Original Research

# Effect of SARS-CoV-2 antibody screening on participants' attitudes and behaviour: a study of industry workers in Split, Croatia

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## ARTICLE INFO

## ABSTRACT

*Objectives:* To investigate the changes in personal attitudes and behaviour before and after negative serological test results for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) antibodies.
*Study design:* Cross-sectional questionnaire survey.
*Methods:* A survey questionnaire was conducted with 200 industry workers (68% males and 32% females) who had previously tested negative for SARS-CoV-2 antibodies. The survey examined participants' self-reported general attitudes towards coronavirus disease 2019 (COVID-19), their sense of fear, as well as their behaviour towards protective measures before and after the testing.
*Results:* Participants perceived the disease as a severe health threat and acknowledged that the protective measures were appropriate. Respondents reported a high level of adherence to measures and low level of fear, both before and after the testing. Although these indicators were statistically significantly reduced after the test ($P < 0.004$), they did not result in irresponsible non-adherence behaviours. Almost all respondents attributed their application of personal protection measures to factors other than the results of serological screening.
*Conclusions:* Serological tests do not contribute to irresponsible non-adherence behaviours in an environment where protective measures are efficient. However, they may help reduce fear within society and working environments.

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## Introduction

Since November 2019, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, resulting in coronavirus 2019 (COVID-19), has been spreading around the globe. As of 15 May 2020, the COVID-19 pandemic has resulted in >4.5 million recorded cases and >300,000 deaths globally.[1] Countries worldwide are testing their populations to estimate the number of people with active virus infection and the number of those who have recovered from it. It is highly recommended that reverse transcription polymerase chain reaction (RT-PCR) testing is prioritised in hospitalised patients, healthcare facility workers, workers in congregate living settings, first responders, residents in long-term care facilities and in the general population with symptoms of (potential) COVID-19 infection.[2] To estimate the number of people who have previously been exposed to and/or infected with the virus, serological immunoassay tests are currently the best option, especially because of their low cost and short amount of time needed to obtain the results.[3]

The first case of COVID-19 in the Republic of Croatia was reported in late February 2020. To prevent the spread and exponential growth of the disease, restrictive measures were introduced by the Croatian Government on 19 March 2020.[4,5] From 23 March 2020, leaving the place of residence was also prohibited.[6] With such restrictive measures, Croatia earned first place on the stringency scale compiled by the Oxford COVID-19 Government Response Tracker on 26 March.[7] Among mandatory protective measures, citizens were continuously provided with

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recommendations for personal protection, including social distancing (1 m in open areas, 2 m in closed areas), wearing face masks and maintaining personal hygiene. In addition to national measures,[4–6] many companies introduced additional measures to further protect the health of their employees and to allow their businesses to continue functioning. Such is the case for the DIV Group, a company specialising in shipbuilding and the production and trade of screws and mechanical parts, which introduced serological testing for employees, using rapid serological immunoassay, as a health protection element within their corporate security system.[8,9]

Although the findings of serological tests for COVID-19 can be an essential part of investigating the disease, the tests vary in sensitivity and specificity and also produce false-negative and false-positive results.[10,11] These issues pose a danger to not only the health of tested individuals and communities, but they can also reduce the positive effects of national health policies and protective or restrictive measures necessary for the containment of disease.[12] This can be especially devastating as some health experts worry that testing populations and providing them with the knowledge of their health and/or immunity status regarding COVID-19 could lead to psychological and behavioural changes.[13]

The psychological and behavioural effects of receiving negative test results have already been investigated in various screenings for different conditions. There is concern that after receiving negative test results, individuals may perceive they have a lower risk of developing the disease they were tested for and may subsequently be less likely to take the necessary protective precautions.[14,15] A systematic review that included eight screening programmes for diseases linked to lifestyle behaviours (type 2 diabetes; breast, bowel, lung and cervical cancer and abdominal aortic aneurysm) investigated the postscreening changes in behaviours, attitudes and emotions. The study showed that negative screening results are unlikely to cause changes in observed characteristics or have a negative impact on behaviour.[16] Nevertheless, since COVID-19 is a novel disease whose spread is most effectively prevented by maintaining social distancing, community consciousness, personal protection and hygiene practices,[17] behaviours that are dependent on the conscientiousness and self-control of individuals, it is of utmost importance to examine the behaviours and attitudes of people who receive negative test results. Furthermore, these factors are vital in specific working environments, where interpersonal contact cannot be avoided entirely due to production characteristics. In these settings, changes in behaviour and attitudes of workers could impact the general psychological environment and, most importantly, the health of company workers and their families.

