Cerić et al.: COVID-19 vaccination among cancer patients

Acceptance, effects, and tolerability in the vaccination process against SARS-CoV-2 virus among cancer patients in Bosnia and Herzegovina: a single-center cross-sectional study

Timur Cerić*, Emir Sokolović, Anes Pašić, Emina Borovac-Gurda, Velda Smajlbegović, Berisa Hasanbegović, Emina Bičakčić Filipović, Elma Kapisazović, Selma Sokolović, Semir Bešlija

Clinic of Oncology, Clinical Center University of Sarajevo, Sarajevo, Bosnia and Herzegovina

*Corresponding author: Timur Cerić, Clinic of Oncology, Clinical Center University of Sarajevo, Bolnička 25, Sarajevo, 71000, Bosnia and Herzegovina.

E-mail: timur_ceric@yahoo.com

DOI: https://doi.org/10.17305/bjbms.2021.7134

Submitted: 03 March 2022/Accepted: 02 April 2022/ Published online: 08 April 2022

Conflicts of interest: Authors declare no conflicts of interest.

Funding: Authors received no specific funding for this work.

License: © The Author(s) (2022). This work is licensed under a Creative Commons Attribution 4.0 International License.
ABSTRACT

The SARS-CoV-2 pandemic has been the main public health issue since the end of 2019. The vaccination campaign in Bosnia and Herzegovina started in April 2021, with several vaccines available. Our study aimed to evaluate the acceptance, effects, and tolerability of vaccines against SARS-COV 2 virus among cancer patients. We conducted a cross-sectional, observational study between 22 October and 30 November 2021, at the Clinic of Oncology, Clinical Center University of Sarajevo. Patients were enrolled during their regular visit to the Clinic of Oncology by agreeing to complete an individual paper questionnaire. The study included 1063 patients with malignant diseases, of whom 681 (64.1%) were adequately vaccinated patients. In the study population, 76.9% of patients reported that they did not experience any side effects due to vaccination, while only 0.5% had side effects, causing a delay in their treatment. Among adequately vaccinated patients, there were 40 patients (3.8%) who were infected with SARS-CoV-2 after the second or booster dose of the vaccine. Five patients (0.5%) were hospitalized due to COVID-19 after being adequately vaccinated. The findings of our study suggest that cancer patients have a higher acceptance of vaccines against SARS-CoV-2 than the general population in Bosnia and Herzegovina. Vaccination side effects are tolerable and do not cause major delays in specific cancer treatment. The protective effects of SARS-CoV-2 vaccines in the cancer patients presented in our study are comparable to available results of similar studies, which included the general population.

KEYWORDS: COVID-19; vaccination; cancer patients; acceptance

INTRODUCTION

The SARS-CoV-2 pandemic has been the main public health issue since the end of 2019. Caused by the acute respiratory syndrome coronavirus-2 (SARS-CoV 2), COVID-19 can
present with a diapason of cases - ranging from asymptomatic to severe, the most severe including respiratory distress, pneumonia and even death [1].

As of 4 December 2021, 267,865,289 confirmed cases of COVID-19, including 5,285,888 deaths (1.97% of confirmed cases), have been reported worldwide to WHO [2].

The emergence of this pandemic drastically influenced the care of oncology patients worldwide, as well as in Bosnia and Herzegovina [3]. Given that COVID-19 is transmitted mainly by person-to-person contact, public health orders were issued in order to minimize person-to-person interaction [4, 5]. The first non-pharmaceutical interventions, colloquially known as lockdowns (stay-at-home orders, quarantines, and police curfews), had been implemented in order to reduce the spread of SARS-CoV-2 starting in China, then across multiple countries [6]. Studies so far have shown that the measures implemented played a significant role in effectively controlling the spread of the COVID-19 pandemic [7].

A single-centre study in Southern Bosnia and Herzegovina, published by Arapović et al. showed that the prompt introduction of restrictive socio-epidemiological measures resulted in better control of the pandemic in comparison with some higher-income countries (e.g., France, Italy, Spain) during the first several months of the pandemic [8].

