Quantitative Assessment of the Antibody Response to the COVID-19 Sputnik Vaccine

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Original Article

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ABSTRACT

Background: SARS-CoV-2 is a highly contagious virus that elicits COVID-19, a respiratory illness with a range of symptoms that can progress systemically and prove fatal. Vaccine development against the virus has been a crucial advance in combatting the pandemic, with vaccine efficacy being evaluated through analysis of antibody response. However, the magnitude of antibody response varies by vaccine and individual immunological status. Although even suboptimal antibody response may provide protection, COVID-19 immunity is a multi-factorial process that includes other immune components.

Objective: To measure changes in IgGSP antibody levels in response to the COVID-19 Sputnik vaccine, as analyzed by three serum samples collected at different time points in both seropositive and seronegative individuals.

Methods: A pre-post interventional study was carried on 324 military HCWs administering the Sputnik Vaccine at the Military Central COVID-19 Vaccination Unit from March till the end of July 2021.

Results: Participants were divided into seropositive and seronegative groups based on SARS-CoV-2 antibody levels. The seropositive group had a greater increase in IgGSP antibody titer after one vaccine dose. Both groups showed a significant decline in IgGSP levels after 12 weeks of complete vaccination, but the decline was less prominent in the seropositive group. This suggests the need for booster doses every six months to strengthen the immune system after the decline.

Conclusion: IgGSP antibodies are effective against SARS-CoV-2, but the minimum level for protection is unclear and requires further research to establish a cut-off point.

Key Words: COVID-19; COVID-19 Sputnik Vaccine; IgGSP; SARS-CoV-2; Spike Protein.

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BACKGROUND

The current pandemic caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is not the first time that a virus has caused a pandemic. In the past twenty years, there have been two highly pathogenic and fatal coronaviruses that have emerged, namely SARS-CoV and MERS-CoV A respiratory disease outbreak in several nations was traced to the severe acute respiratory syndrome (SARS-CoV) in the years 2002–2003, while the Middle East respiratory syndrome (MERS) outbreak in 2012 was linked to the MERS-CoV[1].

The SARS-CoV-2 is a virus that spreads easily and causes coronavirus disease 2019 (COVID-19), a respiratory illness that can be fatal and has a variety of symptoms which include fever, cough, and difficulty breathing and progresses to major systemic illness with the emergence of critically ill individuals suffering from multiple organ failure, eventually leading to death[2].

The development and approval of the vaccines has marked a significant milestone in the combat against the pandemic hazards. In addition to vaccination efforts, containment measures have been crucial in halting the spread of COVID-19. These measures include social seclusion, wearing face masks, and hand cleanliness[3,4].

Currently, mRNA vaccines, vector vaccines, protein subunit vaccinations, and inactivated or killed viral vaccines have all been licensed for use against COVID-19[5,6]. The most recent generation (mRNA-LNP) includes lipid-based mRNA nanoparticle vaccinations[7].

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The development of the vaccine has been an important advance forward in the combat against the pandemic. To determine the efficacy of COVID-19 vaccines, researchers are analysing the antibody response. The amount of antibodies generated varies depending on the type of vaccination and the individual's immune system. Yet, even a small number of antibodies can provide some protection against the virus. It is critical to remember that antibodies are not the sole sign of immunity; other components of the immune system may also play a role in COVID-19 protection[8].

The effectiveness of COVID-19 vaccinations must be also monitored in the battle against the pandemic. Research have shown that the vaccinations are quite successful at avoiding serious illness and death, more research is still required to ascertain how long the vaccines last and how well they guard against new emerging virus strains. Monitoring vaccination effectiveness entails keeping tabs on the population being immunized as well as their reaction to the vaccine. Decisions concerning the distribution of vaccines and other public health initiatives may be made with the use of this information[9].

MATERIALS AND METHODS

Study sample

The present study is a pre-post interventional study that was carried out on healthcare workers (HCWs) in the Egyptian Army who administered the COVID-19 Sputnik Vaccine at the Military Central COVID-19 Vaccination Unit. The study included male and female military personnel between the ages of 21 and 60 who had not contracted COVID-19 in the three months prior to receiving the vaccine at the Military Central COVID-19 Vaccination Unit. Participants with a history of COVID-19 within the past three months and those who did not meet the inclusion criteria were excluded from the study. In total, 324 individuals who fulfilled the inclusion and exclusion criteria were included in the study.

