Outcomes of COVID-19 on Patients with Cancer: A Scoping Review

Amjad A. Alrehaili[1], Samah M. Sofar[2], Duha Y. Wazqar[3]

[1]Master of Medical-Surgical Nursing, Faculty of Nursing, King Abdulaziz University, Jeddah, Saudi Arabia.
e-mail: amjad.abdullah.alrehaili@gmail.com
[2]Assistant Professor of Medical-Surgical Nursing Department, Faculty of Nursing, King Abdulaziz University, Jeddah, Saudi Arabia.
Assistant Professor of Medical-Surgical Nursing Department, Faculty of Nursing, Alexandria University, Egypt.
e-mail: sssofar@kau.edu.sa
[3]Associate Professor of Medical-Surgical Nursing Department, Faculty of Nursing, King Abdulaziz University, Jeddah, Saudi Arabia.
e-mail: dwazger@kau.edu.sa

Received October 24, 2023, accepted September 20, 2023, Published January 1, 2024.

ABSTRACT

Context: The COVID-19 pandemic has resulted in an unprecedented global health crisis. Among the most vulnerable populations during this pandemic are patients with cancer, who face a double burden of navigating their underlying malignancy and the added risks posed by COVID-19. Understanding the unique challenges and consequences of COVID-19 in cancer patients has become a critical area of investigation.

Aim: The current scoping review aims to summarize the impact of COVID-19 infection on the outcomes in patients with cancer.

Methods: The literature search was conducted in the following electronic databases: PubMed, MEDLINE, and EBSCOhost. In addition, a Google Scholar search was conducted to explore gray literature. The reference lists of the selected studies were manually checked to find any further related articles. Ten studies were retrieved to assess the outcomes of COVID-19 in patients with cancer.

Results: The current scoping review categorized the retrieved studies into three main themes. The first theme is the COVID-19-associated complications in patients with cancer; the second theme is the COVID-19-associated severity in patients with cancer; and the third theme is the COVID-19-associated clinical outcomes among patients with cancer. The initial search identified a total of 1650 articles. After eliminating duplicates, 1023 articles remained. Following stringent inclusion and exclusion criteria, 849 articles were excluded, leaving 174 articles for further examination. The researcher conducted a thorough manual screening of titles, abstracts, and full texts to retrieve only the relevant articles. Consequently, 164 articles were excluded, and 10 Full-text articles were included to explore the impact of COVID-19 infection on the outcomes of patients with cancer.

Conclusion: Patients with cancer are a high-risk group for COVID-19 infection. They are more prone to having a severe form of COVID-19 infection. Moreover, ARDS is the most frequent complication of COVID-19 among patients with cancer. In addition, hospitalization, intensive care unit admission, oxygen support, and mechanical ventilation are all increased in patients with cancer infected with COVID-19.

Keywords: COVID-19, cancer, outcome

Citation: *Alrehaili, A. A., Sofar, S. M., & Wazqar, D. Y. (2024).* Outcomes of COVID-19 on patients with cancer: A scoping review. *Evidence-Based Nursing Research*, 6(1), 14-27. http://doi.org/10.47104/ebnrojs3.v6i1.318.

1. Introduction

The new generation of Coronavirus, named SARS-CoV-2, has spread rapidly around the world and caused the COVID-19 pandemic *(Zhao et al., 2020; Wang et al., 2020).* COVID-19 is a highly infectious disease with a basic reproduction rate of 2.68% *(Wu et al., 2020).* By April 2022, more than 400 million cases of COVID-19 had been reported worldwide, with more than 6 million deaths *(WHO, 2022).* COVID-19 is characterized by dyspnea, fever, headache, sore throat, cough, fatigue, and gastrointestinal symptoms such as diarrhea, nausea, and anorexia *(Marago & Minen, 2020).*

Previous studies have shown that chronic disease patients are more susceptible to getting infected with COVID-19 and developing unfavorable prognoses *(Espinosa et al., 2020; Wu et al., 2020; Liang et al., 2020).* Moreover, patients with cancer tend to be more susceptible to infectious diseases than others *(Zong et al., 2021).* There are several factors causing patients with cancer to be more susceptible to COVID-19, such as cancer itself, cancer treatment, and other comorbidities *(Liang et al., 2020). Jazieh et al. (2020)* mentioned that the immune system may become compromised in patients with cancer because of the malignancy's negative impact on immune cells, which might change their quantity and quality. Furthermore, cancer treatment affects the immune system differently and elevates the chance of infection. In addition, cancer treatment requires frequent and regular hospital or oncology clinic visits, which may increase the chance of getting infected with COVID-19 from the hospital environment *(Bondeson et al., 2021).*

When patients with cancer get infected with COVID-19, they present with signs and symptoms like those in other COVID-19 patients *(Zhang et al., 2020b).* However, patients with cancer frequently experience symptoms such as fatigue,

[1]*Correspondence author: Amjad Abdullah Alrehaili*

dyspnea, nausea, vomiting, diarrhea, and pain. It can be difficult to diagnose COVID-19 among patients with cancer because many patients with cancer experience COVID-19 symptoms as a consequence of adverse effects from anticancer therapy or as a result of specific neoplasm-related conditions *(Santos Thuler & De Melo, 2020).*

It is widely assumed that people with cancer have a higher risk of developing severe COVID-19 *(Rüthrich et al., 2021).* In addition, *Wu and McGoogan (2020)* reported that the case fatality rate for patients with cancer is 5.6%, almost twice as high as the general population.

Dai et al. (2020). *Miyashita et al. (2020)* and *Fratino et al. (2020)* found that outcomes of COVID-19 in patients with cancer tend to be more severe than outcomes of COVID-19 in healthy or noncancer patients. Additionally, outcomes of COVID-19 are influenced by differences in geographic regions due to differences in incidence rate and prevalence rate, healthcare facilities, and access to supportive intensive care *(Calles et al., 2020).* Previous studies have shown that cancer elevates COVID-19 vulnerability, and it is a contributing factor for worse clinical outcomes in COVID-19 patients *(Dai et al., 2020; Ma et al., 2020).* Furthermore, outcomes of COVID-19 in patients with cancer are affected by age, gender, cancer stages, tumor type, and type of cancer treatment *(Zhang et al., 2020b; Kuderer et al., 2020).*

2. Significance of the study

The current scoping review is important across healthcare, research, and public health. Cancer remains one of the leading causes of death globally, with an estimated 10 million deaths reported worldwide in 2020 *(Sung et al., 2021).* In Saudi Arabia specifically, there were 13,069 reported deaths from cancer and 27,885 new cases in 2020 *(WHO, 2022),* emphasizing the importance of understanding and addressing this critical health issue within the country.

This scoping review will provide crucial insights for clinical decision-making by summarizing the impact of COVID-19 on patients with cancer, aiding healthcare professionals in treatment decisions and protective measures. Additionally, it helps policymakers formulate effective strategies for managing the pandemic within this vulnerable population. Furthermore, the review identifies research gaps, guides future investigations, and serves as a valuable advocacy tool for patients with cancer communities. In the broader context, it contributes to global health preparedness by highlighting the vulnerabilities of specific patient groups, advancing our understanding of the COVID-19-cancer interplay, and ultimately enhancing the well-being of patients with cancer during the pandemic.

3. Aim of the study

The current scoping review aims to summarize the impact of COVID-19 infection on the outcomes of patients with cancer.

4. Methods

The present scoping review used a five-stage methodology defined by *Arksey and O'Malley (2005)* and then refined further by *Anderson et al. (2008), Davis et al. (2009), Brien et al. (2010), Levac et al. (2010)* and *Daudt et al. (2013).* The five stages include identifying the research question, identifying and selecting relevant articles, charting data, and organizing, summarizing, and writing the results.

Initially, 1650 articles were recognized, and 1023 articles were included after the elimination of duplicates. After following the inclusion and exclusion criteria, 849 articles were excluded. Then, the researcher manually screened the remaining 174 articles, titles, abstracts, and full texts, and only relevant articles were retrieved. Therefore, as a result, 164 articles were excluded from the present scoping review because of articles focusing on the outcomes of COVID-19 on the psychological and social health of patients with cancer (n=37), articles conducted among child and elderly patients (n=9), article that focus on first generation of Coronavirus (n=63), articles that focus on patients with cancer with another health problem (n= 42), and non-English language articles, editorials, comments, and review articles (n=13). Finally, 10 Full-text articles were included.

