Research Article

EVALUATION OF SARS-COV-2 SEROPREVALENCE AMONG CLINICAL LABORATORY WORKERS AND ITS ASSOCIATION WITH PAST EXPOSURE TO INFECTION AND VACCINATION

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ABSTRACT:

The pandemic of COVID-19, due to the SARS-CoV-2 virus, has significantly impacted global health. Understanding the dynamics of immunity, both natural and vaccine-induced, is crucial for public health strategies. The study aimed to determine the seroprevalence of SARS-CoV-2 antibodies among clinical laboratory workers and its relationship with previous exposure to infection and vaccination. This was a prospective observational study conducted at the chemical Pathology section of Dow Diagnostic Research and Reference Laboratory (DDRRL), Dow University of Health Sciences, Karachi, Sindh, Pakistan from 1st January to 30th December 2021. Following ethical approval, 80 clinical laboratory workers provided informed consent to participate. Blood samples were collected and tested for SARS-CoV-2 IgG antibodies. The baseline demographic and clinical information was recorded, and conducted follow-up antibody tests six months later. The mean age of the participants was 37.7 years, with a standard deviation of 9.42. There were 46 males (57.5%) and 34 females (42.5%) in the study. Half of the participants (50%) had been vaccinated, with 35% receiving a single dose and 15% receiving both doses. 71.3% of the participants had comorbidities. SARS-CoV-2 antibodies were found to be reactive in 50% of the participants. The study also found significant associations between antibody presence and prior COVID-19 infection, vaccination status, contact history with COVID-19 patients, and prior history of hospitalization ($p < 0.05$). The study compared the initial and post-booster antibody levels among three groups of subjects (vaccinated, vaccinated with no prior COVID-19 infection, and non-vaccinated with prior COVID-19 infection), and found that antibody levels were significantly high in vaccinated subjects and non-vaccinated subjects with prior COVID-19 infection (p-value < 0.05). A significant difference was observed in antibody titers among subjects with prior history of vaccination and COVID-19 infection. In conclusion both natural infection and vaccination may induce antibodies against SARS-CoV-2 infection.

Keywords: SARS-CoV-2, COVID-19, seroprevalence, vaccination, clinical laboratory personnel.

INTRODUCTION

SARS-CoV-2, the virus responsible for the COVID-19 outbreak in Wuhan, China in December 2019, caused an unprecedented global pandemic with far-reaching consequences (1). The positive-sense single-stranded RNA genome of SARS-CoV-2, a member of the Beta coronavirus family, delineated it from other viruses. Four main structural proteins are present in the virus: the spike (S), membrane (M), envelope (E), and nucleocapsid (N). SARS-CoV-2 spread widely around the globe in a short span of time, and its mechanism of invasion into the host cells is principally mediated by its Spike protein (S) attaching to the ACE-2 receptor on the host's cell membrane. Following this, the virus penetrates the host cell through endocytosis and replicates using the host's cellular machinery (2). It has been determined that there are two main ways for individuals to become immune to SARS-CoV-2 infection: naturally occurring immunity brought on by an earlier infection, and immunity acquired through vaccination. These two immunological groups can be compared to learn important information about the efficiency of vaccines and the longevity of antibody responses. To acquire herd immunity, in which a large enough fraction of the population develops immunity to the infectious agent, it is crucial to comprehend the dynamics of immunity (3).

Several countries have approved and delivered COVID-19 vaccines globally (4). Following infection with the virus, people frequently develop immunity, which protects them from reinfection (5). However, vaccination is highly effective in triggering an immune response against SARS-CoV-2 (5, 6). The seroprevalence of SARS-CoV-2 antibodies in these two groups, naturally immune individuals and those who have received vaccinations, can be compared to provide important evidence about the efficiency of various vaccines in producing a protective immune response (7). In addition, examining the persistence of antibodies in both groups can reveal if follow-up vaccines or booster shots may be necessary to maintain immunity (5, 7).

