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Seroprevalence of COVID antibodies in health-care population of tertiary care government hospital in South India

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ABSTRACT

Background: The pandemic coronavirus disease 2019 (COVID-19) caused by the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has resulted in a worldwide abrupt and significant rise in admissions for pneumonia with multiorgan diseases. **Aims and Objective:** To determine the positive prevalence of SARS-CoV-2 antibodies in health-care professionals over 6 months. In addition, to make a subgroup analysis and estimate the age, gender, and workforce-based prevalence of SARS-CoV-2. **Materials and Methods:** An observational cross-sectional study was conducted on 200 healthcare professionals during 6 months. After taking proper informed consent, the study was started. We included subjects aged ≥18 years in this study. Not receiving any other vaccine during the study, suspected or confirmed immunosuppressive condition, imaging confirmed COVID-19 or recent blood transfusions were excluded from the study. **Results:** Most patients were 26–30 years old. Out of 200 patients, 116 (58%) were males, and 84 (42%) were females. The total positivity of the titers amounts was 57%. In addition, the males had higher mean titers than the females, with 24.186 versus 13.304. Of the 116 males, 68 were positive (58.6%), and of the 84 females, 46 were positive (54.7%). The age-wise positivity of the titers was high among the 26–30 years of age group, of which, in the 53 people, 33 were seropositive, which is 62.2% of this age group and lowest in the 51–55 years age group, of which in the 23 participants 9 were positive (39.31%), and 14 were negative (60.85%). **Conclusion:** We concluded that male doctors and adults had a greater seroprevalence of SARS-CoV-2 infection, suggesting that they are more susceptible to contracting COVID-19 through patient contact or surgical procedures.

Key words: Coronavirus disease 2019; Seroprevalence; Severe acute respiratory syndrome coronavirus 2; Antibodies

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INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), initially identified in China, has now spread to all countries worldwide. Coronavirus disease 2019 (COVID-19) has many symptoms, including asymptomatic infection, moderate upper respiratory disease, severe viral pneumonia with acute respiratory syndrome, and mortality.[1]

Current mortality rate data are based on cases reported multiplied by an asymptomatic case factor. Furthermore, the minimal degree of population immunity to limit illness transmission in the community is required for obtaining so-called acute herd immunity.[2] Knowing the percentage of previously infected and immune persons can help us detect herd immunity, forecast epidemics, and make assumptions. In addition, according to the World Health Organization (WHO), monitoring antibody seropositivity against COVID-19, including immunoglobulin G (IgG) and IgM, in a community can offer information on the extent and cumulative prevalence of the disease.[3]

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COVID-19 is a novel contagion; millions of cases have been diagnosed and notified worldwide, over 180 countries with over 290,000 deaths, following which WHO declared it a global pandemic.[4] As for the Indian scenario, the highest number of COVID cases of around 6.3 million and a total of 97,000 deaths have been recorded around September 2020. Although the diagnostic gold standard of the infection is the reverse transcriptase polymerase chain reaction (RT-PCR) of the nasal or throat swabs, asymptomatic infections have been documented where the clinical indications are not present to go for a nasal swab. Therefore, the only way to determine the past episode of illness is to do a serological survey.[5] The serological test against COVID estimates the cumulative prevalence of COVID-19 in a community.

Further assessing the prevalence of antibodies indicates the dynamics of the immune response, the actual burden of the pandemic, and the still vulnerable proportion of populations. So, the importance of vaccination is further reinforced.[6] Antibodies are one of our key viral defenses, designed to recognize specific proteins on the surface of a virus and activate processes that progressively neutralize and eradicate them.[7] Serological tests to identify the existence of IgG antibodies may offer a more valid estimate of the frequency of SARS-CoV-2 past infection in the community since it is likely to remain long after the viral infection has been cleaned up. The IgG antibody is the most potent and long-lasting antibody against the SARS-CoV-2 virus, and it may be found 14 days (interquartile range 10–18 days) after the beginning of symptoms after infection.[8] This study about the seroprevalence of the antibodies in health-care professionals of Government Rajaji Hospital, Madurai, is a pilot study that indicates the disease burden of the health-care professionals.

Aims and objectives

This study aims to determine the positive prevalence of SARS-CoV-2 antibodies in health-care professionals over 6 months. In addition, to make a subgroup analysis and estimate the age, gender, and workforce-based prevalence of SARS CoV2.

MATERIALS AND METHODS

An observational cross-sectional study was conducted on 200 health-care professionals in Government Rajaji Hospital, Madurai, for 6 months, from January 2021 to June 2021. After getting proper informed consent, the study was started. The ethics committee's approval was taken before the study was initiated in the hospital.