4.1. Identifying the research question

This current scoping review was guided by the research question: What is documented in the literature about the impact of COVID-19 infection on the outcomes of patients with cancer?

4.2. Identifying relevant articles

On October 5, 2021, the initial search was conducted in the following electronic databases: National Library of Medicine's "PubMed," Medical Literature Analysis and Retrieval System Online "MEDLINE," and EBSCO host. Furthermore, a Google Scholar search was conducted to explore gray literature. The present scoping review used Medical Subject Headings 2020 terms (MeSH) in MEDLINE, EBSCO host, and PubMed. The reference lists of the selected studies were manually checked to find any further related articles.

The following combination of keywords was used to find relevant articles: “COVID-19" OR "SARS-CoV-2" OR "coronavirus" AND "cancer" OR "malignancy" AND "outcome OR "impact." The major terms were combined using the Boolean operator "AND" or "OR" in the search engines to conduct the searches. The search found 1650 records that required to be analyzed. (PubMed, 545; MEDLINE, 234; EBSCO host, 868; and Google Scholar, 3). Moreover, during the electronic search, the publication years were restricted to 2020-2022 because of the timeframe of the COVID-19 pandemic.

4.2.1. Inclusion and exclusion criteria

The articles in this review met the following inclusion criteria: Articles should be available in full text and English, focusing on the outcomes of the second generation of the Coronavirus; articles conducted among adult cancer patients; qualitative, quantitative, and mixed method articles; and articles published in the last three years between 2020 and 2022. Articles focusing on patients with cancer who also have another health problem and articles focusing on the outcomes of COVID-19 on the psychological and social

health of patients with cancer were excluded. In addition, non-English language articles, editorials, comments, and review articles were eliminated.

4.2.2. Selecting relevant articles

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analysis) was used to screen the identified literature. PRISMA contains a four-phase flow diagram explained in Figure 1.

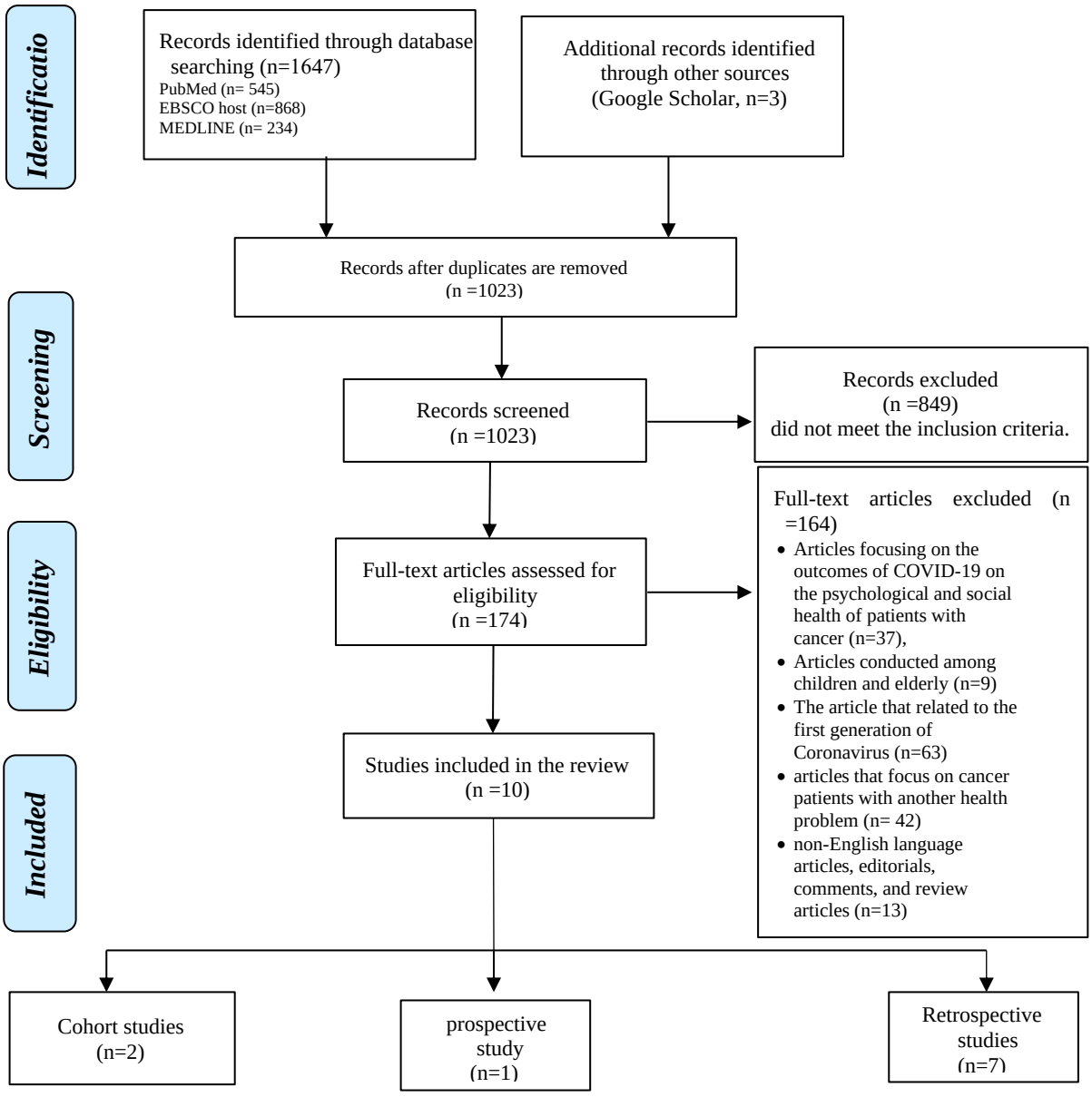

Figure (1): PRISMA Flow Diagram Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement guidelines *(Moher et al., 2015).*

4.3. Charting data

"Charting the data" is a term used to describe the process of extracting data. This process aims to provide a descriptive overview of the results that respond to the review's research question and meet the objectives of the scoping review. Furthermore, all essential data was retrieved individually by two reviewers using a charting table. The data includes authors, country, year of publication, the aim of the study, design, setting, sample size, sampling technique, and results (Table 3). The results were used as a guide for the existing scoping review, which was used to synthesize findings and identify knowledge gaps.

4.4. Organizing, summarizing, and writing the results

This stage was subdivided into the following steps: The first step is analysis, which includes descriptive numerical summary analysis, which describes the included study characteristics such as study design, countries, years of publication, and sample size; and thematic analysis. The second step is reporting the review results.

5. Quality appraisal of included articles

Two reviewers used the Newcastle-Ottawa quality assessment scale (NOS) to assess the quality of the included articles. The NOS was developed through collaboration between the Universities of Newcastle in Australia and Ottawa in Canada to evaluate the quality of observational studies *(Stang, 2010).* The NOS has various advantages, such as being a validated scale, and it demonstrated good adaptability to the research topic due to the flexibility of the scale's indexes. The NOS checklist had eight multiple-choice questions classified into selection, comparability, and outcome. The star system was implemented to provide a semi-quantitative assessment of the study quality. The maximum number of stars that can be assigned to a study for each numbered question in the selection and outcome categories is one, while the maximum number of stars that may be assigned for comparability is two. The ten included studies were assessed by using NOS checklist of cohort studies *(Dai et al., 2020; Kuderer et al., 2020; Bondeson et al., 2021; Calles et al., 2020; Jee et al., 2020; Rahman et al., 2021; Rüthrich et al., 2021; Zeng et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b).*

Eight studies were conducted among one group; they did not include the non-exposed cohort *(Bondeson et al., 2021; Calles et al., 2020; Jee et al., 2020; Zhang et al., 2020a; Kuderer et al., 2020; Zhang et al., 2020b; Rahman et al., 2021; Zeng et al., 2020).* Furthermore, one study *(Kuderer et al., 2020)* did not specify how COVID-19 exposure was determined. In addition, *Dai et al., 2020; Jee et al., 2020 Kuderer et al., 2020 and Rüthrich et al., 2021,* adjusted for age, sex, and other confounding factors. Moreover, *Bondeson et al., 2021,* and *Zhang et al., 2020b,* adjusted for age and sex. While *Calles et al., 2020*; *Zhang et al., 2020a; Rahman et al., 2021; and Zeng et al., 2020,* did not adjust the confounding factors. Furthermore, the adequacy of follow-up with participants was unclear in four studies *(Zhang et al., 2020b; Rahman et al., 2021; Rüthrich et al., 2021; and Zeng et al., 2020).*

The result of the quality appraisal of the included studies is divided into three levels of score according to the number of stars in the checklist: If the score was 7-9, it was considered high quality; between 4 and 6 was considered moderate quality; and 0-3 was considered low quality. The quality appraisal of the included studies in this review is summarized in Table 1. As a result, half of the included studies in this review received high-quality scores *(Bondeson et al., 2021; Dai et al., 2020; Jee et al., 2020; Kuderer et al., 2020; Rüthrich et al., 2021).* At the same time, five studies received moderate scores *(Calles et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b; Rahman et al., 2021; Zeng et al., 2020).*

Table (1): Quality appraisal of included studies.

