Papers please: Predictive factors for the uptake of national and international COVID-19 immunity and vaccination passports

Paul M. Garrett[1], Joshua P. White[1], Simon Dennis[1,2], Stephan Lewandowsky[3,4], Cheng-Ta Yang[5,6], Yasmina Okan[7], Andrew Perfors[1], Daniel Little[1], Anastasia Kozyreva[8], Philipp Lorenz-Spreen[8], Takashi Kusumi[9], and Yoshihisa Kashima[1]

[1] Melbourne School of Psychological Sciences, The University of Melbourne, Australia

[2] Unforgettable Research Services

[3] School of Psychological Science, The University of Bristol, UK

[4] School of Psychological Science, The University of Western Australia

[5] Department of Psychology, National Cheng Kung University, Taiwan

[6] Graduate Institute of Mind, Brain and Consciousness, Taipei Medical University, Taiwan

[7] Centre for Decision Research, Leeds University Business School, University of Leeds, UK

[8] Center for Adaptive Rationality, Max Planck Institute for Human Development, Germany

[9] Division of Cognitive Psychology in Education, Kyoto University, Japan

Author Note

Correspondence concerning this article should be addressed to Paul M. Garrett, School of Psychology, The University of Melbourne, Melbourne, Victoria, Australia. E-mail: `paul.garrett@unimelb.edu.au`.

Abstract

In response to the COVID-19 pandemic, countries are introducing digital passports that allow citizens to return to normal activities if they were previously infected with (immunity passport) or vaccinated against (vaccination passport) SARS-CoV-2. To be effective, policy decision makers must know whether immunity and vaccination passports will be widely accepted by the public, and under what conditions? We collected representative samples across six countries – Australia, Japan, Taiwan, Germany, Spain, and the United Kingdom – during the 2020 COVID-19 pandemic to assess attitudes towards the introduction of immunity passports. Immunity passport support was moderate-to-low, ranging from 51% in the UK and Germany, down to 22% in Japan. Bayesian generalized linear mixed effects modelling controlling for each country showed neoliberal world views, personal concern and perceived virus severity, the fairness of immunity passports, and willingness to become infected to gain an immunity passport, were all predictive factors of immunity passport support. By contrast, gender (woman), immunity passport concern, and risk of harm to society predicted a decrease in support for immunity passports. Minor differences in predictive factors were found between countries. These findings will help policy makers introduce effective immunity passport policies in these six countries and around the world.

Papers please: Predictive factors for the uptake of national and international COVID-19 immunity and vaccination passports

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) responsible for COVID-19 has infected more than 200 million individuals worldwide and resulted in more than 4 million deaths (World Health Organization, 2021b). As the virus continues to spread, countries seek ways to restart their economies and allow citizens to move freely without reigniting the pandemic. Vaccines are the foremost tool in combating the virus, and countries are introducing 'vaccination passports' to allow low-risk individuals to travel, work and gather under lowered restrictions (Kelleher, 2021; Cha, 2021). However, there remains a stark gap between international vaccination programs, with many, predominantly poorer countries, lacking vaccines and still waiting to administer their first dose (Guarascio, 2020). Additionally, it is unclear how effective current vaccines will be against newly emerging virus variants (Mallapaty & Callaway, 2021; Kim et al., 2021). In countries where vaccines are limited, or where virus variants outpace vaccine effectiveness, governments may also introduce immunity passports.

Immunity passports identify previously infected and now recovered individuals, by testing for SARS-CoV-2 antibodies (Liew & Flaherty, 2021). Similar to vaccinated individuals, recovered individuals are thought to have a lower likelihood of contracting, spreading, and experiencing the most severe symptoms of the virus (Liew & Flaherty, 2021). A recent World Health Organization report (World Health Organization, 2021a) suggests recovered individuals develop antibodies within 4-weeks following infection, that immune responses remain robust for 6-8 months (current data only extends to 8-months), and that naturally acquired antibodies may be more robust to emerging virus variants as current vaccines target a specific spike protein and may become less-efficacious with virus mutations (note that vaccines are robust to current variants of concern; e.g., Delta variant). In light of these considerations, immunity passports may prove useful when used in addition to vaccination passports. Indeed, the European Union has proposed exactly this with their new 'green card', a digital certificate that will act as both a vaccination and immunity passport European Union (2021). For simplicity, we refer to these vaccination and immunity passports collectively as 'immunization passports'.

Immunization passports may allow economies to rapidly bounce back, with individuals perceiving crowded shops and workplaces as safer if others are recovered or vaccinated (Brown et al., 2020). Similarly, businesses may require proof of immunization to enter their premises or use their services (Dye & Mills, 2021), and countries may require proof of immunization to cross their borders (Kelleher, 2021). For example, the International Air Transport Association has developed the 'Travel Pass' App (International Air Transport Association, 2021) to store one's COVID-19 vaccination record on the user's phone, such that data can be shared with governments and transport authorities before accessing flights and crossing a country's border. Additional privacy measures may accompany these apps, as is the case with South Korea's 'Green Pass' (Cha, 2021), a vaccination certificate that uses blockchain technology to make passes both shareable and tamper-proof (see Tsoi et al., 2021, for a discussion). These immunity passport Apps are a technological extension of existing vaccination requirements, such as the physical 'yellow card' that accompanies yellow fever vaccination, which is necessary to enter many countries in Africa and Central and South America (Gelb & Mukherjee, 2021).

The potential introduction of immunization passports carries a host of scientific, legal, and ethical questions. For example, are recovered and vaccinated individuals immune to new virus variants (World Health Organization, 2021a)? Will these passports become a legal requirement, and how will people who cannot risk becoming infected or cannot get vaccinated be impacted (Voo et al., 2020)? And will individuals try to become infected if doing so confers additional freedoms (Lewandowsky et al., 2021)? Each of these questions are critical to national health policies and have been the source of recent debates between privacy advocates and politicians in Britain (Davies, 2021), and the cause of public protests in France (Wilford, 2021). It is clear that world governments and health policy decision makers need scientifically informed answers to two key questions: Will people around the world accept and support the use of immunization passports? And if so, why?

Immunization passport acceptance

We narrow the scope of our investigation to the introduction and acceptance of immunity passports — those instances where an individual has been infected and recovered — in six countries around the world, as immunity passports may yet prove relevant to countries both with and without vaccination programs. Of course, these findings may also prove insightful and may extend to the conditions necessary for vaccination passport acceptance. Key to the current investigation is understanding what societal, personal, and contextual factors influence immunization passport acceptance.

Societal factors may shape one's attitude towards whether immunization passports will benefit the community at large, thereby influencing passport acceptance (Tsai, 2020). Health policy acceptance may improve with a sense of communal (rather than individualistic) responsibility for the public's well-being (e.g., Estifanos et al., 2020). Similarly, acceptance may improve or diminish with perceptions of shared societal experiences, such as stay-at-home 'lock-downs' (Zhou et al., 2020), and the perceived effectiveness of Government COVID-19 policies (e.g., COVID-19 vaccine uptake improves with perceived Government effectiveness and trust in Government; Lazarus et al., 2021).

Personal experiences may also affect one's attitude towards using an immunization passport. For example, having had or known someone who has had COVID-19, may incentivize one towards the use of immunity passports (Tsai, 2020). Strong neoliberal worldviews — a belief that the free-market is fair and sensitive to the social and financial needs of the people — and a desire to return to normal economic activities, may also effect passport acceptance (Lewandowsky et al., 2021). Similarly, higher education may prove important to shaping one's opinions regarding the equality and necessity of immunity passports, just as it has with vaccinations (e.g., Khubchandani et al., 2021).

Finally, immunity passport acceptance may depend upon contextual factors regarding the state of the pandemic, for example, COVID-19 cases, deaths, and vaccine progress, which may change country-to-country and across time. In developing an understanding of what factors influence immunization passport acceptance, we may consider i) acceptance while attempting to control for the contextual influences of each country, and ii) acceptance dependent upon each country. The former informs us of the necessary conditions for immunity passport acceptance across countries, allowing our findings to potentially generalize beyond our sample of six countries. By contrast, the latter assesses acceptance within each sampled country and may show how it varies as a function of each country's individual context and culture. As COVID-19 represents a threat to people all over the world, we must provide inferences that can be informative and generalize as much as possible, while also providing a rich analysis of each country we assess, separately, so as to best inform policy decisions regarding the use of immunity passports.

The current study

We surveyed attitudes towards immunity passports in six countries with different experiences during the COVID-19 pandemic: Australia, Germany, the United Kingdom, Spain, Japan, and Taiwan (see Figure 1; note the y-axes differ by two orders of magnitude between Taiwan and Germany, and green bars display data collection windows). Using Bayesian linear mixed-models, we aimed to determine which factors — societal, personal, and contextual issues related to COVID-19 — influenced immunity passport acceptance. We examined our data in two ways. In the first, we attempted to control for the idiosyncratic effects of each country on immunity passport acceptance (using random effects in our modelling) so as to create a generalized framework for immunity passport acceptance. In the second, we assessed acceptance within each country to consider cultural and contextual differences. We did not have specific hypotheses regarding the acceptance of immunity passports, and instead, report a descriptive account of our findings.

