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Health Disparities Among African American Multiple Myeloma Patients in the United States

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
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Walden University
2024

Abstract

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MPH, Charles R. Drew University, 2016

BS, La Sierra University, 2014

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Public Health

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February 2024

Abstract

Multiple myeloma cancer is a major public health issue that impacts many. One's stage at diagnosis is a significant factor in terms of overall cancer diagnosis because it can be used to determine survival and the overall course of the disease. Minimal information about African Americans and multiple myeloma health disparities in the United States is known specifically as it relates to the impact of race and stage (staged or not staged) at diagnosis. The aim of this correlational study was to investigate the impact of race on stage at diagnosis, while also examining age at diagnosis, sex, months of survival and median household income among African American multiple myeloma patients in the U.S. The social-ecological model was the theoretical framework for this study. Ordinal regression analysis, binary logistic regression, and multiple linear regression analysis were applied to address the research questions. Data from 102,539 patients were obtained from the Surveillance, Epidemiology, and End Results (SEER) program. Findings indicated that there is an association between race and stage at diagnosis with multiple myeloma. Non-African Americans are less likely to be staged (distant) for multiple myeloma compared to African Americans. Implications for positive social change include contributing evidence that supports public health professionals by helping to identify health disparities and factors that shape multiple myeloma diagnoses and staging outcomes.

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Dedication

This study is dedicated to my mother, Carolyn Harris, and father, Xezakia Rouse'. Because of you both, I have persevered toward my dreams; you have always supported my academic career and taught me that I could do anything I put my mind to. I would also like to dedicate this study to my two sisters, Tanisha and Zakia, we are all we got, and I love you both for your continued support. Lastly, I would like to dedicate this study to Desiree Hooper, who is the motivation behind me studying multiple myeloma. Her overwhelming strength has inspired me to not only study this topic but has pushed me to contribute to current research surrounding myeloma care in the United States.

To all the boys and girls that look like me, I want to dedicate this study to you and hope to be a motivation that all things are possible if you work hard, focus, and set your mind on your goals. Everything has its time; everyone has their purpose- Ecclesiastes 3; To everything, there is a season, a time for every purpose under heaven. A time to be born, and a time to die; a time to plant, and a time to pluck what is planted; a time to kill, and a time to heal; a time to break down, and a time to build up; a time to weep, and a time to laugh; a time to mourn, and a time to dance; a time to cast away stones, and a time to gather stones; a time to embrace, and a time to refrain from embracing; a time to gain, and a time to lose; a time to keep, and a time to throw away; a time to tear, and a time to sew; a time to keep silent, and a time to speak; a time to love, And a time to hate; a time of war, and a time of peace.

Acknowledgments

I would first and foremost like to acknowledge my lord and savior, Jesus Christ, for helping me get through to the finish line. It has been a long and sometimes difficult road, but I would not have been able to finish without your grace. I want to acknowledge my friends and colleagues who have helped me in any way, whether it was a motivational post or encouraging thoughts; it has helped to push me to the end. I would like to especially thank Sarah Perkins for giving me the confidence, motivation, and assistance when I needed it most. Lastly, I would like to express my sincere gratitude to Dr. Okenu, my doctoral chair, and my committee member Dr. Htway for their feedback and insightful contributions to my study.

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Section 1: Foundation of the Study and Literature Review

Multiple myeloma cancer, characterized by clonal proliferation of bone marrow plasma cells, is a diagnosis that can negatively impact a person's life. Anemia, renal failure, and recurrent infections are some of the effects of multiple myeloma. Multiple myeloma is known to be an incurable malignancy; however, advancement in treatments has allowed for those who are diagnosed to experience increased quality of life (Asher & Streetly, 2021).

Although the cause of multiple myeloma is mostly unknown, some factors such as genetic mutations and environmental exposures can increase an individual's risk of genetic damage. Environmental factors refer to exposure to substances such as pesticides or industrial waste, behaviors such as smoking or having a poor diet, and experiences involving stressful situations such as racism can increase risks of disease-causing health issues such as inflammatory disease, which can be associated with having a higher risk of developing multiple myeloma (Michaels & Petersen, 2017). African Americans have a twofold higher incidence than Whites of multiple myeloma and present symptoms at a younger age (Rajkumar, 2020). Multiple myeloma has been associated with many deaths, and prevention via screening has become particularly important for populations in which multiple myeloma is most common. Screenings are medical tests that doctors use to check for diseases and other health issues before any signs or symptoms develop (Loud & Murphy, 2017). With multiple myeloma, a person may or may not experience signs or symptoms, so physicians must screen with questions and make the justifiable decision to test for monoclonal gammopathy of undetermined significance, especially for higher-risk

patients. Incidence of multiple myeloma has increased in specific populations throughout the U.S. (DeSantis et al., 2019). Researchers have investigated and documented in detail health aspects of multiple myeloma and racial inequities in healthcare as well as health outcomes between African Americans and White Americans. There is, however, very little literature on health disparities associated with stage at diagnosis (staged versus unstaged), age, median household income and other factors that may contribute to multiple myeloma within the African American community. Staged for the purpose of this study reflects that after screening, multiple tumors were found inside or outside the bones and the patient would be diagnosed at the distant stage, and unstaged for the purpose of this study means that no data were collected for the specific patient.

Many factors contribute to one's risk for multiple myeloma. For example, compared to younger adults in the U.S., older adults face a higher risk of a multiple myeloma diagnosis (Rajkumar, 2020). Early intervention can delay organ damage and prolong the life of those diagnosed with multiple myeloma (Rajkumar, 2020). Monoclonal gammopathy of undetermined significance, a precursor to multiple myeloma, is present in roughly 3% of the general population aged 50 years or older and progresses to overt multiple myeloma at a rate of about 1% per year; thus, the significance of early detection is paramount to overall survival, especially among populations who are at high risk (National Cancer Institute, 2019).

To identify the severity of multiple myeloma cancer, the International Myeloma Working Group, an organization set in place to conduct collaborative basic, clinical, and translational research to improve multiple myeloma outcomes developed a staging system

called the Revised International Staging System (R-ISS). Each of these stages is part of the development of multiple myeloma cancer diagnosis and grouped from least to greatest impact by category (Durie, 2021). Stage I is measured using Serum β2 microglobulin, a test that measures the amount of a protein called beta- microglobin in the blood, urine, or cerebrospinal fluid. With a stage one diagnosis, physicians look for a value of < 3.5 mg/L of serum β2 microglobulin and ≥ 3.5 g/dL of serum albumin. Physicians also look for any standard-risk chromosomal abnormalities using fluorescence in-situ hybridization and assess normal lactate dehydrogenase levels. Stage II is understood as anything between stage I or III. Stage III is categorized as a patient having a serum β2 microglobulin level ≥ 5.5 mg/L and either high-risk chromosomal abnormalities according to fluorescence in-situ hybridization or high lactate dehydrogenase levels (Durie, 2021).

The dataset used to conduct this study was taken from the Surveillance, Epidemiology, and End Results (SEER) database. Instead of using stage numbers I-III, the database characterizes stages as localized, regional, or distant. Cancer staging allows physicians to identify the seriousness of a cancer and determine the best course of treatment for it based on its extent and spread (American Cancer Society [ACS], 2017). Multiple myeloma is a cancer that has not been shown to be preventable; however, risk factors such as family history, obesity, age, and gender could make a person more susceptible to developing cancer (Lichtman, 2014). Improvements in survival over time reflect earlier diagnoses, effective screening, and advances in treatment. DeSantis et al. (2019) found certain factors such as excess weight and obesity, immunobiological or

socioeconomic status may be the cause of differences seen in terms of quality of screening and follow up after abnormal results, as well as the cause of less screening seen among African American patients. When considering cancers such as cervical cancer, lower socioeconomic status and older age are associated with lower screening rates and an increased risk of late-stage diagnosis (DeSantis et al., 2019). Research on health disparities associated with stage at diagnosis and other factors associated with outcomes has been limited for multiple myeloma. A better understanding of disease-specific health disparities involving multiple myeloma while also looking at the potential effects of sex, age, median household income, and months of survival can help contribute to further research and encourage early treatment, which can ultimately extend one's quality of life and lead to more positive outcomes.

Background

Health in the U.S. overall has improved over time specifically in terms of life expectancy (World Health Organization [WHO], 2019). However, African Americans have been socially disadvantaged by significant racial health gaps and are more likely to die at an early age from most causes compared to their non-African American counterparts (WHO, 2019).

The U.S. has a deeply rooted history of structural inequities and barriers in healthcare, which African Americans and other minorities have fallen victim to. Adequate healthcare, recommended healthcare services, and preventative care may not be accessible to persons in the African American community (U.S. Department of Health and Human Services, 2020). Multiple myeloma is a diagnosis that negatively impacts

those who are at higher risk, including African Americans (Pierre & Williams, 2020). There is little to no research on health disparities associated with stage at diagnosis of multiple myeloma in the African American community. Fiala and Wildes (2017) found structural barriers in the healthcare system, individual decision-making among African American patients, and health outcomes need to be explored further. These causal factors could be used to explain possible health disparity outcomes associated with a patient's stage at diagnosis, as early diagnosis and adequate staging improves treatment outcomes by giving patients more freedom to make important health decisions (Jacklyn et al., 2017).

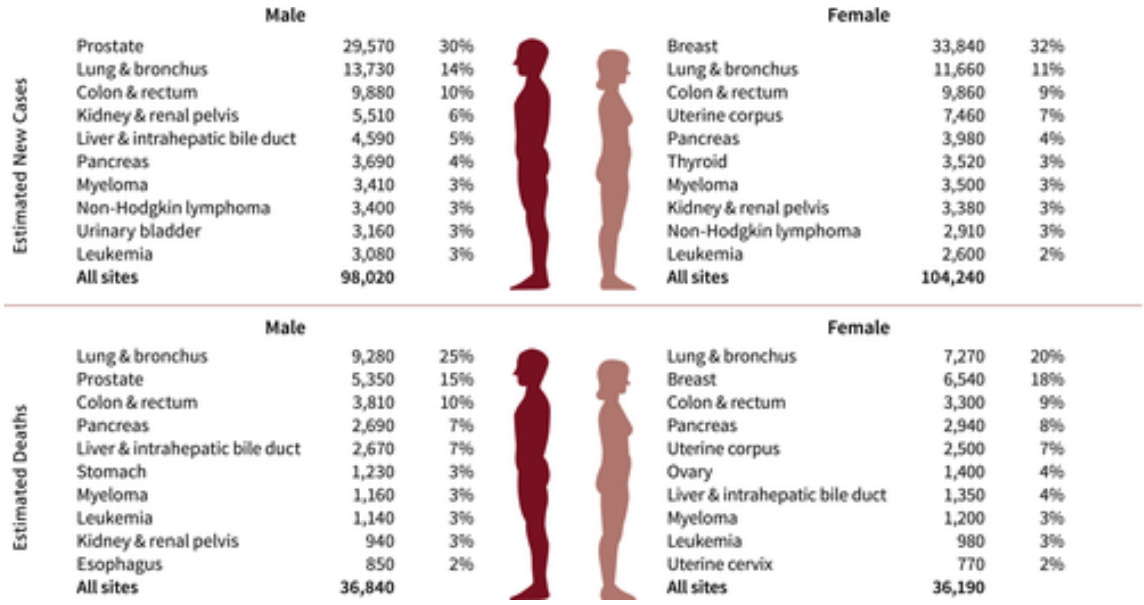
According to the Centers for Disease Control and Prevention (CDC, 2021), African Americans are generally living longer, and the death rate for African Americans has declined about 25% over the past 17 years, primarily for those over the age of 65. Even though overall death rates have decreased, African Americans continue to be disadvantaged by illnesses compared to their non-African American counterparts, resulting in health disparities (CDC, 2021). Compared to White men, African American men have a 6% higher cancer incidence and 19% higher cancer mortality rate, which are lower survival rates. There is an even greater disparity between African American and White women's cancer incidence, with African American women dying from cancer at a higher rate of 12% (ACS, 2022).

