PREVALENCE OF COVID-19 ANTIBODIES IN EMPLOYEES OF ST. JACOB HOSPITAL IN BARDEJOV

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SUMMARY

Objective: The COVID-19 disease caused by the SARS-CoV-2 virus belongs to the group of highly infectious diseases with increased mortality and morbidity in the population. Finding the presence of antibodies plays an important role while finding the number of individuals who overcame the disease or were vaccinated.

Methods: A total of 250 employees of St. Jacob Hospital with Polyclinic, Bardejov, participated in our study, the blood samples were drawn from the index finger and processed with the help of the rapid Ag test for the detection of antibodies and venous blood using the ELISA method. The health workers (doctors, nurses, medical laboratory technicians, laboratory diagnosticians) tested during September and October 2022 participated in our study.

Results: Our experimental study shows the presence of IgG antibodies in 215 (86%) of employees, who get them from overcoming the COVID-19 disease or getting vaccinated. In 17 (6.8%) of employees were detected IgG and IgM antibodies. The biggest number of IgG antibodies was found in 36 (78%) employees of the Surgical Department, 28 (84%) employees of Rehabilitation Department and 25 (89%) employees of the Internal Department, when compared with the Department of Laboratory Medicine 9 (30%) employees and Radiology Department 4 (44%) employees.

Conclusion: Multiple prevalence of COVID-19 disease were found in employees of the internal, surgical and rehabilitation departments in whom we detected a higher presence of IgG antibodies. In department of laboratory medicine workers were proven lower levels of IgG antibodies, mainly for the limited contact with the positive covid patients and working with only their biological material, compared to the first-line employees exposed to direct contact with the patients.

Key words: COVID-19, antibodies, rapid Ag test, ELISA, employees

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INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus is placed in the *Betacoronavirus* genus and *Coronaviridae* family. They are enveloped and their nuclear material is unsegmented, single-stranded ribonucleic acid with positive sense (ssRNA+). CoVs are pleomorphic-spherical in shape, measure 80 to 160 nm in length, and have a small genome of 27–32 kilobytes (KB) with a unique replication strategy (1). On the surface are glycoprotein club-shaped extensions that are helping with the binding of the virus to the receptive cell. Of four structural proteins, the most important is the surface glycoprotein of the extensions ("spike" protein, S protein) that enables the binding to the ACE2 receptor and creates a connection with the host cell, determining the tropism of the virus (2).

In December 2019, in the Chinese city of Wu-chan (Hubei province, China) the occurrence of COVID-19 disease was found for the first time, and in Slovakia, the disease was first identified on 6th March 2020. The World Health Organization (WHO) declared on 30th January 2020 public health emergency status, which led the WHO organization to declare on 11th March 2020 pandemic of COVID-19. The virus SARS-CoV-2 causes infection of the upper and lower airways and is highly infectious. The most common way of transmission is through droplet infection (aerosol) such as coughing, sneezing, communication between two people at short distances (15 cm), singing, etc. The incubation period is between 3 to 7 days (14 in some cases). The main symptoms are also throat aches, cough (54%), fever (76%), general weakness, malaise, tiredness, muscle aches, loss of smell and taste (80%), and CT changes in the thorax (84%) (3). In most cases was recorded asymptomatic, mild to moderate respiratory course of the disease. People diagnosed with poly morbidity (obesity, cardiovascular diseases, diabetes mellitus, cancer, chronic respiratory diseases) were suffering from the

more severe form of the disease and in some cases died from the COVID-19 disease (4).

Antibody Immune Response

The onset of antibodies is variable and depends on the current condition of the immune system. The production of IgA antibodies starts very early – within 5 days, they last for a relatively short time (approximately 10 days), and their presence marks the acute phase of the viral infection, IgM antibodies are produced within 6–7 days and last for few days up to few weeks, IgM antibodies titre signals acute ongoing infection or infection that was overcome in recent days. IgG antibodies are produced at last (in a span of 10 days from the outbreak of the disease). They can be found in the body for a long period and signal the infection that was overcome, or they are present in individuals that were vaccinated against the given virus. All antibodies can be detectable even in asymptomatic individuals. In 98–99% of individuals were created antibodies after the second dose of the vaccine. In 1–2% of vaccinated individuals, the antibodies can be absent. The reason can be immunodeficiency, the natural decrease of antibodies in the body, or the elimination of the antibodies by the own immune system (5).