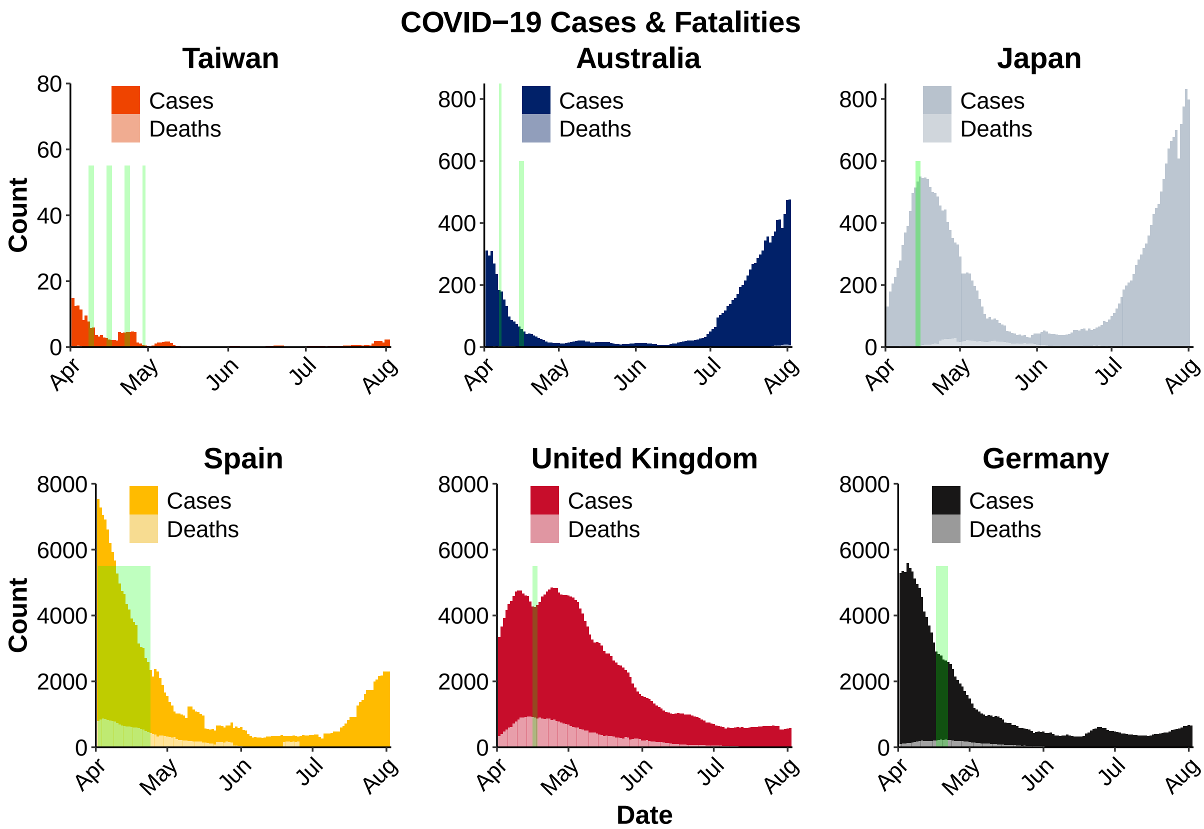

Figure 1. COVID-19 cases and fatalities by country for the period of April 2020 – August 2020. Due to the different case numbers in each country, scales vary by up to two orders of magnitude. Green bars indicate the data collection time-periods.

Methods

Participants

Table 1 displays demographic information for each country and sample. We sampled 12,944 participants across six countries to determine their attitudes towards and acceptance of immunity passports. Each country collected between one and four nationally representative samples. Participants were aged 18 years or older, and completed a 10- to 15-minute online survey for which they were financially reimbursed (see Appendix A for study details by country). Data collection were completed as part of a wider international collaboration examining the acceptability of mobile tracking technologies to address the COVID-19 pandemic (see, Garrett, White, et al., 2021; Garrett, Wang, et al., 2021; Lewandowsky et al., 2021; Kozyreva et al., 2021).

Table 1

Demographic information relevant to each sample (denoted by sample number #) within each country. Edu: Education. Prefer NTS: Prefer not to say.

		Australia		Germany	Japan	Spain	Taiwan				UK
Sample	#	1	2	1	1	1	1	2	3	4	1
	N	1514	578	1514	1081	1505	1500	1500	1500	1500	752
Age (SD)		48 (17)	48 (17)	47 (16)	46 (17)	48 (16)	40 (12)	40 (12)	40 (12)	41 (12)	46 (16)
Gender (%)	Man	50	48	49	49	48	48	47	48	50	48
	Woman	49	51	50	51	52	52	53	52	50	51
	Other	0.17	0.20	0.45	0.00	0.13	0.00	0.20	0.11	0.00	0.27
	Prefer NTS	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.22	0.14
Edu (%)	< H.School	9	11	14	3	10	1	1	1	1	16
	H.School Grad	37	40	63	39	42	12	14	13	13	17
	University Grad	54	49	23	58	47	87	86	86	86	67

Design and procedure

Figure 2 illustrates the primary design elements assessed across countries. As the pandemic evolved, survey designs were updated with each sample; however, the key design elements in Figure 2 remained unchanged. Individual survey items corresponding to COVID-19 perceptions and impact, immunity passports and worldviews are displayed in Table 2.

Each participant provided informed consent and demographic information, before using a Likert-scale to report on their perceptions and impact of the COVID-19 pandemic (scale anchors displayed in Figure 2). Participants then read one of three hypothetical scenarios describing a different type of mobile phone COVID-19 contact tracing system — telecommunication tracking, a government app, or the Apple/Google exposure notification system — that would alert the user if they had contact with an infected individual, before completing a comprehension check and answering questions about these scenarios (for method and results by country, see Kozyreva et al., 2021; Garrett, White, et al., 2021; Garrett, Wang, et al., 2021; Lewandowsky et al., 2021). Finally, participants read a description of immunity passports before responding to items examining their attitudes towards immunity passports and their neoliberal

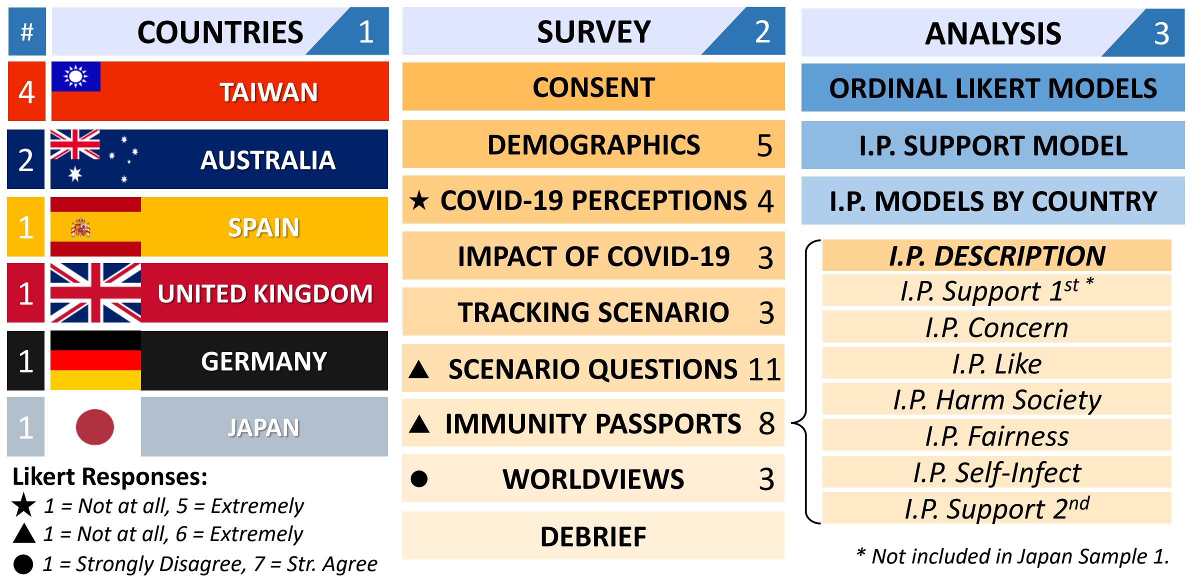

Figure 2. Design. Countries: the left-most column indicates the number of samples collected in each country. Survey: indicates the question-set order; each box represents a number of questions denoted by the right-aligned integer. Immunity passport (I.P.) items are highlighted. Analysis: analysis steps of the current paper. Likert-responses are denoted by symbols in the bottom left.

worldviews (response scales displayed in Figure 2). The survey concluded with a study debrief statement.

Before responding to the immunity passport items, each participant read the following description: "*An 'immunity passport' indicates that you have had a disease [or vaccination] and that you have the antibodies for the virus causing that disease. Having the antibodies implies that you are now immune and therefore unable to spread the virus to other people. Thus, if an antibody test indicates that you have had the disease, you could be allocated an 'immunity passport' which would subsequently allow you to move around freely. Immunity passports have been proposed as a potential step towards lifting movement restrictions during the COVID-19 pandemic.*"

Upon survey completion, data were augmented with country-specific information regarding the state of the pandemic at the time of the survey. These data included COVID-19 cumulative cases and deaths, whether masks were used during outbreaks (binary variable: true or false), whether stay-at-home 'lockdowns' were used to suppress

Table 2

COVID-19 perceived risk and impact, immunity passport and worldview items. [R]everse scored items.

Item	Question	Label
Perception 1	How severe do you think novel coronavirus (COVID-19) will be for the general population?	General harm
Perception 2	How harmful would it be for your health if you were to become infected COVID-19?	Personal harm
Perception 3	How concerned are you that you might become infected with COVID-19?	Concern self
Perception 4	How concerned are you that somebody you know might become infected with COVID-19?	Concern others
Impact 1	Have you ever tested positive to COVID-19?	Positive self
Impact 2	Has somebody you know ever tested positive to COVID-19?	Positive other
Impact 3	Have you temporarily or permanently lost your job as a consequence of the COVID-19 pandemic?	Job loss
Passport 1	Would you support a government proposal to introduce 'immunity passports' for novel coronavirus (COVID-19)?	IP Support 1st
Passport 2	How concerned are you about the idea of introducing an 'immunity passport' for novel coronavirus (COVID-19)?	IP Concern
Passport 3	How much would you like to be allocated an 'immunity passport' for novel coronavirus (COVID-19)?	IP Like
Passport 4	To what extent do you believe an 'immunity passport' for novel coronavirus (COVID-19) could harm the social fabric of your country?	IP Harm
Passport 5	To what extent do you believe that it is fair for people with 'immunity passports' to return to work, while those without a passport cannot?	IP Fair
Passport 6	To what extent would you consider purposefully infecting yourself with novel coronavirus (COVID-19) to get an 'immunity passport' for COVID-19?	IP Self-Infect
Passport 7	Would you support a government proposal to introduce 'immunity passports' for novel coronavirus (COVID-19)?	IP Support 2nd
Wolrdview 1	An economic system based on free markets unrestrained by government interference automatically works best to meet human needs.	WV Economy
Wolrdview 2	The free market system may be efficient for resource allocation but it is limited in its capacity to promote social justice. [R]	WV Freemarket
Wolrdview 3	The government should interfere with the lives of its citizens as little as possible.	WV Small Gov

the virus (binary: true or false) and whether mobile tracking technologies (e.g., COVIDSafe in Australia or the CORONA-WARN-App in Germany) were in use. We further augmented the data with national indices, including the Worldbank's perceived Government effectiveness scale (scale 0-100 with higher values indicating greater effectiveness; Worldbank, 2020), and the individuality subscale from the Hofstede Index of Collectivism (scale 0-100 with higher values indicating a more individualistic, less collectivist culture; Hofstede Insights, 2020).