Multiple myeloma survival and outcome articles were used to provide a foundation for this research and will be addressed in Chapter 2. Using secondary data allowed me to thoroughly investigate multiple myeloma and discover research.

Understanding the stage at diagnosis of multiple myeloma and how persons of different ethnicities and races fall into staging categories can be used to address exposure to possible health disparities in healthcare. Communities of color and urban populations are often disadvantaged in terms of their socioeconomic status, healthcare access, and health insurance when compared to White communities (Taylor, 2019). Inequalities such as these contribute to gaps in health insurance coverage, uneven access to services, and poorer health outcomes among certain populations, specifically African Americans (Taylor, 2019). As a result, African Americans have had to bear the brunt of many preventable and nonpreventable illnesses, including multiple myeloma (see Figure 1).

Figure 1

Leading Sites of New Cancer Cases and Deaths Among Blacks, U.S. 2019 Estimates



Problem Statement

The research problem is that there is a lack of studies investigating multiple myeloma, specifically the impact of variables such as race, sex, age at diagnosis, median

household income, months of survival, and stage at diagnosis (staged versus unstaged). Multiple myeloma accounts for 1.6% of all cancer cases and approximately 10% of hematologic malignancies in the U.S. (Michaels & Petersen, 2017). Multiple myeloma is a rare disease, but it has a large impact on socially disadvantaged communities. This can be attributed to many factors, including socioeconomic status and access to efficient quality of care (Michaels & Petersen, 2017).

Health disparities are differences that exist among specific population groups in the U.S. in terms of attainment of full health potential, which can be measured by differences in incidence, prevalence, mortality, and burden of disease (Weinstein et al., 2017). Persistent racial and ethnic disparities may contribute to the lack of minority physicians in the U.S. About 2.6% of the nation's doctors in 2019 and 7.3% of students enrolled in medical schools in 2020 identified as Black or African American (Alltucker, 2020). There has been some progress in increasing the number of African American doctors in the U.S. but figures still lag 13% behind the overall population (Alltucker, 2020). Increasing African American and other minority health and public health professionals is a strategy that can be used to reduce racial and ethnic health disparities (Alltucker, 2020). When physicians and patients share the same race or ethnicity, this improves medication adherence, shared decision-making, wait times for treatment, screening, patient understanding of cancer risk, and patient perceptions of treatment decisions, thus reducing disparities (Huerto, 2020).

The Institute of Medicine (IOM, 2003) assessed differences in care received by minorities and found that healthcare disparities exist and are associated with worse health

outcomes. They found that health disparities occur in the context of broader inequality and providers and patients are contributing factors. The IOM (2003) also noted that health disparities are caused by bias, stereotyping, prejudice, and clinical uncertainty and can result in minority patients being more likely to refuse treatment.

Racial and ethnic minorities in the U.S. are socially disadvantaged (CDC, 2020). These inequities contribute to health disparities, including higher rates of chronic disease and premature death as compared to Whites (Taylor, 2019). Those who are socially disadvantaged suffer from health disparities involving disease, injury, violence, and diminished opportunities for optimal health (CDC, 2020). In this study, I investigated health disparities among patients diagnosed with multiple myeloma in the U.S. I addressed whether there are differences in terms of stage at diagnosis for patients of different racial backgrounds while also assessing age at diagnosis, sex, months of survival, and median household income. Previous research has shown that African Americans are more at risk for multiple myeloma and die at higher rates (CDC, 2017). I focused on understanding specific health disparities in multiple myeloma patients while considering certain risk factors.

Health Determinants of Multiple Myeloma

Determinants of health encompass a range of personal, social, economic, and environmental factors that influence health status (Office of Disease Prevention and Health Promotion [ODPHP], 2020). Interrelationships between determinants are used to understand individual and population health. Asare et al. (2017) found economic stability involves income, employment, expenses, and debt, all of which can directly impact a

patient's socioeconomic status which in turn can cause a negative impact on individual health and the patient's ability to receive specialized care. People with low socioeconomic status are more likely to have poor living conditions, which increases their cancer risk (Asare et al., 2017). Environmental factors also play a factor in determinants of health in terms of availability of transportation, safe and modern housing, safe walking paths and sidewalks, and neighborhood infrastructure, all of which contribute to individual and population health (Singh & Jemal, 2017). Health and healthcare determinants include availability of health coverage, healthcare specialists, quality of care, and cultural competency of healthcare providers. Multiple myeloma is influenced by many health determinants, including personal, social, economic, and environmental influence (Asare et al., 2017). By identifying these determinants, healthcare disparities can then be addressed.

Health Disparities of Multiple Myeloma

Multiple myeloma disparities are prevalent in the African American community (Padala et al., 2021). African Americans are more than twice as likely to suffer from multiple myeloma, with incidences of 16.5 per 100,000 for men and 12.0 per 100,000 for women, compared to Caucasians with incidences of 8.2 and 5.0, respectively (Padala et al., 2021). Biological determinants are a key factor in multiple myeloma outcomes; for example, race and ancestry play a large role in predicting the risk for multiple myeloma (Smith et al., 2018). Other factors such as sex, sexual identity, age, disability, socioeconomic status, and geographic location can all contribute to a person's ability to achieve good health (Smith et al., 2018). A health disparity is a health difference

involving social, economic, or environmental disadvantages (ODPHP, 2020). There are many health differences between African Americans and White Americans that are not limited to multiple myeloma. According to the ACS (2022), the death rate in the U.S is higher for African American than Whites for heart disease, stroke, influenza, pneumonia, diabetes, hypertension, HIV/AIDS, kidney disease, and homicide. Multiple myeloma disparities result not only from race but also lack of availability and access of adequate healthcare, all of which directly impact overall quality of life (Ailawadhi et al., 2018). Throughout this study, health disparities associated with multiple myeloma diagnosis were explored. These factors play an important role in determining how disparities are experienced for multiple myeloma cancer patients throughout the U.S.

Purpose of the Study

I aimed to explore associations between age at diagnosis, race, sex, months of survival, median household income, and stage at diagnosis (staged vs unstaged) among patients with multiple myeloma. There has been previous research on myeloma cancer statistics, but this research is unique because it focuses on stage at diagnosis of multiple myeloma cancer, as well as possible relationships between age at diagnosis, sex, race, months of survival, and median household income. The National Cancer Institute's SEER database was used to gather appropriate data. Race, age, and sex have been addressed in many studies as common variables in multiple myeloma cancer; however, stage at diagnosis is not thoroughly explored in research. Loud and Murphey (2017) investigated early cancer screening and detection in the 21st century and noted cancer screening has contributed to the decrease in cancer morbidity and mortality. According to Loud and

Murphey (2017), characteristics of an accurate screening test include reliability (delivering the same result each time), validity (delivering the correct result each time), sensitivity (correctly classifying cases, and specificity (identifying all cases).

Efficient cancer screening helps determine cancer in people who have no signs or symptoms as well as identify those who have symptoms at a determined stage (Jacklyn et al., 2017). It is ideal that cancer be caught before it fully develops as it gives the patient a greater chance of survival. Ineffective screening can result in false negative results where an abnormality may be found but is not cancerous. If a patient receives false negative results, this can lead to unnecessary additional screening and tests, which can cause more harm to the patient's body and quality of life (Jacklyn et al., 2017). Overdiagnosis could also occur with ineffective screening; this can cause more significant issues because patients may receive treatment which can cause physical harm and even death (Jacklyn et al., 2017). I aimed to identify health disparities specifically during the diagnosing stage among multiple myeloma patients, I analyzed ways in which race, age, sex, and median household income can have an impact on quality of care.

Research Questions and Hypotheses

The aim of this research was to answer the following questions and test associated hypotheses:

RQ1: Is there an association between race and stage at diagnosis (staged vs unstaged) in terms of multiple myeloma after controlling for age and sex?

$H_0$1: There is no association between race and stage at diagnosis (staged vs unstaged) in terms of multiple myeloma after controlling for age and sex.

H_a1: There is an association between race and stage at diagnosis (staged vs unstaged) in terms of multiple myeloma after controlling for age and sex.

RQ2: Is there an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income?

$H_0 2$: There is no association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

$H_a 2$: There is an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

RQ3: Is there an association between race and months of survival after diagnosis after controlling for stage at diagnosis (staged vs unstaged) and median household income?

$H_0 3$: There is no association between race and months of survival after diagnosis after controlling for stage at diagnosis (staged vs unstaged) and median household income.

$H_a 3$: There is an association between race and months of survival after diagnosis after controlling for stage at diagnosis (staged vs unstaged) and median household income.