Healthcare personnel, specifically those who perform their duties in clinical laboratory settings, have been on the cutting edge of combating the deadly virus, often facing an increased risk of exposure due to their crucial part in determining and monitoring the cases of COVID-19 (8-10). However, there is limited literature available on this particular group regarding pattern of immunity. Therefore, in this study, we aimed to determine the seroprevalence of SARS-CoV-2 antibodies among clinical laboratory workers.

METHODS:

This was a cross-sectional study, conducted at the Section of Chemical Pathology, Dow Diagnostic Research and Reference Laboratory (DDRRL), Dow University of Health Sciences (DUHS), Karachi, Pakistan between 1st January and 30th December 2021. Ethical approval was taken from the Institutional Review Board of DUHS, Karachi (Ref no IRB- 2562)/DUHS/Approval/2022/944. A sample size 80 was determined, accounting for the baseline seroprevalence of antibodies at 3% (11), the required confidence level of 95%, and the allowed margin of error of 5%. A non-probability convenience sampling was employed to collect the blood samples from 80 laboratory workers. All the laboratory personnel including consultants, resident doctors, technologists, and dispatchers more than 18 years of age were included. Pregnant females, staff with active COVID-19, and those who refused to provide consent were excluded.

The principal investigator completed a detailed predefined form for participants who gave informed written consent. 5 mL of blood was obtained from each participant and stored at -70 degrees centigrade till the analysis. Samples were thawed and analyzed for testing Anti Covid-19 IgG Antibody Quantitative assay (Roche, Cobas) using the technique of electrochemiluminescent immunoassay. Calibrators and controls were run according to the manufacturer's recommendations. Sera with a cut-off Index (COI; signal sample/cutt-off, COI >1.0 were considered positive, and those with a COI <1.0 were considered negative.

Relevant participant characteristics, such as age, gender, ethnicity, previous COVID-19 infection, history of exposure to COVID-19 patient, and sample collection date, were meticulously documented. Regardless of their vaccination status (vaccinated and non-vaccinated) and vaccination dose (one or two doses), baseline Covid-19-IgG results were recorded. A history of prior diagnosed and documented COVID-19 was recorded. To observe the longitudinal dynamics of antibody titers, 23 subjects (from 80) were randomly selected if they were vaccinated with the booster dose after an interval of 6 months from baseline sampling. Subjects were divided into three groups to observe the antibody titer pattern among study subjects. Groups 1, 2, and 3 were comprised of vaccinated subjects, unvaccinated subjects without a known history of COVID-19, and unvaccinated subjects with a history of COVID-19, respectively.

Statistical analysis

The data was analyzed using Statistical Package for Social Sciences (IBM SPSS version 26.0). Chi-square tests were used to analyze the association between SARS-CoV-2 seropositivity and prior COVID-19 exposure or vaccination status. Kolmogorov Smirnov test was used to observe the distribution of data, independent t test was used to observe the difference in titers among three groups. The p-value cutoff for statistical significance was established at 0.05.

RESULTS:

The mean (±SD) age of the study subjects was found to be 37.7 (±9.42) years. There were 46 (57.5%) males and 34 (42.5%) females. Among all study subjects, 40 (50%) were vaccinated against COVID-19, among them 28(35%) had a single dose of vaccine, and 12 (15%) 2nd dose. A total of 27 (33.8%) subjects had a history of outstation traveling two months before the baseline sampling. Comorbidities were found in 57 (71.3%) study subjects. Among them, 36 (63.8%), 10 (17.5%), 8 (14.0%), and 3 (5.2%) were suffering from diabetes, hypertension, hypothyroidism, and seasonal allergies respectively. Among all subjects, the antibody status was found reactive in 40 (50%). However,

antibody status was found to be non-reactive in 38 (50%) subjects. The details of vaccination and history of prior COVID-19 among unvaccinated subjects are shown in Table 1. Baseline antibodies median values and IQR for these groups were 7.07 (IQR- 0.5-27.0), 1.48(IQR-0.29-8.57), and 1.01(IQR-0.32-22.0) respectively with significant P-value <0.05. Medians and interquartile ranges of SARS CoV-2 antibody titers among subjects with a booster dose (n=23) are shown in Figure 1. in groups 1, 2, and 3 respectively (P-value >0.05).