Studies	S1	S2	S3	S4	C1	O1	O2	O3	Total Quality Score
Bondeson et al., 2021	1	0	1	1	1	1	1	1	7 (high quality)
Calles et al., 2020	1	0	1	1	0	1	1	1	6 (moderate quality)
Dai et al., 2020	1	1	1	1	2	1	1	1	9 (high quality)
Zhang et al., 2020a	1	0	1	1	0	1	1	1	6 (moderate quality)
Jee et al., 2020;	1	0	1	1	2	1	1	1	8 (high quality)
Kuderer et al., 2020	1	0	0	1	2	1	1	1	7 (high quality)
Zhang et al., 2020b	1	0	1	1	1	1	1	0	6 (moderate quality)
Rahman et al., 2021	1	0	1	1	0	1	1	0	5 (moderate quality)
Rüthrich et al., 2021	1	1	1	1	2	1	1	0	8 (high quality)
Zeng et al., 2020	1	0	1	1	0	1	1	0	5 (moderate quality)

"S1=Representativeness of the exposed cohort; S2=Selection of the non-exposed cohort; S3=Ascertainment of exposure; S4=Demonstration that outcome of interest was not present at start of study; C1= analysis controlled for confounders; O1=Assessment of outcome; O2=Was follow-up long enough for outcomes to occur; O3=Adequacy of follow-up of cohorts."

6. Finding and Results

Following an electronic search and screening for many articles related to the outcome of COVID-19 in patients with cancer, only ten relevant studies were included in this scoping review.

6.1. Characteristics of included studies

Regarding the international scope of included studies, four studies were generated from China, one from Spain, one from Germany, one from Sweden, one from the United States of America, one from Bangladesh, and there was one study conducted among three countries, namely the USA, Canada, and Spain. Moreover, all studies in the current review were published between 2020 and 2021. If we classified the studies by year of publication, in 2020 (n = 7; *Calles et al., 2020; Dai et al., 2020; Jee et al., 2020; Kuderer et al., 2020; Zeng et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b)* and 2021 (n = 3; *Bondeson et al., 2021; Rahman et al., 2021; Rüthrich et al., 2021).*

Concerning the designs of the included studies, one was a cohort study *(Dai et al., 2020);* one was a retrospective study *(Kuderer et al., 2020);* one was a prospective study *(Rahman et al., 2021);* and six was observational retrospective studies *(Bondeson et al., 2021; Calles et al., 2020; Jee et al., 2020; Rüthrich et al., 2021; Zeng et al., 2020; Zhang et al., 2020a)* and one was a retrospective cohort study *(Zhang et al., 2020b).* Furthermore, the sampling technique in eight out of ten studies was purposive sampling *(Bondeson et al., 2021; Calles et al., 2020; Jee et al., 2020; Kuderer et al., 2020; Rahman et al., 2021; Rüthrich et al., 2021; Zhang et al., 2020a; Zhang et al., 2020b).* Two studies did not clarify the sampling technique *(Dai et al., 2020; Zeng et al., 2020).*

The sample sizes in the included studies were ranged from 9 to 3071 patients who get infected with COVID-19; *Bondeson et al. (2021)* (n=107); *Calles et al. (2020)* (n=23); *Dai et al. (2020)* (n=641, 105 patients with cancer and 536 non cancer patients); *Jee et al. (2020)* (n= 309); *Kuderer et al. (2020)* (n= 928); *Rahman et al. (2021)* (n= 43); *Rüthrich et al. (2021)* (n= 3071; 435 patients with cancer and 2636 non cancer patients); *Zeng et al. (2020)* (n=9); *Zhang et al. (2020a)* (n=107); *Zhang et al. (2020b)* (n=28).

Regarding the setting of included studies, six of the included studies were multicenter studies that were conducted in multiple hospitals and centers *(Dai et al., 2020* (14 hospitals); *Zhang et al., 2020a* (5 hospitals); *Kuderer et al., 2020* (number of centers was not clear); *Rahman et al., 2021* (different cancer hospital); *Rüthrich et al., 2021* (number of centers was not clear); and *Zhang et al., 2020b)* (3 hospitals), and four studies were conducted in a single hospital or center; *Bondeson et al's study (2021)* was performed at Sahlgrenska University Hospital; *Calles et al. (2020)* was performed at Hospital General Universitario Gregorio Maranón; *Jee et al. (2020)* was performed at Memorial Sloan Kettering Cancer Center; and *Zeng et al. (2020)* was conducted at the First People's Hospital.

6.2. Thematic analysis

Thematic analysis was used to group the studies retrieved into three categories. The first theme is the COVID-19-associated complications in patients with cancer; the second theme is the COVID-19-associated severity in patients with cancer; and the third theme is the COVID-19-associated clinical outcomes among patients with cancer, which is further subdivided into seven subthemes: The COVID-19-associated level of activity, the COVID-19-associated rate of hospital admission, the COVID-19-associated length of hospitalization, the COVID-19-associated requirement for supplemental oxygen, the COVID-19-associated ICU admission, the COVID-19-associated need for mechanical ventilation, and the COVID-19-associated death.

Theme	Studied
The COVID-19-associated complications in patients with cancer	*Calles et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b*
The COVID-19-associated severity in patients with cancer	*Bondeson et al., 2021; Zhang et al., 2020a; Jee et al., 2020; Rahman et al., 2021*
The COVID-19-associated clinical outcomes among patients with cancer	*Dai et al., 2020; Kuderer et al., 2020; Bondeson et al., 2021; Calles et al., 2020; Jee et al., 2020; Rahman et al., 2021; Rüthrich et al., 2021; Zeng et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b*

Theme 1: The COVID-19-associated complications in patients with cancer

The most reported complications of COVID-19 in patients with cancer were ARDS, heart failure, acute renal injury, and septic shock. According to *Calles et al. (2020)* risk of complication of COVID-19 increase among patients with lung cancer. Three studies out of ten mentioned the complications of COVID-19 on patients with cancer *(Calles et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b)*

The first study was conducted by *Calles et al. (2020),* who reported that only two complications of COVID-19 among patients with lung cancer were ARDS and organ failure, which both occurred in 39% of patients with lung cancer. Additionally, in *Calles et al. (2020)* study, the researchers calculated the median time from the onset of COVID-19 symptoms to the initiation of ARDS, which was six days. The second study, carried out by *Zhang et al. (2020a),* identified COVID-19 complications in patients with cancer as ARDS (19.6%), heart failure (12.1%), and acute renal injury (2.8%). The third study was performed by *Zhang et al. (2020b),* who reported four COVID-19 complications in patients with cancer, including ARDS (28.6%), pulmonary embolism (7.1%), septic shock (3.6%), and acute myocardial infarction (3.6%).