Data analysis and reporting

Participants were not excluded from analyses unless they were missing a response to the immunity passport support item or did not complete the survey (removed N = 1523). The reported analyses use Bayesian methods and credible intervals to determine effects in the data. Bayesian methods sample a posterior distribution of plausible values (the probability that, given our data, the true population mean is 'x'), by weighing the likelihood of a given observation against its prior probability of occurring in the sample. Under parametric assumptions, these posterior distributions act to constrain the effect of outliers in the tails of the sampled data, and allow the highest region of data density — credible regions of the data distribution — to inform our decisions. Practically, this means that instead of testing a threshold of significance (like a p-value or Bayes factor), we may instead compare the 95% credible regions of the data distributions to determine if they overlap or not.

Descriptive Likert comparisons. Bayesian ordinal probit regressions were used to directly compare Likert-responses using the *MCMCoprobit* and *HPDinterval* functions in R packages *MCMCpack* Martin et al. (2011) and *Coda* Plummer et al. (2006), respectively. This method is used to more easily compare Likert items, by assuming that there are latent normally distributed continuous variables that underlie ordinal responses. These latent variables are then segmented into ordinal Likert responses by C – 1 (number of response options – 1) thresholds. To set the location of the underlying latent variable and make the model identifiable, the lowest threshold parameter is fixed at zero Albert & Chib (1993) and all other thresholds are estimated. Country-level data was modelled together to ensure consistent threshold parameters across the Likert-items and countries (see Bürkner & Vuorre, 2019, for model details), and individual samples within countries were not modelled; however, a detailed analyses of these data are reported in Garrett, White, et al. (2021); Garrett, Wang, et al. (2021); Lewandowsky et al. (2021); Kozyreva et al. (2021). Although this statistical approach assumes ordinal thresholds are constant across countries, the analysis poses fewer and more reasonable assumptions than directly comparing the mean or raw distribution of Likert-scales Bürkner & Vuorre (2019).

Predictive Regression modelling. While ordinal probit regression was used to *describe and compare* the Likert responses across countries in relation to immunity passports, Bayesian generalised linear mixed effects modeling was also used to *predict* participant's support for immunity passports, with demographics, perceptions and impact of COVID-19, COVID-19 cases and deaths by country, neo-liberal worldviews, and immunity passport items were treated as additive and independent predictor variables (i.e., no interaction effects were included) of immunity passport support. In our main model, random intercept effects were included to account for dependencies introduced in the data by each country and as an attempt to control for the idiosyncratic effects of each country in search of predictive variables across the countries. Additionally, each country's acceptance ratings were then modeled separately. Likert-ratings were treated as numeric data for the purposes of modelling. All non-categorical variables were scaled, within each country, to have a mean of 0 and standard deviation of 1.

Posterior distributions of model parameters were estimated using Hamiltonian Markov Chain Monte Carlo No-U-turn Sampling implemented in Stan via the R package *brms.* Four chains each with 2000 iterations and 1000 burn-ins were used. Non-informative priors were set for the intercept and random effect standard-deviation parameters (both Cauchy distributions centred on 0 and a scale parameter of 2.5), and fixed effects were estimated from weakly informative priors with a Laplacian distribution centered on 0 and a scale parameter of 1.

The models reported in the main text focus on immunity passport support *after* answering immunity passport questions (reflective of attitudes after having time to consider the wider implications of these passports). Models predicting passport support *before* participants answered questions about immunity passports are included in the supplementary materials (Table S2.2 and Table S2.3). The outcome variable was reduced from a six-point Likert-scale to a binary response-set (support: ‘yes’ or ‘no’) so that all response options indicating ‘moderate’, ‘a lot’ or ‘extreme’ support of immunity passports were classified as supportive, and ‘none’, ‘a bit’ or ‘some’ support was classified as no support. This binary categorization simply reflected the midway division of the six ordinal responses. An ordinal regression model that keeps the structure of the original response variables is reported in the supplementary materials, Table S2.1. However, results are comparable between models, and so we chose to focus on the simpler binomial model for the main text. We did not include sample order in the model (Australia and Taiwan collected data at two and four time-points, respectively, while the remaining countries collected one sample) as this led to poor model fits. Similarly, it was necessary to exclude gender ‘Other’ and gender ‘Prefer not to say’ in the model due to their small N leading to instability in the model fit.

Results

COVID-19 impact

Table 3 displays country counts and percentages (relative to sample size) for the COVID-19 impact variables identifying how many individuals had tested positive to COVID-19, how many individuals knew someone who has tested positive to COVID-19, and how many individuals had lost their jobs due to the pandemic.

Immunity passport, COVID-19 and worldview perceptions

Figure 3 displays the mean ordinal regression posterior distributions and associated Likert-style responses for immunity passport perceptions across six countries.

Table 3

Percentages and counts for affirmative responses to COVID-19 impact variables (testing positive to COVID-19, knowing someone who has tested positive to COVID-19, or losing one's job due to COVID-19) collapsed across samples for each country.

% *(Counts)*	Taiwan	Aus	Spain	UK	Germany	Japan
COVID-19 Positive Self	0.6 (36)	2.4 (50)	7.5 (113)	0.1 (1)	4.4 (67)	0.9 (10)
COVID-19 Positive Other	2.7 (164)	9.3 (194)	48 (722)	41.5 (312)	20.6 (312)	1.9 (21)
Job Loss	8.1 (483)	21.6 (452)	31.1 (468)	33.1 (249)	16.2 (245)	10.9 (118)

Items are detailed in Table 2. Immunity passport acceptance is highest (moderately supportive) in the United Kingdom, Germany and Spain, and lowest in Japan. All countries display little-to-no inclination for infecting one's self to gain an immunity passport, and although most countries are only 'a bit' concerned by the introduction of immunity passports, they are generally deemed as posing a moderate risk of harm to society. For a direct — but less statistically informed — interpretation, we also calculated mean immunity passport support scores based on our binary classifications (support: yes = ['moderate', 'a lot', or 'extreme'], no = ['none', 'a bit', or 'some']). Using this classification, we observe support was highest in Germany and the United Kingdom (51%), followed by Taiwan (47%), Australia and Spain (46%), and lowest in Japan (22%).

Figure 4 (top) shows COVID-19 concerns and perceived severity varied with country, being generally least concerning and severe in Australia and Germany, and most concerning and severe in Spain, the United Kingdom and Japan (see Figure 1 for COVID-19 case numbers). A clear trend within countries shows people are more concerned and view the virus as more severe for others than for themselves.

Figure 4 (bottom) shows attitudes to worldview items were comparable across countries. Overall, attitudes were 'neutral' towards a capitalist economy being best, and all countries 'somewhat agreed' with the free-market being 'unable to promote social justice' and to desiring 'minimal Governmental interference in their citizen's lives'.

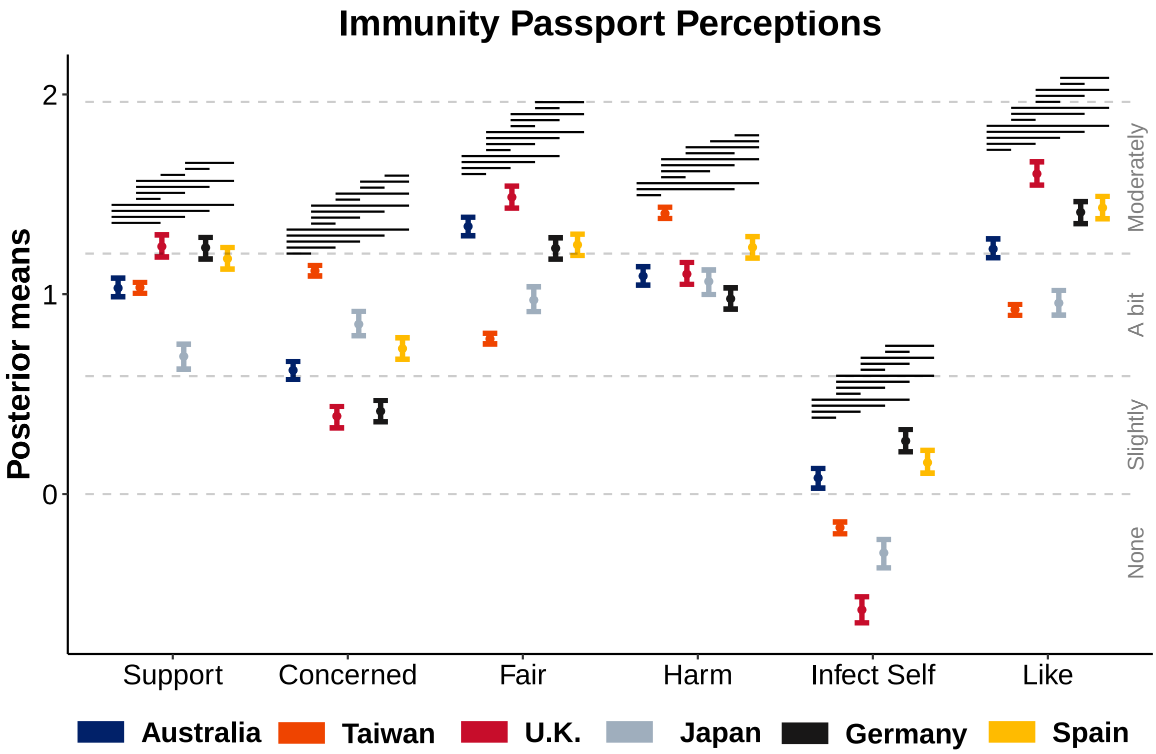

Figure 3. Ordinal regression mean posterior distributions (left axis; vertical error bars) and latent Likert-ratings (right axis; dotted horizontal lines) for immunity passport perceptions in Australia, Taiwan, the United Kingdom, Japan, Germany, and Spain. Error bars display the 95% highest posterior density interval. Dotted lines indicate Likert-categories, and non-overlapping intervals (i.e., effects) between countries are denoted by black horizontal lines within each item.

