable (interested, not interested, unsure) at a hesitancy rate of 20.7% (unsure and not interested combined), using a cross-sectional survey design and logistic regression

Sethi et al. (2021) found that, when holding constant smoker status, graduate status, Black, Asian and minority ethnic (BAME) status, age group and health issues, males were more likely to accept the vaccine than females.

Ireland and the United Kingdom, Murphy et al. (2021): In a nationally representative sample of 1'041 Ireland residents and 2'025 UK residents, Murphy et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable and at hesitancy rates of 35% and 31%

respectively, using a cross-sectional survey design and logistic regression.

In the Irish sample, Murphy et al. (2020) found that when holding constant age, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, females were more likely to be vaccine hesitant than males [OR = 1.62, 95% CI = 1.18, 2.22].

In the British sample, Murphy et al. (2020) found that when holding constant age, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, females were more likely to be vaccine hesitant than males [OR = 1.43, 95% CI = 1.14, 1.80].

United States, Coe et al. (2021): In a nationally representative sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between gender, measured as a categorical variable, and intention to receive the COVID-19 vaccine, measured on a scale of 1 (very unlikely) to 4 (very likely), using a cross-sectional survey design and logistic regression.

Coe et al. (2021) found that when holding constant race, region, ethnicity, age, education, annual household income, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, females were less likely to receive the COVID-19 vaccine than males [AOR = 0.54; 95% CI 0.36-0.80].

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Dorman et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional survey design and t-test.

Dorman et al. (2021) found that males were more willing to be vaccinated than females [$t(12,963) = -20.73, p < 0.001$].

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured (i) as a discrete choice (vaccine A vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental survey design and OLS regression.

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), politics, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, and religion and ethnicity, being female was negatively associated with both vaccine intention measured as a discrete choice [B = -0.02, $p = 0.001$] and as individual vaccine evaluation [B = -0.08, $p < 0.001$] compared with being male, such that the females were less likely to accept the vaccine.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found that more males [71.9%, $p = 0.001$] were likely to get the vaccine than females [53.8%].

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, being 65 years or older, of White race, of Hispanic cultural identity, total household income, education, political party identity, marital status and preferred media for virus news, being male was positive associated with vaccine intention [B = 0.119, $p < 0.001$], such that males were more likely to intend to receive the vaccine than females.

Australia, Edwards et al. (2021): In a representative sample of 3,000 Australia residents, Edwards et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured on a scale of 1 (definitely not get the vaccine) to 4 (definitely get the vaccine) at a hesitancy rate of 41.4%, using a cross-sectional survey design and ordinal probit regression, presenting AME.

Edwards et al. (2021) found that, when holding constant location in Australia, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment, age, and income, females were more likely to be resistant to the vaccine [AME = 0.011, $p < 0.10$], to have high levels of hesitancy towards the vaccine [AME = 0.01, $p < 0.01$], have low levels of hesitancy towards the vaccines [AME = 0.021, $p < 0.10$] and less likely to definitely get the vaccine [AME = -0.042, $p < 0.10$].

Edwards et al. (2021) found that, when holding constant location in Australia, indigenous ethnicity, place of birth,

English language, education, deprivation, residing in a capital city, employment, age, income, belief that too much fuss is being made about COVID-19, social distancing behaviour, having downloaded the COVID-19 Safe App, voting intention, confidence in government, confidence in hospitals and health system, support for migration, populism and religiosity, females were more likely to be resistant to the vaccine [AME = 0.018, $p < 0.10$], to have high levels of hesitancy towards the vaccine [AME = 0.016, $p < 0.05$], have low levels of hesitancy towards the vaccines [AME = 0.027, $p < 0.10$] and less likely to definitely get the vaccine [AME = -0.061, $p < 0.05$].

France, Tivolacci et al. (2021): In a convenience sample of 3'089 French students, Tivolacci et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured as a categorical variable (acceptance, hesitancy, resistance), using a cross-sectional survey design and logistic regression.

Tivolacci et al. (2021) found that, when holding constant age, years of study, courses of study, COVID-19 infection, having a relative hospitalized or died from COVID-19, COVID-19 knowledge, conventional vaccine beliefs, COVID-19 vaccine beliefs, confidence about conventional vaccination, perceived vaccine efficacy and perceived vaccine security, females were more likely to be vaccine hesitant [OR = 2.09, $p < 0.0001$] and to be vaccine resistant [OR = 1.72, $p < 0.0001$] than males.

Portugal, Soares et al. (2021): In a sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between gender, measured as a categorical variable, with vaccine intention (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design and multinomial logistic regression.

Soares et al. (2021) found that, when holding constant age, education, monthly household income, lost income during pandemic and occupation, females were more likely to wait rather than accept the vaccine than males [OR = 1.44, CI = 1.16-1.78], but found no association between gender and not accepting the vaccine vs. accepting the vaccine.

Greece, Zampetakis and Melas (2021): In a convenience sample of 1,006 Greece residents, Zampetakis and Melas (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (I absolutely do not intend to vaccinate) to 7 (I absolutely intend to vaccinate), using a conjoint experimental survey design and linear regression.

Zampetakis et al. (2021) found that when holding constant age, living area, educational level, marital status managerial position, females were less likely to intend to receive the vaccine than males [B = -0.16, $p < 0.01$].

Austria, Paul et al. (2021): In a nationally representative (quota) sample of 1,301 Austrian residents, Paul et al. (2021) examined the relationship between gender, measured as a categorical variable, and readiness to get vaccinated, measured on a scale from 1 (completely disagree) to 5 (completely agree), using a cross-sectional survey design, descriptive statistics and OLS regression.

Using descriptive statistics, Paul et al. (2021) found that more males [52%] completely or somewhat agreed that they intended to receive the vaccine as soon as possible than females [46%].

Using OLS regression, Paul et al. (2021) found that, when holding constant age, education, income situation, pre-existing condition, subjective health risk, sense of community, conspiracy belief and party voted for, being male was positively associated with vaccine intention, such that males were more likely to intend to receive the vaccine than females.

Austria, Schernhammer et al. (2021): In a nationally representative (quota) sample of 1,007 Austria residents, Schernhammer et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) but recoded to be a binary variable at a hesitancy rate of 41.1% (intermediate or severe hesitancy combined), using a cross-sectional survey design and logistic regression.

Schernhammer et al. (2021) found that when holding constant age, region of residence, area of residence, education, politics, optimism, resilience, need for cognitive closure, main source of information and health status, males were less likely to be vaccine hesitant than females [OR = 0.56, CI 0.41-0.76].

Finland, Hammer et al. (2021): In a nationally representative sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 8 (strongly agree), using a cross-sectional survey design and stratified linear regression.

Hammer et al. (2021) found that, when holding constant vaccine safety, vaccine efficacy, infection situation in Finland, side effects, recommendation from a healthcare professional, recommendation from health authorities, conversations with family and friends, how easy it is to get vaccinated, perceived susceptibility, perceived probability of infection, perceived severity if infected, perceived transparency with public, perceived politician honesty, belief in COVID-19 conspiracy theory, belief in other conspiracy theories, education and age, females over the age of 50 were less likely to get vaccinated compared to

males over 50 [$B = -0.22$, $p = 0.019$], although gender was not associated with vaccine acceptance in respondents younger than 50 [$p > 0.05$].

Slovenia, Lamot et al. (2020): In a snowball sample of 851 Slovenia residents, Lamot et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 0 (not likely at all) to 10 (very likely), using a cross-sectional survey design and ordinal regression.

Lamot et al. (2020) found that, when holding constant education, employment status, health and political orientation, being male was negatively associated with vaccine hesitancy [$B = -0.70$, $p = 0.000$], such that males were less likely to be vaccine hesitant than female respondents.

Malta, Cordina et al. (2021): In a convenience sample of 2,529 Malta residents, Coe et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (definitely no) to 10 (definitely yes), using a cross-sectional survey design, t-tests and linear regression.

In simple t-test analysis, Cordina et al. (2021) found that males were more willing to receive the vaccine than females [$p < 0.0005$].

In multiple regression analysis, Cordina et al. (2021) found that, when holding constant COVID-19 knowledge, accessing COVID-19 news and information, engaging in preventative behaviour, vaccine efficacy, importance of family and friends. Opinion of the vaccine, importance of healthcare professionals. Advice, health worker status, chronic health condition status, age, education, flu jab status, opinion on giving the vaccine to children and opinion on encouraging elderly patients to take the vaccine, there was no association between gender and vaccine hesitancy [$p = 0.5311$], which suggests that other factors modelled better accounted for variance in vaccine hesitancy.

In a follow-up study of 843 Malta residents and international visitors, of the 132 respondents who declared that they did not want to receive the vaccine, nearly 60% of female respondents attributed their hesitancy to belief that the vaccine may not be safe, compared with approximately 25% of males attributing their hesitancy to this reason.

Ethiopia, Mesesle (2021): In a random sample of 425 Ethiopia residents, Mesesle (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

Using simple logistic regression, Mesesle (2021) found that males were more likely to accept the vaccine than females [$COR = 2.05$, $p = 0.003$].

Using multiple logistic regression, Mesele et al. (2021) again found that, when holding constant educational status, mass media usage, having received any vaccination during childhood, having a member of household diagnosed with COVID-19, having a relative diagnosed with COVID-19, having a friend diagnosed with COVID-19, having tested for COVID-19 and results of COVID-19 test, males were more likely to accept the vaccine than females [$AOR = 2.14$, $p = 0.003$].

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between gender, measured as a categorical variable (female and male), and vaccine hesitancy, which was measured as a binary variable and at a hesitancy rate of 53.6%, using a cross-sectional survey design and logistic regression.

Echoru et al. (2021) found that, when holding constant age, education, occupation, religion, marital status, income, and rural or urban residence, males were more likely to accept the vaccine than females [$OR = 2.1$, $p = 0.000$].

Using descriptive statistics and simple logistic regression to test significance, Lazarus et al. (2021) found that vaccine acceptance differed by gender [$p < 0.05$] whereby more males accepted the vaccine compared with females in India [71.2% vs. 60.2%], but this association was not significant when holding constant age and education in multiple logistic regression.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (willing = 24.6%, unwilling = 75.4%), using a cross-sectional survey design and logistic regression.

Allagoa et al., (2021) found that when holding constant COVID-19 diagnosis, age, marital status, religion, occupation and educational attainment, and the presence of chronic illnesses, males were more likely to receive the COVID-19 vaccine [$OR = 2.34$, $p = 0.01$] than females.

Latin America and the Caribbean, Urrunaga-Pastor et al. (2021): In a secondary convenience sample of 472,521 Latin America and the Caribbean residents, Urrunaga-Pastor et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured as a categorical variable (definitely yes, probably yes, probably no, definitely no), recoded as a binary variable at a hesitancy rate of 20%, using a cross-sectional survey design and log-linear regression (reporting prevalence ratios).

Urrunaga-Pastor et al. (2021) found that, when holding constant age, living age, COVID-19 symptomatology, compliance with community mitigation strategies, food

insecurity, economic insecurity, fears of becoming ill or that a family member becomes seriously ill from COVID-19, anxiety symptomology, depressive symptomatology, probability of vaccination acceptance when recommended by friends and family, probability of vaccination acceptance when recommended by local health workers, probability of vaccination acceptance when recommended by the WHO, probability of vaccination acceptance when recommended by government health officials and probability of vaccination acceptance when recommended by politicians, females were less likely to intend to receive the vaccine than males [PR = 0.97, $p < 0.001$].

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance) and at a rate of hesitancy 58.9% (refusal and hesitancy categories combined), using a cross-sectional survey design, Chi-square and multiple linear regression.

Using Chi-square, Kuçukkarapinar et al. (2021) found that vaccine acceptance differed by gender [$p < 0.001$] whereby 56% of males accepted the vaccine compared with 43.3% of females.

Using multiple linear regression, Kuçukkarapinar et al. (2021) found that when holding constant age, education level, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, risk perception, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, being male was positively associated with vaccine intention [$B = 0.119$, $p = 0.000$], such that males were more likely to accept the vaccine.

Turkey, Salali and Uysal (2021): In convenience samples of 3,936 Turkey residents, Salali and Uysal (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

Salali and Uysal (2021) found that, when holding constant beliefs about origin of the virus, highest level of education, financial satisfaction, having children, COVID-19-related anxiety and COVID-19 perceived risk, males were more likely to accept the vaccine [OR = 1.47, $p < 0.001$], such that females were more likely to be vaccine hesitant than males.

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does

not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design, Chi-square and logistic regression.

In the simple Chi-square analysis, Alobaidi (2021) found that males were more likely to receive the vaccine than females [47.8% vs. 33.3%, $p < 0.05$], but this association was not found to be significant when holding constant nationality, education, working in health care, monthly income, perceived susceptibility, perceived severity, perceived benefits of vaccine and cues to action in a logistic regression model [$p > 0.05$], which suggests that other factors modelled better accounted for variance in vaccine hesitancy.

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem and Jarab (2021) found that when holding constant age, education level, marital status, having children, perceived COVID-19 risk, perceived susceptibility to COVID-19 infection, perceived seriousness of COVID-19 and COVID-19 knowledge, females were more likely to reject the vaccine (intention = no) [OR = 3.00, $p < 0.01$] and more likely to be hesitant towards the vaccine (intention = not sure) [OR = 1.49, $p < 0.05$] than males.

Jordan, Kuwait, Saudi Arabia, Other Arab Countries, Sallam et al. (2021): In a convenience sample of 3'414 Arab country residents, Sallam et al. (2020) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Sallam et al. (2021) found that more males [38.6%, $p < 0.001$] were likely to get the vaccine than females [23.9%].

Using logistic regression, Sallam et al. (2021) found that, when holding constant COVID-19 origin conspiracy belief, implanting microchips conspiracy belief, infertility belief, general vaccine belief, age, country of residence, education, chronic disease history, self or family experience of COVID-19, males were more likely to accept the vaccine than females [OR = 1.54, $p < 0.001$].

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine willingness, measured as a binary variable (unwilling vs. willing) at a hesitancy rate of 47.3%,

using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Tsai et al. (2021) found that females were more likely to be unwilling to receive the vaccine than males [COR = 1.311, $p = 0.033$].

Tsai et al. (2021) found that when holding constant age, education, occupational status, experience of vaccine refusal, severity of the pandemic in Taiwan and worry about contracting COVID-19, and health and political orientation, females were more likely to be unwilling to receive the vaccine than males [COR = 1.344, $p = 0.039$].

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between gender, as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

In six out of nine scenarios in the conjoint experimental design, males were more likely to accept the vaccine than females. There was no association between gender and vaccine intention in three of the nine scenarios.

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Wong et al. (2021) found that more males [54.6%, $p = 0.002$] definitely intended to receive the vaccine than females [45%].

Using logistic regression, Wong et al. (2021) found that, when holding constant age group, ethnicity, highest education level, occupation category, average monthly household income, location, diagnosed with chronic diseases, perceived overall health, known any friends, neighbours or colleagues infected with COVID-19, perceived susceptibility, perceived severity, perceived benefits, and perceived barriers, males were more likely to have a definite intention to receive the vaccine than females [OR = 1.44, 95% CI 1.11-1.87].

India, Lazarus et al. (2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) and recoded as a binary variable (completely

agree and somewhat agree vs. all other responses), using a cross-sectional survey design, descriptive statistics and logistic regression.

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020): In nationally representative (quota) samples of 18,231 respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely disagree that I would take a vaccine) to 5 (completely agree), using a cross-sectional survey design and OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%], the United States [54%] and France (47%), and the lowest level of vaccine acceptance was in Hungary [47%].

Lindholt et al. (2020) found that, when holding constant trust in national health authorities, trust in scientists, trust in the government, democratic rights, support of public protests, conspiracy beliefs, misinformation, political ideology, vote choice (government), fatigue, behaviour change, knowledge, age, education, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the economy, support for restrictions and interpersonal trust, being female was negatively associated with vaccine acceptance [B = -0.05; 95% CI -0.03-0.07], such that females were less likely to accept the vaccine than males.

Multiple Countries, Rozek et al. (2021): In nationally representative (quota) samples (except for snowball sample from Russia) of 17 countries (Canada, United States, Germany, Poland, Russia, Sweden, Ukraine, China, Hong Kong, Taiwan, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Turkey) totalling 17,608 responses, Rozek et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (yes, no, maybe) but recoded as a binary variable (yes vs. no/maybe) and at a hesitancy rate of 44% (no and maybe combined), using a cross-sectional survey design and logistic regression.

Rozek et al. (2021) found that, when holding constant confidence in local health department, confidence in the ministry of health, confidence in the WHO, trust in medical practitioners, trust in science, trust in religious leaders, trust in political leaders and age, being female was associated with vaccine hesitancy [OR = 1.17, $p < 0.001$], such that females were more likely to be vaccine hesitant than males.

Males are more likely to be vaccine hesitant

Table 12: Studies evidencing that males are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Benis et al. (2021)	United States	North America	Anglo	High Income
2	Savoia et al. (2021)	United States	North America	Anglo	High Income
3	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
4	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
5	Lazarus et al. (2021)	France	Europe	Latin Europe	High Income
		Germany	Europe	Germanic Europe	High Income
		Sweden	Europe	Nordic Europe	High Income
		Russia	Asia	Eastern Europe	High Income

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and logistic regression.

In their first model, Benis et al. (2021) found that when holding constant age, marital status, number of children, education, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19 and opinion on whether vaccines should be free of charge, male respondents were less likely to accept the vaccine than females [OR = 0.39; 95% CI 0.25-0.62, $p = 0.003$]. In their second model, which was restricted to holding constant age, number of children, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry and civic responsibility to take vaccine, male respondents were less likely to accept the vaccine than females [OR = 0.43; 95% CI 0.27-0.65, $p = 0.003$].

United States, Savoia et al. (2021): In a convenience sample of 2640 United States residents, Savoia et al. (2020) examined the relationship between gender, measured as a

categorical variable, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design, and ordinal and logistic regression.

Using simple logistic regression, Savoia et al. (2021) found that females were less likely to be vaccine hesitant than males [OR = 0.85, $p < 0.05$].

Using multiple logistic regression, Savoia et al. (2021) found that, when holding constant age, employment status, education, race, type of job, medical conditions, risk perception, COVID-19 diagnosis and experience of unfair treatment, gender was not associated with vaccine hesitancy [$p > 0.05$], suggesting that other factors better accounted for variance in vaccine hesitancy than gender.

India, Goruntla et al. (2021): In a convenience sample of 2,451 India residents, Goruntla et al. (2021) examined the relationship between gender, measured as a categorical variable, and willingness to pay for a COVID-19 vaccine, measured by asking respondents to identify the maximum amount they would be willing to pay for a vaccine dose and providing four price points, using a cross-sectional survey design and multinomial logistic regression.

Goruntla et al. (2021) found that when holding constant marital status, area of location, education, occupation, income, healthcare profession, chronic disorders and overall health, females were more likely to be willing to

pay for the vaccine at a higher price point than males [OR = 1.51, $p < 0.05$], but this association was not significant at a lower price point [$p > 0.05$].

India, Kumar et al. (2021): In a convenience sample of 841 India residents, Kumar et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine interest, measured as a categorical variable (interested, not interested and not sure) at a hesitancy rate of 46.8% (not interested and not sure combined), using a cross-sectional survey design and multinomial logistic regression.

Kumar et al. (2021) found that, when holding constant information on the vaccine, chances of getting coronavirus disease in the next 6 months, awareness of India COVID 19 vaccine, Indian manufacturing company of vaccine, family history of the laboratory confirmed case, and health status, males were less likely to be interested in receiving the vaccine vs. not interested compared with females [OR = 0.597, $p < 0.05$], although there was no association between gender and interest in receiving the vaccine vs. not sure [$p > 0.05$].

France, Germany, Sweden, Russia, Lazarus et al.

(2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) and recoded as a binary variable (completely agree and somewhat agree vs. all other responses), using a cross-sectional survey design, descriptive statistics and logistic regression.

Using descriptive statistics and simple logistic regression to test significance, Lazarus et al. (2021) found that vaccine acceptance differed by gender [$p < 0.05$] whereby more females accepted the vaccine compared with males in France [67.9% vs. 50.3%], Germany [72.9% vs 62.4%], Sweden [69.9% vs 60.2%] and Russia [60.1% vs. 49.7%].

Using logistic regression, Lazarus et al. (2021) found that, when holding constant age and education, females in France [OR = 0.5], Germany [OR = 0.62], Sweden [OR = 0.74] and Russia [OR = 0.65] were more likely to accept the vaccine than males.

Sex/gender is not associated with vaccine hesitancy

Table 13: Studies evidencing that sex/gender is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Agley et al. (2021)	United States	North America	Anglo	High Income
2	Chu and Liu (2021)	United States	North America	Anglo	High Income
3	Huynh and Senger (2021)	United States	North America	Anglo	High Income
4	Johnson et al. (2021)	United States	North America	Anglo	High Income
5	Willis et al. (2021)	United States	North America	Anglo	High Income
6	Shih et al. (2021)	United States	North America	Anglo	High Income
7	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
8	Wakefield et al. (2021)	United Kingdom	Europe	Anglo	High Income
9	Salali and Uysal (2021)	United Kingdom	Europe	Anglo	High Income

10	Bendau et al. (2021)	Germany	Europe	Germanic Europe	High Income
11	Caserotti et al. (2021)	Italy	Europe	Latin Europe	High Income
12	Lazarus et al. (2021)	United Kingdom	Europe	Anglo	High Income
		United States	North America	Anglo	High Income
		Canada	North America	Anglo	High Income
		Italy	Europe	Latin Europe	High Income
		Spain	Europe	Latin Europe	High Income
		Poland	Europe	Eastern Europe	High Income
		Brazil	South America	Latin America	Upper Middle Income
		Ecuador	South America	Latin America	Upper Middle Income
		China	Asia	Confucian Asia	High Income
		South Korea	Asia	Confucian Asia	High Income
		Singapore	Asia	Confucian Asia	High Income
		Mexico	South America	Latin America	Upper Middle Income
		Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income
		South Africa	Africa	Sub-Saharan Africa	Upper Middle Income

United States, Agley et al. (2021): In a nationally representative (quota) sample of 1,017 United States residents, Agley et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely), using a cross-sectional survey design and linear regression.

Agley et al. (2021) found that when holding constant COVID-19 diagnosis, age, race, being Hispanic or Latin, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19, friends' or family's avoidance of crowded areas, being female [$p = 0.9$] and being non-binary or transgender [$p = 0.51$] was not associated with vaccine intention.

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using an ordinal regression model.

Chu and Liu (2021) found that, when holding constant age, ethnicity, education, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived severity, fear and perceived benefits, there was no statistically significant association between gender and vaccine intention [$p > 0.05$].

United States, Huynh and Senger (2021): In a convenience sample of 351 USA residents, Huynh and Senger (2021)

examined the relationship between gender, measured as a categorical variable, and vaccination intention, measured on a scale of 1 (not at all) to 7 (extremely likely), using a cross-sectional survey design and **hierarchical regression**.

Huynh and Senger (2021) found that, when holding constant ethnicity, age, education, socio-economic situation and political orientation, gender was not associated with vaccination intention [$p > 0.05$].

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design, Fisher exact test and logistic regression.

Using Fisher exact test, Johnson et al. (2021) found that there were no statistically differences in vaccine intention between gender categories [$p = 0.583$].

Using logistic regression, Johnson et al. (2021) found that, when holding constant Black race, Hispanic ethnicity, education, having had the flu or flu vaccine in the last year, flu vaccine intention, income and age, gender was not associated with vaccine intention [$p = 0.449$].

United States, Willis et al. (2021): In a convenience sample of 1,205 Arkansas residents, Willis et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 21.86%, using a cross-sectional survey design, t-test and logistic regression.

Using t-test, Willis et al. (2021) found that there was no significant difference in vaccine hesitancy between males and females [$p = 0.137$].

Using logistic regression, Willis et al. (2021) found that, when holding constant age, race/ethnicity, income, education, COVID-19 health literacy, fear of COVID-19 infection and general vaccine trust, gender was not associated with vaccine hesitancy [OR = 1.38, $p = 0.137$].

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured using an adapted version of the WHO Sage's 10-item scale, which was then dichotomized, using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant residence, generation race/ethnicity, monthly family

income and political affiliation, gender was not associated with vaccine hesitancy [OR = 1.09, $p = 0.3494$].

United Kingdom, Jennings et al. (2021): In a nationally representative sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a rate of 71%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that, when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, social media platforms use, age, posting political content online, fact-checking, having had COVID-19, sources of information, education, trust in the media, voting Conservative, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations, and evaluation of government's handling of COVID-19, gender was not associated with vaccine acceptance [$p > 0.05$].

United Kingdom, Wakefield et al. (2021): In a convenience sample of 130 UK residents, Wakefield et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine willingness, measured on a scale of 1 (definitely not) to 5 (yes, definitely), using a cross-sectional survey design and linear regression.

Wakefield et al. (2021) found that, in preliminary analysis, gender did not correlate with any vaccine willingness variables, so was not included in the regression analyses.

Germany, Bendau et al. (2021): In a convenience sample of 1,779 Germany residents, Bendau et al., (2021) examined the relationship between gender, measured as a categorical variable, and vaccine willingness, measured on a scale of -2 (absolutely) to +2 (absolutely) at a hesitancy rate of 25.1% (absolutely = 64.5%, would rather accept it = 10.4%), using a cross-sectional survey design and Chi-square.

Bendau et al. (2021) found that gender was not associated with vaccine willingness [$p = 0.119$].

United Kingdom, Salali and Uysal (2021): In convenience samples of 3 1,088 United Kingdom residents, Salali and Uysal (2021) examined the relationship between gender, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

Salali and Uysal (2021) found that, when holding constant beliefs about origin of the virus, highest level of education, financial satisfaction, having children, COVID-19-related anxiety, COVID-19 perceived risk, there was no association between gender and vaccine acceptance [$p > 0.05$].

Italy, Caserotti et al. (2021): In a convenience sample of 2,267 Italy residents, Caserotti et al. (2021) examined the relationship between gender, measured as a categorical variable, and (i) vaccine acceptance, measured on a scale from 0 (not at all likely) to 100 (very likely), using a logistic regression model (from which ORs were presented) and (ii) vaccine hesitancy, measured as a binary variable (no hesitancy vs. hesitancy > 0), using a cross-sectional survey design and negative binomial regression (from which IRRs were presented).

Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, age, deprivation and area in Italy, gender was not associated with vaccine acceptance using logistic regression [$p = 0.618$] or vaccine hesitancy using a negative binomial model [$p = 0.44$].

United Kingdom, United States, Canada, Italy, Spain, Poland, Brazil, Ecuador, China, South Korea, Singapore, Mexico, Nigeria, South Africa, Lazarus et al. (2021): In a random sample of 13,426 respondents from high-COVID-19 burden countries in June 2020, Lazarus et al. (2021) examined the relationship between gender, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 1 (completely agree that I would take a vaccine) to 5 (completely disagree) and recoded as a binary variable (completely agree and somewhat agree vs. all other responses), using a cross-sectional survey design, descriptive statistics and logistic regression.

Lazarus et al. (2021) found that gender was not significantly associated with vaccine hesitancy [$p > 0.05$] in Brazil, Canada, China, Ecuador, Italy, Mexico, Nigeria, Poland, South Africa, South Korea, Singapore, Spain, the United Kingdom and the United States.

Conclusions

Table 14: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Females are more likely to be vaccine hesitant [n, %]	Males are more likely to be vaccine hesitant [n, %]		
Studies	35 [78%]		10 [22%]	45
Studies	31 [69%]	4 [9%]	10 [22%]	45
Region				
Europe	14 [54%]	3 [12%]	9 [35%]	26
North America	4 [33%]	2 [17%]	6 [50%]	12
Asia	11 [65%]	3 [18%]	3 [18%]	17
Oceania	1 [100%]	0	0	1
South America	1 [25%]	0	3 [75%]	4
Africa	3 [60%]	0	2 [40%]	5
Cultural Group				
Anglo	11 [50%]	2 [9%]	9 [41%]	22
Germanic Europe	2 [50%]	1 [25%]	1 [25%]	4

Nordic Europe	1 [50%]	1 [50%]	0 [0%]	2
Eastern Europe	1 [33%]	1 [33%]	1 [33%]	3
Latin Europe	4 [50%]	1 [13%]	3 [38%]	8
Latin America	1 [33%]	0 [0%]	2 [67%]	3
Southern Asia	2 [50%]	2 [50%]	0 [0%]	4
Confucian Asia	2 [20%]	0 [40%]	3 [40%]	5
Sub-Saharan Africa	3 [60%]	0 [0%]	2 [40%]	5
Middle East	7 [100%]	0 [0%]	0 [0%]	7
Income				
High Income	24 [49%]	5 [10%]	20 [41%]	49
Upper Middle Income	3 [43%]	0 [0%]	4 [57%]	7
Lower Middle Income	1 [25%]	2 [50%]	1 [25%]	4
Low Income	3 [100%]	0	0	3

Overall: Of the studies that considered the association between sex/gender and vaccine hesitancy, 78% [35 out of 45] found sex/gender to be predictive, such that it can be concluded with high confidence that sex/gender is predictive of vaccine hesitancy. Of the 35 studies that found sex/gender to be predictive of vaccine hesitancy, 89% [31 out of 35] found that females are more likely to be vaccine hesitant, such that it can be concluded with high confidence that, when sex/gender is predictive of vaccine hesitancy, females are more likely to be vaccine hesitant. Out of all studies, still 69% [31 out of 45] found that females are more likely to be vaccine hesitant, such that, overall, it can be confidently concluded that females are more likely to be vaccine hesitant.

NB: Lazarus et al. (2021) and Salali and Uysal (2021) were not included in the above analysis as they contained multiple countries for which there were mixed findings in terms of the association between gender and vaccine hesitancy.

In looking for patterns by region, cultural group and income of the countries in the studies, some associations between sex/gender and vaccine hesitancy are evident.

Region: Of studies conducted in Asian countries, 65% [11 out of 17] found that females were more likely to be vaccine hesitant. Of studies conducted in African countries, 60% [3 out of 5] found that females were more likely to be vaccine hesitant. As such, it can be confidently concluded that in Asian, and African countries, females are more likely to be vaccine hesitant.

Of studies conducted in European countries, 54% [14 out of 26] found that females were more likely to be vaccine hesitant, such that it can be concluded with some confidence that in European countries, females are more likely to be vaccine hesitant.

There is inconclusive evidence of an association between gender and vaccine hesitancy in North America; 33% [4 out of 12] found that females were more likely to be vaccine hesitant, 17% [2 out of 12] found that males were more likely to be vaccine hesitant and 50% [6 out of 12] found no association between gender and vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between gender and vaccine hesitancy in the contexts of South America [4 studies] and Oceania [1 study].

Cultural group: Of studies conducted in Middle East cultural group countries, 100% [7 out of 7] found that females were more likely to be vaccine hesitant, such that it can be concluded with high confidence that in Middle East cultural group countries, females are more likely to be vaccine hesitant.

Of studies conducted in Latin Europe cultural group countries, 60% [6 out of 10] found that females were more likely to be vaccine hesitant. Of the studies conducted in Sub-Saharan Africa cultural group countries, 60% [3 out of 5] found that females were more likely to be vaccine hesitant. As such, it can be confidently concluded that

in Latin Europe and Sub-Saharan Africa cultural group countries, females are more likely to be vaccine hesitant.

Of studies conducted in Anglo [11 out of 22] and Germanic Europe [2 out of 4] cultural group countries, 50% of studies found that females were more likely to be vaccine hesitant, such that it can be concluded with some confidence that in Anglo and Germanic Europe cultural group countries, females are more likely to be vaccine hesitant.

Of studies conducted in Confucian Asia cultural group countries, 60% [3 out of 5] found that gender was not associated with vaccine hesitancy such that it can be confidently concluded that in Confucian Asia cultural group countries, gender is not associated with vaccine hesitancy.

There is inconclusive evidence about the association between gender and vaccine hesitancy in Southern Asia cultural group countries; 50% of studies [2 out of 4] found that females were more likely to be vaccine hesitant and 50% [2 out of 4] found that males were more likely to be vaccine hesitant.

There is insufficient evidence to draw conclusions about the relationship between gender and vaccine hesitancy in the contexts of Latin America [3 studies], Eastern Europe [3 studies] and Nordic Europe [2 studies] cultural group countries.

Income: Of studies conducted in upper middle income countries, 57% [4 out of 7] found that gender was not associated with vaccine hesitancy such that it can be concluded with some confidence that in upper middle income countries gender is not associated with vaccine hesitancy.

Of studies conducted in lower middle income countries, 50% [2 out of 4] found that males were more likely to be vaccine hesitant such that it can be concluded with some confidence that in lower middle income countries males are more likely to be vaccine hesitant.

There is inconclusive evidence about the association between gender and vaccine hesitancy in high income countries; 49% of studies [24 out of 49] found that females were more likely to be vaccine hesitant, 10% [5 out of 49] found that males were more likely to be vaccine hesitant and 41% [20 out of 49] found that gender was not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between sex/gender and vaccine hesitancy in the context of low income [3 studies] countries.

DEMOGRAPHICS
EDUCATION

5.1.3

Education is the process of learning. Education was measured in terms of the highest level of formal education achieved by respondents as a categorical, but ordered, variable from low (e.g., no formal qualifications) to high (e.g., doctoral degree).

In total, 34 studies considered the relationship between education and vaccine hesitancy. Of these, 18 found that education was predictive of vaccine hesitancy and 16 found that age was not predictive of vaccine hesitancy. Of the 18 studies that found that education was predictive of vaccine hesitancy, 14 found that as education level increases, vaccine hesitancy decreases (i.e., less educated are more vaccine hesitant), two found that as education increases, vaccine hesitancy increases (i.e., more educated are more vaccine hesitant) and two found that the relationship between education and vaccine hesitancy was non-linear.

As education level increases, vaccine hesitancy decreases

Table 15: Studies evidencing that as education level increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income
4	Coe et al. (2021)	United States	North America	Anglo	High Income
5	Ruiz and Bell	United States	North America	Anglo	High Income
6	Kreps et al. (2020)	United States	North America	Anglo	High Income
7	Bendau et al. (2021)	Germany	Europe	Germanic Europe	High Income
8	Lamot et al. (2020)	Slovenia	Europe	Eastern Europe	High Income
9	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income

10	Mesesle (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
11	Mose and Yesshaneh (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income
12	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income
13	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income
14	Lindholt et al. (2020)	Multiple countries aggregated			

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured on a scale from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that education level was not associated with vaccine hesitancy [$rs = -0.01$].

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant age, gender, ethnicity, education and household income, education level was negatively associated with vaccine hesitancy [$rs = -0.05$, $p < 0.001$]. When also holding constant reliance on legacy media and reliance on social media for COVID-19 knowledge, level of education was still negatively associated with vaccine hesitancy [$rs = -0.05$, $p = 0.004$]. When holding constant perceived risk of COVID-19 to oneself, the UK and the world, as well as other demographic factors, level of education was further negatively associated with vaccine hesitancy [$rs = -0.07$, $p < 0.001$]. When holding constant trust in the government, scientists working at universities, scientists working at private companies, and doctors and nurses, as well as other demographic factors, level of education was negatively associated with vaccine hesitancy [$rs = -0.04$, $p = 0.015$]. When holding constant general vaccine attitude and COVID-19 conspiracy suspicions, as well as other demographic factors, level of education became positively associated with vaccine hesitancy [$rs = 0.04$, $p = 0.004$]. When holding constant all factors studied in a single model, level of education was no longer associated with vaccine hesitancy [$rs = 0.03$, $p = 0.062$].

Overall, this study evidences a negative association between education level and vaccine hesitancy whereby as education level increases, vaccine hesitancy decreases such that respondents with a lower level of education are

more vaccine hesitant. Education level remained predictive, when holding other factors constant. Furthermore, education level is positively associated with general vaccine attitude [$rs = 0.16$] and negatively associated with belief in COVID-19 conspiracy suspicions [$rs = -0.15$] such that when these factors are modelled alongside education level, the relationship between education level and vaccine hesitancy changes.

United Kingdom, Jennings et al. (2021): In a nationally representative (quota) sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between being a university graduate, measured as a binary variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 29%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, social media platforms use, gender, posting political content online, , having had COVID-19, sources of information, age, trust in the media, voting Conservative, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations and evaluation of government's handling of COVID-19, university graduates were more likely to be willing to accept the vaccine [OR = 1.701, $p < 0.01$] than non-graduates. This positive association between education and vaccine acceptance remained when use of information sources was added to the model [OR = 1.572, $p < 0.01$], when social media use was added to the model [OR = 1.574, $p < 0.01$] and when fact-checking an article online and having posted political content online was added to the model [OR = 1.56, $p < 0.05$].

This evidences a positive association between education level and vaccine acceptance whereby as education level increases, vaccine intention increases such that respondents with a lower level of education are more vaccine hesitant.

United Kingdom, Sethi et al. (2021): In a convenience sample of 4,884 United Kingdom residents, Sethi et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine intention, measured as a categorical variable (interested, not interested, unsure) at a hesitancy rate of 20.7% (unsure and not interested combined), using a cross-sectional survey design and logistic regression.

Sethi et al. (2021) found that, when holding constant gender, smoker status, BAME status, graduates were more likely to intend to receive the vaccine than non-graduates [OR = 3.005], evidencing a negative association between education level and vaccine intention.

United States, Coe et al. (2021): In a nationally representative sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between education level, measured as a categorical variable, and intention to receive the COVID-19 vaccine, measured on a scale of 1 (very unlikely) to 4 (very likely), using a cross-sectional survey design and unadjusted and adjusted logistic regression.

