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Coronavirus Pandemic

When cancer patients encountered COVID-19: clinical characteristics and outcome in China

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Abstract

Introduction: Cancer patients were more likely to be affected by the coronavirus disease 2019 (COVID-19) pandemic. Therefore, we analyzed the clinical characteristics and outcomes in cancer patients who were infected with COVID-19 to determine if they were more vulnerable to COVID-19 than non-cancer patients.

Methodology: This retrospective study involved 150 cancer patients and 300 non-cancer patients with a laboratory-confirmed diagnosis of COVID-19 at the Cancer Hospital of the Chinese Academy of Medical Sciences, at the end of 2022. Multivariable analysis was carried out on the factors associated with COVID-19 severity in cancer patients.

Results: Compared to the non-cancer group, the cancer group saw a notably higher number of hospitalizations and fatalities. Multivariate analysis showed that COVID-19 severity was correlated with male gender (OR: 5.60, 95% CI, 1.89-16.57), and recovery duration was longer than 10 days (OR: 3.19, 95% CI, 1.09-9.32) in the cancer group. However, the severity of COVID-19 was not made worse by the administration of systemic anticancer treatments prior to the outbreak.

Conclusions: During the COVID-19 Omicron epidemic, there seemed to be some association between various antitumor therapies, treatment intervals, and COVID-19 severity. The findings of this study can potentially help allay cancer patients' fears regarding COVID-19 infection and enable them to continue with crucial therapeutic processes for the treatment of cancer.

Key words: COVID-19; Omicron; cancer patients; adult; risk factors.

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Introduction

The coronavirus disease 2019 (COVID-19) was first identified in Wuhan, China, in December 2019 and was caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1,2]. Four months later, the World Health Organization (WHO) announced that the COVID-19 outbreak had reached a pandemic status, considering its rapid spread to several regions worldwide [3]. On January 30, 2023, three years after it was first identified, WHO declared COVID-19 a public health emergency of international concern (PHEIC). Even now, COVID-19 continues to have an effect people around the world [4].

Since SARS-CoV-2 first appeared, the virus underwent a number of modifications that have resulted in the production of many mutant strains, including variants Alpha, Beta, Gamma, and Delta [5]. On November 25, 2021, about 23 months after the first case of COVID-19 was reported, a new SARS-CoV-2 variant of concern (VoC), Omicron, was discovered in South Africa [6]. Omicron differs from earlier strains in that it spreads more quickly, presents atypical symptoms, and, in some cases, causes no symptoms at all [7-9]. In December 2022, China ended the COVID-19 lockdown and implemented an open policy for COVID-19 prevention and control. This was during the Omicron outbreak and, which led to a notable rise in the number of COVID-19-positive patients.

Cancer patients are immunocompromised due to their disease, as well as due to their treatment procedures. On one hand, a considerable proportion of patients with tumors are in a state of immunosuppression or immune insufficiency [10]. On the other hand, the majority of antitumor therapies, such as radiotherapy, chemotherapy, immunotherapy, and targeted therapy, significantly affect the immune

system [11]. The duration of the antineoplastic therapy could be a long cycle, lasting several months, or even years. Cancer patients are at high risk for not only COVID-19 infection, but also for poor prognosis [12-14]. Hence, modifications in the clinical profile of COVID-19 tumor patients warrant consideration. Previous research has reported on the clinical impact of COVID-19 on cancer patients [15-17]. However, the Omicron variant has been the subject of very few investigations. Under these circumstances, patients with cancer who were infected with COVID-19 during the Omicron wave were monitored. COVID-19 data from the non-cancer population was collected concurrently for comparison. Clinical symptoms, recovery, and prognosis following COVID-19 infection, along with cancer characteristics and previous antitumor therapeutic methods, were all analyzed in our study. Identification of the pertinent risk variables for severe performance in cancer patients infected with COVID-19 may help guide clinical practice.

Methodology

Study design and population

This retrospective observational study included people who had a laboratory-confirmed diagnosis of COVID-19 detected at the Cancer Hospital, Chinese Academy of Medical Sciences (CAMS) in Beijing, China, from November 1 to December 10 , 2022.

One hundred and fifty adult patients (≥ 18 years) with a pathological diagnosis of malignant tumors who visited the Cancer Hospital of CAMS, were included in the cancer group. The control group matched 300 non-cancer cases with positive results for SARS-CoV-2 detected contemporaneously in the Cancer Hospital. Cancer patients admitted to the Cancer Hospital were mainly diagnosed with solid tumors and lymphoma, excluding hematological tumors (except lymphoma). Patients who were curative or had undergone antitumor treatments for more than five years were excluded.

The diagnosis of COVID-19 was based on laboratory confirmation of SARS-CoV-2, which was defined as positive results of a real-time reverse transcriptase-polymerase chain reaction (RT-PCR) assay on nasopharyngeal swabs. Patients who only relied on radiological results or clinical symptoms to diagnose COVID-19 without a positive real-time RT-PCR result were excluded from this study.

Data collection

The following data were acquired and checked by clinicians from the electronic medical record system: age, gender, smoking status, body mass index (BMI), comorbidities, tumor location, pathological type, clinical stage, antitumor therapies (chemotherapy, targeted therapy, immunotherapy, radiation therapy, and surgery) within one month before COVID-19, and the time interval of antitumor treatments before COVID-19 diagnosis.

The conditions after COVID-19 infection were obtained by follow-up, including clinical symptoms (fever, hypodynamia, cough, expectoration, ageusia or anosmia, headache, general muscle soreness, chilliness, chest tightness, chest pain, diarrhea, and emesia), weight loss, recovery time, outpatient visits, hospitalization, admission to the intensive care unit (ICU), mechanical ventilation, and survival status at 30 and 90 days.

Relevant definitions

COVID-19 severity was defined based on outpatient visits, hospitalization, ICU admission, mechanical ventilation, or death within 90 days. Fever was defined as axillary temperature ≥ 37.0 ℃. Surgery for malignancy was defined as surgery for antitumor treatment, including cytoreductive and radical surgeries. A long recovery time was defined as the persistence of clinical symptoms or positive antigens for more than ten days after COVID-19 infection. The time intervals of anti-tumor treatments before COVID-19 diagnosis included never received treatment; and treatment within one month, one to three months, and exceeding three months.

Statistical analysis

Continuous variables were analyzed using Student's t-test or the Mann-Whitney U test for independent samples. The Chi square test or Fisher's exact test was used to compare the categorical variables. Variables were analyzed using multivariate logistic regression to identify independent risk factors. Odds ratios (ORs) and 95% confidence intervals (CI) were estimated for each factor using a multivariate regression. Differences were considered statistically significant at a two-sided $p<0.05$. All the statistical analyses were performed by IBM SPSS statistics version 22.0 (IBM Corp., Armonk, NY, USA).