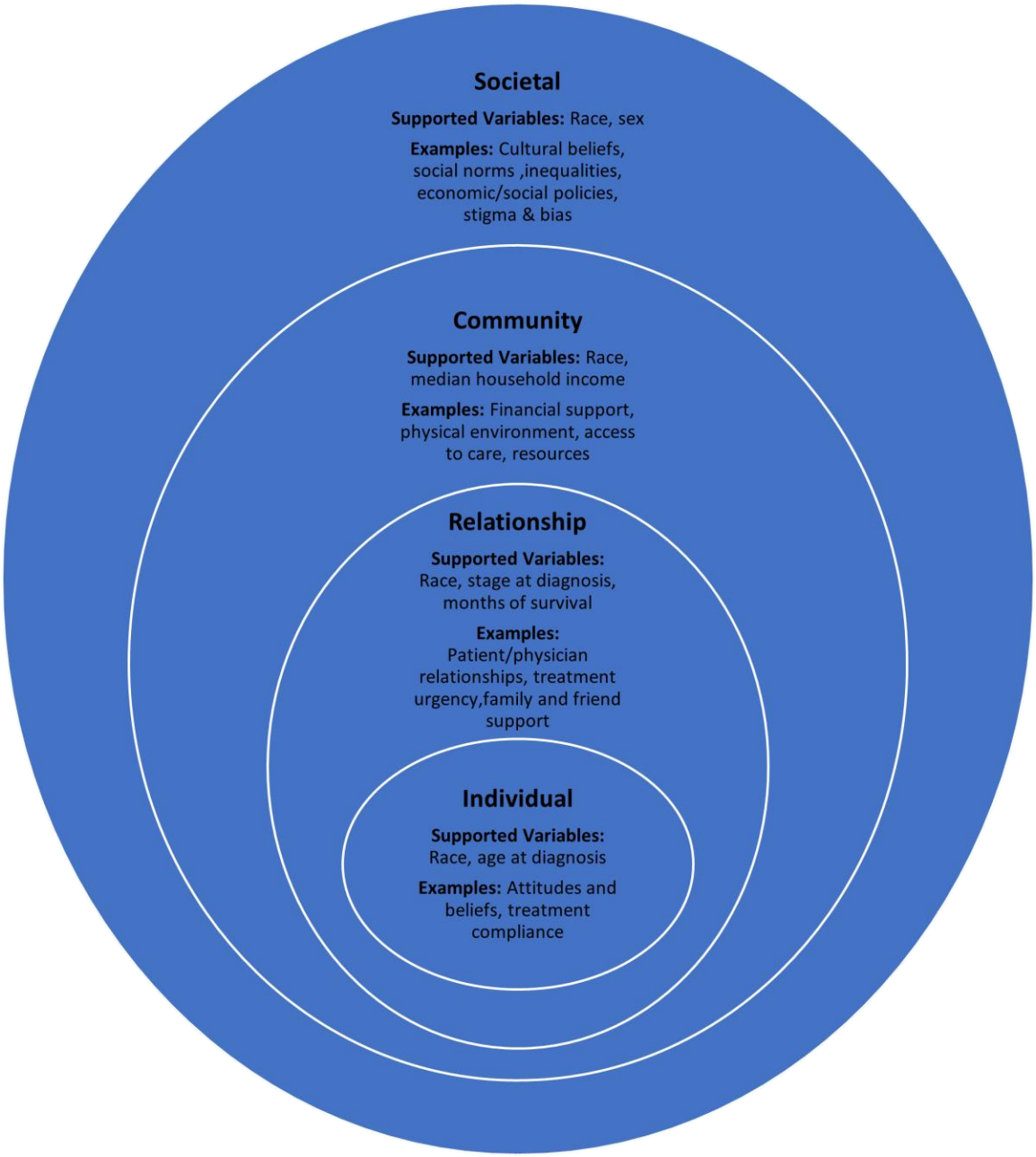
Conceptual Framework

The social-ecological model is a theory which allows integration between behavioral and environmental change by encompassing four essential constructs: societal, community, relationship and individual (CDC, 2021). Overall health is influenced by

interactions between individual, community, and environmental characteristics, including physical, social, and political components (Kilanowski, 2017).

Figure 2

Social-Ecological Model



The social-ecological model is frequently used throughout research and could be used to better understand multiple myeloma. The social-ecological model is a theory-based framework that can be used to pinpoint behavioral and organizational leverage points to encourage a system of equity specifically while operationalizing cancer prevention and control plans (Palafox et al., 2018). The social-ecological model has multiple influences on the societal, community, relationship, and individual level and is significant when addressing continuous health disparities in healthcare across the U.S. (Palafox et al., 2018). Using a multi-care approach and assessing the social-ecological constructs for public health issues, in general, can ensure better outcomes and likeliness of success. The social-ecological model has been used throughout public health research for addressing cancer, obesity, literacy, and other significant public health issues as it emphasizes the importance of patients 'outcome on an individual construct. It also calls for advocacy and resources from the government and policymakers (Palafox et al., 2018).

According to the International Myeloma Working Group, ensuring the correct diagnosis of multiple myeloma requires procedures such as bone marrow biopsies, and identifying at least one myeloma-defining event is necessary for a confirmed diagnosis (Mateos et al., 2019). Policies in healthcare determine decisions, goals, and actions and as well as how care is administered and accessed. According to the CDC (2017), African Americans have a higher mortality rate at a young age for all causes. Young African Americans live with diseases that are typically more common at older ages for other races, such as high blood pressure, diabetes, and stroke (CDC, 2017). Understanding the

social-ecological model, which involves the interplay between individuals, communities, and society, can serve as a foundation for multiple myeloma research as it has for other types of cancer (see Figure 2). The social-ecological model provided a framework to contribute to a greater understanding of how factors such as race can impact outcomes and quality of life, specifically when considering stage at diagnosis for multiple myeloma patients.

The social-ecological model was used to identify and help to understand health disparities between African American and non-African American multiple myeloma patients. This model helps researchers break down barriers in healthcare by establishing a level and foundational understanding of how individuals, communities, relationships, and society could work together and achieve one goal in reducing health care disparities.

According to the International Myeloma Foundation (2020), 32,000 patients annually in the U.S. are diagnosed with multiple myeloma, of which 20% (6,400) are African American. Figure 2 shows the relationship between the research questions and social-ecological four constructs: societal, community, relationships and individual. Race plays a role in all four constructs, as mentioned previously, multiple myeloma is more prevalent among African Americans, but this population is also more likely to have direct negative beliefs regarding healthcare. African Americans have been historically mistreated by the U.S. healthcare system, and this has caused mistrust for many generations. As a collective, African Americans are hesitant to receive healthcare advice and treatment, especially from physicians who do not share the same cultural background as they do (Wells & Gowda, 2020).

The relationship constructed within the social-ecological model holds weight when assessing the outcome of healthcare received by multiple myeloma cancer patients. Specifically, the relationship between patients and physicians can directly affect patient compliance with treatment. Schwartz and Jenkins (2019) found that African Americans were more likely than Whites to identify barriers associated with out-of-pocket medical costs, as well as have anxiety and worry about appointments or not having the means to get an appointment. Strengthened physician-patient relationships correlates with improved patient outcomes, and physician-patient relationships can positively or negatively impact clinical care (Johnson, 2019).

The community construct as seen in figure two identifies examples in which the social-ecological model and multiple myeloma connect. Support, whether it's from family, friends, policy makers, community stakeholders, or leaders, plays a significant role in outcomes when diagnosed with cancer. The support of a network or community can ease logistical burdens of living with cancer, reduce stress, and provide emotional support during diagnosis and treatment (Kue & Browning, 2022). Household income, policies, and resources also can be factors when addressing quality of life of patients diagnosed with multiple myeloma. Pierre and Williams (2020) found that many African Americans living with multiple myeloma do not receive adequate care and may experience delays in diagnosis and treatment initiation. The social-ecological model sets a foundation for addressing the research questions (see Figure 2).

Nature of the Study

The nature of this research was quantitative; ordinal logistic regression, binary logistic regression, and multiple linear regression were used. According to Laerd Statistics (2023), ordinal logistic regression involved one or more independent variables and was used to predict an ordinal dependent variable. Binomial logistic regression was used to predict the probability that an observation will fall into one of two categories based on one or more independent variables that may be continuous or categorical. Lastly, as an extension of simple linear regression, multiple regression was used to predict a variable's value compared to two or more other variables (Laerd Statistics, 2023). I focused on race, sex, age at diagnosis, stage at diagnosis, and months of survival, and all variables were determined from the NIH SEER database.

The study population was gathered online, and all participants were diagnosed with multiple myeloma between 2016 and 2018. Search results provided a solid participation pool, and collected data used in this study will help contribute to future research studies. Results will help bring awareness about health disparities in healthcare and help in terms of developing concerted efforts to understand and perhaps target underrepresentation found in clinical studies, which could ultimately help lead to more equitable treatment, delivery, and positive outcomes for all multiple myeloma patients.

Operational Definitions

Health Disparities: If a health outcome is seen to a greater or lesser extent in one population compared to another, there is disparity. Race or ethnicity, sex, sexual identity,

age, disability, socioeconomic status, and geographic location all contribute to an individual's ability to achieve good health (ODPHP, 2020).

Stage at Diagnosis: Multiple myeloma can be classified into stages I, II, and III (localized, regional, or distant) based on diagnostic tests the doctor performs. Stage I (localized) indicates a less aggressive disease, and stage III (distant - a more advanced disease) indicates the most aggressive disease (Mayo Clinic, 2022).

Unknown: An unknown diagnosis according to the National Institute of Health SEER website, states that there will be cases for which sufficient evidence is not available to adequately assign stage (Examples: Patient expires before workup is completed, patient refuses procedure, and patient is limited to workup due to age or simultaneous contraindicating condition) (NIH, 2022).

Assumptions, Limitations, and Scope

Limitations are influences in the research that the researcher cannot control. Limitations of this study include use of secondary data and not being included in the gathering of the original data. Another limitation is that research on multiple myeloma is scarce, specifically when analyzing data on African Americans. Information bias is another factor to consider, which can occur when there is unintentional or intentional misreporting from participants. There is a large gap in research involving health disparities that are specific to multiple myeloma diagnosis. This could cause

difficulties in terms of not having much information to build upon as a researcher conducting secondary data analysis.

Delimitations are specific choices made by the researcher. To address health disparities of minorities, I focused on African American multiple myeloma patients and their stage at diagnosis compared to non-African Americans. I wanted to show the relationship between race and other factors specifically while looking at outcomes in terms of multiple myeloma diagnoses. All studies have assumptions, which are unexamined beliefs. I assumed participants all had equal access to preventable, equitable healthcare and treatment for multiple myeloma. I also assumed physicians in the United States are adequately trained in cancer diagnosis and treatment for African American patients.

Assumptions specific to the nature of this research include those tests used to ensure accuracy of data. The three forms of analysis used for this study were binary logistic regression, ordinal logistic regression, and multiple linear regression. Each statistical test has its own set of assumptions. For RQ1, I ensured that the dependent variable stage at diagnosis were dichotomous and could support two outcomes, ensuring that there were one or more nominal independent variables. Independence of observations was assessed to ensure there was no relationship between any category of dependent or independent variables. Lastly, assessing sample size was essential to ensure data accuracy. The next three assumptions for research question one was addressed through SPSS statistical analysis. A Box-Tidwell test was used to assess the linear relationship between continuous variables and the dependent variable. The Bonferroni correction was

applied in the model, resulting in statistical significance where $p < 0.01$. Based on this assessment, the independent variable race was found to be linearly related to the logit of the dependent variable stage at diagnosis. Assumption of multicollinearity ensured that no variables were highly correlated with each other. After running collinearity diagnostics using SPSS, the variance inflation factor value showed race (VIF =1.016), age at diagnosis (VIF =1.015), and sex (VIF =1.004). The last assumption model for RQ1 tested for outliers, which was not produced in my output due to all the cases having a standardized residual less than ±2.