MATERIALS AND METHODS

The total experimental sample consisted of 250 health workers of St. Jacob Hospital with Polyclinic, Bardejov. Employees were divided into three age categories: 18–30 years old, 31–50 years old, and 51 and more years old. The research consisted of filling in a short anonymous questionnaire about health status. The employees were clinically healthy, without acute or chronic disease. The research consisted of taking blood samples with subsequent testing of antibodies with the Rapid Ag test and ELISA method, which was carried out during September and October 2022.

The rapid Ag tests and questionnaires were distributed into individual departments of the hospital – Internal Department (INT), Surgical Department (SUR), Neurological Department (NEUR), Psychiatric Department (PSY), Gynaecology Department (GYN), Intensive Care Department (INTENS), Rehabilitation Department (REHAB), Long-term Care Department (LONG), Radiology Department (X-RAY), Children's Department (CHILD), and Laboratory Medicine Department (LABOR) (Table 1).

Two methods were used to detect antibodies. The first method was the rapid Ag test cassette, then the ELISA method was used to interpret the results of the measured absorbance values.

Employees were tested by rapid Ag test cassette (rapid diagnostic test, Zhejiang Orient Gene Biotech Co, Ltd.) It is an immunochromatographic test with sensitivity 97.5%. A drop of blood from the index finger was taken from the employees and subsequently dripped on the cassette with two drops of reagent. After 15 minutes we subtracted the result of the test. There had to be shown a straight line as an indicator near the letter C on every cassette. If the antibodies were present, the line was shown near number 1, which represented IgG antibodies, and number 2 was showing IgM antibodies. If lines were shown near both lines, both antibodies were present. The antibodies were not present if there were no lines near both numbers.

Table 1. *Characteristics of the hospital departments (N = 250)*

Hospital departments	Employees n (%)
Internal department	28 (11.2)
Surgical department	46 (18.4)
Neurological department	17 (6.8)
Psychiatric department	22 (8.8)
Gynaecology department	16 (6.4)
Intensive care department	16 (6.4)
Rehabilitation department	33 (13.2)
Long-term care department	16 (6.4)
Radiology department	9 (3.6)
Children's department	17 (6.8)
Laboratory medicine department	30 (12.0)
Total	250 (100.0)

Blood samples for the ELISA method for antibody detection were collected by venepuncture into 9 ml Vacutainer dry tubes. Subsequently, these whole blood samples were centrifuged for 15 minutes at 4,000 x g at room temperature. Demeditec COVID-19 (SARS-CoV-2) IgG ELISA DECOV1901 and Demeditec COVID-19 (SARS-CoV-2) IgM ELISA DECOV1903 kits (Demeditec, Germany) were used for the detection of specific antibodies against Sars-CoV-2. Detection of these antibodies in human serum was performed on a fully automated Alisei instrument (RADIM diagnostics, Italy). This is a two-antigen sandwich ELISA method.

The questionnaire consisted of 7 questions and the results needed to be marked at the end. Questions were connected to the possibility that the given individual overcame the disease COVID-19 and if so, how many times and when. The next question was connected to the vaccination and the number of administrated vaccines; the choice of sex, inclusion in the age category, departments, and type of profession (doctor, nurse, medical laboratory technician, laboratory diagnostician). At the end of every questionnaire, there was informed consent to the collection of the biological sample.

The results of this study were processed in the statistical program Statistica v.12 using and Pearson's chi-square to determine the relationship between qualitative variables.

RESULTS

In our study, we were comparing the individual points of the questionnaire. Multiple comparisons were made between age, sex, profession, overcoming the disease, vaccination, and antibodies against COVID-19.