Results

Characteristics of the participants

A total of 150 cancer patients and 300 non-cancer participants with positive SARS-CoV-2 results were included in our study. The average age of the cancer patients was 57.49 ± 12.22 years (range: 24-77 years),

while that of the non-cancer group was 55.82 ± 10.58 years (range: 23-83 years) (Table 1). Males accounted for 43.7% of the cancer patients, while 52.7% of the non-cancer participants were males. The average BMI of cancer patients was 23.27 ± 3.63 kg/m^2, and BMI for non-cancer participants was 23.83 ± 3.45 kg/m^2. Thirty-five (23.4%) patients with cancer had an underlying comorbidity. Among them, 13 (8.7%) had two or more comorbidities. Among the patients in the non-cancer group, 20.0% had comorbidities, with only 3.7% having more than one comorbidity. 37.3% of oncological patients had a history of smoking or were current smokers, while only 13.3% in the non-cancer group had a history of smoking. The results are presented in Table 1.

After COVID-19 infection, 8% of the cancer patients experienced outpatient or emergency visits, which was slightly higher than the 4.3% of the non-cancer group (Table 1). The number and proportion of cancer patients hospitalized during COVID-19 were higher than those in the non-cancer group (p<0.01). In both groups, only one patient with tumors was treated in the ICU. None of the participants, in either group, required invasive mechanical ventilation. During the COVID-19 infection period, no statistical difference was observed between the cancer and non-cancer groups as the recovery time exceeded 10 days for both groups. The proportion of patients with fever (≥37.0 ℃) or high fever (>38.5 ℃) was higher in the non-cancer group. In terms of the symptoms of COVID-19, hypodynamia, ageusia or anosmia, headache, general muscle soreness, as well as chilliness were more common in the non-cancer group (p<0.01) (Figure 1A). Among the cancer patients, the mortality at 30 days was 1.3% (2/150), and mortality at 90 days was 2.7% (4/150). In contrast, no deaths occurred within 90 days in the non-cancer group.

Cancer characteristics

The characteristics of the 150 cancer patients who were infected with COVID-19 were further analyzed (Figure 2). Among the various tumor types, 55 (36.7%) were gastrointestinal neoplasms, accounting for the largest proportion (Figure 2A). Thoracic neoplasms were the second most common (48 cases, 32.0%). As far as specific cancer types were concerned, colorectal cancer (25 cases) was the most common, followed by lung cancer (24 cases) (Supplementary Table 1).

Table 1. Basic characteristics of the participants.

Characteristics		Non-cancer n (%)	Cancer n (%)	*p* value
Gender	Male	131 (43.7)	79 (52.7)	0.07
Age (years)	Mean ± SD	55.82 ± 10.58	57.49 ±12.22	0.14
BMI (kg/m^2)	Mean ± SD	23.27 ± 3.63	23.83 ± 3.45	0.12
	< 18.5	18 (6.0)	10 (6.7)	0.42
	18.5-24.9	196 (65.3)	87 (58.0)	
	25.0-29.9	71 (23.7)	46 (30.6)	
	≥ 30.0	15 (5.0)	7 (4.7)	
Addicted to smoking	Yes	40 (13.3)	56 (37.3)	< 0.01
Number of comorbidities	0	240 (80.0)	115 (76.7)	0.08
	1	49 (16.3)	22 (14.7)	
	≥ 2	11 (3.7)	13 (8.7)	
Medical consultations	Outpatient or Emergency	13 (4.3)	12 (8.0)	0.59
Residential treatment	Yes	2 (0.6)	40 (26.7)	< 0.01
ICU treatment	Yes	0 (0)	1 (0.7)	0.33
Recovery course, days	≥ 10	120 (40.0)	53 (35.3)	0.34
Fever	< 37.0	32 (10.7)	30 (20.0)	< 0.01
	37.0-38.5	121 (40.3)	89 (59.3)	
	> 38.5	147 (49.0)	31 (20.7)	
Hypodynamia	Yes	249 (83.0)	93 (62.0)	< 0.01
Cough	Yes	255 (85.0)	121 (80.7)	0.24
Expectoration	Yes	197 (65.7)	87 (58.0)	0.11
Ageusia or anosmia	Yes	143 (47.7)	39 (26.0)	< 0.01
Headache	Yes	186 (62.0)	38 (25.3)	< 0.01
General muscle soreness	Yes	173 (57.7)	45 (30.0)	< 0.01
Chilliness	Yes	164 (54.7)	31 (20.7)	< 0.01
Chest tightness or chest pain	Yes	42 (14.0)	12 (8.0)	0.07
Diarrhoea	Yes	69 (23.0)	23 (15.3)	0.06
Emesia	Yes	25 (8.3)	15 (10.0)	0.56
Mortality	For 30 days	0 (0)	2 (1.3)	0.11
	For 90 days	0 (0)	4 (2.7)	0.01

BMI, body mass index; COVID-19, coronavirus disease 2019; ICU: intensive care unit.

From the perspective of pathological type, the proportions of the different types were adenomatous, carcinoma (Aden. Carc., 58.0%), squamous cell carcinoma (Sq. cell Carc., 26.7%), others (6.0%), neuroendocrine carcinoma (Neu. Carc., 4.0%), urothelial carcinoma (Uro. Carc., 3.3%), and non-Hodgkin lymphoma (Non-Hodgkin lym., 2.0%) (Figure 2B). In terms of clinical stage, the percentages were as follows: stage 4 (36.0%); stage 3 (30.6%); stage 1 (20.7%), and stage 2 (12.7%) (Figure 2C).

Among the 150 cancer patients, the vast majority (88.0%) had received antitumor therapy before the COVID-19 infection, mostly within one month (66.0%). In only 6% of the patients, the duration of antitumor therapy exceeded 3 months prior to COVID-19 infection (Figure 2D).

Classification of cancer patients by COVID-19 severity

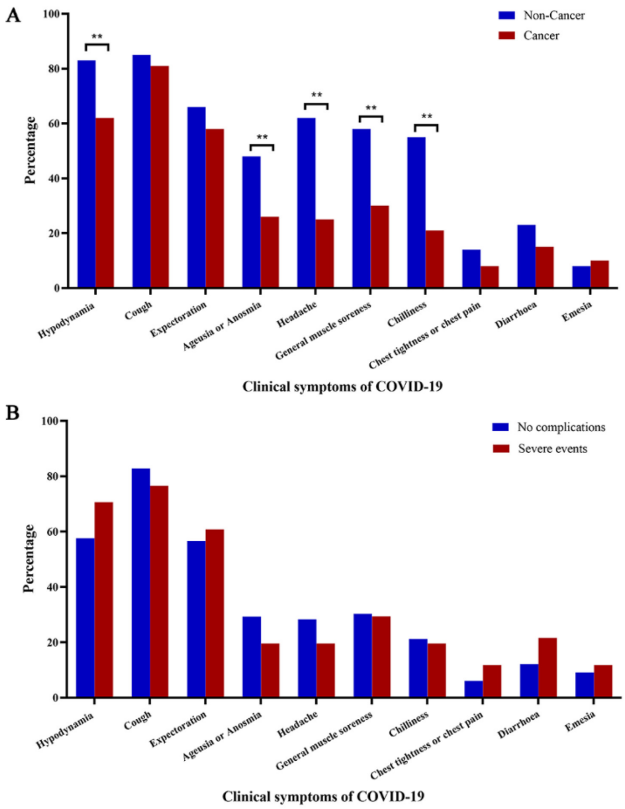
Among the 150 cancer patients, those who had experienced outpatient service, hospitalization, ICU admission, mechanical ventilation, or eventually died within 90 days after COVID-19 infection were classified into the severe group, and the rest were in the no complication group. Ultimately, 51 patients were classified into the severe group, whereas the remaining 99 were classified into the no-complication group.