Thus, this study aims to investigate the changes in personal attitudes and behaviour of the DIV Group industry workers before and after receiving negative serological test results for SARS-CoV-2 antibodies.

## Methods

### Participants and setting

A cross-sectional survey was conducted with the DIV Group industry workers in Split-Dalmatia County, Croatia, who had previously tested negative for SARS-CoV-2 antibodies by rapid immunoassays. The survey was conducted between the 10th and 15th of May, 2020, which corresponds to 12—22 days after serological screening (23—28 April, 2020). The serological testing comprised 1316 participants and was the first mass testing in the Republic of Croatia, and, to the authors' knowledge, was one of the first and largest studies, on a corporate level, in the world at that time.[9] Of 1316 participants, results revealing that only 0.99% of participants (95% confidence interval [CI] 0.53 to 1.68) were positive for SARS-CoV-2 antibodies.[9] All 1316 individuals who took part in the serological screening were invited to participate in this cross-sectional survey.

The DIV Group facility in Split employs about 2200 people, which makes them the second largest employer in the county. The Split facility employee structure includes those working in production, as well as management and administration.[8,9]

To examine if the test results had an impact on participants' attitudes and behaviour, a short questionnaire was designed and employees were surveyed, with the permission of the management of the company. The companies' occupational safety officers distributed the questionnaire to employees in the different company departments (i.e. management, administrative and production) who had participated in the serological screening. Completion of the survey was on a voluntary basis. As only a small proportion (0.99%) of employees tested positive for SARS-CoV-2 antibodies, the current study only includes individuals with negative test results.

### Questionnaire

The questionnaire included the following six sections: (1) information of the study and informed consent; (2) general demographic data and test results; (3) participants' general attitudes towards COVID-19; (4) participants' protective behaviour and fear of the disease prior to testing; (5) participants' protective behaviour and fear of the disease after the testing; and (6) factors related to compliance with personal protection measures.

The general and demographic questions included gender, age, test results (negative/IgG positive/IgM positive/IgM + IgG positive) and level of education. Other personal data were not included to ensure the participants' anonymity.

The third section of the questionnaire included questions on participants' perception of COVID-19 and its severity, as well as their attitudes towards the protective and restrictive measurements given at the national and company level. There were seven statements that participants rated on a five-level Likert scale for agreement (1 = strongly disagree; to 5 = strongly agree).

In sections four and five of the questionnaire, participants were asked about their anxiety and fear of COVID-19, compliance with restrictive measures and application of protective equipment before and after the testing. These sections were each composed of two sub-sections. The first included nine statements regarding the participants' fear and perception of their environment; participants rated these on a five-level Likert scale for agreement (1 = strongly disagree; to 5 = strongly agree). In the second sub-section, participants were asked to rate their frequency of obeying the restrictive measurements and applying personal protective equipment. It included four statements with responses on a five-level Likert scale for frequency (1 = never; to 5 = very frequently).

In the final section of the questionnaire, participants were provided with four statements about factors that influence their adherence to the restrictive and protective measures, including the serological test results and level of actual restrictive measures and recommendations. They were asked to select one of the four statements that best suited their views.

The survey was approved by the University Department of Forensic Sciences Ethics Committee on 22 April 2020 (2181-227-05-12-19-0003; 024-04/19-03/00007) and was in the Croatian language. An English translation of the questionnaire is available in the online supplementary material (see Supplementary Material: Questionnaire).

*Statistical analyses*

Categorical variables, including the gender, education level and factors influencing adherence to the protective measures, are given as frequencies and percentages. For the remaining variables, we provided the mean values with 95% CIs. Differences in categorical variables were examined using the Chi-squared test with the assumption that each category needs to have a similar number of respondents, while the differences in participants' responses before and after the testing were examined using a paired-samples *t*-test. Due to the increased number of multiple comparisons (n = 14), statistical significance was set at $P \leq 0.004$ (Bonferroni correction). All analyses were performed using JASP 0.12.1 (JASP Team, 2020).