Overall, 212 women (84.8%) and 38 men (15.2%) participated in the study. From the whole number of monitored subjects, 212 (84.8%) of employees overcame the disease, and the rest 38 (15.2%) stated that they did not overcome the disease. Among all the employees, 100 (47.2%) individuals had experienced the disease at least once. Others overcame the disease twice 67 (31.6%) and the lowest number of people who overcame the disease was three times 10 (4.8%) and four times 3 (1.2%). More than half of

the whole consisted of 128 (51.2%) vaccinated individuals with all three doses, 78 (31%) were vaccinated twice and 6 (2.4%) were vaccinated with one dose. Participants in the research were 138 (55.2%) nurses, 53 (21.2%) doctors, 49 (19.6%) medical laboratory technicians, and 10 (4%) laboratory diagnosticians. The highest representation belonged to the age group of 31–50, with the number of 135 (54%) employees, the remaining two age categories had the same percentage. From the age group of 18–30, we selected 55 (22%) individuals, and older individuals from the age group of 51 and above were 60 (24%). Among 215 (86%) employees were detected only IgG antibodies, only 17 (6.8%) individuals had both types of antibodies, and in no employees were found only IgM antibodies. Only some comparisons were statistically significant. No significant dependencies were found with other variables while comparing sex and overcoming the disease, sex and the number of overcoming diseases, sex and vaccination, and sex and presence of antibodies. The connection between age groups and overcoming the disease, age and number of overcame diseases, age and vaccination, age and presence of antibodies was not found. A statistical correlation was not found with the type of profession and overcoming the disease, profession and number of overcame diseases. Vaccination status and getting over COVID-19 of hospital employees is presented in Table 2.

Statistical analysis confirmed a significant difference ($p = 0.003$) between vaccination and type of occupation. The number of fully vaccinated nurses (three doses) was 67 (48.55%), the number of nurses with two administrated doses was 47 (34.06%), and the number of nurses with one dose administered was 2 (1.44%). The proportion of vaccinated nurses to the total number of nurses was 116 (84.05%). Compared to this, the number of fully vaccinated doctors was 33 (62.26%), double vaccinated 18 (33.96%), and one dose administered was 2 (3.77%). The proportion of vaccinated doctors to the total number of doctors was 53 (100%). Medical laboratory technicians 15 (30.61%) and 1 (10%) laboratory diagnosticians laboratory diagnosticians were not vaccinated at all. The proportion of vaccinated medical laboratory technicians was 34 (69.38%) and the proportion of vaccinated laboratory diagnosticians was 9 (90%).

Statistically significant differences ($p = 0.003$) were found between IgG antibodies and individual professions. The presence of IgG antibodies was highest in 129 (60%) nurses and comparable amount was found in 44 (20.46%) doctors and 38 (17.67%) medical laboratory technicians (Table 3). Among all individual professions, there were 11 (22.44%) medical laboratory technicians in whom no IgG antibodies were detected, compared to 9 (16.98%) doctors, 9 (6.52%) nurses and 6 (60%) laboratory diagnosticians.

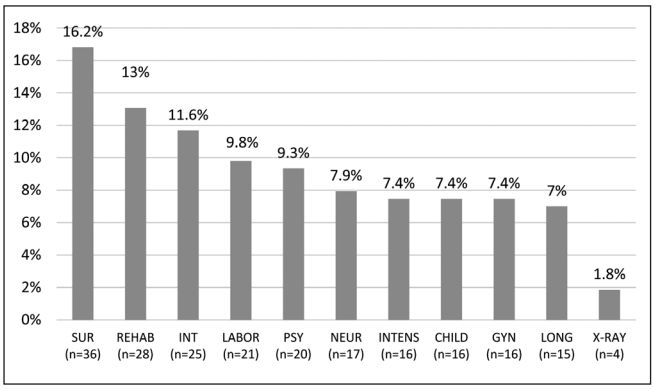

Fig. 1. *Prevalence of IgG antibodies among departments employees.*

Table 3. *Presence of IgG antibodies in hospital employees (N = 250)*

Antibodies	Positive IgG n (%)	Negative IgG n (%)
Doctors	44 (20.46)	9 (25.71)
Nurses	129 (60.0)	9 (25.71)
Medical laboratory technicians	38 (17.67)	11 (31.42)
Laboratory diagnosticians	4 (1.86)	6 (17.14)
Total	215 (100.0)	35 (100.0)
Pearson chi-square: 27.281, p < 0.001		