A study published by Goletić et al. pointed out the importance of travel-associated disease introduction events. Through the molecular analysis of swab samples from different regions in Bosnia and Herzegovina, they pointed out the possible significance of independent travel modes and their impact on the increased incidence of COVID-19 cases as well as the importance of these findings in modifying the socio-epidemiological measures that are to be implemented [9].

For oncology patients globally, the protective measures meant that diagnostic and surgical procedures were delayed, treatment plans were altered in order to minimize visits to
the clinic and routine follow-ups were postponed [8]. Many patients had to receive treatment in-clinic, in larger hospitals or clinical centers meaning greater exposure and higher risk for getting infected with SARS-CoV-2. Changes in the treatment regimen of these patients may lead to disease progression or even worse outcomes [9]. Every oncology center made a management strategy for the spread of COVID-19 in order to reduce the delay of treatment. The COVID-19 pandemic has shown a significant impact on cancer patient care worldwide. The ONCOCARE-COV study published by Brugen et al., shows the dramatic impact the COVID-19 pandemic had on different levels of oncology patient care. A relative decrease in chemotherapy and radiotherapy treatment was observed, as well as a significant negative impact on screening, cancer diagnostics and surgical treatment of oncology patients [10]. Similar results can be found in other European countries such as Belgium, the UK, Spain, as well as in the US [11-16]. Due to limited healthcare personnel a majority of systems were faced with during the pandemic, an international collaborative group recommended a prioritization plan to maximize health benefits, considering the patient, their disease, and its prognosis [10-16]. During the period of March-May 2020 of the 8657 patients planned for the administration of therapy at the Clinic of Oncology Sarajevo, therapy was postponed for 77 individuals due to a positive anamnesis or a high body temperature. Out of the 40 symptomatic patients tested, infection with SARS-CoV-2 was confirmed in two [10]. Susak et al. published a single-centre study in Konjic, Bosnia and Herzegovina demonstrating the correlation between symptoms and IgG seroconversion against SARS-COV-2 one year after infection, with patients having positive IgG serology one year after contact. Symptoms of high fever and headache can be possible indicators of a better immune response as they have shown correlation with IgG levels. The study has also shown a significant increase in antibody titers of vaccinated participants one year after infection which could possibly point to better protection against reinfection [17].
Oncology patients on active treatment were quickly considered as a potentially vulnerable population, especially individuals with risk factors such as therapy-related immunosuppression, co-morbidities, age, etc. [11]. Conducted studies clearly showed that patients that go in for in-patient or out-patient treatment have an increased risk of COVID infection, patients were concerned about the risk of infection with COVID-19 when coming to the hospital, and some showed reluctance to proceed with treatment [12,18]. Thus, leading oncology societies recommend that cancer patients on active treatment, those starting treatment and those that have been treated in the past six months be prioritized for vaccination [19].

Protective behavior is crucial to managing a pandemic and effective immunization could bear the most promise for resolving the health issue of COVID-19 pandemic [13]. During 2020, several vaccines were being developed in multiple countries, and by the end of the year results of the Phase III trial had been published which resulted in the approval of the vaccines against COVID-19 [14-18].

Vaccination against COVID-19 commenced at the beginning of 2021, worldwide. The Strategic Advisory Group of Experts on Immunization (SAGE) issued a framework for the prioritization of COVID-19 vaccination considering cancer patients a high priority population, a plan that was also implemented in our country [19, 20]. Vaccination campaign in Bosnia and Herzegovina started in April 2021 with several vaccines available: SinoPharm(BBIBO), SinoVac (CoronaVac), ChAdOx1 nCoV-19 (Oxford/AstraZeneca), and later on, BNT162b2 (Pfizer/BioNTech). It must be noted that a significant number of individuals were vaccinated outside of the country before the vaccination campaign had started in Bosnia and Herzegovina.

Up until the 9th of December 2021, a total of 8,158,815,265 vaccine doses have been administered, as reported to WHO [20]. Data for Bosnia and Herzegovina show a total of 280,469 confirmed cases of COVID-19 have been reported, out of which 12,882 resulted in death. Up until the 4th of November 2021, a total of 1,553,874 vaccine doses have been
administered; 833,233 individuals have been vaccinated with at least one dose; and 720,631 individuals are fully vaccinated [21].