Using unadjusted logistic regression, Coe et al. (2021) found that respondents with a bachelor's degree [OR = 1.43, 95% CI 1.01-2.03] or a graduate or professional degree [OR = 2.79, 95% CI 1.81-4.31] were more likely to receive the COVID-19 vaccine than high school/General Education Development (GED) graduates. Respondents with no high school degree [95% CI 0.41-1.37] or with a two-year degree or some college [95% CI 0.66-1.31] were not more less likely to receive the COVID-19 vaccine than high school/GED graduates.

Using adjusted logistic regression, Coe et al. (2021) found that, when holding constant race, region, ethnicity, age, gender, annual household income, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, respondents with a two-year degree or some college were less likely to receive the COVID-19 vaccine than high school/GED graduates [OR = 0.59, 95% CI 0.36-0.97]. Respondents with no high school degree [95% CI 0.48-2.77], with a bachelor's degree [95% CI 0.37-1.07] or with a graduate or professional degree [95% CI 0.74-3.04] were not more or less likely to receive the COVID-19 vaccine than high school/GED graduates.

Overall, there is some evidence of a positive association between education level and vaccine intention whereby as education level increases, vaccine intention increases such that respondents with a lower level of education are more vaccine hesitant. However, this association disappears in the adjusted logistic regression, suggesting that other factors better account for variance in vaccine intention.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between education, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found significant differences in vaccine intention between education categories [$p = 0.001$]. Respondents with a bachelor's degree [71.2%] were most likely to get the vaccine followed by respondents with a graduate degree [65.2%] and respondents with some college/associate's degree [60.6%]. Respondents with high school or less education [47.5%] were least likely to get the vaccine.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, gender, of White race, of Hispanic cultural identity, total household income, age, political party identity, marital status and preferred media for virus news, education was not associated with vaccine intention [$p > 0.05$], which suggests that variance in education intention is better accounted for by other factors.

Overall, this study provides some evidence of a positive association between education level and vaccine intention whereby as education level increases, vaccine intention increases such that respondents with a lower level of education are more vaccine hesitant.

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine acceptance, measured (i) as a discrete choice (vaccine A vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental design and OLS regression.

Kreps et al. (2021) found that, when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), politics, age, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion and ethnicity, education level was positively associated with vaccine intention measured as a discrete choice [$B = 0.01, p < 0.01$] and measured as individual vaccine evaluation [$B = 0.03, p < 0.001$] whereby as education level increases, vaccine intention increases such that respondents with a lower level of education are more vaccine hesitant.

Germany, Bendau et al. (2021): In a convenience sample of 1,779 Germany residents, Bendau et al., (2021) examined the relationship between education level, measured as a categorical variable, and vaccine willingness, measured on a scale of -2 (absolutely not) to +2 (absolutely) at a rate of 74.9% (absolutely = 64.5%, would rather accept it = 10.4%), using a cross-sectional survey design and correlations.

Bendau et al. (2021) found that education level was positively associated with vaccine willingness [$r_s = 0.117$, $p < 0.001$], whereby as education level increases, vaccine willingness increases such that respondents with a lower level of education are more vaccine hesitant.

Slovenia, Lamot et al. (2020): In a snowball sample of 851 Slovenia residents, Lamot et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured on a scale of 0 (not likely at all) to 10 (very likely), using a cross-sectional survey design and ordinal regression.

Lamot et al. (2020) found that, when holding constant age, employment status, health and political orientation, respondents with a high school diploma or less [$B = 0.63$, $p = 0.004$] and respondents with a first-cycle degree [$B = 0.74$, $p = 0.000$] were more likely to be vaccine hesitant than respondents in the highest educational group (having at least a second-cycle degree).

This evidences a negative association between education level and vaccine hesitancy whereby as education level increases, vaccine hesitancy decreases such that respondents with a lower level of education are more vaccine hesitant.

Portugal, Soares et al. (2021): In a convenience sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between education, measured as a categorical variable, with vaccine intention (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design, descriptive statistics and multinomial logistic regression.

Using multinomial logistic regression, Soares et al. (2021) found that, when holding constant gender, age, monthly household income, lost income during pandemic and occupation, respondents with secondary education, without education or with a basic education were more likely to be vaccine resistant (vs. vaccine accepting) than respondents with a university degree [$OR = 1.78$, 95% CI: 1.19-2.66] and more likely to be vaccine resistant (vs. vaccine hesitant) than respondents with a university degree [$OR = 2.33$, 95% CI: 1.08-5.05].

Overall, this study evidences a negative association between education and vaccine resistance whereby as education level increases, vaccine resistance decreases

such that respondents with a lower level of education are more vaccine resistant.

Ethiopia, Mesesle (2021): In a random sample of 425 Ethiopia residents, Mesesle (2021) examined the relationship between education, measured as a categorical variable, and vaccine awareness, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Mesesle (2021) found that respondents with college and above education were more likely to accept the vaccine than respondents with no higher than primary education [$AOR = 3.17$, 95% CI 1.72-5.81]. Respondents with no higher than secondary education were not more or less likely to accept the vaccine than respondents with no higher than primary education [95% CI 0.69-2.44].

Using multiple logistic regression, Mesesle et al. (2021) again found that, when holding constant gender, mass media usage, having received any vaccination during childhood, having a member of household diagnosed with COVID-19, having a relative diagnosed with COVID-19, having a friend diagnosed with COVID-19, having tested for COVID-19 and results of COVID-19 test, respondents with college and above education were more likely to accept the vaccine than respondents with no higher than primary education [$AOR = 3.09$, 95% CI 1.5-6.37]. Respondents with no higher than secondary education were not more or less likely to accept the vaccine than respondents with no higher than primary education [95% CI 0.72-3.23].

Overall, this study evidences a positive association between education level and vaccine acceptance whereby as education level increases, vaccine acceptance increases such that respondents with a lower level of education are more vaccine hesitant.

Ethiopia, Mose and Yeshaneh (2021): In a random sample of 396 Ethiopia pregnant women, Mose and Yeshaneh (2021) examined the relationship between education, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Mose and Yeshaneh (2021) found that respondents who had completed primary education were more likely to accept the vaccine than pregnant mothers with no formal education [$COR = 3.281$, $p < 0.05$]. Pregnant mothers with a secondary education and above were not more or less likely to accept the vaccine than pregnant mothers with no formal education.

Using multiple logistic regression, Mose and Yeshaneh (2021) found that, when holding constant age, occupation,

gravidity, parity, ANC visit, medical illness, knowledge, attitude and practice, respondents who had completed primary education were more likely to accept the vaccine than pregnant mothers with no formal education [COR = 3.467, $p < 0.05$]. Pregnant mothers with a secondary education and above were not more or less likely to accept the vaccine than pregnant mothers with no formal education.

Overall, this study evidences a positive association between education level and vaccine acceptance whereby as education level increases, vaccine acceptance increases such that respondents with a lower level of education are more vaccine hesitant.

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable and at a rate of 53.6%, using a cross-sectional survey design and logistic regression.

Echoru et al. (2021) found that, when holding constant age, gender, occupation, religion, marital status, income, and rural or urban residence, respondents with a secondary level of education [OR = 2.8, $p = 0.022$] and respondents with a tertiary level of education [OR = 2.8, $p = 0.009$] were more likely to accept the vaccine than respondents with a primary level of education.

This evidences a positive association between education level and vaccine acceptance whereby as education level increases, vaccine intention increases such that respondents with a lower level of education are more vaccine hesitant.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined the relationship between education level, measured as a categorical variable, and vaccine intention, measured as a categorical variable (willing = 24.6%, unwilling = 75.4%), using a cross-sectional survey design and logistic regression.

Allagoa et al. (2021) found that, when holding constant COVID-19 diagnosis, age, marital status, religion, occupation, gender, and the presence of chronic illnesses, respondents whose highest level of education was secondary [OR = 0.13, $p = 0.001$] and tertiary education [OR = 0.51, $p = 0.001$] were significantly less likely to receive the COVID-19 vaccine than respondents whose highest level of education was postgraduate. However, there was no difference [$p > 0.05$] in vaccine intention between respondents whose highest level of education was primary and respondents whose highest level of education was postgraduate.

Overall, this study evidences that education level is positively associated with vaccine intention whereby as education level increases, so does vaccine intention, such

that respondents with a lower level of education are more vaccine hesitant.

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020):

In nationally representative (quota) sample of 18,231 respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between having accessed tertiary education, measured as a binary variable, and vaccine hesitancy, measured on a scale of 1 (completely disagree that I would take a vaccine) to 5 (completely agree), using a cross-sectional survey design and simple and multiple OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%] the United States [54%], France (47%). and the lowest level of vaccine acceptance was in Hungary [47%].

Using simple OLS regression, Lindholt et al. (2020) found that respondents who accessed tertiary education (i.e., post-secondary education) were more likely to accept the vaccine than respondents who did not [B = 0.049, $p < 0.001$].

Using multiple OLS regression, Lindholt et al. (2020) found that, when holding constant trust in national health authorities, trust in scientists, trust in the government, democratic rights, support of public protests, conspiracy beliefs, misinformation, political ideology, vote choice (government), fatigue, behaviour change, knowledge, gender, age, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the economy, support for restrictions and interpersonal trust, respondents who accessed tertiary education (i.e., post-secondary education) were more likely to accept the vaccine than respondents who did not [B = 0.022, $p < 0.001$]. That the strength of the association decreases in the multiple analysis suggests that other factors better account for some of the variance in vaccine acceptance.

This evidences a positive association between education level and vaccine acceptance whereby as education level increases, vaccine acceptance increases such that respondents with a lower level of education are more vaccine hesitant.

As education level increases, vaccine hesitancy increases

Table 16: Studies evidencing that as education level increases, vaccine hesitancy increases

	Study	Country	Region	Cultural Group	Income
1	Salali and Uysal (2021)	Turkey	Asia	Middle East	Upper Middle Income
2	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
3	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income

Turkey, Salali and Uysal (2021): In convenience samples of 3,936 Turkey residents and 1,088 United Kingdom residents, Salali and Uysal (2021) examined the relationship between education, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

In the Turkey sample, Salali and Uysal (2021) found that, when holding constant beliefs about origin of the virus, sex, financial satisfaction, having children, COVID-19-related anxiety and COVID-19 perceived risk, respondents with a graduate degree were less likely to accept the vaccine than respondents without a graduate degree [OR = 0.69, $p < 0.001$]. There was no difference between respondents with a postgraduate degree and respondents without a graduate degree in Turkey [$p > 0.05$]. Overall, in the Turkey sample, there is evidence of a negative association between education level and vaccine acceptance whereby as education level increases, vaccine acceptance decreases such that respondents with a higher level of education are more vaccine hesitant.

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitance, measured as a binary variable (unwilling vs. willing) at a rate of 47.3%, using simple and multiple logistic regression.

Using simple logistic regression, Tsai et al. (2021) found that respondents with a masters degree and above education, [COR = 2.026, $p = 0.005$] and respondents with college education [AOR = 1.866, $p < 0.001$] were more likely to be unwilling to receive the vaccine than respondents with high school and below education.

Tsai et al. (2021) found that when holding constant age, education, occupational status, experience of vaccine refusal, severity of the pandemic in Taiwan and worry about

contracting COVID-19, and health and political orientation, respondents with a masters degree and above education, [AOR = 2.399, $p = 0.002$] and respondents with college education [AOR = 2.1, $p < 0.001$] were more likely to be unwilling to receive the vaccine than respondents with high school and below education.

Overall, this study evidences a positive association between education and vaccine hesitancy whereby as education level increases, vaccine hesitancy also increases such that respondents with a higher level of education are more vaccine resistant.

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between education level, as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

Yu et al. (2021) found that, when holding constant marital status, having children under 18, employment status and chronic disease status, respondents with a college education or above were less likely to intend to receive the vaccination at the soonest opportunity than respondents with lower than a college education [OR = 0.27, $p < 0.01$].

This evidences a positive association between education and vaccine hesitancy whereby as education level increases, vaccine hesitancy also increases such that respondents with a higher level of education are more vaccine resistant.

Relationship between education and vaccine hesitancy is non-linear

Table 17: Studies evidencing that the relationship between education and vaccine hesitancy is non-linear

	Study	Country	Region	Cultural Group	Income
1	Dorman et al. (2021)	United States	North America	Anglo	High Income
2	Willis et al. (2021)	United States	North America	Anglo	High Income

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Butter et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine willingness, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional survey design and ANOVA.

Dorman et al. (2021) found that vaccine intention differed by education level [$p < 0.001$]. Respondents with less than high school education, on average had the strongest will to receive the vaccine [4.82 on a scale of 1–7], followed by respondents with a four-year college degree [4.51] and respondents with a high school diploma [4.48]. Respondents with a community college degree or some college had the weakest will to receive the vaccine [4.3].

This evidences a non-linear association between education level and vaccine willingness.

United States, Willis et al. (2021): In a convenience sample of 1,205 Arkansas residents, Willis et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured

as a binary variable at a hesitancy rate of 78.14%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Willis et al. (2021) found that there were significant differences in vaccine hesitancy between education categories [$p < 0.001$]. Respondents with some college education had the highest level of vaccine hesitancy [32.17%] followed by respondents with a high school degree or less [27.2%]. Respondents with a four-year degree [16.23%] had the lowest level of vaccine hesitancy.

Using logistic regression, Willis et al. (2021) found that, when holding constant sex, race/ethnicity, income, age, COVID-19 health literacy, fear of COVID-19 infection and general vaccine trust, respondents with some college education were more likely to be vaccine hesitant than respondents with a four-year degree [OR = 1.67, $p = 0.028$]. Respondents with high school or less education were not more or less likely to be vaccine hesitant than respondents with a four-year degree [$p = 0.553$].

Overall, this study evidences a non-linear association between education level and vaccine hesitancy.

Education is not associated with vaccine hesitancy

Table 18: Studies evidencing that education is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Salali and Uysal (2021)	United Kingdom	Europe	Anglo	High Income
3	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income

4	Benis et al. (2021)	United States	North America	Anglo	High Income
5	Chu and Liu (2021)	United States	North America	Anglo	High Income
6	Huynh and Senger (2021)	United States	North America	Anglo	High Income
7	Johnson et al. (2021)	United States	North America	Anglo	High Income
8	Savoia et al. (2021)	United States	North America	Anglo	High Income
9	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
10	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
11	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
12	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
13	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
14	Al-Qerem et al. (2020)	Jordan	Asia	Middle East	High Income
15	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income
16	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
17	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between education level, measured as a categorical variable, and vaccine hesitancy, as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that, when holding constant age, gender, area lived, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and

perceived COVID-19 risk, there was no association between education level and vaccine hesitancy in either the key worker and non-key worker samples [$p > 0.05$].

United Kingdom, Salali and Uysal (2021): In convenience samples of 1,088 United Kingdom residents, Salali and Uysal (2021) examined the relationship between education, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

In the British sample, Salali and Uysal (2021) found that, when holding constant beliefs about origin of the virus, sex, financial satisfaction, having children, COVID-19-related anxiety and COVID-19 perceived risk, there

was no association between education and vaccine acceptance [$p > 0.05$].

Ireland and the United Kingdom, Murphy et al. (2021):

In nationally representative (quota) samples of 1'041 Ireland residents and 2025 UK residents, Murphy et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable with rates of 35% and 31% respectively, using a cross-sectional survey design and multinomial logistic regression.

In both the Irish and British samples, Murphy et al. (2020) found that, when holding constant sex, birthplace, ethnicity, residence, age, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, education was not associated with vaccine intention.

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine acceptance, measured as a binary variable, at a rate of 81.5%, using a cross-sectional survey design and logistic regression.

Benis et al. (2021) found that when holding constant age, marital status, number of children, gender, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19 and opinion on whether vaccines should be free of charge, there was no association between education level and vaccine acceptance [$p = 0.06$].

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between education level, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, ethnicity, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived severity, fear, perceived benefits, perceived barriers and

self-efficacy, there was no association between education level and vaccine intention [$p > 0.05$].

United States, Huynh and Senger. (2021): In a convenience sample of 351 USA residents, Huynh and Senger. (2020) examined the relationship between education, measured as a categorical variable, and vaccination intention, measured on a scale of 1 (not at all) to 7 (extremely likely), using hierarchical regression analyses.

Huynh and Senger. (2021) found that, when holding constant gender, ethnicity, age, socio-economic status and political orientation, education level was not associated with vaccine intention [$p > 0.05$].

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between having completed high school education, measured as a binary variable, and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design, Fisher exact test and logistic regression.

Using Fisher exact test, Johnson et al, (2021) found that there were no statistically differences in vaccine intention between educational levels [$p = 0.3779$].

Using logistic regression, Johnson et al. (2021) found that, when holding constant race, Hispanic ethnicity, age, having had the flu or flu vaccine in the last year, flu vaccine intention, income and gender, having completed high school education was not associated with vaccine intention [$p = 0.163$].

United States, Savoia et al. (2021): In a convenience sample of 2'640 United States residents, Savoia et al. (2020) examined the relationship education level, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Savoia et al. (2021) found that respondents with some college education were less likely to be vaccine hesitant than respondents with less than a high school degree [OR = 0.66, $p < 0.05$]. Respondents with a high school education, respondents with a bachelor's degree and respondents with a post-graduate degree were not more or less likely to be vaccine hesitant than respondents with less than a high school degree [$p > 0.05$].

Using multiple logistic regression, Savoia et al. (2021) found that, when holding constant age, gender, employment status, education, race, type of job, medical conditions, risk perception, COVID-19 diagnosis and experience of unfair treatment, education was not associated with vaccine hesitancy [$p > 0.05$].

Overall, the majority of evidence from this study found that education was not associated with vaccine hesitancy.

Austria, Paul et al. (2021): In a nationally representative (quota) sample of 1,301 Austrian residents, Paul et al. (2021) examined the relationship between education, measured as a categorical variable, and readiness to get vaccinated, measured on a scale from 1 (completely disagree) to 5 (completely agree), using a cross-sectional survey design, descriptive statistics and OLS regression.

Using descriptive statistics, Paul et al. (2021) found that respondents who completed a high level of education were marginally more likely to receive the vaccine as soon as possible [55%] compared with respondents who completed a low [47%] and medium [47%] level of education.

Using OLS regression, Paul et al. (2021) found that, when holding constant age, gender, income situation, pre-existing condition, subjective health risk, sense of community, conspiracy belief and party voted for, education was not associated with receiving the vaccine as soon as possible.

Overall, there was insufficient evidence that education is associated with vaccine hesitancy.

Austria, Schernhammer et al. (2021): In a quota sample of 1,007 Austria residents, Schernhammer et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy rate of 41.1% (intermediate or severe), using a cross-sectional survey design and logistic regression.

Schernhammer et al. (2021) found that, when holding constant gender, area of residence, age, politics, optimism, resilience, need for cognitive closure, main source of information and health status, education was not associated with vaccine hesitancy.

Finland, Hammer et al. (2021): In a nationally representative sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine

acceptance, measured on a scale of 1 (strongly disagree) to 8 (strongly agree), using a cross-sectional survey design and stratified linear regression.

Hammer et al. (2021) found that, when holding constant vaccine safety, vaccine efficacy, infection situation in Finland, side effects, recommendation from a healthcare professional, recommendation from health authorities, conversations with family and friends, how easy it is to get vaccinated, perceived susceptibility, perceived probability of infection, perceived severity if infected, perceived transparency with public, perceived politician honesty, belief in COVID-19 conspiracy theory, belief in other conspiracy theories, gender and age, level of education was not associated with vaccine acceptance [$p > 0.5$].

Malta, Cordina et al. (2021): In a convenience sample of 2,529 Malta residents, Cordina et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine willingness, measured on a scale of 1 (definitely no) to 10 (definitely yes), using a cross-sectional survey design, ANOVA and linear regression.

In simple ANOVA analysis, Cordina et al. (2021) found that there was no association between education level and vaccine willingness [$p = 0.09$].

In multiple regression analysis, Cordina et al. (2021) found that, when holding constant COVID-19 knowledge, accessing COVID-19 news and information, engaging in preventative behaviour, vaccine efficacy, importance of family and friends. opinion of the vaccine, importance of healthcare professionals. advice, health worker status, chronic health condition status, age, gender, flu jab status, opinion on giving the vaccine to children and opinion on encouraging elderly patients to take the vaccine, there was no association between education and vaccine hesitancy [$p > 0.05$].

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between education, measured as both a categorical variable (Chi-square analysis) and numerical discrete variable in years (multiple linear regression), and vaccine intention, measured as a categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance), using Chi-square and multiple linear regression. Vaccine hesitancy (refusal and hesitancy categories combined) was at 58.9%.

Using Chi-square, Kuçukkarapinar et al. (2021) found that vaccine intention differed by education levels [$p = 0.041$]. Vaccine resistance was higher in respondents with up to 12 years of schooling [25.3%] than respondents with at least

13 years of schooling [20.9%], but differences between other categories of vaccine intention were small.

Using multiple linear regression, Kuçukkarapinar et al. (2021) found that when holding constant gender, age, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, risk perception, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, education level was not associated with vaccine acceptance [$p = 0.515$].

Overall, this study provides insufficient evidence that education level is associated with vaccine acceptance.

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between education level, measured as a categorical variable, and vaccine intention, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem and Jarab (2021) found that, when holding constant age, gender, marital status, having children, perceived COVID-19 risk, perceived susceptibility to COVID-19 infection, perceived seriousness of COVID-19 and COVID-19 knowledge, university students were less likely to be vaccine resistant (no) than a postgraduate level of education [OR = 0.49, $p < 0.05$], but there were no differences [$p > 0.05$] in vaccine resistance between the remaining levels of education (high school or less, diploma and bachelor's degree) and postgraduate level of education. There was no association [$p > 0.05$] between level of education and vaccine hesitancy (maybe).

Overall, there is insufficient evidence of an association between education level and vaccine intention.

Jordan, Kuwait, Saudi Arabia, Other Arab Countries, Sallam et al. (2021): In a convenience sample of 3'414 Arab country residents, Sallam et al. (2020) examined the relationship between educational level, measured as a categorical variable, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design, Chi-square and multinomial regression.

Using Chi-square, Sallam et al. (2021) found that vaccine acceptance differed by education level [$p < 0.01$]. Respondents with a postgraduate degree [40.2%] were most likely to accept the vaccine, followed by respondents with an undergraduate degree [27.2%]. Respondents with high school or less education [24%] were least likely to accept the vaccine.

Using multinomial regression, Sallam et al. (2021) found that, when holding constant COVID-19 origin conspiracy belief, implanting microchips conspiracy belief, infertility belief, general vaccine belief, gender, country of residence, age, chronic disease history and self or family experience of COVID-19, education level was negatively associated with vaccine acceptance [OR = 0.78, $p = 0.010$].

Overall, this study provides inconclusive evidence given that the direction of the relationship between education level and vaccine acceptance differs in the Chi-square and multinomial regression analyses.

India, Goruntla et al. (2021): In a convenience sample of 2,451 India residents, Goruntla et al. (2021) examined the relationship between education, measured as a categorical variable, and willingness to pay for a COVID-19 vaccine, measured by asking respondents to identify the maximum amount they would be willing to pay for a vaccine dose and providing four price points, using a cross-sectional survey design, Chi-square and multiple logistic regression.

Using Chi-square, Goruntla et al. (2021) found that there was an association between education level and vaccine hesitancy [$p < 0.001$] whereby the respondents who had the lowest rate of intention to take the vaccine were respondents who were graduates, postgraduates or held PhDs [87.2% intended to take the vaccine].

Goruntla et al. (2021) found that, when holding constant marital status, area of location, gender, occupation, income, healthcare profession, chronic disorders and overall health, respondents who were graduates, postgraduates or held PhDs were more likely to intend to take the vaccine than illiterate respondents [OR = 0.26, $p < 0.05$]. Other education levels were not more or less likely to intend to take the vaccine than illiterate respondents [$p > 0.05$].

Overall, this study provides inconclusive evidence that education level is associated with vaccine hesitancy, especially given that 75.52% of respondents were in the highest education level.

India, Kumar et al. (2021): In a convenience sample of 841 India residents, Kumar et al. (2021) examined the relationship between education, measured as a categorical variable, and vaccine interest, measured as a categorical variable (interested, not interested and not sure) at a hesitancy rate of 46.8% (not interested and not sure combined), using a cross-sectional survey design and ANOVA.

Kumar et al. (2021) found that there was no significant difference between education levels on intention to be vaccinated [$p = 0.06$].

Conclusions

Table 19: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]			Non-predictive [n, %]	Total
	As education level increases, vaccine hesitancy decreases [n, %]	As education level increases, vaccine hesitancy increases [n, %]	Relationship between education and vaccine hesitancy is non-linear		
Studies	18 [53%]			16 [47%]	34
Studies	14 [41%]	2 [6%]	2 [6%]	16 [47%]	34
Region					
Europe	6 [43%]	0	0	8 [57%]	14
North America	3 [30%]	0	2 [20%]	5 [50%]	10
Asia	0	3 [38%]	0	5 [63%]	8
Oceania	0	0	0	0	0
South America	0	0	0	0	0
Africa	4 [100%]	0	0	0	4
Cultural Group					
Anglo	6 [35%]	0	2 [12%]	9 [53%]	17
Germanic Europe	1 [33%]	0	0	2 [67%]	3
Nordic Europe	0	0	0	1 [100%]	1
Eastern Europe	1 [100%]	0	0	0	1
Latin Europe	1 [50%]	0	0	1 [50%]	2
Latin America	0	0	0	0	0
Southern Asia	0	0	0	2 [100%]	2
Confucian Asia	0	2 [100%]	0	0	2
Sub-Saharan Africa	4 [100%]	0	0	0	4
Middle East	0	1 [25%]	0	3 [75%]	4

Income					
High Income	9 [32%]	2 [7%]	2 [7%]	15 [54%]	28
Upper Middle income	0	1 [50%]	0	1 [50%]	2
Lower Middle income	1 [33%]	0	0	2 [67%]	3
Low Income	3 [100%]	0	0	0	3

Overall: The overall relationship between education and vaccine hesitancy is inconclusive: 53% of studies [18 out of 34] found education to be predictive of vaccine hesitancy and 47% of studies [16 out of 34] did not find education to be predictive of vaccine hesitancy, such that the relationship between education and vaccine hesitancy is inconclusive. Of the 18 studies that found education to be predictive of vaccine hesitancy, 78% of studies [14 out of 18] found that as education level increases, vaccine hesitancy decreases (i.e., less educated are more hesitant), such that it can be concluded with high confidence that, when education is predictive of vaccine hesitancy, the association is negative. However, out of all studies, only 41% of studies [14 out of 34] found that as education level increases, vaccine hesitancy decreases (i.e., less educated are more hesitant), such that, overall, the relationship between education and vaccine hesitancy is inconclusive.

NB: Salali and Uysal (2021) was not included in the above analysis as it contained two countries for which there were mixed findings in terms of the association between education and vaccine hesitancy.

In looking for patterns by region, cultural group and income of the countries in the studies, some associations between education level and vaccine hesitancy are evident.

Region: Of studies conducted in countries in Africa, 100% [4 out of 4] found that as education level increases, vaccine hesitancy decreases (i.e., lower educated are more hesitant), such that it can be concluded with high confidence that in African countries, as education level increases, vaccine hesitancy decreases.

An association between education and vaccine hesitancy was not evident in Asian, European and North American contexts. In Asia, 63% of studies [5 out of 8] found that education was not associated with vaccine hesitancy, such that it can be concluded with confidence that in Asia, education is not associated with vaccine hesitancy. In Europe, 57% of studies [8 out of 14] found that education was not associated with vaccine hesitancy. In North America, 50% of studies [5 out of 10] found that education was not associated with vaccine hesitancy. It can be concluded with some confidence that in Europe and

North America, education is not associated with vaccine hesitancy.

There is no evidence to draw conclusions about the relationship between education and vaccine hesitancy in the contexts of Oceania [0 studies] and South America [0 studies].

Cultural group: Of studies conducted in countries in the Sub-Saharan Africa cultural group, 100% [4 out of 4] found that as education level increases, vaccine hesitancy decreases (i.e., lower educated are more hesitant), such that it can be concluded with high confidence that in Sub-Saharan Africa cultural group countries, as education level increases, vaccine hesitancy decreases.

Of studies conducted in countries in the Middle East cultural group, 75% [3 out of 4] found that education was not associated vaccine hesitancy, such that it can be concluded with high confidence that in Middle East cultural group countries, education is not associated with vaccine hesitancy.

An association between education and vaccine hesitancy was not evident in an Anglo cultural group context: 53% of studies [9 out of 17] found that education was not associated with vaccine hesitancy, such that it can be concluded with some confidence that in Anglo cultural group countries, education is not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between education and vaccine hesitancy in the cultural group contexts of Germanic Europe [3 studies], Latin Europe [2 studies], Southern Asia [2 studies], Confucian Asia [2 studies], Nordic Europe [1 study] and Eastern Europe [1 study].

There is no evidence to draw conclusions about the relationship between education and vaccine hesitancy in the context of the Latin America cultural group [0 studies].

Income: Segmenting evidence by income of countries did not identify any associations between education and vaccine hesitancy. Of studies conducted in high income countries, 54% of studies [15 out of 28] found no association between education and vaccine hesitancy, such that it can be concluded with confidence that in high income countries there is no association between education and vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between age and vaccine hesitancy in the contexts of lower middle income countries [3 studies], low income countries [3 studies] and upper middle income countries [2 studies].

DEMOGRAPHICS
INCOME

5.1.4

Income is the regular money received by an individual through work, a pension, investments, benefits or other sources. Income was primarily measured as a categorical, but ordered, variable using different money ranges, differing in terms of unit of income (e.g., household income or individual income) and time frame of income (e.g., monthly or annual income).

In total, 21 studies considered the association between income and vaccine hesitancy. Of these, 13 found that income was predictive of vaccine hesitancy and eight found that income was not predictive of vaccine hesitancy. Of the 13 studies that found income was predictive of vaccine hesitancy, 12 found that as income increases, vaccine hesitancy decreases (i.e., those with a lower income are more vaccine hesitant), zero found that as income increases, vaccine hesitancy increases and one found that the relationship between income and vaccine hesitancy is non-linear.

As income increases, vaccine hesitancy decreases

Table 20: Studies evidencing that as income increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
4	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income
5	Allen et al. (2021)	United States	North America	Anglo	High Income
6	Coe et al. (2021)	United States	North America	Anglo	High Income
7	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
8	Willis et al. (2021)	United States	North America	Anglo	High Income

9	Edwards et al. (2021)	Australia	Oceania	Anglo	High Income
10	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
11	Alobaidi. (2021)	Saudi Arabia	Asia	Middle East	High Income
12	Rozek et al. (2021)	Multiple countries aggregated			

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between household income, measured as a binary variable (< £25,000 vs. £25,000 and above), and vaccine hesitancy, measured from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found a very weak negative correlation between household income and vaccine hesitancy [$r_s = -0.05$] whereby as household income increases, vaccine hesitancy decreases such that respondents with a lower household income are more vaccine hesitant.

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant other demographic factors (gender, ethnicity, education, age), household income was negatively associated with vaccine hesitancy [$r_s = -0.08$, $p < 0.001$], whereby as income increases, vaccine hesitancy decreases such that respondents with a lower household income are more vaccine hesitant.

Household income remained predictive when holding other factors constant. When also holding constant reliance on legacy media and reliance on social media for COVID-19 knowledge, household income was still negatively associated with vaccine hesitancy [$r_s = -0.06$, $p < 0.001$]. When holding constant perceived risk of COVID-19 to oneself, the UK and the world, as well as other demographic factors, household income was still negatively associated with vaccine hesitancy [$r_s = -0.08$, $p < 0.001$]. When holding constant trust in the government, scientists working at universities, scientists working at private companies, and doctors and nurses, as well as other demographic factors, income was still negatively associated with vaccine hesitancy [$r_s = -0.03$, $p < 0.001$]. When holding constant general vaccine attitude and COVID-19 conspiracy suspicions, as well as other demographic factors, income was still negatively associated with vaccine hesitancy [$r_s = -0.04$, $p < 0.001$]. When holding constant all factors studied in a single model, income was still negatively associated with vaccine hesitancy [$r_s = -0.02$, $p < 0.001$].

Overall, this study establishes a negative association between household income and vaccine hesitancy whereby as household income increases, vaccine hesitancy decreases such that respondents with a lower household income are more vaccine hesitant.

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers ($n = 584$) and non-key workers ($n = 1,021$), Butter et al. (2021) examined the relationship between income, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

In the key worker sample, Butter et al. (2021) found that, when holding constant gender, area lived, education, age, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and perceived COVID-19 risk, there was no association between income and vaccine hesitancy.

In the non-key worker sample, Butter et al. (2021) found that, when holding constant gender, area lived, education, age, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and perceived COVID-19 risk, respondents having an average [OR = 2.37, $p < 0.01$] or below average income [OR = 2.58, $p < 0.001$] were more likely to be vaccine hesitant than respondents with an above average income.

Overall, this study evidences a negative association between income and vaccine hesitancy whereby as income increases, vaccine hesitancy decreases such that respondents with a lower income are more vaccine hesitant.

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021) examined the relationship between income, measured as an ordinal variable, and vaccine hesitancy, measured on a

scale from 1 (definitely) to 5 (definitely not) plus an option for don't know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that income was negatively associated with vaccine hesitancy [$B = -0.054$, $p < 0.001$] whereby as income increases, vaccine hesitancy decreases, such that with lower income are more vaccine hesitant. However, income only accounted for a small amount of variance in vaccine hesitancy [$r_s = 0.012$].

United Kingdom, Murphy et al. (2021): In nationally representative (quota) samples of 2'025 UK residents, Murphy et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable with a hesitancy rate of 31%, using a cross-sectional survey design and multinomial logistic regression.

Murphy et al. (2021) found that, when holding constant sex, age, birthplace, ethnicity, residence, education, employment, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, respondents with an income of £0- £15,490 [$AOR = 2.48$, $p < 0.05$], respondents with an income of £15,491-£25,340 [$AOR = 2.68$, $p < 0.05$] and respondents with an income of £25,341-£38,740 [$AOR = 2.31$, $p < 0.05$] were more likely to be vaccine resistant (compared with vaccine accepting) than respondents with an income of £50,000 and over. Respondents with an income of £38,740-£57,930 were not more or less likely to be vaccine resistant (compared with vaccine accepting) than respondents with an income of £50,000 and over [$p > 0.05$]. No income groups were more or less likely to be vaccine hesitant (compared with vaccine accepting) or more or less likely to be vaccine resistant (compared with vaccine hesitant) than respondents with an income of £57,931 and over.

Overall, there is a negative association between income and vaccine resistance whereby as income increases, vaccine resistance decreases such that respondents with a lower income are more vaccine resistant. However, there is no association between income and vaccine hesitancy.

Ireland, Murphy et al. (2021): In nationally representative (quota) samples of 1'041 Ireland residents, Murphy et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable at a hesitancy rate of 35%, using a cross-sectional survey design and multinomial logistic regression.

Murphy et al. (2020) found that, when holding constant sex, age, birthplace, ethnicity, residence, education,

employment, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, respondents with an income of €0- €19,999 [$AOR = 5.73$, $p < 0.05$], respondents with an income of €20,000-€29,999 [$AOR = 3.46$, $p < 0.05$], respondents with an income of €30,000- €39,999 [$AOR = 3.16$, $p < 0.05$] and respondents with an income of €40,000 - €49,999 [$AOR = 4.79$, $p < 0.05$] were more likely to be vaccine resistant (compared with vaccine accepting) than respondents with an income of £50,000 and over.

Respondents with an income of €0- €19,999 [$AOR = 5.44$, $p < 0.05$], respondents with an income of €20,000-€29,999 [$AOR = 2.82$, $p < 0.05$], respondents with an income of £30,000-£39,999 [$AOR = 3.34$, $p < 0.05$] and respondents with an income of £40,000-£49,999 [$AOR = 5.24$, $p < 0.05$] were more likely to be vaccine resistant (compared with vaccine hesitant) than respondents with an income of €50,000 and over. No income groups were more or less likely to be vaccine hesitant (compared with vaccine accepting) than respondents with an income of €50,000 and over.

Overall, there is a negative association between income and vaccine resistance and between income and vaccine hesitancy whereby as income increases, vaccine resistance and hesitancy decrease such that respondents with a lower income are more vaccine resistant and hesitant.

United States, Allen et al (2021): In a purposive sample of 396 United States racially/ethnically diverse women, Allen et al. (2021) examined the relationship between income, measured as a categorical variable, and vaccine intention, measured as a categorical variable (yes, no, don't know/unsure) at a hesitancy rate of 43.2%, using a cross-sectional survey design and Chi-square.

Allen et al. (2021) found that more women with high income (> \$75,000/year) reported that they would get the vaccine [35.1%] than women with low incomes (< \$34,000/year) [25.3%, $p = 0.03$], such that income is positively associated with vaccine intention, whereby as income increases, vaccine intention increases such that respondents with a lower income are more vaccine hesitant.

United States, Coe et al. (2021): In a nationally representative (quota) sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between annual household income, measured as a categorical variable, and intention to receive the COVID-19 vaccine, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that respondents with an annual household income of less than \$15,000 were less likely to intend to receive the vaccine than respondents with an annual household income of \$50,000-99,999 [OR = 0.54, 95% CI 0.35-0.83] and that respondents with an annual household income of \$150,000 or more were more likely to intend to receive the vaccine than respondents with an annual household income of \$50,000-99,999 [OR = 2.20, 95% CI 1.33-3.66]. Respondents with an annual income of \$15,000 to \$49,999 [95% CI 0.64-1.19] and \$100,000-\$149,999 [95% CI 0.9-2.18] were not more or less likely to intend to receive the vaccine than respondents with an annual household income of \$50,000-99,999.

