“Immunity Passports” for SARS-CoV-2: an online experimental study of the impact of antibody test terminology on perceived risk and behaviour

Jo Waller PhD1, G. James Rubin PhD2, Henry W. W. Potts PhD3, Abi Mottershaw4, Theresa M Marteau PhD5 *

1 Jo Waller, Reader in Cancer Behavioural Science, School of Cancer and Pharmaceutical Sciences, King’s College London, Guy’s Hospital, Great Maze Pond, London, SE1 9RT.

2 G. James Rubin, Reader in the Psychology of Emerging Health Risks. Department of Psychological Medicine, King’s College London, Weston Education Centre, Cutcombe Road, London, SE5 9RJ.

3 Henry W. W. Potts, Associate Professor, Institute of Health Informatics, University College London, 222 Euston Road London, NW1 2DA.

4 Abigail L. Mottershaw, Online Experiments Lead. Behavioural Insights Team, 4 Matthew Parker Street, London, SW1H 9NP.

5 Theresa M Marteau, Director of Research, Behaviour and Health Research Unit, University of Cambridge, Institute of Public Health, Forvie Site, Robinson Way, Cambridge, CB2 0SR.

* corresponding author: tm388@cam.ac.uk

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Test results indicating the presence of antibodies to SARS-CoV-2 are often referred to as Immunity Passports or Certificates.
- Due to the limitations of such tests, including uncertainty about the duration of immunity conferred by detected antibodies, those receiving results indicating the presence of antibodies retain a risk of becoming infected by SARS-CoV-2.
- It is unknown whether the use of the terms Immunity Passports or Certificates reduces awareness of the residual risk inherent in an antibody-positive test result and adherence to protective behaviours, thereby increasing risk of transmission.

WHAT THIS STUDY ADDS

- Using the term Immunity - as opposed to Antibody - to describe antibody tests for SARS-CoV-2 more than doubled the proportion who erroneously perceived they would have no risk of catching coronavirus in the future given an antibody-positive test result, from 9.8% for Antibody to 19.1% for Immunity.
- Perceiving no risk of infection with coronavirus given an antibody-positive test result was associated with an intention to wash hands less frequently.
- Using the terms Passport, Certificate or Test had no significant effect.

NOTE: This preprint reports new research that has not been certified by peer review and should not be used to guide clinical practice.
Objective: To assess the impact of describing an antibody-positive test result using the terms Immunity and Passport or Certificate, alone or in combination, on perceived risk of becoming infected with SARS-CoV-2 and intention to continue protective behaviours.

Design: 2 × 3 experimental design.

Setting: Online with data collected between 28th April and 1st May 2020.

Participants: 1,204 adults registered with a UK research panel.

Intervention: Participants were randomised to receive one of six descriptions of an antibody test and results showing SARS-CoV-2 antibodies, differing in the terms used to describe the type of test (Immunity vs Antibody) and the test result (Passport vs Certificate vs Test).

Main outcome measures: The primary outcome was the proportion of participants perceiving no risk of becoming infected with SARS-CoV-2 given an antibody positive test result. Other outcomes include intended changes to frequency of handwashing and physical distancing.

Results: When using the term Immunity (vs Antibody), 19.1% of participants [95% CI: 16.1 to 22.5] (vs 9.8% [95% CI: 7.5 to 12.4]) perceived no risk of catching coronavirus at some point in the future given an antibody-positive test result (AOR: 2.91 [95% CI: 1.52 to 5.55]). Using the terms Passport or Certificate – as opposed to Test – had no significant effect (AOR: 1.24 [95% CI: 0.62 to 2.48] and AOR: 0.96 [95% CI: 0.47 to 1.99] respectively). There was no significant interaction between the effects of the test and result terminology. Across groups, perceiving no risk of infection was associated with an intention to wash hands less frequently (AOR: 2.32 [95% CI: 1.25 to 4.28]) but there was no significant association with intended avoidance of physical contact with others outside of the home (AOR: 1.37 [95% CI: 0.93-2.03]).

Conclusions: Using the term Immunity (vs Antibody) to describe antibody tests for SARS-CoV-2 increases the proportion of people believing that an antibody-positive result means they have no risk of catching coronavirus in the future, a perception that may be associated with less frequent handwashing. The way antibody testing is described may have implications for the likely impact of testing on transmission rates.

Key words: SARS-CoV-2; COVID-19; antibody testing; immunity; passport; certificate; risk perception; protective behaviours

Study registration: Open Science Framework: https://osf.io/tjwz8/files/
Introduction

At the height of the first wave of the COVID-19 pandemic, about a third of the world’s population is estimated to have been in lockdown, with all but essential workers largely confined to home (1).

Without an effective treatment or vaccine, testing for infection combined with contact tracing and isolation will be central to effective strategies to ease populations out of lockdown while keeping the basic reproduction number (R₀) below one (2).

Testing for antibodies to SARS-CoV-2 is a possible complement to testing for active infection to identify those who have developed antibodies to the virus and so may be able to return to work and other activities without significantly increasing transmission rates (3). These tests have been variously described in the media as Immunity Passports (4,5), Immunity Certificates (6,7) Immunity Cards (8) and Release Certificates (9). Unfortunately, the use of these terms implies a certainty unmatched by current evidence about antibody tests (10).

Uncertainties inherent in tests for antibodies to SARS-CoV-2 include the extent and duration of immunity conferred (11). They also include the uncertainties inherent in any test regarding the proportion of those who would be correctly identified. This depends upon the test performance – its sensitivity and specificity – as well as the population prevalence of the tested condition (12). Given these uncertainties, those who receive a test result indicating the presence of antibodies will have a residual risk of becoming infected by SARS-CoV-2 in the future.