## Results

The sample comprised 200 participants (68% men; median age = 43 years, interquartile range of age = 21 years). The majority of respondents had an undergraduate or graduate education (47.7%) or had completed secondary education (32.7%), while fewer participants completed non-university college or professional studies (18.6%). There were two participants with only primary education (1%), and one answer was missing.

Most participants perceived COVID-19 as a dangerous disease and reported that restrictive measures and protective guidelines at the national and company level were efficient and appropriate (see Table 1).

On average, participants had low levels of fear of becoming infected (Table 2, statements 4 and 6) or infecting others with COVID-19 (Table 2, statements 3 and 5); these results were observed both before and after the testing. Participants' perception of other people adhering to protective measures was also high pre- and post-testing (Table 2, statements 7−9). Nonetheless, changes in participants' behaviour and attitudes before and after testing were statistically significant for most variables. Suspicions that a person or people in their physical vicinity were infected were significantly reduced (Table 2, statements 1−2). However, participants' perception of other peoples' adherence to measures did not change significantly (Table 2, statements 7−8).

Participants, on average, showed a high frequency of adherence to protective measures and restrictions (Table 3). When they were asked about their pre-test and post-test adherence frequencies, they reported maintaining the application of personal protective equipment at almost the same level, but a lower adherence to social distancing was seen (Table 3, statements 2−4).

Although participants reported changes in behaviour and attitudes before and after receiving the test results, the majority of participants did not attribute their behaviour to the test itself, but rather to the level of company and national protective measures (Table 4).

## Discussion

The results of the present study show changes in the behaviour and attitudes of participants after receiving negative serological test results, but not to the extent that would lead to irresponsible or dangerous behaviours. Moreover, participants did not report that their adherence to personal protection measures was related to serological test results. To the best of the authors' knowledge, this is the first study to investigate the changes in behaviours and attitudes to COVID-19 before and after receiving negative serological test results.

The results of this study indicate that the levels of fear of being infected or infecting others with COVID-19, as well as behaviours regarding adherence to protective measures, changed significantly after receiving negative test results. However, the fear of becoming infected and/or infecting others was initially at a low-moderate to low level and dropped even lower after receiving negative test results. At the end of February 2020, although COVID-19 was emerging as a pandemic disease and was relatively unexplored, the situation at the DIV Group was under control and protective measures had already been introduced. The company's decision to implement these measures at an early stage was influenced by the experience of their partners in China and Italy, which were, at the time, global pandemic hotspots. The company measures, along with national protective measures, introduced by the second half of March 2020,[4−6] are likely to have had a beneficial impact on the low level of fear seen in the study participants.

The frequency of positive behaviour related to social distancing reduced after the testing but still remained high. In contrast, results indicate no significant changes in behaviour related to wearing protective equipment, masks and gloves, which remained highly adherent. Both of these findings could be attributed to the promoting environment of the company and society, which raised awareness of the need for protective and restrictive measures. In addition, there were no changes in the perception of colleagues' compliance with protective measures pre- and post-testing, which highlights participants' responsibility and conscientiousness, regardless of their test results.

Most importantly, only 1% of participants attributed their application of personal protection measures to the results of serological testing, rather than other factors. This implies that the antibody testing itself was not likely to generate changes in behaviour. Although the current study could not precisely provide causality of observed changes, it is worth noting that most

**Table 1**
General attitudes on COVID-19 and protective measures.[a]

| Statement | Mean (95% CI) |
|---|---|
| 1. COVID-19 is a severe threat to society and health. | 4.0 (3.9−4.2) |
| 2. I consider the COVID-19 antibody test and its results reliable. | 3.9 (3.8−4.0) |
| 3. Protective and restrictive measures in the Republic of Croatia are appropriate and well implemented. | 4.0 (3.9−4.1) |
| 4. Protective and restrictive measures in my workplace are appropriate and well implemented. | 4.3 (4.2−5.0) |
| 5. I adhere to protective measures to protect my health. | 4.5 (4.4−4.6) |
| 6. I adhere to protective measures to protect society. | 4.6 (4.5−4.7) |
| 7. I am afraid of contact with people who have recovered from COVID-19 and returned to the workplace. | 2.4 (2.2−2.6) |

COVID-19, coronavirus disease 2019; CI, confidence interval.
[a] Response to the statements ranged: 1 − strongly disagree; 2 − disagree; 3 − neutral; 4 − agree; 5 − strongly agree.