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant gender, race, region, ethnicity, education, age, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, annual household income was not associated with vaccine intention, suggesting that factors others than income better account for variance in vaccine intention.

Overall, this study evidences a positive association between annual household income and vaccine intention whereby as annual household income increases, vaccine intention increases such that respondents with a lower annual household income are more vaccine hesitant, even though other factors better account for variance in vaccine intention.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between total household income, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found significant differences in vaccine uptake intention between income groups [$p = 0.005$]. Respondents with a total household income of \$120,000 and higher [73.3%] were most likely to receive the vaccine, followed by respondents with a total household income of \$80,000-\$119,000 [72.8%], respondents with a total household income of \$40,000-\$79,999 [61.5%] and respondents with annual income below \$40,000 [54.3%]. Respondents who declined to answer about their income [31.8%] were least likely to get the vaccine.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having

had the flu vaccine, pre-existing conditions, gender, of White race, of Hispanic cultural identity, age, education, political party identity, marital status and preferred media for virus news, respondents with household income of \$120,000 and over were more likely to intend to receive the vaccine than respondents with household income less than \$40,000 [$B = 0.338$, $p = 0.004$]. Respondents with other categories of household income were not more or less likely to intend to receive the vaccine than respondents with household income less than \$40,000 [$p > 0.05$].

Overall, there is some evidence of a positive association between total household income and vaccine intention whereby a total household income increases, vaccine intention increases such that respondents with a lower household income are more vaccine hesitant.

United States, Willis et al. (2021): In a convenience sample of 1,205 Arkansas residents, Willis et al. (2021) examined the relationship between income, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable at a hesitancy rate of 78.14%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Willis et al. (2021) found that there was a significant variation in COVID-19 vaccine hesitancy based on income [$p < 0.001$]. Vaccine hesitancy was highest for respondents with an income of less than \$25,000 [30.68%], followed by respondents with an income of between \$25k and less than \$50k [23.28%], followed by respondents with an income of between \$25,000-\$49,000 [19.7%]. Vaccine hesitancy was lowest in respondents with an income of more than \$75k [13.1%].

Willis et al. (2021) found that when holding constant age, sex, race/ethnicity, education, COVID-19 health literacy, fear of COVID-19 infection and general vaccine trust, income was not associated with vaccine hesitancy [$p > 0.05$], suggesting that factors other than income better accounted for variance in vaccine hesitancy.

Overall, there is some evidence of a negative association between income and vaccine hesitancy whereby as income increases, vaccine hesitancy decreases such that respondents with lower income are more vaccine hesitant.

Australia, Edwards et al. (2021): In a nationally representative (quota) sample of 3,000 Australia residents, Edwards et al. (2021) examined the relationship between household income, measured as a discrete numerical variable, and vaccine acceptance, measured on a scale of 1 (definitely not get the vaccine) to 4 (definitely get the vaccine) at a hesitancy rate of 58.6%, using a cross-sectional survey design and ordinal probit regression, presenting AME.

Edwards et al. (2021) found that, when holding constant location in Australia, gender, age, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city and employment, household income was negatively associated with vaccine resistance [AME = -0.00003, $p < 0.01$], a high level of vaccine hesitancy [AME = -0.00003, $p < 0.01$], a low level of vaccine hesitancy [AME = -0.00005, $p < 0.01$] and positively associated with vaccine acceptance [AME = 0.0001, $p < 0.01$].

Edwards et al. (2021) found that, when holding constant location in Australia, gender, age, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment, belief that too much fuss is being made about COVID-19, social distancing behaviour, having downloaded the COVID-19 Safe App, voting intention, confidence in government, confidence in hospitals and health system, support for migration, populism and religiosity, household income was negatively associated with vaccine resistance [AME = -0.00003, $p < 0.05$], a high level of vaccine hesitancy [AME = -0.00002, $p < 0.01$], a low level of vaccine hesitancy [AME = -0.00004, $p < 0.05$] and positively associated with vaccine acceptance [AME = 0.0009, $p < 0.01$].

Overall, this study establishes a negative association between household income and vaccine resistance and hesitancy whereby as household income increases, vaccine resistance and hesitancy decreases, such that respondents with a lower household income are more vaccine resistant and hesitant.

India, Goruntla et al. (2021): In a convenience sample of 2,451 of India residents, Goruntla et al. (2021) examined the relationship between monthly family income, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 10.73%, using a cross-sectional survey design, Chi-square and multiple logistic regression.

Using ANOVA, Goruntla et al. (2021) found that vaccine acceptance differed by income level of participants [$p < 0.001$]. Vaccine acceptance was highest in respondents with a monthly income of \$40,001-80,000 (\$552.18-1,104.33) [93.66%], followed by respondents with a monthly income more than \$80,000 (\$1,104.33) [92.65%], respondents with a monthly income of \$20,001-40,000 (\$276.10-552.17) [91.21%], respondents with a monthly income of \$10,001-20,000 (\$138.06-276.08) [88.41%] and respondents with an income less than \$5,000 (\$69.02) [84.62%]. Vaccine acceptance was lowest in respondents with a monthly income of \$5,001-10,000 (\$69.03-138.04) [78.79%].

Using multiple logistic regression, Goruntla et al. (2021) found that, when holding constant marital status, area of location, education, occupation, age, healthcare profession, chronic disorders and overall health, respondents with the income of \$20,001-40,000 (\$276.10-552.17) [OR = 1.98,

$p < 0.01$], a monthly income of \$40,001-80,000 (\$552.18-1,104.33) [OR = 2.82, $p < 0.001$], and income more than 80,000 (\$1,104.33) [OR = 2.40, $p < 0.01$] were more likely to accept the vaccine than respondents with an income of less than 5,000 (\$69.02). Respondents with incomes of \$5,001-10,000 (USD 69.03-138.04) and \$10,001-20,000 (\$138.06-276.09) were not more or less likely to accept the vaccine than respondents with an income of less than \$5,000 (\$69.02).

Overall, this study evidences a positive association between monthly family income and vaccine acceptance whereby as monthly family income increases, vaccine acceptance increases such that respondents with a lower monthly income are more vaccine hesitant.

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between monthly income, measured as a categorical variable, and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design and Chi-square.

Alobaidi (2021) found that high income participants (>15,000 SR per month) were most likely to have a definite intent to receive the vaccine [51%, $p < 0.001$] compared with other income categories, evidencing a positive association between household income and vaccine intention whereby as household income increases, vaccine intention decreases such that respondents with a lower monthly income are more vaccine hesitant.

Multiple Countries, Rozek et al. (2021): In nationally representative (quota) samples (except for snowball sample from Russia) of 17 countries (Canada, United States, Germany, Poland, Russia, Sweden, Ukraine, China, Hong Kong, Taiwan, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Turkey) totalling 17,608 responses, Rozek et al. (2021) examined the relationship between age, measured economic wellbeing, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (yes, no, maybe) but recoded as a binary variable (yes vs. no/maybe) and at a hesitancy rate of 44% (no and maybe combined), using a cross-sectional survey design and descriptive statistics.

Using descriptive statistics, Rozek et al. (2021) found that respondents of the lowest levels of economic wellbeing [48%] were more likely to be vaccine hesitant than respondents of the highest level of economic wellbeing [41%], evidencing a negative association between economic wellbeing and vaccine hesitancy whereby as economic wellbeing increases, vaccine hesitancy decreases, such that respondents with lower economic wellbeing are more vaccine hesitant.

Relationship between income and vaccine hesitancy is non-linear

Table 21: Studies evidencing that relationship between income and vaccine hesitancy is non-linear

	Study	Country	Region	Cultural Group	Income
1	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between monthly income, measured as a categorical variable, and vaccine acceptance, measured as a binary variable and at a hesitancy rate of 53.6%, using a cross-sectional survey design and logistic regression.

Echoru et al. (2021) found that, when holding constant gender, education, occupation, religion, marital status,

age, and rural or urban residence, non-salary earners [OR = 2.29, $p = 0.000$] and respondents earning less than \$274 [OR = 1.56] per month were more likely to accept the vaccine than respondents who earned between \$274 and \$548. Respondents earning more than \$548 were not more or less likely to accept the vaccine than respondents who earned between \$274 and \$548 [$p = 0.684$].

Overall, this study evidences a non-linear association between monthly income and vaccine hesitancy.

Income is not associated with vaccine hesitancy

Table 22: Studies evidencing income is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Chu and Liu (2021)	United States	North America	Anglo	High Income
2	Johnson et al. (2021)	United States	North America	Anglo	High Income
3	Shih et al. (2021)	United States	North America	Anglo	High Income
4	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
5	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
6	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
7	Tao et al. (2021)	China	Asia	Confucian Asia	High Income
8	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between income and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, ethnicity, education, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived severity, fear, perceived benefits, perceived barriers and self-efficacy, there was no association between income and vaccine intention [$p > 0.05$].

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between income, measured as a binary variable (less than \$25,000 vs. more than \$25,000), and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design, Fisher exact test and logistic regression.

Using Fisher exact test, Johnson et al. (2021) found that there was no association between income and vaccine intention [$p = 0.666$].

Using logistic regression, Johnson et al. (2021) found that, when holding constant gender, Black race, Hispanic ethnicity, education, having had the flu or flu vaccine in the last year, flu vaccine intention and age, income was not associated with vaccine intention [$p = 0.348$].

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between income, measured as a categorical variable, and vaccine hesitancy, measured using an adapted version of the WHO Sage's 10-item scale, which was then recoded as two binary variables (vaccine rejection and vaccine resistance), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant gender, residence, generation (age), race/ethnicity and political affiliation, respondents with a monthly family income of more than \$10,000 were less likely to be vaccine hesitant than respondents with a monthly family income of \$2,000-\$4,999 [OR = 0.44, 95% CI 0.25-0.77]. Respondents with monthly family incomes of less than \$2,000, respondents with monthly family incomes of \$2,000-\$4,999 and respondents with monthly family incomes of \$5,000-\$9,999 were not more or less likely to be vaccine hesitant than respondents with a monthly family income of \$2,000-\$4,999. There was no association between monthly family income and vaccine rejection.

Overall, this study provides insufficient evidence of an association between income and vaccine hesitancy or vaccine resistance.

Austria, Paul et al. (2021): In a nationally representative (quota) sample of 1,301 Austrian residents, Paul et al. (2021) examined the relationship between financial situation, measured as a categorical variable, and readiness to get vaccinated, measured on a scale from 1 (completely disagree) to 5 (completely agree), using a cross-sectional survey design, descriptive statistics and OLS regression.

Using descriptive statistics, Paul et al. (2021) found that more respondents with good financial situations [55%] completely or somewhat agreed that they intended to receive the vaccine as soon as possible than respondents with medium financial situations [44%] and respondents with difficult financial situations [37%].

Using OLS regression, Paul et al. (2021) found that, when holding constant gender, education, age, pre-existing condition, subjective health risk, sense of community, conspiracy belief and party voted for, income situation was not associated with intention to receive the vaccine as early as possible.

Overall, this study provides insufficient evidence of an association between income situation and readiness to get vaccinated.

Portugal, Soares et al. (2021): In a convenience sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between monthly household income, measured as a categorical variable, with vaccine intention (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design and multinomial logistic regression.

Soares et al. (2021) found that, when holding constant gender, education, age, lost income during pandemic and occupation, there was no association between monthly household income and vaccine intention.

India, Kumar et al. (2021): In a convenience sample of 841 India residents, Kumar et al. (2021) examined the relationship between income, measured as a categorical variable, and vaccine interest, measured as a categorical variable (interested, not interested and not sure) at a hesitancy rate of 46.8% (not interested and not sure combined), using a cross-sectional survey design and ANOVA.

Kumar et al. (2021) found that there was no associations between income and vaccine hesitancy ($p=0.262$).

China (Pregnant Women), Tao et al. (2021): In a multi-stage part-random and part-convenience sample of

1,392 pregnant China residents, Tao et al. (2021) examined the relationship between monthly household income, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy (intermediate or severe) rate of 41.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Tao et al. found that there were no differences in vaccine acceptance between monthly household income groups [$p = 0.11$].

Using logistic regression, Tao et al. (2021) found that, when holding constant age group, region, education, occupation, gravidity, parity, gestational trimester, history of adverse pregnancy outcomes, history of chronic disease, history of

influence vaccination, gestational complications, COVID-19 knowledge, perceived susceptibility, perceived severity, barriers to receiving the vaccine, perceived benefits of the vaccine and cues to action, monthly household income was not associated with vaccine hesitancy [$p > 0.05$].

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between average monthly income, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design and Chi-square.

Wong et al. (2021) found that average monthly income was not associated with vaccine hesitancy [$p = 0.217$].

Conclusions

Table 23: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]			Non-predictive [n, %]	Total
	As income increases, vaccine hesitancy decreases [n, %]	As income increases, vaccine hesitancy increases [n, %]	Relationship between income and vaccine hesitancy is non-linear [n, %]		
Studies	13 [62%]			8 [38%]	21
Studies	12 [57%]	0	1 [5%]	8 [38%]	21
Region					
Europe	5 [71%]	0	0	2 [29%]	7
North America	4 [57%]	0	0	3 [43%]	7
Asia	2 [40%]	0	0	3 [60%]	5
Oceania	1 [100%]	0	0	0	1
South America	0	0	0	0	0
Africa	0	0	1 [100%]	0	1
Cultural Group					
Anglo	10 [77%]	0	0	3 [23%]	13
Germanic Europe	0	0	0	1 [100%]	1
Nordic Europe	0	0	0	0	0

Eastern Europe	0	0	0	0	0
Latin Europe	0	0	0	1 [100%]	1
Latin America	0	0	0	0	0
Southern Asia	1 [33%]	0	0	2 [67%]	3
Confucian Asia	0	0	0	1 [100%]	1
Sub-Saharan Africa	0	0	1 [100%]	0	1
Middle East	1 [100%]	0	0	0	1
Income					
High Income	11 [65%]	0	0	6 [35%]	17
Upper Middle income	0	0	0	1 [100%]	1
Lower Middle income	1 [50%]	0	0	1 [50%]	2
Low Income	0	0	1 [100%]	0	1

Overall: Of the studies that considered the association between income and vaccine hesitancy, 62% [13 out of 21] found income to be predictive, such that it can be confidently concluded that income is predictive of vaccine hesitancy. Of the 13 studies that found income to be predictive of vaccine hesitancy, 92% [12 out of 13] found that as income increases, vaccine hesitancy decreases (i.e., those with a lower income are more hesitant), such that it can be concluded with high confidence that, when income is predictive of vaccine hesitancy, the association is negative. Out of all studies, 57% [12 out of 21] found that as income increases, vaccine hesitancy decreases (i.e., those with a lower income are more hesitant), such that it can be concluded with some confidence that, overall, as income increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and income of the countries in the studies, some associations between income and vaccine hesitancy are evident.

Region: Of studies conducted in European countries, 71% [5 out of 7] found that as income increases, vaccine hesitancy decreases (i.e., those with a lower income are more hesitant), such that it can be concluded with high confidence that in European countries, as income increases, vaccine hesitancy decreases.

Of studies conducted in North American countries, 57% [4 out of 7] found that as income increases, vaccine hesitancy decreases (i.e., those with a lower income are

more hesitant), such that it can be concluded with some confidence that in North American countries, as income increases, vaccine hesitancy decreases.

An association between income and vaccine hesitancy was not evident in studies conducted in Asian countries: 60% of studies [3 out of 5] found that income was not associated with vaccine hesitancy, such that it can be concluded with confidence that in Asia, education is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between income and vaccine hesitancy in the contexts of Oceania [1 study] and Africa [1 study].

There is no evidence to draw conclusions about the relationship between income and vaccine hesitancy in the context of South America [0 studies].

Cultural group: Of studies conducted in countries in the Anglo cultural group, 77% [10 out of 13] found that as income increases, vaccine hesitancy decreases (i.e., those with lower income are more hesitant), such that it can be concluded with high confidence that in countries of the Anglo cultural group, as income increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between income and vaccine hesitancy

in the contexts of the Southern Asia [3 studies], Germanic Europe [1 study], Latin Europe [1 study], Confucian Asia [1 study], Sub-Saharan Africa [1 study] and Middle East [1 study] cultural groups.

There is no evidence to draw conclusions about the relationship between income and vaccine hesitancy in the context of Nordic Europe [0 studies], Eastern Europe [0 studies] and Latin America [0 studies] cultural groups.

Income: Of studies conducted in high income countries, 65% [11 out of 17] found that as income increases, vaccine hesitancy decreases (i.e., those with lower income are more hesitant), such that it can be confidently concluded that in high income countries, as income increases, vaccine hesitancy decreases.

There is insufficient evidence to draw any conclusions about the relationship between income and vaccine hesitancy in the contexts of lower middle income countries [2 studies], upper middle income countries [1 study] and low income countries [1 study].

DEMOGRAPHICS
RACE/ETHNICITY

5.1.5

Race is the physical traits an individual is born with and ethnicity is the cultural identification than an individual learns. Only races/ethnicities that were featured in multiple studies were considered, resulting in evidence purely from the Anglo cultural group. Race/ethnicity was most frequently measured as a categorical variable, but also as a binary variable (e.g., White vs. non-White).

In total, 17 studies considered the association between race/ethnicity and vaccine hesitancy. Of these, 13 found that race/ethnicity was predictive of vaccine hesitancy and four found that race/ethnicity was not predictive of vaccine hesitancy. Of the 13 studies that found race/ethnicity was predictive of vaccine hesitancy, 11 found that members of black ethnic groups were most vaccine hesitant, one that members of non-Hispanic ethnic groups were most vaccine hesitant and one that members of non-BAME ethnic groups were most vaccine hesitant.

Members of black ethnic groups are most vaccine hesitant

Table 24: Studies evidencing that members of black ethnic groups are most vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
3	Agley et al. (2021)	United States	North America	Anglo	High Income
4	Allen et al. (2021)	United States	North America	Anglo	High Income
5	Benis et al. (2021)	United States	North America	Anglo	High Income
6	Coe et al. (2021)	United States	North America	Anglo	High Income
7	Dorman et al. (2021)	United States	North America	Anglo	High Income
8	Kreps et al. (2021)	United States	North America	Anglo	High Income
9	Savoia et al. (2021)	United States	North America	Anglo	High Income

10	Shih et al. (2021)	United States	North America	Anglo	High Income
11	Willis et al. (2021)	United States	North America	Anglo	High Income

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between ethnicity, measured as a binary variable (White vs. non-White), and vaccine hesitancy, measured from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that being non-White was positively correlated with vaccine hesitancy [$r_s = 0.14$], whereby non-White respondents were more likely to be vaccine hesitant.

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant other demographic factors (age, gender, education, household income), being non-White was positively associated with vaccine hesitancy [$r_s = 0.16$, $p < 0.001$], whereby non-White respondents were more likely to be vaccine hesitant than White respondents. Ethnicity remained predictive when holding other factors constant. When also holding constant reliance on legacy media and reliance on social media for COVID-19 knowledge, being non-White was still positively associated with vaccine hesitancy [$r_s = 0.15$, $p < 0.001$]. When holding constant perceived risk of COVID-19 to oneself, the UK and the world, as well as other demographic factors, being non-White was still positively associated with vaccine hesitancy [$r_s = 0.19$, $p < 0.001$]. When holding constant trust in the government, scientists working at universities, scientists working at private companies, and doctors and nurses, as well as other demographic factors, being non-White was still positively associated with vaccine hesitancy [$r_s = 0.11$, $p < 0.001$]. When holding constant general vaccine attitude and COVID-19 conspiracy suspicions, as well as other demographic factors, being non-White was no longer associated with vaccine hesitancy [$p = 0.333$], suggesting that these additional factors interact with being non-White and better account for variance in vaccine hesitancy. When holding constant all factors studied in a single model, being non-White was marginally positively associated with vaccine hesitancy [$r_s = 0.05$, $p = 0.048$]. In this full model, being non-White was the sixth most predictive factor of vaccine hesitancy after general vaccine hesitancy, COVID-19 conspiracy suspicions, age, personal risk perception and gender.

Overall, this study evidences that non-White respondents are most likely to be vaccine hesitant.

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021)

examined the relationship between ethnicity, measured as a numerical discrete variable in years, and vaccine hesitancy, measured on a scale from 1 (definitely) to 5 (definitely not) plus an option for don't know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that Black respondents ($B = 0.542$, $p < 0.001$) and mixed race respondents ($B = 0.316$, $p = 0.003$) were more likely to be vaccine hesitant than White respondents. Asian respondents [$p = 0.074$] and other race respondents [$p = 0.297$] were not more or less likely to be vaccine hesitant than White respondents.

This study evidences that Black respondents are most likely to be vaccine hesitant, followed by mixed race respondents.

United States, Agle et al. (2021): In a nationally representative sample of 1,017 United States residents, Agle et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and linear regression.

Agle et al. (2021) found that when holding constant age, COVID-19 diagnosis, gender, being Hispanic or Latin, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19, friends' or family's avoidance of crowded areas, Black or African Americans were less likely [$B = -1.078$, $p < 0.001$] and Asians were more likely [$B = 0.378$, $p = 0.007$] to accept the vaccine than White respondents. There was no difference in vaccine intention between respondents of other ethnicity and White respondents [$p = 0.44$].

Agle et al. (2021) also found that when holding constant age, COVID-19 diagnosis, gender, ethnicity, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19 and friends' or family's avoidance of crowded areas, there was no association between being Hispanic or Latin and vaccine intention [$p = 0.44$].

Overall, this study evidences that Black or African American respondents are most likely to be vaccine hesitant.

United States, Allen et al. (2021): In a purposive sample of 396 United States racially/ethnically diverse women, Allen et al (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine intention, measured as a categorical variable (yes, no, don't know/unsure) at a hesitancy rate of 43.2%, using a

cross-sectional survey design, Chi-square and simple and multiple logistic regression.

Using Chi-square, Allen et al. (2021) found that there were significant differences in vaccine intentions by ethnicity [$p < 0.01$]. Chinese women were the most likely to intend to be vaccinated [70.7%], followed by Non-Latin White women [62.4%], multiracial women [64.3%] and Latin women [53.5%]. Non-Latin Black women [39.2%] were the least likely to intend to be vaccinated.

Using simple logistic regression, Allen et al. (2021) found that Non-Latin Black women were less likely to intend to be vaccinated than Non-Latin White women [OR = 0.42, 95% CI 0.22-0.8]. Latin women [95% CI 0.59-3.1], Chinese women [95% CI 0.46-1.62] and multiracial women [95% CI 0.23-2.83] were not more or less likely to intend to be vaccinated than Non-Latin White women.

Using multiple logistic regression, Allen et al. (2021) found that, when holding constant age, marital status, income, education, employment, insurance, trust in healthcare professionals and belief in safety/efficacy, ethnicity was not associated with vaccine intention, suggesting that other factors better accounted for variance in vaccine intention.

Overall, this study evidences that non-Latin Black women respondents are most likely to be vaccine hesitant.

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between ethnicity background, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Benis et al. (2021) found that Black or African American respondents [COR = 3.60, 95% CI 1.54-8.12] and respondents who preferred not to say their ethnicity [COR 5.09, 95% CI 2.68-9.68] were more likely to accept the vaccine than White respondents. American Indian/Alaska Native respondents [95% CI 0.25-5.32], Asian respondents [95% CI 0.56-1.8], Hispanic or Latin respondents [95% CI 0.96-3.42], Native Hawaiian/Pacific Islander respondents [95% CI 0-27.25] and mixed race respondents [95% CI 0.74-3.4] were not more or less likely to accept the vaccine than White respondents.

Using multiple logistic regression, Benis et al. (2021) found that, when holding constant gender, marital status, number of children, education, age, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in

government guidance, civic responsibility to take vaccine, being sick from COVID-19, and opinion on whether vaccines should be free of charge, ethnicity was not associated with vaccine acceptance, suggesting that other factors interacted with ethnicity and better accounted for variance in vaccine hesitancy.

Overall, there is some evidence that Black or African American respondents are most likely to be vaccine hesitant.

United States, Coe et al. (2021): In a nationally representative (quota) sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between gender, measured as a binary variable, and intention to receive the COVID-19 vaccine, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that Black respondents [COR = 0.36, 95% CI 0.25-0.51] and other race respondents [COR = 0.62, 95% CI 0.43-0.9] were less likely to intend to receive the vaccine than White respondents.

Using simple logistic regression, Coe et al. (2021) found that Hispanic or Latin respondents were not more or less likely to intend to receive the vaccine than White respondents [95% CI 0.25-0.51].

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant age, gender, Hispanic ethnicity, region, education, annual household income, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, Black respondents [AOR = 0.59, 95% CI 0.35-1.0] were less likely to intend to receive the vaccine than White respondents. Respondents of an other race were not more or less likely to intend to receive the vaccine than White respondents [95% CI 0.42-1.26].

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant age, gender, race, region, education, annual household income, perceptions of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours and seasonal flu vaccine history, Hispanic or Latino respondents were not more or less likely to intend to receive the vaccine than White respondents [95% CI 0.76-2.02].

Overall, this study evidences that Black respondents are most likely to be vaccine hesitant.

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Butter et al. (2021) examined the relationship between ethnicity, measured as

a categorical variable, and vaccine intention, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional research design **and Chi-square**.

Using Chi-square, Dorman et al. (2021) found that vaccine intention differed by age group [$p < 0.001$]. Asian respondents [5.20 out of 7] were most willing to receive the vaccine, followed by Non-Hispanic White respondents [4.72 out of 7], respondents of other race/ethnicity [4.31 out of 7] and non-Hispanic Black participants [3.40 out of 7] were least willing to receive the vaccine.

This study evidences that Black respondents are most likely to be vaccine hesitant.

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine acceptance, measured (i) as a discrete choice (vaccine A vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental design and OLS regression.

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), politics, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion, age and Latin ethnicity, Black respondents were less likely to accept the vaccine than non-Black respondents when vaccine acceptance is measured as a discrete choice [$B = -0.03$, $p = 0.01$] and when measured as individual vaccine evaluation [$B = -0.1$, $p < 0.001$].

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), politics, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion, age and Black race, Latin respondents were not more or less likely to accept the vaccine than non-Latin respondents when vaccine acceptance is measured as a discrete choice [$p = 0.32$] and when measured as individual vaccine evaluation [$p = 0.06$].

This study evidences that Black respondents are most likely to be vaccine hesitant.

United States, Savoia et al. (2021): In a convenience sample of 2,640 United States residents, Savoia et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design and simple logistic regression.

Savoia et al. (2021) found that Black non-Hispanic respondents were more likely to be vaccine hesitant than all other races [OR = 1.22, $p < 0.05$]. White non-Hispanic respondents, Asian non-Hispanic and Hispanic respondents were not more or less likely to be vaccine hesitant than all other races [$p > 0.05$].

Savoia et al. (2021) found that, when holding constant gender, education and risk perception, Black non-Hispanic respondents were not more or less likely to be vaccine hesitant than all other races [$p > 0.05$], suggesting that other factors interact with ethnicity and better account for variance in vaccine hesitancy.

Overall, there is some evidence that Black respondents are most likely to be vaccine hesitant.

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine hesitancy, measured using an adapted version of the WHO Sage's 10-item scale, which was then recoded as two binary variables (vaccine rejection and vaccine resistance), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant gender, residence, generation (age), income and political affiliation, non-Hispanic Black respondents were more likely to be vaccine hesitant [OR = 4.07, 95% CI 1.96-8.42] and vaccine resistant [OR = 2.86, 95% CI 1.4-5.87] than non-Hispanic White respondents. Hispanic respondents [hesitancy 95% CI 0.81-2.99, resistance 95% CI 0.69-3.03] and respondents of an other ethnicity [hesitancy 95% CI 0.72-2.53, resistance 95% CI 0.89-3.49] were not more or less likely to be vaccine hesitant or vaccine resistant than non-Hispanic White respondents.

This study evidences that Black respondents are most likely to be vaccine hesitant.

United States, Willis et al. (2021): In a convenience sample of 1,205 Arkansas residents, Willis et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable at a hesitancy rate of 78.14%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Willis et al. (2021) found that there was significant variation in vaccine hesitancy between ethnic groups [$p < 0.001$]. Black/African American respondents [50%] were most vaccine hesitant, followed by Hispanic/Latin respondents [19.18%] and White respondents [18.37%]. Respondents of an other ethnic group [9.76%]

were least likely to be vaccine hesitant. Using logistic regression, Willis et al. (2021) found that, when holding constant sex, age, income, education, COVID-19 health literacy, fear of COVID-19 infection and general vaccine trust, Black/African American respondents were more likely to be vaccine hesitant than White respondents [OR = 2.42, $p < 0.001$]. Respondents of an other ethnic group were less likely to be vaccine hesitant than White respondents [OR =

0.28, $p < 0.05$]. Hispanic/Latin respondents were not more or less likely to be vaccine hesitant than White respondents [$p > 0.05$].

This study evidences that Black respondents are most likely to be vaccine hesitant.

Members of non-Hispanic ethnic groups are most vaccine hesitant

Table 25: Studies evidencing that members of non-Hispanic ethnic groups are most vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Johnson et al. (2021)	United States	North America	Anglo	High Income

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between ethnicity, measured as a binary variable (Black vs. non-Black; Hispanic vs. non-Hispanic), and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design and logistic regression.

Using logistic regression, Johnson et al. (2021) found that, when holding constant age, Hispanic ethnicity, education, having had the flu or flu vaccine in the last year, flu vaccine intention, income and gender, Black respondents were not

more or less likely to intend to receive the vaccine than non-Black respondents [$p = 0.95$].

Using logistic regression, Johnson et al. (2021) found that, when holding constant age, Black race, education, having had the flu or flu vaccine in the last year, flu vaccine intention, income and gender, Hispanic respondents were more likely to intend to receive the vaccine than non-Hispanic respondents [OR= 4.414, $p = 0.011$].

This study evidences that non-Hispanic respondents are most likely to be vaccine hesitant.

Members of non-BAME ethnic groups are most vaccine hesitant

Table 26: Studies evidencing that members of non-BAME ethnic groups are most vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income

United Kingdom, Sethi et al. (2021): In a convenience sample of 4,884 United Kingdom residents, Sethi et al. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine intent, measured as a categorical variable (interested, not interested, unsure) at a hesitancy rate of 20.7% (unsure and not interested combined), using a cross-sectional survey design and logistic regression.

Sethi et al. (2021) found that, when holding constant gender, smoker status, graduate status, age and health issues, BAME respondents were more likely to intend to

receive the vaccine than non-BAME respondents [OR = 5.48, $p < 0.05$].

This study evidences that non-BAME respondents are most likely to be vaccine hesitant.

Race/ethnicity is not associated with vaccine hesitancy

Table 27: Studies evidencing that Race/ethnicity is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Chu and Liu. (2021)	United States	North America	Anglo	High Income
3	Huynh and Senger. (2021)	United States	North America	Anglo	High Income
4	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income

United Kingdom, Murphy et al. (2021): In nationally representative (quota) samples of 2,025 UK residents, Murphy et al. (2021) examined the relationship between age, measured as a categorical variable, and vaccine hesitancy, measured as a binary variable with a hesitancy rate of 31%, using a cross-sectional survey design and multinomial logistic regression.

Murphy et al. (2020) found that, when holding constant sex, age, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, ethnicity was not associated with vaccine intention [$p > 0.05$].

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, education, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived severity, fear, perceived benefits, perceived barriers and self-efficacy, there was no association between ethnicity and vaccine intention [$p > 0.05$].

United States, Huynh and Senger (2021): In a convenience sample of 351 USA residents, Huynh and Senger. (2021) examined the relationship between ethnicity, measured as a categorical variable, and vaccination intention, measured on a scale of 1 (not at all) to 7 (extremely likely), using a cross-sectional survey design and hierarchical regression.

Huynh and Senger. (2021) found that, when holding constant age, gender, education, socio-economic situation and political orientation, ethnicity was not associated with vaccine intention [$p > 0.05$].

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between ethnicity, measured as a categorical variable for Chi-square analysis and a binary variable for linear regression (White vs. non-White), and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found significant differences in vaccine uptake intention between ethnic groups [$p = 0.001$]. White respondents [67.2%] were most likely to get the vaccine followed by Black/African American respondents [59.8%], and Asian respondents [56.5%]. Multicultural/other race respondents were least likely to get the vaccine [43.9%].

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, gender, age, of Hispanic cultural identity, total household income, education, political party identity, marital status and preferred media for virus news, ethnicity was not associated with vaccine intention [$p = 0.377$].

Overall, there is insufficient evidence of an association between ethnicity and vaccine intention.

Conclusions

Table 28: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]			Non-predictive [n, %]	Total
	Members of Black ethnic groups are most vaccine hesitant [n, %]	Members of non-Hispanic ethnic groups are most vaccine hesitant [n, %]	Members of non-BAME groups are most vaccine hesitant [n, %]		
Studies	13 [76%]			4 [24%]	17
Studies	11 [65%]	1 [6%]	1 [6%]	4 [24%]	17
Region					
Europe	2 [50%]	0	1 [25%]	1 [25%]	4
North America	9 [69%]	1 [8%]	0	3 [23%]	13
Asia	0	0	0	0	0
Oceania	0	0	0	0	0
South America	0	0	0	0	0
Africa	0	0	0	0	0
Cultural Group					
Anglo	11 [65%]	1 [6%]	1 [6%]	4 [24%]	17
Germanic Europe	0	0	0	0	0
Nordic Europe	0	0	0	0	0
Eastern Europe	0	0	0	0	0
Latin Europe	0	0	0	0	0
Latin America	0	0	0	0	0
Southern Asia	0	0	0	0	0
Confucian Asia	0	0	0	0	0
Sub-Saharan Africa	0	0	0	0	0
Middle East	0	0	0	0	0

Income					
High Income	11 [65%]	1 [6%]	1 [6%]	4 [24%]	17
Upper Middle Income	0	0	0	0	0
Lower Middle Income	0	0	0	0	0
Low Income	0	0	0	0	0

Overall: Of the studies that considered the association between race/ethnicity and vaccine hesitancy, 76% [13 out of 17] found race/ethnicity to be predictive, such that it can be confidently concluded that race/ethnicity is predictive of vaccine hesitancy. Of the 13 studies that found race/ethnicity to be predictive of vaccine hesitancy, 85% [11 out of 13] found that as Black respondents were the most vaccine hesitant, such that it can be concluded with high confidence that, when race/ethnicity is predictive of vaccine hesitancy, Black respondents are most hesitant. Out of all studies, 65% [11 out of 17] found that Black respondents are most hesitant, such that it can be confidently concluded that, overall, members of Black ethnic groups are most likely to be vaccine hesitant.

In looking for patterns by region, some associations between race/ethnicity and vaccine hesitancy are evident, but all studies were from the same Anglo cultural group and from high income countries, such that these associations are the same as the overall findings.

Region: Of studies conducted in North American countries, 69% [9 out of 13] found that Black respondents were the most vaccine hesitant, such that it can be confidently concluded that in North American countries, members of Black ethnic groups are most likely to be vaccine hesitant.

Of studies conducted in European countries, 50% [2 out of 4] found that Black respondents were the most vaccine hesitant such that it can be concluded with some confidence that in European countries, members of Black ethnic groups are most likely to be vaccine hesitant.

There is no evidence to draw conclusions about the relationship between race/ethnicity and vaccine hesitancy in the context of Asia [0 studies], Oceania [0 studies], South America [0 studies] and Africa [0 studies].

DEMOGRAPHICS
MARITAL STATUS

5.1.6

Marital status is the legally defined status with regards to a person's relationship with a significant other. In the evidence reviewed, marital status was most frequently measured as a binary variable (i.e., married vs. unmarried), but also as a categorical variable with additional categories (e.g., divorced, widowed).

In total, eight studies considered the association between marital status and vaccine hesitancy. Of these, seven found that marital status was predictive of vaccine hesitancy and one found that marital status was not predictive of vaccine hesitancy. Of the seven studies that found marital status was predictive of vaccine hesitancy, five found that unmarried are more likely to be vaccine hesitant than married and two found that married were more likely to be vaccine hesitant than unmarried.

Unmarried people are more likely to be vaccine hesitant

Table 29: Studies evidencing that unmarried people are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
2	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
3	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
4	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income
5	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between marital status, measured as a binary variable (married vs. not married), and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat

unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found that likelihood of getting the vaccine differed by marital status [$p = 0.001$]. Married respondents were more likely to get the vaccine [69%] than not married respondents [53.3%].

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, being 65 years or older, of White race, of Hispanic cultural identity, total household income, education, political party identity, gender and preferred media for virus news, marital status was not associated with vaccine intention [$p = 0.225$], suggesting other factors better accounted for variance in vaccine intention.

India, Goruntla et al. (2021): In a convenience sample of 2,451 India residents, Goruntla et al. (2021) examined the relationship between marital status, measured as a binary variable (married vs. unmarried), and willingness to pay for a COVID-19 vaccine, measured by asking respondents to identify the maximum amount they would be willing to pay for a vaccine dose and providing four price points, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Goruntla et al. (2021) found that intention to take the vaccine differed by marital status [$p < 0.001$]. Married respondents [94.19%] were more likely to intend to take the vaccine than unmarried respondents [86.35%].