Inclusion criteria

Age ≥18 years to be a health-care professional in GRH, Madurai. Exclusion criteria: Not to receive any other vaccine during the study, suspected or confirmed the immunosuppressive condition and infection history of laboratory, imaging confirmed COVID-19, clinically symptomatic individuals, received recent blood transfusions, and Igs. Under aseptic conditions, around 5 mL of blood sample was collected from each patient by venipuncture at the cubital fossa, using a 23G needle. Blood was dispensed into a sterile test tube without anticoagulant. Samples were transported immediately to the endocrinology laboratory. The blood was centrifuged at 2500 rpm, and the serum was separated. Patients without vaccination status were not included in the study.

Patient data including, age, gender, occupation, and titers were collected by patient data sheet and by one-on-one interviews with the patients while maintaining social distancing norms. An interview-based questionnaire was used after giving the informed consent. The questionnaire included a set of questions based on variables such as demographic details respiratory symptoms, fever (in 6 months), any prior enrolment to study, history of hospitalization for COVID-19, and any treatment received.

Following obtaining informed consent, a 5 mL serum sample was collected from each participant and promptly transported to the laboratory. Upon arrival, the samples underwent centrifugation. The resulting serum was then stored at −70°C until further IgG enzyme-linked immunosorbent assay (ELISA) testing was conducted. Serological assessment for SARS-CoV-2 was conducted utilizing the SARS-CoV-2 ELISA IgG assay provided by Euroimmun (Lübeck, Germany). This automated analyzer targets the S1 domain, which encompasses the receptor-binding domain. It identifies the presence of IgG antibodies specific to SARS-CoV-2 S proteins within human serum. Results are quantified in the form of a ratio, derived by dividing the optical densities of the sample by those of an internal calibrator supplied with the test kit. A sample was considered positive if the ratio was ≥1.1. The sensitivity and specificity of the SARS CoV-2 IgG ELISA kit were determined to be 95% and 96.2%, respectively.[9]

Data were presented as mean, standard deviation, frequency, and percentage.

RESULTS

In our study, we examined a cohort of 200 individuals presenting with a specific medical condition, focusing on several key variables. The age distribution within the cohort revealed that the highest number of cases fell within the age group of 26–30 years, comprising 53 cases, while the age group of individuals over 55 years had the fewest cases, with only 6. In terms of gender, the dataset consisted of 116 male and 84 female patients.

The occupation of the individuals showcased a diverse representation, with doctors accounting for the majority at 107 cases, followed by hospital care workers and staff nurses with 35 cases each, and lab technicians with 23 cases. Titers, an important parameter in the study, displayed varying levels within the cohort. The majority of patients had positive titers (>1), totaling 114 cases. Titers in the range of 10.1–100 were noted in 58 cases, and titers below 1 were observed in 86 cases. Furthermore, 38 individuals exhibited titers between 1 and 10, and 18 patients had titers exceeding 100 (Table 1).

Patients under the age of 25 years have the highest mean titers at 23.397, with a relatively high standard deviation of 50.176, suggesting significant variability within this group. The 36–40 years of age group exhibits the second-highest mean titers at 30.789, accompanied by a considerable standard deviation of 52.013. Conversely, the age group of 31–35 years demonstrates the lowest mean titers at 6.885, reflecting a lower disease marker, but with a standard deviation of 11.547, indicating variance within the group.

Gender versus titers

Comparing gender and titers, we observe that male patients have higher mean titers (24.186) in comparison to females (13.306). Both genders display noteworthy standard deviations (45.747 for males and 26.928 for females), indicating variation in titers within each group.

Occupation versus titers

The occupation-based analysis unveils variations in mean titers among different professional categories. Doctors have a relatively high mean titers (23.082) with a standard deviation of 45.455, suggesting a considerable range of values among doctors. Hospital care workers (HCW) have the lowest mean titers (10.047) but also a lower standard deviation of 21.743, indicating lower variability within this group. Laboratory technicians and staff nurses exhibit intermediate mean titers of 21.864 and 17.115, respectively, with standard deviations of 36.5 and 33.167, signifying moderate variability within these groups (Table 2).

In our investigation, we examined the distribution of "Negative" (titers <1) and "Positive" (titers >1) results in a cohort of individuals based on three key variables: Gender, age groups, and occupation. Our findings reveal intriguing patterns in the relationship between titers and these demographic factors, shedding light on the potential influence of gender, age, and occupation on the immune response or susceptibility to the medical condition under scrutiny.

When examining age groups, the disparities in titers distribution are even more pronounced. The youngest age group (<25) had a nearly even distribution of "Negative" and "Positive" titers, whereas the age group of 26–30 years showed a higher prevalence of "Positive" titers. This trend continued across older age groups, with the highest "Positive" titer proportions observed in individuals aged 46–50, suggesting a potential correlation between age and the antibody response to the studied condition.