Differences between the two groups were revealed after comparing multiple basic factors (gender, age, BMI, smoking, and comorbidities), tumor-related factors (metastasis, tumor type, pathological type, various treatment schemes, and time intervals), and post-COVID-19 status (fever, weight loss, and recovery time exceeding 10 days) (Table 2). The proportion of men in the severe events group was significantly higher ($p<0.01$). Weight loss was more pronounced in the severe group ($p<0.05$). Patients whose recovery time exceeded 10 days were more frequent in the severe group ($p=0.01$).

Patient outcome and risk factors associated with COVID-19 severity

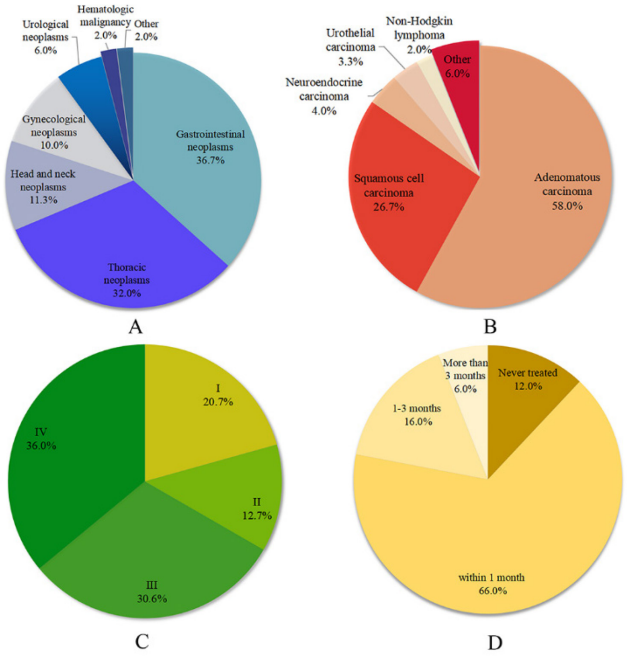
The clinical symptoms and manifestations of cancer patients who were diagnosed with COVID-19 were observed and categorized according to COVID-19 severity (Figure 1B). The proportion of patients with hypodynamia and diarrhea was slightly higher in the severe group. However, this difference was not statistically significant. The other symptoms or clinical features were generally similar and were not statistically significant.

Figure 1. Clinical manifestations after COVID-19 infection.



A: Comparison between non-cancer and cancer group; B: Comparison between no complications group and severe group in cancer patients. COVID-19: coronavirus disease 2019.

Figure 2. Cancer characteristics.



A: Tumor types; B: Pathological types; C: Clinical stages; D: Time interval from the last anticancer therapy to COVID-19 infection. COVID-19: coronavirus disease 2019.

Table 2. Clinical characteristics and therapy stratified by levels of COVID-19 severity among cancer patients.

Description	No complications n (%)	Severe events [a] n (%)	*p* value
Gender (male)	43 (43.3)	36 (70.6)	< 0.001
Age (years)	56.89 ± 11.67	58.65 ± 13.25	0.41
BMI	23.65 ± 3.33	24.16 ± 3.69	0.40
Addicted to smoking	34 (34.3)	22 (43.1)	0.29
Number of comorbidities			0.23
0	79 (79.8)	36 (70.6)	
1	11 (11.1)	11 (21.6)	
≥ 2	9 (9.1)	4 (7.8)	
Metastasis (clinical stage IV)	35 (35.4)	19 (37.3)	0.82
Pathological types			0.97
Aden. Carc.	57 (57.6)	30 (58.8)	
Sq. cell Carc.	27 (27.3)	13 (25.5)	
Others	15 (15.2)	8 (15.7)	
Tumor types			0.25
Lung cancer	14 (14.1)	11 (21.6)	
Others	85 (85.9)	40 (78.4)	
Chemotherapy within 1 month	46 (46.5)	20 (39.2)	0.40
Targeted therapy within 1 month	14 (14.1)	7 (13.7)	0.95
Immunotherapy within 1 month	15 (15.2)	4 (7.8)	0.20
Radioactive therapy within 1 month	24 (24.2)	20 (39.2)	0.06
Surgical therapy or invasive manipulation within 1 month	36 (36.4)	22 (43.1)	0.42
Time interval from the last anti-tumor treatments to COVID-19 diagnosis			0.18
Never received treatment	11 (11.1)	6 (11.8)	
Within 1 month	61 (61.6)	39 (76.5)	
From 1 to 3 mouths	20 (20.2)	4 (7.8)	
Exceeding 3 months	7 (7.1)	2 (3.9)	
Fever	77 (77.8)	43 (84.3)	0.34
Lose weight	32 (32.3)	26 (51.0)	0.02
Long recovery time [b]	28 (28.3)	25 (49.0)	0.01

BMI: body mass index; COVID-19: coronavirus disease 2019; ICU: intensive care unit; Aden. Carc.: Adenomatous carcinoma; Sq. cell Carc.: Squamous cell carcinoma. [a] Severe events were defined as outpatient treatment: hospitalization admission to the ICU: mechanical ventilation: and death during the COVID-19 infection. [b] Long recovery time was defined as the persistence of clinical symptoms or positive antigen for more than ten days after COVID-19 infection.

Multivariate analysis was performed for risk factors associated with increased COVID-19 severity, including gender, age, BMI, smoking, number of comorbidities, tumor-related factors, various anti-tumor therapies, post-COVID-19 status, and so on (Table 3). Compared with female patients, male oncology patients were 5.60 times more likely to be affected by severe post-COVID-19 (95% CI, 1.89-16.57). A long recovery time was associated with 3.19 times increased risk of COVID-19 severity (95%CI, 1.09-9.32).

Discussion

In recent years, SARS-CoV-2 infection had become an emerging global public health concern [18], which affected a dominant portion of the global population. The participants in our study were infected with COVID-19 at the time of the Omicron-predominant phase. Omicron variants were characterized by faster transmissibility, better viral binding and affinity, and increased frequency of mutations [19-21]. Fortunately, the major clinical symptoms of Omicron were relatively mild [22]. The Omicron period had generally lower rates of ICU occupancy, mechanical ventilation, and mortality than the Delta period [23].

The elderly and those with underlying medical conditions were the main populations affected by severe COVID-19 [24]. Therefore, cancer patients were at a higher risk. Immunosuppression was the predominant immunological imbalance that tumor patients experienced [25]. Additionally, anti-tumor treatment regimens typically affected or influenced the immune system. Research by French scholars indicated that cancer patients had high mortality and severe COVID-19, and no anticancer treatments were proven to have a negative effect other than cytotoxic chemotherapy [26]. From January 1 to February 24, 2020, 105 cancer patients participated in a multicenter study conducted in China, which revealed that COVID-19 was more likely to infect cancer patients. While radiotherapy had minimal effect on severe events, cancer patients who underwent surgery were more likely to experience severe episodes of COVID-19 [13]. Additional data published by European researchers [17]

Table 3. Multivariate analysis of factors associated with COVID-19 severity[a] outcome of cancer patients with COVID-19.