Data collection Every participant underwent a medical history interview, a general physical examination, and laboratory testing. From each study participant, three serum samples were collected for evaluation of the immunoglobulin G antibody titer towards the SARS-CoV-2 spike protein (IgGSP). The Armed Forces Laboratories for Medical Research and Blood Bank's virology department received the serum samples from the participants and used Abbott's “ALINITY i” to perform the serological analysis of the IgGSP using the chemiluminescent microparticle immunoassay (CMIA) technology.

Procedures

From each study participant, three serum samples collected for evaluation of the immunoglobulin G antibody titer towards the SARS-CoV-2 spike protein (IgGSP) as follows: Sample 1 (Baseline Sample) was taken before the vaccination setting to check if the individual had recovered from SARS-COV-2 or had already had a subclinical infection. Sample 2 was collected three weeks following the initial immunization dosage. Sample 3 was collected after 12 weeks of complete vaccination for further follow-up and monitoring of the IgGSP level throughout the study participants. The presence of IgG antibodies towards SARS-CoV-2 is regarded as a sign of present or past illness.

The SARS-CoV-2 IgGSP assay

This assay is an automated, two-step immunoassay for the quantitative detection of IgG antibodies to SARS-CoV-2 in human serum chemiluminescent microparticle immunoassay (CMIA) technology. It is performed using Abbott's next generation of systems, "ALINITY i," which is designed to detect immunoglobulin class G (IgG) antibodies to the spike protein of SARS-CoV-2 in serum from individuals suspected to have had coronavirus disease. The assay is intended to aid in identifying individuals with an adaptive immune response to SARS-CoV-2, indicating recent or prior infection. Results are reported by dividing the sample result by the stored calibrator result.

The default result unit for the SARS-CoV-2 IgG assay is Index (S/C) . The cutoff for a positive result is 1.40 Index (S/C), meaning that a result of ≥ 1.40 Index (S/C) is considered positive.

AIM OF THE STUDY

This study aims to evaluate the effectiveness of the COVID-19 Sputnik vaccine by analyzing IgGSP antibody responses in seropositive and seronegative individuals, with the objective of identifying changes in IgGSP antibody levels over time. The study's findings may have significant implications for the design of vaccination schedules and the administration of booster doses to maintain immunity against COVID-19.

Data analysis

The data underwent several analyses using SPSS 26, including reviewing, coding, tabulating, and entering into a PC. Descriptive statistics summarized numerical data using mean, standard deviation, and range, and non-numerical data using frequency and percentage. Appropriate statistical techniques were applied to each parameter. The Chi-Square test evaluated variable relationships at $p<0.05$ significance level. Comparing previous SARS-CoV-2 history and serotypes utilized descriptive statistics and Chi-square tests at $p<0.05$. Kruskal-Wallis and Mann-Whitney U-tests analyzed relationships between serotype, age, gender, and mean SARS-CoV-2 antibodies in the three samples.

RESULTS

This study included 324 participants of both sexes, with males accounting for 293 (90.4%) and females accounting for 31 (9.6%), as shown in (Table 1). Regarding the past history of COVID-19 infection, 57 people (17.6%) had been previously infected in more than 3 months prior to

the start of the vaccination setting, while 267 participants (82.4%) had not been previously infected. Regarding participants' age, their mean age was 41.71 ± 9.36, with a range of 21-59 years old. Most of the participants (206 participants) were above the age of 40 (63.6%) as shown in Table 1.

Table 1: Characteristics of the study participants

Characteristics of study participants		Study sample (n=324)	
		N	%
Gender	Male	293	90.4 %
	Female	31	9.6 %
Previous history of COVID-19	Yes	57	17.6 %
	No	267	82.4 %
Age (years)	< 40	118	36.4 %
	> 40	206	63.6 %
	Mean ± SD	41.71 ± 9.36	
	Minimum	21	
	Maximum	59	

The participants in the study had their IgGSP levels measured before vaccination. This measurement is referred to as "Pre-vaccination sample," "Baseline sample," or "Sample 1" in the subsequent sections of the study. Out of the 324 participants, 274 (84.6%) were classified as seronegative since they had no detectable IgGSP antibodies. On the other hand, the remaining 50 participants (15.4%) were classified as a seropositive group since they had detectable IgGSP antibodies at baseline. These groups can be further categorized based on their previous COVID-19 history, leading to a statistically significant difference ($p < 0.001$).