Understanding that there is this residual risk – albeit one that is difficult to quantify at present – will be important to minimise transmission that could arise from those receiving “antibody positive” test results. If people testing positive perceive that they have no risk of becoming infected by the virus, they may ignore any future symptoms of infection and facilitate transmission if they fail to self-isolate appropriately. Such a perception may also over-generalise to a belief that they are unable to transmit infection through contact with contaminated surfaces. Regardless of antibody status, all individuals can indirectly transmit the virus between surfaces by touch. Hand washing or sanitising therefore need to remain frequent.

Evidence from other testing programmes suggests that interpreting a low risk result to mean no risk can be reduced by verbal and numerical expressions of residual risk when presenting test results (13,14). But even before testing programmes are in place, the terms commonly used to describe these tests – Immunity Passport or Certificates – may inadvertently be fuelling a misplaced sense of certainty about their results. It is unknown whether describing these tests as being for immunity – as opposed to antibodies – or their results as passports or certificates increases misunderstanding of the residual risk inherent in an antibody-positive
test result and thereby reducing adherence to protective behaviours and increasing risk of transmission (15).

This study was designed to test two hypotheses: describing a test indicating the presence of antibodies using the term Immunity (vs Antibody), and describing test results as Passports or Certificates (vs Test), increases the likelihood that those with this test result erroneously perceive they have no risk of becoming infected in the future with coronavirus.

**Methods**

Ethical approval for this study was granted by the King’s College London Research Ethics Committee (reference: MRA-19/20-18685).

The protocol was preregistered on the Open Science Framework [https://osf.io/tjwz8/ Study 2](https://osf.io/tjwz8/).

The statistical analysis plan was pre-specified and uploaded to the Open Science Framework prior to receipt of the data [https://osf.io/tjwz8/ Study 2](https://osf.io/tjwz8/).

An initial study with similar methods was conducted [https://osf.io/tjwz8/ Study 1](https://osf.io/tjwz8/) but, due to an error, the intervention was not correctly programmed. This study is therefore not reported.

**Design**

The study was an online experiment using a 2 × 3 factorial design, with participants randomised, with an equal allocation ratio, to one of six groups varying in the description of an antibody test and a result showing the presence of antibodies. These descriptions differed only in the term used for what was being tested (Immunity vs Antibody) and the term used for the test result (Passport vs Certificate vs Test).

**Participants**

A quota sample of 1,204 adults was recruited via Predictiv, the Behavioural Insights Team’s online experimentation platform ([https://www.bi.team/bi-ventures/predictiv/](https://www.bi.team/bi-ventures/predictiv/)) comprising 500,000 adults in the UK. Quotas were based on age, gender and UK region to achieve a sample broadly representative of the UK population. 1373 clicked on the link to enter the study of whom 1214 subsequently completed the study. Ten were excluded for failing to meet quality checks. Participants were reimbursed in points (equivalent to £1) which could be redeemed in cash, gift vouchers or charitable donations. Participants did not know the topic of the study prior to participation.

**Patient and public involvement**

Due to the rapid nature of this research, the public was not involved in the development of the study.
Power
The sample size was chosen pragmatically without reference to a specific power calculation. We are fitting a full model with an interaction. Conservatively, we then had an 80% chance of detecting, at a 5% significance level, an increase in the primary outcome measure from 50% in a baseline group to 64% in another group.

Randomisation
Participants were randomised to groups by random number generation. A random number between 1 and 6 was generated for every participant upon entry to the study to determine which description they saw, with each of the six numbers corresponding to one of the six description. As this is based on true randomness, the number of participants within each group can vary due to chance.

Intervention
The intervention comprised a description of antibody testing and test results indicating the presence of antibodies [see Box 1 for one example and S1 for wording of all six descriptions]. These differed across six groups in test name of results indicating the presence of antibodies. All descriptions included the information that the result would mean a lower risk of future infection and transmission, and that people with this result could return to work earlier.

Box Immunity Passport: one of the six descriptions of an antibody-positive test result

| Immunity Passport |
|---------------------------------|
| Scientists are developing tests to see who has already had coronavirus. |

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future, and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get an immunity passport.

They could return to work early.

Outcomes measures
Wording of the items used for each measure is shown in Supplementary Materials (S2).
**Primary outcome**
Proportion of participants perceiving an antibody-positive test result to mean no risk of catching coronavirus in the future, assessed in response to a question with four response options.

**Secondary outcomes**
Perceived likelihood of catching coronavirus in the future, assessed on a visual analogue scale from 0% to 100%.

Intention to engage in handwashing less or more frequently than now, given an antibody-positive test result: assessed in response to a question with five response options.

Intention to avoid physical contact with others outside the home more or less frequently than now, given an antibody-positive test result: assessed in response to a question with five response options.

Interest in undergoing the test if offered today: assessed in response to a question with four response options.

**Other measures**
Demographic characteristics: age, gender, level of education and geographical region of residence. Employment status, planned to be included, was omitted due to a technical error.

**Statistical analyses**
A detailed statistical analysis plan is available on the Open Science Framework, specified prior to receipt of the data https://osf.io/tjwz8/ Study 2. Binary logistic regression was used to assess the impact of test type (immunity/antibody) and result type (passport/certificate/test) on the odds of believing the antibody test result means there is no risk of future infection. An interaction term was included in the model (16). The analysis was repeated adjusting for age (including a quadratic function to model a non-linear relationship), gender, education and region based on prior results showing these are predictors of risk beliefs.

Binary logistic regressions were run (as above) for the secondary outcomes: intention to wash hands less, intention to engage less in social distancing and intention to undergo the test. Unadjusted and adjusted odds ratios and 95% confidence intervals are reported. Logistic regression was run to assess the extent to which intentions to engage in less frequent handwashing or social distancing measures is predicted by perceiving the test result to mean no risk of being infected in the future by coronavirus.