Variable	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)	*p* values
Gender (ref. female)	0.320 (0.155– 0.658)	5.604 (1.895–16.570)	< 0.01
Age	1.012 (0.984–1.042)	1.007 (0.972–1.044)	0.69
BMI	1.044 (0.946–1.151)	1.082 (0.948–1.235)	0.24
Addicted to smoking	1.450 (0.726–2.898)	0.680 (0.253–1.827)	0.44
Number of comorbidities (ref. 0)			0.35
1	2.194 (0.871–5.529)	1.255 (0.386–4.077)	0.71
≥ 2	0.975 (0.282–3.377)	0.348 (0.071–1.708)	0.19
Metastasis (clinical stage IV)	1.086 (0.538–2.189)	1.724 (0.616–4.820)	0.30
Pathological types (ref. others)			0.87
Aden. Carc.	0.915 (0.413–2.027)	0.984 (0.330–2.938)	0.98
Sq. cell Carc.	1.013 (0.386–2.660)	0.718 (0.205–2.510)	0.60
Tumor types (ref. others)			
Lung cancer	1.670 (0.696–4.003)	1.982 (0.615–6.382)	0.25
Chemotherapy within 1 month	0.743 (0.374–1.478)	0.504 (0.155–1.644)	0.26
Targeted therapy within 1 month	0.966 (0.363–2.567)	0.300 (0.066–1.373)	0.12
Immunotherapy within 1 month	0.477 (0.150–1.519)	0.199 (0.039–1.008)	0.05
Radioactive therapy within 1 month	2.016 (0.975–4.167)	1.919 (0.611–6.026)	0.26
Surgical therapy or invasive manipulation within 1 month	1.328 (0.667–2.644)	0.837 (0.283–2.477)	0.75
Time interval from the last anti-tumor treatments to COVID-19 diagnosis (ref. never received treatment)			0.11
Within 1 month	1.172 (0.401–3.427)	2.139 (0.329–13.914)	0.43
Between 1 to 3 mouths	0.367 (0.085–1.584)	0.252 (0.044–1.431)	0.12
Exceeding 3 months	0.524 (0.082–3.364)	0.290 (0.032–2.648)	0.27
Fever	1.536 (0.630–3.744)	1.859 (0.598–5.774)	0.28
Lose weight	2.177 (1.090–4.350)	1.228 (0.455–3.317)	0.69
Long recovery time[b]	2.438 (1.208–4.919)	3.190 (1.091–9.325)	< 0.05

BMI: body mass index; CI confidence interval; COVID-19: coronavirus disease 2019; *ref.:* reference group; Aden. Carc.: Adenomatous carcinoma; Sq. cell Carc.: Squamous cell carcinoma. [a] COVID-19 severity was classified into two levels: severe events: defined as outpatient treatment: hospitalization admission to the ICU: mechanical ventilation: and death during COVID-19 infection; and non-severe events. [b] Long recovery time was defined as persistence of clinical symptoms or positive antigen for more than ten days after COVID-19 infection.

showed that chemotherapy, targeted therapy, or immunotherapy did not increase mortality. The above studies did not address COVID-19 infection during the Omicron outbreak and instead concentrated primarily on the waves during 2020. Our study was conducted at the end of 2022, which helped gather data and information on cancer patients with COVID-19 during the Omicron period.

Compared to non-cancer group after COVID-19 infection, there were no statistically significant differences in gender, age, BMI, or number of comorbidities in cancer patients. However, both the proportion and number of people addicted to smoking was significantly higher in the cancer group. No statistical difference was observed in the number of outpatient visits after COVID-19 between the cancer and non-cancer groups. However, the number of hospitalized patients was higher in the cancer group. The symptoms were relatively mild after infection with Omicron, which was reflected by the fact that only one person in the cancer group was admitted to the ICU. Invasive mechanical ventilation was not used in any group. Post-infection symptoms, regardless of mild fever or high fever, were significantly higher in the non-oncology group. This phenomenon was similar to that reported in previous studies [13,27]. Other symptoms, such as hypodynamia, headache, and muscle soreness, were also more common in the non-cancer group. Presumably, the immune level of patients with tumors was inferior, which resulted in a weaker response to SARS-CoV-2 than that of the general population. Additionally, the application of steroids in tumor treatment might be one of the reasons for the reduction of post-COVID-19 symptoms in cancer patients compared with the general population. Cancer patients often use steroids, especially glucocorticoids, as part of symptomatic therapy or in specific chemo-regimen. Glucocorticoids can prevent the occurrence of immune inflammatory response and pathological immune response, which had been the most widely used and effective anti-inflammatory and immunosuppressant in clinical practice. Therefore, the degree and time of various inflammatory reactions after COVID-19 infection were significantly reduced in cancer patients who were administered steroids previously. Further research on this topic should be conducted.

Although the cancer group appeared to be less severe in terms of clinical features, the number of deaths at 30 or 90 days increased visibly in the cancer group, while no deaths occurred in the non-cancer group. The mortality within 90 days of the cancer group was 2.67%, which was slightly higher than that in the

overall population [23,28]. Of the two cancer patients who died within 30 days, one died quickly because of the complications of white lung after COVID-19. The other one recovered well after COVID-19 but died of massive bleeding caused by rapid tumor progression. The other two patients who died within 90 days had similar clinical progression. Both of them lost weight significantly after COVID-19 and continued symptoms of fatigue. The complications of COVID-19 accelerated the death of the two cancer patients. The general condition of cancer patients in the terminal stage was poor, and the deterioration of tumors could have been aggravated after COVID-19 infection, which led to eventual death. The reason for the absence of deaths in the non-cancer group might be the relatively small number of elderly, disabled, or uncooperative participants involved in SARS-CoV-2 detection in the Cancer Hospital, CAMS.

Multivariate analysis was conducted on 150 cancer patients according to the severity of the COVID-19 infection. Being male (OR 5.60, 95% CI 1.90-16.57) was an independent risk factor for COVID-19 severity among the cancer patients. In our study, male patients with Omicron were more likely to develop serious adverse events. This has been confirmed by several previous studies [17,26]. Another factor associated with this was a long recovery time (OR 3.19, 95% CI 1.09-9.33). It is not difficult to perceive that a longer recovery time was required for severe events after a COVID-19 infection. The time for the disappearance of clinical symptoms or antigen conversion was prolonged in patients with serious events after COVID-19 infection.

In our study, a limited correlation was observed between the type and time interval of anticancer treatment and COVID-19 severity. Among the various antitumor therapies, the only one that revealed portents was immunotherapy; however, the difference was not statistically significant (p=0.054). Immunotherapy enhanced the overall immune response. Elevated immune response levels could help fight foreign pathogens, such as SARS-CoV-2. Follow-up studies with larger sample sizes, particularly those involving immunotherapy were required. The above findings revealed the safety of previous antitumor treatment during the pandemic, which was consistent with previous reports [17,26]. Additionally, lung cancer patients were compared with other tumors, referring to the basic data, tumor characteristics, and treatments, as well as the performance after COVID-19 infection, which indicated no potentially valuable factors.