According to the Institute for Public Health of the Federation of Bosnia and Herzegovina, in the period from March 3rd to December 5th a total of 995,646 persons were vaccinated, out of which 525,844 with at least one dose, 461,597 with two doses administered, and 8,205 people received the third dose [22].

According to current data, several studies have been conducted to assess the cancer population’s attitude toward COVID-19 immunization. Several cross-sectional surveys have been conducted in order to better understand the acceptance of the SARS-CoV-2 vaccination of patients with malignant diseases. Most studies have shown that the majority of patients are willing to get vaccinated [23-26].

The aim of our study is to evaluate the acceptance, effects and tolerability of vaccines against the SARS-COV 2 virus among cancer patients. We conducted a cross-sectional, observational study between the 22nd of October and the 30th of November 2021 at the Clinic of Oncology, Clinical Center University of Sarajevo.

MATERIALS AND METHODS

We conducted a cross-sectional, observational study between the 22nd of October and the 30th of November 2021 at the Clinic of Oncology, Clinical Center University of Sarajevo. The study included 1063 patients with malignant disease that have been visiting inpatient or outpatient departments of our clinic for treatment, follow up and consultations. They were enrolled during their regular visit to the Clinic of Oncology by agreeing to fill in an individual paper questionnaire on personal demographic information (initials, age, gender, area of living), information on previous COVID-19 infection, anti SARS-CoV-2 vaccination acceptance, vaccinational status, side effects of SARS-CoV-2 vaccination and eventual delay of oncologic treatment caused by vaccines side effects. During the scheduled appointment, the attending
physician filled in information about the diagnosis, presence of metastatic disease and modality of the therapy into the questionnaire. Vaccinated patients in our study received one of the following vaccines against SARS-CoV-2: BNT162b2 (Pfizer/BioNtech); ChAdOx1 nCoV-19 (Oxford/AstraZeneca); SinoPharm (BBIBO); CoronaVac (SinoVac).

**Ethical statement**

Ethical approval was obtained from the Hospital Ethics Committee at the Clinical Center University of Sarajevo (number 1178/21). Participation in the study was voluntary. Participants were assured of the anonymity and confidentiality of their responses. Refusals were not documented. Patients received no financial compensation. The questionnaire was approved by the institutional ethics committee.

**Statistical analysis**

IBM SPSS Statistics v. 23.0 was used for the statistical analysis. We defined the descriptive measures, including absolute value and percentages. The chi-square test of independence was used to evaluate the relationship of categorical variables between adequately vaccinated and inadequately vaccinated patients. The chi-square test of independence was used to evaluate the presence of side effects and type of administered vaccine. Post hoc chi square testing was performed to analyse adjusted residuals and to identify cells with statistically significant z-scores in cross tabulation. $P<0.05$ was an indicator of significance.

**RESULTS**

Our study included 1063 patients who were treated or examined at the Clinic of Oncology, Clinical Centre University of Sarajevo during October and November 2021.

The mean age of all patients included in our study was 61.9 (SD=11.5) years old and study population consisted of 65.7% of female patients and 34.3% of male patients.

The characteristics of the study population are presented in Table 1.
In our study population there were 339 (31.9%) unvaccinated patients and 43 (4.0%) patients who were vaccinated with the first dose of a vaccine. These patients were classified as inadequately vaccinated patients in further analysis. Patients who were classified as adequately vaccinated were those who received a second dose of a SARS-CoV-2 vaccine (63.9% of patients) or a booster dose (3rd dose) of the vaccine (0.2% of patients). The frequency distribution difference of vaccinated patients across cantons (areas of living) was statistically significant (p<0.001). The highest percentage of vaccinated patients was in the Sarajevo Canton (68.9%), while the lowest percentage was in the Una-Sana Canton (33.3%).