As only a very small proportion of participants gave a ‘zero’ response on the sliding scale of future risk, we used a linear regression model to examine this outcome, rather than a binary (zero vs. other) logistic regression as pre-specified in the analysis plan.

**Procedure**
Data were collected using an online survey platform, Predictiv. Upon entry to the study, participants were informed that they were to be asked some questions about coronavirus and that it would take about five minutes to complete. Participants were then shown one of six brief descriptions of an antibody test for coronavirus (see S1 for full text for each of the six descriptions). They were then asked five questions, assessing the primary and secondary outcomes. Participants’ demographic characteristics were accessed from the survey platform.

**Results**

**Sample characteristics**
The sample comprised 606 women and 598 men with a median age of 36 years. Around a quarter had some graduate-level education (24.2%) and there was good representation of all UK regions (see Table 1). Distribution of sample characteristics by exposure group is shown in Table 1.

**Descriptive statistics**

**Primary outcome**
Responses to the five outcome questions for the whole sample and by experimental group are shown in Table 2. Overall, 14.5% of respondents [95% CI: 12.5 to 16.6] interpreted the test result as meaning they had no risk of future infection. Over half (57.8% [95% CI: 55.0 to 60.1]) correctly interpreted the test result as meaning that their future risk of coronavirus was ‘lower’.

**Secondary outcomes**
Perceived level of future risk (on a scale of 0 to 100%) showed a complex, trimodal distribution. The median was 35% with an interquartile range from 18% to 51%. Only 5% of respondents put their risk at 0%. Overall, 63% put their risk below 50%. 10% put their risk at 50%, which was the modal response. 24% put their risk at greater than 50%, but below 100%. 3% of respondents put their risk at 100%; that is, they said they were certain to contract the virus.

On the behavioural outcomes, 4.9% [95% CI: 3.8 to 6.3] said they would wash their hands less frequently than now if they received a positive result while 19.7% [95% CI: 17.5 to 22.1] said they would be less inclined to avoid physical contact with others outside the home. Intentions to have the test if offered were high, with 56.1% [95% CI: 53.2 to 58.9] saying they would definitely, and 29.2% [95% CI: 26.6 to 31.8] saying they would probably have the test if offered today.
Table 1 – Demographic characteristics of participants by experimental group (n=1204)

| Characteristics       | All (n=1204) | Passport (n=187) | Certificate (n=235) | Test (n=179) | Passport (n=219) | Certificate (n=209) | Test (n=175) |
|-----------------------|-------------|-----------------|--------------------|-------------|-----------------|--------------------|-------------|
| Gender [n (%)]        |             |                 |                    |             |                 |                    |             |
| Female                | 606 (50.3)  | 86 (46.0)       | 126 (53.6)         | 94 (52.5)   | 112 (51.1)      | 98 (46.9)          | 90 (51.4)   |
| Male                  | 598 (49.7)  | 101 (54.0)      | 109 (46.4)         | 85 (47.5)   | 107 (48.9)      | 111 (53.1)         | 85 (48.6)   |
| Age [median (IQR)]    | 36 (32)     | 35 (34)         | 36 (34)            | 36 (31)     | 38 (32)         | 34 (27)            | 36 (31)     |
| Education [n (%)]     |             |                 |                    |             |                 |                    |             |
| Below degree          | 888 (73.8)  | 139 (74.3)      | 177 (75.3)         | 126 (70.4)  | 165 (75.3)      | 150 (71.8)         | 131 (74.9)  |
| Degree or above       | 291 (24.2)  | 45 (24.1)       | 52 (22.1)          | 49 (27.4)   | 49 (22.4)       | 55 (26.3)          | 41 (23.4)   |
| Missing               | 25 (2.1)    | 3 (1.6)         | 6 (2.6)            | 4 (2.2)     | 5 (2.3)         | 4 (1.9)            | 3 (1.7)     |
| UK region [n (%)]     |             |                 |                    |             |                 |                    |             |
| England – London      | 160 (13.3)  | 24 (12.8)       | 33 (14.0)          | 27 (15.1)   | 25 (11.4)       | 27 (12.9)          | 24 (13.7)   |
| England – Midlands    | 189 (15.7)  | 38 (20.3)       | 34 (14.5)          | 24 (13.4)   | 30 (13.7)       | 32 (15.3)          | 31 (17.7)   |
| England – South & East| 373 (31.0)  | 48 (25.7)       | 74 (31.5)          | 51 (28.5)   | 75 (34.2)       | 74 (35.4)          | 51 (29.1)   |
| England – North       | 308 (25.6)  | 46 (24.6)       | 65 (27.7)          | 50 (27.9)   | 59 (26.9)       | 43 (20.6)          | 45 (25.7)   |
| Scotland/Wales/NI     | 174 (14.5)  | 31 (16.6)       | 29 (12.3)          | 27 (15.1)   | 30 (13.7)       | 33 (15.8)          | 24 (13.7)   |
Table 2 – Primary and secondary outcomes by experimental group (n=1204)