Using logistic regression, Goruntla et al. (2021) found that, when holding constant gender, area of location, education, occupation, income, healthcare profession, chronic disorders and overall health, married respondents were more likely to intend to take the vaccine than unmarried respondents [OR = 2.56, $p < 0.001$].

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between marital status, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and simple logistic regression.

Yu et al. (2021) found that single respondents were less likely to receive the vaccine at the soonest opportunity than married respondents [COR = 0.29, $p < 0.05$]. Respondents of other marital status were more likely to receive the vaccine at the soonest opportunity than married respondents [COR = 2.54, $p < 0.05$].

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between marital status, measured as a binary variable (married vs. unmarried), and vaccine hesitancy, measured as a binary variable and at a hesitancy rate of 53.6%, using a cross-sectional survey design and logistic regression.

Echoru et al. (2021) found that, when holding constant age, sex, education, occupation, religion, income, and rural or urban residence, unmarried respondents were less likely to accept the vaccine than married respondents [OR = 0.73, $p = 0.012$].

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between marital status, measured as a binary variable (married vs. not married), and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem and Jarab (2021) found that when holding constant age, education level, marital status, having children, perceived COVID-19 risk, perceived susceptibility to COVID-19 infection, perceived seriousness of COVID-19 and COVID-19 knowledge, not married respondents were more likely to be vaccine resistant (compared with vaccine accepting) than married respondents [OR = 0.45, $p < 0.01$]. However, not married respondents were not more or less likely to be vaccine hesitant (compared with vaccine accepting) than married respondents [$p > 0.05$].

Married people are more likely to be vaccine hesitant

Table 30: Studies evidencing that married people are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
2	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021) examined the relationship between relationship status measured as a categorical variable, and vaccine hesitancy, measured on a scale from 1 (definitely) to 5 (definitely not) plus an option for don't know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that single respondents [B = - 0.286, $p < 0.001$] and widowed respondents [B = - 0.377, $p < 0.001$] were less likely to be vaccine hesitant than respondents who were married or in a civil partnership. Cohabiting [$p = 0.477$] and separated [$p = 0.193$] were not more or less likely to be vaccine hesitant than respondents who were married or in a civil partnership.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined the relationship between marital status, measured as a binary variable (single vs. married), and vaccine hesitancy, measured as a categorical variable (willing = 24.6%, unwilling = 75.4%), using a cross-sectional survey design and logistic regression.

Allagoa et al., (2021) found that when holding constant sex, age, educational attainment, occupation, residential location, chronic illness, positive for COVID-19, possible infection, loss of smell and taste, contact with COVID-19 positive persons and having lost a relative to COVID-19, single respondents were more likely to be willing to take the vaccine than married respondents [OR = 1.55, $p = 0.007$].

Marital status is not associated with vaccine hesitancy

Table 31: Studies evidencing that marital status is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Benis et al. (2021)	United States	North America	Anglo	High Income

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between marital status, measured as a categorical variable, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Benis et al. (2021) found that separated/divorced respondents [COR = 1.92, 95% CI 1.1-3.27] and respondents who preferred not to state their marital status [OR = 4.36, 95% CI 1.43-13.08] were more likely to intend to take the vaccine than single respondents. Married/civil union respondents [95% CI 0.82-1.44] and widowed respondents [95% CI 0.26-5.87] were not more or less likely to intend to take the vaccine than single respondents.

Using multiple logistic regression, Benis et al. (2021) found that, when holding constant age, gender, number of children, education, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19

and opinion on whether vaccines should be free of charge, marital status of participants was not associated with vaccine intention [$p = 0.552$].

Overall, considering the lack of distinction between the categories of single and separated/divorced, there is unconvincing evidence that marital status is associated with vaccine hesitancy.

Conclusions

Table 32: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Unmarried people are more likely to be vaccine hesitant [n, %]	Married people are more likely to be vaccine hesitant [n, %]		
Studies	7 [88%]		1 [12%]	8
Studies	5 [63%]	2 [25%]	1 [12%]	8
Region				
Europe	0	1 [100%]	0	1
North America	1 [50%]	0	1 [50%]	2
Asia	3 [100%]	0	0	3
Oceania	0	0	0	0
South America	0	0	0	0
Africa	1 [50%]	1 [50%]	0	2
Cultural Group				
Anglo	1 [33%]	1 [33%]	1 [33%]	3
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	0	0	0	0
Latin America	0	0	0	0
Southern Asia	1 [100%]	0	0	1
Confucian Asia	1 [100%]	0	0	1
Sub-Saharan Africa	1 [50%]	1 [50%]	0	2
Middle East	1 [100%]	0	0	1
Income				
High Income	3 [60%]	1 [20%]	1 [20%]	5
Upper Middle Income	0	0	0	0

Lower Middle Income	1 [50%]	1 [50%]	0	2
Low Income	1 [100%]	0	0	1

Overall: Of the studies that considered the association between marital status and vaccine hesitancy, 88% [7 out of 8] found marital status to be predictive, such that it can be concluded with high confidence that marital status is predictive of vaccine hesitancy. Of the seven studies that found marital status to be predictive of vaccine hesitancy, 71% [5 out of 7] found that unmarried people are more likely to be vaccine hesitant, such that it can be concluded with high confidence that, when marital status is predictive of vaccine hesitancy, unmarried people are more likely to be vaccine hesitant. Out of all studies, still 63% [5 out of 8] found that unmarried people are more likely to be vaccine hesitant, such that, overall, it can be confidently concluded that unmarried people are more likely to be vaccine hesitant.

In looking for patterns by region, cultural group and income of the countries in the studies, there is insufficient evidence to draw conclusions on associations when segmenting by region and cultural group, but an association is evident when segmenting evidence by income.

Income: Of studies conducted in high income countries, 60% [3 out of 5] found that unmarried people were more likely to be vaccine hesitant such that it can be confidently concluded that in high income countries unmarried people are more likely to be vaccine hesitant.

There is insufficient evidence to draw any conclusions about the relationship between marital status and vaccine hesitancy in the contexts of lower middle income [2 studies] and low income [1 study] countries.

There is no evidence to draw conclusions about the relationship between marital status and vaccine hesitancy in the context of upper middle income [0 studies] countries.

DEMOGRAPHICS
LIVING AREA

5.1.7

Living area was defined in terms of urban-rural classification. An urban living area is a densely developed area of cities or towns, whereas a rural living area is not densely developed outside of cities and towns in the countryside. Living area was most frequently measured as a binary variable (i.e., urban vs. rural), but some studies broke these categories down further (e.g., city, town and countryside).

In total, eight studies considered the association between living area and vaccine hesitancy. Of these, three found that living area was predictive of vaccine hesitancy and five found that living area was not predictive of vaccine hesitancy. Of the three studies that found living income was predictive of vaccine hesitancy, two found that rural dwellers were more likely to be vaccine hesitant and one found that urban dwellers were more likely to be vaccine hesitant.

Rural dwellers are more likely to be vaccine hesitant

Table 33: Studies evidencing that rural dwellers are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
2	Urrunaga-Pastor et al. (2021)	Latin America and the Caribbean		Latin America	Varies

Austria, Schernhammer et al. (2021): In a nationally representative (quota) sample of 1,007 Austria residents, Schernhammer et al. (2021) examined the relationship between living area, measured as a categorical variable (urban, populous rural, non-populous rural), and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy rate of 41.1% (intermediate or high hesitancy), using a cross-sectional survey design and logistic regression.

Schernhammer et al. (2021) found that, when holding constant age, gender, education, politics, optimism, resilience, need for cognitive closure, main source of information and health status, non-populous rural dwellers were more likely to be vaccine hesitant than urban dwellers

[OR = 1.86, 95% CI 1.36-2.54]. Populous rural dwellers were not more or less likely to be vaccine hesitant than urban dwellers [95% CI 0.48-1.99].

Overall, this study provides some evidence of rural dwellers being more vaccine hesitant than urban dwellers.

Latin America and the Caribbean, Urrunaga-Pastor et al. (2021): In a secondary convenience sample of 472,521 Latin America and the Caribbean residents, Urrunaga-Pastor et al. (2021) examined the relationship between living area, measured as a categorical variable (city, town, village or rural area), and vaccine intention, measured as a categorical variable (definitely yes, probably yes, probably no, definitely no), recoded as a binary variable and at

a hesitancy rate of 20%, using a cross-sectional survey design and simple and multiple log-linear regression (reporting prevalence ratios).

Using simple log-linear regression, Urrunaga-Pastor et al. (2021) found that respondents living in a town [CPR = 0.96, $p = 0.001$] and respondents living in a village or rural area [CPR = 0.92, $p < 0.001$] were less likely to intend to receive the vaccine compared with respondents living in a city.

Using multiple log-linear regression, Urrunaga-Pastor et al. (2021) found that, when holding constant gender, age, COVID-19 symptomatology, compliance with community mitigation strategies, food insecurity, economic insecurity, fears of becoming ill or that a family member becomes seriously ill from COVID-19, anxiety symptomatology,

depressive symptomatology, probability of vaccination acceptance when recommended by friends and family, probability of vaccination acceptance when recommended by local health workers, probability of vaccination acceptance when recommended by the WHO, probability of vaccination acceptance when recommended by government health officials and probability of vaccination acceptance when recommended by politicians, rural dwellers were less likely to receive the vaccine than city dwellers [ARP = 0.96; $p < 0.001$]. Town dwellers were not more or less likely to receive the vaccine than city dwellers [$p = 0.659$].

Overall, this study evidences that village or rural dwellers are more likely to be vaccine hesitant than city dwellers.

Urban dwellers are more likely to be vaccine hesitant

Table 34: Studies evidencing that urban dwellers are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Echoru et al. (2021)	Western Uganda	Africa	Sub-Saharan Africa	Low Income

Western Uganda, Echoru et al. (2021): In a snowball sample of 1,067 western Uganda residents, Echoru et al. (2021) examined the relationship between living area, measured as a binary variable (rural vs. urban), and vaccine acceptance, measured as a binary variable and at a hesitancy rate of 53.6%, using a cross-sectional survey design and logistic

regression. Echoru et al. (2021) found that, when holding constant age, education, occupation, religion, marital status, income, and gender, urban dwellers were less likely to accept the vaccine [OR = 0.78, $p = 0.062$] compared with rural dwellers.

Living area is not associated with vaccine hesitancy

Table 35: Studies evidencing that living area is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income
3	Shih et al. (2021)	United States	North America	Anglo	High Income

4	Kumar et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
5	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between living area, measured as a categorical variable (rural, town, city), and vaccine hesitancy, measured as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that, when holding constant gender, age, education, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19, perceived symptom severity and perceived COVID-19 risk, living area was not associated with vaccine hesitancy in both the key workers and non-key workers samples [p > 0.05].

United Kingdom and Ireland, Murphy et al. (2021): In a nationally representative sample of 2025 UK residents and 1041 Ireland residents, Murphy et al. (2021) examined the relationship between living area, measured as a categorical variable (suburb, town, rural), and vaccine hesitancy, measured as a categorical variable (acceptance, hesitance, resistance) with hesitancy rates (hesitance and resistance combined) of 35% and 31% respectively, using a cross-sectional survey design and logistic regression.

In the British sample, Murphy et al. (2020) found that, when holding constant age, birthplace, ethnicity, gender, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection, COVID-19 infection of a relative, suburb dwellers were more likely to be vaccine resistant (compared with vaccine accepting) than rural dwellers [OR = 2.13, p < 0.05]. City dwellers and town dwellers were not more or less likely to be vaccine resistant (compared with vaccine resistant) than rural dwellers [p > 0.05]. City dwellers, suburb dwellers and town dwellers were not more or less likely to be vaccine hesitant (compared with vaccine accepting) or vaccine resistant (compared with vaccine hesitant) than rural dwellers [p > 0.05].

In the Irish sample, Murphy et al. (2020) found that, when holding constant age, birthplace, ethnicity, gender, education, employment, income, only adult in household, children in household, politics, religion, whether voted,

mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, COVID-19 infection and COVID-19 infection of a relative, city dwellers were more likely to be vaccine resistant (compared with vaccine accepting) than rural dwellers [OR = 1.90, p < 0.05]. Suburb dwellers and town dwellers were not more or less likely to be vaccine resistant (compared with vaccine resistant) than rural dwellers [p > 0.05]. City dwellers, suburb dwellers and town dwellers were not more or less likely to be vaccine hesitant (compared with vaccine accepting) or vaccine resistant (compared with vaccine hesitant) than rural dwellers [p > 0.05].

Overall, across both samples, there is insufficient evidence that living area is associated with vaccine hesitancy.

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between perceived risk of being infected with COVID-19, measured from 0% to 100%, and vaccine hesitancy, measured as a categorical variable (acceptance, hesitance, resistance), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant gender, generation race/ethnicity, monthly family income, political affiliation, general vaccine hesitancy, perceived risk, perceived vaccine safety and perceived vaccine effectiveness, living area was not associated with vaccine hesitancy.

India, Kumar et al. (2021): In a convenience sample of 841 India residents, Kumar et al. (2021) examined the relationship between living area, measured as a categorical variable (urban, rural, semi-urban), and vaccine interest, measured as a categorical variable (interested, not interested and not sure) and at a hesitancy rate of 46.8% (not interested and not sure combined), using a cross-sectional survey design and multinomial logistic regression.

Kumar et al. (2021) found that, when holding constant information on the vaccine, chances of getting coronavirus disease in the next 6 months, awareness in India COVID 19 vaccine, Indian manufacturing company of vaccine, family history of the laboratory confirmed case, and health status, living area was not associated with vaccine intention [p = 0.171].

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between living area, measured as a binary variable (urban vs. suburban/rural), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely

vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design and Chi-square.

Using Chi-square, Wong et al. (2021) found that living area was not associated with vaccine intention [$p = 0.178$].

Conclusions

Table 36: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Rural dwellers are more likely to be vaccine hesitant [n, %]	Urban dwellers are more likely to be vaccine hesitant [n, %]		
Studies	3 [38%]		5 [62%]	8
Studies	2 [25%]	1 [13%]	5 [62%]	8
Region				
Europe	1 [25%]	0	3 [75%]	4
North America	0	0	1 [100%]	1
Asia	0	0	2 [100%]	2
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	1 [100%]	0	1
Cultural Group				
Anglo	0	0	4 [100%]	4
Germanic Europe	1 [100%]	0	0	1
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	0	0	0	0
Latin America	1 [100%]	0	0	1
Southern Asia	0	0	2 [100%]	2
Confucian Asia	0	0	0	0
Sub-Saharan Africa	0	1 [100%]	0	1

Middle East	0	0	0	0
Income				
High Income	1 [20%]	0	4 [80%]	5
Upper Middle Income	0	0	1 [100%]	1
Lower Middle Income	0	0	1 [100%]	1
Low Income	0	1 [100%]	0	1

Overall: Of the studies that considered the association between living area and vaccine hesitancy, 62% [5 out of 8] found that living area was not associated with vaccine hesitancy, such that it can be confidently concluded that living area is not associated with vaccine hesitancy.

In segmenting the evidence by region, cultural group and income, this lack of association becomes even stronger in some segments.

Region: Of studies conducted in European countries, 75% [3 out of 4] found that living area was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in European countries, living area is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between living area and vaccine hesitancy in the context of Asia [2 studies], North America [1 study] and Africa [1 study].

There is no evidence to draw conclusions about the relationship between ethnicity and vaccine hesitancy in the context of Oceania [0 studies] and South America [0 studies].

Cultural group: Of studies conducted in Anglo cultural group countries, 100% [4 out of 4] found that living area was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in Anglo cultural group countries, living area is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between living area and vaccine hesitancy in the cultural group contexts of Southern Asia [2 studies], Germanic Europe [1 study], Latin America [1 study] and Sub-Saharan Africa [1 study].

There is no evidence to draw conclusions about the relationship between living area and vaccine hesitancy in the cultural group contexts of Nordic Europe [0 studies], Eastern Europe [0 studies], Latin Europe [0 studies], Confucian Asia [0 studies] and Middle East [0 studies].

Income: Of studies conducted in high income countries, 80% [4 out of 5] found that living area was not associated

with vaccine hesitancy, such that it can be concluded with high confidence that in high income countries, living area is not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between living area and vaccine hesitancy in the contexts of upper middle income countries [1 study], lower middle income countries [1 study] and low income countries [1 study].

DEMOGRAPHICS
HAVING CHILDREN

5.1.8

Having children is the status of being a parent or guardian for children. In the evidence reviewed, marital status was most frequently measured as a binary variable (i.e., have children vs. do not have children), but also as a categorical variable or discrete numerical variable in terms of number of children. Some studies further defined this factor in terms of age of children (i.e., under 18 years of age) and whether the children lived with the respondent.

In total, 10 studies considered the association between having children and vaccine hesitancy. Of these, five found that having children was not predictive of vaccine hesitancy and five found that having children was predictive of vaccine hesitancy. Of the five studies that found having children was predictive of vaccine hesitancy, three found that respondents without children are more likely to be vaccine hesitant than respondents with children and two found that respondents with children are more likely to be vaccine hesitant than respondents without children.

Parents are more likely to be vaccine hesitant

Table 37: Studies evidencing that parents are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
2	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
3	Salali and Uysal (2021)	Turkey	Asia	Middle East	Upper Middle Income

Portugal, Soares et al. (2021): In a sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between having school-age children, measured as a binary variable (yes vs. no), with vaccine intention (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design and multinomial logistic regression.

Soares et al. (2021) found that, when holding constant intention to take the flu vaccine, perception of the health status, number of comorbidities, self-reported diabetes, self-reported respiratory disease, and self-reported

autoimmune disease, respondents with school-age children were more likely to be vaccine resistant compared with vaccine accepting [AOR: 1.93, 95% CI 1.37-2.73] and compared with vaccine hesitant [AOR: 1.94, CI: 1.39, 2.69] than respondents without children.

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between having children under 18 years of age, measured as a binary variable, and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary

variable, using a conjoint experimental design and simple logistic regression.

Yu et al. (2021) found that respondents who had children under 18 years of age were less likely to accept the vaccine at the earliest opportunity than respondents without children under 18 years of age [OR = 0.23, 95% CI 0.06-0.99].

Turkey, Salali and Uysal (2021): In convenience samples of 3,936 Turkey residents, Salali and Uysal (2021) examined the relationship between having children, measured as a binary variable (yes vs. no), and vaccine acceptance,

measured as a binary variable, using a cross-sectional survey design and logistic regression.

Salali and Uysal (2021) found that, when holding constant beliefs about origin of the virus, sex, financial satisfaction, education level, COVID-19-related anxiety and COVID-19 perceived risk, respondents with children were less likely to accept the vaccine than respondents without children [OR = 0.82, $p < 0.05$].

NB: Data on having children was not collected from the UK sample in this study.

Childless people are more likely to be vaccine hesitant

Table 38: Studies evidencing that childless people are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Benis et al. (2021)	United States	North America	Anglo	High Income
2	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between having children, measured as a categorical variable (0, 1 or 2, 3 or more), and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Benis et al. (2021) found that respondents with three or more children were more likely to intend to take the vaccine than respondents with no children [OR = 2.84, 95% CI 1.9-4.22]. Respondents with one or two children were not more or less likely to intend to take the vaccine than respondents with no children [95% CI 0.93-1.67].

Using multiple logistic regression, Benis et al. (2021) found that, when holding constant age, marital status, gender, education, ethnicity, region, COVID-19 risk, COVID-19 diagnosis, COVID-19 fear, desire to protect family, confidence in healthcare providers, confidence in pharmaceutical industry, belief in vaccines as revolutionary and innovative, employer recommendations/demands, confidence in government guidance, civic responsibility to take vaccine, being sick from COVID-19, opinion on whether vaccines should be free of charge, respondents with three or more children were more likely to intend to take the vaccine than respondents with no children [OR =

3.88, 95% CI 1.8-8.37]. Respondents with one or two children were not more or less likely to intend to take the vaccine than respondents with no children [95% CI 0.61-1.94].

Overall, this study found that number of children is positively associated with vaccine acceptance whereby as number of children increase, vaccine acceptance increases such that respondents with less children are more hesitant.

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between having children under 18 in the household, measured as a binary variable (yes vs. no), and vaccine intention, measured as a categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance) at a hesitancy rate of 58.9% (refusal and hesitancy categories combined), using a cross-sectional survey design and multiple linear regression.

Kuçukkarapinar et al. (2021) found that, when holding constant age, education level, being a healthcare worker, gender, chronic illness, knowledge, self-efficacy, risk perception, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, respondents who had children under 18 years in their household were more likely to intend to receive the vaccine than respondents who did not have children under 18 years in their household [B = 0.039, $p = 0.013$].

Having children is not associated with vaccine hesitancy

Table 39: Studies evidencing that having children is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Coe et al. (2021)	United States	North America	Anglo	High Income
3	Montagni et al. (2021)	France	Europe	Latin Europe	High Income
4	Nazli et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
5	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between having children, measured as a binary variable (yes vs. no), and vaccine hesitancy, measured as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that, when holding constant gender, age, area, education, income, country, physical health condition, mental health condition, COVID-19 social media exposure, COVID-19 traditional media exposure, knowing someone diagnosed with COVID-19, perceived symptom severity and six-month risk perception, having children was not associated with vaccine hesitancy in the key worker and non-key worker samples [$p > 0.05$].

United States, Coe et al. (2021): In a nationally representative sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between having a child under 18 years of age, measured as a binary variable (yes vs. no), and intention to receive the COVID-19 vaccine, measured on a scale of 1 (very unlikely) to 4 (very likely), using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that having a child under 18 years of age was not associated with intention to receive the vaccine [95% CI 0.81-1.36].

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant race, region, ethnicity, age, education, annual household income, perceptions

of COVID-19 severity, risk and susceptibility, views of a potential COVID-19 vaccine, virus and vaccine information sources, vaccine beliefs and behaviours, and seasonal flu vaccine history, having a child under 18 years of age was not associated with intention to receive the vaccine [95% CI 0.61-1.34].

France, Montagni et al. (2021): In a convenience sample of 2,344 France residents, Montagni et al. (2021) examined the relationship between having children, measured as a binary variable (yes vs. no), and vaccine acceptance, measured as a categorical variable (anti-vaccination = 18.6%, hesitant = 10.9%, pro-vaccination = 70.5%), using a cross-sectional survey design and Chi-square.

Montagni et al. (2021) found that having children was not associated with vaccine acceptance [$p = 0.17$].

Turkey, Nazli et al. (2021): In a convenience sample of 467 Turkey residents, Nazli et al. (2021) examined the relationship between having children, measured as a binary variable (yes vs. no), number of children, measured as a discrete numerical variable, and vaccine attitude, measured as a categorical variable (trust and want to get vaccinated, undecided about positive effects of vaccine but want to get vaccinated, undecided about positive effects of vaccine and do not want to get vaccinated, think vaccine has negative effects and is ineffective and do not want to get vaccinated) at a hesitancy rate of 15%, using a cross-sectional survey design, Chi-square and ANOVA.

Using Chi-square, Nazli et al. (2021) found that having children was not associated with vaccine attitude [$p = 0.073$].

Using ANOVA, Nazli et al. (2021) found that number of children was not associated with vaccine attitude [$p = 0.337$].

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between having children, measured as a binary variable (yes vs. no), and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not

sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem and Jarab (2021) found that when holding constant age, education level, marital status, gender, perceived COVID-19 risk, perceived susceptibility to COVID-19 infection, perceived seriousness of COVID-19 and COVID-19 knowledge, having children was not significantly associated with vaccine hesitancy ($p > 0.05$).

Conclusions

Table 40: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Parents are more likely to be vaccine hesitant [n, %]	Childless people are more likely to be vaccine hesitant [n, %]		
Studies	5 [50%]		5 [50%]	10
Studies	3 [30%]	2 [20%]	5 [50%]	10
Region				
Europe	1 [33%]	0	2 [67%]	3
North America	0	1 [50%]	1 [50%]	2
Asia	2 [40%]	1 [20%]	2 [40%]	5
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	0	1 [33%]	2 [67%]	3
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	1 [50%]	0	1 [50%]	2
Latin America	0	0	0	0
Southern Asia	0	0	0	0

Confucian Asia	1 [100%]	0	0	1
Sub-Saharan Africa	0	0	0	0
Middle East	0	1 [33%]	2 [67%]	3
Income				
High Income	2 [29%]	1 [14%]	4 [57%]	7
Upper Middle Income	1 [33%]	1 [33%]	1 [33%]	3
Lower Middle Income	0	0	0	0
Low Income	0	0	0	0

Overall: Of the studies that considered the association between having children and vaccine hesitancy, 50% [5 out of 10] found having children to be predictive of vaccine hesitancy and 50% [5 out of 10] found having children not to be predictive of vaccine hesitancy, such that the association between having children and vaccine hesitancy is inconclusive. However, when segmenting predictive findings by positive and negative associations, 50% of studies [5 out of 10] found that having children is not associated with vaccine hesitancy, 30% of studies [3 out of 10] found that parents are more likely to be vaccine hesitant and 20% of studies [2 out of 10] found that childless people are more likely to be vaccine hesitant, such that, overall, it can be concluded with some confidence that having children is not associated with vaccine hesitancy.

In looking for patterns by region, cultural group and income of the countries in the studies, there is only inconclusive or insufficient evidence to draw conclusions regarding associations when segmenting by region and cultural group, but an association is evident when segmenting evidence by income.

Income: Of studies conducted in high income countries, 57% [4 out of 7] found that having children was not associated with vaccine hesitancy such that it can be concluded with some confidence that in high income countries having children is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between having children and vaccine hesitancy in the context of upper middle income countries [3 studies].

There is no evidence to draw conclusions about the relationship between having children and vaccine hesitancy in the context of lower middle income [0 studies] and low income [0 studies] countries.

DEMOGRAPHICS
COVID-19 INFECTION

5.1.9

COVID-19 infection is whether or not an individual has previously been infected with COVID-19, whether a belief or confirmed via test. A previous COVID-19 infection was measured as a binary variable (i.e., yes vs. no).

In total, six studies considered the association between a previous COVID-19 infection and vaccine hesitancy. Of these, five found that having previously had COVID-19 was not predictive of vaccine hesitancy and one found that a previous COVID-19 infection was predictive of vaccine hesitancy, finding that previously infected with COVID-19 were more likely to be vaccine hesitant.

Previously COVID-19 infected people are more likely to be vaccine hesitant

Table 41: Studies evidencing that previously COVID-19 infected people are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between history of COVID-19 infection, measured as a binary variable (yes vs. no, and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get

vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design and Chi-square.

Alobaidi (2021) found that respondents who had no history of COVID-19 infection were more likely to receive the vaccine than those with a history of COVID-19 infection [41.9% vs. 37.7%, $p = 0.008$].

COVID-19 infection is not associated with vaccine hesitancy

Table 42: Studies evidencing that COVID-19 infection is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income

2	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income
3	Agley et al. (2021)	United States	North America	Anglo	High Income
4	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
5	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income

United Kingdom, Jennings et al. (2021): In a nationally representative sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between having had COVID-19, measured as a binary variable (yes vs. no), and vaccine acceptance, measured as a binary variable at a rate of 71%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that, when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, social media platforms use, age, posting political content online, fact-checking, gender, sources of information, education, trust in the media, voting Conservative, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations, and evaluation of government's handling of COVID-19, having had COVID-19 was not associated with vaccine acceptance [$p > 0.05$].

Ireland and the United Kingdom, Murphy et al. (2021): In a nationally representative sample of 1,041 Ireland residents and 2025 UK residents, Murphy et al. (2021) examined the relationship between having had a COVID-19 infection, a relative having had a COVID-19 infection, both measured as binary variables (yes vs. no), and vaccine hesitancy, measured as a binary variable and at hesitancy rates of 35% and 31% respectively, using a cross-sectional survey design and logistic regression.

In the Irish sample, Murphy et al. (2020) found that when holding constant age, birthplace, ethnicity, residence, education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, and gender, having had a COVID-19 infection and a relative having had a COVID-19 infection were not associated with vaccine hesitancy [$p > 0.05$].

In the British sample, Murphy et al. (2020) found that when holding constant age, birthplace, ethnicity, residence,

education, employment, income, only adult in household, children in household, politics, religion, whether voted, mental health, underlying health conditions, underlying health conditions of a relative, pregnancy, and gender, having had a COVID-19 infection and a relative having had a COVID-19 infection were not associated with vaccine hesitancy [$p > 0.05$].

United States, Agley et al. (2021): In a nationally representative (quota) sample of 1,017 United States residents, Agley et al. (2021) examined the relationship between covid-19 infection diagnosis, measured as a binary variable (yes vs. no), and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely), using a cross-sectional survey design and linear regression.

Agley et al. (2021) found that when holding constant gender, age, race, being Hispanic or Latin, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19 and friends' or family's avoidance of crowded areas, having a COVID-19 infection diagnosis was not associated with vaccine intention [$p = 0.3$].

France, Tavolacci et al. (2021): In a convenience sample of 3089 French students Tavolacci et al. (2021) examined the relationship between having had a COVID-19 infection, a relative having had a COVID-19 infection, both measured as binary variables (yes vs. no), and vaccine intention, measured as a categorical variable (acceptance, hesitancy, resistance), using a cross-sectional survey design and logistic regression.

Tavolacci et al. (2021) found that, when holding constant age, gender, years of study, courses of study, COVID-19 infection, having a relative hospitalized or died from COVID-19, COVID-19 knowledge, conventional vaccine beliefs, COVID-19 vaccine beliefs, confidence about conventional vaccination, perceived vaccine efficacy and perceived vaccine security, having had a COVID-19 infection [$p = 0.26$] and a relative having had a COVID-19 infection [$p = 0.9$] were not associated with vaccine intention.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined the relationship between testing positive for COVID-19, possible COVID-19 infection, both measured as a binary variable (yes vs. no), and vaccine hesitancy, measured as a categorical variable (willing = 24.6%, unwilling = 75.4%), using a cross-sectional survey design and logistic regression.

Allagoa et al. (2021) found that when holding constant, age, marital status, religion, occupation and educational attainment, and the presence of chronic illnesses, both testing positive for COVID-19 [$p = 0.081$] and having possible COVID-19 infection [$p = .149$] were not associated with vaccine intention.

Conclusions

Table 43: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Previously COVID-19 infected people are more likely to be vaccine hesitant [n, %]	Non-previously COVID-19 infected people are more likely to be vaccine hesitant [n, %]		
Studies	1 [17%]		5 [83%]	6
Studies	1 [17%]	0	5 [83%]	6
Region				
Europe	0	0	4 [100%]	4
North America	0	0	1 [100%]	1
Asia	1 [100%]	0	0	1
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	1 [100%]	1
Cultural Group				
Anglo	0	0	4 [100%]	4
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	0	0	1 [100%]	1
Latin America	0	0	0	0
Southern Asia	0	0	0	0

Confucian Asia	0	0	0	0
Sub-Saharan Africa	0	0	1 [100%]	1
Middle East	1 [100%]	0	0	1
Income				
High Income	1 [17%]	0	5 [83%]	6
Upper Middle Income	0	0	0	0
Lower Middle Income	0	0	1 [100%]	1
Low Income	0	0	0	0

Overall: Of the studies that considered the association between a previous COVID-19 infection and vaccine hesitancy, 83% [5 out of 6] found that having previously been infected with COVID-19 was not associated with vaccine hesitancy, such that it can be concluded with high confidence that having previously had a COVID-19 infection is not associated vaccine hesitancy.

In segmenting the evidence by region, cultural group and income, this lack of association becomes even stronger in some segments.

Region: Of studies conducted in European countries, 100% [4 out of 4] found that having previously had a COVID-19 infection was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in European countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the context of North America, [1 study], Asia [1 study] and Africa [1 study].

There is no evidence to draw conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the context of Oceania [0 studies] and South America [0 studies].

Cultural group: Of studies conducted in Anglo cultural group countries, 100% [4 out of 4] found that having previously had a COVID-19 infection not associated with vaccine hesitancy, such that it can be concluded with high confidence that in Anglo cultural group countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the cultural group contexts of Latin

Europe [1 study], Sub-Saharan Africa [1 study] and the Middle East [1 study].

There is no evidence to draw conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the cultural group contexts of Germanic Europe [0 studies], Nordic Europe [0 studies], Eastern Europe [0 studies], Latin America [0 studies], Southern Asia [0 studies] and Confucian Asia [0 studies].

Income: Of studies conducted in high income countries, 83% [5 out of 6] found that having previously had a COVID-19 infection was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in high income countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the context of lower middle income countries [1 study].

There is no evidence to draw conclusions about the relationship between a COVID-19 infection and vaccine hesitancy in the context of upper middle income countries [0 studies] and low income countries [0 studies].

**WHY ARE PEOPLE MORE LIKELY TO
DELAY OR REFUSE VACCINATION
AND IN WHAT CONTEXT?**

06

PSYCHOLOGICAL CAPABILITY
COVID-19 KNOWLEDGE

6.1.1

COVID-19 knowledge is the state of knowing about COVID-19, including knowledge about the virus itself and the vaccine. Belief in debunked COVID-19 conspiracy theories (i.e., improbable explanations) is consistent with a lack of COVID-19 knowledge. It was primarily measured as a test, requiring respondents to indicate whether COVID-19 statements (including COVID-19 conspiracy theories) were true or false, producing a numerical score, but also measured as self-reported perceived COVID-19 knowledge.

In total, 11 studies considered the relationship between COVID-19 and vaccine hesitancy. Of these, eight found that COVID-19 knowledge was predictive of vaccine hesitancy and three found that perceived susceptibility was not predictive of vaccine hesitancy. Of the eight studies that found COVID-19 knowledge was predictive of vaccine hesitancy, all found that as COVID-19 knowledge increases, vaccine hesitancy decreases (i.e., those with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more hesitant) and zero found that as COVID-19 knowledge increases, vaccine hesitancy increases.

As COVID-19 knowledge increases, vaccine hesitancy decreases

Table 44: Studies evidencing that as COVID-19 knowledge increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Lockyer et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Ruiz and Bell (2021)	United States	North America	Anglo	High Income
3	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
4	Sharun et al. (2020)	India	Asia	Southern Asia	Lower Middle Income
5	Tao et al. (2021)	China	Asia	Confucian Asia	High Income
6	Mose and Yesshaneh (2021)	Ethiopia	Africa	Sub-Saharan Africa	Low Income

7	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income
8	Lindholt et al. (2020)	Multiple countries aggregated			

United Kingdom, Lockyer et al. (2021): In a convenience sample of 20 United Kingdom (Bradford) residents, Lockyer et al. (2021) examined COVID-19 misinformation and vaccine hesitancy using in-depth phone interviews and reflexive thematic analysis.

Lockyer et al. (2021) found that participants who were vaccine hesitant believed COVID-19 conspiracy theories and had low knowledge about COVID-19.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between (i) vaccine knowledge, measured via a test out of 9, (ii) acceptance of vaccine conspiracies, measured on a scale of 1 (no acceptance) to 5 (full acceptance), and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design and linear regression.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, being 65 years or older, of White race, of Hispanic cultural identity, total household income, education, political party identity, marital status and preferred media for virus news, vaccine knowledge was positively associated with vaccine intention [B = 0.137, p = 0.001], whereby as general vaccine knowledge increases, vaccine intention increases such that respondents with low vaccine knowledge are more hesitant.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, being 65 years or older, of White race, of Hispanic cultural identity, total household income, education, political party identity, marital status and preferred media for virus news, acceptance of vaccine conspiracies was negatively associated with vaccine intention [B = -0.134, p = 0.003], whereby as acceptance of vaccine conspiracies increases, vaccine intention decreases such that respondents who accept vaccine conspiracies are more hesitant.

Overall, this study evidences that vaccine knowledge and rejection of vaccine conspiracies are positively associated with vaccine intention, whereby as vaccine knowledge and rejection of vaccine conspiracies increase, vaccine intention increases such that respondents with low vaccine knowledge and acceptance of vaccine conspiracies are more hesitant.

France, Tavalacci et al. (2021): In a convenience sample of 3,089 French students Tavalacci et al. (2021) examined the relationship between (i) conventional vaccine knowledge (ii) COVID-19 vaccine knowledge, both measured as numerical scores, and vaccine intention, measured as a categorical variable (acceptance, hesitancy, resistance), using a cross-sectional survey design, ANOVA and logistic regression.

Using ANOVA, Tavalacci et al. (2021) found that both conventional vaccine [p < 0.0001] and COVID-19 vaccine knowledge [p < 0.0001] differed by vaccine decision groups. Conventional vaccine knowledge was highest in respondents who accepted the vaccine [Mean score = 6.5], followed by respondents who were hesitant towards the vaccine [Mean score = 5.1] and lowest in respondents who were vaccine resistant [Mean score = 4.8]. COVID-19 vaccine knowledge was highest in respondents who accepted the vaccine [Mean score = 5.5], followed by respondents who were vaccine resistant [Mean score = 4.4] and lowest in respondents who were hesitant towards the vaccine [Mean score = 4.1].

Tavalacci et al. (2021) found that, when holding constant age, years of study, courses of study, COVID-19 infection, having a relative hospitalized or died from COVID-19, gender, conventional vaccine beliefs, COVID-19 vaccine beliefs, confidence about conventional vaccination, perceived vaccine efficacy, perceived vaccine security, conventional vaccine knowledge was negatively associated with vaccine hesitancy [OR = 0.81, p < 0.0001] and vaccine resistance [OR = 0.81, p < 0.0001]. COVID-19 vaccine knowledge was negatively associated with vaccine hesitancy [OR = 0.84, p < 0.0001] and vaccine resistance [OR = 0.9, p < 0.0001].