The most commonly applied vaccine was BNT162b2 (Pfizer/BioNtech) - 53% of the patients, while 23.3% patients were vaccinated with ChAdOx1 nCoV-19 (Oxford/AstraZeneca) vaccine, 20.7% with the SinoPharm (BBIBO) vaccine and 3% chose the CoronaVac (SinoVac) vaccine.

SARS-CoV-2 infection prior to filling out the questionnaire was reported by 261 (26.5%) patients.

BNT162b2 was the most commonly administered vaccine in almost all age groups except in patients over 80 years where the most common vaccine was ChAdOx1 nCoV-19 (Figure 1).

In our study population, 76.9% of patients reported that they did not experience any side effects of vaccination, while only 0.5% of patients had a delay in their treatment due to side effects of vaccination. The most commonly reported side effect was local pain at the site of vaccine injection and it was reported in 12.3% of patients. Beside local pain, fever was reported in 5.5% of patients, myalgia in 5.0% of patients, fatigue in 4.1% of patients, bone pain in 2.9% of patients and 1% of patients complained about having nausea or vomiting after vaccination. Table 2 presents the most common side effects reported by type of vaccine administered. In the post-hoc chi square testing, using values of adjusted residuals (z-scores)
in cross tabulation we have identified that side effects of vaccination were most commonly reported in patients vaccinated with ChAdOx1 nCoV-19 vaccine (z-score = 2.1; p = 0.03) and that patients without side effects of vaccination were most commonly vaccinated with SinoPharm vaccine (z-score = 3.8; p < 0.001). Local pain was the most commonly reported side effect - 12.3% of patients and it was most commonly present in patients vaccinated by the BNT162b2 vaccine (z-score = 3.8; p < 0.001). ChAdOx1 nCoV-19 vaccine was the most commonly administered vaccine in patients who reported fever as a side effect of vaccination against SARS-CoV-2 (z-score = 3.8; p < 0.001).

Beside side effects reported in Table 2, three patients reported headache as side effect of vaccination, two of them were vaccinated with the BNT162b2 vaccine and one with the ChAdOx1 nCoV-19 vaccine. No serious adverse events of SARS-CoV-2 vaccines were reported by the patients.

Among adequately vaccinated patients, there were 40 patients (3.8%) who were infected with SARS-CoV-2 after the second or booster dose of the vaccine. The mean number of months of SARS-COV-2 infection after being adequately vaccinated was 3.35 (SD = 1.77). Five patients (0.5%) were hospitalized because of COVID-19 after being adequately vaccinated.

The type of vaccine administered was not significantly related with patients who were infected with SARS-CoV-2 or hospitalized due to COVID-19 after full vaccination.

The presence of metastatic disease did not have a statistically significant relation with being infected with SARS-CoV-2 or hospitalized due to COVID-19 after adequate vaccination.

DISCUSSION

The first cases of COVID-19 in Bosnia and Herzegovina were reported at the beginning of March 2020. The vaccine campaign in Bosnia and Herzegovina had started later than in other European countries, probably due to the late arrival of the vaccines to our country [27].
In order to minimise the risk of COVID-19 infection and severe complications in this vulnerable population, cancer patients were prioritized as a group and encouraged to get vaccinated by the on-going campaign for vaccination via media outlets along with recommendations from their oncologists. Variations in the vaccination rate of population among different geographical areas could be attributed to the different quality and intensity of the implementation of vaccination campaigns against the SARS-CoV-2 virus by local experts.

Several studies reporting on the safety and efficacy of COVID vaccines amongst the cancer patient population have been published. Yasin et al. published a multicenter cohort study showing that cancer patients have significantly lower seropositivity rates compared to non-cancer patients (85.2% and 97.5%, respectively) when vaccinated with the CoronaVac vaccine. These findings were not surprising, considering that cancer patients are immunosuppressed, which therefore has a negative effect on the immune response. The study also confirmed the safety and efficacy of applying the CoronaVac in cancer patients[28]. Ariamanesh et al. found a 86.9% seropositivity rate in cancer patients vaccinated with Sinopharm inactivated vaccine (BBIBP), also finding that low seropositivity rates are mostly found in elderly cancer patients, those on active treatment and patients with haematologic malignant diseases[29]. Massarweh et al. found that 90% of patients receiving systemic anticancer treatment had an adequate immune response, but also significantly lower antibody titers compared to a healthy control group after receiving the BNT162b2 vaccine. The lowest antibody titers observed were in patients receiving chemotherapy in combination with immunotherapy[30].