|                          | All (n=1204) | Passport (n=187) | Immunity Certificate (n=235) | Test (n=179) | Passport (n=219) | Certificate (n=209) | Test (n=175) |
|--------------------------|--------------|------------------|------------------------------|--------------|------------------|---------------------|--------------|
| **Perceived meaning of result for future risk [n (%)]** |              |                  |                              |              |                  |                     |              |
| No risk                  | 174 (14.5)   | 26 (13.9)        | 50 (21.3)                    | 39 (21.8)    | 24 (11.0)        | 19 (9.1)            | 16 (9.1)     |
| Lower risk (correct)     | 697 (57.9)   | 106 (56.7)       | 127 (54.0)                   | 92 (51.4)    | 126 (57.5)       | 134 (64.1)          | 112 (64.0)   |
| Average risk             | 248 (20.6)   | 40 (21.4)        | 42 (17.9)                    | 36 (20.1)    | 54 (24.7)        | 41 (19.6)           | 35 (20.0)    |
| Higher risk              | 85 (7.1)     | 15 (8.0)         | 16 (6.8)                     | 12 (6.7)     | 15 (6.8)         | 15 (7.2)            | 12 (6.9)     |
| **Perceived absolute risk (0-100) [Mean (SD)]**      |              |                  |                              |              |                  |                     |              |
| 1-100%                   | 1144 (95.0)  | 179 (95.7)       | 219 (93.2)                   | 161 (89.9)   | 214 (97.7)       | 200 (95.7)          | 171 (97.7)   |
| 0%                       | 60 (5.0)     | 8 (4.3)          | 16 (6.8)                     | 18 (10.1)    | 5 (2.3)          | 9 (4.3)             | 4 (2.3)      |
| **Intention to wash hands [n (%)]**                   |              |                  |                              |              |                  |                     |              |
| Much less than now       | 13 (1.1)     | 3 (1.6)          | 7 (3.0)                      | 0 (0.0)      | 0 (0.0)          | 2 (1.0)             | 1 (0.6)      |
| Less than now            | 46 (3.8)     | 6 (3.2)          | 11 (4.7)                     | 7 (3.9)      | 8 (3.7)          | 10 (4.8)            | 4 (2.3)      |
| Same as now              | 800 (66.4)   | 121 (64.7)       | 159 (67.7)                   | 127 (70.9)   | 138 (63.0)       | 143 (68.4)          | 112 (64.0)   |
| More than now            | 161 (13.4)   | 23 (12.3)        | 26 (11.1)                    | 18 (10.1)    | 34 (15.5)        | 29 (13.9)           | 31 (17.7)    |
| Much more than now       | 184 (15.3)   | 34 (18.2)        | 32 (13.6)                    | 27 (15.1)    | 39 (17.8)        | 25 (12.0)           | 27 (15.4)    |
| **Intention to avoid physical contact [n (%)]**        |              |                  |                              |              |                  |                     |              |
| Much less than now       | 36 (3.0)     | 2 (1.1)          | 9 (3.8)                      | 10 (5.6)     | 4 (1.8)          | 6 (2.9)             | 5 (2.9)      |
| Less than now            | 201 (16.7)   | 35 (18.7)        | 48 (20.4)                    | 29 (16.2)    | 32 (14.6)        | 33 (15.8)           | 24 (13.7)    |
| Same as now              | 642 (53.3)   | 96 (51.3)        | 116 (49.4)                   | 96 (53.6)    | 116 (53.0)       | 126 (60.3)          | 92 (52.6)    |
| More than now            | 178 (14.8)   | 28 (15.0)        | 34 (14.5)                    | 21 (11.7)    | 44 (20.1)        | 27 (12.9)           | 24 (13.7)    |
| Much more than now       | 147 (12.2)   | 26 (13.9)        | 28 (11.9)                    | 23 (12.8)    | 23 (10.5)        | 17 (8.1)            | 30 (17.1)    |
| **Would you have the test if offered? [n (%)]**         |              |                  |                              |              |                  |                     |              |
| No, definitely not       | 38 (3.2)     | 5 (2.7)          | 14 (6.0)                     | 5 (2.8)      | 5 (2.3)          | 4 (1.9)             | 5 (2.9)      |
| No, probably not         | 140 (11.6)   | 24 (12.8)        | 28 (11.9)                    | 23 (12.8)    | 23 (10.5)        | 20 (9.6)            | 22 (12.6)    |
| Yes, probably            | 351 (29.2)   | 54 (28.9)        | 67 (28.5)                    | 53 (29.6)    | 62 (28.3)        | 58 (27.8)           | 57 (32.6)    |
| Yes, definitely          | 675 (56.1)   | 104 (55.6)       | 126 (53.6)                   | 98 (54.7)    | 129 (58.9)       | 127 (60.8)          | 91 (52.0)    |
Table 3 – Logistic regression analysis examining impact of Test type and Result type on perception that the test result means ‘no risk’

| Test Type        | Proportion answering ‘no risk’ in each sub-group | Result means “No Risk” of future infection | Odds ratio (95% confidence interval) |
|------------------|-------------------------------------------------|-------------------------------------------|-------------------------------------|
| Antibody (n=603) | 9.8 (7.5-12.4)                                   | Mutually adjusted                         | Ref                                 |
| Immunity (n=601) | 19.1 (16.1-22.5)                                 | Adjusted for demographics¹ (n=1179)      | 2.77 (1.48-5.17)                    |

| Result Type      | Proportion answering ‘no risk’ in each sub-group | Result means “No Risk” of future infection | Odds ratio (95% confidence interval) |
|------------------|-------------------------------------------------|-------------------------------------------|-------------------------------------|
| Test (n=354)     | 15.5 (11.9-19.7)                                 | Mutually adjusted                         | Ref                                 |
| Certificate (n=444) | 15.5 (12.3-19.3)                               | Adjusted for demographics                 | 0.99 (0.50-2.00)                    |
| Passport (n=406) | 12.3 (9.3-15.9)                                  |                                           | 1.22 (0.63-2.38)                    |

| Test by result interaction | Proportion answering ‘no risk’ in each sub-group | Result means “No Risk” of future infection | Odds ratio (95% confidence interval) |
|---------------------------|-------------------------------------------------|-------------------------------------------|-------------------------------------|
| Certificate by Immunity result | 0.98 (0.42-2.27)                               | Mutually adjusted                         | Ref                                 |
| Passport by Immunity result | 0.47 (0.20-1.12)                                | Adjusted for demographics                 | 1.00 (0.42-2.40)                    |