Statistical significance p < 0.001

Table 4. *Presence of IgG and IgM antibodies in hospital employees (N = 250)*

Antibodies	Positive IgG IgM n (%)	Negative IgG IgM n (%)
Doctors	3 (17.64)	50 (21.45)
Nurses	4 (23.52)	134 (57.51)
Medical laboratory technicians	8 (47.05)	41 (17.59)
Laboratory diagnosticians	2 (1.17)	8 (3.43)
Total	17 (100.0)	233 (100.0)
Pearson chi-square: 13.189, p = 0.004		

Statistical significance p < 0.01

Table 2. *Vaccination status and getting over COVID-19 of hospital employees*

Profession	3 doses n = 128 n (%)	2 doses n = 78 n (%)	1 dose n = 6 n (%)	Not vaccinated n = 38 n (%)	Post COVID-19 n = 212 n (%)
Doctors	33 (25.7)	18 (23.0)	2 (33.3)	0 (0.0)	42 (19.8)
Nurses	67 (52.3)	47 (60.2)	2 (33.3)	22 (59.4)	122 (57.5)
Medical laboratory technicians	20 (15.6)	12 (15.3)	2 (33.3)	15 (39.4)	40 (18.8)
Laboratory diagnosticians	8 (6.2)	1 (1.2)	0 (0.0)	1 (1.6)	8 (3.7)
Pearson chi-square: 24.44, p = 0.003					

Statistical significance p < 0.01

A statistically significant difference ($p = 0.004$) was confirmed in the presence of both antibodies (IgM and IgG) and the type of occupation. The presence of IgG and IgM antibodies was found in 134 (97.10%) nurses, 50 (94.33%) doctors, 41 (83.67%) medical laboratory technicians, and 8 (80%) laboratory diagnosticians (Table 4).

Significant differences were also found when comparing department type and employees vaccination rates. Statistically significant ($p < 0.001$) prevalence of vaccinated medical employees was in SUR dept. 41 (16.4%), REHAB dept. 25 (10%), and INT dept. 25 (10.4%). On the other hand, among all the departments, the number of unvaccinated employees was the highest in LABOR dept. 11 (4.44%).

A significant difference ($p = 0.003$) was confirmed between IgG antibody levels and department type. The presence of IgG antibodies was predominant in 36 (16.74%) SUR dept. employees, 28 (13.02%) employees of REHAB dept. and in 25 (11.62%) employees of INT dept. The highest absence of IgG antibodies was by employees of LONG dept. 9 (25.71%), and 4 (11.42%) of X-RAY dept. (Fig. 1).

There was a significant difference ($p = 0.016$) between the absence of IgG and IgM antibodies depending on the type of department – as many as 41 (89.13%) employees of SUR dept., 28 (84.84%) of REHAB dept., 27 (96.42%) of INT dept., 24 (80%) of LABOR dept., and 22 (100%) of PSY dept. On the other hand, 6 (20%) LABOR employees were found to have both types of antibodies. Presence of both IgG and IgM antibodies was also found in 5 (10.86%) employees of SUR dept. and 5 (15.15%) employees of REHAB dept.

The association between the type of department and overcoming the disease ($p = 0.161$), type of department and number of overcame diseases was not significantly confirmed ($p = 0.267$).

DISCUSSION

Study of Hoffman et al. detected COVID-19 antibodies with the help of the rapid Ag test and concluded that 93.1% of individuals are present with the IgG antibodies (5). The results of our study correlate with their results, as we detected IgG antibodies in 250 (86%) of the total number of employees.