Our study had several limitations. First, it was a mono-institutional study. A nationwide study involving multiple regions and larger patient groups may provide more representative data to determine the association between COVID-19 and cancer. Second, many mild cases only visited the hospital for nucleic acid detection without other laboratory results during the COVID-19 infection period. However, a series of laboratory indicators, such as D-dimer, could assist in predicting the severity of COVID-19 patients [29]. Even with the subsequent positive results for SARS-CoV-2, they preferred recovering by themselves, and relevant laboratory testing were not done. Consequently, laboratory indicators were not acquired and statistical analyses were not performed in this study. Lastly, COVID-19 circulating strains in all samples were not verified by sequencing. In this study, patient samples were analyzed by real-time RT-PCR. The determination of COVID-19 Omicron strains was mainly based on the overall epidemic situation in Beijing and the relative clinical symptoms. Although the prevalence of Omicron strains was predominant by the end of 2022, the specific branches were unclear.

Conclusions

In the context of the ongoing COVID-19 pandemic, our data indicate that there might be some association between various active antitumor therapies, treatment intervals, and COVID-19 severity. These findings may be essential to dispel COVID-19 concerns among cancer patients and to continue the key therapeutic steps in their antitumor treatment. Nevertheless, the study of a larger cohort to determine the effect of immunotherapy and COVID-19 in cancer patients is a future direction.

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Authors' contributions

GJW and BJW, study design; WC, critical revisions; GJW, XD, and SKH, analyzing and writing the manuscript; XTX and XW, data analysis; XTY and QQG, image analysis; KG, WFZ, and BJW manuscript review; WC, final approval of the manuscript submitted.

Ethics statement

This study was conducted in accordance with the principles of the Declaration of Helsinki. Waiver for informed consent from the patients was approved by the Human Research

Ethics Committee and Research Committee of Cancer Hospital, CAMS. This study was approved by the Human Research Ethics Committee and the Research Committee of Cancer Hospital, CAMS (approval number: 23/259-4001).

References

1. Rana R, Kant R, Huirem RS, Bohra D, Ganguly NK (2022) Omicron variant: current insights and future directions. Microbiol Res 265: 127204. doi: 10.1016/j.micres.2022.127204.
2. Lino A, Cardoso MA, Martins-Lopes P, Gonçalves HA-O (2022) Omicron-the new SARS-CoV-2 challenge? Rev Med Virol 32: e2358. doi: 10.1002/rmv.2358.
3. Abdihamid O, Cai C, Kapesa L, Zeng S (2020) The landscape of COVID-19 in cancer patients: prevalence, impacts, and recommendations. Cancer Manag Res 12: 8923–8933. doi: 10.2147/CMAR.S272008.
4. The Lancet (2023) The COVID-19 pandemic in 2023: far from over. Lancet 401: 79. doi: 10.1016/S0140-6736(23)00050-8.
5. Fontanet A, Autran B, Lina B, Kieny MP, Karim SSA, Sridhar D (2021) SARS-CoV-2 variants and ending the COVID-19 pandemic. Lancet 397: 952–954. doi: 10.1016/S0140-6736(21)00370-6.
6. World Health Organization (2021) Update on Omicron. Available: https://www.who.int/news/item/28-11-2021-update-on-omicron/. Accessed: 28 November 2021.
7. Callaway E, Ledford H (2021) How bad is Omicron? What scientists know so far. Nature 600: 197–199. doi: 10.1038/d41586-021-03614-z.
8. Ledford H (2021) How severe are Omicron infections? Nature 600: 577–578. doi: 10.1038/d41586-021-03794-8.
9. Karim SSA, Karim QA (2021) Omicron SARS-CoV-2 variant: a new chapter in the COVID-19 pandemic. Lancet 398: 2126–2128. doi: 10.1016/S0140-6736(21)02758-6.
10. Axelrad JE, Lichtiger S, Yajnik V (2016) Inflammatory bowel disease and cancer: the role of inflammation, immunosuppression, and cancer treatment. World J Gastroenterol 22: 4794–4801. doi: 10.3748/wjg.v22.i20.4794.
11. Finn OJ (2012) Immuno-oncology: understanding the function and dysfunction of the immune system in cancer. Ann Oncol 23 Suppl 8: viii6–9. doi: 10.1093/annonc/mds256.
12. Liang W, Guan W, Chen R, Wang W, Li J, Xu K, Li C, Ai Q, Lu W, Liang H, Li S, He J (2020) Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. Lancet Oncol 21: 335–337. doi: 10.1016/S1470-2045(20)30096-6.
13. Dai M, Liu D, Liu M, Zhou F, Li G, Chen Z, Zhang Z, You H, Wu M, Zheng Q, Xiong Y, Xiong H, Wang C, Chen C, Xiong F, Zhang Y, Peng Y, Ge S, Zhen B, Yu T, Wang L, Wang H, Liu Y, Chen Y, Mei J, Gao X, Li Z, Gan L, He C, Li Z, Shi Y, Qi Y, Yang J, Tenen DG, Chai L, Mucci LA, Santillana M, Cai H (2020) Patients with cancer appear more vulnerable to SARS-CoV-2: a multicenter study during the COVID-19 outbreak. Cancer Discov 10: 783–791. doi: 10.1158/2159-8290.CD-20-0422.
14. Miyashita H, Mikami T, Chopra N, Yamada T, Chernyavsky S, Rizk D, Cruz C (2020) Do patients with cancer have a poorer prognosis of COVID-19? An experience in New York City. Ann Oncol 31: 1088–1089. doi: 10.1016/j.annonc.2020.04.006.
15. Kuderer NM, Choueiri TK, Shah DP, Shyr Y, Rubinstein SM, Rivera DR, Shete S, Hsu CY, Desai A, de Lima Lopes G Jr, Grivas P, Painter CA, Peters S, Thompson MA, Bakouny Z, Batist G, Bekaii-Saab T, Bilen MA, Bouganim N, Larroya MB, Castellano D, Del Prete SA, Doroshow DB, Egan PC, Elkrief A, Farmakiotis D, Flora D, Galsky MD, Glover MJ, Griffiths EA, Gulati AP, Gupta S, Hafez N, Halfdanarson TR, Hawley JE, Hsu E, Kasi A, Khaki AR, Lemmon CA, Lewis C, Logan B, Masters T, McKay RR, Mesa RA, Morgans AK, Mulcahy MF, Panagiotou OA, Peddi P, Pennell NA, Reynolds K, Rosen LR, Rosovsky R, Salazar M, Schmidt A, Shah SA, Shaya JA, Steinharter J, Stockerl-Goldstein KE, Subbiah S, Vinh DC, Wehbe FH, Weissmann LB, Wu JT, Wulff-Burchfield E, Xie Z, Yeh A, Yu PP, Zhou AY, Zubiri L, Mishra S, Lyman GH, Rini BI, Warner JL; COVID-19 and Cancer Consortium (2020) Clinical impact of COVID-19 on patients with cancer (CCC19): a cohort study. Lancet 395: 1907–1918. doi: 10.1016/S0140-6736(20)31187-9.
16. Grivas P, Khaki AR, Wise-Draper TM, French B, Hennessy C, Hsu CY, Shyr Y, Li X, Choueiri TK, Painter CA, Peters S, Rini BI, Thompson MA, Mishra S, Rivera DR, Acoba JD, Abidi MZ, Bakouny Z, Bashir B, Bekaii-Saab T, Berg S, Bernicker EH, Bilen MA, Bindal P, Bishnoi R, Bouganim N, Bowles DW, Cabal A, Caimi PF, Chism DD, Crowell J, Curran C, Desai A, Dixon B, Doroshow DB, Durbin EB, Elkrief A, Farmakiotis D, Fazio A, Fecher LA, Flora DB, Friese CR, Fu J, Gadgeel SM, Galsky MD, Gill DM, Glover MJ, Goyal S, Grover P, Gulati S, Gupta S, Halabi S, Halfdanarson TR, Halmos B, Hausrath DJ, Hawley JE, Hsu E, Huynh-Le M, Hwang C, Jani C, Jayaraj A, Johnson DB, Kasi A, Khan H, Koshkin VS, Kuderer NM, Kwon DH, Lammers PE, Li A, Loaiza-Bonilla A, Low CA, Lustberg MB, Lyman GH, McKay RR, McNair C, Menon H, Mesa RA, Mico V, Mundt D, Nagaraj G, Nakasone ES, Nakayama J, Nizam A, Nock NL, Park C, Patel JM, Patel KG, Peddi P, Pennell NA, Piper-Vallillo AJ, Puc M, Ravindranathan D, Reeves ME, Reuben DY, Rosenstein L, Rosovsky RP, Rubinstein SM, Salazar M, Schmidt AL, Schwartz GK, Shah MR, Shah SA, Shah C, Shaya JA, Singh SRK, Smits M, Stockerl-Goldstein KE, Stover DG, Streckfuss M, Subbiah S, Tachiki L,Tadesse E, Thakkar A, Tucker MD, Verma AK, Vinh DC, Weiss M, Wu JT, Wulff-Burchfield E, Xie Z, Yu PP, Zhang T, Zhou AY, Zhu H, Zubiri L, Shah DP, Warner JL, Lopes GdL (2021) Association of clinical factors and recent anticancer therapy with COVID-19 severity among patients with cancer: a report from the COVID-19 and Cancer Consortium. Ann Oncol 32: 787–800. doi: 10.1016/j.annonc.2021.02.024.
17. Pinato DJ, Zambelli A, Aguilar-Company J, Bower M, Sng C, Salazar R, Bertuzzi A, Brunet J, Mesia R, Segui E, Biello F, Generali D, Grisanti S, Rizzo G, Libertini M, Maconi A, Harbeck N, Vincenzi B, Bertulli R, Ottaviani D, Carbo A, Bruna R, Benafif S, Marrari A, Wuerstlein R, Carmona-Garcia MC, Chopra N, Tondini C, Mirallas O, Tovazzi V, Betti M, Provenzano S, Fotia V, Cruz CA, Dalla Pria A, D'Avanzo F, Evans JS, Saoudi-Gonzalez N, Felip E, Galazi M, Garcia-Fructuoso I, Lee AJX, Newsom-Davis T, Patriarca A, Garcia-Illescas D, Reyes R, Dileo P, Sharkey R, Wong YNS, Ferrante D, Marco-Hernandez J, Sureda A, Maluquer C, Ruiz-Camps I, Gaidano G, Rimassa L, Chiudinelli L, Izuzquiza M, Cabirta A, Franchi M, Santoro A, Prat A, Tabernero J, Gennari A (2020) Clinical portrait of the SARS-CoV-2 epidemic in European cancer patients. Cancer Discov 10: 1465–1474. doi: 10.1158/2159-8290.CD-20-0773.
18. Umakanthan S, Sahu P, Ranade AV, Bukelo MM, Rao JS, Abrahao-Machado LF, Dahal S, Kumar H, Kv D (2020) Origin, transmission, diagnosis and management of