¹Fully adjusted model includes age (with quadratic term), gender, education level and region (coded as per Table 1)
Between-group differences in the primary outcome

When Test type (Immunity vs. Antibody), Result type (Certificate vs. Passport vs. Test) and an interaction term were entered into a logistic regression model predicting the belief that the test result meant ‘no risk’ of future infection (see Table 3), there was a significant effect of Test type, which persisted when we adjusted for demographic factors (age (including a quadratic term), gender, education level and UK region; AOR: 2.91 [95% CI: 1.52 to 5.55]. Those in the ‘Immunity’ group were more likely to believe the result meant ‘no risk’ than those in the Antibody group (19.1% [95% CI: 16.1 to 22.5] vs. 9.8% [95% CI: 7.5 to 12.4]) [Figure 1]. There was no significant effect of result type and no significant interaction.

Between-group differences in secondary outcomes

We analysed the continuous measures of future perceived risk of infection using a linear model (ANOVA) with two levels for test type, three levels for result type, and an interaction term. Overall, there was no significant effect: \( F_{5,1198} = 1.46, p = 0.20, \) adjusted \( R^2 < 1\% \). We repeated the analysis adjusting for demographic factors as covariates. Overall, there was a significant effect: \( F_{13,1165} = 1.88, p = 0.03, \) adjusted \( R^2 = 1\% \). This was because of a significant effect of age: as age increased, perceived risk decreased. There remained no significant effect of the experimental variables.

Logistic regression analyses examining the impact of Test type, Result type and their interaction on intentions to wash hands and avoid physical contact less frequently and on willingness to have the test are shown in Supplementary tables 1 and 2. Neither Test type, Result type nor their interaction were significantly associated with these behavioural outcomes.

Association between test result meaning ‘no risk’ and behavioural intentions

Logistic regression analyses were used to examine belief that the result meant ‘no risk’ as a predictor of intention to wash hands and avoid physical contact less frequently, given a positive result (see Figure 2 and Supplementary table 3). In analyses adjusting for demographic factors, those who believed there was no residual risk were at increased odds of intending to wash their hands less (AOR: 2.32 [95% CI: 1.25 to 4.28]). The association with intentions to physically distance outside the home was not significant (AOR: 1.37 [95% CI: 0.93 to 2.03]).
Discussion

Using the term Immunity – as opposed to Antibody – to describe antibody tests for SARS-CoV-2 doubled the proportion who erroneously perceived they would have no risk of becoming infected with the virus in the future if they were given an antibody-positive test result, from 9.8% for Antibody to 19.1% for Immunity (AOR: 2.91 [95% CI: 1.52 to 5.55]). Using the terms Passport, Certificate or Test to describe the results had no significant effect on risk perception (AOR: 0.96 [95% CI: 0.47-1.99] for Certificate and 1.24 [0.62-2.48] for Passport, compared with Test). The terms used to describe the test and results had no significant direct impact on intentions to engage in the protective behaviours of handwashing or physical distancing. However, across conditions, a greater proportion of those perceiving the result to mean no risk intended to wash their hands less often (10.3% [95% CI: 6.3 to 15.9]) compared with 4.0% who understood there was a residual risk (4.3% [95% CI: 2.8 to 5.3]).

These was no significant association with intended frequency of avoiding physical contact with others outside of the home. Interest in undergoing the test was high – with 85.2% saying they would probably or definitely have it if offered – and was unaffected by the terms used to describe the tests.

This study was designed to test two hypotheses, providing strong support for the first, that describing a test indicating the presence of antibodies using the term Immunity (vs Antibody) increases the likelihood that those with this test result erroneously perceive they have no risk of becoming infected in the future with coronavirus. This likely reflects a certainty about risk of future infection implicit in lay understandings of the term immunity that is not implied by the term antibody (17). Qualitative studies could explore this and other potential mechanisms for the effect observed.

The results of this study did not support the second hypothesis that describing test results as Passports or Certificates increases the likelihood that those with this test result erroneously perceive they have no risk of becoming infected in the future with coronavirus. This does not mean that these terms are unproblematic however, only that they did not influence the specific perceptions that we explored. Qualitative studies are warranted to understand the broader meanings these terms have in the context of testing for antibodies for SARS-CoV-2 and other contexts.

Responses on the sliding scale of future risk showed a high variability and were largely unexplained by the experimental intervention or other variables measured. This may point to considerable uncertainty in the public as to how to interpret test results. It also likely reflects the well-described tendency of people to use a 50% response to indicate uncertainty rather than a true judgement of probability (18). We also saw that about a quarter of respondents on the first question stated their risk was “average” or “higher”. This may point to considerable uncertainty in the public as to how to interpret test results Use of the top end of the scale is hard to interpret but may either reflect a failure to read the information carefully and
therefore a misunderstanding of the meaning of the result, or participants’ using information beyond the experiment to assess their risk and not adequately considering the hypothetical test result when making their response.

While we found no evidence for a direct effect on protective behaviours of the terms used to describe antibody tests results, there was indirect evidence that perceiving no risk of future infection might reduce frequency of handwashing. This finding is tentative, given it is based on behavioural intentions in response to a hypothetical antibody-positive result. Nonetheless the potential for antibody testing to increase viral transmission must be considered alongside the potential benefits the tests might have in allowing the easing of lockdown restrictions. Clear communication about the ongoing need for handwashing, in particular, will be essential and raising public awareness of the main mechanisms through which SARS-CoV-2 is transmitted – through air and surfaces – might help improve adherence. This, in addition to acknowledgment of the imperfect nature of the tests, will give the public a more accurate representation of the meaning and implications of an antibody test result and a better understanding of how to reduce the risk of transmission. Such communications need to emphasise that transmission can occur through contact regardless of antibody status. Such communications also need to be rigorously evaluated to ensure their effectiveness at communicating these points both to those undergoing antibody tests as well as to general populations that are now having to learn to live with SARS-CoV-2.