Overall, conventional and COVID-19 vaccine knowledge is negatively associated with vaccine hesitancy and

resistance whereby as knowledge increases, vaccine hesitancy and resistance decrease such that respondents with low knowledge are more hesitant.

India, Sharun et al. (2020): In a convenience sample of 351 India residents, Sharun et al. (2020) examined the examined reasons for vaccine hesitancy, using a cross-sectional survey design and descriptive statistics.

Sharun et al. (2020) found that the third most common barrier to vaccine acceptance reported by respondents was the belief that COVID-19 vaccination is a conspiracy [12% of respondents].

China (Pregnant Women), Tao et al. (2021): In a multi-stage part-random and part-convenience sample of 1,392 pregnant China residents, Tao et al. (2021) examined the relationship between COVID-19 knowledge, measured as a categorical variable (Chi-square analysis) and numerical score (logistic regression analysis), and vaccine acceptance, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy (intermediate or severe) rate of 41.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Tao et al. (2021) found that vaccine acceptance differed by total COVID-19 knowledge score [$p < 0.01$]. Vaccine acceptance was highest in respondents with high COVID-19 knowledge [81.5%], followed by respondents with moderate COVID-19 knowledge [78.8%] and lowest in respondents with low COVID-19 knowledge [71.2%].

Using logistic regression, Tao et al. (2021) found that, when holding constant region, education, occupation, income, gravidity, parity, gestational trimester, history of adverse pregnancy outcomes, history of chronic disease, history of influence vaccination, gestational complications, age, perceived susceptibility, perceived severity, barriers to receiving the vaccine, perceived benefits of the vaccine and cues to action, COVID-19 knowledge score was positively associated with vaccine acceptance [OR = 1.05, $p = 0.01$] whereby as COVID-19 knowledge increases, vaccine acceptance increases such that respondents with low COVID-19 knowledge are more hesitant.

Ethiopia, Mose and Yeshaneh (2021): In a random sample of 396 Ethiopia pregnant women, Mose and Yeshaneh (2021) examined the relationship between COVID-19 knowledge, measured as a binary variable (good = more than or equal to 80% correct responses to knowledge assessment tool vs. poor < 80%), and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design, descriptive statistics and multiple logistic regression.

Using descriptive statistics, Mose and Yeshaneh (2021) found that respondents with good COVID-19 knowledge

[64.6% vaccine acceptance] were more likely to accept the vaccine than respondents with poor COVID-19 knowledge [6% vaccine acceptance].

Using multiple logistic regression, Mose and Yeshaneh (2021) found that, when holding constant age, educational status, occupation, gravidity, parity, ANC visit, medical illness, attitude and practice, respondents with good COVID-19 knowledge were more likely to accept the vaccine than respondents with poor COVID-19 knowledge [AOR = 5.946, 95% CI 3.147-7.065].

Overall, this study evidences that COVID-19 knowledge is positively associated with vaccine acceptance whereby respondents with good COVID-19 knowledge are more likely to accept the vaccine than respondents with poor COVID-19 knowledge, such that respondents with poor COVID-19 knowledge are more vaccine hesitant.

Jordan, Kuwait, Saudi Arabia, Other Arab Countries, Sallam et al. (2021): In a convenience sample of 3,414 Arab country residents, Sallam et al. (2020) examined the relationship between COVID-19 conspiracy beliefs, measured as binary variables (yes vs. no), and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design and multinomial regression.

Sallam et al. (2021) found that, when holding constant age, sex, country of residence, educational level, history of chronic disease and self or family experience of COVID-19, respondents who believed that COVID-19 was man-made were less likely to accept the vaccine than respondents who believed that COVID-19 originated naturally [OR = 0.47, 95% CI 0.38-0.57]. Respondents who did not believe that COVID-19 is man-made to force people to get the vaccine were more likely to accept the vaccine than respondents who believed COVID-19 is man-made to force people to get the vaccine [OR = 1.89, 95% CI 1.46-2.43]. Respondents who did not believe that the COVID-19 vaccine will be used to implant microchips to humans were more likely to accept that vaccine than respondents who believed the COVID-19 vaccine will be used to implant microchips to humans [OR = 2.39, 95% CI 1.72-3.3]. Respondents who did not believe that the COVID-19 vaccine causes infertility were more likely to accept that vaccine than respondents who believed the COVID-19 vaccine causes infertility [OR = 2.73, 95% CI 1.9-3.93].

Overall, this study evidences that rejection of COVID-19 conspiracy theories is positively associated with vaccine acceptance, whereby respondents who do not believe conspiracy theories are more likely to accept the vaccine than respondents who believe COVID-19 conspiracy theories.

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020): In a nationally representative (quota) sample of 18,231

respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between COVID-19, measured on a scale of 1 (not at all) to 4 (a high degree), and vaccine acceptance, measured on a scale of 1 (completely disagree that I would take a vaccine) to 5 (completely agree), using a cross-sectional survey design and simple and multiple OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%] the United States [54%] and France (47%), and the lowest level of vaccine acceptance was in Hungary [47%].

Using simple OLS regression, Lindholt et al. (2020) found that COVID-19 knowledge was positively associated with vaccine acceptance [B = 0.232, p < 0.001], whereby as COVID-19 knowledge increases, vaccine acceptance

increases such that respondents with lower COVID-19 knowledge are more hesitant.

Using multiple OLS regression, Lindholt et al. (2020) found that, when holding constant trust in national health authorities, trust in scientists, trust in the government, democratic rights, support of public protests, conspiracy beliefs, misinformation, political ideology, vote choice (government), fatigue, behaviour change, gender, education, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the economy, support for restrictions and interpersonal trust, COVID-19 knowledge was not associated with vaccine acceptance [p > 0.05], suggesting that other factors better account for variance in vaccine acceptance than COVID-19 knowledge.

Overall, there is some evidence that COVID-19 knowledge is positively associated with vaccine acceptance.

COVID-19 knowledge is not associated with vaccine hesitancy

Table 45: Studies evidencing that COVID-19 knowledge is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
2	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
3	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income

Malta, Cordina et al. (2021): In a convenience sample of 2,529 Malta residents, Coe et al. (2021) examined the relationship between self-perceived COVID-19 knowledge, measured on a scale of 1 (not at all) to 10 (very much), and vaccine hesitancy, measured on a scale of 1 (definitely no) to 10 (definitely yes), using a cross-sectional survey design and linear regression.

In multiple regression analysis, Cordina et al. (2021) found that, when holding constant age, accessing COVID-19 news and information, engaging in preventative behaviour, vaccine efficacy, importance of family and friends. Opinion of the vaccine, importance of healthcare professionals. advice, health worker status, chronic health condition status, gender, education, flu jab status, opinion on giving the vaccine to children and opinion on encouraging elderly patients to take the vaccine, self-perceived COVID-19 knowledge was not associated with vaccine hesitancy [p = 0.41243].

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the relationship between COVID-19 knowledge, measured as a categorical variable (high scores, medium scores, low scores), and vaccine intention, measured as a binary variable (unwilling vs. willing) at a rate of 47.3%, using a cross-sectional survey design and Chi-square.

Using Chi-square, Tsai et al. (2021) found that COVID-19 knowledge did not differ by vaccine intention [p = 0.497].

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between COVID-19 knowledge of participants, measured as a discrete numerical variable (score ranging from 0-21 from a COVID-19 knowledge test), and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%),

using a cross-sectional survey design and logistic regression. Al-Qerem and Jarab (2021) found that when holding constant age, sex, education level, marital status, having children, perceived COVID-19 risk, perceived susceptibility and perceived seriousness of COVID-19,

COVID-19 knowledge score was positively associated with greater protective practices [OR = 1.5, 95% CI 1.38-1.62] but was not associated with vaccine resistance [OR = 1.01, 95% CI 0.94-1.1] or vaccine hesitancy [OR = 1, 95% CI 0.92-1.08].

Conclusions

Table 46: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As COVID-19 knowledge increases, vaccine hesitancy decreases [n, %]	As COVID-19 knowledge increases, vaccine hesitancy increases [n, %]		
Studies	8 [73%]		3 [27%]	11
Studies	8 [73%]	0	3 [27%]	11
Region				
Europe	2 [67%]	0	1 [33%]	3
North America	1 [100%]	0	0	1
Asia	4 [67%]	0	2 [33%]	6
Oceania	0	0	0	0
South America	0	0	0	0
Africa	1 [100%]	0	0	1
Cultural Group				
Anglo	2 [100%]	0	0	2
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	1 [50%]	0	1 [50%]	2
Latin America	0	0	0	0
Southern Asia	1 [100%]	0	0	1
Confucian Asia	1 [50%]	0	1 [50%]	2
Sub-Saharan Africa	1 [100%]	0	0	1

Middle East	1 [50%]	0	1 [50%]	2
Income				
High Income	6 [67%]	0	3 [33%]	9
Upper Middle Income	0	0	0	0
Lower Middle Income	1 [100%]	0	0	1
Low Income	1 [100%]	0	0	1

Overall: Of the studies that considered the relationship between COVID-19 knowledge and vaccine hesitancy, 73% [8 out of 11] found COVID-19 knowledge to be predictive, such that it can be concluded with high confidence that COVID-19 knowledge is predictive of vaccine hesitancy. Of the eight studies that found COVID-19 knowledge to be predictive of vaccine hesitancy, 100% [8 out of 8] found that as COVID-19 knowledge increases, vaccine hesitancy decreases (i.e., those with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more hesitant), such that it can be concluded with high confidence that, when COVID-19 knowledge is predictive of vaccine hesitancy, the association is negative. Out of all studies, 73% [8 out of 11] found that as COVID-19 knowledge increases, vaccine hesitancy decreases (i.e., those with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more hesitant), such that it can be concluded with high confidence that, overall, as COVID-19 knowledge increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and income of the countries in the studies, some associations between COVID-19 knowledge and vaccine hesitancy are evident when segmenting by region and income, but there is insufficient evidence to draw any conclusions on the basis of cultural group.

Region: Of studies conducted in Asian countries, 60% [3 out of 5] found that as COVID-19 knowledge increases, vaccine hesitancy decreases (i.e., those with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more hesitant), such that it can be confidently concluded that in Asian countries, as COVID-19 knowledge increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between COVID-19 and vaccine hesitancy in the contexts of Europe [3 studies], North America [1 study] and Africa [1 study].

There is no evidence to draw any conclusions about the relationship between COVID-19 knowledge and vaccine hesitancy in the contexts of Oceania [0 studies] and South America [0 studies].

Income: Of studies conducted in high income countries, 67% [6 out of 9] found that as COVID-19 knowledge increases, vaccine hesitancy decreases (i.e., those with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more hesitant), such that it can be confidently concluded that in high income countries, as COVID-19 knowledge increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between COVID-19 knowledge and vaccine hesitancy in the context of lower middle income countries [1 study].

There is no evidence to draw any conclusions about the relationship between COVID-19 knowledge and vaccine hesitancy in upper middle income countries [0 studies] and low income countries [0 studies].

PSYCHOLOGICAL CAPABILITY
SOCIAL MEDIA

6.1.2

Social media are media that facilitate the creation and sharing of information, ideas, interests, and beliefs through virtual communities and networks. Studies primarily considered the use of social media for COVID-19 information and news, either measuring use independently on a scale or measuring use in comparison with other forms of media. One study considered the general use of social media and two considered the exposure to or belief that social media provides positive messages about the COVID-19 vaccine.

In total, six studies considered the relationship between using social media for COVID-19 information and vaccine hesitancy. Of these, five found that using social media for COVID-19 information was predictive of vaccine hesitancy and one found that using social media for COVID-19 information was not predictive of vaccine hesitancy. Of the five studies that found using social media for COVID-19 information was predictive of vaccine hesitancy, all found that users of social media for COVID-19 information were more likely to be vaccine hesitant.

Users of social media for COVID-19 information are more likely to be vaccine hesitant

Table 47: Studies evidencing that users of social media for COVID-19 information are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Allen et al. (2021)	United States	North America	Anglo	High Income
2	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
3	Bendau et al. (2021)	Germany	Europe	Germanic Europe	High Income
4	Schernhammer et al. (2021)	Austria	Europe	Germanic Europe	High Income
5	Sallam et al. (2021)	Jordan, Kuwait, Saudi Arabia, Other Arab Countries	Asia	Middle East	High Income

United States, Allen et al (2021): In a purposive sample of 396 United States racially/ethnically diverse women, Allen (2021) examined the relationship between trust in information from social media, measured as a binary variable (yes vs. no), and vaccine intention, measured as a categorical variable (yes, no, don't know/unsure) at a hesitancy rate of 43.2%, using a cross-sectional survey design and Chi-square.

Allen et al. (2021) found an association between trust in information from social media and vaccine intention. Respondents not intending to get the vaccine [34.8%] trusted information from social media more than respondents intending to get the vaccine [24.9%].

Overall, this study evidences a negative association between trusting information from social media usage and vaccine intention whereby those who have greater trust in social media information are more hesitant.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between preferred media for virus news, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, gender, of White race, of Hispanic cultural identity, total household income, education, political party identity, marital status and age, respondents whose preferred media for virus news was social media [$B = -0.090$, $p < 0.002$] and other media sources [$B = -0.249$, $p = 0.02$] were less likely to intend to receive the vaccine than respondents whose preferred media for virus news was traditional broadcast news. Respondents whose preferred media for virus news was CNN/MSNBC [$p = 0.525$], Fox News [$p = 0.243$] and the New York Times [$p = 0.308$] were not more or less likely to intend to receive the vaccine than respondents whose preferred media for virus news was traditional broadcast news.

Germany, Bendau et al. (2021): In a convenience sample of 1,779 Germany residents, Bendau et al., (2021) examined the relationship between usage of social medias and/or official websites to gain information about the pandemic, measured as a categorical variable, and vaccine willingness, measured on a scale of -2 (absolutely not) to +2 (absolutely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and Chi-square.

The usage of social media and/or official websites to gain information about the pandemic was significantly associated with vaccine willingness ($p < 0.001$). Respondents who used neither official websites nor social media were least willing to accept the vaccine (Mean = 0.96), followed by respondents who used only social media (Mean = 1.16) and respondents who used only official websites (Mean = 1.33). Respondents who used both official websites and social media to gain information about the pandemic were most willing to accept the vaccine (Mean = 1.38).

Overall, this study evidences a negative association between reliance on social media for information about the pandemic, but importantly, that usage of official websites is a more important factor in that, even if people are getting information from social media, they appear able to decipher fact from fiction if also accessing official websites.

Austria, Schernhammer et al. (2021): In a quota sample of 1,007 Austria residents, Schernhammer et al. (2021) examined the relationship between main source of COVID-19 information, and vaccine hesitancy, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy rate of 41.1% (intermediate or severe), using a cross-sectional survey design and descriptive statistics.

Schernhammer et al. (2021) found that respondents whose main source of information was social media were most likely to have intermediate or high hesitancy [49%] followed by respondents whose main source of information was TV [42%], respondents whose main source of information was friends [42%], respondents whose main source of information was radio [39%], respondents whose main source of information was an online newspaper [39%] and respondents whose main source of information was a paper newspaper [38%]. Respondents whose main source of information was the web pages of the Austrian ministries [30%] were least likely to have intermediate or high hesitancy.

Overall, respondents whose main source of information was social media were most likely to be hesitant.

Jordan, Kuwait, Saudi Arabia, Other Arab Countries, Sallam et al. (2021): In a convenience sample of 3,414 Arab country residents, Sallam et al. (2020) examined the relationship between main source of information about COVID-19, and vaccine acceptance, measured as a binary variable (yes vs. no) at a hesitancy rate of 70.6%, using a cross-sectional survey design, Chi-square and multinomial regression.

Sallam et al. (2020) found that vaccine acceptance differed by main sources of information about COVID-19 [$p <$

0.001]. Willingness to get a COVID-19 vaccine was the lower among the respondents who relied on social media as their main source of information about COVID-19 [22.1%] compared with respondents who relied on medical doctors, scientists and scientific journals as their main source of information about COVID-19 [36.1%].

Furthermore, belief in conspiracy theories [Mean = 27.4] was highest in respondents who relied on social media as their main source of information about COVID-19, including beliefs that the vaccine contained microchips [33.8%] and caused infertility [27.3%].

Using social media for COVID-19 information is not associated with vaccine hesitancy

Table 48: Studies evidencing that using social media for COVID-19 information is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between frequency of watching, reading, and hearing reports or updates about COVID-19 on social media (e.g., Twitter, Facebook, and WhatsApp) and on traditional media (e.g., TV, radio, and newspaper), measured as a binary variable (low vs. high exposure), and vaccine hesitancy, as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

exposure to COVID-19 updates on traditional media and vaccine hesitancy in the key worker and non-key worker samples [$p > 0.05$].

Butter et al. (2021) found that, when holding constant gender, age, area, education, income, having children, country, physical health condition, knowing someone diagnosed with COVID-19 and exposure to COVID-19 updates on traditional media, there was no association between exposure to COVID-19 updates on social media and vaccine hesitancy in the key worker and non-key worker samples [$p > 0.05$].

Butter et al. (2021) found that, when holding constant gender, age, area, education, income, having children, country, physical health condition, knowing someone diagnosed with COVID-19 and exposure to COVID-19 updates on social media, there was no association between

Overall, this study finds no association between the media used to receive COVID-19 updates and vaccine hesitancy.

Using social media is not associated with vaccine hesitancy

Table 49: Studies evidencing that using social media is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income

United Kingdom, Jennings et al. (2021): In a nationally representative (quota) sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between social media use, measured as a numerical discrete variable in years, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 29%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, age, gender, posting political content online, fact-checking, having had COVID-19, sources of information, education, trust in the media, voting Conservative, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations, evaluation of government's

handling of COVID-19, users of YouTube were less likely to be willing to accept the vaccine than non-users of YouTube [OR = 0.672, 95% CI 0.472-0.956]. However, users of Facebook [95% CI 0.654-3.702], Twitter [95% CI 0.787-1.625], Instagram [95% CI 0.902-1.964], Reddit [95% CI 0.561-1.236], Snapchat [95% CI 0.567-1.755] and TikTok [95% CI 0.512-1.764] were not more or less likely to be willing to accept the vaccine than non-users.

Overall, there is insufficient evidence that social media use is associated with vaccine hesitancy. However, it is important to note that use of social media is a different variable to use of social media for COVID-19 information.

Positive social media about COVID-19 vaccine is not associated with vaccine hesitancy

Table 50: Studies evidencing that positive social media about COVID-19 vaccine is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Mir et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
2	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income

India, Mir et al. (2021): In a convenience sample of 254 India residents, Mir et al. (2021) examined the relationship between belief that social media is supportive of vaccine uptake, measured via three items on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured on a scale of 1 (strongly disagree) to 5 (strongly agree), using a cross-sectional survey design and structural equation modelling.

Mir et al. (2021) found that the belief that social media is supportive of vaccine uptake was not associated with vaccine intention [p = 0.269]. Considering that social media is more likely to not support vaccine uptake than traditional media, the use of this social media variable as a means to understand vaccine hesitancy is theoretically limited.

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents,

Yu et al. (2021) examined the relationship between frequency of exposure to positive social media messages about COVID-19 vaccines, measured on a scale of 1 (extremely/quite infrequent) to 3 (extremely/quite frequent), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

Yu et al. (2021) found that, when holding constant overall trust toward government, trust toward governmental measures in controlling COVID-19, overall satisfaction with government, perceived level of vaccination among Hong Kong citizens and acquaintances, perceived vaccine efficacy, perceived duration of vaccine efficacy, perceived risk and life satisfaction, frequency of exposure to positive social media messages about COVID-19 vaccines was not associated with vaccine intention.

Conclusions

Table 51: Analysis of evidence by findings, region, cultural group and income

	Predictive		Non-predictive [n, %]	Total	Non-predictive [n, %]		Total
	Users of social media for COVID-19 information are more likely to be vaccine hesitant [n, %]	Users of social media for COVID-19 information are less likely to be vaccine hesitant [n, %]	Using social media for COVID-19 information is not associated with vaccine hesitancy [n, %]		Using social media is not associated with vaccine hesitancy [n, %]	Positive social media about COVID-19 vaccine is not associated with vaccine hesitancy [n, %]	
Studies	5 [83%]		1 [17%]	6	3 [100%]		3
Studies	5 [83%]	0	1 [17%]	6	1 [100%]	2 [100%]	3
Region							
Europe	2 [67%]	0	1 [33%]	3	1 [100%]	0	0
North America	2 [100%]	0	0	2	0	0	0
Asia	1 [100%]	0	0	1	0	2 [100%]	2
Oceania	0	0	0	0	0	0	0
South America	0	0	0	0	0	0	0
Africa	0	0	0	0	0	0	0
Cultural Group							
Anglo	2 [67%]	0	1 [33%]	3	1 [100%]	0	1
Germanic Europe	2 [100%]	0	0	2	0	0	0
Nordic Europe	0	0	0	0	0	0	0
Eastern Europe	0	0	0	0	0	0	0
Latin Europe	0	0	0	0	0	0	0
Latin America	0	0	0	0	0	0	0
Southern Asia	0	0	0	0	0	1 [100%]	1
Confucian Asia	0	0	0	0	0	1 [100%]	1

Sub-Saharan Africa	0	0	0	0	0	0	0
Middle East	1 [100%]	0	0	1	0	0	0
Income							
High Income	5 [83%]	0	1 [17%]	6	1 [100%]	1 [100%]	2
Upper Middle Income	0	0	0	0	0	0	0
Lower Middle Income	0	0	0	0	0	1 [100%]	1
Low Income	0	0	0	0	0	0	0

Overall: Studies considered the relationship between vaccine hesitancy and (i) using social media for COVID-19 information, (ii) using social media generally and (iii) positive social media messages about the COVID-19 vaccine.

There was only a single study considering the relationship between using social media generally, which found that general social media use was not associated with vaccine hesitancy, such that there is insufficient evidence to draw any conclusions about the association between use of social media generally and vaccine hesitancy.

There were only two studies considering the relationship between positive social media messages about the COVID-19 vaccine, which found that positive social media messages about the COVID-19 vaccine use were not associated with vaccine hesitancy, such that there is insufficient evidence to draw any conclusions about the association between positive social media messages about the COVID-19 vaccine and vaccine hesitancy.

Of the studies that considered the relationship between using social media for COVID-19 information and vaccine hesitancy, 83% [5 out of 6] found using social media for COVID-19 information to be predictive, such that it can be confidently concluded that using social media for COVID-19 information is predictive of vaccine hesitancy. Of the five studies that found using social media for COVID-19 information to be predictive of vaccine hesitancy, 100% [5 out of 5] found that users of social media for COVID-19 information were more likely to be vaccine hesitant, such that it can be concluded with high confidence that, when using social media for COVID-19 information is predictive of vaccine hesitancy, users of social media for COVID-19 information are most hesitant. Out of all studies, 83% [5 out of 6] found that users of social media for COVID-19 information are most hesitant, such that it can be concluded with high confidence that, overall, users of social media for COVID-19 information are most likely to be vaccine hesitant.

In looking for patterns by region, cultural group and income of the countries in the studies, there was insufficient evidence to draw any additional conclusions about the relationship between using social media for COVID-19 information and vaccine hesitancy.

SOCIAL OPPORTUNITY
POLITICAL IDEOLOGY

6.2.1

Political ideology refers to people's political beliefs and affiliations. It was measured either as a categorical variable in terms of political parties voted for or identified with or on scales associated with political spectrums (e.g., liberal to conservative; left to right) or even as a binary variable (e.g., left vs. right political orientation).

In total, 10 studies considered the association between political ideology and vaccine hesitancy. Of these, seven found that political ideology was predictive of vaccine hesitancy and three found that political ideology was not predictive of vaccine hesitancy. Of the seven studies that found political ideology was predictive of vaccine hesitancy, all found that right-wing or conservative voters were more likely to be vaccine hesitant.

Right-wing or conservative voters are more likely to be vaccine hesitant

Table 52: Studies evidencing that right-wing or conservative voters are more likely to be vaccine hesitant

	Study	Country	Region	Cultural Group	Income
1	Agley et al. (2021)	United States	North America	Anglo	High Income
2	Huynh and Senger (2021)	United States	North America	Anglo	High Income
3	Kreps et al. (2021)	United States	North America	Anglo	High Income
4	Ruiz and Bell. (2021)	United States	North America	Anglo	High Income
5	Edwards et al. (2021)	Australia	Oceania	Anglo	High Income
6	Paul et al. (2021)	Austria	Europe	Germanic Europe	High Income
7	Lamot et al. (2020)	Slovenia	Europe	Eastern Europe	High Income

United States, Agle et al. (2021): In a nationally representative (quota) sample of 1,017 United States residents, Agle et al. (2021) examined the relationship between political orientation, measured on a scale of 1 (liberal) to 10 (conservative), and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely), using a cross-sectional survey design and linear regression.

Agle et al. (2021) found that when holding constant COVID-19 diagnosis, age, race, being Hispanic or Latin, trust in science, religious commitment, gender, perceived seriousness of contracting COVID-19, perceived confidence in avoiding COVID-19, friends' or family's avoidance of crowded areas, being more conservative (right) in political orientation was negatively associated with vaccine intention [$B = -0.134$, $p < 0.001$] whereby the more conservative an individual was, the less likely they were to intend to receive the vaccine such that conservative people are more hesitant.

United States, Huynh and Senger. (2021): In a convenience sample of 351 USA residents, Huynh and Senger. (2020) examined the relationship between political orientation, measured on a scale of 1 (completely liberal) to 11 (completely conservative), and vaccination intention, measured on a scale of 1 (not at all) to 7 (extremely likely), using a cross-sectional survey design and hierarchical regression.

Huynh and Senger. (2021) found that, when holding constant ethnicity, age, education, socio-economic situation and gender, a conservative political orientation was negatively associated with vaccination intention [$B = -0.20$, $p < 0.001$] whereby as strength of conservative (right) political orientation increases, vaccine intention decreases such that conservative people are more hesitant.

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between political partisanship, measured as a categorical variable (Republican, Democrat, Independent), and vaccine acceptance, measured (i) as a discrete choice (vaccine A vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental survey design and OLS regression.

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, safety, approving body, origin, endorsements), gender, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion and ethnicity, Democrat voters [$B = 0.12$, $p < 0.001$] and Republican voters [$B = 0.05$, $p = 0.01$] were more likely to accept the vaccine than

Independent voters, such that Democrats (left) were most likely to accept the vaccine.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the relationship between political party affiliation, measured as a categorical variable, and vaccine intention, measured on a scale of 1 (extremely unlikely) to 5 (extremely likely) and at a hesitancy rate of 37.8% (extremely or somewhat unlikely and unsure combined), using a cross-sectional survey design, Chi-square and linear regression.

Using Chi-square, Ruiz and Bell (2021) found that vaccine intention differed by political party identity [$p = 0.001$]. Respondents who identified as Democrat [73.2%] were most likely to get the vaccine, followed by respondents who identified as Independent [63%]. Respondents who identified as Republican [62.6%] were least likely to get the vaccine.

Using linear regression, Ruiz and Bell (2021) found that, when holding constant vaccine knowledge, belief in vaccine conspiracies, COVID-19 threat appraisal, having had the flu vaccine, pre-existing conditions, being 65 years or older, of White race, of Hispanic cultural identity, total household income, education, gender, marital status and preferred media for virus news, respondents who identified as Democrat were more likely to get the vaccine than respondents who identified as Republican [$B = 0.199$, $p = 0.029$]. There were no other differences between respondents who identified with other political parties.

Australia, Edwards et al. (2021): In a representative sample of 3,000 Australia residents, Edwards et al. (2021) examined the relationship between political orientation, measured as a binary variable (voted Labor vs. voted Coalition), and vaccine acceptance, measured on a scale of 1 (definitely not get the vaccine) to 4 (definitely get the vaccine) at a hesitancy rate of 41.4%, using a cross-sectional survey design and ordinal probit regression, presenting AME.

Edwards et al. (2021) found that, when holding constant location in Australia, indigenous ethnicity, place of birth, English language, education, deprivation, residing in a capital city, employment, age, income and social attitudes, respondents who voted for Labor (left) were more likely to accept the vaccine than respondents who voted for the Coalition (centre-right) [$B = 0.076$, $p = 0.05$].

Austria, Paul et al. (2021): In a nationally representative (quota) sample of 1,301 Austrian residents, Paul et al. (2021) examined the relationship between vote choice, measured as a categorical variable, and readiness to get vaccinated, measured on a scale from 1 (completely

disagree) to 5 (completely agree), using a cross-sectional survey design, descriptive statistics and OLS regression.

Using descriptive statistics, Paul et al. (2021) found that voters for the New Austria and liberal forum (65%) and Green (59%) intended to receive the vaccine as soon as possible than voters for Freedom Party of Austria (31%).

Using OLS regression, Paul et al. (2021) found that, when holding constant age, education, income situation, pre-existing condition, subjective health risk, sense of community, conspiracy belief, gender, respondents who voted for the populist-right-wing Freedom Party of Austria were significantly less likely to receive the vaccine as soon as possible than respondents who voted for the more central wing Austrian People’s Party [B = -0.2, p <

0.05]. There were no other significant differences between respondents who voted for other parties [p > 0.05].

Slovenia, Lamot et al. (2020): In a snowball sample of 851 Slovenia residents, Lamot et al. (2021) examined the relationship between political orientation, measured as a binary variable (left vs. rightist political orientation), and vaccine hesitancy, measured on a scale of 0 (not likely at all) to 10 (very likely), using a cross-sectional survey design and ordinal regression.

Lamot et al. (2020) found that, when holding constant age, education, employment status and health, respondents of a left political orientation were less likely to be vaccine hesitant than respondents of rightist political orientation [B = -0.58, p = 0.01].

Political ideology is not associated with vaccine hesitancy

Table 53: Studies evidencing that political ideology is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Freeman et al. (2020)	United Kingdom	Europe	Anglo	High Income
2	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Lindholt et al. (2021)	Multiple countries aggregated			

United Kingdom, Freeman et al. (2020): In a convenience sample of 5,114 UK residents, Freeman et al. (2021) examined the relationship between libertarian and populist political views, measured on a scale of 1 (strongly disagree) to 6 (strongly agree), and vaccine hesitancy, measured on a scale from 1 (definitely) to 5 (definitely not) plus an option for don’t know, using a cross-sectional survey design and simple linear regression.

Freeman et al. (2021) found that political view was not associated with vaccine hesitancy [p = 0.462].

United Kingdom, Jennings et al. (2021): In a nationally representative sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between voting intention, measured as a binary variable (voting Conservative vs. not voting Conservative), and vaccine acceptance, measured as a binary variable at a rate of 71%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that, when holding constant conspiracy beliefs, vaccine distrust, being COVID-19 misinformed, lockdown scepticism, mistrust of government, distrust of government, social media platforms use, age, gender, posting political content online, fact-checking, having had COVID-19, sources of information, education, trust in the media, perceived personal threat, social trust, trust in the government, trust in experts, trust in health organizations, and evaluation of government’s handling of COVID-19, voting Conservative (right) was not associated with vaccine acceptance [p > 0.05].

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020): In nationally representative (quota) samples of 18,231 respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between vote choice, measured as a categorical variable, political ideology, measured on a scale from 1 (the left) to 10 (the right), and vaccine hesitancy, measured on a scale of 1 (completely disagree that I would take a vaccine) to 5 (completely agree), using a cross-sectional survey design and OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%] the United States [54%] and France (47 %), and the lowest level of vaccine acceptance was in Hungary [47%].

Lindholt et al. (2020) found that, when holding constant trust in national health authorities, trust in scientists, trust in the government, democratic rights, support of public protests, conspiracy beliefs, misinformation, gender,

fatigue, behaviour change, knowledge, age, education, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the economy, support for restrictions and interpersonal trust, vote choice and political ideology were not associated with vaccine hesitancy [$p > 0.05$].

Conclusions

Table 54: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	Right-wing or conservative voters are more likely to be vaccine hesitant [n, %]	Left-wing or liberal voters are more likely to be vaccine hesitant [n, %]		
Studies	7 [70%]		3 [30%]	10
Studies	7 [70%]	0	3 [30%]	10
Region				
Europe	2 [50%]	0	2 [50%]	4
North America	4 [100%]	0	0	4
Asia	0	0	0	0
Oceania	1 [100%]	0	0	1
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	5 [71%]	0	2 [29%]	7
Germanic Europe	1 [100%]	0	0	1
Nordic Europe	0	0	0	0
Eastern Europe	1 [100%]	0	0	1
Latin Europe	0	0	0	0
Latin America	0	0	0	0

Southern Asia	0	0	0	0
Confucian Asia	0	0	0	0
Sub-Saharan Africa	0	0	0	0
Middle East	0	0	0	0
Income				
High Income	7 [78%]	0	2 [22%]	9
Upper Middle Income	0	0	0	0
Lower Middle Income	0	0	0	0
Low Income	0	0	0	0

Overall: Of the studies that considered the association between political ideology and vaccine hesitancy, 70% [7 out of 10] found that political ideology is predictive of vaccine hesitancy, such that it can be concluded with high confidence that political ideology is predictive of vaccine hesitancy. Of the seven studies that found political ideology to be predictive of vaccine hesitancy, 100% [7 out of 7] found that right-wing or conservative voters are more likely to be vaccine hesitant, such that it can be concluded with high confidence that, when political ideology is predictive of vaccine hesitancy, right-wing or conservative voters are more likely to be vaccine hesitant. Out of all studies, still 70% [7 out of 10] found that right-wing or conservative voters are more likely to be vaccine hesitant, such that, overall, it can be concluded with high confidence that right-wing or conservative voters are more likely to be vaccine hesitant.

In looking for patterns by region, cultural group and income of the countries in the studies, some associations between political ideology and vaccine hesitancy are evident.

Region: Of studies conducted in North American countries, 100% [4 out of 4] found that right-wing or conservative voters are more likely to be vaccine hesitant, such that it can be concluded with high confidence that in North American countries, right-wing or conservative voters are more likely to be vaccine hesitant.

There is inconclusive evidence about the association between political ideology and vaccine hesitancy in European countries: 50% of studies [2 out of 4] found that as right-wing or conservative voters are more likely to be vaccine hesitant, but 50% [2 out of 4] also found that political ideology was not associated with vaccine hesitancy.

There is insufficient evidence to draw conclusions about the relationship between political ideology and vaccine hesitancy in the context of Oceania [1 study].

There is no evidence to draw any conclusions about the relationship between political ideology and vaccine hesitancy in the contexts of Asia [0 studies], South America [0 studies] and Africa [0 studies].

Cultural group: Of studies conducted in Anglo cultural group countries, 71% [5 out of 7] found that right-wing or conservative voters are more likely to be vaccine hesitant, such that it can be concluded with high confidence that in Anglo cultural group countries, right-wing or conservative voters are more likely to be vaccine hesitant.

There is insufficient evidence to draw conclusions about the relationship between political ideology and vaccine hesitancy in the contexts of Germanic Europe [1 study] and Eastern Europe [1 study].

There is no evidence to draw conclusions about the relationship between political ideology and vaccine hesitancy in the contexts of Nordic Europe [0 studies], Latin Europe [0 studies], Latin America [0 studies], Southern Asia [0 studies], Confucian Asia [0 studies] and Sub-Saharan Africa [0 studies].

Income: Of studies conducted in high income countries, 78% [7 out of 9] found that right-wing or conservative voters are more likely to be vaccine hesitant, such that it can be concluded with high confidence that in high income countries, right-wing or conservative voters are more likely to be vaccine hesitant.

There is no evidence to draw any conclusions about the relationship between political ideology and vaccine hesitancy in the contexts of upper middle income countries [0 studies], lower middle income countries [0 studies] and low income countries [0 studies].

REFLECTIVE MOTIVATION
PERCEIVED VACCINE SAFETY

6.3.1

Perceived vaccine safety is the perceived chance of being harmed by a COVID-19 vaccine if taken and is frequently defined in terms of concern and fear of experiencing side effects. It is most frequently measured as an ordinal variable (i.e., on a scale), but also as a binary variable (e.g., not worried vs. worried).

In total, 16 studies considered the relationship between perceived vaccine safety and vaccine hesitancy. Of these, all 16 found that perceived vaccine safety was predictive of vaccine hesitancy. Of the 16 studies that found perceived vaccine safety was predictive of vaccine hesitancy, all 16 found that as perceived vaccine safety increases, vaccine hesitancy decreases (i.e., those who perceive the vaccine to be less safe or to cause side effects are more hesitant).

As perceived vaccine safety increases, vaccine hesitancy decreases

Table 55: Studies evidencing that as perceived vaccine safety increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Sethi et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Chu and Liu (2021)	United States	North America	Anglo	High Income
3	Dorman et al. (2021)	United States	North America	Anglo	High Income
4	Johnson et al. (2021)	United States	North America	Anglo	High Income
5	Kreps et al. (2021)	United States	North America	Anglo	High Income
6	Ruiz and Bell (2021)	United States	North America	Anglo	High Income
7	Shih et al. (2021)	United States	North America	Anglo	High Income
8	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income

9	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
10	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
11	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
12	Sharun et al. (2020)	India	Asia	Southern Asia	Lower Middle Income
13	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
14	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
15	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Low Income
16	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income

United Kingdom, Sethi et al. (2021): In a convenience sample of 4,884 United Kingdom residents, Sethi et al. (2021) examined the reasons for vaccine hesitancy, using a cross-sectional survey design and descriptive statistics.

Sethi et al. (2021) found that, among 16 key reasons for not accepting the vaccine, the most common reason [reported by 60% of vaccine hesitant respondents] for being vaccine hesitant was the possibility of the COVID-19 vaccine having side effects.