coronavirus disease 2019 (COVID-19). Postgrad Med J 96: 753–758.
19. Meo SA, Meo AS, Al-Jassir FF, Klonoff DC (2021) Omicron SARS-CoV-2 new variant: global prevalence and biological and clinical characteristics. Eur Rev Med Pharmacol Sci 25: 8012–8018.
20. Fan Y, Li X, Zhang L, Wan S, Zhang L, Zhou F (2022) SARS-CoV-2 Omicron variant: recent progress and future perspectives. Signal Transduct Target Ther 7: 141. doi: 10.1038/s41392-022-00997-x.
21. Keske Ş, Güney-Esken G, Vatansever C, Beşli Y, Kuloğlu ZE, Nergiz Z, Barlas T, Şencanlı Ö, Kuşkucu MA, Palaoğlu E, Can F, Önder Ergönül (2023) Duration of infectious shedding of SARS-CoV-2 Omicron variant and its relation with symptoms. Clin Microbiol Infect 29: 221–224. doi: 10.1016/j.cmi.2022.07.009.
22. Bazargan M, Elahi R, Esmaeilzadeh A (2022) Omicron: virology, immunopathogenesis, and laboratory diagnosis. J Gene Med 24: e3435. doi: 10.1002/jgm.3435.
23. Lu G, Zhang Y, Zhang H, Ai J, He L, Yuan X, Bao S, Chen X, Wang H, Cai J, Wang S, Zhang W, Xu J (2022) Geriatric risk and protective factors for serious COVID-19 outcomes among older adults in Shanghai Omicron wave. Emerg Microbes Infect 11: 2045–2054. doi: 10.1080/22221751.2022.2109517.
24. Gao YD, Ding M, Dong X, Zhang JJ, Kursat Azkur A, Azkur D, Gan H, Sun YL, Fu W, Li W, Liang HL, Cao YY, Yan Q, Cao C, Gao HY, Brüggen MC, van de Veen W, Sokolowska M, Akdis M, Akdis CA (2021) Risk factors for severe and critically ill COVID-19 patients: a review. Allergy 76: 428–455. doi: 10.1111/all.14657.
25. Chen J, Douglass J, Prasath V, Neace M, Atrchian S, Manjili MH, Shokouhi S, Habibi M (2019) The microbiome and breast cancer: a review. Breast Cancer Res Treat 178: 493–496. doi: 10.1007/s10549-019-05407-5.
26. Lièvre A, Turpin A, Ray-Coquard I, Le Malicot K, Thariat J, Ahle G, Neuzillet C, Paoletti X, Bouché O, Aldabbagh K, Michel P, Debieuvre D, Canellas A, Wislez M, Laurent L, Mabro M, Colle R, Hardy-Bessard AC, Mansi L, Colomba E, Bourhis J, Gorphe P, Pointreau Y, Idbaih A, Ursu R, Di Stefano AL, Zalcman G, Aparicio T; GCO-002 CACOVID-19 collaborators/investigators (2020) Risk factors for coronavirus disease 2019 (COVID-19) severity and mortality among solid cancer patients and impact of the disease on anticancer treatment: a French nationwide cohort study (GCO-002 CACOVID-19). Eur J Cancer 141: 62–81. doi: 10.1016/j.ejca.2020.09.035.
27. Liu C, Zhao Y, Okwan-Duodu D, Basho R, Cui X (2020) COVID-19 in cancer patients: risk, clinical features, and management. Cancer Biol Med 17: 519–527. doi: 10.20892/j.issn.2095-3941.2020.0289.
28. Long B, Carius BM, Chavez S, Liang SY, Brady WJ, Koyfman A, Gottlieb M (2022) Clinical update on COVID-19 for the emergency clinician: presentation and evaluation. Am J Emerg Med 54: 46–57. doi: 10.1016/j.ajem.2022.01.028.
29. Hosseinzadeh M, Pouladzadeh M, Eftekhar A, Choghakabodi PM, Sokooti A (2022) Evaluation of D-dimer as a predictor of severity, degree of pulmonary involvement and mortality in patients with COVID-19. Sci Med 32: e43281. [Article in Portuguese]. doi: 10.15448/1980-6108.2022.1.43281.