Strengths and Limitations
This study provides the first experimental evidence for the potentially adverse impact on risk perceptions and protective behaviours of commonly used terms to describe SARS-CoV-2 antibody tests and their results. As such, it provides timely evidence to inform policy and research to mitigate these effects to realise the potential benefits of such tests.

The study has several limitations. First, participants were responding to a hypothetical test and asked to imagine that they had received a test result that had detected antibodies. Findings from such studies can generalise to clinical settings (19,20) but some caution is warranted.

Second, the protective behaviours of handwashing and physical distancing were measured using single items assessing behavioural intentions following a hypothetical test result.

Third, the sample size was insufficient to detect effect sizes that could be important at a population level. It is possible, for example, that the use of the terms Certificate or Passport might impact on risk perception, but the current study lacked the power to detect this.

Fourth, while quotas were used to achieve a sample broadly representative of the UK population, research panels are not representative of the general population (21,22). We found no evidence that the impact of the interventions in this study was modified by demographic characteristics of the participants, providing some reassurance about the generalisability of results across age groups, gender, educational level and geographical region of the UK.
Implications for research and policy

The results of this study have several implications for research and policy. The effectiveness of antibody tests for SARS-CoV-2 will depend not only on the extent and duration of any immunity conferred and the performance of a test, but also upon a good understanding of the meaning of tests results among those offered them. First, the use of the term Immunity should be avoided in phrases to describe antibody tests, whether described as Passports, Certificates or Tests. Second, research is needed to evaluate different ways of informing those offered tests and receiving tests results to minimise the proportion erroneously perceiving an antibody-positive test result to mean no risk of becoming infected with the virus. It should also focus on maximising understanding that – regardless of antibody-status – anyone can indirectly transmit the virus by touching a contaminated surface and infecting the next surface they touch. Hand washing or sanitising therefore need to remain frequent. Research is also needed with those undergoing actual tests, powered to detect effects judged meaningful in the context of a population-based testing programme and involving measures of actual behaviour.

Conclusion

Interest in SARS-CoV-2 antibody testing is high – across many countries, employers and populations. While such testing could contribute to wider strategies to ease lock-down restrictions, their use may have an adverse impact on transmission-related behaviour. This appears to vary with the way the tests are described. Using the term Immunity (vs Antibody) to describe antibody tests increases the proportion of people believing that an antibody-positive result means they have no future risk of coronavirus, a perception that may be associated with less frequent handwashing and hence increased risk of transmission.
Figure 1  Proportion believing an antibody-positive test result means ‘no risk’ of future infection Error bars show 95% confidence intervals

Figure 2  Perceived meaning of an antibody-positive test result for future risk and intentions to reduce frequency of hand washing Error bars show 95% confidence intervals
References

1. Hale T, Webster S, Petherick A, Phillips T, Kira B. *Oxford COVID-19 Government Response Tracker*, Blavatnik School of Government [Internet]. 2020. Available from: https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker

2. World Health Organization. *Critical preparedness, readiness and response actions for COVID-19*. World Health Organization [Internet]. 2020. (Interim Guidance 22 March 2020). Report No.: WHO/2019-nCoV/Community_Actions/2020.3. Available from: https://www.who.int/publications-detail/critical-preparedness-readiness-and-response-actions-for-covid-19

3. Studdert DM, Hall MA. Disease Control, Civil Liberties, and Mass Testing — Calibrating Restrictions during the Covid-19 Pandemic. *N Engl J Med* [Internet]. 2020 Apr 9. Available from: https://doi.org/10.1056/NEJMp2007637

4. Proctor K, Sample I, Oltermann P. ‘Immunity passports’ could speed up return to work after Covid-19. *The Guardian* [Internet]. 2020 Mar 30; Available from: https://www.theguardian.com/world/2020/mar/30/immunity-passports-could-speed-up-return-to-work-after-covid-19

5. Slotnick D. Delta’s CEO said he would support an ‘immunity passport’ program or other steps to jumpstart travel as the airline reports its first quarterly loss in more than 5 years. *Business Insider* [Internet]. Available from: https://www.businessinsider.com/delta-first-quarter-coronavirus-air-travel-outlook-after-the-pandemic-2020-4

6. Merrick R. People could be given coronavirus ‘immunity certificates’ to leave lockdown early. *The Independent* [Internet]. 2020 Apr 2. Available from: https://www.independent.co.uk/news/uk/politics/coronavirus-uk-immunity-certificate-boris-johnson-test-germany-a9442211.html

7. Giugliano F. Mass Coronavirus Antibody Tests Have Serious Limits. *Bloomberg.com* [Internet]. 2020 Apr 24. Available from: https://www.bloomberg.com/opinion/articles/2020-04-24/coronavirus-mass-covid-19-antibody-tests-have-serious-limits

8. Forgey Q. Fauci: Coronavirus immunity cards for Americans are ‘being discussed’. *POLITICO* [Internet]. Available from: https://www.politico.com/news/2020/04/10/fauci-coronavirus-immunity-cards-for-americans-are-being-discussed-178784

9. Sherwood D. Chile to push ahead with coronavirus ‘release certificates’ despite WHO warning. *Reuters* [Internet]. 2020 Apr 26. Available from: https://www.reuters.com/article/us-health-coronavirus-chile-idUSKCN2280NW

10. Adams ER, Anand R, Andersson MI, Auckland K, Baillie JK, Barnes E, et al. Evaluation of antibody testing for SARS-Cov-2 using ELISA and lateral flow immunoassays. MedRxiv Prepr. 2020 Jan 1;2020.04.15.20066407.
11. Altmann DM, Douek DC, Boyton RJ. What policy makers need to know about COVID-19 protective immunity. *The Lancet* [Internet]. 2020 Apr 27. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30985-5/abstract

12. Loong T-W. Understanding sensitivity and specificity with the right side of the brain. *BMJ*. 2003;327(7417):716–719.