Table 1: Distribution of age, gender, occupation, and titers

Variable	Number of cases
Age	
<25	20
26–30	53
31–35	26
36–40	17
41–45	25
46–50	30
51–55	23
>55	6
Gender	
Male	116
Female	84
Occupation	
Doctor	107
Hospital care workers	35
Laboratory technician	23
Staff nurse	35
Titers	
<1	86
1–10	38
10.1–100	58
>100	18
Negative (<1)	86
Positive (>1)	114

Table 2: Distribution of mean age, gender, occupation, and titers

Variable (n)	Mean	SD
Age versus titers		
<25 (20)	23.397	50.176
26–30 (53)	13.691	29.993
31–35 (26)	6.885	11.547
36–40 (17)	30.789	52.013
41–45 (25)	11.239	24.832
46–50 (30)	28.868	44.964
51–55 (23)	19.716	40.312
>55 (6)	71.135	74.139
Gender versus titers		
Male (116)	24.186	45.747
Female (84)	13.306	26.928
Occupation versus titers		
Doctor (107)	23.082	45.455
HCW (35)	10.047	21.743
Laboratory technician (23)	21.864	36.5
Staff nurse (35)	17.115	33.167

SD: Standard deviation, HCW: Health-care worker

In addition, our study investigated the impact of occupation on titers. Doctors, who comprised the largest occupational group in our cohort, displayed an almost equal distribution of "Negative" and "Positive" titers. In contrast, HCW, laboratory technicians, and staff nurses exhibited varying proportions of "Negative" and "Positive" titers, with lab technicians having the highest prevalence of "Positive" titers among these professional categories (Table 3).

DISCUSSION

The seroprevalence assessment of SARS-CoV-2 within the cohort of HCW who had not received the COVID-19 vaccine at our medical center in January 2021 revealed a rate of 38%. This evaluation occurred approximately 1 year following the initial identification of a COVID-19 case in India. Notably, the observed seroprevalence rate among HCW (38%) in our study exceeded the 26% prevalence estimated in a comprehensive sero-surveillance study conducted among health-care workers during the corresponding period, spanning from December 2020 to January 2021, within India.[10] Our cross-sectional study among 200 health-care professional provide insight on the prevalence of SARS-CoV-2 antibodies and analyze the demographic details correlated to the infection.

The current study finding reported a high number of cases in the age group between 26 and 30 years of age (53 patients) and 46–50 years of age (30 patients) with positive infections. This can be attributed to several confounding factors resulting in widespread of the infection. Kumar et al., found that seropositivity was highest among males aged 41–50 and 61–70 in rural regions. Only sore throat, myalgia, and work absence had statistically significantly adjusted IgG positive chances in logistic regression. Results extrapolated to the adult population indicated a 14.4-fold higher exposure to SARS-CoV-2 than was observed.[11]

Table 3: Distribution of titer positivity in gender and age

Variable (n)	Negative (<1)	Positive (>1)
Titers versus gender		
Male (116)	48	68
Female (84)	38	46
Titers versus age		
<25 (20)	9	11
26–30 (53)	20	33
31–35 (26)	9	17
36–40 (17)	7	10
41–45 (25)	12	13
46–50 (30)	14	16
51–55 (23)	14	9
>55 (6)	1	5
Titers versus occupation		
Doctor (107)	51	56
HCW (35)	15	20
Laboratory technician (23)	5	18
Staff nurse (35)	15	20

HCW: Health-care worker

According to our study, the laboratory technicians had a higher seroprevalence percentage with the population chosen, too, in the 26–30-year age group. These people may have high exposure since they collect and process the patients' samples and, therefore, are at a higher exposure rate. The population group with the second highest percentage is the staff nurses and workers as they are involved in shifting the patient who is a potential source of infection and may have a high viral load like those admitted to intensive care units. The doctors with a seroprevalence of 52.1% have a low value because of their higher sample size than the other occupational samples. In the study by Siva Ganesa Karthikeyan et al., seropositivity was highest in the intermediate-risk group (19.5%), followed by the low-risk group (18.6%), and then the high-risk group (13.7%). Higher seropositivity was seen among day students compared to hostellers. Results showed that the prophylactic measures implemented against COVID-19 infection were successful, as evidenced by decreased seropositivity in the high-risk group.[12]

According to the research done by Sharma et al., the seropositivity rate is much higher among administrative employees (20.1%) and lowest among medical professionals (5.5%). Independent risk factors for prior SARS-CoV-2 infection were being male and having previously worked in a containment zone. The findings suggest that the seroprevalence of SARS-CoV-2 diseases in healthcare professionals is lower than in the general population.[13]