Theme 2: The COVID-19-associated severity in patients with cancer

According to *Dai et al. (2020),* patients with cancer have many factors, such as age, type of tumor, stage of cancer, and cancer treatment, which may contribute to the severity of COVID-19. Four out of ten included studies explored COVID-19-associated severity in patients with cancer. The included studies showed significant variations in the COVID-19 disease severity levels *(Bondeson et al., 2021; Zhang et al., 2020a; Jee et al., 2020; Rahman et al., 2021)*

The first study was conducted by *Bondeson et al. (2021),* who classified the severity of COVID-19 as follows: Mild if the patient did not need to be admitted to the hospital or if the admission was for observation only and no therapeutic interventions; moderate if the patient required to be admitted to the hospital along with treatment for COVID-19 symptoms; and severe if the patient needed to be admitted to an intensive care unit. *Bondeson et al. (2021)* found that 64% of patients with cancer had mild severity of COVID-19, 32% of them had moderate severity, and 4.7% had severe COVID-19 illness. The second study was conducted by *Zhang et al. (2020a),* who found two levels of COVID-19 severity: mild and severe. Patients were considered to have severe COVID-19 if they presented any of the following clinical manifestations: Tachypnea, oxygen saturation less than 93% at room air, arterial partial pressure of oxygen (PaO_2) per fraction of inspired oxygen (FiO_2) less than 300 mm Hg, respiratory failure requiring MV, septic shock, and multiorgan failure requiring care in the ICU. Furthermore, the severity of COVID-19 among patients with cancer was mild in 47.7% of participants and severe in 52.3% of participants.

The third study was conducted by *Jee et al. (2020),* who mentioned that there were two categories of COVID-19 severity: mild and severe; patients were considered to have severe COVID-19 if they manifested one or more of the following criteria: Hypoxemia, tachypnea, respiratory failure, admission to the ICU for intubation, or death. In *Jee et al. (2020),* the severity of COVID-19 was correlated with patient characteristics. *Jee et al. (2020)* reported that severe COVID-19 was not significantly associated with the use of chemotherapy, increased COVID-19 severity was correlated with hematologic malignancy, patients with lung cancer also reported higher incidences of severe or critical COVID-19 events, and higher incidences of severe or critical disease were associated to lymphopenia at the time of COVID-19 diagnosis.

The fourth study was conducted by *Rahman et al. (2021);* the severity of COVID-19 was categorized as follows: Asymptomatic, mild, moderate, severe, and critical. *Rahman et al. (2021)* added that the severity of COVID-19 among patients with cancer was 23.3% of participants were asymptomatic, 23.3% mild, 23.3% moderate, 27.9% had severe COVID-19 and 2.3% of participants were critical.

Theme 3: The COVID-19-associated clinical outcomes among patients with cancer

Clinical outcomes of COVID-19 in cancer patients include level of activity, rate of hospital admission, length of hospitalization, the requirement for supplemental oxygen, ICU admission, need for mechanical ventilation, and death. Seven subthemes were identified related to the impact of cancer on COVID-19-associated clinical outcomes.

Subtheme 3.1: The COVID-19-associated level of activity among patients with cancer

The level of activity in patients with cancer during the COVID-19 infection was measured in four out of ten included studies *(Bondeson et al., 2021; Calles et al., 2020; Kuderer et al., 2020; Rüthrich et al., 2021).* These studies utilized the Eastern Cooperative Oncology Group (ECOG) scale to measure activity levels, a well-established tool categorizing patients into four performance status levels. ECOG zero scores indicate that patients can continue their pre-disease activities without restrictions. ECOG scores of one signify restrictions in strenuous physical activity but the ability to engage in light or sedentary work. ECOG scores of two indicate ambulatory capability with limitations on work activities, and ECOG scores of three denote limited self-care ability.

The study by *Bondeson et al. (2021)* found that 14% of patients had an ECOG score of zero, 20% scored one to two, and 6.5% had scores greater than two, which is associated with an increased mortality risk. Similarly, *Calles et al. (2020)* reported that 43% of patients had an ECOG score of zero, 35% scored one, and 22% scored two. Higher ECOG scores (greater than one) were statistically correlated with an increased mortality risk in *Calles et al. (2020)* study. *Kuderer et al. (2020)* observed that 66% of patients had ECOG scores of zero or one, 8% scored two, and 5% scored three or four, with patients having an ECOG performance status of two or higher and active cancer found to be at a greater risk for worse COVID-19 outcomes. Finally, *Rüthrich et al. (2021)* reported that 23.5% of patients had an ECOG score greater than two. These studies collectively highlight the importance of ECOG scores in assessing patient outcomes, with higher scores consistently associated with increased mortality risk and worse COVID-19 outcomes.

Subtheme 3.2: The COVID-19-associated rate of hospital admission among patients with cancer

Four out of ten included studies have been conducted on this subtheme: *Bondeson et al. (2021), Calles et al. (2020), Jee et al. (2020), and Kuderer et al. (2020).* There have been contrasting results in the included studies. *Bondeson et al. (2021)* found that the hospital admission rate among patients with cancer with a COVID-19 infection was 36%. However, *Jee et al. (2020)* and *Kuderer et al. (2020)* reported that 47.6% and 50% of patients with cancer were admitted to the hospital when they got infected with COVID-19, respectively. Meanwhile, *Calles et al.'s (2020)* study showed the highest rate of hospital admission among the included

studies, which was 74% of patients with lung cancer admitted to the hospital.

As reported by *Bondeson et al. (2021)* and *Kuderer et al. (2020),* there are factors affecting the rate of hospital admission among patients with cancer, which include the type of tumor, another comorbidity, the type of cancer treatment, and the variation in geographical region. Moreover, *Bondeson et al. (2021)* found a higher need for hospital admission among patients with lung cancer (54%), patients with rare types of tumors (46%), patients with at least one comorbidity (50%), and patients undergoing chemotherapy (39%). Additionally, *Kuderer et al.'s (2020)* study's findings were as follows: Hospital admission was higher among patients under active anticancer treatment (38%); in the US-West region, the rate of hospital admission was 32%, while in Canada, it was 69%.

Subtheme 3.3: The COVID-19-associated length of hospitalization among patients with cancer

The length of hospitalization among patients with cancer during COVID-19 infection was measured in two out of ten included studies (*Zhang et al., 2020b; Zeng et al., 2020).* The results of *Zhang et al.'s (2020b)* study illustrated that 35.7% of patients had been discharged after an average hospital stay of 13.5 days. However, *Zeng et al. (2020)* reported that the length of hospitalization among patients with cancer during the COVID-19 infection was 26 days.

Subtheme 3.4: The COVID-19-associated requirement for supplemental oxygen among patients with cancer

Three out of ten included studies explored the COVID-19-associated requirement for supplemental oxygen among patients with cancer *(Calles et al., 2020; Zhang et al., 2020a; Zhang et al., 2020b).* According to *Zhang et al. (2020b)* and *Zhang et al. (2020a),* 78.6% and 85% of patients with cancer required oxygen supplementation, respectively. *Calles et al.'s (2020)* study illustrated that the maximum oxygen requirement for patients with cancer was as follows: 26% on room air, 35% on low flow, 30% on Ventimask, and 30% on high flow.

Subtheme 3.5: The COVID-19-associated ICU admission among patients with cancer

Six out of ten included studies explored COVID-19-associated ICU admission among patients with cancer *(Calles et al., 2020; Dai et al., 2020; Kuderer et al., 2020; Rüthrich et al., 2021; Zhang et al., 2020b; Zeng et al., 2020).* The included studies have had conflicting results regarding the ICU admission rate. As reported by *Calles et al. (2020),* 4% of patients with cancer were admitted to the ICU during the COVID-19 infection. At the same time, *Kuderer et al. (2020)* reported that the ICU admission rate among cancer patients was 14%. However, *Dai et al. (2020), Zhang et al. (2020b),* and *Rüthrich et al. (2021)* reported that 19.05%, 21%, and 27% of patients were admitted to the ICU during the COVID-19 infection, respectively.

Meanwhile, *Zeng et al. (2020)* reported the highest ICU admissions, which was 44% of patients with cancer. In addition, *Kuderer et al. (2020)* reported that the rate of ICU admission was high in patients with comorbidities (21%), former smokers (20%), and hematological cancer (22%). Moreover, *Rüthrich et al. (2021)* found that the length of stay in the ICU was 11 days.