**Table 2**
Self-reported behavioural characteristics before and after the serological test for SARS-CoV-2 antibodies.[a]

| Statement | Mean (95% CI) | | P-value[b,c] |
|---|---|---|---|
| | Before the test | After the test | |
| 1. I suspect I am infected with COVID-19. | 1.6 (1.4–1.7) | 1.3 (1.2–1.4) | **0.002** |
| 2. I suspect that some people in my work environment are infected with COVID-19. | 2.0 (1.8–2.1) | 1.6 (1.5–1.7) | **<0.001** |
| 3. I was afraid to be around colleagues because I might infect them. | 2.1 (1.9–2.2) | 1.5 (1.4–1.6) | **<0.001** |
| 4. I was afraid to be around colleagues because they might infect me. | 2.2 (2.1–2.4) | 1.7 (1.6–1.9) | **<0.001** |
| 5. I was afraid to be around people who were not part of my household or immediate work environment because I might infect them. | 2.4 (2.2–2.6) | 1.7 (1.6–1.8) | **<0.001** |
| 6. I was afraid to be around people who were not part of my household or immediate work environment because they might infect me. | 2.6 (2.4–2.8) | 2.2 (2.0–2.4) | **<0.001** |
| 7. People in my work environment have complied with all current protection measures. | 4.2 (4.1–4.3) | 4.1 (4.0–4.3) | 0.470 |
| 8. Members of my household and/or people I socialise with, adhered to all current protection measures to protect me. | 4.2 (4.1–4.4) | 4.1 (4.0–4.3) | 0.145 |
| 9. Members of my household and/or people I socialise with, adhered to all current protection measures to protect others. | 4.3 (4.2–4.4) | 4.1 (4.0–4.2) | **0.002** |
| Total score | 25.4 (24.6–26.2) | 22.4 (21.7–23.1) | **<0.001** |

COVID-19, coronavirus disease 2019; CI, confidence interval; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.
[a] Response to the statements ranged: 1 − strongly disagree; 2 − disagree; 3 − neutral; 4 − agree; 5 − strongly agree.
[b] Paired-samples *t*-test.
[c] Statistically significant values are in bold.

**Table 3**
Self-reported frequency of adherence to protective measures.[a]

| Statement | Mean (95% CI) | | P-value[b,c] |
|---|---|---|---|
| | Before the test | After the test | |
| 1. Since the introduction of restrictive measures, I have worn protective equipment (mask and/or gloves). | 4.3 (4.2–4.4) | 4.2 (4.0–4.3) | 0.011 |
| 2. Since the introduction of restrictive measures, I have maintained a social distance. | 4.5 (4.4–4.6) | 4.3 (4.2–4.4) | **<0.001** |
| 3. Since the introduction of restrictive measures, I have avoided socialising with more than five people. | 4.5 (4.4–4.6) | 4.2 (4.1–4.3) | **<0.001** |
| 4. Since the introduction of restrictive measures, I have avoided socialising with people who are not part of my household and immediate work environment. | 4.3 (4.2–4.4) | 4.0 (3.9–4.1) | **<0.001** |
| Total score | 17.6 (17.2–17.9) | 16.6 (16.2–17.1) | **<0.001** |

CI, confidence interval.
[a] Response to the statements ranged: 1 − never; 2 − seldom; 3 − sometimes; 4 − frequently; 5 − very frequently.
[b] Paired-samples t-test.
[c] Statistically significant values are in bold.

respondents reported considerable influence of national measures to their application of personal protection measures.