The seropositive participant group consisted of 50 individuals, out of which 41 (82%) had been infected with COVID-19 more than three months before the vaccination started. The remaining 9 participants (18%) had no history of infection. In contrast, among the seronegative participant group, 258 individuals (94.2%) had no previous history of COVID-19 infection, whereas the remaining 16 participants (5.8%) had been infected before.

After three weeks of receiving the first dose of vaccination and just before receiving the second dosage, the serum samples of the participants were collected, and their IgGSP levels were measured. The results indicated that most seronegative participants had IgG titers in the range of (10,000 - < 20,000 IU/mL), whereas most seropositive participants had IgG titers in the range of (30,000 - < 40,000 IU/mL).

After 12 weeks of receiving the second vaccination dose, the participants' blood samples were collected again, and their IgGSP levels were measured. The majority of the seronegative participants' group had an IgG titer of less than 10,000 IU/mL, while the majority of the seropositive participants' group had IgG titers in the range of (30,000 - 40,000 IU/mL) as shown in (Figure 1).

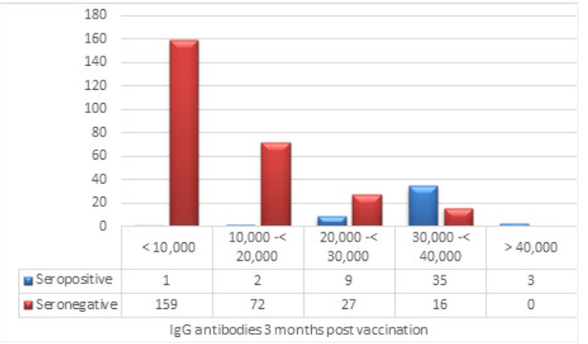

Fig. 1: The SARS-CoV-2 IgG Spike Proteins Antibodies in the Vaccination Sample (12 weeks after full vaccination).

According to the study findings, when the seronegative group was examined three weeks after receiving the initial dose of vaccination, it was found that most seronegative participants had slightly raised IgG titers between 10,000 and 20,000 IU/mL. Their IgG titers, however, steadily decreased to less than 10,000 IU/mL after a full 12-week follow up post-vaccination.

Our study findings showed that 15.4% of participants had detectable IgGSP at baseline, classifying them as members of the seropositive subgroup. After three weeks after getting the first vaccine dose (Sample 2), the majority of seropositive individuals' IgG titers were found to be within (30,000 - 40,000 IU/mL), and they remained in this range for approximately 11 weeks after having all three vaccination doses, as shown.

Our results show that the study findings suggest that the IgG response in the seropositive participants' group increased significantly after three weeks of receiving the first vaccination dose (Sample 2), resulting in most individuals having IgG titers between 30,000 and 40,000 IU/mL. However, their IgG titers decreased slightly over the next 12 weeks after being fully vaccinated. On the other hand, the seronegative group showed a limited increase in IgG titers after three weeks of the first vaccination dose (Sample 2), but at a slower rate than the seropositive group. Most seronegative participants had IgG titers between 10,000 and 20,000 IU/mL, which began to decline at a faster rate than in the seropositive group. After 12 weeks of being fully vaccinated, the majority of seronegative participants' IgG titers declined to less than 10,000 IU/mL.

(Table 2) shows that there is a statistically significant difference between the seropositive and seronegative participants groups in respect to the three study sampling occasions (sample 1,2 and3 ($p < 0.001$). The statistical analysis indicates that there is a significant difference between sample one and sample two ($p < 0.001$), sample one and sample three ($p < 0.001$), and sample two and sample three ($p < 0.001$) within the seronegative subgroup. Similarly, within the seropositive subgroup, there is a significant difference between sample one and sample two ($p < 0.001$), sample one and sample three ($p < 0.001$), and sample two and sample three ($p = 0.004$).