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between COVID-19 vaccine safety concerns, measured on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, ethnicity, education, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived susceptibility, fear, perceived benefits, perceived barriers and self-efficacy, COVID-19 vaccine safety concerns were negatively associated with vaccine intention [$B = -0.118$, $p < 0.001$] whereby as safety concerns increase, vaccine intention decreases such that respondents with greater safety concerns are more hesitant.

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Dorman et al. (2021) examined the relationship between confidence in the COVID-19 vaccine, measured via three statements on a scale of 1 (strongly disagree) to 7 (strongly agree), and vaccine intention, measured on a scale of 1 (strongly

disagree) to 7 (strongly agree), using a cross-sectional research design and linear regression.

Dorman et al. (2021) found that, when holding constant complacency about the disease, convenience of getting vaccinated, whether one is a person who calculates risks and benefits and concern for others, confidence in the COVID-19 vaccine was positively associated with vaccine intention [$B = 0.621$, $p < 0.001$] whereby as confidence in the COVID-19 vaccine increases, so does vaccine intention, such that respondents with lower confidence in the COVID-19 vaccine are more vaccine hesitant.

United States, Johnson et al. (2021): In a convenience sample of 248 primary care patients of the Louisiana State University Medicine Clinic in USA, Johnson et al. (2021) examined the relationship between concern about serious side effects of the vaccine, measured as a binary variable, and vaccine intention, measured as a binary variable (yes vs. no/unsure) and at a hesitancy rate of 67%, using a cross-sectional survey design, descriptive statistics and Chi-square.

Johnson et al. (2021) found that among participants ($n=167$) who were unsure or did not intend to receive the COVID-19 vaccination, 48% ($n=80$) attributed their hesitancy to concern with the side effects of the vaccine.

Using Chi-square, Johnson et al. (2021) found that concern about serious side effects of the vaccine differed by vaccine intention [$p < 0.001$]. Respondents who intended to receive the vaccine [27.2%] were less likely to be concerned about serious side effects of the vaccine than respondents who were resistant or hesitant to receiving the vaccine [79%].

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between vaccine attribute of risk of severe and mild side effects, measured as a binary variable (risk of severe side effects (hospitalization or death) 1 in 10,000 vs. 1 in 1,000,000; risk of mild side effects (flu-like symptoms) 1 in 10 vs. 1 in 30) and vaccine preference, measured as a discrete choice (vaccine A vs. vaccine B), and vaccine evaluation, measured on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental survey design and OLS regression.

Kreps et al. (2021) found that when holding constant vaccine attributes (efficacy, duration, approving body, origin, endorsements), politics, education, flu vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion and ethnicity and gender, vaccine attribute of lower risk of severe side effects (1 in 1,000,000) was associated with greater vaccine preference [$B = 0.07$, $p < 0.001$] and greater vaccine evaluation [$B = 0.04$, $p < 0.001$] compared with a vaccine attribute of greater risk of severe side effects (1 in 10,000), such that greater side effects risk is associated with greater hesitancy. Vaccine attribute of lower risk of mild side effects (1 in 30) was associated with greater vaccine preference [$B = 0.01$, $p = 0.04$] and greater vaccine evaluation [$B = 0.02$, $p = 0.001$] compared with a vaccine attribute of greater risk of mild side effects (1 in 10), such that greater side effects risk is associated with greater hesitancy.

United States, Ruiz and Bell (2021): In a nationally representative (quota) sample of 804 United States residents, Ruiz and Bell (2021) examined the reasons for vaccine hesitancy, using a cross-sectional survey design and descriptive statistics.

Ruiz and Bell (2021) found that the belief that the vaccine might have dangerous side effects [43.8% of 304 vaccine hesitant respondents] was the most frequently cited reason for vaccine hesitancy. Of 73 respondents that were extremely unlikely to receive the vaccine, 57.5% believed that the vaccine might have dangerous side effects.

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between vaccine safety attribute, measured as a binary variable (5% fever risk vs. 20% fever risk), and vaccine rejection, measured as a binary variable (rejected vs. not rejected), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant gender, generation race/ethnicity, monthly family income, political affiliation, general vaccine hesitancy, perceived vaccine effectiveness and perceived risk of infection, vaccines with a 20% fever risk were more likely to be

rejected than vaccines with a 5% fever risk [$OR = 1.63$, 95% CI 1.03-2.57] whereby as side effect risk increases, vaccine resistance increases.

Finland, Hammer et al. (2021): In a nationally representative sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between perception of possible side effects of the vaccine, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional survey design and stratified linear regression.

Hammer et al. (2021) found that, when holding constant vaccine efficacy, infection situation in Finland, gender, recommendation from a healthcare professional, recommendation from health authorities, conversations with family and friends, how easy it is to get vaccinated, perceived susceptibility, perceived probability of infection, perceived severity if infected, perceived transparency with public, perceived politician honesty, belief in COVID-19 conspiracy theory, belief in other conspiracy theories, education, gender and age, perception of possible side effects of the vaccine was negatively associated with vaccine acceptance [Under 50s: $B = -0.27$, $p < 0.001$; Over 50s: $B = -0.24$, $p < 0.001$] whereby as perception of possible side effects of the vaccine increases, vaccine acceptance decreases such that those who perceive that the vaccines will have side effects are more hesitant.

France, Tavalacci et al. (2021): In a convenience sample of 3,089 French students, Tavalacci et al. (2021) examined the relationship between perceived vaccine security, and vaccine intention, measured as a categorical variable (acceptance, hesitancy, resistance), using a cross-sectional survey design, ANOVA and logistic regression.

Using ANOVA, Tavalacci et al. (2021) found that perceived vaccine security differed by vaccine intention [$p < 0.0001$]. Respondents who intended to receive the vaccine had the highest perception of vaccine security [Mean = 8.8], followed by respondents who were vaccine hesitant [Mean = 6.8]. Respondents who intended to reject the vaccine had the lowest perception of vaccine security [Mean = 5.4].

Using logistic regression, Tavalacci et al. (2021) found that, when holding constant age, gender, years of study, courses of study, COVID-19 infection, having a relative hospitalized or died from COVID-19, COVID-19 knowledge, conventional vaccine beliefs, COVID-19 vaccine beliefs, confidence about conventional vaccination and perceived vaccine efficacy, perceived vaccine security was negatively associated with vaccine hesitancy [$OR = 0.57$, $p < 0.0001$] and vaccine resistance [$OR = 0.46$, $p < 0.0001$] whereby as perceived vaccine security increases, vaccine intention increases such that those who perceive vaccine security to be lowest are most hesitant.

Malta, Cordina et al. (2021): In a convenience sample of 834 Malta residents, Cordina et al. (2021) examined reasons for unwillingness to receive the vaccine, using a cross-sectional survey design.

Lack of vaccine safety was the most frequent reason cited for unwillingness to take the vaccine.

India, Goruntla et al. (2021): In a convenience sample of 2,451 India residents, Goruntla et al. (2021) examined the relationship between perception of side effects, measured as a categorical variable, and vaccine intention, measured as a binary variable, using a cross-sectional survey design, descriptive statistics, Chi-square and logistic regression.

Goruntla et al. (2021) found that concerns about side effects from the vaccine [reported by 85.68% of respondents] was the most common perceived barrier to accepting the vaccine.

Using Chi-square, Goruntla et al. (2021) found that vaccine intention differed by concern about having side effects to the vaccine [$p < 0.001$]. Respondents who agreed that they were concerned about having side effects from the vaccine [87.41%] were less likely to intend to receive the vaccine than respondents who disagreed that they were concerned about having side effects from the vaccine [95%].

Using logistic regression, Goruntla et al. (2021) found that, when holding constant perceived susceptibility to COVID-19 infection, perceived severity of a COVID-19 infection, perceived benefits of COVID-19 vaccination and perceived barriers to accept the vaccine, respondents who agreed that they were concerned about having side effects from the vaccine were less likely to intend to receive the vaccine than respondents who disagreed that they were concerned about having side effects from the vaccine [OR = 0.36, $p < 0.001$].

India, Sharun et al. (2020): In a convenience sample of 351 India residents, Sharun et al. (2020) examined the examined reasons for vaccine hesitancy, using a cross-sectional survey design and descriptive statistics.

Sharun et al. (2020) found that the most common barrier to vaccine acceptance reported by respondents was concern about COVID-19 vaccine side effects [64.4% of respondents].

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the reasons for vaccine refusal, using a cross-sectional survey design and descriptive statistics.

Tsai et al. (2021) found that concerns regarding side effects [30.3%] was the second most frequent reason for vaccine refusal after perception that the Emergency Use Authorization process was not strict enough [48.7%].

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between side effect attributes, measured in terms of risk (rare vs. common) and severity (mild vs. severe), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

Yu et al. (2021) found that the risk of side effects was the most influential vaccine attribute and the severity of side effects was the third most influential vaccine attribute for vaccine intention.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined reasons for unwillingness to receive the vaccine, using a cross-sectional survey design.

Allagoa et al., (2021) found that no trust for the COVID-19 vaccine manufacturers was the most common reason for unwillingness [reported by 43.4% of unwilling respondents], belief that the vaccine is unsafe was the third most common reason for unwillingness [reported by 31.7% of unwilling respondents], belief that there have not been enough clinical trials for the vaccine was the fourth most common reason for unwillingness [reported by 23.2% of unwilling respondents] and belief that the vaccine will make one sick (i.e., side effects) was the sixth most common reason for unwillingness [reported by 20% of unwilling respondents].

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between worry about possible side effects of the vaccine and concern about the safety of the vaccine, both measured on a scale of 1 (strongly disagree) to 4 (strongly agree) and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Alobaidi (2021) found that vaccination intention differed by worry about possible side effects of the vaccine [$p < 0.001$]. Respondents who strongly agreed or agreed that they were worried about possible side effects of the vaccine [7.6%] were less likely to intend to receive the vaccine than respondents who disagreed or strongly disagreed that they were worried about possible side effects of the vaccine [33.8%].

Using Chi-square, Alobaidi (2021) found that vaccination intention differed by concern about the safety of the vaccine [$p < 0.001$]. Respondents who strongly agreed or agreed that they were concerned about the safety of the vaccine [6.4%] were less likely to intend to receive

the vaccine than respondents who disagreed or strongly disagreed that they were worried about possible side effects of the vaccine [34.9%].

Using logistic regression, Alobaidi (2021) found that, when holding constant perceived susceptibility, perceived severity, perceived benefits of vaccination, perceived barriers to vaccination and cues to action, worry about

possible side effects of the vaccine [OR=0.31, $p = 0.009$] and concern about the safety of the vaccine [OR= 0.062, $p < 0.001$] were negatively associated with intention to receive the vaccine whereby as worry about side effects and concern about safety increased, vaccine intention decreased, such that respondents who were more worried about side effects or more concerned about safety were more hesitant.

Conclusions

Table 56: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As perceived vaccine safety increases, vaccine hesitancy decreases [n, %]	As perceived vaccine safety increases, vaccine hesitancy increases [n, %]		
Studies	16 [100%]		0	16
Studies	16 [100%]	0	0	16
Region				
Europe	4 [100%]	0	0	4
North America	6 [100%]	0	0	6
Asia	5 [100%]	0	0	5
Oceania	0	0	0	0
South America	0	0	0	0
Africa	1 [100%]	0	0	1
Cultural Group				
Anglo	7 [100%]	0	0	7
Germanic Europe	0	0	0	0
Nordic Europe	1 [100%]	0	0	1
Eastern Europe	0	0	0	0
Latin Europe	2 [100%]	0	0	2
Latin America	0	0	0	0
Southern Asia	2 [100%]	0	0	2

Confucian Asia	2 [100%]	0	0	2
Sub-Saharan Africa	1 [100%]	0	0	1
Middle East	1 [100%]	0	0	1
Income				
High Income	13 [100%]	0	0	13
Upper Middle Income	0	0	0	0
Lower Middle Income	2 [100%]	0	0	2
Low Income	1 [100%]	0	0	1

Overall: Of the studies that considered the relationship between perceived vulnerability and vaccine hesitancy, 100% [16 out of 16] found perceived vaccine safety to be predictive, such that it can be concluded with high confidence that perceived vaccine safety is predictive of vaccine hesitancy. Out of all studies, 100% [16 out of 16] found that as perceived vaccine safety increases, vaccine hesitancy decreases (i.e., those who perceive the vaccine to be less safe or to cause side effects are more hesitant), such that it can be concluded with high confidence that, as perceived vaccine safety increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and economies of the countries in the studies, some associations between perceived vaccine safety and vaccine hesitancy are evident.

Region: Of studies conducted in North American [6 out of 6], Asian [5 out of 5] and European [4 out of 4] countries, 100% found that as perceived vaccine safety increases, vaccine hesitancy decreases (i.e., those who perceive the vaccine to be less safe or to cause side effects are more hesitant). As such, that it can be concluded with high confidence that in North American, Asian and European countries, as perceived vaccine safety increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in the context of Africa [1 study].

There is no evidence to draw any conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in the contexts of Oceania [0 studies] and South America [0 studies].

Cultural group: Of studies conducted in countries in the Anglo cultural group, 100% [7 out of 7] found that as perceived vaccine safety increases, vaccine hesitancy decreases (i.e., those who perceive the vaccine to be less safe or to cause side effects are more hesitant), such that

it can be concluded with high confidence that in countries of the Anglo cultural group, as perceived vaccine safety increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in the contexts of the Latin Europe [2 studies], Southern Asia [2 studies], Confucian Asia [2 studies], Nordic Europe [1 study], Sub-Saharan Africa [1 study] and Middle East [1 study] cultural groups.

There is no evidence to draw conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in the contexts of the Germanic Europe [0 studies] Eastern Europe [0 studies] and Latin America [0 studies] cultural groups.

Income: Of studies conducted in high income countries, 100% [13 out of 13] found that as perceived vaccine safety increases, vaccine hesitancy decreases (i.e., those who perceive the vaccine to be less safe or to cause side effects are more hesitant), such that it can be concluded with high confidence that in high income countries, as perceived vaccine safety increases, vaccine hesitancy decreases.

There is insufficient evidence to draw any conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in the contexts of lower middle income countries [2 studies] and low income countries [1 study].

There is no evidence to draw conclusions about the relationship between perceived vaccine safety and vaccine hesitancy in upper middle income countries [0 studies].

REFLECTIVE MOTIVATION
PERCEIVED VACCINE EFFICACY

6.3.2

Perceived vaccine efficacy is the belief in the effectiveness of a COVID-19 vaccine in terms of controlling COVID-19, catching COVID-19 and protecting against COVID-19. It is measured as both an ordinal variable (i.e., on a scale) and a categorical variable in terms of level of efficacy.

In total, five studies considered the relationship between perceived vaccine efficacy and vaccine hesitancy. Of these, four found that perceived vaccine efficacy was predictive of vaccine hesitancy. Of the four studies that found that perceived vaccine efficacy was predictive of vaccine hesitancy, all four found that as perceived vaccine efficacy increases, vaccine hesitancy decreases (i.e., those who have less trust in the effectiveness of the vaccine are more hesitant).

As perceived vaccine efficacy increases, vaccine hesitancy decreases

Table 57: Studies evidencing that as perceived vaccine efficacy increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Kreps et al. (2021)	United States	North America	Anglo	High Income
2	Tavolacci et al. (2021)	France	Europe	Latin Europe	High Income
3	Sharun et al. (2020)	India	Asia	Southern Asia	Lower Middle Income
4	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income

United States, Kreps et al. (2020): In a convenience sample of 1,971 United States residents, Kreps et al. (2021) examined the relationship between perceived vaccine efficacy, measured as categorical variable (50%, 70%, 90%), and vaccine acceptance, measured (i) as a discrete choice (vaccine A vs. vaccine B) and (ii) individual vaccine evaluation on a scale of 1 (extremely unlikely) to 7 (extremely likely), using a conjoint experimental design and OLS regression.

Kreps et al. (2021) found that, when holding constant, demographic characteristics (politics, education, flu

vaccination, health insurance, pharma favourability, knowing a COVID-19 case, believing that the worst of the pandemic is yet to come, religion and ethnicity, and age) and other vaccine attributes (duration, safety, approving body, origin, endorsements), when vaccine efficacy was 70%, respondents were more likely to choose the vaccine [B = 0.08, p < 0.001] and more likely to accept the vaccine [B = 0.05, p < 0.001] than when vaccine efficacy was 50%. When vaccine efficacy was 90%, respondents were more likely to choose the vaccine [B = 0.17, p < 0.001] and more likely to accept the vaccine [B = 0.10, p < 0.001] than when vaccine efficacy was 50%.

Overall, vaccine efficacy is positively associated with vaccine acceptance whereby as vaccine efficacy increases, vaccine acceptance increases such that more effective vaccines are more likely to be accepted.

France, Tivolacci et al. (2021): In a convenience sample of 3,089 French students, Tivolacci et al. (2021) examined the relationship between confidence in efficacy of vaccine, measured as a binary variable (yes vs. no), and vaccine intention, measured as a categorical variable (acceptance, hesitancy, resistance), using a cross-sectional survey design and logistic regression.

Tivolacci et al. (2021) found that, when holding constant age, years of study, courses of study, COVID-19 infection, having a relative hospitalized or died from COVID-19, COVID-19 knowledge, conventional vaccine beliefs, COVID-19 vaccine beliefs, confidence about conventional vaccination, gender and perceived vaccine security, respondents who perceived the vaccine to be effective were more likely to be vaccine hesitant [OR = 0.61, $p < 0.0001$] and less likely to be vaccine resistant [OR = 0.50, $p < 0.0001$] than respondents who perceived the vaccine to not be effective.

India, Sharun et al. (2020): In a convenience sample of 351 India residents, Sharun et al. (2020) examined the examined reasons for vaccine hesitancy, using a cross-sectional survey design and descriptive statistics.

Sharun et al. (2020) found that the second most common barrier to vaccine acceptance reported by respondents was the belief that the vaccine will not stop infection [20.2% of respondents].

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between perceived vaccine efficacy (vaccination decreases worry about catching COVID-19; vaccination decreases chance of getting COVID-19), both measured on a scale of 1 (strongly disagree) to 4 (strongly agree), and vaccine uptake, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Alobaidi (2021) found that vaccine intention differed by perception that vaccination decreases worry about catching COVID-19 [$p < 0.001$]. Respondents who perceived that vaccination decreases worry about catching COVID-19 [38.5%] were more likely to definitely accept the vaccine than respondents who did not perceive that vaccination decreases worry about catching COVID-19 [2.9%].

Using Chi-square, Alobaidi (2021) found that vaccine intention differed by perception that vaccination decreases chance of getting COVID-19 [$p < 0.001$]. Respondents who perceived that vaccination decreases chance of getting COVID-19 [40.5%] were more likely to definitely accept the vaccine than respondents who did not perceive that vaccination decreases chance of getting COVID-19 [0.9%].

Using logistic regression, Alobaidi (2021) found that, when holding constant perceived susceptibility, perceived severity, perceived barriers of COVID-19 vaccination, cues to action and perception that vaccination decreases chance of getting COVID-19, perception that vaccination decreases worry about catching COVID-19 was positively associated with vaccine uptake [OR = 7.59, $p = 0.009$].

Using logistic regression, Alobaidi (2021) found that, when holding constant perceived susceptibility, perceived severity, perceived barriers of COVID-19 vaccination, cues to action and perception that vaccination decreases worry about catching COVID-19, perception that vaccination decreases chance of getting COVID-19 was not associated with vaccine uptake [$p = 0.712$], suggesting that another factor better accounted for variance in vaccine uptake.

Overall, the majority of evidence found that vaccine efficacy is positively associated with vaccine uptake whereby as perceived vaccine efficacy increases, vaccine uptake increases such that those who perceive vaccine efficacy to be lower are more hesitant.

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined reasons for unwillingness to receive the vaccine, using a cross-sectional survey design.

Al-Qaram and Jarab (2021) found that 85.3% of respondents who were vaccine resistant and 82.5% of respondents who were vaccine hesitant had concerns about vaccine efficacy.

Perceived vaccine efficacy is not associated vaccine hesitancy

Table 58: Studies evidencing that perceived vaccine efficacy is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between perceived impact of vaccine controlling COVID-19, measured as a categorical variable (very low/quite low, moderate, quite strong/very strong, don't know), perceived duration of effectiveness of vaccine, measured as a categorical variable (less than 1 year, 1 year and more, don't know), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

Yu et al. (2021) found that, when holding constant overall government trust, trust towards governmental measures in controlling COVID-19, overall satisfaction with government, frequency of exposure to positive social media messages about vaccines, descriptive norms and perceived duration of effectiveness of the vaccine, respondents who moderately [95% CI 0.43-3.95] and strongly [95% CI 0.16-

25.98] perceived the vaccine would be effective in controlling COVID-19 were not more or less likely to accept the vaccine at the earliest opportunity than respondents who did not perceive the vaccine would be effective in controlling COVID-19.

Yu et al. (2021) found that, when holding constant overall government trust, trust towards governmental measures in controlling COVID-19, overall satisfaction with government, frequency of exposure to positive social media messages about vaccines, descriptive norms and perceived impact of vaccine on controlling COVID-19, respondents who believed the vaccine would be effective for a year and more were more likely to accept the vaccine at the earliest opportunity than respondents who believed the vaccine would be effective for less than a year [OR = 2.83, $p < 0.05$].

Overall, this study provides inconclusive evidence that vaccine efficacy is associated with vaccine acceptance.

Conclusions

Table 59: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As perceived vaccine efficacy increases, vaccine hesitancy decreases [n, %]	As perceived vaccine efficacy increases, vaccine hesitancy increases [n, %]		
Studies	4 [80%]		1 [20%]	5
Studies	4 [80%]	0	1 [20%]	5

Region				
Europe	1 [100%]	0	0	1
North America	1 [100%]	0	0	1
Asia	2 [67%]	0	1 [33%]	3
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	1 [100%]	0	0	1
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	1 [100%]	0	0	1
Latin America	0	0	0	0
Southern Asia	1 [100%]	0	0	1
Confucian Asia	0	0	1 [100%]	1
Sub-Saharan Africa	0	0	0	0
Middle East	1 [100%]	0	0	1
Income				
High Income	3 [75%]	0	1 [25%]	4
Upper Middle Income	0	0	0	0
Lower Middle Income	1 [100%]	0	0	1
Low Income	0	0	0	0

Overall: Of the studies that considered the relationship between perceived vaccine efficacy and vaccine hesitancy, 80% [4 out of 5] found perceived vaccine efficacy to be predictive, such that it can be concluded with high confidence that perceived vaccine efficacy is predictive of vaccine hesitancy. Of the four studies that found perceived vaccine efficacy to be predictive of vaccine hesitancy, 100% of studies [4 out of 4] found that as perceived vaccine efficacy increases, vaccine hesitancy decreases (i.e., those with less belief in the efficacy of the vaccine are more hesitant), such that it can be concluded with

high confidence that, when perceived vaccine efficacy is predictive of vaccine hesitancy, the association is negative. Out of all studies, 80% [4 out of 5] found that as perceived vaccine efficacy increases, vaccine hesitancy decreases (i.e., those with less belief in the efficacy of the vaccine are more hesitant), such that, overall, it can be concluded with high confidence that, as perceived vaccine efficacy increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and economies of the countries in the studies, there is only

inconclusive or insufficient evidence to draw conclusions on associations when segmenting by region and cultural group, but an association is evident when segmenting evidence by income.

Income: Of studies conducted in high income countries, 75% [3 out of 4] found that as perceived vaccine efficacy increases, vaccine hesitancy decreases (i.e., those with less belief in the efficacy of the vaccine are more hesitant) such that it can be concluded with high confidence that in high income countries as perceived vaccine efficacy increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between perceived vaccine efficacy and vaccine hesitancy in the context of lower middle income countries [1 study].

There is no evidence to draw any conclusions about the relationship between perceived vaccine efficacy and vaccine hesitancy in the context of upper middle income [0 studies] and low income [0 studies] countries.

**REFLECTIVE MOTIVATION
PERCEIVED VULNERABILITY
TO COVID-19**

6.3.3

Perceived vulnerability to COVID-19 is the perceived chance of being harmed by COVID-19 if infected. In the evidence reviewed, the factors considered within the theme of perceived vulnerability include perceived severity of COVID-19, perceived risk of COVID-19, perceived seriousness of contracting COVID-19, fear of COVID-19 and worry of contracting COVID-19. These factors were most frequently measured as an ordinal variable (i.e., on a scale), but also as a binary variable (e.g., not worried vs. worried).

In total, 14 studies considered the association between perceived vulnerability and vaccine hesitancy. Of these, 11 found that perceived vulnerability was predictive of vaccine hesitancy and three found that perceived vulnerability was not predictive of vaccine hesitancy. Of the 11 studies that found perceived vulnerability was predictive of vaccine hesitancy, all 11 found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant) and zero found that as income increases, vaccine hesitancy increases.

As perceived vulnerability increases, vaccine hesitancy decreases

Table 60: Studies evidencing that as perceived vulnerability increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Agley et al. (2021)	United States	North America	Anglo	High Income
2	Chu and Liu (2021)	United States	North America	Anglo	High Income
3	Coe et al. (2021)	United States	North America	Anglo	High Income
4	Dorman et al. (2021)	United States	North America	Anglo	High Income
5	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
6	Caserotti et al. (2021)	Italy	Europe	Latin Europe	High Income
7	Zampetakis and Melas (2021)	Greece	Europe	Latin Europe	High Income

8	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
9	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income
10	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income
11	Al-Qerem and Jarab (2021)	Jordan	Asia	Middle East	High Income

United States, Agley et al. (2021): In a nationally representative sample of 1,017 United States residents, Agley et al. (2021) examined the relationship between perceived seriousness of contracting COVID-19, measured on a scale of 1 (not at all) to 10 (very), and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and linear regression.

Agley et al. (2021) found that, when holding constant age, COVID-19 diagnosis, gender, race, being Hispanic or Latin, trust in science, religious commitment, political orientation, confidence in avoiding COVID-19 and friends' or family's avoidance of crowded areas, seriousness of contracting COVID-19 was positively associated with vaccine intention [B = 0.207, p < 0.001] whereby as perceived seriousness of contracting COVID-19 increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less serious are more hesitant.

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between perceived severity of COVID-19 (three items) and fear of COVID-19 (three items), measured on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, ethnicity, education, income, general vaccine hesitancy, norms, cues to action, perceived susceptibility, perceived susceptibility, fear, perceived benefits, perceived barriers and self-efficacy, perceived severity was not associated with vaccine intention [p > 0.05], but fear of COVID-19 was positively associated with vaccine intention [B = 0.05, p < 0.01] whereby as fear of COVID-19 increases, so does vaccine intention such that respondents with less fear of COVID-19 were more vaccine hesitant.

Variance in vaccine intention is better accounted for when defining perceived severity in terms of fear.

United States, Coe et al. (2021): In a nationally representative (quota) sample of 1,047 United States

residents, Coe et al. (2021) examined the relationship between perceived severity of COVID-19, measured on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that perceived severity was positively associated with vaccine intention [COR = 1.66, 95% CI 1.42-1.94] whereby as perceived severity increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant.

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant age, gender, race, region, ethnicity, education, annual household income, having a child, vaccine information sources, past influenza vaccine, influenza vaccine last year, perceived susceptibility of COVID-19, perceived clinical barriers to vaccination, perceived access barriers to vaccination, perceived COVID-19 specific vaccine benefit and perceived general vaccine benefits, perceived severity was positively associated with vaccine intention [AOR = 1.44, 95% CI 1.09-1.91] whereby as perceived severity increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant.

United States, Dorman et al. (2021): In a convenience sample of 26,324 United States residents, Dorman et al. (2021) examined the relationship between perceived severity of COVID-19, measured via three statements on a scale of 1 (strongly disagree) to 7 (strongly agree), and vaccine intention, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional research design and linear regression.

Dorman et al. (2021) found that, when holding constant confidence in the COVID-19 vaccine, convenience of getting vaccinated, whether one is a person who calculates risks and benefits and concern for others, perceived severity of COVID-19 was positively associated with vaccine intention [B = 0.178, p < 0.001] whereby as perceived severity increases, so does vaccine intention, such that respondents

who do not perceive COVID-19 to be severe are more vaccine hesitant.

Finland, Hammer et al. (2021): In a nationally representative (quota) sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between perceived severity of COVID-19, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional survey design and stratified linear regression.

Hammer et al. (2021) found that, when holding constant perceived COVID-19 vaccine safety, general vaccine attitude, perceived COVID-19 vaccine efficacy, infection situation in Finland, importance of COVID-19 vaccine efficacy in protecting oneself, importance of vaccine efficacy in protecting others, importance of possible side effects, importance of a recommendation from a healthcare professional, importance of a recommendation from health authorities, importance of conversations with family and friends, importance of how easy it is to get vaccinated, own assessment of susceptibility of infection, own assessment of probability of infection, perceived transparency with public, perceived politician honesty, belief in COVID-19 conspiracy theory, belief in other conspiracy theories, education, gender and age, own assessment of severity of infection was positively associated with vaccine acceptance in respondents younger than 50 years old [$B = 0.1$, $p = 0.016$] and respondents 50 years old and above [$B = 0.08$, $p = 0.021$] whereby as perceived severity increases, so does vaccine acceptance, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant.

Italy, Caserotti et al. (2021): In a convenience sample of 2,267 Italy residents, Caserotti et al. (2021) examined the relationship between perceived risk of COVID-19, measured via combining three items (perceived likelihood of being infected, perceived severity of COVID-19, fear of COVID-19) on a scale of 1 (not at all likely, not at all likely, not at all scared) to 100 (extremely likely, extremely severe, extremely scared) and recoded into tertiles (low, medium, high), and (i) vaccine acceptance, measured on a scale from 0 (not at all likely) to 100 (very likely), using a logistic regression model (from which ORs were presented) and (ii) vaccine hesitancy, measured as a binary variable (no hesitancy vs. hesitancy > 0), using a negative binomial (from which IRRs were presented).

In modelling vaccine acceptance, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, age, gender, deprivation and area in Italy, respondents with medium perceived risk of COVID-19 [$OR = 2.46$, $p < 0.001$] and respondents with high

perceived risk of COVID-19 [$OR = 3.53$, $p < 0.001$] were more likely to accept the vaccine than respondents with low perceived risk of COVID-19.

In modelling vaccine hesitancy, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, age, gender, deprivation and area in Italy, respondents with medium perceived risk of COVID-19 [$IRR = 0.72$, $p < 0.001$] and respondents with high perceived risk of COVID-19 [$IRR = 0.66$, $p < 0.001$] were less likely to be vaccine hesitant than respondents with low perceived risk of COVID-19.

Overall, Caserotti et al. (2021) found a positive association between perceived risk from COVID-19 and vaccine acceptance whereby as perceived risk increases, vaccine acceptance increases, such that respondents who perceive greater risk are more accepting of the vaccine, and a positive association between perceived risk from COVID-19 and vaccine hesitancy whereby as perceived risk increases, vaccine hesitancy decreases, such that respondents who perceive greater risk are less vaccine hesitant.

Greece, Zampetakis and Melas (2021): In a convenience sample of 1,006 Greece residents, Zampetakis and Melas (2021) examined the relationship between perceived severity of COVID-19, measured as a binary variable [low vs. high], and vaccine intention, measured on a scale of 1 (I absolutely do not intend to vaccinate) to 7 (I absolutely intend to vaccinate), using a conjoint experimental survey design and linear regression.

Zampetakis and Melas (2021) found that, when holding constant perceived susceptibility if I get the vaccine, perceived benefits of the vaccine and perceived barriers to getting the vaccine, perceived severity was positively associated with vaccine intention [$B = 0.29$, $p < 0.001$] whereby as perceived severity increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant.

India, Goruntla et al. (2021): In a convenience sample of 2,451 of India residents, Goruntla et al. (2021) examined the relationship between perceived severity of COVID-19, measured via two items (getting very sick from COVID-19, afraid of getting COVID-19) as binary variables (agree vs. disagree), and vaccine acceptance, measured as a binary variable at a hesitancy rate of 10.73%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Goruntla et al. (2021) found that respondents who agreed that they will get very sick if they get COVID-19 were more likely to intend to get the vaccine

[90.65%, $p = 0.05$] than those who disagreed that they will get very sick if they get COVID-19 [88.18%]. Respondents who agreed that they were very afraid of getting COVID-19 were more likely to intend to get the vaccine [93.53%, $p < 0.001$] than those who disagreed that they were afraid of getting COVID-19 [85.24%].

Using logistic regression, Goruntla et al. (2021) found that when holding constant perceived susceptibility to COVID-19 infection, perceived benefits of COVID-19 vaccination, perceived barriers to accept vaccine and cues to action, respondents who agreed that they will get very sick if they get COVID-19 were more likely to intend to get the vaccine [OR = 1.29, $p < 0.05$] than those who disagreed that they will get very sick if they get COVID-19 and respondents who agreed that they were afraid of getting COVID-19 were more likely to intend to get the vaccine [OR = 2.5, $p < 0.001$] than those who disagreed that they were afraid of getting COVID-19.

Across all data, there is a positive association between perceived severity and vaccine intention whereby as perceived severity increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant. Similar to Chu and Liu (2021), when perceived severity is defined in terms of fear it has a stronger association with vaccine intention.

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between perceived severity (complications from COVID-19 are serious, being very sick if getting COVID-19, fear of getting COVID-19), measured as binary variables (agree vs. disagree), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Wong et al. (2021) found that respondents who agreed that complications from COVID-19 are serious were more likely [49.2%, $p < 0.001$] to definitely accept the vaccine than respondents who disagreed [26.9%].

Respondents who agreed that they would be very sick if getting COVID-19 were more likely [50.7%, $p < 0.002$] to definitely accept the vaccine than respondents who disagreed [39.5%].

Respondents who agreed that they are afraid of getting COVID-19 were more likely [49.7%, $p < 0.001$] to definitely accept the vaccine than respondents who disagreed [32.3%].

Using logistic regression, Wong et al. (2021) found that, when holding constant age, gender, ethnicity, highest education level, occupation category, average monthly household income, location, diagnosed with chronic diseases, perceived overall health, known others infected

by COVID-19, perceived susceptibility, perceived benefits and perceived barriers, complications from COVID-19 are serious, being very sick if getting COVID-19 and fear of getting COVID-19 were not associated with vaccine intention [$p > 0.05$], suggesting that other factors better accounted for variance in vaccine intention.

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between perceived severity of COVID-19, measured on a scale of 1 (extremely unlikely/not at all susceptible) to 7 (extremely likely/very susceptible), and vaccine intention, measured on a scale of 1 to 7 and recoded as a categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance) at a hesitancy rate of 58.9% (refusal and hesitancy categories combined), using a cross-sectional survey design, ANOVA and linear regression.

Using ANOVA and Tukey tests, Kuçukkarapinar et al. (2021) found that perceived severity of COVID-19 was highest in respondents who accepted the vaccine [Mean = 4.16], followed by respondents who were vaccine hesitant [Mean = 4.01] and lowest in respondents who were vaccine resistant [Mean = 3.75] and that differences were significant [$p < 0.001$].

Using linear regression, Kuçukkarapinar et al. (2021) found that when holding constant age, gender, education level, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, perceived susceptibility to COVID-19, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, perceived severity of COVID-19 was positively associated with vaccine intention [B = 0.044, $p = 0.019$] whereby as perceived severity increases, so does vaccine intention, such that respondents who perceive COVID-19 to be less severe are more vaccine hesitant.

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem et al. (2021) examined the relationship between perceived seriousness of COVID-19, measured as an ordinal variable, and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem et al. (2021) found that when holding constant age, sex, education level, marital status, having children, perceived COVID-19 risk, perceived susceptibility and COVID-19 knowledge, perceived seriousness of COVID-19 was negatively associated with vaccine resistance (no) [OR = 0.75, $p > 0.01$] and vaccine hesitance (not sure) [OR = 0.88, $p < 0.01$] whereby as perceived seriousness of COVID-19 increases, resistance and hesitance decreases, such that respondents who perceive COVID-19 to be less serious are more hesitant.

Perceived vulnerability is not associated with vaccine hesitancy

Table 61: Studies evidencing that perceived vulnerability is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Tsai et al. (2021)	Taiwan	Asia	Confucian Asia	High Income
3	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between perceived COVID-19 symptom severity, measured on a scale of 1 (asymptomatic/no symptoms) to 5 (deadly symptoms), and vaccine hesitancy, measured as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that, when holding constant age, gender, area lived, education, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19 and perceived COVID-19 risk, there was no association between perceived COVID-19 symptom severity and vaccine hesitancy in the key worker and non-key worker samples [$p > 0.05$].

Taiwan, Tsai et al. (2021): In a convenience sample of 1,020 Taiwan residents, Tsai et al. (2021) examined the relationship between worry about contracting COVID-19, measured as a binary variable (not worried vs. worried), and vaccine hesitance, measured as a binary variable (unwilling vs. willing) at a rate of 47.3%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Tsai et al. (2021) found that worry about contracting COVID-19 was not associated with vaccine hesitancy [$p = 0.57$].

Using multiple logistic regression, Tsai et al. (2021) found that when holding constant age, sex, education, occupational status, experience of vaccine refusal, severity of the pandemic in Taiwan, health and political orientation, worry about contracting COVID-19 was not associated with vaccine hesitancy [$p = 0.11$].

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between perceived severity of COVID-19, measured via three items (perception that complications from COVID-19 are serious, perception of being very sick if getting COVID-19, fear of getting COVID-19) on a scale of 1 (strongly disagree) to 4 (strongly agree), and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design and logistic regression.