Table 1: Vaccination details and history of COVID-19.

Characteristics of subjects	Antibody reactive n (%)	Antibody non-reactive n (%)	Total n (%)	P-value*
Vaccinated				
Prior COVID-19	19 (23.75)	3 (3.75)	22 (27.5)	
No prior COVID-19	6 (7.5)	12 (15)	18 (22.5)	
Non-Vaccinated				
Prior COVID 19	8 (10)	2 (2.5)	10 (12.5)	
No prior COVID 19	7 (8.75)	23 (28.75)	30 (37.5)	
Total	40 (50)	40 (50)	80 (100)	

*Chi-square Test

Table 2: Characteristics of Subjects with Vaccination status (n=80)

Characteristics	Vaccinated n (%)	Non-vaccinated n (%)	Total n (%)	P -value*
Contact History with known COVID-19 patient				
Present	22 (27.5)	15 (18.75)	37 (46.2)	**0.009**
Absent	18 (22.5)	25 (31.25)	43 (53.7)	
Travel History				
Present	16 (20)	11 (13.75)	27 (33.7)	0.151
Absent	24 (30)	29 (36.25)	53 (66.2)	
Past exposure to COVID-19 infection				
Yes	22 (27.5)	19 (23.75)	41 (51.2)	**0.000**
No	18 (22.5)	21 (26.25)	39 (48.7)	
Previous hospitalization history				
Yes	7 (8.75)	12 (15)	19 (23.7)	**0.018**
No	33 (41.25)	28 (35)	61 (76.2)	

*Chi-square Test

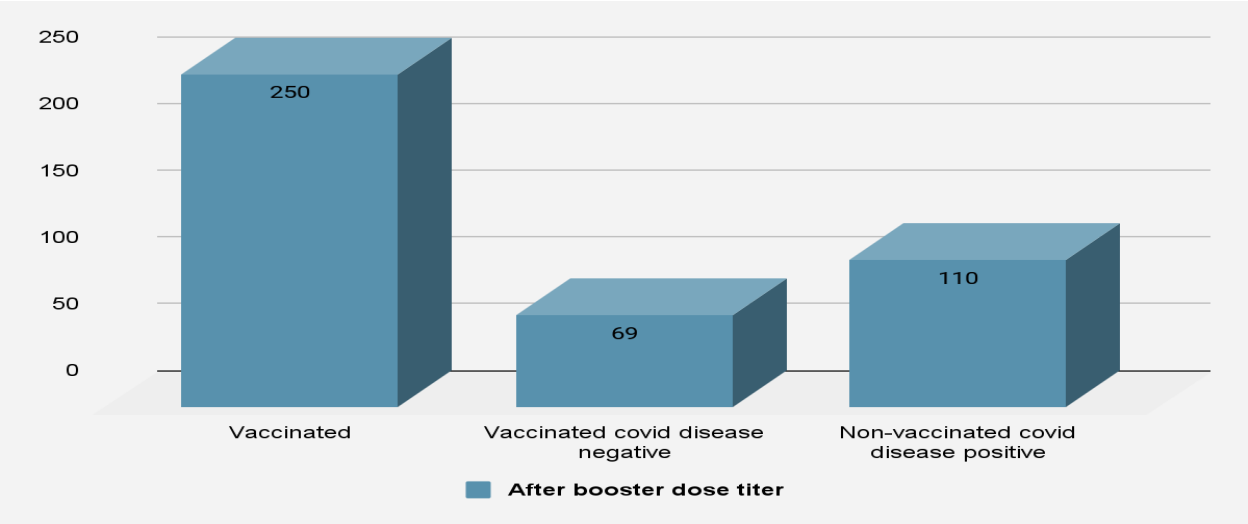

Figure 1: Antibody titers after booster dose among study subjects

DISCUSSION

Healthcare workers (HCWs) are frontline personnel who deal with the clinical management of suspected or confirmed COVID-19 patients. Literature responses indicate that laboratory HCWs face an elevated risk of occupational transmission of SARS-CoV-2 due to their crucial role in the COVID-19 response, which increases their susceptibility to viral transmission. The present study included consultant pathologists, resident doctors, laboratory technologists, and laboratory support personnel to determine the seroprevalence of SARS-CoV-2 IgG antibodies among clinical laboratory personnel and to find the association between vaccinated and non-vaccinated individuals, as well as those with and without prior COVID-19 infection.