13. Marteau T, Saidi G, Goodburn S, Lawton J, Michie S, Bobrow M. Numbers or words? A randomized controlled trial of presenting screen negative results to pregnant women. Published in affiliation with the International Society for Prenatal Diagnosis. *Prenat Diagn* 2000209714-718.

14. Marteau TM, Senior V, Sasieni P. Women’s understanding of a “normal smear test result”: experimental questionnaire based study. *BMJ*. 2001;322(7285):526–528.

15. World Health Organization. ‘Immunity passports’ in the context of COVID-19 [Internet]. World Health Organization. Report No.: WHO/2019-nCoV/Sci_Brief/Immunity_passport/2020.1. Available from: https://www.who.int/publications-detail/immunity-passports-in-the-context-of-covid-19

16. Jaki T, Vasileiou D. Factorial versus multi-arm multi-stage designs for clinical trials with multiple treatments. *Stat Med*. 2017 Feb 20;36(4):563–80.

17. Lohm D, Davis M, Flowers P, Stephenson N. ‘Fuzzy’ virus: indeterminate influenza biology, diagnosis and surveillance in the risk ontologies of the general public in time of pandemics. *Health Risk Soc*. 2015 Feb 17;17(2):115–31.

18. de Bruin WB, Fischhoff B, Millstein SG, Halpern-Felsher BL. Verbal and Numerical Expressions of Probability: ‘It’s a Fifty-Fifty Chance’. *Organ Behav Hum Decis Process*. 2000 Jan;81(1):115–31.

19. Wright AJ, Takeichi C, Whitwell SCL, Hankins M, Marteau TM. The impact of genetic testing for Crohn’s disease, risk magnitude and graphical format on motivation to stop smoking: an experimental analogue study. *Clin Genet*. 2008 Apr;73(4):306–14.

20. Hollands GJ, Whitwell SCL, Parker RA, Prescott NJ, Forbes A, Sanderson J, et al. Effect of communicating DNA based risk assessments for Crohn’s disease on smoking cessation: randomised controlled trial. *BMJ*. 2012 Jul 20;345. Available from: https://www.bmj.com/content/345/bmj.e4708

21. Office for National Statistics. *Internet users, UK:2019*. Office for National Statistics; 2019 May. Available from: https://www.ons.gov.uk/businessindustryandtrade/itandinternetindustry/bulletins/internetusers/2019

22. Wright KB. Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services. *J Comput-Mediat Commun*. 2005;10(3).
Funding
Data collection for this study was funded by a block UK government grant to the Behavioural Insights Team. JW is funded by a career development fellowship from Cancer Research UK (ref C7492/A17219). GJR is funded by the National Institute for Health Research Health Protection Research Unit (NIHR HPRU) in Emergency Preparedness and Response at King’s College London in partnership with Public Health England (PHE), in collaboration with the University of East Anglia. The views expressed in this paper are those of the authors and not necessarily those of UK government, Cancer Research UK, NIHR or Public Health England.

Competing interests
All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; and no financial relationships with any organisations that might have an interest in the submitted work in the previous three years. HWWP declares consultancy fees from Babylon Health; all authors declare no other relationships or activities that could appear to have influenced the submitted work.

Transparency declaration
The authors affirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned have been explained.

Data sharing statement
Anonymised data will be made available upon reasonable request.

Author contribution statement
The study was conceptualised by TMM, JW & GJR. AM completed data collection. JW & HP analysed the data. All authors contributed to, and approved, the final manuscript.

Acknowledgements
We thank Steve Reicher for comments on an earlier draft of the study protocol
Supplementary Materials

51 Interventions

Intervention A

Immunity Passport

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get an immunity passport.

They could return to work early.

Intervention B

Immunity Certificate

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get an immunity certificate.

They could return to work early.
Intervention C

**Immunity Test**

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get a result showing immunity.

They could return to work early.

Intervention D

**Antibody Passport**

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get an antibody passport.

They could return to work early.

Intervention E

**Antibody Certificate**

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get an antibody certificate.

They could return to work early.
Intervention F

Antibody Test

Scientists are developing tests to see who has already had coronavirus.

No test is 100% effective.

This means that those who test ‘positive’ would have:

- Lower risk of catching coronavirus in the future - and therefore also
- Lower risk of passing it on to others

Those who test ‘positive’ would get a result showing antibodies.

They could return to work early.
S2. Measures

Primary outcome

I Imagine you were given [an immunity passport/an immunity certificate/a result showing immunity/an antibody passport/an antibody certificate/a result showing antibodies] which one of the following statements is true: [order of response options to be randomised]

1. I have no risk of catching coronavirus in the future
2. I have a lower risk of catching coronavirus in the future
3. I have an average risk of catching coronavirus in the future
4. I have a higher risk of catching coronavirus in the future

Secondary outcomes

II Imagine you were given [an immunity passport/an immunity certificate/a result showing immunity/an antibody passport/an antibody certificate/a result showing antibodies] how likely is it that you will get coronavirus at some point in the future?

Please answer on a scale from 0 % to 100% where 0% means no chance and 100% means certain.