For RQ2, assumptions were tested to ensure accuracy of data, and I assumed that the dependent variable age at diagnosis would need to be measured on an ordinal level. Next, the independent variable race would need to be ordinal or categorical. Testing for multicollinearity is important in ordinal regression to ensure that two or more variables are not highly correlated with one another (Laerd Statistics, 2023). This ensured that proportional odds were met. A parallel line test was analyzed and showed that parameters of proportional odds were not met, with $\chi 2(30) = 302.627$ and $p = <.001$. Since this assumption was not met, multinomial logistic regression was run using SPSS to satisfy the assumption of proportional odds. After running statistical analysis, it was found that race, sex, and median household income were significant predictors of age at diagnosis $p <.001$ for all three variables: stage at diagnosis, months of survival and median household income.

For RQ3, assumptions were run, and linearity was assessed by observing regression plots. Independence of residuals was confirmed via a Durbin-Watson statistic

of 1.752. A visual inspection of plots revealed homoscedasticity and no evidence of multicollinearity. In this study, there were no studentized deleted residuals that were larger than three standard deviations, no leverage values greater than 0.2, and no Cook's distance values higher than 1. According to a Q-Q plot, the assumption of normality was met. These tests of assumptions, along with several other specific tests were analyzed using SPSS, which ensured that data were acceptable.

Significance of the Study

According to the CDC (2022), more than 1.6 million people are diagnosed with cancer every year in the U.S., and nearly 600,000 people die from it. Cancer care costs continue to rise and are expected to reach almost $174 billion by 2020 (CDC, 2022). Data from the SEER database can be used to support research and treatment for multiple myeloma patients. Results of this study may expand on current research that demonstrates associations between race and multiple myeloma in African Americans. This study may also help determine if additional significant health disparities exist in terms of multiple myeloma diagnoses.

This study may help in terms of developing concerted efforts to understand and target underrepresentation found in clinical studies, which could help lead to more equitable treatment delivery and outcomes for all multiple myeloma patients. This study has the potential for positive social change in that it may assist in predicting unseen health disparities involving cancer diagnosis and identify possible deficiencies in current public health education as well as encourage participation for clinical trials and compliance with existing therapies. This study may also provide insights regarding

strategies that could lead to a more significant reduction of disparities found in healthcare altogether for all cancer patients.

Cowan et al. (2022) claimed approximately 57% of multiple myeloma patients have some indicating factors or conditions that point to their multiple myeloma diagnosis Approximately 73% of multiple myeloma patients had anemia, 79% had osteolytic bone disease, and 19% had acute kidney injury at the time of presentation (Cowan et al., 2022). Providing an understanding of how disparities contribute to multiple myeloma outcomes leads to contributions to social change in terms of awareness, prevention efforts, and future studies. Landgren (2017) studied the prevalence of monoclonal gammopathy of undetermined significance in younger individuals between 10 and 49 years. The population studied included 12,372 individuals: 4,073 African Americans, 4,146 Mexican American, 3,595 Whites, and 558 Other race.

Monoclonal gammopathy of undetermined significance, a precursor to multiple myeloma, was shown to be higher in African Americans (88%) compared to White Americans (22%) (Landgren, 2017). Creating awareness and programs involving monoclonal gammopathy of undetermined significance could make a significant difference in the rate reducing the significance of multiple myeloma throughout the U.S. I explored the concept of health disparities and how they truly impact underrepresented populations in the U.S. Multiple myeloma is a disease that is a public health concern, and researchers can use this study to develop additional awareness and produce resources among those who are affected.

Literature Review

In this section, I explore peer-reviewed literature involving African Americans and multiple myeloma cancer. I specifically review health disparities and critical factors that lead to healthcare inequities among multiple myeloma patients. In addition, I examine differences in outcomes between African Americans and non-African Americans throughout the U.S.

The prevalence of multiple myeloma among African Americans is higher than non-African Americans (Smith et al., 2018). African Americans are two times more likely to have multiple myeloma than persons of Caucasian descent and almost four times more likely to have it than Asians and Pacific Islanders (Smith et al., 2018). I provide an overview of cancer statistics and multiple myeloma in the U.S., focusing on stage at diagnosis. I then explore the social-ecological model. Lastly, I explore identified social and contextual factors related to multiple myeloma health disparities and stage at diagnosis.

Search Strategy

For this study, I used SAGE Premier, PubMed, Wiley Online Library, EBSCO Host, and JSTOR to search for articles published between 2017 and 2022. I used the following keywords: *multiple myeloma, African Americans and myeloma*, *health disparities, cancer disparities, biological determinants, racial disparities, myeloma treatment, socioeconomic factors, genomics, multiple myeloma treatment, cancer statistics, myeloma incidence, myeloma mortality, social-economic factors, disparities in treatment, trends in multiple myeloma*, and *cancer mortality*.

Overview of Cancer Statistics and Multiple Myeloma in the U.S.

Cancer is a disease characterized by uncontrollable growth and the spread of abnormal cells throughout the body (DeSantis et al., 2019). The cause of cancer is not fully understood, but specific risk factors are known to increase one's risk, such as unhealthy lifestyle habits, alcohol, and smoking (DeSantis et al., 2019). In the U.S., cancer is the second leading cause of death after heart disease (DeSantis et al., 2019). In 2020, over 600,000 deaths in the U.S. were associated with cancer, with men dying at higher rates than women (CDC, 2022). There have been substantial advancements in cancer prevention, treatment, and diagnosis over the years. Screening is an essential factor when considering cancer prevention or early diagnosis. Detecting cancer in its early stages can save lives and encourage early or less intrusive treatments (DeSantis et al., 2019).

Multiple Myeloma

Also known as Kahler's disease, multiple myeloma is a blood disease with no cure but plenty of treatments that can slow down progression (Pathak, 2021). In patients with multiple myeloma, the white blood cells that are essential to fighting internal infections do not function as intended, but instead break down the body's ability to defeat illnesses. A person with multiple myeloma can experience increased immunoglobin, which is a protein in the blood, and when elevated, can cause organ damage. As multiple myeloma gets worse, plasma cells spill out of the bone marrow and spread, and in return this causes more organ damage (Pathak, 2021). Multiple myeloma complications include bone problems, blood problems, infections, and kidney damage. Many patients do not

live through these complications, and those who do often experience difficulties involving everyday skills (Pruthi, 2022). Giaquinto et al. (2022) noted that a small fraction of variations in cancer mortality rates could be attributed to genetic differences, and most African American-White disparities are due to variations in socioeconomic status and access to care because of decades of structural racism.

DeSantis et al. (2019) found African Americans bear a disproportionate share of the cancer burden in the U.S. African Americans often experience lower socioeconomic status, which leads to many racial inequities such as lacking adequate insurance coverage. Substantial progress has been made to reduce cancer disparities over the past several decades; however, it is still important to continue progress towards equitable cancer outcomes. Progress can be made by expanding access to high-quality cancer prevention, in addition to early detection and treatment for all Americans (DeSantis et al., 2019). Multiple myeloma is characterized as a malignancy of plasma cells that accumulate in the bone marrow and ultimately overproduce a monoclonal protein (Mayo Clinic, 2017). Multiple myeloma is responsible for 1.6% of all cancer cases and approximately 10% of hematologic malignancies in the U.S. (Michaels & Petersen, 2017). According to the ACS (2019), 14.1 per 100,000 non-Hispanic Blacks are likely to get multiple myeloma compared to 6.1 per 100,000 non-Hispanic Whites. African Americans are also more likely to die from multiple myeloma than other races. Marinac et al. (2020) found that multiple myeloma is a fatal plasma cell dyscrasia with a median overall survival rate of 5-10 years.

Marinac et al. found significant racial disparities throughout the progression of the illness, and claimed the root of this disparity is multifactorial. When comparing patients, there are differences in terms of risk factors, biology, clinical characteristics, and frequency of participation in clinical studies. Multiple myeloma is a public health issue that deserves more research, and there are multiple factors to consider when addressing health disparities among multiple myeloma patients (Marinac et al., 2020). According to Singh and Jemal (2017), individuals in more deprived areas or with lower education and income levels had higher mortality and incidence rates. Excess risk was particularly marked for lung, colorectal, cervical, stomach, and liver cancer. Education and income inequalities were more likely in lower socioeconomic groups, and cancer mortality was higher among African Americans. Many factors contribute to outcomes associated with multiple myeloma diagnoses, especially relating to the costs of care.

Ailawadhi et al. (2018) highlighted that health disparities exist among minority populations in the U.S.; thus, exploring multiple myeloma care and racial disparities is warranted. Ailawadhi et al. found there is higher Medicare use by Hispanics and Asian patients who have multiple myeloma compared with White and African Americans, which suggested that supplemental insurance may be used to a lesser extent because of affordability issues. Fila and Wildes (2017) discussed racial disparities in treatments that are used for multiple myeloma by studying patterns of stem cell transplantation and bortezomib treatment within African American patients who have been diagnosed with multiple myeloma, and found that stem cell transplantation and bortezomib treatment methods have dramatically improved prognoses in many patients especially among the

African American community; eliminating health disparities is an ongoing public health issue that can be complex in patients with multiple myeloma and barriers are not entirely explained. Other factors such as structural barriers in the healthcare system and individual decision-making among African American patients need to be explored further. According to Ganguly et al. (2019), even with recent improvements in patient outcomes, there are undoubted disparities in terms of race and ethnicity. Although outcomes for patients with multiple myeloma have improved since 2003, substantial disparities are noted globally across rural and urban settings and among different races and ethnicities. According to the WHO (2019), early cancer diagnosis allows patients the best chance for survival. Therefore, early diagnosis improves cancer outcomes by providing care at the earliest possible stage, which is an effective public health strategy in all settings (WHO, 2019). Pierre and Williams (2020) suggested that African Americans living with multiple myeloma do not receive adequate care and may experience delays in treatment initiation. This can be due to financial and social disparities as well as lack of cultural competency among healthcare teams. There have been improvements in multiple myeloma survival rates; however, healthcare disparities still need to be addressed overall.

With increased knowledge regarding these disparities, nurses and physicians can help eliminate inequalities (Pierre & Williams, 2020). Patients who belong to minority populations experience greater health disparities involving multiple myeloma compared to those who are not in these populations. Daniel et al. (2018) mentioned access to care is an important factor to consider when addressing differences in survival. Patients from specific zip codes were less likely to survive compared to others (Tabuchi, 2020).

Race/Ethnicity

Race and ethnicity tend to play a significant role in cancer diagnosis, and a disproportionate number of cancer deaths occur within specific ethnic groups (ACS, 2019). African Americans are the second-largest racial and ethnic minority group in the U.S., after Hispanics. It has been projected that by 2060, African Americans will make up 15% of the total U.S. population (ACS, 2019). African Americans have the highest death rates and shortest survival rates of any racial or ethnic group in the U.S. for most cancers (ACS, 2019). Disparities in terms of lower overall survival rates among African Americans and worse socioeconomic factors lead to less access to novel treatments and an extended quality of life (Covut et al., 2020).

