**Capstone Project: Final Research Paper**

Darice Shafer

Colorado State University Global

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Dr. Justin Bateh

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**Abstract**

Cancer mortality had been decreasing year on year until COVID pandemic in 2020 and 2021 cancer mortality increased (Blevins Primeau, 2023). Previous research has been done to show the disparities in cancer outcomes and how cancer mortality was impacted during COVID. This research project focuses on the factors that are correlated to higher cancer mortality in the first two years of the COVID pandemic, 2020 and 2021. Using data extracted from the Center for Disease Control and Prevention WONDER database containing mortality rate with age adjustment factor a stepwise regression model was created evaluating patient state, sex, cancer location, race, and ethnicity. The outcome of this research is in line with the previous studies reviewed but with a focus on the first two years of COVID. Based on these factors’ cancer sites were the most significant factor, specifically Pancreatic, Liver, Esophagus, Brain, and Liver Cancer. It is recommended that during times of community stress or pandemic that screening and treatment for this cancer be priorities and continue. Based on the modeled data, Black communities are also at a higher risk for cancer mortality during the COVID pandemic. It is recommended that the Black community is supported with additional resources to bridge this disparity in cancer mortality. Finally, it was found that males have a higher rate of mortality than females. This could be based on biological differences or bias in the data for uncontrolled factors. This is an area that future work could be done to isolate the cancers that affect only one gender. Additional research could be explored by adding in more variables and factors to get an even broader understanding of what is driving the disparities between different groups.

**Introduction**

Cancer care and patients’ survival was gravely impacted during the COVID-19 pandemic (Blevins Primeau, 2023). This paper is a deeper dive into the data and at-risk demographics for cancer deaths during the COVID-19 pandemic in 2020 and 2021. In 2019 the global pandemic COVID-19 started to spread across the world affecting every aspect of life. One major area that was impacted was the survival rate of cancer. In the first two years of the COVID-19 pandemic, cancer deaths increased 4% in the United States (Lawrence, 2023). Many studies have shown the negative impact COVID-19 pandemic had on cancer patients and mortality while COVID-19 was spreading in 2020 and 2021. This research is focused on what factors in the COVID-19 pandemic correlated to the higher mortality rate among cancer patients. It is important to understand which demographics and factors led to the greatest impact on cancer mortality during the pandemic.

**Problem Statement**

The first step of the research process is problem definition (Polonsky & Waller, 2019). In this project proposal the problem statement is what specific demographics impacted are correlated to the increase in cancer mortality during the period of COVID-19 spread, 2020 and 2021. This problem statement is neither too narrow nor too broad, therefore it will be able to provide clear answers.

Within the cancer community the goal is to reduce cancer cases and cancer deaths. With research, new treatments, and new medical development, cancer survival has been increasing steadily from 2015-2019 (National Cancer Institute, 2024). While this trend is great there are certain groups that are at a higher risk for specific cancer types and lower chances of survival. Additionally, this trend reversed in 2020 and 2021 during the pandemic.

**Objectives**

After the problem statement is defined, the next step is to develop the research objectives (Polonsky & Waller, 2019). The research objective should define the action that needs to be completed to answer the problem statement (Polonsky & Waller, 2019). In this project the objective is to determine what demographics within cancer patients were impacted the most by COVID-19, the greatest and had the highest increase in mortality.

Defining the research question is a key first step in the research process (Polonsky & Waller 2019). If the problem is unclear or poorly designed the rest of the project could result in wasted time and resources (Polonsky & Waller, 2019). In this project the problem to have answered is what specific demographics are correlated to the increase in cancer mortality during the period of COVID-19 spread, 2020 and 2021. In this the key areas of evaluation are sex, age, cancer location, patient location at time of death, and race. This information will provide insight into cancer patients’ risk factors that were impacted greater by the COVID pandemic.

**Overview of Study**

Using the findings of this research project will aid medical organizations and governments in prevention efforts to support the demographics that were disproportionally impacted by the COVID-19 pandemic. Additionally, these findings can support future research and understanding of why those specific demographics were disproportionally impacted with higher mortality. Using the results from this project to determine what areas to fund further research and equity measures to specific communities. Based on results from by Henley et. al (2022), “Cancer was one of the first conditions to be linked with increased risk for severe COVID-19 morbidity and mortality”. Understanding the health risks for cancer patients is an important first step in finding ways to prevent the risk and save lives.