Immunity passport support model

The following model examines the conditions under which acceptance of immunity passports is facilitated or inhibited, while controlling for the idiosyncratic effects of each country using random effects. Figure 5 displays the posterior estimates of the Bayesian generalized linear mixed effects model of immunity passport support using demographics, COVID-19 perceptions and impact, country-specific indices (e.g., mask usage, government effectiveness), worldview, and attitudes to immunity passports as additive factors, with a random intercept for each country (not displayed in the Figure). Error bars display the 95% highest density interval. The posterior estimates and 95% credible intervals of the random country intercepts are displayed alongside all parameter

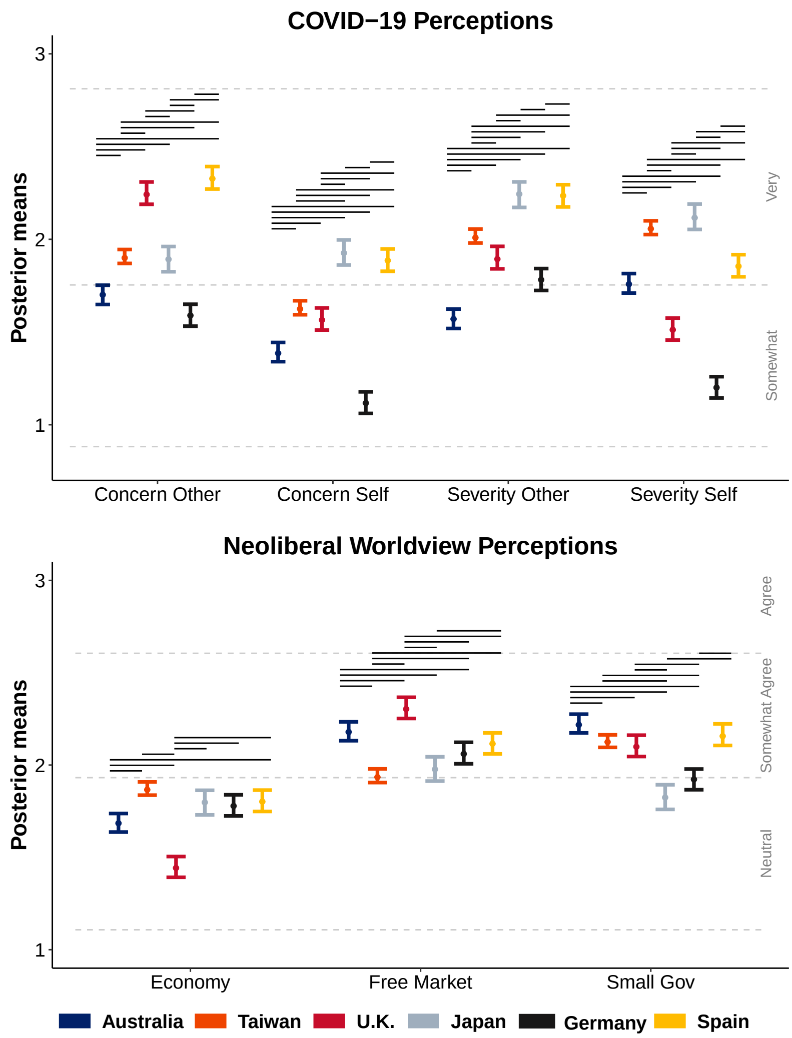

Figure 4. Ordinal regression mean posterior distributions (left axis; vertical error bars) and latent Likert-ratings (right axis; dotted horizontal lines) for COVID-19 perceptions (top) and world view perceptions (bottom) in Australia, Taiwan, the United Kingdom, Japan, Germany, and Spain. Error bars display the 95% highest posterior density interval. Dotted lines indicate Likert-categories, and non-overlapping intervals (i.e., effects) between countries are denoted by black horizontal lines within each item.

coefficients in Table S3.1. The global intercept had a mean of -1.67 (CI [-3.14:-0.32]). Country intercept means were ordered lowest-to-highest, Japan, Spain, Australia, United Kingdom, Germany and Taiwan; credible intervals ranged lowest for Japan (M = -0.66, CI[-2.10:0.57]) and highest for Taiwan (M = 0.61, CI[-0.79:2.31]), and intervals for all countries extended over the zero midpoint. As posterior mean estimates are rather opaque to interpret, we next provide an explanation of the main model variables in terms of their odds ratios.

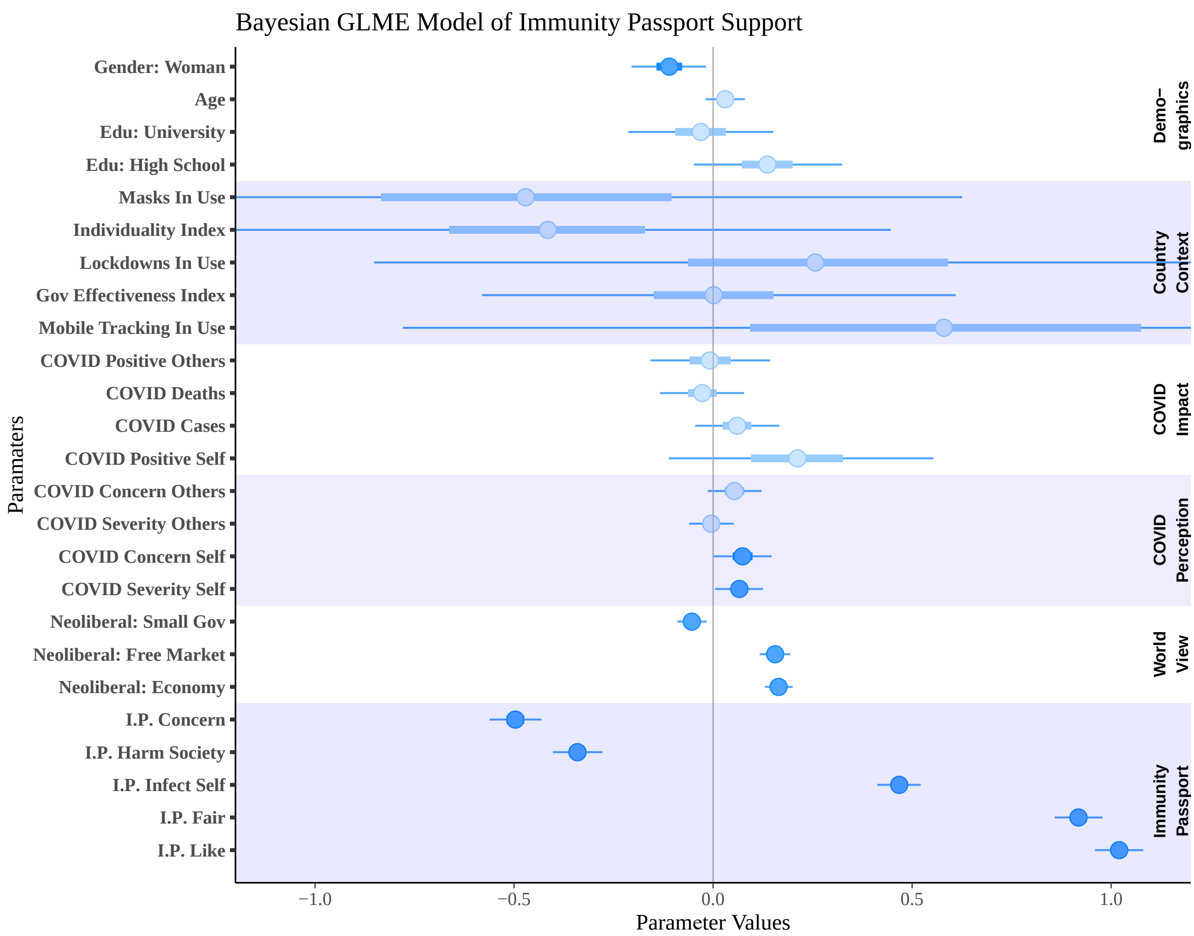

Figure 5. Bayesian generalized linear mixed effects model of immunity passport support (post immunity passport questions) across countries. Positive parameters display immunity passport support; negative values display a decrease in support. Bars represent 50% of the parameter distribution centred on the parameter mean, tails display the 95% highest density interval. Opaque variables show instances where the posterior interval does not overlap zero.

Predictive variables of immunity passport acceptance - those where the 95% highest density interval does not cross zero - included increased COVID-19 concern, perceived virus severity to one's self, worldview (believing the free-marked works best and that it is limited in its ability to support social justice), and immunity passport items (liking and thinking immunity passports are fair, and being willing to self-infect to receive an immunity passport). Personally liking the idea of immunity passports was the strongest predictor variable, with an odds ratio of 2.8; that is, a 1 standard-deviation increase in ‘liking’ immunity passports corresponded to a 2.8-factor standard deviation increase in the odds of supporting their introduction. This may seem rather tautological, but shows that positive attitudes towards immunity passports are the strongest predictor of their acceptance.

Predictive variables against the introduction of immunity passports included gender (identifying as a woman), world view (supporting minimal government interference), and immunity passport items (concern and risk of harm to society). Immunity passport concern was the most predictive item against the acceptance of immunity passports, with a 1 standard-deviation increase therein corresponding to a 0.61 factor increase in the odds of supporting the introduction of immunity passports (equivalent to a 1.65 factor increase in the odds of not supporting the introduction of immunity passports).

Country differences

The mixed effects model presented in Figure 5 displays immunity passport acceptability while controlling for the effect of each country. However, differences may be observed between countries due to cultural and contextual variation. To highlight these differences, we completed the above modelling for each country separately. The results of these models are presented in the supplementary material tables S3.1 – S3.6. Table 4 summarizes the main parameters of interest in the main mixed effects model (top row) and models of each country. For direct comparison, we present parameters in terms of their odds ratios — the degree to which each parameter increases the odds of immunity passport support — and indicate whether they increase (blue) or decrease (red) the likelihood of immunity passport support. An odds ratio of 1 indicates no effect, an odds ratio less than one indicates a negative relationship between parameters, while an odds ratio greater-than one indicates a positive relationship between parameters. Three notable differences are observed between predictive parameters for each individual country and the main model: gender and COVID-19 severity-self parameters were only predictive in the main mixed-effects model after controlling for country, and COVID-19 concern for others was only predictive in Japan.