Kumar et al., estimated the seroprevalence was 11.1%. The prevalence of seropositivity was higher among males (13.5% vs. 8.9%) and ancillary employees (18.5% vs. 6.9%) than among physicians and nurses. Seventy-two (7.74%) had a history of SARS-CoV-2 infection confirmed by RT-PCR testing. Of them, 44 (71%) tested negative for antibodies. Based on the analysis, cellular immunity plays a significant part in preventing diseases.[14]

According to research conducted by Kshatri et al., seroprevalence for the second and third phases was higher in those between the ages of 30 and 39 years. Seroconversion was seen in 93.93% of those who had tested positive using real-time RT-PCR and in 46.57% of those who had tested negative in the past. According to the findings, the population's compliance with social isolation and mask use was strong throughout the first and second surveys; hence, the prevalence was low.[15]

In a study by Sakalle et al., the prevalence was similar between genders (7.91% vs. 7.57%). The seropositivity was highest among those over 60 (10.04%). Reports from seroprevalence studies provide the percentage of the population that was exposed; however, the presence or absence of antibodies is not diagnostic of complete or partial immunity.[16]

Saple et al., discovered that the overall seroprevalence of anti-SARS-CoV-2 IgG antibody was 40%, with a 0.7% infection fatality rate (IFR). Furthermore, seroprevalence was substantially higher among homemakers/unemployed (49%) and laborers (55%), compared to business (30%) and service occupations (21%). According to the findings, antibody testing reveals a high proportion of asymptomatic or previously infected individuals that clinical diagnosis would have missed.[17]

A study conducted by Bhartiya et al. showed that the seroprevalence was highest among males (75.1%), followed by females (69.8%), and then people aged 18–39 (76.4%). Furthermore, staff with COVID-19-positive residents (89.6%), staff who had previously reported COVID-19 (95.5%), and staff who had previously demonstrated PCR positivity (96.4%) showed considerably higher seroprevalences than other staff. These results can potentially contribute to estimating transmission status in the population and disease burden, which might help prioritize health-care services.[18]

In the study of Rafi et al., 8.75% of the employees screened positive for COVID-19 antibodies. In the past, 32/37 (86.5%) have tested positive for COVID-19 Antigen/RT-PCR. Seropositivity is correlated with increased COVID-19 incidences linearly. Upper respiratory signs in the past were revealed to be a significant predictor of a positive serology result. There was a clear pattern of seropositivity among nurses compared to other health-care professionals.[19]

Murhekar et al., conducted a study where 70% of patients were aged 18 years, 52.3% were female, and seroprevalence was considerably greater among persons who had received one vaccination and two vaccine doses than non-vaccinated adults. For health-care workers, the frequency of IgG antibodies was 85.2%. Considering that a third of the population is still seronegative, increasing the coverage of COVID-19 immunization among adults is urgently required.[20]

In the treatment part of our study, this serological study also helps choose patients for antibody therapy, either monoclonal antibodies or convalescent plasma therapies. These people who are seronegative and have heavy exposure can be subjected to monoclonal antibody treatment and reduce the risk of infection after exposure, reducing the severity of manifestations following illness and reducing the viral load in these patients. A high positive prevalence can be attributed to the dominant strains' widespread, low immunity, and non-compliance to precautionary measures.[21] While the emergence of the Delta variant in India led to a significant increase in mortality, it was observed that breakthrough cases, irrespective of an individual's immune status, generally resulted in less severe outcomes compared to COVID-19 cases prior to widespread vaccination efforts. These findings underscore the effectiveness of SARS-CoV-2 vaccinations and highlight the critical role of complete vaccination in preventing breakthrough infections.

The current study is one of the essential studies that reports the prevalence of seropositive patients based on their clinical roles in the healthcare fraternity. Overall, this study contributes to our understanding of the prevalence of SARS-CoV-2 antibodies in health-care workers, offering insights that can inform public health policies, vaccination strategies, and the protection of frontline workers. It also highlights the need for continued vigilance and preventive measures to control the spread of the virus, particularly in high-risk populations.

There is also an additional element of the false positive reaction in these seropositive people. The antibodies could be positive even with infection to viruses like cytomegalovirus and Epstein-Barr virus, dengue, and other autoimmune conditions such as rheumatoid arthritis and systemic lupus erythematosus. However, the test kit used in our case has 100% specificity as specified by the manufacturer.

Limitations of the study

The study has several limitations, including the uneven distribution of the sample population by age, occupation, and gender, the small sample size, the cross-sectional observational design, the potential for recall bias, and the inability to conduct logarithmic regression analysis. These limitations should be considered when interpreting the results of the study.

CONCLUSION

We find that male doctors and adults had a greater seroprevalence of SARS-CoV-2 infection, suggesting that they are more susceptible to COVID-19 through patient contact or surgical procedures. The studies found the need to educate medical professionals on the importance of maintaining high safety standards even when not on duty or in the presence of patients.

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