Alobaidi (2021) found that, when holding constant gender, nationality, education, working in health care, monthly income, perceived susceptibility, perceived benefits of vaccine and cues to action, perception that complications from COVID-19 are serious [$p = 0.167$], perception of being very sick if getting COVID-19 [$p = 0.907$] and fear of getting COVID-19 [$p = 0.352$] are not associated with vaccine intention.

Conclusions

Table 62: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As perceived vulnerability increases, vaccine hesitancy decreases [n, %]	As perceived vulnerability increases, vaccine hesitancy increases [n, %]		
Studies	11 [79%]		3 [21%]	14
Studies	11 [79%]	0	3 [21%]	14
Region				
Europe	3 [75%]	0	1 [25%]	4
North America	4 [100%]	0	0	4
Asia	4 [67%]	0	2 [33%]	6
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	4 [80%]	0	1 [20%]	5
Germanic Europe	0	0	0	0
Nordic Europe	1 [100%]	0	0	1
Eastern Europe	0	0	0	0
Latin Europe	2 [100%]	0	0	2
Latin America	0	0	0	0
Southern Asia	2 [100%]	0	0	2
Confucian Asia	0	0	1 [100%]	1
Sub-Saharan Africa	0	0	0	0
Middle East	2 [67%]	0	1 [33%]	3
Income				
High Income	8 [73%]	0	3 [27%]	11

Upper Middle Income	2 [100%]	0	0	2
Lower Middle Income	1 [100%]	0	0	1
Low Income	0	0	0	0

Overall: Of the studies that considered the association between perceived vulnerability and vaccine hesitancy, 79% [11 out of 14] found perceived vulnerability to be predictive, such that it can be concluded with high confidence that perceived vulnerability is predictive of vaccine hesitancy. Of the 11 studies that found perceived vulnerability to be predictive of vaccine hesitancy, 100% [11 out of 11] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant), such that it can be concluded with high confidence that, when perceived vulnerability is predictive of vaccine hesitancy, the association is negative. Out of all studies, 79% [11 out of 14] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant), such that it can be concluded with high confidence that, overall, as perceived vulnerability increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and economies of the countries in the studies, some associations between perceived vulnerability and vaccine hesitancy are evident.

Region: Of studies conducted in North American countries, 100% [4 out of 4] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant). Of studies conducted in European countries, 75% [3 out of 4] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant). As such, that it can be concluded with high confidence that in North American and European countries, as perceived vulnerability increases, vaccine hesitancy decreases.

Of studies conducted in Asian countries, 67% [4 out of 6] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant), such that it can be confidently concluded that in Asian countries, as perceived vulnerability increases, vaccine hesitancy decreases.

There is no evidence to draw conclusions about the relationship between perceived vulnerability and vaccine

hesitancy in the contexts of Oceania [0 studies], South America [0 studies] and Africa [0 studies].

Cultural group: Of studies conducted in countries in the Anglo cultural group, 80% [4 out of 5] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant), such that it can be concluded with high confidence that in countries of the Anglo cultural group, as perceived vulnerability increases, vaccine hesitancy decreases.

There is insufficient evidence to make conclusions about the relationship between perceived vulnerability and vaccine hesitancy in the contexts of the Middle East [3 studies], Latin Europe [2 studies], Southern Asia [2 studies], Nordic Europe [1 study] and Confucian Asia [1 study] cultural groups.

There is no evidence to draw conclusions about the relationship between perceived vulnerability and vaccine hesitancy in the contexts of the Germanic Europe [0 studies], Eastern Europe [0 studies], Latin America [0 studies] and Sub-Saharan Africa [0 studies] cultural groups.

Income: Of studies conducted in high income countries, 73% [8 out of 11] found that as perceived vulnerability increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less vulnerable to COVID-19 are more hesitant), such that it can be concluded with high confidence that in high income countries, as perceived vulnerability increases, vaccine hesitancy decreases.

There is insufficient evidence to draw any conclusions about the relationship between perceived vulnerability and vaccine hesitancy in the contexts of upper middle income countries [2 studies] and lower middle income countries [1 study].

There is no evidence to draw conclusions about the relationship between perceived vulnerability and vaccine hesitancy in low income countries [0 studies].

**REFLECTIVE MOTIVATION
PERCEIVED SUSCEPTIBILITY
TO COVID-19**

6.3.4

Perceived susceptibility to COVID-19 is the perceived chance of being infected with COVID-19, but does not confer the perceived risk of being harmed by COVID-19 if infected, which is considered in sub-section 6.6 as perceived vulnerability. Perceived susceptibility was primarily measured as an ordinal variable from low to high.

In total, 14 studies considered the association between perceived susceptibility and vaccine hesitancy. Of these, seven found that perceived susceptibility was predictive of vaccine hesitancy, six found that perceived susceptibility was not predictive of vaccine hesitancy and one had mixed findings in different contexts. Of the seven studies that found perceived susceptibility was predictive of vaccine hesitancy, all found that as perceived susceptibility increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less susceptible to COVID-19 are more hesitant) and zero found that as perceived susceptibility increases, vaccine hesitancy increases.

As perceived susceptibility increases, vaccine hesitancy decreases

Table 63: Studies evidencing that as perceived susceptibility increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Salali and Uysal. (2021)	United Kingdom	Europe	Anglo	High Income
2	Coe et al. (2021)	United States	North America	Anglo	High Income
3	Shih et al. (2021)	United States	North America	Anglo	High Income
4	Caserotti et al. (2021)	Italy	Europe	Latin Europe	High Income
5	Goruntla et al. (2021)	India	Asia	Southern Asia	Lower Middle Income
6	Tao et al. (2021)	China	Asia	Confucian Asia	High Income
7	Wong et al. (2021)	Malaysia	Asia	Southern Asia	Upper Middle Income
8	Alobaidi (2021)	Saudi Arabia	Asia	Middle East	High Income

United Kingdom, Salali and Uysal (2021): In convenience samples of 1,088 United Kingdom residents, Salali and Uysal (2021) examined the relationship between perceived risk of catching COVID-19, measured on a scale of 0 (no chance of catching it) and 100 (will definitely catch it), and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

Salali and Uysal (2021) found that, when holding constant education, beliefs about origin of the virus, sex, financial satisfaction, having children and COVID-19-related anxiety, perceived risk of catching COVID-19 was positively associated with vaccine acceptance [OR = 1.07, $p < 0.01$] whereby as perceived risk of catching COVID-19 increases, so does vaccine acceptance such that respondents who perceive a lower risk of catching COVID-19 are more vaccine hesitant.

United States, Coe et al. (2021): In a nationally representative (quota) sample of 1,047 United States residents, Coe et al. (2021) examined the relationship between perceived susceptibility, measured on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured as a binary variable, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Coe et al. (2021) found that perceived susceptibility was positively associated with vaccine intention [COR = 1.67, 95% CI 1.45-1.93] whereby as perceived susceptibility increases, so does vaccine intention, such that respondents who perceive themselves to be less susceptible to COVID-19 are more vaccine hesitant.

Using multiple logistic regression, Coe et al. (2021) found that, when holding constant age, gender, race, region, ethnicity, education, annual household income, having a child, vaccine information sources, past influenza vaccine, influenza vaccine last year, perceived severity of COVID-19, perceived clinical barriers to vaccination, perceived access barriers to vaccination, perceived COVID-19 specific vaccine benefit, perceived general vaccine benefits, perceived susceptibility was not associated with vaccine intention [AOR = 1.01, 95% CI 0.81-1.27], suggesting that other factors better accounted for the variance in vaccine intention.

United States, Shih et al. (2021): In a nationally representative (quota) sample of 713 United States residents, Shih et al. (2021) examined the relationship between perceived risk of being infected, measured on a scale of 0% to 100%, and vaccine hesitancy, measured as a categorical variable (acceptance, hesitance, resistance), using a conjoint experimental survey design and logistic regression.

Shih et al. (2021) found that, when holding constant gender, generation race/ethnicity, monthly family income, political affiliation, general vaccine hesitancy, perceived vaccine safety and perceived vaccine effectiveness, perceived risk of infection was negatively associated with being vaccine resistant [OR = 0.97, 95% CI 0.95-0.98] whereby as perceived risk of being infected increases, likelihood of being vaccine resistant decreases, such that respondents with lower perceived risk of being infected were more hesitant.

Italy, Caserotti et al. (2021): In a convenience sample of 2,267 Italy residents, Caserotti et al. (2021) examined the relationship between perceived risk of COVID-19, measured by combining three items (perceived likelihood of being infected, perceived severity of COVID-19, fear of COVID-19) on a scale of 1 (not at all likely, not at all severe, not at all scared) to 100 (extremely likely, extremely severe, extremely scared) and recoded into tertiles (low, medium, high), and (i) vaccine acceptance, measured on a scale from 0 (not at all likely) to 100 (very likely), using a logistic regression model (from which ORs were presented) and (ii) vaccine hesitancy, measured as a binary variable (no hesitancy vs. hesitancy > 0), using a negative binomial (from which IRRs were presented).

In modelling vaccine acceptance, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, age, gender, deprivation and area in Italy, respondents with medium perceived risk of COVID-19 [OR = 2.46, $p < 0.001$] and respondents with high perceived risk of COVID-19 [OR = 3.53, $p < 0.001$] were more likely to accept the vaccine than respondents with low perceived risk of COVID-19.

In modelling vaccine hesitancy, Caserotti et al. (2021) found that, when holding constant presence of a lockdown, perceived risk from COVID-19, perceived risk from flu, perceived risk from external ventricular drain, having had the flu vaccine in 2019, vaccine doubts, willingness to pay for the COVID-19 vaccine, age, gender, deprivation and area in Italy, respondents with medium perceived risk of COVID-19 [IRR = 0.72, $p < 0.001$] and respondents with high perceived risk of COVID-19 [IRR = 0.66, $p < 0.001$] were less likely to be vaccine hesitant than respondents with low perceived risk of COVID-19.

Overall, Caserotti et al. (2021) found a positive association between perceived risk from COVID-19 and vaccine acceptance whereby as perceived risk increases, vaccine

acceptance increases, such that respondents who perceive greater risk are more accepting of the vaccine and a positive association between perceived risk from COVID-19 and vaccine hesitancy whereby as perceived risk increases, vaccine hesitancy decreases, such that respondents who perceive greater risk are less vaccine hesitant.

India, Goruntla et al. (2021): In a convenience sample of 2,451 of India residents, Goruntla et al. (2021) examined the relationship between perceived susceptibility to get COVID-19, measured via three items (worry about getting COVID-19, risk of getting COVID-19, working or communicating with many people each day increases chances of getting COVID-19) as binary variables (agree vs. disagree), and vaccine acceptance, measured as a binary variable at a hesitancy rate of 10.73%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Goruntla et al. (2021) found that vaccine acceptance differed by perceived susceptibility agreement group [$p < 0.001$]. Respondents who agreed that they worry a lot about getting COVID-19 were more likely to intend to get the vaccine [91.44%] than those who disagreed that they worry a lot about getting COVID-19 [86.74%]. Respondents who agreed that they were at risk of getting COVID-19 were more likely to intend to get the vaccine [91.81%] than those who disagreed that they were at risk of getting COVID-19 [87.37%]. Respondents who agreed that working or communicating with many people each day increases their chances of getting COVID-19 were more likely to intend to get the vaccine [90.69%] than those who disagreed that working or communicating with many people each day increases their chances of getting COVID-19 [81.96%].

Using logistic regression, Goruntla et al. (2021) found that when holding constant perceived severity of COVID-19 infection, perceived benefits of COVID-19 vaccination, perceived barriers to accept vaccine and cues to action, respondents who agreed that they worry a lot about getting COVID-19 were more likely to intend to get the vaccine [OR = 1.63, $p < 0.001$] than those who disagreed that they worry a lot about getting COVID-19, respondents who agreed that they were at risk of getting COVID-19 were more likely to intend to get the vaccine [OR = 1.62, $p < 0.001$] than those who disagreed that they were at risk of getting COVID-19 and respondents who agreed that working or communicating with many people each day increases their chances of getting COVID-19 were more likely to intend to get the vaccine [OR = 2.14, $p < 0.001$] than those who disagreed that working or communicating with many people each day increases their chances of getting COVID-19.

Overall, there is a positive association between perceived susceptibility and vaccine intention whereby

as sense of perceived susceptibility increases, so does vaccine intention, such that respondents who perceive themselves to be less susceptible to COVID-19 are more vaccine hesitant.

China (Pregnant Women), Tao et al. (2021): In a multi-stage part-random and part-convenience sample of 1,392 pregnant China residents, Tao et al. (2021) examined the relationship between perceived susceptibility, measured on a scale of 1 (low) to 3 (high), and vaccine acceptance, measured as a categorical variable (no or little hesitancy, undecided, intermediate or high hesitancy) at a hesitancy (intermediate or severe) rate of 41.1%, using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Tao et al. (2021) found that vaccine acceptance was highest in respondents concerned about getting COVID-19 [79%] compared with those not concerned [63.5%, $p < 0.01$] and that vaccine acceptance was highest in respondents concerned about their unborn baby getting COVID-19 [78.9%] compared with those not concerned [61.2%, $p < 0.01$].

Using logistic regression, Tao et al. (2021) found that, when holding constant region, education, occupation, income, gravidity, parity, gestational trimester, history of adverse pregnancy outcomes, history of chronic disease, history of influence vaccination, gestational complications, COVID-19 knowledge, perceived susceptibility, perceived severity, barriers to receiving the vaccine, perceived benefits of the vaccine and cues to action, respondents who perceived a high level of susceptibility were more likely to accept the vaccine than respondents who perceived a low level of susceptibility [AOR = 2.18, $p = 0.01$].

Overall, there is a positive association between perceived susceptibility and vaccine acceptance whereby as sense of perceived susceptibility increases, so does vaccine acceptance, such that respondents who perceive themselves to be less susceptible to COVID-19 are more vaccine hesitant.

Malaysia, Wong et al. (2021): In a random sample of 1,159 Malaysia residents, Wong et al. (2021) examined the relationship between perceived susceptibility (chances of getting COVID-19, worry about likelihood of getting COVID-19, possibility of getting COVID-19), measured as binary variables (agree vs. disagree), and vaccine intention, measured on a scale of 1 (definitely not) to 5 (yes, definitely) but recoded as a binary variable (yes, definitely vs. yes, probably/yes, possibly/probably not/definitely not), using a cross-sectional survey design, Chi-square and logistic regression.

Using Chi-square, Wong et al. (2021) found that respondents who agreed that they had a greater chance

of catching COVID-19 were more likely [53%, $p < 0.001$] to definitely accept the vaccine than respondents who disagreed [41.3%].

Respondents who agreed that they were worried about the likelihood of getting COVID-19 were more likely [50.7%, $p < 0.001$] to definitely accept the vaccine than respondents who disagreed [33.7%].

Respondents who agreed that getting COVID-19 was a possibility for them were more likely [53.7%, $p < 0.001$] to definitely accept the vaccine than respondents who disagreed [41.2%].

Using logistic regression, Wong et al. (2021) found that, when holding constant age, gender, ethnicity, highest education level, occupation category, average monthly household income, location, diagnosed with chronic diseases, perceived overall health, known others infected by COVID-19, perceived severity, perceived benefits and perceived barriers, perceived chance of getting COVID-19 and worry about the likelihood of getting COVID-19 were not associated [$p > 0.05$] with vaccine intention, but perceived possibility of getting COVID-19 was positively associated with vaccine intention [OR = 1.36, $p < 0.05$] whereby respondents who agreed that there was a possibility of them getting COVID-19 were more likely to accept the vaccine.

Overall, this study evidences a positive association between perceived susceptibility and vaccine intention whereby a greater sense of susceptibility is associated with greater vaccine intent such that those who perceive themselves to be less susceptible are more vaccine hesitant. However, that two of the perceived susceptibility

items are not associated with vaccine intention in the multiple logistic regression suggests that other factors better account for the variance in vaccine intention than perceived susceptibility.

Saudi Arabia, Alobaidi (2021): In a convenience sample of 1,333 Saudi Arabia residents, Alobaidi (2021) examined the relationship between perceived susceptibility of catching COVID-19, measured via three items (chances of getting COVID-19, worried about likelihood of getting COVID-19, possibility of getting COVID-19) on a scale of 1 (strongly disagree) to 4 (strongly agree), and vaccine intention, measured on a scale from 1 (definitely no) to 4 (definitely yes) and transformed to a binary variable of 1 (intends to get vaccinated) and 0 (does not intend to get vaccinated) at a hesitancy rate of 18.1%, using a cross-sectional survey design and logistic regression.

Alobaidi (2021) found that, when holding constant gender, nationality, education, working in health care, monthly income, perceived severity, perceived benefits of vaccine and cues to action, chances and possibility of getting COVID-19 were not associated with vaccine intention [$p > 0.05$], but being worried about the likelihood of getting COVID-19 was positively associated with vaccine intention [OR = 3.82, $p = 0.002$] whereby as worry about the likelihood of getting COVID-19 increases, so does vaccine intention, such that respondents less worried about the likelihood of getting COVID-19 are more vaccine hesitant.

Although Alobaidi (2021) defined all three items as perceived susceptibility of contracting COVID-19, being worried about getting COVID-19 is arguably more a measure of perceived vulnerability than susceptibility.

Perceived susceptibility is not associated with vaccine hesitancy

Table 64: Studies evidencing that perceived susceptibility is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Butter et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Agley et al. (2021)	United States	North America	Anglo	High Income
3	Chu and Liu (2021)	United States	North America	Anglo	High Income
4	Hammer et al. (2021)	Finland	Europe	Nordic Europe	High Income
5	Kuçukkarapinar et al. (2021)	Turkey	Asia	Middle East	Upper Middle Income

6	Salali and Uysal (2021)	Turkey	Asia	Middle East	Upper Middle Income
7	Al-Qerem and Jarab (2021)	Jordan	Asiaa	Middle East	High Income

United Kingdom, Butter et al. (2021): In a convenience sample of 1,605 UK key workers (n = 584) and non-key workers (n = 1,021), Butter et al. (2021) examined the relationship between perceived risk of getting COVID-19, measured on a scale from 0% to 100% and recoded into quartiles, and vaccine hesitancy, measured as a binary variable (yes to accepting the vaccine vs. no and don't know to accepting the vaccine), using a cross-sectional survey design and logistic regression.

Butter et al. (2021) found that there was no statistically significant association between age and vaccine hesitancy in the key worker sample, but age was associated with vaccine hesitancy in the non-key worker sample. When holding constant age, gender, area lived, education, income, having children, country lived in, having a physical health condition, having a mental health condition, exposure to COVID-19 social media, exposure to COVID-19 traditional media, knowing someone diagnosed with COVID-19 and perceived symptom severity, key workers who perceived their risk of getting COVID-19 in the bottom quartile (0-25%) were more likely to be vaccine hesitant than key workers who perceived their risk of getting COVID-19 in the top quartile (75-100%) [OR = 2.44, p < 0.05]. There was no difference in likelihood of vaccine hesitance between respondents in the other quartiles of perceived risk of getting COVID-19 [p > 0.05], and perceived risk of getting COVID-19 was not associated with vaccine hesitancy for non key-workers.

Overall, there is insufficient evidence that perceived susceptibility is associated with vaccine intention, whereby a greater sense of susceptibility is only associated with lower vaccine hesitancy for key workers, but there is no association between perceived susceptibility and vaccine hesitancy in the general population.

United States, Agle et al. (2021): In a nationally representative sample of 1,017 United States residents, Agle et al. (2021) examined the relationship between confidence in avoiding COVID-19, measured on a scale of 1 (not at all confident) to 5 (very confident), and vaccine intention, measured on a scale of 1 (unlikely) to 7 (likely) at a hesitancy rate of 25.1%, using a cross-sectional survey design and linear regression.

Agle et al. (2021) found that, when holding constant age, COVID-19 diagnosis, gender, race, being Hispanic or Latin, trust in science, religious commitment, political orientation, perceived seriousness of contracting COVID-19 and friends' or family's avoidance of crowded areas, confidence in

avoiding COVID-19 was not associated with vaccine intention [p = 0.39].

United States, Chu and Liu (2021): In a convenience sample of 934 United States residents, Chu and Liu (2021) examined the relationship between perceived susceptibility to COVID-19, measured via three items on a scale of 1 (strongly disagree) to 5 (strongly agree), and vaccine intention, measured on a scale of 1 (very unlikely) to 5 (very likely), using a cross-sectional survey design and ordinal regression.

Chu and Liu (2021) found that, when holding constant age, gender, ethnicity, education, income, general vaccine hesitancy, norms, cues to action, perceived severity, fear, perceived benefits, perceived barriers and self-efficacy, perceived susceptibility was not associated with vaccine intention [p > 0.05].

Finland, Hammer et al. (2021): In a nationally representative (quota) sample of 4,141 Finland residents, Hammer et al. (2021) examined the relationship between susceptibility of COVID-19 infection and probability of COVID-19 infection, both measured as on a scale of 1 (strongly disagree) to 7 (strongly agree), and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 7 (strongly agree), using a cross-sectional survey design and stratified linear regression.

Hammer et al. (2021) found that, when holding constant perceived COVID-19 vaccine safety, general vaccine attitude, perceived COVID-19 vaccine efficacy, infection situation in Finland, importance of COVID-19 vaccine efficacy in protecting oneself, importance of vaccine efficacy in protecting others, importance of possible side effects, importance of a recommendation from a healthcare professional, importance of a recommendation from health authorities, importance of conversations with family and friends, importance of how easy it is to get vaccinated, own assessment of severity if infected, perceived transparency with public, perceived politician honesty, belief in COVID-19 conspiracy theory, belief in other conspiracy theories, education, gender and age, own assessment of susceptibility of infection [p = 0.646, p = 0.688] and own assessment of probability of infection [p = 0.566, p = 0.601] were not associated with vaccine acceptance for respondents younger than 50 years old and respondents 50 years old and above.

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al.

(2021) examined the relationship between perceived possibility of getting COVID-19 and perceived susceptibility to COVID-19, measured on a scale of 1 (extremely unlikely/not at all susceptible) to 7 (extremely likely/very susceptible), and vaccine intention, measured on a scale of 1 to 7 and recoded as a categorical variable (vaccine refusal, vaccine hesitancy, vaccine acceptance) at a hesitancy rate of 58.9% (refusal and hesitancy categories combined), using a cross-sectional survey design, ANOVA and linear regression.

Using ANOVA and Tukey tests, Kuçukkarapinar et al. (2021) found that perceived possibility of getting infected was highest in respondents who accepted the vaccine [Mean = 4.74], followed by respondents who were vaccine hesitant [Mean = 4.52] and lowest in respondents who were vaccine resistant [Mean = 4.33] and that differences were significant [p < 0.001].

Perceived susceptibility to COVID-19 was highest in respondents who accepted the vaccine [Mean = 4.71], followed by respondents who were vaccine hesitant [Mean = 4.65] and lowest in respondents who were vaccine resistant [Mean = 4.38] and that differences were significant [p < 0.001].

Using linear regression, Kuçukkarapinar et al. (2021) found that when holding constant age, gender, education level, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, perceived severity of COVID-19, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust and preventative measures, perceived possibility of getting COVID-19 [p = 0.056] and perceived susceptibility to COVID-19 [p = 0.471] were not associated with vaccine intention.

Overall, when considering that the mean differences were small relative to a scale of 1-7 in the ANOVA analysis, this study does not provide sufficient evidence of an association between vaccine intention and perceived possibility of getting COVID-19 or perceived susceptibility to COVID-19.

Turkey, Salali and Uysal (2021): In convenience samples of 3,936 Turkey residents, Salali and Uysal (2021) examined the relationship between perceived risk of catching COVID-19, measured on a scale of 0 (no chance of catching it) and 100 (will definitely catch it), and vaccine acceptance, measured as a binary variable, using a cross-sectional survey design and logistic regression.

Salali and Uysal (2021) found that, when holding constant education, beliefs about origin of the virus, sex, financial satisfaction, having children and COVID-19-related anxiety, there was no association between perceived risk of catching COVID-19 and vaccine acceptance [p = 0.06].

Jordan, Al-Qerem and Jarab (2021): In a convenience sample of 1,144 Jordan residents, Al-Qerem and Jarab (2021) examined the relationship between perceived susceptibility, measured as a categorical variable, and vaccine hesitancy, measured as a categorical variable (no, not sure, yes) at a hesitancy rate of 63.2% (no = 36.8%, not sure = 26.4%), using a cross-sectional survey design and logistic regression.

Al-Qerem and Jarab (2021) found that when holding constant age, sex, education level, marital status, having children, perceived COVID-19 risk, perceived seriousness of COVID-19 and COVID-19 knowledge, perceived susceptibility was not associated with vaccine hesitancy [p > 0.05].

Conclusions

Table 65: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As perceived susceptibility increases, vaccine hesitancy decreases [n, %]	As perceived susceptibility increases, vaccine hesitancy increases [n, %]		
Studies	7 [54%]		6 [46%]	13
Studies	7 [54%]	0	6 [46%]	13
Region				
Europe	2 [50%]	0	2 [50%]	4

North America	2 [50%]	0	2 [50%]	4
Asia	4 [57%]	0	3 [43%]	7
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	3 [50%]	0	3 [50%]	6
Germanic Europe	0	0	0	0
Nordic Europe	0	0	1 [100%]	1
Eastern Europe	0	0	0	0
Latin Europe	1 [100%]	0	0	1
Latin America	0	0	0	0
Southern Asia	2 [100%]	0	0	2
Confucian Asia	1 [100%]	0	0	1
Sub-Saharan Africa	0	0	0	0
Middle East	1 [25%]	0	3 [75%]	4
Income				
High Income	6 [55%]	0	5 [45%]	11
Upper Middle Income	1 [33%]	0	2 [67%]	3
Lower Middle Income	1 [100%]	0	0	1
Low Income	0	0	0	0

Overall: Of the studies that considered the association between perceived susceptibility and vaccine hesitancy, 54% [7 out of 13] found perceived susceptibility to be predictive, such that it can be concluded with some confidence that perceived susceptibility is predictive of vaccine hesitancy. Of the seven studies that found perceived susceptibility to be predictive of vaccine hesitancy, 100% [7 out of 7] found that as perceived susceptibility increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less susceptible to COVID-19 are more hesitant), such that it can be concluded with high confidence that, when perceived susceptibility is predictive of vaccine hesitancy, the association is negative. Out of all studies, 54% [7 out of 13] found that as perceived susceptibility increases, vaccine hesitancy decreases (i.e.,

those who perceive themselves to be less susceptible to COVID-19 are more hesitant), such that it can be concluded with some confidence that, overall, as perceived susceptibility increases, vaccine hesitancy decreases.

NB: Salali and Uysal (2021) was not included in the above analysis as it contained two countries for which there were mixed findings in terms of the association between perceived susceptibility and vaccine hesitancy.

In looking for patterns by region, cultural group and economies of the countries in the studies, some associations between perceived susceptibility and vaccine hesitancy are evident.

Region: Of studies conducted in Asian countries, 57% [4 out of 7] found that as perceived susceptibility increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less susceptible to COVID-19 are more hesitant), such that it can be concluded with some confidence that in Asian countries, as perceived susceptibility increases, vaccine hesitancy decreases.

There is inconclusive evidence about the association between perceived susceptibility and vaccine hesitancy in European and North American contexts: In Europe and North America 50% of studies [2 out of 4] found that as perceived susceptibility increases, vaccine hesitancy decreases, but 50% [2 out of 4] also found that perceived susceptibility was not associated with vaccine hesitancy.

There is no evidence to draw conclusions about the relationship between perceived susceptibility and vaccine hesitancy in the contexts of Oceania [0 studies], South America [0 studies] and Africa [0 studies].

Cultural group: Of studies conducted in countries in the Middle East cultural group, 75% [3 out of 4] found that perceived susceptibility was not associated with vaccine hesitancy, such that it can be concluded with high confidence that in Middle East cultural group countries, perceived susceptibility is not associated with vaccine hesitancy.

There is inconclusive evidence about the association between perceived susceptibility and vaccine hesitancy in the context of countries in the Anglo cultural group: 50% of studies [3 out of 6] found that as perceived susceptibility increases, vaccine hesitancy decreases, but 50% [3 out of 6] also found that perceived susceptibility was not associated with vaccine hesitancy.

There is insufficient evidence to draw any conclusions about the relationship between perceived susceptibility and vaccine hesitancy in the contexts of the Southern Asia [2 studies], Nordic Europe [1 study], Latin Europe [1 study] and Confucian Asia [1 study] cultural groups.

There is no evidence to draw conclusions about the relationship between perceived susceptibility and vaccine hesitancy in the contexts of the Germanic Europe [0 studies], Eastern Europe [0 studies], Latin America [0 studies] and Sub-Saharan Africa [0 studies] cultural groups.

Income: Of studies conducted in high income countries, 55% [6 out of 11] found that as perceived susceptibility increases, vaccine hesitancy decreases (i.e., those who perceive themselves to be less susceptible to COVID-19 are more hesitant), such that it can be concluded with some confidence that in high income countries, as perceived susceptibility increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between perceived susceptibility and vaccine hesitancy in the contexts of upper middle income countries [3 studies] and lower middle income countries [1 study].

There is no evidence to draw conclusions about the relationship between perceived susceptibility and vaccine hesitancy in low income countries [0 studies].

REFLECTIVE MOTIVATION
TRUST IN HEALTHCARE
PROFESSIONALS

6.3.5

Trust in healthcare professionals is the belief in the reliability and integrity of healthcare or medical professionals, providers, practitioners or organizations. It is most frequently measured as an ordinal variable (i.e., on a scale), but also as a categorical variable in terms of level of trust.

In total, six studies considered the relationship between trust in healthcare professionals and vaccine hesitancy. Of these, all six found that trust in healthcare professionals was predictive of vaccine hesitancy. Of the six studies that found that trust in healthcare professionals was predictive of vaccine hesitancy, all six found that as trust in healthcare professionals increases, vaccine hesitancy decreases (i.e., those who have less trust in healthcare professionals are more hesitant).

As trust in healthcare professionals increases, vaccine hesitancy decreases

Table 66: Studies evidencing that as trust in healthcare professionals increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income
3	Murphy et al. (2021)	United Kingdom	Europe	Anglo	High Income
		Ireland	Europe	Anglo	High Income
4	Benis et al. (2021)	United States	North America	Anglo	High Income
5	Cordina et al. (2021)	Malta	Europe	Latin Europe	High Income
6	Rozek et al. (2021)	Multiple countries aggregated			

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between trust in medical professionals, measured on a scale from 1 (not at all) to 4 (a great deal) plus an option for don't know, and vaccine hesitancy, measured from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that trust in medical professionals was negatively associated with vaccine hesitancy [$r_s = -0.34$]. Of the 21 factors studied, trust in medical professionals was the fourth most predictive after vaccine attitude, conspiracy suspicions and trust of scientists working in universities.

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant trust in the government, trust in scientists working in universities and trust in the scientific community, trust in medical professionals was negatively associated with vaccine hesitancy [$r_s = -0.18$, $p < 0.001$]. When also holding constant age, gender, ethnicity, education and household income, trust in medical professionals was still negatively associated with vaccine hesitancy [$r_s = -0.14$, $p < 0.001$]. When also holding constant legacy media use, social media use, personal risk perception, UK risk perception and world risk perception, trust in medical professionals was still negatively associated with vaccine hesitancy [$r_s = -0.03$, $p < 0.001$].

Across all data, trust in medical professionals was negatively associated with vaccine hesitancy whereby as trust in medical professionals increases, vaccine hesitancy decreases such that respondents with low trust in medical professionals are most hesitant.

United Kingdom, Jennings et al. (2021): In a nationally representative (quota) sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between trust in health organizations, and vaccine acceptance, measured as a binary variable at a hesitancy rate of 29%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that, when holding constant social trust, government trust, government mistrust, government distrust, media trust, experts. trust, government handling of COVID-19, perceived personal threat of COVID-19, lockdown scepticism, conspiracy beliefs, vaccine distrust, COVID-19 misinformed, had COVID-19, gender, age, education, support for Conservative Party, information sources, social media use, having

fact-checked an article online and having posted political content online, trust in health organizations was positively associated with vaccine acceptance [OR = 6.218, $p < 0.001$], whereby as trust in health organizations increased, vaccine acceptance increased such that respondents with lower trust in health organizations are more hesitant.

Trust in health organizations was the third strongest predictor of vaccine acceptance out of 30 factors.

Ireland and the United Kingdom, Murphy et al. (2021): In nationally representative (quota) samples of 1,041 Ireland residents and 2025 UK residents, Murphy et al. (2021) examined the relationship between trust in healthcare professionals, measured on a scale of 1 to 5, and vaccine hesitancy, measured as a binary variable with rates of 35% and 31% respectively, using a cross-sectional survey design and ANOVA.

In the Irish sample, Murphy et al. (2020) found that trust in healthcare professionals differed by vaccine intention [$p < 0.001$]. Trust in healthcare professionals was highest in respondents who were vaccine accepting [Mean = 3.95], followed by respondents who were vaccine hesitant [Mean = 3.57] and lowest in respondents who were vaccine resistant [Mean = 3.36].

In the UK sample, Murphy et al. (2020) found that trust in healthcare professionals differed by vaccine intention [$p < 0.001$]. Trust in healthcare professionals was highest in respondents who were vaccine accepting [Mean = 4.01], followed by respondents who were vaccine hesitant [Mean = 3.71] and lowest in respondents who were vaccine resistant [Mean = 3.32].

Overall, there is a positive association between trust in healthcare professionals and vaccine intention whereby as trust in healthcare professionals increases, vaccine intention increases such that respondents with lower trust in healthcare professionals are more hesitant.

United States, Benis et al. (2021): In a convenience sample of 1,644 United States residents, Benis et al. (2021) examined the relationship between confidence in healthcare providers, measured as a categorical variable (agree, neutral/no opinion, disagree), and vaccine acceptance, measured as a binary variable at a hesitancy rate of 18.5%, using a cross-sectional survey design and simple and multiple logistic regression.

Using simple logistic regression, Benis et al. (2021) found that respondents who were neutral or had no opinion [OR = 4.99, 95% CI 3.4-7.29] and who disagreed [OR = 22.01, 95% CI 14.82-33.09] that they had confidence in healthcare

providers were more likely to be vaccine hesitant than respondents who agreed that they had confidence in healthcare providers.

Using multiple logistic regression, Benis et al. (2021) found that, when holding constant age, gender, having children, fear of the COVID-19 disease, desire to protect family and relatives, confidence in pharmaceutical industry and civic responsibility to take vaccine, respondents who disagreed that they had confidence in healthcare providers were more likely to be vaccine hesitant than respondents who agreed that they had confidence in healthcare providers [OR = 2.81, 95% CI 1.5-5.29]. Respondents who were neutral or had no opinion that they had confidence in healthcare providers were not more or less likely to be vaccine hesitant than respondents who agreed that they had confidence in healthcare providers [95% CI 0.6-2.03].

When also holding constant marital status, education, ethnicity, residence, vulnerability, COVID-19 diagnosis, belief in vaccines as revolutionary and innovative, employer recommending or demanding vaccination, confidence in government guidance, being sick from COVID-19 and opinion on whether vaccines should be free of charge, respondents who disagreed that they had confidence in healthcare providers were more likely to be vaccine hesitant than respondents who agreed that they had confidence in healthcare providers [OR = 2.83, 95% CI 1.45-5.52]. Respondents who were neutral or had no opinion that they had confidence in healthcare providers were not more or less likely to be vaccine hesitant than respondents who agreed that they had confidence in healthcare providers [95% CI 0.56-2.05].

Overall, respondents without confidence in healthcare providers were more hesitant than respondents with confidence in healthcare providers.

Malta, Cordina et al. (2021): In a convenience sample of 2,529 Malta residents, Cordina et al. (2021) examined the relationship between value of healthcare professionals' advice regarding effectiveness of the vaccine, measured on a scale of 1 (not at all) to 10 (very much), and vaccine acceptance, measured on a scale of 1 (definitely no) to 10 (definitely yes), using a cross-sectional survey design and linear regression.

Cordina et al. (2021) found that, when holding constant COVID-19 knowledge, accessing COVID-19 news and information, engaging in preventative behaviour, vaccine efficacy, importance of family and friends. opinion of the vaccine, health worker status, chronic health condition status, gender, education, flu jab status, opinion on giving the vaccine to children and opinion on encouraging elderly patients to take the vaccine, value of healthcare professionals' advice regarding effectiveness of the vaccine was positively associated with vaccine acceptance [B = 0.236737, p < 0.0005] whereby as value of healthcare

professionals' advice regarding effectiveness of the vaccine increases, vaccine hesitancy increases such that those who value healthcare professionals' advice regarding effectiveness of the vaccine less are more hesitant.

Turkey, Kuçukkarapinar et al. (2021): In a convenience sample of 3,888 Turkey residents, Kuçukkarapinar et al. (2021) examined the relationship between trust in medical professional organizations, measured on a scale of 1 (very low confidence) to 7 (very high confidence), and vaccine acceptance, measured on a scale of 1 (strongly disagree) to 7 (strongly agree) at a hesitancy rate of 58.9% (1-5 on intention scale), using a cross-sectional survey design and linear regression.

Kuçukkarapinar et al. (2021) found that, when holding constant gender, education level, being a healthcare worker, having children, chronic illness, knowledge, self-efficacy, risk perception, conspiracy theories, COVID-19 worries, attitudes to COVID-19, coping, trust in Ministry of Health and trust in media and preventative measures, trust in medical professional organizations was positively associated with vaccine acceptance [B = 0.068, p = 0.000] whereby as trust in medical professional organizations increased, vaccine acceptance increased such that respondents with lower trust in medical professional are more hesitant.