Table 4

Parameters that support (blue) or go against (red) immunity passport acceptance in our primary model (Figure 5) and when modelled for each country, separately. Numbers are odds ratios representing the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the Bayesian models posterior estimate. All parameter means, errors and credible intervals are displayed in the supplementary material, Table S3.1 to Table S3.6.

	Gender	COVID-19 Perceptions			Worldview Items			Immunity Passport Items				
	Woman	Concern Self	Severity Self	Concern Others	Small Gov	Free Market	Economy	Concern	Harm	Infect Self	Fair	Like
Main Model	0.9	1.07	1.07		0.95	1.17	1.17	0.61	0.71	1.6	2.51	2.77
Australia					0.88		1.31	0.64		2.03	3.42	3.71
Germany					0.9	1.14	1.23	0.76	0.73	1.58	2.36	3.67
Japan				1.48		1.25		0.63		2.01	1.82	2.56
Spain					0.85	1.28	1.12	0.54		1.9	3.19	3.29
Taiwan		1.14				1.16	1.17	0.61	0.63	1.38	2.27	2.05
United Kingdom								0.57	0.53		3.16	5.47

Discussion and conclusion

Between April and May of 2020, we assessed the perceptions and impact of the COVID-19 pandemic, and attitudes towards immunity passports in Australia, Taiwan, Japan, Germany, the United Kingdom, and Spain. Using Bayesian linear mixed effects modelling, we determined the societal, personal and context factors that influence the acceptance of immunity passports while controlling for country. We then explored these factors within each country.

Modelling of international attitudes towards the introduction of COVID-19 immunity passports identified several predictive variables — world view, COVID-19 concern for one's self and perceived virus severity to one's self — however, the most predictive variables were those directly assessing attitudes towards immunity passports. Desiring a passport, perceiving these passports as fair, and being willing to infect one's self to gain an immunity passport were all positively predictive of passport support.

These variables all codified how immunity passports can benefit one's self.

Similarly, we observed that, overall, COVID-19 concern and perceived severity to one's self were predictive of immunity passport uptake, but to a lesser degree. COVID-19 concern and perceived virus severity for others were not predictive, even through ordinal analyses revealed greater concern for others than for one's self within each country. These findings once again show how immunity passport support may hinge upon the personal benefits these certificates confer. Indeed, similar findings have been observed for vaccine uptake (Ashworth et al., 2021).

Against the growing account of immunity passport support due to their personal benefits, we also see support improve with neoliberal worldviews — seeing the free-market as fair and as working best if unrestrained by government interference. By contrast, limiting government interference was negatively predictive of immunity passport support, and so too were gender, immunity passport concern and perceived risk of harm to society. These parameters appear to code societal factors that influence one's judgement on immunity passport acceptance. Additionally, we posit that worldview items may serve as a proxy for correlated attitudes, such as political worldviews, and may prove important in countries prone to political tribalism (e.g., the United States; Helmuth et al., 2016). In these cases, policy makers may need bipartisan support when promoting immunity passports, not from a legislative standpoint, but from the view of gaining public support and the 'social licence to operate' (see e.g., Moffat et al., 2016; White et al., 2021, for a modern modelling approach to understanding social licence).

While in our combined model, we did not observe predictive effects for the contextual differences among countries, such as COVID-19 cases and deaths in each country at the time of their survey, we did observe differences between countries when modelled separately. Factors in some countries placed emphasis on concern for others (e.g., Japan) or on their concern for one's self (e.g., Taiwan), or differed by the lack of a predictive variable; for example, immunity passport support increased with the likelihood of infecting one's self in every country except the United Kingdom. By contrast, some factors were consistently predictive across countries, such as 'liking' or seeing immunity passports as being 'fair'. Observing this variance is key to understanding international attitudes; no one country is a monolith from which understanding or predictions may be extrapolated. However, modelling attitudes when combined across countries may provide new insights, such as displayed by the predictive qualities of one's gender or the perceived severity of COVID-19 to one's self in our primary model. This nuanced account of the data allows policy makers to consider how immunity passports would be perceived within their own countries (if one of the six assessed), or make generalized inferences based upon our collective modelling of these countries together.

COVID-19 policy decisions - wearing masks, home lock-downs, and the introduction of mobile tracking technologies - and country specific indices - COVID-19 cases and deaths, individualism, government effectiveness - were not predictive of immunity passport support. This finding reinforces our theory that attitudes towards the uptake of immunity passports are driven primarily by personal risks and benefits, and to a lesser extent, societal factors. This being said, we note a trend in our primary model away from immunity passport support in individualistic cultures and where masks are used; and towards support where mobile tracking-technologies are in use. While these estimates are too variable to draw meaningful inferences from, they may be an avenue of future research and may prove meaningful at a different stage of the pandemic. For now, the wide posterior distributions over the country-level variables makes any meaningful inference impossible in the current study, highlighting a key limitation of our analysis.

The current investigation was primarily limited by our sampling options. Representative online samples were conducted in all countries; however, these online samples may be biased towards technological solutions to large-scale problems. Further, our samples were not representative when considering education level, with the respondents in each country skewing towards being more heavily educated than their respective population. Indeed, our samples were not stratified by education, and this is a clear limitation of the study. We were also limited by public perceptions at the time of this investigation. In April-May of 2020, international vaccine roll-outs were yet to begin and focus was on non-pharmaceutical methods for virus suppression (e.g., mobile tracing apps). Attitudes may have since shifted as media begins to report on governments seeking to introduce vaccination and/or immunity passports, and the risks and benefits these documents provide. We expect this discussion will only become more heated as corporations, such as international airlines, begin limiting their services based on whether an individual has been vaccinated or recently recovered, and as the long-term side-effects of COVID-19 (i.e., long-COVID) become apparent.

Governments and corporations are now introducing immunity and vaccination passports as a way to quickly return society and the economy to normal, while encouraging the public to get vaccinated to protect themselves and their loved ones. However, the introduction of these passports will only work if the public supports their use. We find that immunity passport support is predicted by the personal benefits and risks they confer, gender, neoliberal world views, and the concern and perceived severity COVID-19 poses to one's self. Successfully accounting for these factors in policy decisions regarding immunity passports may be the difference between public acceptance or public backlash when individuals are prompted: "Papers please?"

Additional content

Data availability

Anonymized data and analysis code for this study are available through the Open Science Framework (OSF), https://osf.io/pwb9x/.

Supporting information

Supplementary materials associated with this paper include additional methods, figures and tables referenced in the text. Supplementary materials 1 describes mythological differences between countries and where to find additional methodology details, code and data for each country. Supplementary materials 2 describes the different modelling accounts of the immunity passport data. Supplementary materials 3 describes the immunity passport modelling completed for each country, separately.

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Author's contributions

The overarching project was led by S.Dennis and S.Lewandowsky, and coordinated with the input of all named authors. Data collection in Australia was handled by P.Garrett., J.White., and S.Dennis, in Taiwan by C.-T.Yang, in Germany by A.Kozyreva and P.Lorenz-Spren, in Japan by T.Kusumi, in the U.K. by S.Lewandowsky, and in Spain by Y.Okan. Survey translations for Germany were handled by A.Kpzyreva and P.Lorenz-Spren, for Spain by Y.Okan, for Taiwan by C.-T.Yang, and for Japan by T.Kusumi. Data collation and analysis was completed by P.Garrett. Manuscript writing and revisions were led by P.Garrett and contributed to by all authors.

References

Albert, J. H., & Chib, S. (1993). Bayesian analysis of binary and polychotomous response data. *Journal of the American statistical Association*, *88*(422), 669–679.

Ashworth, M., Thunström, L., Cherry, T. L., Newbold, S. C., & Finnoff, D. C. (2021). Emphasize personal health benefits to boost covid-19 vaccination rates. *Proceedings of the National Academy of Sciences*, *118*(32).

Brown, R. C., Savulescu, J., Williams, B., & Wilkinson, D. (2020). Passport to freedom? immunity passports for covid-19. *Journal of Medical Ethics*, *46*(10), 652–659.

Bürkner, P.-C., & Vuorre, M. (2019). Ordinal regression models in psychology: A tutorial. *Advances in Methods and Practices in Psychological Science*, *2*(1), 77–101.

Cha, S. (2021, Apr). *South korea to issue blockchain-protected digital 'vaccine passports'.* Thomson Reuters. Retrieved from https://www.reuters.com/article/us-health-coronavirus-southkorea-idUSKBN2BO43W

Davies, G. (2021). *Vaccine passports are being trialed in the uk: Why are they so controversial?* ABC News. Retrieved from https://abcnews.go.com/International/vaccine-passports-trialed-uk-controversial/story?id=76976981

Dye, C., & Mills, M. C. (2021). *Covid-19 vaccination passports.* American Association for the Advancement of Science.

Estifanos, A. S., Alemu, G., Negussie, S., Ero, D., Mengistu, Y., Addissie, A., … others (2020). 'i exist because of we': shielding as a communal ethic of maintaining social bonds during the covid-19 response in ethiopia. *BMJ Global Health*, *5*(7), e003204.

European Union. (2021). *Coronavirus: Commission proposes a digital green certificate.* Retrieved from https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1181

Garrett, P. M., Wang, Y., White, J. P., Hsieh, S., Strong, C., Lee, Y.-C., ... Yang, C.-T. (2021). Young adults view smartphone tracking technologies for covid-19 as acceptable: the case of taiwan. *International journal of environmental research and public health*, *18*(3), 1332.

Garrett, P. M., Wang, Y. W., White, J. P., Kashima, Y., Dennis, S., & Yang, C.-T. (n.d.). High national acceptance for covid-19 contact tracing technologies in taiwan. *PsyArXiV*.

Garrett, P. M., White, J. P., Lewandowsky, S., Kashima, Y., Perfors, A., Little, D. R., ... Dennis, S. (2021). The acceptability and uptake of smartphone tracking for covid-19 in australia. *Plos one*, *16*(1), e0244827.

Gelb, A., & Mukherjee, A. (2021). A covid vaccine certificate building on lessons from digital id for the digital yellow card. *Center for Global Development*, 27.