Subtheme 3.6: The COVID-19-associated need for mechanical ventilation among patients with cancer

The COVID-19-associated need for mechanical ventilation among patients with cancer was explored by five out of ten included studies *(Calles et al., 2020; Dai et al., 2020; Rüthrich et al., 2021; Zhang et al., 2020a; Zhang et al., 2020b).* The rate of need for mechanical ventilation among patients with cancer varied among the included studies. According to *Calles et al. (2020), Dai et al. (2020),* and *Zhang et al. (2020a),* the rate of need for mechanical ventilation among patients with cancer was 4%, 9.52 %, and 16.8%, respectively. While *Rüthrich et al. (2021)* found that 65.5% of patients with cancer admitted to the ICU were on MV. However, as reported by *Zhang et al. (2020b),* 35.7% of patients with cancer were placed on invasive mechanical ventilation (IMV).

Subtheme 3.7: The COVID-19-associated deaths among patients with cancer

The COVID-19-associated deaths among patients with cancer mentioned by five out of ten included studies *(Calles et al., 2020; Dai et al., 2020; Zhang et al., 2020a; Jee et al., 2020; Rahman et al., 2021; Zhang et al., 2020b).* The death rate varied among the included studies: *Jee et al. (2020), Dai et al. (2020), Rahman et al. (2021), Zhang et al. (2020a), Zhang et al. (2020b),* and *Calles et al. (2020)* found that 10%, 11.43%, 19%, 21.5%, 28.6%, and 35% of patients with cancer died when they got infected with COVID-19, respectively.

7. Discussion

The current scoping review contributes to the existing body of knowledge regarding the impact of COVID-19 infection on the outcomes of patients with cancer and supports the results of earlier research. The current scoping review aimed to summarize the impact of COVID-19 infection on the outcomes of patients with cancer. Patients with cancer are more vulnerable to getting infected with COVID-19 than people without cancer due to their general poor health, underlying chronic disease, and systemic immunosuppressive conditions caused by cancer and anticancer therapies *(Rahman et al., 2021).*

Regarding COVID-19 complications, *Dai et al. (2020)* reported that patients with a history of or active malignancies may be more vulnerable to experiencing complications from COVID-19. Moreover, as reported by *Kuderer et al. (2020),* the overall rate of COVID-19 complications was high among patients with cancer. In addition, *Zhang et al. (2020b)* found that ARDS, pulmonary embolism, heart failure, acute myocardial infarction, septic shock, and acute renal injury were the most common COVID-19 complications in patients with cancer.

Concerning the frequency of COVID-19 complications, *Calles et al. (2020)* stated that over two-thirds of patients with cancer who get infected with COVID-19 develop ARDS and organ failure. Moreover, *Zhang et al. (2020b)* reported that more than a quarter of patients with cancer developed ARDS, less than one-tenth contracted pulmonary embolism, and a low proportion experienced septic shock and acute myocardial infarction. This result contrasts with *Zhang et al. (2020a),* who found that less than a quarter of patients with cancer developed ARDS, around a tenth developed heart failure, and a few percent developed acute renal injury. The current scoping review found that ARDS was the most frequent complication of COVID-19 among patients with cancer. This result is consistent with *Wu et al. (2020),* who found that around half of patients with COVID-19 developed ARDS.

Concerning the severity of COVID-19 in patients with cancer, patients with cancer are more likely to have illnesses that are much more severe than those in other populations *(Dai et al., 2020).* In this respect, *Zeng et al. (2020)* found that more than three-quarters of patients with cancer who got infected with COVID-19 had a severe form of COVID-19 illness. However, *Dai et al. (2020)* found that around half of patients with cancer had severe COVID-19. *Bondeson et al.'s (2021)* findings contradict those of *Zeng et al. (2020)* and *Dai et al. (2020),* who found that less than a tenth of patients with cancer had a severe COVID-19 illness. Furthermore, *Bondeson et al. (2021)* reported that there were most deaths in the moderate severity category, and no patients in the severe category passed away within 30 days. The current scoping review found that there was a variation in COVID-19 severity among patients with cancer, which might be attributed to some risk factors, such as patients' age, gender, tumor type, cancer stage, health care provided, and type of cancer treatment. This result is supported by *Liu et al. (2020)* and *Guan et al. (2020).*

Regarding the clinical outcomes of COVID-19 in patients with cancer, *Dai et al. (2020)* stated that the clinical outcomes of COVID-19 in patients with cancer included level of activity, hospital admission rate, length of hospitalization, the requirement for supplemental oxygen, admission to the ICU, demand for a mechanical ventilator, and death, which were often more severe than those in healthy or noncancer patients.

Concerning the level of activity, ECOG performance scores have emerged as valuable tools for assessing patients' levels of activity in various medical contexts. *Bondeson et al.'s (2021)* study revealed that higher ECOG scores, particularly scores greater than two, was associated with an increased mortality risk. This result is consistent with *Ozer et al. (2021),* who found that patients who died due to COVID-19 had a worse ECOG score. This score emphasizes the importance of considering patients' physical well-being when making prognostic assessments in cancer care. Similarly, *Calles et al. (2020)* established a statistically significant correlation between ECOG scores greater than one and elevated mortality risk, affirming the predictive value of ECOG scores in assessing patient outcomes.

Moreover, *Kuderer et al. (2020)* found that patients with ECOG performance scores of two or higher, combined with active cancer, faced a heightened risk of worse COVID-19 outcomes. This outcome indicates that ECOG scores can serve as valuable indicators for assessing cancer patients' vulnerability to infectious diseases, such as COVID-19. *Rüthrich et al. (2021)* also highlighted that many patients had ECOG scores greater than two, indicating decreased activity. This observation underscores the prevalence of functional impairment among patients with cancer, necessitating targeted interventions and supportive care.

The hospitalization rate among patients with cancer due to the COVID-19 illness is significantly high, ranging from nearly half to approximately three-quarters. The high hospitalization rate might be attributed to several factors, such as COVID-19 severity, hospital bed availability, and cancer type. This result is consistent with a previous study by *Garassino et al. (2020),* who found that more than three-quarters of patients with cancer were hospitalized due to the COVID-19 infection.

In the included studies, the length of hospitalization for patients with cancer with COVID-19 illness ranged from 13.5 to 26 days. Furthermore, the current scoping review found that the average length of hospitalization related to COVID-19 among patients with cancer was 19 days, with variations across different geographical regions. These variations may be attributed to differences in healthcare facilities and COVID-19 severity among countries. This result aligns with the findings of *Alimohamadi et al. (2022),* who reported a hospitalization length of 15.35 days, and *Namayandeh et al. (2023),* who reported a length of 21 days.

The current scoping found that the need for supplemental oxygen due to COVID-19 was high among patients with cancer. This result is consistent with the findings of *Chen et al. (2020), Wang et al. (2020),* and *Wu et al. (2020),* who reported that more than three-quarters of patients required oxygen supplementation due to COVID-19 infection. The high requirements of supplements due to COVID-19 among patients with cancer can be attributed to their weakened immune systems, underlying medical conditions like COPD or heart disease, and the potential lung damage due to cancer treatments, which renders them more vulnerable to severe COVID-19 infections and respiratory complications.

The proportion of ICU admissions for patients with cancer due to COVID-19 illness varied across articles and countries, ranging from less than one-tenth to less than half. This finding is consistent with the results of *Alharbi et al. (2021),* who reported differences in the proportion of ICU admissions across various regions in Saudi Arabia. Several factors can explain this variation, including COVID-19 severity, cancer type, overall patient health, ICU bed availability, and admission criteria.

The mechanical ventilation requirements for patients with cancer due to COVID-19 varied widely across articles and countries, ranging from less than one-tenth to approximately two-thirds. This variation is supported by *Wunsch (2020),* who reported global differences in the rates of invasive mechanical ventilation during the COVID-19

pandemic. This variation can be attributed to multiple risk factors, including COVID-19 severity, cancer type, ventilator availability, and criteria for initiating mechanical ventilation.

The current scoping review found that the case fatality rate (CFR) due to COVID-19 among patients with cancer varied from more than a tenth to more than one-third. This result is consistent with *Provencio et al. (2021)* and *da Silva et al. (2021),* who found that the mortality rate among patients with cancer due to COVID-19 varies across studies. The variation in COVID-19 mortality among patients with cancer is attributed to several factors, such as differences in geographical regions, patient age, cancer type, and the presence of comorbidities. As reported by *Lee et al. (2020)* and *Aries et al. (2020),* high mortality in patients due to COVID-19 infection is associated with advanced age and the presence of more than one comorbidity.