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Annex – Supplementary Items

Supplementary Table 1. Detailed information of 150 cancer patients infected with coronavirus disease 2019 (COVID-19).

Patient ID	Gender	Age	No. of comorbidities	Tumor type	Phase	Pathological type	Smoking history	Severe events	Survival status
No.1	Male	53	1	Colorectal cancer	IV	Aden. Carc.	Smoker	No	Alive
No.2	Male	45	0	Renal cancer	I	Other	Smoker	No	Alive
No.3	Male	59	0	Lung cancer	III	Aden. Carc.	Smoker	No	Alive
No.4	Female	59	0	Breast cancer	I	Aden. Carc.	Never smoked	No	Alive
No.5	Female	64	0	Lung cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.6	Male	65	2	Colorectal cancer	IV	Aden. Carc.	Smoker	No	Alive
No.7	Female	54	0	Colorectal cancer	II	Aden. Carc.	Never smoked	No	Alive
No.8	Female	38	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.9	Female	63	1	Lung cancer	I	Aden. Carc.	Never smoked	No	Alive
No.10	Male	53	0	Stomach cancer	III	Aden. Carc.	Smoker	No	Alive
No.11	Female	66	0	Ovarian cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.12	Female	62	0	Lung cancer	IV	Neu. Carc.	Never smoked	No	Alive
No.13	Male	33	0	Thyroid cancer	IV	Other	Never smoked	No	Alive
No.14	Male	76	1	Colorectal cancer	III	Aden. Carc.	Smoker	Yes	Alive
No.15	Female	61	0	Ovarian cancer	IV	Sq. cell Carc.	Never smoked	No	Alive
No.16	Male	52	0	Lung cancer	III	Sq. cell Carc.	Smoker	No	Alive
No.17	Male	63	1	Esophagus cancer	I	Sq. cell Carc.	Never smoked	No	Alive
No.18	Female	65	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.19	Female	32	0	Cervical cancer	IV	Sq. cell Carc.	Never smoked	Yes	Alive
No.20	Female	67	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.21	Female	59	0	Breast cancer	III	Aden. Carc.	Never smoked	No	Alive
No.22	Male	50	0	Hypopharyngeal cancer	III	Sq. cell Carc.	Smoker	No	Alive
No.23	Female	63	0	Colorectal cancer	III	Aden. Carc.	Never smoked	No	Alive
No.24	Female	60	1	Ovarian cancer	III	Aden. Carc.	Never smoked	No	Alive
No.25	Male	59	1	Lung cancer	II	Neu. Carc.	Smoker	Yes	Alive
No.26	Female	58	0	Esophagus cancer	IV	Aden. Carc.	Smoker	No	Alive
No.27	Male	52	0	Stomach cancer	IV	Aden. Carc.	Smoker	No	Alive
No.28	Male	67	2	Prostate cancer	IV	Aden. Carc.	Smoker	Yes	Alive
No.29	Male	64	1	lymphoma	I	Non-Hodgkin lym.	Never smoked	Yes	Alive
No.30	Male	68	0	Bladder cancer	IV	Uro. Carc.	Smoker	Yes	Alive
No.31	Male	69	1	Prostate cancer	III	Aden. Carc.	Smoker	Yes	Alive
No.32	Male	29	0	Stomach cancer	III	Aden. Carc.	Smoker	No	Alive
No.33	Male	76	0	Colorectal cancer	III	Aden. Carc.	Never smoked	No	Alive
No.34	Female	54	0	Cervical cancer	IV	Sq. cell Carc.	Never smoked	No	Alive
No.35	Female	42	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.36	Female	68	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.37	Male	55	0	Pleura cancer	III	Other	Never smoked	No	Alive
No.38	Female	61	0	Breast cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.39	Female	24	0	Brain cancer	III	Other	Never smoked	Yes	Alive
No.40	Female	33	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.41	Female	65	2	Breast cancer	III	Aden. Carc.	Never smoked	No	Alive
No.42	Female	56	0	Breast cancer	III	Aden. Carc.	Never smoked	Yes	Alive
No.43	Male	58	0	Colorectal cancer	II	Aden. Carc.	Smoker	Yes	Alive
No.44	Male	66	2	Parotid cancer	IV	Sq. cell Carc.	Never smoked	No	Alive
No.45	Male	26	1	Tongue cancer	IV	Sq. cell Carc.	Never smoked	Yes	Alive
No.46	Male	67	0	Hypopharyngeal cancer	III	Sq. cell Carc.	Smoker	No	Alive
No.47	Male	59	0	Hypopharyngeal cancer	IV	Sq. cell Carc.	Smoker	No	Alive
No.48	Male	59	0	Hypopharyngeal cancer	IV	Sq. cell Carc.	Never smoked	No	Alive
No.49	Female	53	0	lymphoma	II	Non-Hodgkin lym.	Never smoked	No	Alive
No.50	Male	44	0	Colorectal cancer	III	Aden. Carc.	Smoker	Yes	Alive
No.51	Male	69	2	Hepatobiliary cancer	I	Aden. Carc.	Never smoked	Yes	Alive
No.52	Female	60	0	Breast cancer	III	Aden. Carc.	Never smoked	Yes	Alive
No.53	Male	64	1	Colorectal cancer	III	Aden. Carc.	Smoker	Yes	Alive
No.54	Male	66	0	Prostate cancer	IV	Aden. Carc.	Never smoked	Yes	Alive
No.55	Female	51	0	Breast cancer	I	Aden. Carc.	Never smoked	No	Alive
No.56	Female	38	0	Breast cancer	II	Aden. Carc.	Never smoked	Yes	Alive
No.57	Female	49	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.58	Male	66	1	Hepatobiliary cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.59	Female	51	0	Breast cancer	I	Aden. Carc.	Never smoked	No	Alive