Guarascio, F. (2020). *Exclusive-who vaccine scheme risks failure, leaving poor countries with no covid shots until 2024.* Reuters.

Helmuth, B., Gouhier, T. C., Scyphers, S., & Mocarski, J. (2016). Trust, tribalism and tweets: has political polarization made science a "wedge issue"? *Climate Change Responses*, *3*(1), 1–14.

Hofstede Insights. (2020). *Country comparison.* Retrieved from `https://www.hofstede-insights.com/country-comparison/`

International Air Transport Association. (2021). *Iata travel pass initiative.* Retrieved from `https://www.iata.org/en/programs/passenger/travel-pass/`

Kelleher, S. R. (2021, June). *Europe update: These 12 countries are now using e.u.'s digital covid certificate, with another 16 on deck.* Forbes. Retrieved from `https://www.forbes.com/sites/suzannerowankelleher/2021/06/13/europe-digital-covid-certificate-vaccine-passport/?sh=79f5600c2251`

Khubchandani, J., Sharma, S., Price, J. H., Wiblishauser, M. J., Sharma, M., & Webb, F. J. (2021). Covid-19 vaccination hesitancy in the united states: a rapid national assessment. *Journal of Community Health*, *46*(2), 270–277.

Kim, J. H., Marks, F., & Clemens, J. D. (2021). Looking beyond covid-19 vaccine phase 3 trials. *Nature medicine*, *27*(2), 205–211.

Kozyreva, A., Lorenz-Spreen, P., Lewandowsky, S., Garrett, P., Herzog, S., Pachur, T., & Hertwig, R. (2021). Psychological factors shaping public responses to covid-19 digital contact tracing technologies in germany. *PsyArXiv*.

Lazarus, J. V., Ratzan, S. C., Palayew, A., Gostin, L. O., Larson, H. J., Rabin, K., … El-Mohandes, A. (2021). A global survey of potential acceptance of a covid-19 vaccine. *Nature medicine*, *27*(2), 225–228.

Lewandowsky, S., Dennis, S., Perfors, A., Kashima, Y., White, J. P., Garrett, P., … Yesilada, M. (2021). Public acceptance of privacy-encroaching policies to address the covid-19 pandemic in the united kingdom. *Plos one*, *16*(1), e0245740.

Liew, C. H., & Flaherty, G. T. (2021). Immunity passports to travel during the covid-19 pandemic: controversies and public health risks. *Journal of Public Health*, *43*(1), e135–e136.

Mallapaty, S., & Callaway, E. (2021). What scientists do and don't know about the oxford-astrazeneca covid vaccine. *Nature*, *592*(7852), 15–17.

Martin, A. D., Quinn, K. M., & Park, J. H. (2011). Mcmcpack: Markov chain monte carlo in r. *Foundation for Open Access Statistics*.

Moffat, K., Lacey, J., Zhang, A., & Leipold, S. (2016). The social licence to operate: a critical review. *Forestry: An International Journal of Forest Research*, *89*(5), 477–488.

Plummer, M., Best, N., Cowles, K., & Vines, K. (2006). Coda: convergence diagnosis and output analysis for mcmc. *R news*, *6*(1), 7–11.

Tsai, C. (2020). Personal risk and societal obligation amidst covid-19. *Jama*, *323*(16), 1555–1556.

Tsoi, K. K., Sung, J. J., Lee, H. W., Yiu, K. K., Fung, H., & Wong, S. Y. (2021). The way forward after covid-19 vaccination: vaccine passports with blockchain to protect personal privacy. *BMJ Innovations*, *7*(2).

Voo, T. C., Clapham, H., & Tam, C. C. (2020). Ethical implementation of immunity passports during the covid-19 pandemic. *The Journal of infectious diseases*, *222*(5), 715–718.

White, J. P., Dennis, S., Tomko, M., Bell, J., & Winter, S. (2021, 05). Paths to social licence for tracking-data analytics in university research and services. *PLOS ONE*, *16*(5), 1-19. Retrieved from https://doi.org/10.1371/journal.pone.0251964 doi: 10.1371/journal.pone.0251964

Wilford, G. (2021). *French mob destroys portrait of macron in protest against vaccine passports.* The Times. Retrieved from https://www.thetimes.co.uk/article/french-mob-destroys-portrait-of-macron-in-protest-against-vaccine-passports-q9tl9x88d

World Health Organization. (2021a, May). *Covid-19 natural immunity.* Retrieved from https://melbourneuni.au1.qualtrics.com/Q/MyProjectsSection

World Health Organization. (2021b). *Who coronavirus disease (covid-19) dashboard.* World Health Organization. Retrieved from https://covid19.who.int

Worldbank. (2020). *Worldwide governance indicator.* Retrieved from http://info.worldbank.org/governance/wgi/

Zhou, J., Yang, S., Xiao, C., & Chen, F. (2020). Examination of community sentiment dynamics due to covid-19 pandemic: a case study from australia. *arXiv preprint arXiv:2006.12185*.

Supplementary Material S1.

Survey differences by country

Due to the rapidly changing nature of the COVID-19 pandemic, surveys were updated regularly and modified for each country. To maximise survey similarities, survey translations were handled by researchers in each of their respective countries (e.g., English surveys were translated to Japanese, Spanish, German, and Chinese), and the survey order was kept the same (see Figure 2 of the main text). Here, we briefly highlight the survey differences between countries, and point to published methods where possible.

Australia

The Australian surveys were collected on April 15th and May 7th of 2020. The first survey assessed attitudes towards three hypothetical tracing technologies (telecommunication tracing, a Bluetooth Government App, and an App using the Apple/Google Exposure Notification system) and immunity passports. The second survey assessed attitudes towards the Australian COVIDSafe App and attitudes towards immunity passports. A representative sample of the Australian public stratified by age, gender and state were collected through the data sampling platform Dynata, and participants were reimbursed in the form of gift cards, points programs, or charitable contributions as per their agreement with Dynata. The complete surveys may be found via the Australian paper's Open Science Foundation (OSF) page, https://osf.io/sw7rq/, and the methods in full are reported in Garrett, White, et al. (2021). This study received ethics approval from the University of Melbourne's psychology health and applied sciences human ethics sub-committee, approval number 1955555.

United Kingdom

The United Kingdom survey was collected on April 16th 2020 and assessed attitudes towards three hypothetical tracing technologies and immunity passports. A representative sample of 752 participants stratified by age, gender and state were collected through Prolific Academic, and were reimbursed 85 Pence for completing a

10-minute survey. The survey materials are freely available via OSF, https://osf.io/pw5yj/, and the methods are reported in full in Lewandowsky et al. (2021). This survey did not differ in any meaningful way from the first Australian survey, except in how country specific words were replaced - United Kingdom rather than Australia - for this new audience. This study received ethics approval from the University of Bristol, approval number 103344.

Germany

The German survey was collected between the 17th – 22nd April and assessed attitudes towards three hypothetical tracing technologies and immunity passports. A representative sample of 1665 participants were collected through the online platform, Lucid, stratified by age, gender and region, and participants were reimbursed per their agreement with Lucid. The full methods for this paper are reported in Kozyreva et al. (2021), and the original surveys may be found in full through the study's OSF page, https://osf.io/xvzph. This survey did not differ meaningfully from the first Australian survey. The Institutional Review Board of the Max Planck Institute for Human Development approved the surveys (approval L2020-4).

Spain

The Spanish survey was collected between April 27th and May 5th 2020, and assessed attitudes towards one-of-three hypothetical tracing apps and immunity passport items. As in Germany, a representative sample of 1505 participants were collected through the online data sampling platform, Lucid, and participants were reimbursed per their agreement with Lucid. The Spanish survey was a translation of the United Kingdom survey (reported above), copies of which — along with the associated data — can be access through the Spanish OSF page, https://osf.io/xa4sf. A detailed breakdown of the results from this Spanish sample can be found at https://stephanlewandowsky.github.io/UKsocialLicence/SpainCov1.html. Ethics was obtained for this study through the University of Leeds, ethical approval code: 103402.

Taiwan

The Taiwan surveys were collected in four waves separated by one-week intervals, starting April 8th 2020 and ending April 29th 2020. Each wave collected a representative sample of 1500 participants (6000 in total) stratified by age, gender, and region, through the survey distribution company, Gosurvey, at a cost of $21,500 USD. Participants were reimbursed per their agreement with Gosurvey. Each survey assessed participant's psychological resilience, before asking participant's about their attitudes towards one-of-three hypothetical tracing technologies, and then their attitudes towards immunity passports. The full methods for this paper are reported in Garrett et al. (n.d.), and the surveys and data can be downloaded from the study's OSF page, https://osf.io/u28n7. These surveys did not differ meaningfully from the first Australian survey. Ethics approval for this study was obtained from the Ethics Committee of the Department of Psychology at the National Cheng Kung University (ethics code 108-072).

Japan

The Japan survey was collected between May 13th – 14th 2020. A representative sample of 1000 members of the Japanese public were collected through the data sampling company, 'Cross Marketing' ('Kurosu Marketing'), in Japan, and participants were reimbursed based on their personal agreement with Cross Marketing. Participants were queried on their attitudes to one-of-two tracing technologies - a Government Bluetooth App and the Apple/Google exposure notification system - before being assessed on their attitudes towards immunity passports.

Supplementary Material S2.

Alternative models

Alternative models were fit to the immunity passport support items including an ordinal probit model assessing immunity passport support post immunity passport questions. This probit model used the original ordinal categories, with each intercept representing a boundary between Likert categories. For example, intercept 1 would represents the lowest boundary between 'none' and 'a little', while intercept 5 would represent the boundary between 'a lot' and 'extremely'. Additionally, we modeled a binary and ordinal account of immunity passport support as measured prior to answering the immunity passport questions - the reader can think of this as participant's 'gut reaction', while the findings presented in the main paper reflect attitudes after having thought about the risks and benefits that accompany immunity passports. The following details the results of these alternative modelling accounts. Each model was instantiated with four chains, 2000 iterations each with 1000 burn-ins each, using non-informative priors for the intercept, with fixed effects estimated from weakly informative Laplacian distributed priors centered on 0 with a scale parameter of 1. For ease of reading, bold parameters denote where the 95% credible intervals do not cross zero, thus indicating an effect. Odds ratios were not calculated for the probit models; doing so would be a misrepresentation of the data as the probit account does not measure the log odds of moving between response categories, however, this would be true for an ordinal *logistic* regression.