This data can be used to develop prevention intervention measures tailored to specific communities. It can also be used to break down social barriers and protect those communities disproportionally affected by COVID-19 and save lives in the future. Having a clear research plan will set the project up for success. Clearly defining the problem definition as well as research objectives will allow for a solid starting point for the research project. Knowing the benefits the research can have for the organization is critical. Having the problem definition and research objectives contribute to the organizational goals will help guide the project. In this project the focus is saving future lives. Understanding which areas were most affected will benefit the organization in the future and can fuel further research to understand why those demographics were impacted more than others.

**Research Question and Hypothesis**

Developing hypothesis that will answer the research question is critical in setting up a research analysis and project. In the analysis it is determined if the hypothesis can be rejected or not rejected (Polonsky & Waller, 2019). In this research project the hypothesis is that some demographics are correlated to cancer mortality during the years of COVID-19 (2020 and 2021).

*Null Hypothesis*:  No demographics or variables are correlated to cancer deaths in during the COVID-19 pandemic, 2020-2021.

*Alternative Hypothesis*:Some demographics or variables correlate to cancer deaths during the COVID-19 pandemic, 2020-2021.

If the analysis fails to reject the null hypothesis, then no variables in the data are correlated to cancer deaths during COVID-19. If the null is rejected, then there is a statistically significant correlation between some variables and cancer mortality.

Understanding how specific groups were impacted during the COVID-19 pandemic regarding cancer survival is critical for understanding who was impacted the most during the pandemic. This will not only improve preparation plans for future pandemics but also understand the impact the pandemic had on the specific cancer demographics and communities. Understanding if the same demographics that typically high risk for specific cancers and/or higher cancer mortality are the same during the pandemic. Understanding how the pandemic changed the mortality of cancer patients will allow for justification for additional resources, studies, and education within those high-risk groups.

**Literature Review**

A literature review is a way to review the academic research that has already been done in this area (Polonsky & Waller, 2019). An integrated research literature review of the research that has already been completed in COVID-19 and cancer impacts. Additionally, a general background review of the research of COVID-19 and cancer mortality was also reviewed to get a better understanding of the background of those areas.

**General Background Review**

Looking at research done on cancer mortality, many studies are focused on specific cancer types. In reviewing work done by Lee et al (2024) they looked at all cancer types and found that working age adults living alone have a higher mortality rate from cancer than adults living with others. This correlation was strongest with non-Hispanic Whites and adults with higher education (Lee et al, 2024). This study corrected for sociodemographic, behavioral and health characteristics and spanned 22 years of mortality follow-up (Lee et al, 2024).

Research on mortality during COVID-19 pandemic was done by Atanasov et al (2024). In their research they focused on the states of Indiana, Wisconsin, and Illinois. Previous studies found that COVID-19 deaths had a strong positive correlation with age and were higher among men than women. This is also found in mortality in general for all causes of death. In this study the researchers focused on a factor COVID Excess Mortality Percentage which allowed the isolation of the COVID specific factors impacting COVID deaths (Atanasov et al, 2024). The results showed racial and ethnic minorities had a higher mortality than Whites. This correlation was strong for Hispanics (Atanasov et al, 2024). This study also found that the disparity in mortality between COVID excess and general population mortality was greater in age groups under sixty (Atanasov et al, 2024).

**Integrated Research**

In 2019 the global pandemic COVID-19 spread across the world affecting every aspect of life. Many studies have shown the negative impact COVID-19 pandemic had on cancer patients and mortality while COVID-19 was spreading in 2020 and 2021.One major area that was impacted was the survival rate of cancer. In the first two years of the COVID-19 pandemic, cancer deaths increased 4% in the United States (Lawrence, 2023). This research by Lawrence (2023) mortality rates were higher based on an age adjusted factor looking at cancer patients with COVID-19. Some factors that the study identified as higher risk for COVID-19 and cancer patients were non-Hispanic Black race, male sex, and zip code of residency (Lawrence, 2023). Cancer patients had a greater impact from COVID-19 than other groups due to many factors to include immunosuppression from chemotherapy treatments, more frequent medical appointments, healthcare shift in focus, and potential delays in diagnosis and treatment.

