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The impact of the Sputnik V vaccine on antibody responses in the general population of Golestan province, Iran

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Abstract

Background: Although public health interventions have slowed the spread of SARS-CoV-2 infections, the worldwide pandemic of COVID-19 is progressing. Thus, effective and safe vaccination against SARS-CoV-2 is an important tool for controlling the COVID-19 pandemic. Now in the early stages of COVID-19 vaccination, vaccinated individuals are interested in using antibody tests to confirm vaccination success and estimate the time of protection. Here, we assessed anti-spike IgG responses in the general population 2 weeks after the second dose of the Sputnik V vaccine.

Methods: This study included blood samples of 67 individuals without a previous SARS-CoV-2 infection taken 14 days after the second dose of the Sputnik V vaccine. Anti-spike IgG responses were assessed with an enzyme-linked immunosorbent assay (ELISA).

Results: Anti-spike IgG was detected in 55 (82.1%) of 67 samples 14 days after the second dose of the Sputnik V vaccine. Antibody levels were significantly lower in males than in females, and 9 (75%) of 12 seronegative individuals were males.

Conclusion: Vaccination resulted in detectable anti-spike IgG in 82.1% of individuals, and gender may be an important factor in the humoral response.

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Introduction

Although public health interventions (such as face masks, social distancing, and hand hygiene) have slowed the spread of SARS-CoV-2 infections (1), the worldwide pandemic of COVID-19 is progressing, particularly after the appearance of more aggressive variants of the virus (2). Thus, effective and safe vaccination against SARS-CoV-2 is an important tool for controlling the COVID-19 pandemic and reducing deaths associated with COVID-19 (3). Most COVID-19 vaccines are focused on the spike glycoprotein of SARS-CoV-2 for inducing neutralizing antibodies. The spike protein present on the surface of the virus binds to the receptor of angiotensin-converting enzyme 2 (ACE2) on target cells during viral entry (4).

Among the several types of COVID-19 vaccines, Sputnik V, produced by the Gamaleya Institute, is based on non-replicating viral vector platforms. This vaccine used 2 different vectors (recombinant adenovirus serotype 26 [Ad26] and recombinant Ad5), which both encode full-length spike protein (5). The adenoviral vectors, after entry into host cells, can replicate and produce viral proteins through gene transcription. The produced viral proteins can then stimulate strong antibody and T-cell responses (6). The results of phases 1 and 2 of the Sputnik V vaccine showed that the vaccine was safe and stimulated robust cellular and humoral immune responses in all healthy participants (7). Also, the results of phase 3 showed that the efficacy of a vaccine against COVID-19 and severe COVID-19 was 91.6% and 100%, respectively. The vaccine efficacy in all age groups was more than 87%, and in subjects older than 60 years was 91.8% (8).

SARS-CoV-2 antibody testing played a critical role in identifying those at risk of COVID-19 infection and controlling the COVID-19 pandemic (9). Now in the early stages of COVID-19 vaccination, vaccinated individuals are interested in using antibody tests to confirm vaccination success and estimate the time of protection. Here, we assessed anti-spike IgG responses in the general population 2 weeks after the second dose of the Sputnik V vaccine.

Methods

This study included blood samples of 67 individuals without a previous SARS-CoV-2 infection 14 days after the second dose of the Sputnik V vaccine. Participants taking immunomodulatory drugs, having a previous positive reverse transcriptase–polymerase chain reaction (RT-PCR) or antigen tests for SARS-CoV-2, or having the presence of SARS-CoV-2 antibodies were excluded. This study was approved by the Ethics Committee of Golestan University of Medical Sciences (code: IR.GOUMS.REC.1400.220). Written informed consent was obtained from all participants.

Anti-spike IgG responses were assessed with an enzyme-linked immunosorbent assay (ELISA; Quantitative SARS-CoV-2–Spike IgG ELISA Kit, Lot No: 14007, Pishtaz Teb Diagnostics, Iran). According to the manufacturer, the clinical sensitivity and specificity were 98.16% and 99.01%, respectively, at a cutoff value of 44 binding antibody units (BAU)/mL based on measurements of the WHO International Standard Anti–SARS-CoV-2 Immunoglobulin (code 20-136, NIBSC). Serum samples were run at a 1/101 starting dilution.

After evaluating the normal distribution of data by the Shapiro-Wilk test, a t test was used to detect statistical differences in the anti-spike IgG titers between females and males; in addition, a correlation between the titers of the anti-spike IgG and age was performed using the Pearson test. P values less than 0.05 were considered statistically significant. Data were expressed as n/N (%), mean ± SD, and medians and interquartile ranges (IQRs).