According to WHO, up to November 2021 a total of 720 631 individuals were fully vaccinated, while 882 641 people were vaccinated with at least one dose in Bosnia and Herzegovina [28].

According to the data from the Institute for Public Health of the Federation of Bosnia and Herzegovina, in the period from March 3rd 2021 to January 16th 2022, only 28.20% of the
population has been fully vaccinated, while 7.47% received a booster dose [29]. Marijanović et al. showed that most cancer patients (62.2%) had a hesitancy towards immunization with COVID-19 vaccines through their cross-sectional study conducted at the Clinic of Oncology, Mostar, Bosnia and Herzegovina [30]. Although we had a small sample of patients from this area of Bosnia and Herzegovina, our results are compatible since 40% of patients from the Herzegovina-Neretva Canton were adequately vaccinated. However, we should mention that this study was conducted during February 2021, when data on the safety of vaccination in cancer patients were limited.

A French cross-sectional study has shown that 53.7% of oncology patients, on active treatment or active surveillance, were likely to be vaccinated, while 29.7% considered themselves not ready yet [24].

Similar results have been documented in a Portuguese study by M.J.P. de Sousa et al. where a majority of cancer patients (84%) on immunosuppressive therapy had the intention to be vaccinated, as well as a Lebanese study where 55% of patients had shown willingness for COVID-19 vaccination [31, 23].

A cross-sectional study carried out in Serbia has shown that 41.72% of cancer patients were vaccinated, while 17.67% wanted to be vaccinated as soon as possible. More than half of the patients not wanting vaccination stated that they wish to be vaccinated after their cancer treatment, which may point to a fear of the possibility of delaying active cancer treatment due to possible side effects [26].

However, data from our study shows that 64.1% of patients were adequately vaccinated and these results outweigh the first data on vaccination hesitancy amongst cancer patients. In the majority of studies conducted, the main reasons for patients unwilling to get vaccinated lie in the uncertainty of the possible side effects or that vaccines may impact cancer treatment efficacy and outcomes, suggesting that these may be the reasons that in our study patients who
were on follow up were significantly more vaccinated compared to patients on active treatment (74.3% and 62.2%, respectively) [32].

When divided by the area of living, the highest percentage of vaccinated patients was in the Sarajevo Canton (68.9%). According to the Institute for Public Health of Canton Sarajevo in the period between March 2021 and January 2022 50.1% of the Sarajevo Canton population has been fully vaccinated with a SARS-CoV-2 vaccine [33]. Comparing these two results, we can conclude that the encouragement and recommendation of oncologists at local clinics for vaccination against SARS-CoV-2 were fruitful and successful since the percentage of vaccinated cancer patients from Canton Sarajevo is higher than in the general population. The lowest percentage of vaccinated patients was in the Una-Sana Canton (33.3%). The difference in the percentage of vaccinated patients could be caused by the fact that the Sarajevo Canton has a much wider urban zone, and thus greater exposure of the population to vaccination campaigns conducted, among other things, through health institutions and various media.

As with most studies published to this day, data show that there is a significant correlation between age and vaccine acceptance [34]. We note that the majority of patients vaccinated were 50 years old and above, while only 33.3% patients between 18 and 24 years old were adequately vaccinated which may imply that the older part of the population consider themselves to have a greater benefit from vaccination and decreased risk of COVID complications.

In our study 53% of patients received BNT162b2 (Pfizer/BioNtech), while in the neighbouring Serbia it was reported that the majority of cancer patients received the SinoPharm (BBIBO) vaccine [26].

Since cancer patients were not included in clinical trials of the vaccine, limited data about vaccine tolerability is available for this part of population [35].
Meta-analysis on the safety of COVID vaccines in cancer patients suggested that vaccination appeared to be generally very safe, with mostly mild and moderate adverse effects reported. None of the included studies have described serious adverse events [36].