Table 2: Participants serotype and mean anti-SARS-CoV-2 IgGSP in the three samples

Serotype	Sample 1	Sample 2	Sample 3	P1	P2	P3
Negative	0 (0, 0)	11612 (8219, 16590)	8842 (5116, 13159)	< 0.001	< 0.001	< 0.001
Positive	809 (467, 1028)	38750 (35531, 40000)	36370 (31320, 37727)	< 0.001	< 0.001	0.004
P	< 0.001	< 0.001	< 0.001			

The data presented is expressed as mean and standard deviation. A p-value of less than 0.05 indicates statistical significance. The p-value was used to determine the statistical difference between the seropositive and seronegative groups for each sample, with P1 representing the difference between samples 1 and 2, P2 representing the difference between samples 1 and 3, and P3 representing the difference between samples 2 and 3.

(Table 3) shows that there is no significant statistical difference between the participant groups aged < 40 and > 40 years old regarding sample 1 ($p = 0.376$), sample 2 ($p = 0.129$), and sample 3 ($p = 0.318$). However, among the < 40 years old subgroup, a significant statistical difference was observed between sample 1&2 ($p < 0.001$), sample 1&3 ($p < 0.001$), and sample 2&3 ($p < 0.001$). Similarly, among the > 40 years old subgroup, there was a significant statistical difference between sample 1&2 ($p < 0.001$), sample 1&3 ($p < 0.001$), and sample 2&3 ($p < 0.001$).

Table 3: Participants' age and mean anti-SARS-CoV-2 IgGSP in the three samples

Age	Sample 1	Sample 2	Sample 3	P1	P2	P3
< 40	0 (0, 0)	14104 (10149, 25251)	10442 (6044, 20284)	< 0.001	< 0.001	< 0.001
> 40	0 (0, 0)	12461 (8292, 25107)	9368 (5336, 23094)	< 0.001	< 0.001	< 0.001
P	0.376	0.129	0.318			

The data presented is expressed as mean and standard deviation. A p-value of less than 0.05 indicates statistical significance. The p-value was used to determine the statistical difference between the seropositive and seronegative groups for each sample, with P1 representing the difference between samples 1 and 2, P2 representing the difference between samples 1 and 3, and P3 representing the difference between samples 2 and 3.

(Table 4) shows that there is no significant statistical difference between the male and female participant groups regarding sample 1 ($p = 0.337$), sample 2 ($p = 0.151$), and sample 3 ($p = 0.181$). However, among the male subgroup, a significant statistical difference was observed between sample 1&2 ($p < 0.001$), sample 1&3 ($p < 0.001$), and sample 2&3 ($p < 0.001$). Similarly, among the female subgroup, there was a significant statistical difference between sample 1&2 ($p < 0.001$), sample 1&3 ($p < 0.001$), and sample 2&3 ($p = 0.004$).

Table 4: Participants' gender and mean anti-SARS-CoV-2 IgGSP in the three samples

Gender	Sample 1	Sample 2	Sample 3	P1	P2	P3
Male	0 (0, 0)	12863 (9042, 24550)	9486 (5590, 20963)	< 0.001	< 0.001	< 0.001
Female	0 (0, 0)	16104 (11242, 30636)	14805 (6582, 27531)	< 0.001	< 0.001	0.004
P	0.337	0.151	0.181			

The data presented is expressed as mean and standard deviation. A p-value of less than 0.05 indicates statistical significance. The p-value was used to determine the statistical difference between the seropositive and seronegative groups for each sample, with P1 representing the difference between samples 1 and 2, P2 representing the difference between samples 1 and 3, and P3 representing the difference between samples 2 and 3.

DISCUSSION

In the current investigation, we evaluated the antibody responses in 324 individuals of both sexes who received the Sputnik V, with or without a prior history of COVID-19 (N = 50 and N = 274, respectively). With a mean age of 41.71 ± 9.36, the participants' ages varied from twenty-one to fifty-nine. Men made up 90.4% of the participants in the current research.

Only 15.4% of the participants had detectable IgGSP at the baseline and were categorised as a seropositive group, indicating a previous COVID-19 infection, while 84.6% were not previously infected and had no detectable antibodies at the baseline and were categorised as a seronegative group. This was determined by measuring the IgGSP levels for the study participants before receiving the first vaccination dose.