Results

Of the 67 participants, 34 (50.7%) were female and 33 (49.3%) were male. The median age of the participants was 40.0 years (IQR 31-47). Fourteen days after the second dose of the vaccine, 82.1% (55/67) of the participants were seropositive. The mean ± SD serum level of anti-spike IgG was 261.5 ± 48.1 BAU/mL. The antibody level in females was 306.8 ± 49 BAU/mL, while it was 215 ± 42.4 BAU/mL in males. The difference in antibody levels was statistically significant between females and males ($P < .05$). No statistically significant correlation was found between age and the antibody level of vaccinated individuals ($r = 0.097$; $P > .05$). Among seronegative individuals, the median age was 37.5 years (28-45); 25% of these individuals were female, and 75% were male (Table1).

Table 1. Clinical characteristics of the vaccinated individuals

	No. (%)	Age (years), Median with IQR	Anti-spike IgG (BAU/mL)	Vaccine responders, No. (%)
Total	67	40 (31–47)	261.5 ± 48.1	55 (82.1%)
Female	34 (50.7%)	38.5 (28.7–45.2)	306.8 ± 49*	31 (56.4%)
Male	33 (49.3%)	41 (33.5–48.5)	215 ± 42.4*	24 (43.6%)

Abbreviations: IQR, Interquartile range; BAU, Binding antibody units.
*Significant group difference at $P < 0.05$. Data were expressed as median with IQR, Mean ± SD, or numbers and percentages.

Discussion

In this study, anti-spike IgG was detected in 55 (82.1%) of 67 samples 14 days after the second dose of the Sputnik V vaccine. The results of phase 3 showed that receptor-binding domain (RBD)-specific IgG were detected in 98% of samples on day 42. Antibody levels were not significantly different between females and males, but they were significantly higher in the age group of 18-30 years than in other age groups (8). A study conducted in Argentina reported that 21 days after the second dose, 100% of health care workers showed a positive immune response to the anti-spike IgG with a geometric mean titer (GMT) of 2148 (10). Also, a study conducted in Venezuela showed that 2 doses of the Sputnik V vaccine trigger a strong IgG response in all individuals (100%) (11).

Genetic and immunological factors, aging, obesity, parasitic infections, vaccine quality, and how vaccines are administered are factors related to vaccine efficacy (12, 13). One of the factors associated with vaccine efficacy in the use of Ad5-based vaccines is the pre-existing anti-Ad5–neutralizing antibody. The majority (30%-80%) of the Asian population exhibit high (>200) pre-existing anti-Ad5–neutralizing antibody titers from prior infections (14). Therefore, this high seroprevalence could potentially reduce the immunogenicity of these vaccines (15).

Since obesity is a key risk factor for COVID-19 (16), the efficacy of COVID-19 vaccines in obese individuals should be considered. Obesity can be associated with vaccine inefficacy due to increased interleukin 6 (IL-6) levels and reduced IgG concentrations (17). Also, obesity can disrupt the immune system's response to the influenza virus by reducing CD8+ T cell activity (18).

Immunosenescence is an age-associated dysfunction of the immune system, which may lead to a poor immune response to the vaccine in the elderly due to dysregulation of innate and adaptive immune systems (19). Studies show that aging the immune system reduces vaccination effectiveness (20). Another study shows that in older people, an increase in the level of $CD27^{+}$ age-associated B cells is associated with a decrease in the specific antibody titers of influenza (21). Our results showed that antibody levels were not related to age, which could be due to the small sample size and the age of the participants (which was less than 60 years).

Our results showed that antibody levels were significantly lower in males than in females, and 9 (75%) of 12 seronegative individuals were males. Females have usually more strong immune responses to infections and vaccination than males, which can be related to hormonal differences, such as estrogen and testosterone (22). Studies on the association between estradiol and humoral immunity have shown that hormone therapy with estrogen in menopausal women increases circulating B cells (23). Also, estradiol can increase the activation of interferon α (IFN-α) signaling in B cells and indirectly increase toll-like receptor 7 (TLR-7) expression in these cells. Toll-like receptors play a significant role in the recognition of pathogens. B cells express more TLR-7 in females than in males (24). In response to influenza vaccination, females produce higher antibody titers than males (25). Studies have shown that testosterone levels are inversely related to inactivate seasonal influenza vaccination antibody levels (26).

Conclusion

In our population vaccinated with the Sputnik V vaccine, vaccination resulted in detectable anti-spike IgG in 82.1% of individuals. Gender can probably be an important factor in the humoral response, as a higher antibody titer was detected in females. Further research is needed to examine the factors related to vaccine efficacy in the larger population.

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Ethical statement

This study was approved by the Ethics Committee of Golestan University of Medical Sciences (Code: IR.GOUMS.REC.1400.220). All procedures were performed in agreement with the principles of the Declaration of Helsinki (1964) and later amendments.

Conflicts of interest

The authors declare no competing interests.

Author contributions

Ommolbanin Younesian wrote the paper; Behnaz Khodabakhshi contributed data or analysis tools; Sara Hosseinzadeh contributed data or analysis tools; Seyedeh Somayeh Hosseini Alarzi conceived and designed the analysis; Samareh Younesian performed the analysis; Mojtaba Pourmomen collected the data; Mana Zakeri collected the data; Hamidreza Joshaghani wrote the paper, conceived and designed the analysis.

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