A nationwide study conducted by scientists from the University of Pavol Jozef Šafárik in Košice in 2021 monitored the presence of COVID-19 antibodies among the so-called general unvaccinated population in the Košice region (6). The presence of antibodies was proven approximately among 25% of Košice residents. Only 38 unvaccinated people participated in our study, indicating active vaccination of healthcare workers working in covid wards during the pandemic. The highest number of unvaccinated staff was in the LABOR, but they also had an antibody prevalence of 99%.

Several recent studies focusing on the presence of COVID-19 antibodies have demonstrated the presence of IgG antibodies in patients who had the disease several months ago (up to 6 months), after which their levels slowly declined. They found that 90% of patients had a stronger immune response after natural infection with SARS-COV-2 virus and recovered more quickly from the disease. New variants and subtypes (especially the Omicron variant) are influencing diagnosis of the disease, its course, the impact of vaccination, and previous contact with the virus. The same findings were also obtained in our study, when we used a questionnaire method among healthcare workers and found several reinfections of the disease either after a recent recovery from the disease or after vaccination. We observed such responses mainly among nurses and doctors, who were always the first to encounter covid patients. The course of their disease was milder compared to previous diseases. The production of antibodies by vaccination may not ensure a sufficiently high level of antibodies in every person, so re-vaccination after a certain period of time is necessary.

The study by Assaid et al. monitored by ELISA (enzyme-linked immunosorbent assay) the appearance of IgG and IgM antibodies at 3 months after the onset of COVID-19. In their study (7), they showed that IgG antibodies appeared between 2 weeks and one month after the onset of infection, persisted for 3 months in 79% of the probands studied, and then gradually decreased in levels. In contrast, 19% of probands had declining IgM antibodies after the first month of symptom onset. In our study, we reached the same conclusion because 86% of the employees studied had IgG antibodies, no one had IgM antibodies only, and both types of antibodies were detected in 6.8% (confirmed recent onset of illness – within a month).

In our study, we did not confirm an association between gender type and the prevalence of antibodies, which is also consistent with the results of the study by Assaid et al. (7).

The association between males and females and the presence of antibodies was not confirmed in our study, which is identical to the results of the study by Smagul et al. (8) who monitored the presence of antibodies using ELISA method. In their study, 86.5% of probands had IgG antibodies and 13.5% of probands had no antibodies. In our study, we found IgG antibodies in 86% of the employees, 6.8% of the employees had IgG and IgM antibodies, and we did not confirm the presence of IgM antibodies in only one employee.

The results of a scientific study by Kaduskar et al. (9) dealing with IgM and IgG antibody dynamics in covid patients show the detection of IgG antibodies on day 45 of the disease until day 124, until the general symptoms of the disease have subsided, and IgM antibodies from the onset of symptoms until day 35. Scientists have confirmed a correlation between IgG antibodies and the body's protective immune response (9). Our results are consistent with their results, as we confirmed IgG antibodies in 86% of the employees after a previous illness or vaccination, which also allowed us to confirm the protective immunity of the employees.

The study by Mansour et al. (10) investigating the prevalence of SARS-CoV-2 antibodies among healthcare workers came up with results that the highest prevalence of IgG was in healthcare workers working in covid units and in healthcare workers after a recent COVID-19 illness. The results of their study correlate with our results, as we detected a higher prevalence of IgG antibodies during the pandemic in healthcare workers working in the frontline – 44 (83%) doctors and 129 (93.4%) nurses compared to 38 (77.5%) healthcare laboratory technicians and 4 (40%) laboratory diagnosticians who did not have direct contact with a positive patient (10).