When we applied the natural history of infection to this group, we found that 9 of the 50 seropositive participants' group at the baseline had never been infected by SARS-CoV-2 before, indicating a subclinical infection rate of 18%. In contrast, 16 of the 274 seronegative participants had previously had an infection, demonstrating that after at least three months of natural infection, COVID-19 is still susceptible to poor protective immunity.

The seropositive group IgGSP titers were further assessed for three weeks after receiving the first vaccination dosage. It was found that the majority of seropositive participants' IgGSP titers ranged from 30,000 to 40,000 IU/mL and remained at this level for roughly 12 weeks after receiving the full course of vaccination, which is significantly higher than those of the seronegative participants' group in both the second and third sample.

This was in concordance with Claro *et al*.'s[10] study which was conducted in Venezuela in October 2021, where they evaluated the IgGSP antibody response in 86 individuals before and after each dosage of the sputnik vaccine. They found that the seropositive individuals had baseline IgG titers that were approximately 40% higher than their fully vaccinated seronegative peers, suggesting that the seropositive group's IgG levels were unaffected by the second immunization dosage.

Ledesma *et al*.[11] conducted a study in Argentina that involved 118 volunteers who received the complete two doses of Sputnik V vaccine. They measured the IgGSP levels at baseline, three weeks after the first dosage, and three weeks, six weeks, and 21 weeks after the second dosage. Their findings were consistent with the current study, showing that participants who had previously been infected with COVID-19 had a more robust antibody response than those who had not been infected. They also found that IgGSP levels decreased significantly in both serogroups after 12 weeks of complete vaccination, but the decline was less in the seropositive group.

Rossi *et al*.[12] conducted a study on 289 medical professionals from Argentina, evaluating the IgGSP responsiveness following the Sputnik immunization. The researchers measured the IgGSP levels at baseline, three weeks after the first dosage, and three weeks after the second dosage, regardless of whether the participants had previously contracted the disease. Their findings were in agreement with the current study, indicating that participants with pre-existing immunity had significantly higher antibody activity after receiving just one dose of the vaccine compared to those receiving one or both doses ($p < 0.0001$). This implies that seropositive individuals mount a stronger response to a single dose than those receiving two doses.

Furthermore, our findings supported all comparable SARS-CoV-2 vaccination studies carried out in various nations, which demonstrated that administering a single dose of the vaccine to someone who has been previously infected results in a more potent antibody response than vaccinating uninfected individuals with the two doses.

According to Swedish researchers, Just one dose of Oxford-AstraZeneca's vaccination ChAdOx1 nCoV-19 can significantly boost the immune response in individuals who have previously been infected with COVID-19 for at least 11 months. This finding suggests that a single dose vaccination regimen may be sufficient for individuals who have already contracted SARS-CoV-2[13].

Based on serology tests, healthcare professionals in the USA who had previously contracted COVID-19 responded more strongly to a single dose of the Pfizer or Moderna vaccine than those who had not[14-17].

Saadat *et al*.[14] conducted a study at the University of Maryland Medical Center in the USA, examining the antibody responses to a single dose of the Pfizer-BioNTech or Moderna vaccines in fifty-nine healthcare workers (HCW) with confirmed COVID-19 infection. They compared the results with the IgG-negative antibody responses to the SARS-CoV-2 spike protein in HCWs. The study found that HCWs who had previously contracted COVID-19 had significantly higher levels of antibodies than those who had not. This study was conducted from July to August 2021.

Krammer *et al*.[15] conducted a study in April 2021 in New York, USA, involving 110 participants. The study assessed the SARS-CoV-2 antibody responses of individuals who had or had not previously contracted the virus following vaccination. Their findings were consistent with the current study, indicating that individuals with prior immunity had significantly higher antibody titers than those without immunity at the same time periods after receiving the first dose of the vaccine. The antibody titers of vaccination recipients with prior immunity were 10 to 45 times greater than those of recipients without prior immunity.

Ebinger *et al*.[16] conducted a study in June 2021 in the USA, involving a group of 1,090 people who received the Pfizer-BioNTech vaccine. Their findings were consistent with the current study, indicating that individuals with past history of COVID-19 had similar levels of IgG SP antibodies after a single dose of the vaccine as those without prior infection had after two doses (n = 35 for individuals with prior infection and n = 228 for those without).