Race and ancestry play a significant role in predicting risks of multiple myeloma; however, there is little research to support this. Monoclonal gammopathy of undetermined significance and multiple myeloma are both two to three times more common among African Americans, Afro-Caribbeans, and Africans compared to persons of European ancestry (Asher & Streetly, 2021). Monoclonal gammopathy of undetermined significance is the premalignant condition before multiple myeloma and is more frequent among African Americans than those of European descent. African Americans were 17% more likely to develop multiple myeloma compared to European Americans at 15% (Asher & Streetly, 2021).

Age

According to the ACS (2019), the risk of developing multiple myeloma goes up as you get older. Costa et al. (2017) studied recent improvements seen amongst multiple

myeloma patients. The study was conducted with 34,505 multiple myeloma patients, of whom 13,229 patients (38.9%) were under the age of 65, while 9,834 patients (28.5%) were between 65 and 74, and 11,442 patients (33.2%) were 75 or older (Costa et al., 2017). There have been notable gains in survival rates among ethnic minorities, specifically in terms of multiple myeloma patients who are between 65 and 74 (Costa et al., 2017). Access to care and cultural patterns may play a bigger role in survival than biological aspects (Costa et al., 2017). According to the NCI (2021), the incidence rate for cancer climbs steadily as age increases from fewer than 25 cases per 100,000 in age groups under 20 to about 350 per 100,000 for persons between 45 and 49 and 1,000 per 100,000 for adults who are 60 years and older.

Many studies have been conducted on relationships between multiple myeloma and projected health disparities. Older age leads to higher risk for multiple myeloma (Covut et al., 2020). Covut et al. (2020) investigated contributions of early mortality to the long-term survival of multiple myeloma patients while looking at race and age. They identified 76,878 multiple myeloma patients, of which 80% were European American and 20% were African American. Early mortality, which is defined as death less than 6 months after diagnosis, occurred in 8,783 patients (11%); early mortality occurred for 10.3% (95% CI: 9.8– 10.7) of African Americans and 11.7% (95% CI: 11.5–11.9) of European Americans (Covut et al. 2020). The racial gap in terms of early mortality widened for elderly patients who were older than 65 years with rates of 13.8% (95% CI: 13.0–14.7) for African Americans and 15.7% (95% CI: 15.3–16.1) for European Americans (Covut et al.,2020). The early mortality rate among patients who were

younger than 65 at diagnosis was higher in African Americans (7.4%, 95% CI: 6.8–7.9) compared with European Americans (6.5%, 95% CI: 6.2–6.8). This may be because European Americans more often received immunomodulatory drugs (19% vs. 18%, $p < 0.013$) and autologous hematopoietic stem cell transplant (22% vs. 17%, $p < 0.0001$) compared with African Americans (Covut et al., 2020).

Sex

DeSantis et al. (2019) found that cancer was the second leading cause of death among both men and women. The study shown a population of 35,215 non-Hispanic African American men having cancer compared to 34,510 non-Hispanic African American women. In the same study, among non-Hispanic White participants, 23% of men were diagnosed with cancer compared to 21% non-Hispanic White women. DeSantis et al. (2019) found that when assessing the estimated new cases of myeloma, 3,410 (3%) persons out of a total population of 98,020 were male. Similarly, 3,500 (3%) persons out of 104,240 were female (DeSantis et al., 2019). Derman et al. (2021) conducted a study analyzing the sex differences in outcomes in multiple myeloma. The researchers used data from the Surveillance, Epidemiology and Results Program for the period 2000-2017 and identified multiple myeloma patients N=78,351. The researchers found that overall survival and progression-free survival was significantly better for females than males. It was suggested that biologic sex plays a role in multiple myeloma diagnosis and outcome, and this topic alone requires further investigation. The researchers did however make an indication that certain factors might explain better outcomes of overall survival and progression-free survival for women than men. It was

noted that women tend to have healthier attitudes and behaviors after intensive treatment. Similarly, male patients have more comorbidities at the time of diagnosis, which may contribute to poorer health outcomes (Derman, 2021).

Socioeconomic Status

Socioeconomic status is the social standing or class of an individual or group, and it is often measured as a combination of education, income, and occupation (ACS, 2022). Analyzing socioeconomic and racial/ethnic patterns in cancer mortality and incidence is essential because it allows us to quantify cancer-related health disparities between the least and most-advantaged social groups. This will help to identify areas or population groups that are at most significant risk of cancer diagnosis and mortality and who may therefore benefit from targeted social and medical interventions (Singh & Jemal, 2017).

Persons with lower socioeconomic status are more likely to have higher cancer mortality rates compared to those of a higher socioeconomic status (Singh & Jemal, 2017). Persons of lower socioeconomic status have a higher probability of having advanced staged cancer when diagnosed and a lower chance of early detection (Singh & Jemal, 2017). A study of 15,357 American men and women found that those with ≥16 years of education are a sub-set of those with ≤11 years of education and were likely to have advanced-stage colon cancer. Similarly, subjects with an annual median household income <$12,500 were 1.38 times more likely than subjects with an annual median household income >$50,000 to have advanced staged colon cancer when diagnosed (Tabuchi, 2020). This shows that socioeconomic status influences a person's ability to receive equitable care. According to Arpey et al. (2017) physicians are less likely to

perceive low socioeconomic status patients as intelligent, independent, or responsible and believe that they are less likely to comply with medical advice or return for routine follow-ups, and it has been shown that these physicians' perceptions directly impact clinical decisions. Socioeconomic status is paramount in understanding cancer outcomes. Throughout my study, Median Household Income is based on data pulled from the Surveillance, Epidemiology, and End Results database of individual patient income ranging between $35K and $75K.

Social-Ecological Model

There have been improvements in survival for multiple myeloma patients compared to those diagnosed in prior decades (Costa et al., 2017). The social-ecological model was introduced as a conceptual framework in the 1970's and formalized as a theory in the 1980's. Psychologist Urie Bronfenbrenner developed the "social-ecological model" (The Ecology of Human Development) to recognize that individuals affect and are affected by a complex range of social influences and nested environmental interactions (Bronfenbrenner, 1974). The social-ecological model is a very common theory used and was utilized as a conceptual framework to guide this study. The social-ecological model considers the complex interplay between the individual, relationship, community, and society (Bronfenbrenner, 1974).

The individual construct of the model will be used to discuss the importance of health literacy as well as possible biological or genetic connections seen in multiple myeloma patients. The relationship construct can be used to address patients' relationship with their physician and the importance thereof. The relationship construct can also

address further health disparities, including media, oppression, racism, marginalization, and quality of life-based on one living condition. The community construct can be addressed by understanding the impact cancer has on specific communities compared to others and stressing the importance of health education and literacy. Additionally, as shown in Figure 2, the community construct can be used to address screening policies and testing procedures. The society construct can encompass a range of organizational and political strategies which can improve multiple myeloma support and outcomes in the United States. Strategies can be encouraged to address decisions about laws, policies, regulations, resources, and money directly and indirectly associated with health disparities and those diagnosed with multiple myeloma.

The social-ecological framework can be used to leverage organizational structure that, in turn, can create better outcomes for multiple myeloma patients. Multiple myeloma is twice as common in African Americans as in White people, with an even more significant disparity in younger age groups (Rajkumar, 2020).

Individual

The individual construct influences behaviors such as knowledge, beliefs, and personality (CDC, 2021). According to Rajkumar (2020), multiple myeloma is always preceded by a premalignant condition called monoclonal gammopathy of undetermined significance. Monoclonal gammopathy of undetermined significance is characterized by an abnormal monoclonal immunoglobulin protein in the blood and sometimes by a precursor condition called smoldering multiple myeloma, which can be present for many years before diagnosis. This information alone could set individuals up for possible early

diagnosis. It is essential for patients to practice efficient health literacy to recognize the potential benefits of early intervention. African Americans have a higher risk of two to three times more likely to have monoclonal gammopathy of undetermined significance, which is critical for physicians to identify so they can provide appropriate testing leading to an early-stage diagnosis (Rajkumar, 2020). The individual construct also encompasses patient attitudes or beliefs about specific treatment of diagnosis. It is paramount that patients are provided adequate resources to help assist them in making the best decision regarding their health. A study analyzing African American views about health disparities within health care found that 40% of African American adults say they have had to speak up to get the proper care either recently (13%) or in the past (27%), furthermore demonstrating the importance of patient centered care (Funk, 2022).

Relationship

The relationship construct focuses on a person's interactions with other people; this can be in a social support setting, for example, a patient's relationship with their physician. Relationships must be valued both ways; the patient should maintain preventative care and treatment while the physician provides equitable care for all patients. Despite encouraging trends of decreasing myeloma death rates, health disparities still exist in outcomes when looking at race/ethnicity (Ailawadhi et al., 2018). It is well documented that African American individuals have a disproportionate cancer burden, including the highest mortality and the lowest survival of any racial/ethnic group for most cancers (Ailawadhi et al., 2018). It is paramount for physicians to recognize this and, with their expertise, establish ways to communicate more effectively and ensure

compliance with recommended treatment. Similarly, it is beneficial for patients to have a strong social relationship with family or friends to help encourage them through the treatment process.

Community

Characteristics associated with lower income areas increase the risk of cancer incidence and mortality, disproportionately affecting African American people (Giaquinto et al., 2022). The community construct focuses on formal or informal social norms that exist among individuals, groups, or organizations, all of which can benefit or hinder a particular community (Giaquinto et al., 2022). Access to adequate healthcare could be a factor associated with a late-stage diagnosis of multiple myeloma. Researchers have found that social factors, including economic disadvantage, inequities in education, and lack of access to health care, impact a person's ability to lead a healthy and productive life (Taylor, 2019). Having access to healthcare and understanding that health literacy is paramount to adequate treatment is essential to creating a successful complex interplay between community and healthcare. Food desert conditions and the lack of safe outdoor physical activity are more prevalent in low-income neighborhoods. As a result, they are associated with poor health outcomes, including reduced survival (Giaquinto et al., 2022).

Society

Racial/ethnic disparities in multiple myeloma care are multifactorial, with differential utilization of and access to treatments, such as novel drugs and stem cell transplantation, and the interplay of patient age and insurance status (Zavala et al., 2020).

The society construct encompasses the broad societal factors that create certain environments where specific behaviors or outcomes are encouraged (CDC, 2021). An important aspect of the societal construct is understanding the influence of laws, policies, and resources. There are many ways multiple myeloma can be diagnosed, including blood tests, urine tests, x-rays, bone marrow biopsies, or imaging tests, to name a few; ensuring that these specialized tests are available in all communities is an essential factor in preventing disparities. The benefits of early intervention are important to emphasize, and screening to detect multiple myeloma at its smoldering stage is justifiable and should be highly encouraged considering early therapy has been shown to provide clinical benefit especially in populations where prevalence is particularly high (Zavala et al., 2020).