8. Conclusion

This scoping review summarized the outcomes of COVID-19 for patients with cancer. It can be concluded that patients with cancer are a high-risk group for COVID-19 infection, and they are more prone to having the severe form of COVID-19 infection. Moreover, ARDS is the most frequent complication of COVID-19 among patients with cancer. In addition, the significance of performance scores in determining a patient's prognosis is further emphasized by the study. Additionally, it reveals high hospitalization rates, prolonged hospitalizations, and a high need for supplemental oxygen. The review suggests the need for personalized approaches to managing COVID-19 for cancer patients, considering the varying proportions of ICU admissions and mechanical ventilation requirements. Finally, the case fatality rate findings reflect the complexity of factors affecting mortality in these patients.

9. Recommendation

Hospitals, nursing administrations, and oncology nurses should be aware of the need to execute accurate primary prevention precautions to protect patients with cancer from virus exposure. Furthermore, they should develop and establish a strategy to avoid and manage severe COVID-19 illness in patients with cancer. In addition, it is critical for future nursing research to consider the effects of COVID-19 on patients with cancer undergoing chemotherapy, and it is recommended to conduct comparison studies between cancer and noncancer populations to identify differences in COVID-19 outcomes. Moreover, a longer period of follow-up research is necessary to gain a better understanding of the impact of COVID-19 on cancer-related outcomes.

10. Reference

Alharbi, A. A., Alqassim, A. Y., Gosadi, I. M., Aqeeli, A. A., Muaddi, M. A., Makeen, A. M., Alhazmi, A. H., & Alharbi, A. A. (2021). Regional differences in COVID-19 ICU admission rates in the Kingdom of Saudi Arabia: A simulation of the new model of care under Vision 2030. *Journal of Infection and Public Health, 14*(6), 717–723. https://doi.org/10.1016/j.jiph.2021.04.012.

Alimohamadi, Y., Yekta, E. M., Sepandi, M., Sharafoddin, M., Arshadi, M., & Hesari, E. (2022). Hospital length of stay for COVID-19 patients: A systematic review and meta-analysis. *Multidisciplinary Respiratory Medicine*, *17*(1), 856. https://doi.org/10.4081/mrm.2022.856.

Anderson, S., Allen, P., Peckham, S., & Goodwin, N. (2008). Asking the right questions: Scoping studies in the commissioning of research on the organization and delivery of health services. *Health Research Policy and Systems*, *6*(1), 7. https://doi.org/10.1186/1478-4505-6-7.

Aries, J. A., Davies, J. K., Auer, R. L., Hallam, S. L., Montoto, S., Smith, M., Sevillano, B., Foggo, V., Wrench, B., Zegocki, K., Agrawal, S., Le Dieu, R., Truelove, E., Erblich, T., Araf, S., Okosun, J., Oakervee, H., Cavenagh, J. D., Gribben, J. G., & Riches, J. C. (2020). Clinical outcome of coronavirus disease 2019 in haemato-oncology patients. *British Journal of Haematology*, *190*(2), e64–e67. https://doi.org/10.1111/bjh.16852.

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616.

Bondeson, L., Thulin, A., Ny, L., Levin, M., Svensson, J., Lindh, M., & Zhao, Z. (2021). Clinical outcomes in cancer patients with COVID-19 in Sweden. *Acta Oncologica* (Stockholm, Sweden), *60*(12), 1572–1579. https://doi.org/10.1080/0284186X.2021.1973679.

Brien, S. E., Lorenzetti, D. L., Lewis, S., Kennedy, J., & Ghali, W. A. (2010). Overview of a formal scoping review on health system report cards. *Implementation Science: IS*, *5*(1), 2. https://doi.org/10.1186/1748-5908-5-2.

Calles, A., Aparicio, M. I., Alva, M., Bringas, M., Gutierrez, N., Soto, J., Arregui, M., Tirado, V. C., Álvarez, E. L., Del Monte-Millán, M., Massarrah, T., Galera, M., Álvarez, R., & Martín, M. (2020). Outcomes of COVID-19 in patients with lung cancer treated in a tertiary hospital in Madrid. *Frontiers in Oncology*, *10*, 1777. https://doi.org/10.3389/fonc.2020.01777.

Chen, N., Zhou, M., Dong, X., Qu, J., Gong, F., Han, Y., Qiu, Y., Wang, J., Liu, Y., Wei, Y., Xia, J., Yu, T., Zhang, X., & Zhang, L. (2020). Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *Lancet (London, England)*, *395*(10223), 507–513. https://doi.org/10.1016/S0140-6736(20)30211–7.

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., … Cai, H. (2020). Patients with cancer appear more vulnerable to SARS-CoV-2: A multicenter study during the COVID-19 outbreak. *Cancer Discovery*, *10*(6), 783–791. https://doi.org/10.1158/2159-8290.CD-20-0422.

Daudt, H. M. L., van Mossel, C., & Scott, S. J. (2013). Enhancing the scoping study methodology: A large, inter-professional team's experience with Arksey and O'Malley's

framework. *BMC Medical Research Methodology*, *13*(1), 48. https://doi.org/10.1186/1471-2288-13-48.

Davis, K., Drey, N., & Gould, D. (2009). What are scoping studies? A review of the nursing literature. *International Journal of Nursing Studies*, *46*(10), 1386–1400. https://doi.org/10.1016/j.ijnurstu.2009.02.010.

Espinosa, O. A., Zanetti, A. D. S., Antunes, E. F., Longhi, F. G., Matos, T. A., & Battaglini, P. F. (2020). Prevalence of comorbidities in patients and mortality cases affected by SARS-CoV2: A systematic review and meta-analysis. *Rev Inst Med Trop Sao Paulo*, *62*, e43. https://doi.org/10.1590/S1678-9946202062043.

Fratino, L., Procopio, G., Di Maio, M., Cinieri, S., Leo, S., & Beretta, G. (2020). Coronavirus: Older persons with cancer in Italy in the COVID-19 pandemic. Frontiers in Oncology, *10*, 648. https://doi.org/10.3389/fonc.2020.00648.

Garassino, M. C., Whisenant, J. G., Huang, L.-C., Trama, A., Torri, V., Agustoni, F., Baena, J., Banna, G., Berardi, R., Bettini, A. C., Bria, E., Brighenti, M., Cadranel, J., De Toma, A., Chini, C., Cortellini, A., Felip, E., Finocchiaro, G., Garrido, P., … TERAVOLT investigators. (2020). COVID-19 in patients with thoracic malignancies (TERAVOLT): First results of an international, registry-based, cohort study. *The Lancet Oncology*, *21*(7), 914–922. https://doi.org/10.1016/S1470-2045(20)30314-4.

Guan, W.-J., Ni, Z.-Y., Hu, Y., Liang, W.-H., Ou, C.-Q., He, J.-X., Liu, L., Shan, H., Lei, C.-L., Hui, D. S. C., Du, B., Li, L.-J., Zeng, G., Yuen, K.-Y., Chen, R.-C., Tang, C.-L., Wang, T., Chen, P.-Y., Xiang, J., … China Medical Treatment Expert Group for Covid-19 (2020). Clinical characteristics of 2019 novel coronavirus infection in China. *The New England Journal of Medicine*, *382*(18), 1708–1720. https://doi.org/10.1056/NEJMoa2002032.

Jazieh, A.-R., Alenazi, T. H., Alhejazi, A., Al Safi, F., & Al Olayan, A. (2020). Outcome of oncology patients infected with Coronavirus. *JCO Global Oncology*, *6*(6), 471–475. https://doi.org/10.1200/GO.20.00064.

Jee, J., Foote, M. B., Lumish, M., Stonestrom, A. J., Wills, B., Narendra, V., Avutu, V., Murciano-Goroff, Y. R., Chan, J. E., Derkach, A., Philip, J., Belenkaya, R., Kerpelev, M., Maloy, M., Watson, A., Fong, C., Janjigian, Y., Diaz, L. A., Bolton, K. L., & Pessin, M. S. (2020). Chemotherapy and COVID-19 outcomes in patients with cancer. *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, *38*(30), 3538–3546. https://doi.org/10.1200/JCO.20.01307.