CONCLUSION

The COVID-19 infection spread rapidly across the world and caused a global pandemic. The detection of antibodies serves as

an important tool for evaluating the individual and potential immunity of the population. The results of our experimental study showed the presence of IgG antibodies in 182 (86%) of employees, which were acquired from overcoming the disease of COVID-19 or by vaccination. IgG and IgM antibodies were detected in 17 (6.8%) of employees. This group reported symptoms of respiratory illness one or two months before the testing. When comparing the individual departments, the IgG antibodies are dominant in SUR, REHAB and INT dept. versus the absence of IgG antibodies in employees of LABOR dept. and X-RAY. The presence of both types of antibodies was detected in employees of LABOR, SUR and REHAB dept. The higher presence of IgG antibodies in our experimental study was found in employees that worked in the first line during the COVID-19 pandemic. Among employees of the Internal, Rehabilitation and Surgical Departments were found multiple cases of reoccurring infection caused by the disease, and therefore we can observe higher levels of IgG antibodies. The employees who got vaccinated with three doses of vaccine were 128 (51.2%), followed by two doses in 78 (31.2%), single dose got 6 (2.4%), and unvaccinated was 38 (15.2%) of employees. Despite the use of personal protective working equipment while treating patients, the staff got infected multiple times. The workers in the LABOR dept. were found to have lower levels of antibodies because of the lack of direct contact with covid patients, even though they were exposed to their biological material.

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Conflicts of Interest

None declared

REFERENCES

1. Pal M, Berhanu G, Desalegn C, Kandi V. Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2): an update. Cureus. 2020 Mar 26;12(3):e7423. doi: 10.7759/cureus.7423.
2. Czirfuszová M, Stanková Valkovičová D, Nikš M, Horniačková M, Nováková E, Miková E, et al. [Standard procedure for microbiological diagnosis of suspected SARS-CoV-2 virus infection for clinical microbiology laboratories] [Internet]. Bratislava: Ministry of Health of the Slovak Republic; 2021 [cited 2023 Mar 27]. Available from: https://www.health.gov.sk/Zdroje?/Sources/dokumenty/SDTP/standardy/SDTP-pre-diagnostiku-pri-COVID-pre-lab-mikrobiologie.pdf. Slovak.
3. European Centre for Disease Prevention and Control. Covid-19 [Internet]. Sweden: ECDC; 2023 [cited 2023 Mar 27]. Available from: https://www.ecdc.europa.eu/en/covid-19.
4. World Health Organization. Coronavirus disease (Covid-19) [Internet]. Geneva: WHO; 2023 [cited 2023 Mar 27]. Available from: https://www.who.int/health-topics/coronavirus#tab=tab_1.
5. Hoffman T, Nissen K, Krambrich J, Rönnberg B, Akaberi D, Esmaelizadeh M, et al. Evaluation of a COVID-19 IgM and IgG rapid test; an efficient tool for assessment of past exposure to SARS-CoV-2. Infect Ecol Epidemiol. 2020;10(1): 1754538. doi: 10.1080/20008686.2020.1754538.
6. Faculty of Medicine at Pavol Jozef Šafárik University. [Employees and students of our faculty tested residents for antibodies against the disease Covid-19] [Internet]. Košice: UPJŠ; 2021 [cited 2023 Mar 27]. Available from: https://www.upjs.sk/lekarska-fakulta/actual-news/24763/. Slovak.
7. Assaid N, Arich S, Charoute H, Akarid K, Sadat MA, Maaroufi A, et al. Kinetics of SARS-CoV-2 IgM and IgG antibodies 3 months after COVID-19 onset in Moroccan patients. Am J Med Hyg. 2023;108(1):145-54.
8. Smagul M, Esmagambetova A, Nusupbaeva G, Kirpicheva U, Kasabekova L, Nukenova G, et al. Sero-prevalence of SARS-CoV-2 in certain cities of Kazakhstan. Health Sci Rep. 2022;5(2):e562. doi: 10.1002/hsr2.562.
9. Kaduskar O, Gurav YK, Deshpande K, Desphande GR, Yadav P, Rakhe A, et al. Understanding the dynamics of IgM & IgG antibodies in COVID-19-positive patients. Indian J Med Res. 2022 May-Jun;155(5&6):565-9.
10. Mansour B, Hassan AA, Attia FM, Mohamed SA, Abdo MM, Fahmy E, et al. High SARS CoV2 antibody-prevalence among health care workers with variable exposure to COVID-19 patients: a cross-sectional university hospital study. Microbes Infect Dis. 2022;3(4):842-51.

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