This was also in agreement with Fraley *et al*.[17] study which examined the humoral immune responses in 194 participants after receiving the BNT162b2 vaccine (Pfizer-BioNTech) , whether they had a history of COVID-19 or not. The study was conducted in the USA in July 2021. They discovered that the antibody levels in seropositive people were much higher after a single dose than those in seronegative people and were comparable to those in seronegative people after two doses. This reinforced the idea that future immunization strategies should take into account the history of earlier SARS-CoV-2 infections.

At Tucuman, Argentina, between December 2020 and July 2021 Chahla *et al*.[18] used the IgGSP titer measures at 0, 14, 28, 60, and 180 days after receiving SPUTNIK V to study the humoral immune responses in 602 healthcare personnel.The study found that those who had baseline IgG antibodies reacted to the initial dose of Sputnik V considerably better than individuals who had never experienced the illness. According to this research, delivering SPUTNIK V just once to those who have already had COVID-19 before may assist maximise the utilisation of the available dosages.

This was also consistent with the findings of Gobbi *et al*.[19], who assessed at the antibody response in the COVID-19 previously infected people just after receiving the first dosage of the BNT162b2 (Pfizer-BioNTech)

mRNA vaccine. It took place for 1958 healthcare workers between January 1 and March 30, 2021. The results of this study showed that the IgGSP titers were significantly higher in healthcare workers (HCWs) with COVID-19 infections compared to those who were not infected, but significantly lower in HCWs with infections following the BNT162b2 vaccine compared to those with infections prior to receiving the vaccine.

This also agreed with Manisty *et al*.[20], who evaluated fifty volunteers receiving their first dose of the BNT162b2 (Pfizer-BioNTech) mRNA vaccine in March 2021 in the UK. The spike protein antibodies titers were evaluated for all study participants 19 to 29 days after receiving their first dose. Their result revealed that following a single dose of vaccination, the IGSP antibodies in previously seronegative, uninfected individuals reached their maximum levels in unvaccinated persons who had previously had a natural illness. Also, in patients who had previously caught SARS-CoV-2, the antibody titer increased by more than 140 times from the highest pre-vaccine levels.

Furthermore, in India, Sasikala *et al*.[21] assessed the immunological memory in 280 healthcare workers receiving a single dose of the Oxford, AstraZeneca COVISHIELD vaccine and who had previously contracted COVID-19 and their results showed a higher antibody response and protective immunity.

Several countries, notably France, recommend a single dosage for people who are sick since this could assist in using dosages more efficiently, expand the limited supply, and administer immunizations more quickly[10].

Nevertheless, the Sputnik vaccine contains two distinct vector components: rAd26-S (main dosage) and rAd5-S. (booster dose). A booster dose of rAd5-S may no longer be required in patients who have already contracted the disease, rendering the rAd5-S vaccine useless. Moreover, it is not known if the booster rAd5-S dose could be administered as the main dose in patients who have already developed the infection and if it will still have the same powerful stimulant impact. Thus, the two-dose regimen should be used in those who have already contracted the disease until more is known about vaccination protection and until the available vaccine doses are used more efficiently[10].

On the other hand, when we return to our study, we find that we find that 84.6% of our study participants were not previously infected and had no detectable antibodies at the baseline and classified as a seronegative group. Those seronegative group was further examined for the IgGSP in three weeks after receiving the first vaccination dose (sample 2), and it was discovered that most of the seronegative participants' IgG titers were elevated to a limited extent, ranging from 10,000 to 20,000 IU/mL, before gradually declining to less than 10,000 IU/mL after 12 weeks of being fully vaccinated (Sample 3).

This seems to be in agreement to Claro *et al*.'s[10] study, which examined the IgGSP in a cohort of 86 Venezuelans, discovered that 42% of the group of trial subjects who were seronegative did not exhibit a measurable IgG response after receiving the first dosage of the vaccine and only underwent seroconversion after getting the second dose.