0% -------------------------------------------------------------------------------- 100%

III Imagine that you were given [an immunity passport/an immunity certificate/a result showing immunity/an antibody passport/an antibody certificate/a result showing antibodies] would you wash your hands with soap and water or sanitiser:

1. Much more than now
2. More than now
3. Same as now
4. Less than now
5. Much less than now

IV Imagine you were given [an immunity passport/an immunity certificate/a result showing immunity/an antibody passport/an antibody certificate/a result showing antibodies] would you avoid physical contact with others outside of your home:

1. Much more than now
2. More than now
3. Same as now
4. Less than now
5. Much less than now

V If you were offered a test today by the NHS to check whether you have ever had coronavirus, would you have it?

1. Yes, definitely
2. Yes, probably
3. No, probably not
4. No, definitely not
## Supplementary Table 1 – Logistic regression analysis examining impact of Test type and Result type on protective behaviours

|                               | % responding less/much less in each subgroup | Mutually adjusted (n=1204) | Adjusted for demographics¹ (n=1179) | % responding less/much less in each subgroup | Mutually adjusted (n=1204) | Adjusted for demographics¹ (n=1179) |
|--------------------------------|-------------------------------------------|-----------------------------|-------------------------------------|-------------------------------------------|-----------------------------|-------------------------------------|
| **Intend to wash hands less** |                                           |                             |                                     |                                           |                             |                                     |
| Test Type                      |                                          |                             |                                     |                                           |                             |                                     |
| Antibody (n=603)               | 4.1 (2.7-6.1)                             | Ref                         | 1.38 (0.43-4.45)                    | 17.2 (104)                               | Ref                         | 1.40 (0.82-2.39)                   |
| Immunity (n=601)               | 5.7 (4.0-7.8)                             | Ref                         | 1.62 (0.46-5.73)                    | 22.1 (133)                               | Ref                         | 1.46 (0.85-2.50)                   |
| Result Type                    |                                          |                             |                                     |                                           |                             |                                     |
| Test (n=354)                   | 3.4 (1.8-5.9)                             | Ref                         | 2.07 (0.72-6.00)                    | 19.2 (68)                                | Ref                         | 2.47 (0.77-7.96)                   |
| Certificate (n=444)            | 6.8 (4.6-9.5)                             | Ref                         | 2.47 (0.77-7.96)                    | 21.6 (96)                                | Ref                         | 1.16 (0.68-1.96)                   |
| Passport (n=406)               | 4.2 (2.5-6.6)                             | Ref                         | 1.29 (0.41-4.01)                    | 18.0 (73)                                | Ref                         | 1.79 (0.52-6.16)                   |
| Test by Result interaction     |                                          |                             |                                     |                                           |                             |                                     |
| Certificate by Immunity result | 0.98 (0.25-3.95)                          | 0.80 (0.18-3.56)            |                                     | 1.00 (0.49-2.01)                       | 0.94 (0.46-1.93)            |
| Passport by Immunity result    | 0.96 (0.21-4.40)                          | 0.58 (0.11-2.98)            |                                     | 0.89 (0.43-1.87)                       | 0.84 (0.40-1.78)            |

¹Fully adjusted model includes age (with quadratic term), gender, education level and region (coded as per Table 1)
**Supplementary Table 2 – Logistic regression examining impact of Test and Result type on intention to have the test**

|                        | Do not intend to have the test |                             |                             |
|------------------------|-------------------------------|-----------------------------|-----------------------------|
|                        | Proportion who would not have test in each sub-group | Mutually adjusted (n=1204) | Adjusted for demographics¹ (n=1179) |
| **Test Type**          |                               |                             |                             |
| Antibody (n=603)       | 13.1 (10.5-16.1)              | Ref                         | Ref                         |
| Immunity (n=601)       | 16.5 (13.6-19.7)              | 1.02 (0.57-1.81)            | 0.97 (0.54-1.74)            |
| **Result Type**        |                               |                             |                             |
| Test (n=354)           | 15.5 (11.9-19.7)              | Ref                         | Ref                         |
| Certificate (n=444)    | 14.9 (11.7-18.5)              | 0.71 (0.39-1.28)            | 0.63 (0.34-1.15)            |
| Passport (n=406)       | 14.0 (10.8-17.8)              | 0.80 (0.54-1.42)            | 0.82 (0.46-1.47)            |
| **Test by Result interaction** |                                   |                             |                             |
| Certificate by Immunity result | 1.65 (0.75-3.63)              | 1.91 (0.84-4.31)            |
| Passport by Immunity result | 1.23 (0.55-2.75)              | 1.22 (0.54-2.78)            |

¹Fully adjusted model includes age (with quadratic term), gender, education level and region (coded as per Table 1)
### Supplementary Table 3 – Logistic regression analysis examining impact of perceived risk on anticipated behaviour

| Perceived meaning of result | Intend to wash hands less | Intend to avoid contact less |
|-----------------------------|---------------------------|-----------------------------|
|                             | % responding less/much less in each sub-group % (95% CI) | Unadjusted (n=1204) | Adjusted for demographics\(^1\) (n=1179) | % responding less/much less in each sub-group % (95% CI) | Unadjusted (n=1204) | Adjusted for demographics\(^1\) (n=1179) |
| Some residual risk (n=1030) | 4.0 (2.8-5.3) | Ref | Ref | 18.8 (16.5-21.4) | Ref | Ref |
| No residual risk of future infection (n=175) | 10.3 (6.3-15.9) | 2.78 (1.56-4.97) | 2.32 (1.25-4.28) | 24.7 (18.5-31.8) | 1.41 (0.97-2.06) | 1.37 (0.93-2.03) |

\(^1\)Fully adjusted model includes age (with quadratic term), gender, education level and region (coded as per Table 1)