In our study population 76.9% of patients reported that they did not have any side effects of vaccination, while only 0.5% of patients had a delay in their treatment caused by the side effects of vaccination.

The most common side effect was local pain at the injection site, reported in 12.3% of patients, out of whom the majority received the BNT162b2 vaccine.

Our study results correspond to the other results where the incidence of side effects in patients receiving the SinoPharm vaccine was lowest compared to other types of vaccines [26]. Reports of fever were the highest amongst patients receiving the ChAdOx1 nCOV-19 vaccine [11.2%] and it was significantly higher compared to other vaccines.

Tenfored et al presented that vaccine effectiveness was significantly reduced for patients with immunocompromising conditions (59.2%) compared to individuals without an immunocompromising condition (91.3%) and that when restricted to immunocompromised patients with an active solid organ or hematologic malignancy or solid organ transplant, vaccine effectiveness was 51.2%. In this study, authors also reported that 20% of patients who developed COVID-19 symptoms after being vaccinated were patients with active solid organ or hematologic malignancy. In the group of patients who developed COVID-19 infection after being adequately vaccinated the median time between the final vaccine dose and symptom onset was 44 days [37]. In our study only 3.8% of patients were infected with SARS-CoV-2 after the second or booster dose of the vaccine and the mean number of months of SARS-COV-2 infection after being adequately vaccinated was 3.35 months (SD=1.77).

According to the report of the Institute for Public Health of Canton Sarajevo 76% of hospitalized patients are unvaccinated, while only 24% of hospitalized patients have been fully
vaccinated [33]. The Israeli study shows only 7.7% of patients hospitalised with COVID-19 were fully vaccinated with 7 or more days after the second dose of vaccine, pointing to vaccine effectiveness opposed to 71.8% of COVID-related hospitalizations where patients were not vaccinated [38]. In our study population five patients (0.5%) were hospitalized because of COVID-19 after being adequately vaccinated and it represents 12.5% of patients who developed COVID-19 after being adequately vaccinated.

The limitation of our study was that it was conducted in a single centre, although oncology patients from different geographical areas of Bosnia and Herzegovina are getting treated at our centre. Also, the period between the initiation of the vaccine campaign in Bosnia and Herzegovina and initiation of our study was too short to fully assess the effects of vaccines regarding developing COVID-19 and frequency of hospitalizations caused by COVID-19 among vaccinated patients. Also, another limitation of our study was the method of patient enrolment in the study, since it was based on the voluntary filling out of the questionnaire during their regular visit at our clinic. We can assume that a certain number of patients with poor COVID-19 outcome did not show up for regular check-ups and therefore were not a part of the analyzed study population.

CONCLUSION

The findings of our study suggest that cancer patients have a higher acceptance of vaccines against SARS-CoV-2 than the general population in Bosnia and Herzegovina. Vaccination side effects are tolerable and do not cause any major delay of specific cancer treatment. The protective effects of SARS-CoV-2 vaccines in the cancer patients presented in our study are comparable to available results of similar studies which included the general population.

In order to have more reliable conclusions about the efficacy and safety of the use of SARS-COV-2 vaccines among cancer patients, it is necessary to conduct a number of studies.
of different designs that will have longer follow-up periods. However, at this point, we have enough available evidence to convincingly recommend SARS-CoV-2 vaccination to cancer patients.

REFERENCES


35. Preporuke Stručnog savjetodavnog tijela za imunizaciju o prioritetnim skupinama za cijepljenje protiv COVID-19. Institute for Public Health of Federation of Bosnia and