Based on the work by Blevins Primeau in 2023 he used data from the US Center of Disease Control and Prevention WONDER database showed cancer-related deaths and cancer contributing cause of death increased across major cancer types. Cancer care and patients’ survival was gravely impacted during the COVID-19 pandemic (Blevins Primeau, 2023). This research was focused on the cancer type and the mortality rate between the years of COVID-19 and previous years. The trend of decreasing cancer mortality over the previous decade was reversed in 2020 and 2021 with the first increase in cancer deaths across all cancer types (Blevins Primeau, 2023).

In research by Elkefi & Matthews (2024) they found that surviving cancer patients during the COVID-19 pandemic were more likely to have disruptions by changing their treatment plans and appointments if they were over 65, white, and higher income. This research helps plan future support and focused interventions to reduce the discrepancies during times of emergencies (Elkefi & Matthews, 2024).

Another study done by da Silva et al (2023) focused on the mortality of cancer patients due to COVID-19. This research found the factors that correlated to higher risk of COVID-19 mortality such as metastatic disease, race, extended hospitalization, age, race, sex, and others significantly contributed to increased risk of mortality (da Silva et al, 2023). This work can aid in developing strategies in treating clinically fragile and comorbidities in the future.

Many studies have been done looking into different aspects of cancer mortality and COVID-19 mortality and the combination of the two and how mortality increased during 2020 and 2021. Many of the studies focused on one area or one specific element or factors that correlated to the increase in mortality risk. A lot more research can be done on this broad and important topic. Knowing who is at the greatest risk during a pandemic or other global emergencies will help save lives in the future.

In research by Turtle et al (2024) they studied how COVID impacted cancer patients. In their findings they found that of the COVID patients in the group that had cancer 32% died within thirty days. For the group without cancer the mortality was only 18% (Turtle, 2024). This disparity in COVID survival had a greater impact on patients under 50. Additionally, COVID deaths for cancer patients were higher for if they were admitted in the hospital than for non-cancer patients. This study shows what impact COVID had on cancer patients and what factors raised their mortality risk.

In a study done by Potter et al (2023) they looked at COVID impact on cancer patients during different stages of the pandemic. The stages were broken into three categories, wild-type variants from December 2020 to February 2021, the Delta variant July 2021 to November 2021, and the Omicron December 2021 to February 2022 (Potter et al, 2023). During the Omicron wave the general population saw 29% fewer deaths than the previous winter surge, however patients with cancer died at a higher rate during the Omicron wave of the pandemic. Understanding that different variants had different effects on cancer patients versus the general population is important to understand how to close these disparities.

**Research Design**

**Methodology**

In this research project methodology is based on data available from the CDC’s Wonder Website. The data available from the database is quantitative data reported on cancer deaths. The collection is based on all the data available in the years 2020 and 2021 within the US. The data was collected through filtered extracts of the database queries.

Data collection can take a significant amount of time and resources to work on a research project (Polonsky & Waller, 2019). When gathering data, it is important to evaluate some key factors to determine which data will fit best to answer the problem statement. These factors are validity, reliability, appropriateness, amount of data, flexibility, costs, time restraints, potential for errors, and researcher’s ability (Polonsky & Waller, 2019). Based on these factors a dataset was extracted from the Centers for Disease Control and Prevention Wonder database (CDC, 2024). The Center for Disease Control and Prevention is an agency of the United States federal government. This database combines a wide range of public health information by integrating information for public health.

The data selection used in this project was titled, *United States and Puerto Rico Cancer Statistics, 1999-2021 Mortality Request.* In this data the years 2020 and 2021 were selected as the years COVID cases were prevalent. In the data several variables were selected, those were cancer site, metropolitan statistical area (MSA), age group, sex, ethnicity, and race. The rate of deaths per 100,000 is reported by line grouping. This data was extracted each year by cancer site and combined to meet the system limitations. All zero and suppressed data lines were not reported.