Kuderer, N. M., Choueiri, T. K., Shah, D. P., Shyr, Y., Rubinstein, S. M., Rivera, D. R., Shete, S., Hsu, C.-Y., Desai, A., de Lima Lopes, G., Jr, Grivas, P., Painter, C. A., Peters, S., Thompson, M. A., Bakouny, Z., Batist, G., Bekaii-Saab, T., Bilen, M. A., Bouganim, N., … COVID-19 and Cancer Consortium. (2020). Clinical impact of COVID-19 on patients with cancer (CCC19): A cohort study. *Lancet*, *395*(10241), 1907–1918. https://doi.org/10.1016/S0140-6736(20)31187–9.

Lee, L. Y., Cazier, J.-B., Angelis, V., Arnold, R., Bisht, V., Campton, N. A., Chackathayil, J., Cheng, V. W., Curley, H. M., Fittall, M. W., Freeman-Mills, L., Gennatas, S., Goel, A., Hartley, S., Hughes, D. J., Kerr, D., Lee, A. J., Lee, R. J., McGrath, S. E., … Middleton, G. (2020). COVID-19 mortality in patients with cancer on chemotherapy or other anticancer treatments: A prospective cohort study. *Lancet*, *395*(10241), 1919–1926. https://doi.org/10.1016/S0140-6736(20)31173–9.

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science: IS*, *5*(1), 69. https://doi.org/10.1186/1748-5908-5-69.

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. *The Lancet Oncology*, *21*(3), 335–337. https://doi.org/10.1016/S1470-2045(20)30096-6.

Liu, J., Liu, Y., Xiang, P., Pu, L., Xiong, H., Li, C., Zhang, M., Tan, J., Xu, Y., Song, R., Song, M., Wang, L., Zhang, W., Han, B., Yang, L., Wang, X., Zhou, G., Zhang, T., Li, B., … Wang, X. (2020). Neutrophil-to-lymphocyte ratio predicts critical illness patients with 2019 coronavirus disease in the early stage. *Journal of Translational Medicine*, *18*(1), 206. https://doi.org/10.1186/s12967-020-02374-0.

Ma, J., Yin, J., Qian, Y., & Wu, Y. (2020). Clinical characteristics and prognosis in cancer patients with COVID-19: A single center's retrospective study. *The Journal of Infection*, *81*(2), 318–356. https://doi.org/10.1016/j.jinf.2020.04.006.

Marago, I., & Minen, I. (2020). Hospital-acquired COVID-19 infection – the magnitude of the problem. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3622387.

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. *Annals of Oncology: Official Journal of the European Society for Medical Oncology*, *31*(8), 1088–1089. https://doi.org/10.1016/j.annonc.2020.04.006.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., & PRISMA-P Group. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews*, *4*(1), 1. https://doi.org/10.1186/2046-4053-4-1.

Namayandeh, S. M., Dehghan, H., Lotfi, M. H., Khajehaminian, M. R., Hosseini, S., Bahrevar, V., Jarrahi, A., & Majidpour, F. (2023). Clinical courses of 24,563 hospitalized COVID-19 patients during the first 12 months of the pandemic in the Central City of Iran. *Scientific Reports*, *13*(1), 6521. https://doi.org/10.1038/s41598-023-32292-2.

Ozer, M., Goksu, S. Y., Mahdi, M., & Gandhi, N. (2021). Characteristics and outcomes of cancer patients with COVID-19 at a safety-net hospital. *Cancer Treatment and*

Research Communications, *28*(100418), 100418. https://doi.org/10.1016/j.ctarc.2021.100418.

Provencio, M., Mazarico Gallego, J. M., Calles, A., Antoñanzas, M., Pangua, C., Mielgo Rubio, X., Nadal, E., Castro, R. L., López-Martín, A., Del Barco, E., Dómine, M., Franco, F., Diz, P., Sandoval, C., Girona, E. S., Sullivan, I., Sala, M. Á., Ledo, G. G., Cucurull, M., … Cao, M. G. (2021). Lung cancer patients with COVID-19 in Spain: GRAVID study. *Lung Cancer (Amsterdam, Netherlands)*, *157*, 109–115. https://doi.org/10.1016/j.lungcan.2021.05.014.

Rahman, S., Bahar, T., Wazib, A., Chowdhury, Z. Z., Hossain, M. M., Anne, R. T., & Begum, S. A. (2021). Clinical presentation and outcome of COVID-19 infected cancer patients: A prospective study. *Bangladesh Journal of Medicine*, *32*(2), 90–94. https://doi.org/10.3329/bjm.v32i2.53794.

Rüthrich, M. M., Giessen-Jung, C., Borgmann, S., Classen, A. Y., Dolff, S., Grüner, B., Hanses, F., Isberner, N., Köhler, P., Lanznaster, J., Merle, U., Nadalin, S., Piepel, C., Schneider, J., Schons, M., Strauss, R., Tometten, L., Vehreschild, J. J., von Lilienfeld-Toal, M., … LEOSS Study Group. (2021). COVID-19 in cancer patients: Clinical characteristics and outcome-an analysis of the LEOSS registry. *Annals of Hematology*, *100*(2), 383–393. https://doi.org/10.1007/s00277-020-04328-4.

Santos Thuler, L. C., & De Melo, A. C. (2020). A SARS-CoV-2/COVID-19 em pacientes com câncer. *Revista Brasileira de Cancerologia*, *66*(2). https://doi.org/10.32635/2176-9745.rbc.2020v66n2.970.

da Silva, T. T. M. da, de Araújo, N. M., Sarmento, S. D. G., de Castro, G. L. T., Dantas, D. V., & Dantas, R. A. N. (2021). Impact of COVID-19 in patients with cancer: A scoping review. *Texto & Contexto Enfermagem*, *30*. https://doi.org/10.1590/1980-265x-tce-2020-0415.

Stang, A. (2010). Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *European Journal of Epidemiology*, *25*(9), 603–605. https://doi.org/10.1007/s10654-010-9491-z.

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, *71*(3), 209–249. https://doi.org/10.3322/caac.21660

Wang, D., Hu, B., Hu, C., Zhu, F., Liu, X., Zhang, J., Wang, B., Xiang, H., Cheng, Z., Xiong, Y., Zhao, Y., Li, Y., Wang, X., & Peng, Z. (2020). Clinical characteristics of 138 hospitalized patients with 2019 novel Coronavirus-infected pneumonia in Wuhan, China. *JAMA: The Journal of the American Medical Association*, *323*(11), 1061–1069. https://doi.org/10.1001/jama.2020.1585.

World Health Organization (WHO). (2022). Who. Int. Retrieved April 25, 2022, from https://covid19.who.int

Wu, C., Chen, X., Cai, Y., Xia, J., Zhou, X., Xu, S., Huang, H., Zhang, L., Zhou, X., Du, C., Zhang, Y., Song, J., Wang, S., Chao, Y., Yang, Z., Xu, J., Zhou, X., Chen, D., Xiong, W., … Song, Y. (2020). Risk factors associated with acute respiratory distress syndrome and death in patients with Coronavirus disease 2019 pneumonia in Wuhan, China. *JAMA Internal Medicine*, *180*(7), 934–943. https://doi.org/10.1001/jamainternmed.2020.0994.

Wu, Z., & McGoogan, J. M. (2020). Characteristics of and important lessons from the Coronavirus disease 2019 (COVID-19) outbreak in China: Summary of a report of 72,314 cases from the Chinese Center for Disease Control and Prevention. *JAMA: The Journal of the American Medical Association*, *323*(13), 1239–1242. https://doi.org/10.1001/jama.2020.2648.

Wunsch, H. (2020). Mechanical ventilation in COVID-19: Interpreting the current epidemiology. *American Journal of Respiratory and Critical Care Medicine*, *202*(1), 1–4. https://doi.org/10.1164/rccm.202004-1385ED.

Zeng, Y., Zhang, B., Zhang, X., & Yi, C. (2020). Clinical characteristics of 9 cancer patients with SARS-CoV-2 infection. *Chinese Medicine*, *15*(1), 47. https://doi.org/10.1186/s13020-020-00328-8.

Zhang, H., Wang, L., Chen, Y., Wu, Q., Chen, G., Shen, X., Wang, Q., Yan, Y., Yu, Y., Zhong, Y., Wang, X., Chua, M. L. K., & Xie, C. (2020a). Outcomes of novel coronavirus disease 2019 (COVID-19) infection in 107 patients with cancer from Wuhan, China. *Cancer*, *126*(17), 4023–4031. https://doi.org/10.1002/cncr.33042.