**Table 1. Characteristics of patients included in the study**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All patients n (%)</th>
<th>Adequately vaccinated n (%)</th>
<th>Not adequately vaccinated n (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1063</td>
<td>681 (64.1)</td>
<td>382 (35.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>365 (34.3)</td>
<td>255 (69.9)</td>
<td>110 (30.1)</td>
<td>p=0.004</td>
</tr>
<tr>
<td>Female</td>
<td>698 (65.7)</td>
<td>426 (61.0)</td>
<td>272 (39.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Age group (years)</strong></td>
<td></td>
<td></td>
<td></td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>18-24</td>
<td>6</td>
<td>2 (33.3)</td>
<td>4 (66.7)</td>
<td></td>
</tr>
<tr>
<td>25-49</td>
<td>131</td>
<td>74 (56.5)</td>
<td>57 (43.5)</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>257</td>
<td>130 (50.6)</td>
<td>127 (49.4)</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>380</td>
<td>264 (69.5)</td>
<td>116 (30.5)</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>243</td>
<td>173 (71.2)</td>
<td>70 (28.8)</td>
<td></td>
</tr>
<tr>
<td>&gt;80</td>
<td>46</td>
<td>38 (82.6)</td>
<td>8 (17.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Primary tumor</strong></td>
<td></td>
<td></td>
<td></td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>395 (37.2)</td>
<td>251 (63.5)</td>
<td>144 (36.5)</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal cancer</td>
<td>236 (22.2)</td>
<td>132 (55.9)</td>
<td>104 (44.1)</td>
<td></td>
</tr>
<tr>
<td>Genitourinary cancer</td>
<td>203 (19.1)</td>
<td>157 (77.3)</td>
<td>46 (22.7)</td>
<td></td>
</tr>
<tr>
<td>Lung cancer</td>
<td>58 (5.8)</td>
<td>43 (74.1)</td>
<td>15 (25.9)</td>
<td></td>
</tr>
<tr>
<td>Gynecological cancer</td>
<td>111 (10.4)</td>
<td>61 (55.0)</td>
<td>50 (45.0)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>59 (5.7)</td>
<td>36 (61.0)</td>
<td>23 (39.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Cancer treatment phase</strong></td>
<td></td>
<td></td>
<td></td>
<td>p=0.005</td>
</tr>
<tr>
<td>Active treatment</td>
<td>895 (84.2)</td>
<td>557 (62.2)</td>
<td>338 (37.8)</td>
<td></td>
</tr>
<tr>
<td>Follow up</td>
<td>168 (15.8)</td>
<td>124 (74.3)</td>
<td>44 (25.7)</td>
<td></td>
</tr>
<tr>
<td><strong>Canton</strong></td>
<td></td>
<td></td>
<td></td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Sarajevo Canton</td>
<td>787 (74.0)</td>
<td>542 (68.9)</td>
<td>245 (31.1)</td>
<td></td>
</tr>
<tr>
<td>Central Bosnia Canton</td>
<td>184 (17.3)</td>
<td>93 (50.5)</td>
<td>91 (49.5)</td>
<td></td>
</tr>
<tr>
<td>Una-Sana Canton</td>
<td>18 (1.7)</td>
<td>6 (33.3)</td>
<td>12 (66.7)</td>
<td></td>
</tr>
<tr>
<td>Herzegovina-Neretva Canton</td>
<td>10 (0.9)</td>
<td>4 (40.0)</td>
<td>6 (60.0)</td>
<td></td>
</tr>
<tr>
<td>Bosnian-Podrinje Canton</td>
<td>42 (4.0)</td>
<td>22 (52.4)</td>
<td>20 (47.6)</td>
<td></td>
</tr>
<tr>
<td>Zenica-Doboj Canton</td>
<td>22 (2.1)</td>
<td>14 (63.6)</td>
<td>8 (38.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Metastatic disease</strong></td>
<td></td>
<td></td>
<td></td>
<td>p=0.003</td>
</tr>
<tr>
<td>Yes</td>
<td>403 (37.9)</td>
<td>235 (58.5)</td>
<td>168 (41.5)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>660 (62.1)</td>
<td>445 (67.4)</td>
<td>215 (32.6)</td>
<td></td>
</tr>
</tbody>
</table>

Frequency distribution difference between patient characteristics and their vaccination status was analysed by Chi-square test, p<0.05 was considered statistically significant.
Table 2. Side effects of specific types of vaccines administered to study subjects.