This dataset was chosen to support the project objective to determine specific demographics within cancer patients during COVID-19 pandemic that experienced the highest mortality. This data was free, available, complete, and reputable. It is a subset of a larger mortality dataset tracked by the CDC filtered to cancer deaths. Selecting the years of 2020 and 2021 creates the intersection between cancer patients and COVID-19. Using the findings of this research project will aid medical organizations and governments in prevention efforts to support the demographics that were disproportionally impacted by the COVID-19 pandemic. Additionally, these findings can support future research and understanding of why those specific demographics were disproportionally impacted with higher mortality.

This data can be used to develop prevention intervention measures tailored to specific communities. It can also be used to break down social barriers and protect those communities disproportionally affected by COVID-19 and save lives in the future. Understanding which areas were most affected will benefit the organization in the future and can fuel further research to understand why those demographics were impacted more than others.

**Methods**

Using data extracted from the CDC Wonder Database (2024), several statistical analyses were performed. The data set contains five variables, leading cancer sites, sex, age group, geographical area, and race. Descriptive statistics were looked at to understand the mortality statistics. Next, regression models were developed to determine which variables were contributing to the cancer mortality. This was done in both SAS Studio and SAS Enterprise Miner. In addition to the regression model each variable was looked at in comparison to the 2018-2019 data to determine if there was a significant difference in the mortality of that group between the year prior to COVID-19 and during COVID-19. This will be done through an ANOVA t-test. These tests are diagnostic analytics that help determine what factors lead to more deaths. Utilizing SAS Studio and SAS Enterprise Miner allowed for quick analysis and results.

**Limitations**

The limitations in the analysis and data are based on the data available in the WONDER database. The dataset is limited to only a few demographic reporting measures that having more variables to report would allow for a broader analysis. It is a balance between detailed data and more granular. In the dataset available the location data could be extracted at several levels between regional, state, or MSA data. The cancer site could also be more specific or more general. The other major limitation in the data is the way it is structured it does not have populations for each group but only the cancer death counts. Additionally, the data suppresses any death counts in a group if less than 16 due to privacy concerns. This is a limitation to the data. Groups with zero cancer deaths are also eliminated from the data extract.

It would have been beneficial to be able to expand the dataset to include other variables such as hospitalization data, stage of cancer treatment, delayed diagnosis, treatment interruptions, family support network, living situations, education, other underlying conditions, marital status, leading vs. contributing causes of death, or household income. These additional variables would add more considerations to the research and factors to explore.

This data was collected by various reporting agencies and compiled at the Center for Disease Control and Prevention. Having different reporting agencies can add bias and inaccuracy to the data. This inaccuracy can either be from preconceived notions or cognitive biases. Different agencies may have different ways of recording information and collecting the information. Some of the data may be inaccurately recorded or fall into the selected options. Some reporting agencies may have a robust process for tracking and reporting data while others are more informal. This could also lead to bias in data based on the specific agency reporting processes.

Reviewing the variables of the data used to build the model, below is the metadata for each of the variables.

***Cancer Site***: These are the primary cancers were the highest incidence for each race and sex (CDC, 2024). These types are: Brain and Other Nervous System, Breast, Cervix Uteri, Colon and Rectum, Corpus Uteri, Esophagus, Gallbladder, Kidney and Renal Pelvis, Larynx, Leukemias, Liver, Lung and Bronchus, Melanoma of the Skin, Myeloma, Non-Hodgkin Lymphoma, Oral Cavity and Pharynx, Ovary, Pancreas, Prostate, Stomach, Thyroid, and Urinary Bladder. Variable Type: Categorical/Nominal

***State:*** The state the patient was located at the time of death. Variable Type: Categorical/Nominal

***Sex****:* This variable indicates if the individual was female or male. Variable Type: Binary

***Ethnicity****:* This variable includes Hispanic, Non-Hispanic, Unknown or Missing. Variable Type: Categorical/ Nominal

***Race****:* This variable has the following selections: American Indian or Alaska Native, Asian or Pacific Islander, Black or African American, and White. Variable Type: Categorical/ Nominal

***Mortality-Incidence Age-Adjusted Rate Ratio:*** The ratio of deaths due to cancer related to total population mortality with an age adjustment factor. Variable Type: Continuous/Numerical

*Other notes about the data-set*: If fewer than 16 cases per line were reported, then the data was suppressed to protect personal privacy. For gender specific cancers to number of deaths shows N/A for the genders that do not apply. For the population rate for gender specific cancers the gender population was used.