This study revealed a notable seroprevalence rate of 50% for SARS-CoV-2 IgG antibodies among clinical laboratory personnel, indicating a significant proportion had previously been exposed to the virus or had a robust immune response following vaccination. This finding contrasts with earlier literature findings from studies, where seroprevalence rates varied considerably. Studies in Denmark reported a low prevalence of 4% (1), 12.2% in Italy (2), London (3), China, 11% in Spain (4), 13% in India (5), 11.2% in Sweden (6) 18% in Ireland (7) and 3.8% in USA (8, 9). In comparison, our study's seroprevalence aligns closely with findings reported by Korona Głowniak et al. (10) in Poland, where healthcare workers exhibited a 43% seroprevalence rate. This suggests that our observed seroprevalence is consistent with similar occupational groups in different regions, despite varying infection rates and vaccination strategies globally. The higher seroprevalence observed in our study could be attributed to several factors, including the intensity of exposure to COVID-19 within clinical laboratory settings, varying local epidemiological trends, and differences in healthcare policies and infection control practices across regions.

However, as we compare the subjects group we see high antibody titer after booster dose in groups 1(vaccinated) and group 3(un-vaccinated COVID-19 positive) as compared to group 2 (un-vaccinated without a history of COVID-19). This indicates past exposure to infection significantly raises the antibody titer as stated by the study conducted by MC Connel in Ireland(11).

This study also revealed distinct patterns based on vaccination status and prior COVID-19 infection. Specifically, 23.75% of vaccinated individuals with prior COVID-19 infection showed reactive antibodies, indicating strong immune responses post-vaccination. In contrast, only 7.5% of vaccinated individuals without prior infection demonstrated reactive antibodies. Vaccinated individuals who tested positive for COVID-19 exhibit a higher prevalence of contact history compared to vaccinated negatives and non-vaccinated positives and negatives, with a significant p-value of 0.009. Similarly, vaccinated individuals reporting past exposure to infection significantly contrast with non-vaccinated individuals, with a p-value of <0.001. Moreover, hospitalization history showed significant results between vaccinated and non-vaccinated individuals, with vaccinated positives showing fewer hospitalizations than non-vaccinated positives, with a p-value of 0.018. Additionally, the presence of a booster dose varies among vaccinated individuals tested positive versus negative, with a p-value of < 0.01. However, travel history does not exhibit a significant association with vaccination status ($p>0.05$).

Few limitations were identified in this study that merit consideration when interpreting the findings. Firstly, the study's cross-sectional design limits our ability to establish causal relationships between variables. This design also restricts our understanding of the temporal dynamics of antibody responses over time. Secondly, the sample size of 80 clinical laboratory personnel, while sufficient for our primary analyses, may not be representative of all healthcare settings or larger populations. Additionally, the time period between sampling and vaccination was missing.

In this study, the six-month follow-up period for booster dose titer testing may capture the long-term antibody dynamics or the durability of immune responses following natural infection or vaccination. This highlights the heightened occupational risk faced by healthcare workers, particularly those in frontline roles like laboratory personnel, during the COVID-19 pandemic.

CONCLUSION

In conclusion, this study among clinical laboratory personnel revealed a significant seroprevalence of SARS-CoV-2 IgG antibodies, indicating substantial exposure to the virus or effective immune responses from vaccination.

Conflict of Interest

Authors declare no conflict of interest

Ethical consideration

The study was approved by the Ethical Review Committee of Dow University of Health Sciences, Karachi, Pakistan.

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