Ordinal probit model of support measured *after* the immunity passport questions (i.e., an alternative modelling account of the binomial model presented in the main text).

Table S2.1

Ordinal probit model of immunity passport acceptance after answering immunity passport items.

Parameter	**Estimate**	**Error**	**Lower 95% CI**	**Upper 95% CI**
Intercept[1]	-1.11	0.41	-2.01	-0.25
Intercept[2]	-0.16	0.41	-1.06	0.7
Intercept[3]	0.68	0.41	-0.22	1.54
Intercept[4]	1.83	0.41	0.94	2.69
Intercept[5]	2.91	0.41	2.02	3.76
Age	-0.01	0.01	-0.03	0.01
GenderWoman	-0.02	0.02	-0.06	0.02
EducationHighschoolorGreater	-0.01	0.04	-0.08	0.07
EducationUniversityorEquivalent	-0.09	0.04	-0.16	-0.01
COVID_PositiveTRUE	0.24	0.07	0.1	0.37
COVID_PositiveOtherTRUE	0.02	0.03	-0.04	0.08
CumDeaths	0.02	0.02	-0.02	0.07
CumCases	-0.01	0.02	-0.05	0.03
TrackingTechnologyTRUE	0.27	0.43	-0.67	1.14
MaskUsageTRUE	-0.25	0.35	-0.96	0.51
LockdownTRUE	0.11	0.34	-0.63	0.8
GovEffectiveness	-0.01	0.18	-0.37	0.41
IndexOfCommunality	-0.26	0.24	-0.74	0.25
COVID_SeveritySelf	0.04	0.01	0.02	0.06
COVID_SeverityOther	0	0.01	-0.02	0.02
COVID_ConcernSelf	0.02	0.02	0	0.06
COVID_ConcernOther	0.04	0.01	0.01	0.07
WVeconomy	0.08	0.01	0.07	0.1
WVfreemarket	0.07	0.01	0.06	0.09
WVsmallgov	-0.04	0.01	-0.05	-0.02
IP_Concerned	-0.28	0.01	-0.31	-0.25
IP_Like	0.61	0.01	0.59	0.64
IP_HarmSociety	-0.25	0.01	-0.27	-0.22
IP_Fair	0.53	0.01	0.5	0.55
IP_InfectSelf	0.23	0.01	0.21	0.25

Binomial model of support before immunity passport questions

Table S2.2

Binomial model of immunity passport acceptance before answering immunity passport items. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds Ratio**	**Error**	**Lower 95% CI**	**Upper 95% CI**
Intercept	-0.06	0.94	0.64	-1.63	0.99
Age	0.12	1.13	0.03	0.07	0.18
GenderWoman	0.02	1.02	0.05	-0.08	0.11
EducationHighschoolorGreater	0.11	1.12	0.1	-0.08	0.31
EducationUniversityorEquivalent	0.15	1.16	0.1	-0.03	0.35
COVID_PositiveTRUE	-0.26	0.77	0.17	-0.59	0.06
COVID_PositiveOtherTRUE	0.11	1.12	0.08	-0.05	0.28
CumDeaths	-0.02	0.98	0.05	-0.13	0.08
CumCases	0.07	1.07	0.05	-0.03	0.18
TrackingTechnologyTRUE	0.09	1.09	0.59	-1.25	1.26
MaskUsageTRUE	-0.5	0.61	0.45	-1.37	0.52
LockdownTRUE	-0.16	0.85	0.47	-1.13	0.91
GovEffectiveness	0.21	1.23	0.26	-0.4	0.72
IndexOfCommunality	-0.69	0.5	0.43	-1.38	0.33
COVID_SeveritySelf	0.08	1.08	0.03	0.01	0.14
COVID_SeverityOther	0.06	1.06	0.03	0	0.12
COVID_ConcernSelf	-0.05	0.95	0.04	-0.13	0.02
COVID_ConcernOther	0.15	1.16	0.04	0.08	0.22
WVeconomy	0.14	1.15	0.02	0.11	0.18
WVfreemarket	0.15	1.16	0.02	0.12	0.19
WVsmallgov	-0.03	0.97	0.02	-0.07	0
IP_Concerned	-0.63	0.53	0.04	-0.7	-0.56
IP_Like	1.19	3.29	0.03	1.13	1.26
IP_HarmSociety	-0.32	0.73	0.03	-0.38	-0.25
IP_Fair	0.57	1.77	0.03	0.5	0.63
IP_InfectSelf	-0.02	0.98	0.03	-0.08	0.04

Ordinal probit model of support before immunity passport questions

Table S2.3

Ordinal probit model of immunity passport acceptance before answering immunity passport items.

Parameter	Estimate	Error	Lower 95% CI	Upper 95% CI
Intercept[1]	-1.66	0.45	-2.49	-0.47
Intercept[2]	-0.9	0.45	-1.73	0.29
Intercept[3]	-0.09	0.45	-0.92	1.09
Intercept[4]	1.08	0.45	0.25	2.27
Intercept[5]	2.18	0.45	1.34	3.36
Age	0.04	0.01	0.02	0.06
Gender (Woman)	0.03	0.02	-0.01	0.07
Education: High School	-0.03	0.04	-0.1	0.05
Education: University	0	0.04	-0.08	0.07
COVID Positive Self	-0.08	0.07	-0.21	0.06
COVID Positive Other	0.08	0.03	0.02	0.14
COVID Deaths (cumulative)	0.02	0.02	-0.02	0.06
COVID Cases (cumulative)	0	0.02	-0.04	0.04
Tracking Technology in Use	0.05	0.52	-1.06	1.11
Masks in Use	-0.29	0.37	-0.98	0.53
Lockdown in Use	-0.06	0.37	-0.82	0.82
Gov Effectiveness	0.06	0.2	-0.42	0.47
Index Of Communality	-0.33	0.27	-0.81	0.39
COVID Severity Self	0.05	0.01	0.02	0.07
COVID Severity Other	0.04	0.01	0.01	0.06
COVID Concern Self	-0.02	0.02	-0.05	0
COVID Concern Other	0.08	0.01	0.05	0.1
Neoliberal WV: Economy	0.07	0.01	0.06	0.09
Neoliberal WV: Freemarket	0.08	0.01	0.07	0.09
Neoliberal WV: Small Gov	-0.02	0.01	-0.03	0
I.P Concerned	-0.38	0.01	-0.41	-0.36
I.P Like	0.69	0.01	0.67	0.72
I.P Harm Society	-0.17	0.01	-0.19	-0.14
I.P Fair	0.29	0.01	0.26	0.31
I.P InfectSelf	-0.02	0.01	-0.05	0

Supplementary Material S3.

Binomial model parameters

Table S3.1

*Parameter coefficients for the binomial predictive model presented in text. All Rhat values were 1. * Denotes random intercepts. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.*

Paramater	**Estimate**	**Odds Ratio**	**Error**	**Lower 95% CI**	**Upper 95% CI**
Global Intercept	-1.67	0.19	0.69	-3.14	-0.32
Japan*	-0.66	0.52	0.67	-2.10	0.57
Spain*	-0.20	0.82	0.86	-2.00	1.54
Australia*	-0.07	0.93	0.67	-1.40	1.33
United Kingdom*	0.07	1.08	0.73	-1.49	1.56
Germany*	0.11	1.11	0.66	-1.29	1.38
Taiwan*	0.61	1.84	0.78	-0.79	2.31
Age	0.03	1.03	0.03	-0.02	0.08
Gender (Woman)	-0.11	0.9	0.05	-0.20	-0.02
Education: High School	0.14	1.15	0.10	-0.05	0.32
Education: University	-0.03	0.97	0.09	-0.21	0.15
COVID Positive Self	0.21	1.23	0.17	-0.11	0.55
COVID Positive Other	-0.01	0.99	0.08	-0.16	0.14
COVID Deaths (cumulative)	-0.03	0.97	0.05	-0.13	0.08
COVID Cases (cumulative)	0.06	1.06	0.05	-0.04	0.17
Tracking Technology in Use	0.58	1.79	0.70	-0.78	1.90
Masks in Use	-0.47	0.63	0.56	-1.55	0.63
Lockdowns in Use	0.26	1.30	0.54	-0.85	1.31
Government Effectivness	0.00	1.00	0.29	-0.58	0.61
Index of Individuality	-0.42	0.66	0.42	-1.23	0.45
COVID Severity Self	0.07	1.07	0.03	0.01	0.13
COVID Severity Other	0.00	1.00	0.03	-0.06	0.05
COVID Concern Self	0.07	1.07	0.04	0.00	0.15
COVID Concern Other	0.05	1.05	0.04	-0.01	0.12
Neoliberal WV: Economy	0.16	1.17	0.02	0.13	0.20
Neoliberal WV: Free Market	0.16	1.17	0.02	0.12	0.19
Neoliberal WV: Small Gov	-0.05	0.95	0.02	-0.09	-0.02
I.P Concern	-0.50	0.61	0.03	-0.56	-0.43
I.P Like	1.02	2.77	0.03	0.96	1.08
I.P Harm	-0.34	0.71	0.03	-0.40	-0.28
I.P Fair	0.92	2.51	0.03	0.86	0.98
I.P Infect Self	0.47	1.60	0.03	0.41	0.52

Supplementary Material S3.

Models by country

The following details the results of Bayesian generalized linear models completed separately for each country. Parameters that did not vary within a country (e.g., Government effectiveness was a point-estimate measure that varied between but not within countries), were excluded from the models. Each model was instantiated with four chains, 2000 iterations each with 1000 burn-ins each, using non-informative priors for the intercept, with fixed effects estimated from weakly informative Laplacian distributed priors centered on 0 with a scale parameter of 1. The following tables present estimates for each country, separately. For ease of reading, bold parameters denote where the 95% credible intervals do not cross zero, indicating an effect.