Zhang, L., Zhu, F., Xie, L., Wang, C., Wang, J., Chen, R., Jia, P., Guan, H. Q., Peng, L., Chen, Y., Peng, P., Zhang, P., Chu, Q., Shen, Q., Wang, Y., Xu, S. Y., Zhao, J. P., & Zhou, M. (2020b). Clinical characteristics of COVID-19-infected cancer patients: A retrospective case study in three hospitals within Wuhan, China. *Annals of Oncology*, *31*(7), 894–901. https://doi.org/10.1016/j.annonc.2020.03.296.

Zhao, Y.-M., Shang, Y.-M., Song, W.-B., Li, Q.-Q., Xie, H., Xu, Q.-F., Jia, J.-L., Li, L.-M., Mao, H.-L., Zhou, X.-M., Luo, H., Gao, Y.-F., & Xu, A.-G. (2020). Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery. *EClinicalMedicine*, *25*(100463), 100463. https://doi.org/10.1016/j.eclinm.2020.100463.

Zong, Z., Wei, Y., Ren, J., Zhang, L., & Zhou, F. (2021). The intersection of COVID-19 and cancer: Signaling pathways and treatment implications. *Molecular Cancer*, *20*(1), 76. https://doi.org/10.1186/s12943-021-01363-1.

Table (3): Review Matrix Table

Author	Country	Aim	Design/setting	Samples size/sampling technique	Results
Bondeson et al. (2021)	Sweden	To examine the incidence of COVID-19 among patients and to evaluate and identify risk factors for poor outcomes, hospital care, and death associated with COVID-19 among cancer patients	Retrospective study /Sahlgrenska University Hospital	107 patients with cancer /purposive sampling	- 64% of patients with cancer had mild severity of COVID-19, 32% of them had moderate severity, and 4.7% had severe COVID-19 illness. - It was found that 14% of patients had an ECOG score of zero, 20% scored one to two, and 6.5% had scores greater than two, associated with an increased mortality risk. - The hospital admission rate among patients with cancer with a COVID-19 infection was 36%. - It was found a higher need for hospital admission among patients with lung cancer (54%), patients with rare types of tumors (46%), patients with at least one comorbidity (50%), and patients undergoing chemotherapy (39%).
Calles et al. (2020)	Spain	To analyze the outcomes of COVID-19-affected lung cancer patients in a tertiary hospital in a high-incidence region during the pandemic	Observational, retrospective, single-center study /Hospital General Universitario Gregorio Marañón	23 patients with lung cancer /purposive sampling	- Hospitalization rate was 74%, - ARDS and organ failure both occurred in 39% of patients with lung cancer. - 43% of patients had an ECOG score of zero, 35% scored one, and 22% scored two. Higher ECOG scores (greater than one) were statistically correlated with an increased mortality risk. - 74% of patients with lung cancer are admitted to the hospital. - The maximum oxygen requirement for patients with cancer was as follows: 26% on room air, 35% on low flow, 30% on Ventimask, and 30% on high flow. - 4% of patients with cancer were admitted to the ICU during the COVID-19 infection. - The rate of need for mechanical ventilation among patients with cancer was 4%. - 35% of patients with cancer died when they got infected with COVID-19.
Dai et al. (2020)	China	To conduct a systematic analysis of diverse cohorts of COVID-19-positive cancer patients	Cohort study/ 14 hospitals in Hubei Province, China	641 patients (105 patients with cancer and 536 patients without cancer) /sampling techniques not clarified	- The rate of ICU admission among patients with cancer was 19% - The rate of need for mechanical ventilation among patients with cancer was 9.52%, - 11.43% of patients with cancer died when they got infected with COVID-19.
Zhang et al. (2020a)	China	To determine the clinical manifestations and outcomes of cancer patients who have been diagnosed with COVID-19	Retrospective, observational study/ five hospitals in Wuhan	107 patients with cancer /purposive sampling	- ARDS (19.6%), heart failure (12.1%), acute renal injury (2.8%), and death (21.5%). - The severity of COVID-19 among patients with cancer was mild in 47.7% of participants and severe in 52.3% of participants. - 85% of patients with cancer required oxygen supplementation. - The rate of need for mechanical ventilation among patients with cancer was 16.8%. - 21.5% of patients with cancer died when they got infected with COVID-19.

Author	Country	Aim	Design/setting	Samples size/sampling technique	Results
Jee et al. (2020)	US	To determine whether recent cytotoxic chemotherapy and other cancer-related characteristics are associated with a more severe COVID-19 disease course	Retrospective study/Memorial Sloan Kettering Cancer Center	309 patients with cancer /purposive sampling	- Cytotoxic chemotherapy administration was not significantly associated with a severe or critical COVID-19 event. -Hematologic malignancy was associated with increased COVID-19 severity. -Patients with lung cancer also demonstrated higher rates of severe or critical COVID-19 events. - Lymphopenia at COVID-19 diagnosis was associated with higher rates of severe or critical illness. - 47.6% of patients with cancer were admitted to the hospital when they got infected with COVID-19. - 10% of patients with cancer died when they got infected with COVID-19.
Kuderer et al. (2020)	USA, Canada, and Spain	To characterize the outcomes of a cohort of cancer patients infected with COVID-19 and to identify potential prognostic factors for mortality and severe illness	Retrospective study	928 patients with cancer /purposive sampling	- 66% of patients had ECOG scores of zero or one, 8% scored two, and 5% scored three or four, with patients having an ECOG performance status of two or higher and active cancer found to be at a greater risk for worse COVID-19 outcomes. - 50% of patients with cancer were admitted to the hospital when they got infected with COVID-19. - Hospital admission was higher among patients under active anticancer treatment (38%); in the US-West region, the hospital admission rate was 32%, while in Canada, it was 69%. - The rate of ICU admission among patients with cancer was 14%. - The rate of ICU admission was high in patients with comorbidities (21%), former smokers (20%), and hematological cancer (22%).
Zhang et al. (2020b)	China	To Identify the clinical characteristics of COVID-19-infected cancer patients	retrospective cohort study/ three hospitals within Wuhan, China	28 patients with cancer /purposive sampling	- ARDS (28.6%), pulmonary embolism (7.1%), septic shock (3.6%), and acute myocardial infarction (3.6%). - 35.7% of patients had been discharged after an average hospital stay of 13.5 days. - 78.6% of patients with cancer required oxygen supplementation, - The rate of ICU admission among patients with cancer was 21%. - The rate of need for mechanical ventilation among patients with cancer was 35.7%. - 28.6% of patients with cancer died when they got infected with COVID-19.
Rahman et al. (2021)	Bangladesh	To find out the clinical characteristics and outcomes of COVID-19-infected cancer patients	Prospective study /different cancer hospitals in Dhaka, Bangladesh	43 patients with cancer /purposive sampling	- 23.3% of participants were asymptomatic, 23.3% mild, 23.3% moderate, - Severe and critical illness were found in 27.9% and 2.3% of cases, respectively. - 19% of patients with cancer died when they got infected with COVID-19.

Author	Country	Aim	Design/setting	Samples size/sampling technique	Results
Rüthrich et al. (2021)	Germany	To describe epidemiological and clinical features and to determine whether cancer patients are at higher risk for severe infection course and COVID-19 mortality compared to noncancer patients.	Retrospectively analyzed a cohort.	Three thousand seventy-one patients included 435 patients with cancer and 2636 patients without cancer. /purposive sampling	- 23.5% of patients had an ECOG score greater than two. - Progression to severe COVID-19 was seen in 55% and ICU admission in 27.5%. - The rate of ICU admission among patients with cancer was 27%, and the length of stay in the ICU was 11 days. - The rate of need for mechanical ventilation among patients with cancer was 65.5%,
Zeng et al. (2020)	China	To describe the clinical characteristics of nine cancer patients who were infected with SARS-CoV-2	A retrospective study/ the First People's Hospital affiliated with Yangtze University in Jingzhou, China.	Nine patients with cancer//sampling techniques not clarified	- The length of hospitalization among patients with cancer during the COVID-19 infection was 26 days. - Highest number of ICU admissions, which was 44% of patients with cancer