No.60	Female	67	1	Cervical cancer	III	Sq. cell Carc.	Never smoked	No	Alive
No.61	Male	56	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	Yes	Alive
No.62	Female	71	0	Esophagus cancer	I	Sq. cell Carc.	Never smoked	No	Alive
No.63	Female	64	0	Lung cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.64	Female	40	0	Breast cancer	I	Aden. Carc.	Never smoked	No	Alive
No.65	Male	59	0	Colorectal cancer	III	Aden. Carc.	Smoker	No	Alive
No.66	Male	62	0	Colorectal cancer	IV	Aden. Carc.	Smoker	No	Alive
No.67	Male	25	0	lymphoma	II	Non-Hodgkin lym.	Smoker	No	Alive
No.68	Female	59	1	Lung cancer	III	Neu. Carc.	Never smoked	No	Alive
No.69	Female	58	0	Breast cancer	II	Aden. Carc.	Smoker	Yes	Alive
No.70	Male	63	0	Esophagus cancer	I	Sq. cell Carc.	Never smoked	Yes	Alive
No.71	Female	65	0	Lung cancer	II	Aden. Carc.	Never smoked	Yes	Alive
No.72	Male	67	2	Lung cancer	I	Aden. Carc.	Smoker	Yes	Alive
No.73	Female	26	1	Thyroid cancer	I	Aden. Carc.	Never smoked	No	Alive
No.74	Male	65	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.75	Female	42	1	Endometrial cancer	III	Aden. Carc.	Never smoked	Yes	Alive
No.76	Male	74	2	Colorectal cancer	III	Aden. Carc.	Smoker	No	Alive
No.77	Female	43	1	Lung cancer	I	Aden. Carc.	Never smoked	No	Alive
No.78	Male	67	0	Esophagus cancer	I	Sq. cell Carc.	Smoker	No	Alive
No.79	Male	57	0	Esophagus cancer	III	Aden. Carc.	Smoker	No	Alive
No.80	Male	73	0	Esophagus cancer	I	Sq. cell Carc.	Never smoked	Yes	Alive
No.81	Male	54	0	Lung cancer	IV	Aden. Carc.	Smoker	No	Alive
No.82	Male	64	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	Yes	Alive
No.83	Male	53	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.84	Female	53	0	Pleura cancer	IV	Other	Never smoked	No	Alive
No.85	Female	64	0	Lung cancer	IV	Aden. Carc.	Smoker	No	Alive
No.86	Male	57	0	Esophagus cancer	IV	Sq. cell Carc.	Smoker	Yes	Alive
No.87	Male	58	0	Lung cancer	IV	Neu. Carc.	Never smoked	No	Alive
No.88	Female	47	0	Breast cancer	III	Aden. Carc.	Smoker	No	Alive
No.89	Male	75	0	Esophagus cancer	III	Sq. cell Carc.	Smoker	Yes	Dead
No.90	Male	63	0	Lung cancer	IV	Aden. Carc.	Smoker	No	Alive
No.91	Male	47	0	Brain cancer	II	Other	Smoker	No	Alive
No.92	Male	64	0	Tongue cancer	IV	Sq. cell Carc.	Smoker	No	Alive
No.93	Male	57	0	Stomach cancer	II	Aden. Carc.	Never smoked	No	Alive
No.94	Female	45	0	Breast cancer	I	Aden. Carc.	Smoker	No	Alive
No.95	Female	64	0	Hepatobiliary cancer	IV	Aden. Carc.	Never smoked	Yes	Dead
No.96	Female	50	0	Cervical cancer	I	Sq. cell Carc.	Never smoked	No	Alive
No.97	Male	71	0	Esophagus cancer	IV	Sq. cell Carc.	Smoker	Yes	Dead
No.98	Female	35	0	Cervical cancer	I	Sq. cell Carc.	Never smoked	No	Alive
No.99	Female	67	0	Thymic cancer	I	Other	Never smoked	No	Alive
No.100	Female	64	0	Cervical cancer	III	Sq. cell Carc.	Never smoked	No	Alive
No.111	Female	70	0	Vaginal stump cancer	III	Sq. cell Carc.	Never smoked	No	Alive
No.112	Male	70	0	Esophagus cancer	II	Sq. cell Carc.	Never smoked	Yes	Alive
No.113	Male	56	0	Laryngeal cancer	IV	Neu. Carc.	Smoker	No	Alive
No.114	Male	64	0	Bladder cancer	I	Uro. Carc.	Smoker	No	Alive
No.115	Female	52	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.116	Female	42	0	Cervical cancer	III	Sq. cell Carc.	Never smoked	No	Alive
No.117	Female	43	0	Cancer of soft tissue	I	Other	Never smoked	No	Alive
No.118	Male	63	0	Colorectal cancer	III	Aden. Carc.	Smoker	No	Alive
No.119	Female	62	2	Nasopharyngeal cancer	IV	Sq. cell Carc.	Never smoked	No	Alive
No.120	Male	68	0	Stomach cancer	III	Aden. Carc.	Never smoked	Yes	Alive
No.121	Male	64	1	Colorectal cancer	IV	Aden. Carc.	Smoker	Yes	Alive
No.122	Female	38	0	Colorectal cancer	IV	Aden. Carc.	Smoker	No	Alive
No.123	Male	67	1	Lung cancer	II	Sq. cell Carc.	Smoker	No	Alive
No.124	Female	73	0	Breast cancer	II	Aden. Carc.	Never smoked	No	Alive
No.125	Female	65	0	Lung cancer	III	Aden. Carc.	Never smoked	Yes	Alive
No.126	Male	49	0	Esophagus cancer	III	Sq. cell Carc.	Smoker	Yes	Alive
No.127	Male	42	0	Pancreatic cancer	IV	Aden. Carc.	Smoker	Yes	Alive
No.128	Female	69	0	Cervical cancer	III	Sq. cell Carc.	Never smoked	No	Alive
No.129	Male	76	2	Hepatobiliary cancer	III	Aden. Carc.	Smoker	No	Alive
No.130	Male	77	0	Colorectal cancer	III	Aden. Carc.	Never smoked	No	Alive
No.141	Female	69	0	Esophagus cancer	I	Sq. cell Carc.	Never smoked	No	Alive
No.142	Male	70	0	Lung cancer	I	Aden. Carc.	Smoker	Yes	Alive
No.143	Male	40	0	Nasopharyngeal cancer	III	Sq. cell Carc.	Never smoked	Yes	Alive
No.144	Male	66	0	Esophagus cancer	III	Sq. cell Carc.	Never smoked	No	Alive

No.145	Female	41	2	Endometrial cancer	III	Aden. Carc.	Smoker	No	Alive
No.146	Female	69	1	Anal canal cancer	III	Sq. cell Carc.	Never smoked	Yes	Alive
No.147	Male	66	0	Bladder cancer	III	Uro. Carc.	Smoker	Yes	Alive
No.148	Female	58	0	Colorectal cancer	IV	Aden. Carc.	Never smoked	No	Alive
No.149	Female	55	2	Cervical cancer	IV	Sq. cell Carc.	Never smoked	Yes	Alive
No.150	Male	75	1	Lung cancer	IV	Aden. Carc.	Smoker	Yes	Alive

Aden. Carc.: Adenomatous carcinoma; Sq. cell Carc.: Squamous cell carcinoma; Neu. Carc.: Neuroendocrine carcinoma; Non-Hodgkin lym.: Non-Hodgkin lymphoma; Uro. Carc.: Urothelial carcinoma.