Cancer diagnosis typically entails several approaches, depending on the type of symptoms a person experiences, the physician will decide on which approach to use. Physical exams, laboratory tests, imaging tests and biopsies are the most common approaches to diagnosing cancer (Pruthi, 2022). Understanding how laws and policies directly impact the quality and quantity of resources accessible to at risk communities is essential and can adversely impact a patient's quality of life.

Stage at Diagnosis

The International Staging System uses serum beta2-microglobulin and albumin levels and is the most widely adopted multiple myeloma staging system (Durie, 2021). According to the American Cancer Society, the revised international staging system categorizes the Stage at Diagnosis as the following: Stage zero- serum monoclonal

protein (immunoglobulin A or immunoglobulin G) greater than or equal to 30 g/L or urinary monoclonal protein greater than or equal to 500 mg per 24 hours and/or clonal bone marrow plasma cells 10-60 percent *(American Cancer Society, 2018)*. Stage one- Serum β2 microglobulin < 3.5 mg/L; Stage two- Serum β2 microglobulin < 3.5 mg/L or Serum β2 microglobulin 3.5 to 5.5 mg/L, irrespective of serum; Stage three- Serum β2 microglobulin > 5.5 mg/L (Durie, 2021).

Data collected by the NCI SEER database are used and relied upon by the American Cancer Society *(American Cancer Society, 2018*). The SEER program identifies three stages of diagnosis as the following: Localized where only one tumor is growing in the bone or outside the bone. Regional where according to the ACS, this stage does not apply to multiple myeloma because this type of cancer does not spread to lymph nodes, and distant where many tumors are found inside and outside of the bones.

Before patients develop multiple myeloma, they pass through two earlier disease stages: monoclonal gammopathy of undetermined significance and smoldering myeloma (Durie, 2021). Monoclonal gammopathy of undetermined significance is the earliest stage of multiple myeloma and is not cancer but more of a benign condition in which patients experience a low level of monoclonal protein, also called M- protein. Patients also display a low level of abnormal plasma cells in the bone marrow but show no indicators of active disease. Though monoclonal gammopathy of undetermined significance is not cancerous, it has an annual risk of progression of 1% per year, and around 20% of the patients develop multiple myeloma, amyloid, or lymphoma, with 70% of these patients developing multiple myeloma (Durie, 2021). Smoldering myeloma represents patients

who do not have any symptoms or organ damage; it is considered pre-cancerous and is shown when there are certain proteins in the blood or an increase of plasma cells in bone marrow, patients with smoldering myeloma experience monoclonal gammopathy of undetermined significance with a higher but stable number of abnormal plasma cells. Patients with smoldering myeloma will have minimally progressive myeloma without calcium elevation, renal dysfunction, anemia, and bone disease criteria or myeloma-defining events. Lastly, the patients will display moderately progressive myeloma, but with no damage to red blood cells, kidneys, or bones.

Smoldering multiple myeloma has an overall higher risk of progressing to multiple myeloma compared to monoclonal gammopathy of undetermined significance. The incidence and prevalence of smoldering myeloma are widely unknown; however, a study conducted by Kristinsson et al. (2013), used the Swedish Myeloma Registry from 2008-2011 with a total of 2,494 patients with newly diagnosed myeloma, the population specifically shown that 360 (14.4%) of the patients had smoldering multiple myeloma. Among the 360 patients with smoldering myeloma, 104 (28.8%) developed high-risk smoldering myeloma; persons with high-risk myeloma accounted for 4.2% of all patients with any type of newly diagnosed multiple myeloma (Kristinsson et al., 2013). The age-standardized incidence of smoldering myeloma was determined to be 0.44 cases per 100,000 persons (Landgren, 2017).

Summary

Multiple myeloma is a major disease in the U.S. that is common in African American communities. Healthcare disparities across different ethnicities cause

inadequate health outcomes (CDC, 2017). Recent studies concerning multiple myeloma cancer and health disparities have various common themes involving age, gender, and race. Older people have a higher risk of having multiple myeloma (Covut et al., 2020). Race is another important risk factor (Taylor, 2019). According to the CDC (2021), the prevalence of multiple myeloma among African Americans is higher than non-African Americans. African Americans are two times more likely to have multiple myeloma than persons of Caucasian descent and almost four times more likely to have it than Asians and Pacific Islanders (CDC, 2021). Specific risk factors such as race, age, sex, and unhealthy lifestyle habits can make one more susceptible to getting multiple myeloma (CDC, 2021).

According to the Office of Disease Prevention and Health Promotion (2014), cancer objectives for Healthy People 2020 support monitoring trends in terms of cancer incidence, mortality, and survival to better assess progress made towards decreasing trends of cancer in the U.S. Findings of this study will provide insights regarding stage at diagnosis and how it possibly contributes to the cycle of health disparities. There have been few studies investigating health disparities among multiple myeloma patients while considering their race and stage at diagnosis and the potential effects of sex, age at diagnosis, median household income, and months of survival. It is essential to address stage at diagnosis because late-stage diagnosis leads to a higher probability of early death and takes away the patient's choice of receiving adequate treatment and limits their probability of survival. This study can provide awareness to those living with multiple myeloma and researchers looking to improve public health.

Section 1 included a review of current literature on multiple myeloma, the social-ecological model, and how it was used in this study. In Section 1, I presented studies to support the social-ecological model and risk factors. I focused on race, sex, survival, and age findings related to multiple myeloma risk factors. In my study, I further investigate multiple myeloma, specifically looking at stage at diagnosis and how differences in outcomes might occur due to known health disparities. In Section 2, the research design, population, sampling rationale, and power analysis are discussed. Also, the data collection process, instrument, and data analysis plan for independent and dependent variables is presented.

Section 2: Research Design and Data Collection

I aimed to investigate disease-specific health disparities involving multiple myeloma, specifically stage at diagnosis (staged versus unstaged) in African American populations in comparison to their non-African American counterparts. I addressed potential effects of sex, age at diagnosis, median household income, and months of survival on stage at diagnosis and analyzed the differences in outcomes between African Americans and Whites. I analyzed these results to expand on current research demonstrating associations between race and stage at diagnosis in terms of multiple myeloma in African Americans. This study may help determine if additional significant health disparities exist involving those found in multiple myeloma diagnoses. I used quantitative methods with ordinal and binary logistic regression in addition to a multiple linear regression analysis to research this topic.

For this study, multiple linear regression was used based on past similar studies involving multiple myeloma survival. With multiple linear regressions, independent variables are each optimally weighted such that their composite will have the most significant possible correlation with the dependent variable (Jensen, 2006). Ordinal logistic regression was used in this study to model the relationship between the independent variable race and dependent variable age at diagnosis. Lastly, binary logistic regression was used to test the predictor variables race and the nature of the relationship between the variables will be analyzed for stage at diagnosis, age at diagnosis and sex to identify important factors impacting the target variables.

Research Questions and Hypotheses

The aim of this research was to answer the following questions and test associated hypotheses:

RQ1: Is there an association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex?

$H_0$1: There is no association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex.

H_a1: There is an association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex.

RQ2: Is there an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income?

$H_0$2: There is no association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

H_a2: There is an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

RQ3: Is there an association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income?

$H_0$3: There is no association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income.

H_a3: There is an association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income.

Methodology

Population

Secondary data were collected from the NIH SEER database. The population included a sample from population-based cancer registries, covering approximately 48.0% of the U.S. population (NIH, 2022). The SEER program is the only comprehensive source of population-based information in the U.S. that includes stage of cancer at the time of diagnosis and patient survival data (NIH, 2022). I examined health disparities that exist among multiple myeloma cancer patients while also looking at associated variables.

Sampling Procedures and Sample Size

Sampling included data collected from 31 population-based cancer registries that are part of the SEER program throughout the U.S. Registries include persons from the following states: Kentucky, Greater California, Utah, Louisiana, Georgia, New York, Massachusetts, Wisconsin, and Idaho, who all receive funding from the CDC.

For RQ1, the dependent variable stage at diagnosis and independent variable race were assessed with the covariates age at diagnosis and sex. G*Power analysis was used for binary logistic regression to determine sample size. The minimum sample size required for this study based on G*Power analysis to provide a level of significance was 311. I needed at least 311 study participants from the sample population to achieve a power of 80%. The alpha level was set at .05, power level of .80 (80%) with a medium effect size (see Figure 3). For RQ2, the dependent variable age at diagnosis, independent variable race and covariates sex and median household income were assessed. The power analysis for minimum sample size calculations was conducted using the Mann-Whitney

test for ordinal logistic regression. The Mann-Whitney test is mainly used with larger sample sizes (Walters, 2004). The alpha level for RQ2 was set at .05 with a power level of .80 and medium effect size. T-test output was 75, the output shows that I needed at least 89 study participants from the sample population to achieve a power of 80%.

To calculate sample size for RQ3, the dependent variable months of survival, independent variable race and covariates stage at diagnosis and median household income were assessed, a multiple regression G*Power analysis was used. The effect size was shown at 0.15, with three predictors. The minimum sample size required for the study based on G*Power analysis to provide a level of significance was 77. I needed at least 77 participants from the sample population to achieve a power of 80%. The alpha level was set at .05 with a power level of .80 (80%) and medium effect size. For all three research questions, the alpha level was set at .05 with a power level of .80 (80%). The null hypothesis will be accepted for this study if the p-value is greater than .05. The null hypothesis will be rejected if the p-value is less than .05, which will determine whether there is a significant difference between the variables.

Figure 3

*G*Power Analysis Logistic Regression*

Analysis:	A priori: Compute required sample size	
Input:	Tail(s)	= Two
	Pr(Y=1|X=1) H1	= 0.4964029
	Pr(Y=1|X=1) H0	= 0.3
	α err prob	= 0.05
	Power (1−β err prob)	= 0.80
	R^2 other X	= 0
	X distribution	= Binomial
	X parm π	= 0.19
Output:	Critical z	= 1.9599640

Total sample size = 311
Actual power = 0.8002334

Data Analysis Plan

Ordinal Logistic Regression

The data analysis plan summary is presented in Table 2. SPSS software was used to analyze the data for all three research questions, any missing data was omitted, and the rest of the data analyzed. Ordinal logistic regression is used to predict an ordinal dependent variable given one or more independent variables (*Laerd* statistics, 2018). For my study, the independent variable race was used to predict the dependent variable age at diagnosis, while sex and median household income were assessed as confounding variables. When conducting ordinal regression, the output is essential to understanding the significance of data. The test of parallel lines is used to test the assumption of proportional odds, the output should be greater than .05 (Laerd Statistics, 2018).