**Ethical Considerations**

According to Polonsky & Waller (2019) there are several types of harm to be aware of when working on a research project, psychological harm, financial harm, and social harm. Psychological harm would involve the participants in something that would be offensive or frighten them. Financial harm would be affecting the reputation of a company or disclosing data that could impact their future success. Social harm would be disclosing sensitive personal information about individuals that they would want to keep private. In this project when the data is under 16 individuals the data was hidden to protect personal identities. Given the topic of mortality, it is important to keep that each of these deaths were someone’s family members, friends, and coworkers. They are much more than statistics and reports but someone’s life that was lost to cancer.

**Findings**

Initially the data was reviewed for descriptive statistics. This allowed for a better understanding of the data and how the cancer deaths were distributed between the different variables. In figure one you can see the cancer deaths by leading cancer sites. The main cancer sites are represented, and the rest were combined into Other. The leading cause behind the others is Lung and Bronchus, followed by Colon and Rectum, and Pancreas. In figure two you can see the cancer deaths by age grouping. The older patients had higher death count with a little exception between 75 and 84. The final two figures three and four show the cancer deaths by race and most of the deaths were within the white community. Additionally, more male deaths than female in this period.

**Figure 1**

*Cancer Deaths by Leading Cancer Sites*

A pie chart with numbers and text

Description automatically generated

**Figure 2**

*Cancer Deaths by Age*

A graph of cancer death

Description automatically generated

**Figure 3**

*Cancer Deaths by Race*

A graph with a number of people in the middle

Description automatically generated with medium confidence

**Figure 4**

*Cancer Deaths by Sex*

A graph showing a number of cancer patients

Description automatically generated

Using the dataset a stepwise regression model was created in SAS. The dependent variable was Mortality-Incidence Age-Adjusted Ratio, and the independent variables were Sex, State, Ethnicity, Race, and Leading Cancer Site. Below in Figure five are the model parameters.

**Figure 5**

*Regression Model Set-up*

*A screenshot of a computer

Description automatically generated*

The results of the regression model where leading cancer sites were the primary predictor or mortality in the years 2020 and 2021 during COVID. The model included Leading Cancer Site, State, Sex, and Race. The details of the model are shown in Figure six. Looking at the results we can see t-Values between -17and 79 these values have a high confidence that the significance of the independent variables explains the dependent variable. The R square of 0.87 shows that the independent variable has a strong explanation of variability of the dependent variable. Looking at the F statistics being 501, the model is significant and provides a significantly better fit to the data than just the mean. The model can utilize the independent variables to explain a substantial amount of the variance in the dependent variable. Looking at the t values for each of the variables many have a strong influence on the model. The highest were Pancreas Cancer (-79), Esophagus Cancer (-67), Brain Cancer (-61), Liver Cancer (-63), and Lung Cancer (-57). The states the patient died in also had some significant variances between states. New York (6.9), New Jersey (6.6), and Connecticut (5.3) were correlated to a higher survival rate while Nevada (-1.4) had a lower survival rate. Males had a significant lower survival than females (-14). Looking at race Black/African Americas had a significant higher risk of mortality. In evaluating the model results it is critical to understand the dataset and the variables that are being evaluated and if there is any bias in the model. One of the limitations or potential bias in the data is regarding how population affects the model. Looking at the different mortality rates of different states the population within each of those states are variable which can cause additional uncontrolled elements. Additionally, when looking at cancer types and genders some cancers only effect males while others only effect females. This can add additional data bias. In future work ways to reduce this bias could be explored. In looking at race as a factor the data could not be accurate for patients that are of mixed race or choose not to report race. The factors also can have interdependencies. Different areas of the country have different proportions of each race as well as different environmental factors that can affect cancer mortality. The interplay of these elements can cause errors in the model. In future work looking for ways to isolate and control for these factors would improve the results.