Studies on screening for various diseases, such as different types of cancer, sexually transmitted diseases (STDs) and diabetes, have been conducted to determine their psychological and behavioural impacts, but also the perception of ones' health and future risk of getting sick.[18–22] A recent review on these types of studies showed a small decrease in perceived risk of the disease screened for, slightly lower levels of anxiety or worry in the screen-negative group and highlighted that only 5 of 28 studies showed an unfavourable change in the negatively screened groups' health-related behaviours.[16]

Although the present study findings indicate changes of similar direction and extent, it is difficult to compare its results with the abovementioned studies. This is due to the very nature of COVID-19, which is an infectious disease spread primarily by human contact and interaction. With the exception of STDs, the other diseases that populations are usually screened for are not transmittable.[18–22] It is also not possible to compare STD screening with COVID screening, as the transmission of STDs is usually restricted to the most intimate of human interactions and thus comparisons are limited. In the absence of a viable vaccine, stopping the spread of infectious diseases, such as COVID-19, is impossible without necessary changes in human interactions and behaviour, which must be applied to all members of society.

A limitation of this study is that all data were collected after the serological testing took place, in the single survey questionnaire, thus potentially introducing reporting bias. To obtain pre-test

**Table 4**
Factors affecting adherence to protective measures.

| Statement best describing participants' opinion | n (%)[a] | P-value[b,c] |
|---|---|---|
| My application of personal protection measures against COVID-19 was more influenced by the test result than the current level of restrictive measures. | 2 (1.04) | **<0.001** |
| The current level of restrictive measures more influenced my application of personal protection measures against COVID-19 than the test result. | 100 (51.81) | |
| The test result and the current level of restrictive measures had an equal impact on my application of personal protection measures against COVID-19. | 61 (31.61) | |
| Neither the test result nor the current level of restrictive measures had an impact on my application of personal protection measures against COVID-19. | 30 (15.54) | |

COVID-19, coronavirus disease 2019.
[a] Seven answers were missing.
[b] Chi-squared test.
[c] Statistically significant values are in bold.

measurements, participants would have been required to complete an initial survey on the day of voluntary serological testing; however, this was not feasible for practical reasons. From the organisational and protective standpoint, it was of utmost importance to minimise the time participants spent at the testing station.[9] If an additional survey had been introduced, this would result in not only the prolonged absence of participants from their workplace but also potentially increased exposure to the virus. Since the period between serological testing and completing the survey questionnaire was a maximum of 22 days, we relied on participants' ability to recall recent behaviours and attitudes. While other studies on the impact of negative-screening results repeated measurements after several months or years,[16] this was not possible for the current study due to the very nature of COVID-19, as well as differing levels of national restrictive measures. Hence, we cannot exclude the possibility that changes of national measures, which occurred in Croatia on April 19 and April 27, had an impact on the study results.

An additional limitation of this study was the lack of a control group. The COVID-19 screening in the DIV Group in Split[9] resulted in an insufficient number of positive participants to represent a separate group. Therefore, due to the extremely low seroprevalence in the tested sample (about 1%), including positive participants would not provide relevant information for the scope of the study. Also, having an adequate control group of non-tested participants was not possible since almost all of the DIV Group industry workers in Split were screened. Surveying the general population for that purpose would not be appropriate, as DIV Group employees were immersed in an all-encompassing working atmosphere with special and more severe protection measures prescribed by the employer, which were introduced considerably earlier than the national measures. However, even if a general population control group showed less adherence to the protective measures, due to social climate influenced by the smaller number of newly infected or the current level of national restrictions, it could have only implied that the test results had even fewer negative consequences on behaviour related to protective measures.

In conclusion, the current study indicates that COVID-19 serological tests do not contribute to irresponsible non-adherence behaviours in an environment where protective measures are efficient. However, serological tests may help reduce fear within society and working environments.

As study participants were recruited from just one company, in one location, the findings may not be fully generalisable. Therefore, future research should include different target and general populations to reveal more details on the changes in attitudes and behaviour following serological testing. To obtain more comprehensive understandings, corroborating quantitative study findings with qualitative studies is suggested.

## Author statements

### Ethical approval

The survey was approved by the University Department of Forensic Sciences Ethics Committee on 22 April 2020 (2181-227-05-12-19-0003; 024-04/19-03/00007).

### Competing interests

None declared.

### Disclaimer

This article does not represent in whole or in part the views of the authors' institutions. However, it does express those of the authors.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.12.001.

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