The model fitting information is essential as it allows you to determine how well the model fits the given data, in this outcome we would like to see a value of less than .05 for statistical significance (Laerd Statistics, 2018). In the goodness of fit value, we want the significant value to fail, therefore we want the value to be greater than .05 (Laerd statistics, 2018). A p-value less than or equal to the significance level of .05 will result in a rejected null hypothesis and infer that there is a statistically significant association between the variables. If the p-value is larger than the significance level.05, I will not

reject the null hypothesis as there is not enough evidence to conclude that there is an association between the variables.

Binary Logistic Regression

During data analysis, there was a deviation from the planned analysis. Ordinal logistic regression was originally planned to be used for research question 1, but binary logistic regression was instead used. Data analysis using SPSS revealed that many patients were diagnosed at distant stages of multiple myeloma compared to regional or localized stages. As a result of this overrepresentation, the original plan was deviated from. Binary logistic regression was ran using SPSS software, this predicted the probability that an observation fell into one of two categories. The binary logistic regression technique estimates the relationship between dichotomous dependent variables based on one or more independent variables (Laerd Statistics, 2018). For my study, race was used to predict stage at diagnosis (staged vs unstaged), while age and sex was used as confounding factors. The output for a binary regression analysis is essential for the significance of data. Using the Hosmer-Lemeshow goodness-of-fit test, I determined whether the data is acceptable and how well it fits the model. When the Hosmer and Lemeshow goodness of fit test is greater than 0.05, the model is considered a good fit (Laerd statistics, 2023). Another way to determine significance between the variables is to analyze the Omnibus test of model coefficient summary in which chi-square test are used to see if there's a significant difference between the log-likelihood of the baseline model and new model. Lastly, Nagelkerke R Square values are used to understand the variation found within the dependent variable (Laerd statistics, 2023).

Multivariable Analysis

After performing an ordinal regression analysis and binary logistic regression, I investigated the potential impact of the main independent variable (race), dependent variables (months of survival) and covariates (median household income, and stage at diagnosis (staged vs unstaged) on the overall outcome of multiple myeloma survival months. A multivariable analysis allows all variables to be measured for correlation. The results showed a 95% confidence interval and the p-value for the model to be low or high in that the lower the p-value, the greater the statistical significance of the observed difference. A p-value of 0.05 or lower is generally considered statistically significant (Laerd statistics, 2018).

Covariates/Confounders

The covariates associated with this study include age, sex, median household income and stage at diagnosis (staged vs unstaged) as seen below in Table 1. Previous research on multiple myeloma has included sex, survival, insurance type, race, among other variables. For example, Ailawadhi et al. (2018) explored the clinical characteristics at the time of presentation and during the disease course, patterns of management, cost of care, and outcomes to provide a different lens to outcomes seen among multiple myeloma patients. The researchers' results indicated that there had been significant changes in multiple myeloma management over time. These results can provide an understanding of the factors that may help explain racial differences in outcome. In another study, Smith et al. (2018) explored the influence of race and ancestry on the immune system. The researchers found that the relationship between genes, race, and disease is complex and

needs to be explored further, especially when considering populations at risk of developing illness such as multiple myeloma.

Table 1

Original Plan: Research Questions, Variables, and Statistical Tests

RQ	Independent variable	Dependent variable	Statistical test	covariates
1	Race	Stage at diagnosis (staged versus unstaged)	Ordinal regression	Age, sex
2	Race	Age at diagnosis	Ordinal regression	Sex, median household income stage at diagnosis (staged versus unstaged)
3	Race	Months of survival	Multiple linear regression	Median household income

Threats to Validity

Validity refers to the extent to which a concept is accurately measured in a study; it looks specifically at credibility (Trochim, 2020). It's important to consider internal validity, referring to the degree of confidence that the causal relationship being tested is trustworthy and not influenced by other factors and variables, and external validity referring to the extent to which the results from a study can be generalized to other situations (Trochim, 2020). Minimizing threats to internal validity is paramount in that it makes the conclusion of one's research credible and trustworthy. High internal validity demonstrates a causal link between the variables. External validity is minimized by ensuring a good sample is drawn, and the context of variables is thoroughly described (Trochim, 2020) . Since this is a correlational study using secondary data, the present

study results should be generalized to other populations with caution. As mentioned previously, SPSS revealed that many patients were diagnosed at distant stages of multiple myeloma compared to regional or localized stages causing an overrepresentation of patients diagnosed at the distant stage. This overrepresentation could compromise population validity, which looks at the degree to which the study results from a sample can be generalized to a larger target group of interest (Bhandari, 2022).

Ethical Considerations

Ethics is defined as norms for conduct and that it is a transparent understanding of what is acceptable and unacceptable behavior (Resnik, 2020). Ethics can be plausibly explained and recognized one way but is up for interpretation for many. Some people recognize common ethical norms but interpret, apply, and balance them in different ways considering their own experiences (Resnik, 2020). The data used in this study is secondary data from the Surveillance, Epidemiology, and End Results database; this data is collected and explicitly stored for future research and data analysis. Like primary data, secondary data has ethical considerations in that any identifying information on participants could be linked to an identified participant and would require a complete review by the board to ensure the data is truly anonymous (Tripathy, 2013). Ownership of original data should always be acknowledged in secondary research to ensure transparency pertaining to the data. The data collection for each participant includes a patient identification number. No personal data are to be used to identify participants in this study.

Summary

In Section 2, I provided a summary of the quantitative correlational study design. This study investigates age at diagnosis, sex, race, median household income, and stage at diagnosis as it relates to multiple myeloma cancer outcomes for African Americans compared to non-African Americans. Study results are based on secondary data collected from the NIH SEER database. Research questions and hypotheses were presented and assessed based on G*Power analysis and ordinal logistic regression sampling procedures. Effective sample sizes for each research question were determined, along with threats and internal and external validity. Results of this study are presented in Section 3.

Section 3: Presentation of the Results and Findings

The purpose of this study was to understand health disparities that exist among African Americans suffering from multiple myeloma while also looking at potential effects of stage at diagnosis (staged versus unstaged), sex, age at diagnosis, median household income, and months of survival. Section 3 includes a description of data, deviations from the original plan, descriptive and demographic characteristics of the sample, and statistical analyses (binary logistic regression, ordinal logistic regression, and multiple logistic regression) for data collected from the NIH SEER database.

Data Collection of Secondary Data Set

The SEER database was used to capture results for this study; it was a convenient tool for analyzing cancer-related statistics. It was used to view individual cancer records (SEER Stat, 2023*).* Statistics within the SEER database includes frequencies and rates, survival statistics, mortality data, case listings, and trends. The SEER database covers 26.5% of the U.S. population based on the 2010 census. Populations include White, African American, American Indian/American Native, and Asian/Pacific Islander. There are 17 geographic regions that are covered in this database. These are San Francisco, Connecticut, Hawaii, Iowa, New Mexico, Seattle, Utah, Atlanta, San Jose, Los Angeles, Alaska Natives, Rural Georgia, California, Kentucky, Louisiana, New Jersey, and greater Georgia (SEER Stat, 2023*).* To ensure reliability of the study, missing variables, out of range values, and outliers were removed from the original dataset.

Deviations from the Plan

The dataset collected from the NIH SEER database presented a challenge throughout the study that ultimately necessitated remediations for Section 2. Specifically, it was found by running frequencies through SPSS that many patients were diagnosed at the distant stage of multiple myeloma compared to regional or localized. It is not well documented in current research why many patients are diagnosed at the distant stage. There are, however, some factors that may explain this. Chamoun et al. (2021) found racial differences between types of insurance coverage, which in turn can play a significant role in cancer prevention and survival. African Americans were more likely to be uninsured or receive Medicaid (16%) compared to White Americans (6%). Chamoun et al. (2021) found that the type of insurance a patient has can directly impact the quality of care that they receive. Cancer screening is lower among minorities, especially African Americans, Hispanics, Asians, and Pacific Islanders as compared to their White counterparts (Liu et al., 2020). Screening and early diagnosis are essential to quality of life in patients and can also save lives. I used SPSS and set the stage at diagnosis as a binary variable: staged versus unstaged. Staged reflects that after screening, multiple tumors were found inside or outside the bones and the patient would be diagnosed at the distant stage, and unstaged means no data were collected for the specific patient. The original analysis for RQ1 was intended to be ordinal logistic regression, and the new analysis is binary logistic regression (see Table 2). Since localized and regional stages are not considered in this study, I assessed those who were diagnosed at the distant stage versus those who were not. Setting up staging this way allows readers to see

distinguishing differences between binary variables. I was able to effectively analyze and compare it against other variables.

Table 2

Deviations from the Plan: Research Questions, Variables, and Statistical Tests

RQ	Independent variable	Dependent variable	Statistical test	Covariates
1	Race	Stage at diagnosis (staged versus unstaged)	Binary logistic regression	Age at diagnosis, sex
2	Race	Age at diagnosis	Ordinal regression	Sex, median household income
3	Race	Months of survival	Multiple linear regression	Stage at diagnosis (staged versus unstaged), median household income

Descriptive and Demographic Characteristics

In this analysis, the target group was between 18 and 85+ and diagnosed with multiple myeloma between 2016 and 2018. The dataset was composed of 102,539 individuals whose data were collected from population-based registries covering approximately 48.0% of the U.S. population. Table 3 shows descriptive analyses of demographic variables.

Table 3

Descriptive Analysis for Demographic Variables

Variable Name	Category	Frequency	Percentage
Race	African American	19379	18.9
	Non-African American	83160	81.9
Stage	Unstaged	16096	15.7
	Staged	86443	81.1
Sex	Female	46004	44.9
	Male	56535	55.1
Age at Diagnosis			
	Age 15-19	6	.0
	Age 20-24	21	.0
	Age 25-29	82	.1
	Age 30-34	313	.3
	Age 35-39	805	.8
	Age 40-44	2050	2.0
	Age 45-49	4017	3.9
	Age 50-54	6974	6.8
	Age 55-59	10035	9.8
	Age 60-64	12662	12.3
	Age 65-69	15087	14.7
	Age 70-74	15236	14.9
	Age 75-79	14344	14.0
	Age 80-84	11504	11.2
	Age 85+	9401	9.2

Analysis of Hypotheses

RQ1

RQ1: Is there an association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex?

$H_0$1: There is no association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex.

H_a1: There is an association between race and stage at diagnosis in terms of multiple myeloma after controlling for age and sex.