**Figure 6**

*Regression Model Results*

A screenshot of a computer screen

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**Figure 7**

*Regression Model Parameter Estimates*

*A screenshot of a table with numbers and states

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Removing Cancer location variable from the regression we get a model that is not as strong. The t Values range from -7 to 2. Looking at only Sex, State, Ethnicity, and Race as the variables in this model only Sex and Race are significant. The F value is 25 and the R square is .0183. This indicates that the model is only able to predict 1.83% of the variability using the independent variables sex and race. Without the cancer site variable, the model is still significant. The highest survival rates were seen in white females, while the lowest were with black males. These results are significant in understanding how to better support the black community with resources. Further research would need to be done to understand what is contributing to a higher mortality for black males. Could this be linked to diet, professions, education, income, healthcare bias, physical factors, or cultural factors. These variables would need to be considered in future research. Additionally, what makes males have a higher mortality than females. It could be that women go to the doctor more than men, it could be in the biology of women, or the cultural norms for women. Understanding more why these factors contribute to higher mortality will allow for better new plans to be put in place to close the gap. In Figures eight, nine, and ten below show the results of this alternative model.

**Figure 8**

*Regression Model Set-up*

*A screenshot of a computer

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**Figure 9**

*Regression Model Results*

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**Figure 10**

*Regression Model Parameter Estimates*

*A screenshot of a data

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**Conclusion**

Looking back at the null hypothesis of this research project, the data in the model rejects the null hypothesis. Based on this we have determined that some of the variables are correlated with the independent variable and are a better predictor of cancer mortality during COVID than the mean. In the first model the greatest factor in cancer mortality is cancer site/location. When this is removed from the model the greatest predictors are gender and race. Both these models are significant and could be used to gain additional insights into the impacts of cancer patients during the COVID pandemic. This model could assist local governments and healthcare providers to serve the community during times of community stress or global pandemics.

Knowing that Pancreatic, Liver, Esophagus, Brain, and Liver Cancer have the strongest correlation to increased mortality it would be critical to continue screening for these cancer types even during a pandemic. It would also be recommended for these cancer types to limit the disruption in treatment during community crises to increase the survival rates. Ensuring plans are in place to continue screening and treatment for specific cancers is important when creating priorities in screening and treatment scheduling. This information may also be beneficial in identifying areas that need different screening procedures and research in treatment options.

Looking at the other risk factors of gender and race the model shows that males and Blacks have a higher risk or mortality. Understanding what is causing this would need further research. Looking at more variables may also assist in finding the reason for this association. Men maybe less likely to go to the doctor for screening and have later diagnosis. Another factor when looking at the impact on gender with cancer is some cancers are gender specific such as Cervix, Ovary, and Prostrate. While both genders can have Breast cancer it is much more prevalent in women. These disparities in the data could create bias in the outcome. This is something that should be researched further.

These results are in line with the previous research in this area of study. Specific factors have a greater impact on cancer mortality during COVID these include cancer type, race, and sex. Understanding these factors is the starting point to working on plans for community leaders and healthcare providers to close the gap and find the resources that will support these at-risk groups. While some of the factors may have bias and limits in scope it is a good starting point for further research.

**Recommendations**

Next steps in this analysis would be to communicate these results with stakeholders as well as expand the research. Looking at the same data for the two years prior to COVID and the two years after COVID and determining which of the variables were significant in predicting cancer mortality between the three different time periods. It would also be valuable to be able to expand this dataset and model to include other variables that were discussed in previous research such as hospitalization, other conditions, income levels, educations levels, living situations, and treatment disruptions.