<table>
<thead>
<tr>
<th>Side effects</th>
<th>Types of vaccines</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ChAdOx1 nCoV-19 n (%)</td>
<td>BNT162b2n (%)</td>
</tr>
<tr>
<td>Local pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>153 (90.5)</td>
<td>321 (83.4)</td>
</tr>
<tr>
<td>Yes</td>
<td>16 (9.5)</td>
<td>64 (16.6)</td>
</tr>
<tr>
<td></td>
<td>169 (100)</td>
<td>575 (98.2)</td>
</tr>
<tr>
<td>Bone pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>165 (97.6)</td>
<td>372 (96.6)</td>
</tr>
<tr>
<td>Yes</td>
<td>4 (2.4)</td>
<td>13 (3.4)</td>
</tr>
<tr>
<td></td>
<td>169 (100)</td>
<td>575 (98.2)</td>
</tr>
<tr>
<td>Fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>150 (88.8)</td>
<td>368 (95.6)</td>
</tr>
<tr>
<td>Yes</td>
<td>19 (11.2)</td>
<td>17 (4.4)</td>
</tr>
<tr>
<td></td>
<td>169 (100)</td>
<td>575 (98.2)</td>
</tr>
<tr>
<td>Myalgia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>160 (94.7)</td>
<td>363 (94.3)</td>
</tr>
<tr>
<td>Yes</td>
<td>9 (5.3)</td>
<td>22 (5.7)</td>
</tr>
<tr>
<td></td>
<td>169 (100)</td>
<td>575 (98.2)</td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>159 (94.1)</td>
<td>373 (96.9)</td>
</tr>
<tr>
<td>Yes</td>
<td>10 (5.9)</td>
<td>12 (3.1)</td>
</tr>
<tr>
<td></td>
<td>169 (100)</td>
<td>575 (98.2)</td>
</tr>
<tr>
<td>Nausea/Vomiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>169 (100)</td>
<td>378 (98.2)</td>
</tr>
<tr>
<td>Yes</td>
<td>0 (0)</td>
<td>7 (1.8)</td>
</tr>
</tbody>
</table>

Frequency distribution difference between specific side effects and type of administered vaccine was analysed by Chi-square test, p<0.05 was considered statistically significant.

*cells with bolded numbers had statistically significant z-scores in post-hoc chi-square testing.
Figure 1. Frequency of different types of administered vaccines in different age groups of patients
SUPPLEMENTAL DATA

Questionnaire S1

PLEASE ANSWER THE FOLLOWING QUESTIONS:

1. Patient initials ____________________________

2. Age of patient (years) _______________________

3. Gender M F

4. Are you currently receiving oncology therapy? YES NO

5. Have you had COVID-19 before vaccination? YES NO

6. Vaccination status a) Vaccinated – III doses b) Vaccinated – II doses c) Vaccinated – I dose d) Unvaccinated

7. Date of the administration of the first dose of vaccine? ___________________________

8. Type of vaccine: a) BNT162b2 (Pfizer/BioNtech) b) ChAdOx1 nCoV-19 (Oxford/AstraZeneca) c) SinoPharm (BBIBO) d) CoronaVac (SinoVac)

9. Side effects of vaccine: a) without any side effects b) local pain c) fever d) muscle pain e) bone pain f) fatigue g) nausea and vomiting h) other symptoms (please describe)

10. Have you had COVID-19 after vaccination? YES NO

(If answer is YES please specify exact date of positive PCR SARS-CoV-2 test ______________________)

11. Have you been in the hospital due to COVID-19 infection after vaccination against SARS-CoV-2? YES NO

12. Whether your oncology therapy has been delayed due to the side effects of the vaccine against SARS-CoV-2? YES NO

13. Canton of living? a) Sarajevo b) SBK c) USK d) HNK e) BPK f) ZDK g) ZHK

TO BE COMPLETED BY A DOCTOR WHO PERFORMS AN EXAMINATION

1. Patient diagnosis

____________________________________________________

2. Metastatic disease? YES NO

3. Setting of therapy A) Adjuvant B) Neoadjuvant C) Metastatic milieu

4. Modality of therapy A) Chemotherapy B) Target therapy C) Hormonal therapy D) Immunotherapy E) Radiotherapy