In this investigation, we assessed the SARS-CoV-2 IgGSP antibody levels in the seronegative group after a lengthy 12-week follow-up period following the second dose of immunisation. The results showed that after 12 weeks of full immunisation, the IgG titre considerably reduced, necessitating the administration of a booster dose every six months.

The Ledesma *et al*.[11] study, which examined the anti-spike IgG antibody level to SARS-CoV-2 12 weeks after receiving the whole two-dose course of the Sputnik V in Argentina between January and August 2021, was likewise in agreement with this. Their results demonstrated a substantial decline in SARS-CoV-2 IgGSP antibody levels in persons who were seronegative.

By categorizing the data by sex and age, we could then evaluate how gender and age affected vaccination antibody responses. Then we discovered that there were no significant differences in antibody levels between sexes ($p = 0.151$) or between ages ($p = 0.129$) at 21 days following the initial vaccination dose.

This was in agreement with Fraley *et al*. study[17], which discovered that there were no sex-based changes in antibody levels following the first dosage of the vaccination (week 3). Their results showed that older (> 50 years old) seronegative patients had much less antibodies than younger individuals (50 years of age). Nevertheless, the seropositive group did not show any observable age differences ($P = 0.0003$).

While according to Rossi *et al*.'s[12] study, individuals were divided into age groups after receiving the first dosage of Sputnik V, and seroconversion was found in 96% of persons under 60 and 89% of participants over 60.

Following 12 weeks of complete immunization, our data likewise showed a significant drop in IgGSP levels in both study serogroups, however this decline was less pronounced in the seropositive study group. This decrease supports the need to provide a booster dose every six months.

We acknowledge that there are some potential pitfalls in our study as there is an overrepresentation of males, which is due to the demographic characteristics of the Egyptian Armed Forces, and the fact that all the study participants are military personnel administering the Sputnik Vaccine at the Military Central COVID-19 Vaccination Unit.

This study offers fresh information on the humoral immune responses of uninfected and previously exposed SARS-CoV-2 people to the Sputnik V as a single dose

creates higher titers in seropositive individuals than two doses do in naïve individuals. However, because the number of seropositive participants in our study is small, the findings need to be validated across clinical subcategories, bigger, more heterogeneous demographics, with larger sample sizes—all of which are known to reflect differences in antibody levels.

CONCLUSION AND RECOMMENDATIONS

The IgGSP antibodies have been demonstrated to be effective in protecting against SARS-CoV-2, however the minimum titer of antibodies needed to provide protection is yet unclear and needs further research to determine its cut-off point.

CONFLICT OF INTERESTS

There are no conflicts of interest.

REFERENCES

1. American Academy of Pediatrics. Coronaviruses, including SARS and MERS. In: Kimberlin DW, Brady MT, Jackson MA, Long SS, editors. Red Book®: 2018 Report of the Committee on Infectious Diseases. 31st ed. Itasca (IL): American Academy of Pediatrics, 2018:297-301.

2. Lippi, G.; Sanchis-Gomar, F.; Henry, B.M. COVID-19: Unravelling the clinical progression of nature's virtually perfect biological weapon. Ann. Transl. Med. 2020, 8, 693.

3. Fauci, A.S. The story behind COVID-19 vaccines. Science 2021, 372, 109.

4. Pradhan, D.; Biswasroy, P.; Naik, P.K.; Ghosh, G.; Rath, G. A Review of Current Interventions for COVID-19 Prevention. Arch. Med. Res. 2020, 51, 363–374.

5. Forni, G.; Mantovani, A. COVID-19 Commission of Accademia Nazionale dei Lincei, Rome. COVID-19 vaccines: Where we stand and challenges ahead. Cell Death Differ. 2021, 28, 626–639.

6. Creech, C.B.; Walker, S.C.; Samuels, R.J. SARS-CoV-2 Vaccines. JAMA 2021, 325, 1318–1320.

7. Topol, E.J. Messenger RNA vaccines against SARS-CoV-2. Cell 2021, 184, 1401.

8. Karim, S.S.A.; de Oliveira, T. New SARS-CoV-2 Variants—Clinical, Public Health, and Vaccine Implications. N. Engl. J. Med. 2021,384, 1866–1868.

9. Lippi, G.; Sciacovelli, L.; Trenti, T.; Plebani, M. Kinetics and biological characteristics of humoral response developing after SARS-CoV-2 infection: Implications for vaccination. Clin. Chem. Lab. Med. 2021.