Specific recommendations for health care workers would be to promote screenings for Pancreatic, Liver, Esophagus, Brain, and Liver Cancer during times of community stress or pandemics. Additionally, not limit treatment or delay treatments for these cancer types if at all possible. For researchers I would recommend investing more funding in these cancers to determine what is causing the increased mortality and if new treatment or better screen options are available. For community leaders understand a potential need for the Black community to have more access to healthcare during pandemics. Available transportation, paid time-off, and healthcare insurance are all ways to support the Black community. For government officials it is recommended to have awareness campaigns for cancers that effect males. Additionally, public service campaigns to educate on the resources available for low-income medical benefits, recommended screenings, importance of routine well checks, and availability of healthcare during pandemic events.

These results, while significant and useful, are just the start of what research can be completed in this broad area of study. Understanding the impacts global pandemics and community stress can have on cancer patients is critical in improving mortality rates. Having the right resources available to bridge the disparity gaps is critical in saving lives and increasing the cancer mortality. Further research should be done to refine these findings but actions can be taken now with these findings that can help populations that need more support, education, and resources.

**References**

Atanasov, V., Barreto, N., Franchi, L., Whittle, J., Meurer, J., Weston, B. W., Luo, Q., Yuan, A. Y., Zhang, R., & Black, B. (2024). Evidence on COVID-19 Mortality and Disparities Using a Novel Measure, COVID excess mortality percentage: Evidence from Indiana, Wisconsin, and Illinois. *PLoS ONE*, *19*(1), 1–21. <https://doi-org.csuglobal.idm.oclc.org/10.1371/journal.pone.0295936>

Blevins Primeau, A. S. (2023, September 27). Cancer Deaths Increased During the First 2 Years of the COVID-19 Pandemic. *Infectious Disease Advisor*.

da Silva, J. L., de Souza, B. S. W., de Albuquerque, L. Z., Aleixo, S. B., Resende, G. A. da S., de Oliveira, D. G. B., dos Santos, E. N., Nogueira-Rodrigues, A., Clara, R. O., Gaui, M. de F. D., Mota, A. C. de A., de Lima, V. C. C., Rosa, D. D., Munhoz, R. R., Morbeck, I. A. P., Gelatti, A. C. Z., Mathias, C. M. de C., & de Melo, A. C. (2023). Factors influencing COVID-19 mortality among cancer patients: A Brazilian multi-institutional study. *PLoS ONE*, *18*(12), 1–19. <https://doi-org.csuglobal.idm.oclc.org/10.1371/journal.pone.0295597>

Elkefi, S., & Matthews, A. K. (2024). Disparities in the Care Disruption During COVID-19 and in its Impacts on the Mental and Physical Well-Being of Cancer Survivors. *American Journal of Health Promotion*, *38*(8), 1188–1198. <https://doi-org.csuglobal.idm.oclc.org/10.1177/08901171241262224>

Lawrence, L. (2023). Deaths Among Cancer Patients Increased During the First 2 Years of the COVID-19 Pandemic. *Cancer Therapy Advisor*, NA. <http://dx.doi.org.csuglobal.idm.oclc.org/10.1002/cam4.6364>

Lee, H., Singh, G. K., Jemal, A., & Islami, F. (2024). Living alone and cancer mortality by race/ethnicity and socioeconomic status among US working‐age adults. *Cancer (0008543X)*, *130*(1), 86–95. <https://doi-org.csuglobal.idm.oclc.org/10.1002/cncr.35042>

National Cancer Institute. (2024, May 9). Cancer Statistics. *National Institutes of Health.* Accessed: December 15, 2024 <https://www.cancer.gov/about-cancer/understanding/statistics>

Polonsky, M. J., & Waller, D. S. (2019). *Designing and managing a research project: A business student's guide* (4th ed.). SAGE Publications. ISBN: 9781544316468

Potter, A. L., Vaddaraju, V., Venkateswaran, S., et al. (2023). Deaths Due to COVID-19 in Patients With Cancer During Different Waves of the Pandemic in the US. *JAMA Oncol.* 9(10):1417–1422. doi:10.1001/jamaoncol.2023.3066

Turtle, Lance et al. (2024, May). Changes in hospital mortality in patients with cancer during the COVID-19 pandemic (ISARIC-CCP-UK): a prospective, multicentre cohort study. *The Lancet Oncology*, Volume 25, Issue 5, 636 – 648 <https://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(24)00107-4/fulltext>