Multiple Countries, Rozek et al. (2021): In nationally representative (quota) samples (except for snowball sample from Russia) of 17 countries (Canada, United States, Germany, Poland, Russia, Sweden, Ukraine, China, Hong Kong, Taiwan, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Turkey) totalling 17,608 responses, Rozek et al. (2021) examined the relationship between trust in medical practitioners, measured as a categorical variable (high, medium, low, none), and vaccine hesitancy, measured as a categorical variable (yes, no, maybe) but recoded as a binary variable (yes vs. no/maybe) and at a hesitancy rate of 44% (no and maybe combined), using a cross-sectional survey design and logistic regression.

Rozek et al. (2021) found that, when holding constant confidence in local health department, confidence in the ministry of health, confidence in the WHO, age, trust in science, trust in religious leaders, trust in political leaders and gender, level of trust in medical practitioners was negatively associated with vaccine hesitancy whereby respondents with high trust [OR = 0.25], medium trust [OR = 0.5] and low trust [OR = 0.75] were less likely to be vaccine hesitant than respondents with no trust of medical practitioners.

Overall, as trust in medical practitioners increases, the odds of vaccine hesitancy decreases such that respondents with lower trust in medical practitioners are more hesitant.

Conclusions

Table 67: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As trust in medical professionals increases, vaccine hesitancy decreases [n, %]	As trust in medical professionals increases, vaccine hesitancy increases [n, %]		
Studies	6 [100%]		0	6
Studies	6 [100%]	0	0	6
Region				
Europe	5 [100%]	0	0	5
North America	1 [100%]	0	0	1
Asia	0	0	0	0
Oceania	0	0	0	0
South America	0	0	0	0
Africa	0	0	0	0
Cultural Group				
Anglo	5 [100%]	0	0	5
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	1 [100%]	0	0	1
Latin America	0	0	0	0
Southern Asia	0	0	0	0
Confucian Asia	0	0	0	0
Sub-Saharan Africa	0	0	0	0
Middle East	0	0	0	0
Income				
High Income	6 [100%]	0	0	6

Upper Middle Income	0	0	0	0
Lower Middle Income	0	0	0	0
Low Income	0	0	0	0

Overall: Of the studies that considered the relationship between trust in medical professionals and vaccine hesitancy, 100% [6 out of 6] found trust in medical professionals to be predictive, such that it can be concluded with high confidence that trust in medical professionals is predictive of vaccine hesitancy. Out of all studies, 100% [6 out of 6] found that as trust in medical professionals increases, vaccine hesitancy decreases (i.e., those who have less trust in healthcare professionals are more hesitant), such that it can be concluded with high confidence that, as trust in healthcare professionals increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and economies of the countries in the studies, some associations between perceived vaccine safety and vaccine hesitancy are evident.

Region: Of studies conducted in European countries, 100% [5 out of 5] found that as trust in healthcare professionals increases, vaccine hesitancy decreases (i.e., those who have less trust in healthcare professionals are more hesitant). As such, that it can be concluded with high confidence that in European countries, as trust in healthcare professionals increases, vaccine hesitancy decreases.

There is insufficient evidence to draw any conclusions about the relationship between trust in healthcare professionals and vaccine hesitancy in the context of North America [1 study].

There is no evidence to draw conclusions about the relationship between trust in healthcare professionals and vaccine hesitancy in the contexts of Asia [0 studies], Oceania [0 studies], South America [0 studies] and Africa [0 studies].

Cultural group: Of studies conducted in countries in the Anglo cultural group, 100% [5 out of 5] found that as trust in healthcare professionals increases, vaccine hesitancy decreases (i.e., those who have less trust in healthcare professionals are more hesitant), such that it can be concluded with high confidence that in countries of the Anglo cultural group, as trust in healthcare professionals increases, vaccine hesitancy decreases.

There is insufficient evidence to draw conclusions about the relationship between trust in healthcare professionals and vaccine hesitancy in the context of the Latin Europe [1 study] cultural group.

There is no evidence to draw conclusions about the relationship between trust in healthcare professionals and vaccine hesitancy in the contexts of the Germanic Europe [0 studies], Nordic Europe [0 studies], Eastern Europe [0 studies], Latin America [0 studies], Southern Asia [0 studies], Confucian Asia [0 studies], Sub-Saharan Africa [0 studies] and Middle East [0 studies] cultural groups.

Income: Of studies conducted in high income countries, 100% [6 out of 6] found that as trust in healthcare professionals increases, vaccine hesitancy decreases (i.e., those who have less trust in healthcare professionals are more hesitant), such that it can be concluded with high confidence that in high income countries, as trust in healthcare professionals increases, vaccine hesitancy decreases.

There is no evidence to draw any conclusions about the relationship between trust in healthcare professionals and vaccine hesitancy in the contexts of upper middle income [0 studies], lower middle income [0 studies] and low income countries [0 studies].

REFLECTIVE MOTIVATION
TRUST IN GOVERNMENT

6.3.6

Trust in government is the belief in the reliability and integrity of the government. It is most frequently measured as an ordinal variable (i.e., on a scale), but also as a categorical variable in terms of level of trust.

In total, six studies considered the relationship between trust in government and vaccine hesitancy. Of these, five found that trust in government was predictive of vaccine hesitancy. Of the five studies that found that trust in government was predictive of vaccine hesitancy, all five found that as trust in government increases, vaccine hesitancy decreases (i.e., those who have less trust in government are more hesitant).

As trust in government increases, vaccine hesitancy decreases

Table 68: Studies evidencing that as trust in government increases, vaccine hesitancy decreases

	Study	Country	Region	Cultural Group	Income
1	Allington et al. (2021)	United Kingdom	Europe	Anglo	High Income
2	Soares et al. (2021)	Portugal	Europe	Latin Europe	High Income
3	Yu et al. (2021)	Hong Kong	Asia	Confucian Asia	High Income
4	Allagoa et al. (2021)	Nigeria	Africa	Sub-Saharan Africa	Lower Middle Income
5	Lindholt et al. (2020)	Multiple countries aggregated			

United Kingdom, Allington et al. (2021): In a nationally representative (quota) sample of 4,343 UK residents, Allington et al. (2021) examined the relationship between trust in government, measured as a great deal, a fair amount, not very much, not at all, don't know, and vaccine hesitancy, measured from 1 (definitely not) to 6 (certain), using a cross-sectional survey design, rank-order correlations and linear rank-order regression.

Using rank-order correlations, Allington et al. (2021) found that trust in government was negatively associated with vaccine hesitancy [$r_s = -0.17$].

Using linear rank-order regression models, Allington et al. (2021) found that, when holding constant trust in medical professionals, trust in scientists working in universities and trust in the scientific community, trust in the government

was negatively associated with vaccine hesitancy [$r_s = -0.05, p < 0.001$]. When also holding constant age, gender, ethnicity, education and household income, trust in the government was still negatively associated with vaccine hesitancy [$r_s = -0.05, p < 0.001$]. When also holding constant legacy media use, social media use, personal risk perception, UK risk perception and world risk perception, trust in the government was not associated with vaccine hesitancy [$p = 0.0071$], suggesting that one or more of the new factors added to the model better accounted for variance in vaccine hesitancy.

Overall, trust in the government was negatively associated with vaccine hesitancy whereby as trust in the government increases, vaccine hesitancy decreases such that respondents with low trust in the government are most hesitant.

Portugal, Soares et al. (2021): In a convenience sample of 1,935 Portugal residents, Soares et al. (2021) examined the relationship between perception of the adequacy of measures implemented by the government, measured as a categorical variable (very adequate and adequate vs. not very adequate and not adequate), with vaccine intention (yes, wait, no) at a hesitancy rate of 65% (wait and no combined), using a cross-sectional survey design, descriptive statistics and multinomial logistic regression.

Using descriptive statistics, Soares et al. (2021) found that respondents who were vaccine resistant were more likely to perceive the adequacy of measures implemented by the government to not be adequate [46.6%] compared with respondents who were vaccine hesitant [4.93%] and respondents who were vaccine accepting [3.4%].

Using multinomial logistic regression, Soares et al. (2021) found that respondents who found the measures implemented by the government to be inadequate were more likely to be vaccine resistant vs. vaccine accepting [OR = 8.49, 95% CI 5.44-13.25] and vs. vaccine hesitant [OR = 6.04, 95% CI 3.93-9.3] compared with respondents who found the measures implemented by the government to be inadequate.

Overall, there is positive association between perception of the adequacy of measures implemented by the government and vaccine intention whereby as perception of the adequacy of measures implemented by the government increases, vaccine intention decreases such that those who perceive greater inadequacy are more resistant.

Hong Kong, Yu et al. (2021): In a random sample (subject to non-response bias) of 450 Chinese Hong Kong residents, Yu et al. (2021) examined the relationship between overall trust toward government, measured as a categorical variable (very strong mistrust/mistrust, neutral, trust/very strong trust, don't know), trust toward governmental measures in controlling COVID-19, measured as a categorical variable

(very strong mistrust/mistrust, neutral, trust/very strong trust), overall satisfaction with government (very strong dissatisfaction/dissatisfaction, neutral, satisfaction/very strong satisfaction, don't know) and vaccine intention, measured on a scale of 1 (definitely not) to 5 (definitely yes) and recoded as a binary variable, using a conjoint experimental design and logistic regression.

Yu et al. (2021) found that, when holding constant frequency of exposure to positive social media messages about vaccines, descriptive norms, perceived impact of vaccine on controlling COVID-19, perceived duration of effectiveness of the vaccine, trust towards governmental measures in controlling COVID-19, and overall satisfaction with government, respondents who trusted the government were more likely to accept the vaccine at the earliest opportunity than respondents who mistrusted the government [OR = 9.39, $p < 0.01$]. Respondents who were neutral in terms of trusting the government were not more or less likely to accept the vaccine at the earliest opportunity than respondents who mistrusted the government [$p > 0.05$].

Yu et al. (2021) found that, when holding constant frequency of exposure to positive social media messages about vaccines, descriptive norms, perceived impact of vaccine on controlling COVID-19, perceived duration of effectiveness of the vaccine, overall trust toward government and overall satisfaction with government, respondents who trusted the government's measures in controlling COVID-19 were more likely to accept the vaccine at the earliest opportunity than respondents who mistrusted the government's measures in controlling COVID-19 [OR = 11.97, $p < 0.01$]. Respondents who were neutral in terms of trusting the government's measures in controlling COVID-19 were not more or less likely to accept the vaccine at the earliest opportunity than respondents who mistrusted the government's measures on controlling COVID-19 [$p > 0.05$].

Yu et al. (2021) found that, when holding constant frequency of exposure to positive social media messages about vaccines, descriptive norms, perceived impact of vaccine on controlling COVID-19, perceived duration of effectiveness of the vaccine, overall trust towards government and trust toward governmental measures in controlling COVID-19, respondents who were satisfied with the government were more likely to accept the vaccine at the earliest opportunity than respondents who mistrusted the government's measures in controlling COVID-19 [OR = 17.43, $p < 0.01$]. Respondents who were neutral in terms of satisfaction with the government were more likely to accept the vaccine at the earliest opportunity than respondents who were dissatisfied the government [OR = 6.16, $p < 0.05$].

Overall, trust and satisfaction in the government is positively associated with accepting the vaccine at the

earliest opportunity whereby as trust and satisfaction increases, vaccine acceptance at the earliest opportunity increases such that those with less trust and satisfaction in the government are more hesitant.

Nigeria, Allagoa et al. (2021): In a convenience sample of 1,000 Nigeria residents, Allagoa et al. (2021) examined reasons for unwillingness to receive the vaccine, using a cross-sectional survey design.

Allagoa et al., (2021) found that lack of trust in government was the second most common reason [41.8%] for being unwilling to accept the vaccine.

Denmark, France, Germany, Hungary, Sweden, Italy, United Kingdom, United States, Lindholt et al. (2020): In a nationally representative (quota) sample of 18,231 respondents from eight Western democracies, Lindholt et al. (2020) examined the relationship between trust in the government, measured on a scale of 1 (no confidence at all) to 10 (full confidence), and vaccine acceptance, measured on a scale of 1 (completely disagree that I would take a vaccine) to 5 (completely agree that I would take a vaccine), using a cross-sectional survey design and simple and multiple OLS regression.

Lindholt et al. (2020) found that the highest level of vaccine acceptance was in Denmark [83%], followed by the United Kingdom [73%], Sweden [61%], Germany [60%], Italy [60%] the United States [54%] and France (47%), and the lowest level of vaccine acceptance was in Hungary [47%].

Using simple OLS regression, Lindholt et al. (2020) found that trust in the government was positively associated with vaccine acceptance [B = 0.344, p < 0.001].

Using multiple OLS regression, Lindholt et al. (2020) found that, when holding constant trust in health authorities, trust in scientists, concern about democratic rights, support for protests, conspiracy beliefs, misinformation, ideology vote choice, fatigue, behaviour change, knowledge, sex, age, education, concern for you and your family, concern for hospitals, concern for society, concern for social unrest and crime, concern for the country's economy, support for restriction and interpersonal trust, trust in the government was positively associated with vaccine acceptance [B = 0.05, p < 0.05].

Overall, trust in the government was positively associated with vaccine acceptance whereby as trust in the government increases, vaccine acceptance increases such that respondents with low trust in the government are most hesitant.

Trust in government is not associated with vaccine hesitancy

Table 69: Studies evidencing that trust in government is not associated with vaccine hesitancy

	Study	Country	Region	Cultural Group	Income
1	Jennings et al. (2021)	United Kingdom	Europe	Anglo	High Income

United Kingdom, Jennings et al. (2021): In a nationally representative (quota) sample of 1,476 of UK residents, Jennings et al. (2021) examined the relationship between government trust, mistrust and distrust, all measured on a scale of 1-5, and vaccine willingness, measured as a binary variable at a hesitancy rate of 29%, using a cross-sectional survey design and logistic regression. Predictors were rescaled to a range from 0-1 to allow direct comparison of effect sizes.

Jennings et al. (2021) found that, when holding constant social trust, health organizations trust, media trust, experts trust, government handling of COVID-19, perceived personal threat of COVID-19, lockdown scepticism, conspiracy beliefs, vaccine distrust, COVID-19 misinformed, had COVID-19, gender, age, education, support for Conservative Party, information sources, social media use, having fact-checked an article online and having

posted political content online, government mistrust was negatively associated with vaccine willingness [OR = 0.349, p < 0.05], whereby as mistrust increases, vaccine willingness decreases, but government trust and distrust were not associated with vaccine willingness [p > 0.05].

Overall, there is inconsistent evidence of an association between government trust-related variables and vaccine willingness.

Conclusions

Table 70: Analysis of evidence by findings, region, cultural group and income

	Predictive [n, %]		Non-predictive [n, %]	Total
	As trust in government increases, vaccine hesitancy decreases [n, %]	As trust in government increases, vaccine hesitancy increases [n, %]		
Studies	5 [83%]		1 [17%]	6
Studies	6 [83%]	0	1 [17%]	6
Region				
Europe	2 [67%]	0	1 [33%]	3
North America	0	0	0	0
Asia	1 [100%]	0	0	1
Oceania	0	0	0	0
South America	0	0	0	0
Africa	1 [100%]	0	0	1
Cultural Group				
Anglo	1 [50%]	0	1 [50%]	2
Germanic Europe	0	0	0	0
Nordic Europe	0	0	0	0
Eastern Europe	0	0	0	0
Latin Europe	1 [100%]	0	0	1
Latin America	0	0	0	0
Southern Asia	0	0	0	0
Confucian Asia	1 [100%]	0	0	1
Sub-Saharan Africa	1 [100%]	0	0	1
Middle East	0	0	0	0
Income				
High Income	2 [67%]	0	1 [33%]	3

Upper Middle Income	0	0	0	0
Lower Middle Income	2	0	0	2
Low Income	0	0	0	0

Overall: Of the studies that considered the relationship between trust in the government and vaccine hesitancy, 83% [5 out of 6] found trust in the government to be predictive, such that it can be concluded with high confidence that trust in the government is predictive of vaccine hesitancy. Of the five studies that found trust in the government to be predictive of vaccine hesitancy, 100% of studies [5 out of 5] found that as trust in the government increases, vaccine hesitancy decreases (i.e., those with less trust in the government are more hesitant), such that it can be concluded with high confidence that, when trust in the government is predictive of vaccine hesitancy, the association is negative. Out of all studies, 83% of studies [5 out of 6] found that as trust in government increases, vaccine hesitancy decreases (i.e., those with less trust in the government are more hesitant), such that, overall, it can be concluded with high confidence that, as trust in the government increases, vaccine hesitancy decreases.

In looking for patterns by region, cultural group and income of the countries in the studies, no further associations between trust in government and vaccine hesitancy can be made due to insufficient evidence.

07

WHO IS MORE LIKELY TO DELAY OR REFUSE VACCINATION AND IN WHAT CONTEXT?

7.1

Age

Younger age groups are more likely to be vaccine hesitant.

Overall, it can only be concluded with some confidence that as age increases, vaccine hesitancy decreases [55 per cent of studies; 26 out of 47].

Regional context: It can be concluded with high confidence that in European countries, as age increases, vaccine hesitancy decreases [71 per cent of studies, 17 out of 24].

Cultural group context: It can be concluded with high confidence that in countries in the Germanic Europe cultural group, as age increases, vaccine hesitancy decreases [100 per cent of studies, 4 out of 4].

It can be concluded with high confidence that in countries in the Latin American cultural group, age is not associated with vaccine hesitancy [75 per cent of studies, 3 out of 4].

Sex/gender

Females are more likely to be vaccine hesitant.

Overall, it can be confidently concluded that females are more likely to be vaccine hesitant [69 per cent of studies, 31 out of 45].

Cultural group context: It can be concluded with high confidence that in Middle East cultural group countries, females are more likely to be vaccine hesitant [100 per cent of studies, 7 out of 7].

Education

The relationship between education and vaccine hesitancy is inconclusive.

Overall, the relationship between education and vaccine hesitancy is inconclusive [47 per cent of studies, 16 out of 34 found that education is not predictive; 41 per cent of studies, 14 out of 34 found that as education level increases, vaccine hesitancy decreases].

Regional context: It can be concluded with high confidence that in African countries, as education level increases, vaccine hesitancy decreases [100 per cent of studies, 4 out of 4].

Cultural group context: It can be concluded with high confidence that in Sub-Saharan Africa cultural group countries, as education level increases, vaccine hesitancy decreases [100 per cent of studies, 4 out of 4].

It can be concluded with high confidence that in Middle East cultural group countries, education is not associated with vaccine hesitancy [75 per cent of studies, 3 out of 4].

Income

People with lower income are more likely to be vaccine hesitant.

Overall, it can be concluded with some confidence that, as income increases, vaccine hesitancy decreases [57 per cent of studies, 12 out of 21].

Regional context: It can be concluded with high confidence that in European countries, as income increases, vaccine hesitancy decreases [71 per cent of studies, 5 out of 7].

Cultural group context: It can be concluded with high confidence that in countries of the Anglo cultural group, as income increases, vaccine hesitancy decreases [77 per cent of studies, 10 out of 13].

Ethnicity/Race

Members of Black ethnic groups are most likely to be vaccine hesitant.

Overall, it can be confidently concluded that, members of Black ethnic groups are most likely to be vaccine hesitant [65 per cent of studies, 11 out of 17].

Marital status

Unmarried people are more likely to be vaccine hesitant.

Overall, it can be confidently concluded that unmarried people are more likely to be vaccine hesitant [63 per cent of studies, 5 out of 8].

Living area

Whether someone is a rural or urban dweller is not associated with vaccine hesitancy.

Overall, it can be concluded with some confidence that living area is not associated with vaccine hesitancy [62 per cent of studies, 5 out of 8].

Regional context: It can be concluded with high confidence that in European countries, living area is not associated with vaccine hesitancy [75 per cent of studies, 3 out of 4].

Cultural group context: It can be concluded with high confidence that in Anglo cultural group countries, living area is not associated with vaccine hesitancy [100 per cent of studies, 4 out of 4].

Income context: It can be concluded with high confidence that in high income countries, living area is not associated with vaccine hesitancy [80 per cent of studies, 4 out of 5].

Having children

Whether someone has children or not is not associated with vaccine hesitancy.

Overall, it can be concluded with some confidence that having children is not associated vaccine hesitancy [50 per cent of studies, 5 out of 10].

COVID-19 infection

Previously having had COVID-19 is not associated with vaccine hesitancy.

Overall, it can be concluded with high confidence that having previously had a COVID-19 infection is not associated vaccine hesitancy [83 per cent of studies, 5 out of 6].

Regional context: It can be concluded with high confidence that in European countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy [100 per cent of studies, 4 out of 4].

Cultural group context: It can be concluded with high confidence that in Anglo cultural group countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy [100 per cent of studies, 4 out of 4].

Income context: It can be concluded with high confidence that in high income countries, having previously had a COVID-19 infection is not associated with vaccine hesitancy [83 per cent of studies, 5 out of 6].

WHY ARE PEOPLE MORE LIKELY TO DELAY OR REFUSE VACCINATION AND IN WHAT CONTEXT?

7.2

Capability (psychological)

COVID-19 knowledge

People with less COVID-19 knowledge or who believe COVID-19 conspiracy theories are more likely to be vaccine hesitant. Overall, it can be concluded with high confidence that as COVID-19 knowledge increases, vaccine hesitancy decreases [73 per cent of studies, 8 out of 11].

Social media

Users of social media for COVID-19 information are most likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that users of social media for COVID-19 information are most likely to be vaccine hesitant [83 per cent of studies, 5 out of 6].

Capability (physical)

Nothing identified in the rapid evidence review with regard to physical capability.

Opportunity (social)

Political ideology

Right-wing or conservative voters are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that right-wing or conservative voters are more likely to be vaccine hesitant [70 per cent of studies, 7 out of 10].

Regional context: It can be concluded with high confidence that in North American countries, right-wing or conservative voters are more likely to be vaccine hesitant [100 per cent of studies, 4 out of 4].

Cultural group context: It can be concluded with high confidence that in Anglo cultural group countries, right-wing or conservative voters are more likely to be vaccine hesitant [71 per cent of studies, 5 out of 7].

Income context: It can be concluded with high confidence that in high income countries, right-wing or conservative voters are more likely to be vaccine hesitant [78 per cent of studies, 7 out of 9].

Opportunity (physical)

Nothing identified in the rapid evidence review with regard to physical opportunity.

Motivation (reflective)

Perceived vaccine safety

People who perceive the vaccine to be less safe or to cause side effects are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that, as perceived vaccine safety increases, vaccine hesitancy decreases [100 per cent of studies, 16 out of 16].

Regional context: It can be concluded with high confidence that in North American [100 per cent of studies, 6 out of 6], Asian [100 per cent of studies, 5 out of 5] and European countries [100 per cent of studies, 4 out of 4], as perceived vaccine safety increases, vaccine hesitancy decreases.

Cultural group context: It can be concluded with high confidence that in countries of the Anglo cultural group, as perceived vaccine safety increases, vaccine hesitancy decreases [100 per cent of studies, 7 out of 7].

Income context: It can be concluded with high confidence that in high income countries, as perceived vaccine safety increases, vaccine hesitancy decreases [100 per cent of studies, 13 out of 13].

Perceived vaccine efficacy

People who perceive the vaccine to be less effective are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that, as perceived vaccine efficacy increases, vaccine hesitancy decreases [80 per cent of studies, 4 out of 5].

Income context: It can be concluded with high confidence that in high income countries, as perceived vaccine efficacy increases, vaccine hesitancy decreases [75 per cent of studies, 3 out of 4].

Perceived vulnerability

People who perceive themselves to be less vulnerable to COVID-19 are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that as perceived vulnerability increases, vaccine hesitancy decreases [79 per cent of studies, 11 out of 14].

Regional context: It can be concluded with high confidence that in North American [100 per cent of studies, 4 out of 4] and European countries [75 per cent of studies, 3 out of 4], as perceived vulnerability increases, vaccine hesitancy decreases.

Cultural group context: It can be concluded with high confidence that in countries of the Anglo cultural group, as perceived vulnerability increases, vaccine hesitancy decreases [80 per cent of studies, 4 out of 5 studies].

Income context: It can be concluded with high confidence that in high income countries, as perceived vulnerability increases, vaccine hesitancy decreases [73 per cent of studies, 8 out of 11].

Perceived susceptibility

People who perceive themselves to be less susceptible to catching COVID-19 are more likely to be vaccine hesitant.

Overall, it can be concluded with some confidence that, overall, as perceived susceptibility increases, vaccine hesitancy decreases [54 per cent of studies, 7 out of 13].

Cultural group context: It can be concluded with high confidence that in Middle East cultural group countries, perceived susceptibility is not associated with vaccine hesitancy [75 per cent of studies, 3 out of 4].

Trust in healthcare professionals

People who have less trust in healthcare professionals are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that, as trust in healthcare professionals increases, vaccine hesitancy decreases [100 per cent of studies, 6 out of 6].

Regional context: It can be concluded with high confidence that in European countries, as trust in healthcare professionals increases, vaccine hesitancy decreases [100 per cent of studies, 5 out of 5].

Cultural group context: It can be concluded with high confidence that in countries of the Anglo cultural group, as trust in healthcare professionals increases, vaccine hesitancy decreases [100 per cent of studies, 5 out of 5].

Income context: It can be concluded with high confidence that in high income countries, as trust in healthcare professionals increases, vaccine hesitancy decreases [100 per cent of studies, 6 out of 6].

Trust in government

People who have less trust in the government are more likely to be vaccine hesitant.

Overall, it can be concluded with high confidence that, as trust in the government increases, vaccine hesitancy decreases [83 per cent of studies, 5 out of 6].

Motivation (automatic)

Nothing identified in the rapid evidence review with regard to automatic motivation.

POLICY IMPLICATIONS

08

TARGETING THOSE MORE LIKELY TO DELAY OR REFUSE VACCINATION

8.1

Age

Support younger age groups to receive the COVID-19 vaccine

Policy makers, particularly in European countries and countries belonging to the Germanic Europe and Latin Europe cultural groups, should support younger age groups to receive the COVID-19 vaccine.

Further research is required to understand why younger age groups are more likely to be vaccine hesitant so to inform the design of interventions and policies that can support their vaccine uptake. As part of this review, only two studies shed any light on potential mechanisms of vaccine hesitancy. Using correlations between predictors, Allington et al. (2021) found that age was negatively associated with informational use of social media, which, in turn, was positively associated with conspiracy suspicions. Using a linear regression model stratified by age group (under 50 years old vs. 50 years old and above), Hammer et al. (2021) found that only the younger age group were less likely to accept the vaccine when they have previously been infected, more likely to accept the vaccine with a recommendation from a healthcare professional and require it to be easy to get a vaccine.

Environmental restructuring

Health services should present easy and convenient opportunities to receive a COVID-19 vaccine. For example, the NHS in the UK is using pop-up vaccination sites near young people's most common work, study and leisure locations.

Enablement

Also, smoothing out the registration process for an appointment makes it easier to get a vaccine. For example, the NHS in the UK is making it easier to book and cancel appointments online.

Incentivization

However, financial incentives should be used with caution. There is currently no evidence to support effectiveness of lottery-based incentives in the United States (9)

Sex/gender

Support females to receive the COVID-19 vaccine

In many contexts, but especially in Middle East and Nordic Europe cultural group countries, policy makers should support females to receive the COVID-19 vaccine. Further research is required to understand why females are more likely to be vaccine hesitant to inform the design of interventions and policies that can support their vaccine uptake.

For example, females may be concerned that the COVID-19 vaccine poses a threat to fertility or that the vaccine should not be taken during pregnancy or when breast feeding, related to uncertainty at the start of the vaccine roll out when there was not enough data to be as conclusive about the safety of the vaccine for pregnant women and breast feeding women.

Communication

Doctors and midwives should assure pregnant and breast feeding women of the safety of the vaccine based upon the extensive data that are now available.

Research has not confirmed that having COVID-19 during pregnancy carries a far higher risk than having the vaccine. Stock et al. (2022) (10) found pre-term births, stillbirths and newborn deaths were more common among women who had COVID-19 28 days, or less, before their delivery date.

Income

Support low income people and households to receive the COVID-19 vaccine

Policy makers, especially in European and Anglo cultural group countries, should support low income people and households to receive the COVID-19 vaccine. Further research is required to understand why low income people and households are more likely to be vaccine hesitant as to inform the design of interventions and policies that can support their vaccine uptake. For example, they may not have the resources (e.g., time, transport, childcare) to access the vaccine, therefore the vaccine should be taken to them, e.g., as pop-up vaccination centres in areas of greater deprivation.

Race/Ethnicity

Support Black communities to receive the COVID-19 vaccine

In countries of the Anglo cultural group, policy makers should support Black communities to receive the COVID-19 vaccine. Further research is required to understand why Black communities are more likely to be vaccine hesitant (e.g., lack of trust due to previous abuses of the Black community) so as to inform the design of interventions and policies that can support their vaccine uptake.

Marital status

Support unmarried people to receive the COVID-19 vaccine

Policy makers should seek support for unmarried people to receive the COVID-19 vaccine once efforts to target other groups more definitively established as hesitant have been made. Further research is required to understand why unmarried people are more likely to be vaccine hesitant in order to inform the design of interventions and policies that can support their vaccine uptake.

Education

No need to target groups on the basis of education

Only in Africa and the Sub-Saharan Africa cultural group was there evidence that less educated people are more likely to be vaccine hesitant. Overall, policy makers should not target lower educated people with interventions and policies to support vaccine uptake.

In an African context, further research is required to understand why less educated people are more vaccine hesitant so as to inform interventions and policies.

Living area

No need to target groups on basis of living area

Living area was not associated with vaccine hesitancy, so policy makers should not target specific support to rural or urban dwellers.

Having children

No need to target groups on basis of having children

Having children was not associated with vaccine hesitancy, so policy makers should not target specific support to those with children or without children.

COVID-19 infection

No need to consider previous infection in policy and interventions

Having previously had a COVID-19 infection was not associated with vaccine hesitancy, such that policymakers need not consider the psychology associated with having previously been infected with COVID-19 (which offers much less immunity to COVID-19 than the vaccine) in the design of policies and interventions.

IMPROVING PSYCHOLOGICAL CAPABILITY

8.2

COVID-19 knowledge

Increase COVID-19 knowledge and reduce acceptance of COVID-19 conspiracy theories

Increasing COVID-19 knowledge and reducing acceptance of COVID-19 conspiracy theories would reduce vaccine hesitancy.

Regulation

Continued regulation of COVID-19 conspiracy theories on social media and other channels can help to limit the spread of information that is eroding COVID-19 knowledge.

Education

However, a more sustainable approach is empowering people to be able to think critically about information, and therefore be able to distinguish fact from fiction. Schools should place an emphasis on teaching critical thinking, rather than attempting the futile task of converting vaccine-resistant people who are invested in conspiracy theories.

Communication

Changing highly engrained beliefs in the short term is unlikely. Rather, there is a need to engage with the themes of power, personal freedom, agency, citizen against state and loss of traditional lifestyle, which anti-vax conspiracy theories revolve around and are now being extended to the climate change challenge. Such engagement can be undertaken in schools and universities, and town hall meetings.

Social media

Reduce reliance on social media for COVID-19 information

There is no evidence that using social media is associated with vaccine hesitancy, but when users rely primarily on social media for COVID-19 information, they are more likely to be vaccine hesitant, which can be explained by a greater belief in conspiracy theories about COVID-19.

Regulation

Further to policy implications for COVID-19 knowledge, continued regulation of fake COVID-19 news on social media can help to limit the broadcasting of COVID-19 conspiracy theories. However, mega media corporations labelling pseudoscience as misleading may only support the beliefs of conspiracy theorists. Also, regulating the information shared in groups, such as WhatsApp groups, is much more of a challenge and is where most fake news and conspiracy theories are spread.

IMPROVING SOCIAL OPPORTUNITY

8.3

Political ideology

Depoliticize the vaccine, avoid mandates and diversify pro-vaccine messengers

That political ideology is predictive of vaccine hesitancy suggests a need to depoliticise vaccine hesitancy.

Regulation

Governments mandating vaccines serves to strengthen the political divide and should be avoided wherever possible, with focus instead being on building trust and addressing concerns related to receiving the vaccine.

Communication and modelling

There is a need to diversify the messengers, using non-political figures to promote pro-vaccine messages. Also, given that right-wing and conservative voters are more likely to be vaccine hesitant, right-wing and conservative leaders (especially when not in government) should be involved in promoting pro-vaccine messages.

IMPROVING REFLECTIVE MOTIVATION

8.4

Perceived vaccine safety

Communicate real-world safety data in a meaningful context

Policy makers, in particular those in North America, Asia, Europe, Anglo cultural group countries and high income countries, should address perceived lack of vaccine safety and the risks of side effects as a barrier to vaccine acceptance.

Communication

Transparent communication of trial and real-world data, focusing not just on the efficacy data, but also the safety data, is required for confidence in vaccine safety. Safety data should be put into context so that they can be more meaningful, such as providing comparable data on blood clot risk from the vaccine, versus COVID-19 itself or birth control pills, or even calculating the risk of hospitalization and death from a COVID-19 vaccine and comparing this with the risk of hospitalization and death from undertaking a car journey.

Perceived vaccine efficacy

Communicate real-world efficacy data for transmission, hospitalizations and deaths when adhering to an appropriate vaccine schedule

Policy makers, in particular those in high income countries, should address perceived lack of vaccine efficacy as a barrier to vaccine acceptance.

Communication

Timely communication about effectiveness of vaccines against new COVID-19 variants is critical to maintain confidence in the efficacy of vaccines so that, even where efficacy in transmission drops, the efficacy of the vaccines in limiting transmission and the spread of the virus is understood and that, even where efficacy in limiting transmission decreases, that efficacy in limiting hospitalizations and deaths remains very high. Furthermore, communication of efficacy data should also consider efficacy of number of doses and boosters and how long protection can be expected to last for before it starts to wane, in order to build confidence in the vaccines when an appropriate vaccine schedule is followed. Real-world data, rather than trial data, should be used wherever possible to ensure communications are more meaningful.

Perceived vulnerability to COVID-19

Challenge beliefs of invulnerability

Policy makers, in particular those in North America, Europe, Anglo cultural group countries and high income countries, should address perceived invulnerability as a barrier to vaccine acceptance.

Coercion

Communicate risks to groups who do not perceive themselves to be vulnerable to COVID-19, with a focus on different risk profiles dependent upon vaccination status, publicize hospital occupancy rates for different age groups segmented by vaccination status. This will help reframe personal risk assessment to be about the risk of not receiving the vaccine, rather than about the risk of catching COVID-19. For example, in the first half of 2021 in the United Kingdom, for every one death from COVID-19 in the vaccinated population, there were nearly 200 deaths from COVID-19 in the unvaccinated population.

Modelling

Deliver messages via age-appropriate and relevant people who previously considered themselves to be invulnerable until they were infected.

Trust in healthcare professionals

Understand historical reasons for lack of trust as a foundation to rebuild trust and diversify messengers

Policy makers, especially those in Europe, Anglo cultural group countries and high income countries, should address low trust in healthcare professionals as a barrier to vaccine acceptance.

Understand, rather than blame

Research is required to understand why different groups have a lack of trust in healthcare professionals as a foundation from which trust can be rebuilt. For example, do certain groups face or have certain groups faced unethical and medical treatment in the past from healthcare professionals? For example, for 40 years in the United States from 1932, the Tuskegee Syphilis Study was an experiment conducted on a group of African American men without their knowledge to see what would happen if their syphilis was left untreated, despite an effective drug (penicillin) being available, resulting in many preventable deaths. More recently, Black Africans have been used to trial experimental drugs, such as in 1996 when 11 Nigerian children died and were left dozens disabled after an experimental meningitis drug was tested on them. This history may lead groups who are being prioritized to receive a vaccine due to age, health conditions and occupation to believe that they are again being used as guinea pigs for experimental drugs.

Modelling

Policymakers should seek to understand community hierarchies and local patterns of trust to diversify the messengers and deliver messages via age-appropriate, relevant and trusted people known to each target group (11). In an experiment by Martin and Sherrington (2021) (11), adverts featuring nurses who had rejected the job but then changed their mind were shown to care home workers, producing a 93 per cent acceptance rate (compared with the 80 per cent typically found in major UK centres).

Trust in government

Policymakers should address low trust in the government as a barrier to vaccine acceptance

Modelling

State-level research is required to understand if and why trust in a government is a barrier to vaccine acceptance to serve as a foundation from which to rebuild trust. For example, the United Kingdom government lost the trust of many of the British public by not adhering to the same protective rules they were asking the British public to adhere to, in a series of parties that were illegal at the time and which have since been investigated by the police. Governments should model the behaviour that they also expect from their public, including receiving vaccines and engaging in other protective behaviours. Also, if a government is perceived to not accurately be reporting cases and deaths of COVID-19, it may be difficult to trust them with regard to a vaccine. Governments should be transparent and honest during a public health emergency to maintain trust.

Perceived susceptibility to COVID-19

No need to factor perceived susceptibility into policy and interventions design

Although there is some evidence that perceived susceptibility is positively associated with vaccine hesitancy, the relationship is not conclusive, such that policy makers should focus on other factors to support vaccine uptake. This may be because the perceived chance of being infected with COVID-19 is distinct from the perceived risk of being harmed by COVID-19, and for many, being infected with COVID-19 can be mild or even asymptomatic. As variants become more contagious, such as the omicron variant, variability in perceived susceptibility will decrease.

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09

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