10. Claro F, Silva D, Rodriguez M, Rangel HR, de Waard JH. Immunoglobulin G antibody response to the Sputnik V vaccine: previous SARS-CoV-2 seropositive individuals may need just one vaccine dose. International Journal of Infectious Diseases. 2021 October 1;111:261-6.

11. Ledesma MM, Sanchez L, Ojeda DS, Rouco SO, Rossi AH, Varesse A, Mazzitelli I, Pascuale CA, Miglietta EA, Rodriguez PE, Pallares HM. Temporal Increase in Neutralization Potency of SARS-CoV-2 Antibodies and Reduced Viral Variant Escape after Sputnik V Vaccination. medRxiv. 2021 August 25.

12. Rossi AH, Ojeda DS, Varese A, Sanchez L, Ledesma MM, Mazzitelli I, Juliá AA, Rouco SO, Pallarés HM, Navarro GS, Rasetto NB. Sputnik V vaccine elicits seroconversion and neutralizing capacity to SARS-CoV-2 after a single dose. Cell Reports Medicine. 2021 Aug 17;2(8):100359.

13. Havervall S, Marking U, Greilert-Norin N, Ng H, Salomonsson AC, Hellstrom C, Pin E, Blom K, Mangsbo S, Phillipson M, Klingstrom J. Antibody responses after a single dose of ChAdOx1 nCoV-19 vaccine in healthcare workers previously infected with SARS-CoV-2. medRxiv. 2021 January 1.

14. Saadat S, Tehrani ZR, Logue J, Newman M, Frieman MB, Harris AD, Sajadi MM. Binding and neutralization antibody titers after a single vaccine dose in health care workers previously infected with SARS-CoV-2. Jama. 2021 Apr 13;325(14):1467-9.

15. Krammer F, Srivastava K, Alshammary H, Amoako AA, Awawda MH, Beach KF, Bermúdez-González MC, Bielak DA, Carreño JM, Chernet RL, Eaker LQ. Antibody responses in seropositive persons after a single dose of SARS-CoV-2 mRNA vaccine. New England Journal of Medicine. 2021 Apr 8;384(14):1372-4.

16. Ebinger JE, Fert-Bober J, Printsev I, Wu M, Sun N, Prostko JC, Frias EC, Stewart JL, Van Eyk JE, Braun JG, Cheng S. Antibody responses to the BNT162b2 mRNA vaccine in individuals previously infected with SARS-CoV-2. Nature Medicine. 2021 Jun;27(6):981-4.

17. Fraley E, LeMaster C, Geanes E, Banerjee D, Khanal S, Grundberg E, Selvarangan R, Bradley T. Humoral immune responses during SARS-CoV-2 mRNA vaccine administration in seropositive and seronegative individuals. BMC medicine. 2021 Dec; 19(1): 1-2.

18. Chahla RE, Tomas-Grau RH, Cazorla SI, Ploper D, Pingitore EV, Lopez MA, Aznar P, Alcorta ME, del Mar Velez EM, Stagnetto A, Avila CL. Past SARS-CoV-2 infection elicits a strong immune response after a single vaccine dose. medRxiv. 2021 Jan 1.

19. Gobbi F, Buonfrate D, Moro L, Rodari P, Piubelli C, Caldrer S, Riccetti S, Sinigaglia A, Barzon L. Antibody response in individuals infected with SARS-CoV-2 early after the first dose of the BNT162b2 mRNA vaccine. J Infect. 2021 Aug 8

20. Manisty C, Otter AD, Treibel TA, McKnight Á, Altmann DM, Brooks T, Noursadeghi M, Boyton RJ, Semper A, Moon JC. Antibody response to first BNT162b2 dose in previously SARS-CoV-2-infected individuals. The Lancet. 2021 March 20; 397(10279): 1057-8.

21. Sasikala M, Shashidhar J, Deepika G, Ravikanth V, Krishna VV, Sadhana Y, Pragathi K, Reddy DN. Immunological memory and neutralizing activity to a single dose of COVID-19 vaccine in previously infected individuals. International Journal of Infectious Diseases. 2021 July 1;108:183-6.