Table S3.1

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for Australia. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Error**	**Lower 95% CI**	**Upper 95% CI**
Intercept	-1.16	0.31	1.17	-3.38	1.29
Age	0.08	1.08	0.07	-0.07	0.23
Gender (Woman)	-0.24	0.79	0.14	-0.51	0.03
Education: High School	0.05	1.05	0.2	-0.34	0.45
Education: University	-0.08	0.92	0.2	-0.48	0.29
COVID Positive Self	0.84	2.32	0.46	-0.04	1.78
COVID Positive Other	0.27	1.31	0.22	-0.14	0.71
COVID Deaths (cumulative)	-0.03	0.97	0.83	-1.69	1.71
COVID Cases (cumulative)	-0.47	0.63	0.63	-1.85	0.67
Tracking Technology in Use	0.32	1.38	1.12	-1.86	2.88
Masks in Use	0.34	1.4	1.2	-2.04	3.05
Lockdown in Use	-0.36	0.7	1.16	-2.93	1.81
COVID Severity Self	0.09	1.09	0.09	-0.07	0.27
COVID Severity Other	0.04	1.04	0.08	-0.12	0.2
COVID Concern Self	0.21	1.23	0.12	-0.02	0.44
COVID Concern Other	-0.07	0.93	0.11	-0.28	0.14
Neoliberal WV: Economy	0.27	1.31	0.06	0.16	0.38
Neoliberal WV: Freemarket	0.08	1.08	0.06	-0.05	0.21
Neoliberal WV: Small Gov	-0.13	0.88	0.05	-0.23	-0.02
I.P Concerned	-0.45	0.64	0.1	-0.63	-0.27
I.P Like	1.31	3.71	0.09	1.14	1.48
I.P Harm Society	-0.16	0.85	0.09	-0.34	0.01
I.P Fair	1.23	3.42	0.09	1.05	1.41
I.P InfectSelf	0.71	2.03	0.08	0.55	0.87

Table S3.2

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for Germany. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Est.Error**	**Lower 95% CII**	**Upper 95% CI**
Intercept	-1.03	0.36	0.39	-1.8	-0.27
Age	0.09	1.09	0.08	-0.07	0.26
Gender (Woman)	-0.09	0.91	0.13	-0.35	0.17
Education: High School	-0.01	0.99	0.17	-0.35	0.33
Education: University	0.2	1.22	0.21	-0.19	0.63
COVID Positive Self	0.17	1.19	0.32	-0.45	0.81
COVID Positive Other	-0.18	0.84	0.17	-0.52	0.14
COVID Deaths (cumulative)	0.36	1.43	0.49	-0.48	1.45
COVID Cases (cumulative)	-0.43	0.65	0.49	-1.54	0.42
COVID Severity Self	0.1	1.11	0.1	-0.09	0.29
COVID Severity Other	-0.16	0.85	0.09	-0.34	0.01
COVID Concern Self	-0.06	0.94	0.11	-0.29	0.16
COVID Concern Other	0.12	1.13	0.1	-0.07	0.32
Neoliberal WV: Economy	0.21	1.23	0.05	0.11	0.31
Neoliberal WV: Freemarket	0.13	1.14	0.06	0.02	0.24
Neoliberal WV: Small Gov	-0.11	0.9	0.05	-0.21	-0.01
I.P Concerned	-0.28	0.76	0.1	-0.48	-0.09
I.P Like	1.3	3.67	0.1	1.11	1.5
I.P Harm Society	-0.32	0.73	0.1	-0.5	-0.13
I.P Fair	0.86	2.36	0.09	0.69	1.03
I.P InfectSelf	0.46	1.58	0.09	0.29	0.63

Table S3.3

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for Japan. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Est.Error**	**Lower 95% CII**	**Upper 95% CI**
Intercept	-2.45	0.09	0.73	-3.91	-1
Age	0.06	1.06	0.09	-0.12	0.25
Gender (Woman)	0.01	1.01	0.17	-0.31	0.34
Education: High School	-0.46	0.63	0.43	-1.36	0.29
Education: University	-0.62	0.54	0.43	-1.5	0.13
COVID Positive Self	1.09	2.97	0.88	-0.4	2.98
COVID Positive Other	-1.47	0.23	0.97	-3.62	0.09
COVID Deaths (cumulative)	-0.06	0.94	0.7	-1.52	1.4
COVID Cases (cumulative)	-0.05	0.95	0.7	-1.49	1.42
COVID Severity Self	0.17	1.19	0.11	-0.04	0.39
COVID Severity Other	-0.06	0.94	0.11	-0.27	0.15
COVID Concern Self	-0.23	0.79	0.15	-0.53	0.06
COVID Concern Other	0.39	1.48	0.16	0.08	0.71
Neoliberal WV: Economy	0.01	1.01	0.1	-0.17	0.2
Neoliberal WV: Freemarket	0.22	1.25	0.1	0.01	0.41
Neoliberal WV: Small Gov	0.01	1.01	0.08	-0.16	0.18
I.P Concerned	-0.46	0.63	0.13	-0.72	-0.2
I.P Like	0.94	2.56	0.11	0.72	1.16
I.P Harm Society	-0.09	0.91	0.11	-0.31	0.13
I.P Fair	0.6	1.82	0.11	0.39	0.81
I.P InfectSelf	0.7	2.01	0.1	0.52	0.89

Table S3.4

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for Spain. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Est.Error**	**Lower 95% CII**	**Upper 95% CI**
Intercept	-1.45	0.23	0.42	-2.27	-0.63
Age	0.03	1.03	0.08	-0.13	0.19
Gender (Woman)	0.05	1.05	0.14	-0.22	0.32
Education: High School	0.39	1.48	0.23	-0.03	0.84
Education: University	0.06	1.06	0.22	-0.36	0.51
COVID Positive Self	-0.11	0.9	0.29	-0.69	0.48
COVID Positive Other	-0.01	0.99	0.14	-0.29	0.27
COVID Deaths (cumulative)	0.16	1.17	0.23	-0.26	0.64
COVID Cases (cumulative)	-0.16	0.85	0.23	-0.64	0.26
COVID Severity Self	-0.08	0.92	0.1	-0.27	0.11
COVID Severity Other	0.1	1.11	0.09	-0.07	0.29
COVID Concern Self	0.04	1.04	0.12	-0.19	0.27
COVID Concern Other	-0.02	0.98	0.1	-0.22	0.18
Neoliberal WV: Economy	0.11	1.12	0.05	0.01	0.21
Neoliberal WV: Freemarket	0.25	1.28	0.05	0.14	0.35
Neoliberal WV: Small Gov	-0.16	0.85	0.06	-0.27	-0.05
I.P Concerned	-0.61	0.54	0.11	-0.82	-0.4
I.P Like	1.19	3.29	0.1	1.01	1.38
I.P Harm Society	-0.1	0.9	0.1	-0.31	0.1
I.P Fair	1.16	3.19	0.09	0.99	1.35
I.P InfectSelf	0.64	1.9	0.09	0.46	0.83

Table S3.5

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for Taiwan. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Est.Error**	**Lower 95% CII**	**Upper 95% CII**
Intercept	-1.62	0.2	0.31	-2.27	-1.04
Age	0.06	1.06	0.04	-0.01	0.13
Gender (Woman)	-0.09	0.91	0.07	-0.23	0.05
Education: High School	0.41	1.51	0.28	-0.1	1
Education: University	0.06	1.06	0.26	-0.42	0.62
COVID Positive Self	-0.29	0.75	0.42	-1.13	0.47
COVID Positive Other	-0.11	0.9	0.2	-0.53	0.28
COVID Deaths (cumulative)	-0.01	0.99	0.06	-0.12	0.09
COVID Cases (cumulative)	0.1	1.11	0.06	0	0.21
COVID Severity Self	0.05	1.05	0.04	-0.03	0.14
COVID Severity Other	0.01	1.01	0.04	-0.08	0.09
COVID Concern Self	0.13	1.14	0.05	0.03	0.24
COVID Concern Other	0.03	1.03	0.05	-0.07	0.13
Neoliberal WV: Economy	0.16	1.17	0.03	0.11	0.22
Neoliberal WV: Freemarket	0.15	1.16	0.03	0.09	0.21
Neoliberal WV: Small Gov	0	1	0.03	-0.06	0.06
I.P Concerned	-0.5	0.61	0.04	-0.59	-0.42
I.P Like	0.72	2.05	0.04	0.64	0.8
I.P Harm Society	-0.46	0.63	0.04	-0.54	-0.37
I.P Fair	0.82	2.27	0.04	0.74	0.9
I.P InfectSelf	0.32	1.38	0.04	0.24	0.39

Table S3.6

Parameter coefficients for the binomial predictive model of immunity passport support as assessed for the United Kingdom. All Rhat values were 1. Odds ratio denotes the multiplicative increase each coefficient confers to immunity passport support, calculated as the natural exponent of the estimate.

Parameter	**Estimate**	**Odds ratio**	**Est.Error**	**Lower 95% CII**	**Upper 95% CI**
Intercept	-0.6	0.55	0.6	-1.8	0.58
Age	0.07	1.07	0.09	-0.12	0.26
Gender (Woman)	-0.2	0.82	0.17	-0.51	0.12
Education: High School	-0.26	0.77	0.26	-0.81	0.23
Education: University	-0.06	0.94	0.22	-0.5	0.36
COVID Positive Self	0.36	1.43	1.22	-1.75	3.27
COVID Positive Other	0.19	1.21	0.2	-0.18	0.6
COVID Deaths (cumulative)	-0.74	0.48	1.19	-3.76	1.13
COVID Cases (cumulative)	-0.71	0.49	1.13	-3.37	1.2
COVID Severity Self	0.06	1.06	0.11	-0.15	0.27
COVID Severity Other	-0.03	0.97	0.09	-0.22	0.15
COVID Concern Self	0.05	1.05	0.12	-0.19	0.29
COVID Concern Other	0.07	1.07	0.11	-0.15	0.3
Neoliberal WV: Economy	0.1	1.11	0.06	-0.03	0.22
Neoliberal WV: Freemarket	0.06	1.06	0.08	-0.09	0.22
Neoliberal WV: Small Gov	-0.03	0.97	0.06	-0.16	0.09
I.P Concerned	-0.57	0.57	0.12	-0.81	-0.33
I.P Like	1.7	5.47	0.12	1.46	1.95
I.P Harm Society	-0.64	0.53	0.11	-0.87	-0.43
I.P Fair	1.15	3.16	0.12	0.92	1.39
I.P InfectSelf	0.13	1.14	0.09	-0.03	0.31