For research question 1, SPSS descriptive statistics shown in Table 3 include race; African American (N=19,379) and non-African American (N=83,160), stage; unstaged (N=16,096) and staged (N=86,443), sex; female (N=46,004) and male (N=56,535) and age, shown as an ordinal variable grouped in five-year increments grouped from age 15 to 85+. For research question one, the independent variable was race, dependent variable was stage at diagnosis (staged vs unstaged) and the covariates were age and sex. Binary logistic regression was performed to determine whether race was associated with one's stage at diagnosis (staged/unstaged) in multiple myeloma patients while also looking at the effect of age at diagnosis and sex. The Hosmer-Lemeshow goodness of fit was significant ($p < .05$), indicating that the model is not a good fit (Laerd statistics, 2023). Additionally, the –2 log likelihood is 89015.183, and the Nagelkerke R Square is .002,

which show the proportion of variance explained by the predictors in the study (Laerd statistics, 2023).

The odds ratio of the variables in the equation table shows the probability of falling into the target group, which is equal to the probability of falling into the non-targeted group. An odds ratio of less than one means the probability of the event occurring is low or decreases (Laerd statistics, 2023). Table 4, variables in the equation show the odds ratio for age at diagnosis being (P<.001, B=-.023, Exp (B)= .977) which reflects that older patients are less likely to be staged for multiple myeloma. The output also shows the odds ratio for sex being Exp(B)= .911 reflecting that males are approximately 1% less likely to be staged for multiple myeloma compared to females. Lastly, race had an odds ratio of -12.9, Exp(B)=.871 demonstrating that non-African Americans are approximately 13% less likely to be staged for multiple myeloma compared to their African American counterparts.

From SPSS, analyzing independent and dependent variables, omnibus test of model coefficients gave a chi-square of 115.519 with df =3 and a significance of p <.001. The model summary indicated a -2 log-likelihood of 89015.183, Cox & Snell R square of .001, and a Nagelkerke R square of .002. This indicates that between .1 and .2 percent of variance from the dependent variable, stage at diagnosis (staged vs unstaged) is explained by the model. Finally, the Hosmer and Lemeshow test produced a chi-square result of 129.684 with df =-8 and a significance of p <.001. Before the analysis was conducted, block 0 in SPSS data output indicated that the model was at 84.3% as shown below in Table 5. After including the variables in the study, the model was approved upon at a

percentage of precisely 84.3% as shown in Table 6 below. Based on the overall analysis, the output shown an association between race and stage at diagnosis (staged vs unstaged) of multiple myeloma patients after controlling for age and sex.

Table 4

Variables in Equation

	B	S.E.	Wald.	Df	Sig.	Exp(B)	Lower	Upper
Race	-.138	.023	36.521	1	<.001	.871	.833	.911
Sex	-.093	.017	28.857	1	<.001	.911	.881	.943
AOD	-.023	.004	40.068	1	<.001	.977	.971	.984
Constant	2.323	.067	1218.807	1	<.001	10.211		

Note: AOD=Age of Diagnosis
Sex: Female (1) Male (2)
Race: African American (1) Non-African American (2)

Table 5

Classification Table: Predicted Step 0

Observed		Unstaged	Staged	Percentage Correct
Stage	Unstaged	0	16096	0
	Staged	0	86443	100.0
Overall Percentage				84.3

Table 6

Classification Table: Predicted Step 1

Observed		Unstaged	Staged	Percentage Correct
Stage	Unstaged	0	16096	0
	Staged	0	86443	100.0
Overall Percentage				84.3

RQ2

RQ2: Is there an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income?

$H_0$2: There is no association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

H_a2: There is an association between race and age at diagnosis in terms of multiple myeloma after controlling for sex and median household income.

The SPSS descriptive statistics output for research question 2 show race; African Americans (N=19,379) and non-African American (N=83,160), stage; staged (N=86,443) and unstaged (N=16,096), sex; female (N=46,004) and male (N=56,535) age was represented as an ordinal variable grouped in five-year increments, and median household income showed patients having an income ranging from 1.4% (<$35,000), 8.23% ($50,000-54,999), to 31.74% (>$75,000). For research question two, the independent variable was race, dependent variable was age at diagnosis (18-85+) and the covariates were sex and median household income (<$35k-$75k+). Ordinal logistic regression was used to determine if there was an association between race and age at diagnosis of multiple myeloma after controlling for sex and median household income (<$35k-$75k+). The model fitting information is significant at $p<.001$, showing that the model adequately describes the data. The goodness of fit statistics shows $p<.001$, a significant value indicates a difference in the observed vs. the fitted model (Laerd statistics, 2018). After analyzing the test for parallel lines in Table 7 below, I can conclude that the proportional odds assumption was not met, as evidenced by the significant test for

parallel lines (X2= 341.267, *df*=45, *p* <.001). This means that the ordered logit coefficients were not equal across the outcome levels, and I would need to use a less restrictive model. The ordinal regression model that includes age as the dependent variable and race as the independent variable while controlling for sex and median household income was statistically significant (X2=1513.035, *df*= 3, *p* <.001).

Table 7

Test for Parallel Lines

Model	-2 log likelihood	Chi-Squared	df	Sig.
Null Hypothesis	3669.333			
General	3328.065	341.267	45	<.001

Table 8 shows 16 threshold estimates for the dependent variable age at diagnosis. Based on these threshold estimates, threshold 2 ranged from ages 15-19 to threshold 16, which ranged from 80-84+years of age. The thresholds were established to help determine how close the variables were to the next level of intervals and ranks. Focusing on the targeted age range 18-85, threshold two estimates were -11.949, while threshold 16 was estimated at 1.923. A positive in the estimate shows an increased likelihood of the case falling into a higher category in the dependent variable. In contrast, a negative in the estimate would reflect an increased likelihood of the case falling into a lower category in the dependent variable (Laerd statistics, 2018).

The parameter estimates for median household income (<$35k-$75k+), sex, and race were statistically significant predictors (p<.001). Sex was a statistically significant predictor (β= -.147, p<.001), since the estimate is negative, it indicates that sex as a

predictor would fall into a lower category on the dependent variable age at diagnosis, further indicating that there is an association between sex; with males being diagnosed at an younger age for multiple myeloma. Median household income (<$35k-$75k) was found to be a statistically significant predictor (β= -.008, p<.001), showing that there is an association between median household income and age at diagnosis, specifically the results indicate that the lower a patient falls on the scale for median household income (<$35k-$75k), the more likely they are to be staged at a later age for multiple myeloma, what this means is that patients with higher median household income, are more likely to be diagnosed at a younger age. Lastly, *race* was shown to be a statistically significant predictor (β= -.523, p<.001). This means that there is an association between race and age

at diagnosis for multiple myeloma patients, specifically, the results show that non-African Americans were diagnosed a younger age than African Americans.

Table 8

Ordinal Regression Parameter Estimates

		Estimate	Wald	Sig.	95% C.I-Lower	95% C.I-Upper
Threshold	[AOD=2]	-11.949	142.682	<.001	-13.909	-9.988
	[AOD=4]	-11.256	253.055	<.001	-12.643	-9.869
	[AOD=5]	-9.869	775.270	<.001	-10.564	-9.175
	[AOD=6]	-8.581	2096.918	.001	-8.949	-8.214
	[AOD=7]	-7.238	5433.292	.001	-7.431	-7.046
	[AOD=8]	-5.895	11615.287	.001	-6.002	-5.788
	[AOD=9]	-4.824	16072.408	.001	-4.898	-4.749
	[AOD=10]	-3.820	15568.574	.001	-3.880	-3.760
	[AOD=11]	-2.977	11532.393	.001	-3.031	-2.922
	[AOD=12]	-2.226	7082.4721	.001	-2.278	-2.174
	[AOD=13]	-1.568	3677.151	.001	-1.619	-1.517
	[AOD=14]	-.967	1431.439	.001	-1.017	-.917
	[AOD=15]	-.357	197.441	<.001	-.407	-.307
	[AOD=16]	.266	109.408	<.001	.216	.315
	[AOD=17]	.987	1483.091	.001	.937	1.038
	[AOD=18]	1.923	5200.063	.001	1.871	1.975
Sex		-.147	178.473	<.001	-.168	-.125
Median Household Income		-.008	12.537	<.001	-0.12	-.004
Race		-.523	1364.271	<.001	-.551	-.495
		0				

Note. AOD=Age of Diagnosis

Sex: Female (1) Male (2)

Race: African American (1) Non-African American (2)

RQ3

RQ3: Is there an association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income?

$H_0$3: There is no association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income.

H_a3: There is an association between race and months of survival after diagnosis after controlling for stage at diagnosis and median household income.

The descriptive statistics output for research question 3 show race; African American (N=19,379) and non-African American (N=83,160), stage at diagnosis; staged (N=86,443) and unstaged (N=16,096), median household income (<$35k-$75k+). Showing a range of patients having an income ranging from 1.4% ($35,000), 8.23% ($50,000-54,999), to 31.74% ($75,000) and months of survival, (Min=1, Max=240, Mean=43.05). For RQ3, the independent variable was race, the dependent variable was months of survival, and the covariates were stage at diagnosis and median household income. Multiple linear regression was used to analyze this research question; the output displayed an ANOVA table, which reflected the overall model being significant since the p-value is less than .05.

Under the model summary, Psuedo-R-square is .008, indicating that 8% of the variance is accounted for with the dependent variable months of survival and the predictor variables. Table 9 shows precisely what variables significantly predict the dependent variable and its impact. The output show that stage at diagnosis (staged vs unstaged) significantly predicts survival months (p<.001); furthermore, β=-9.636, a negative value show that if a patient was staged then their months of survival for multiple myeloma decreases by approximately nine months. The output indicates that median household income significantly predicts survival months. This can be interpreted by

looking at p<.001, which shows statistical significance and the beta coefficient β=.697. Based on this, one can conclude that when the variable median household income increases, months of survival decrease by approximately two weeks. In other words, patients who have a lower income are likely to survive longer than those who have a higher income. Lastly, the predictor variable race shows to be a significant predictor of survival months, specifically *p<.001*, β=-2.057, showing that non-African Americans with multiple myeloma have an approximately two-month shorter survival compared to African Americans with multiple myeloma.

Table 9

Coefficients for Dependent Variable: Months of Survival

Model	B	Standard Coefficients Beta	T	Sig.
Constant	59.346		57.028	.001
Stage	-9.636	-.079	-25.082	<.001
Race	-2.057	18	-5.766	<.001
Median Income	.697	-.038	12.072	<.001

Race: African American (1) Non- African American (2)

Stage: Unstaged (1) Staged(2)

Summary

The purpose of this study was to investigate health disparities among African Americans suffering from multiple myeloma while also looking at potential effects of stage at diagnosis, sex, age at diagnosis, median household income, and months of

survival. Results of RQ1 indicated an association between race and stage at diagnosis. Specifically, non-African Americans were 13% less likely to be staged for multiple myeloma compared to African Americans. For RQ2, after controlling for sex and median household income, I found there was an association between sex and age at diagnosis for myeloma patients; specifically, males were found to be diagnosed at a younger age than females. Similarly, race was found to be a statistically significant predictor in that there was an association between race and age at diagnosis. Specifically, non-African Americans were found to be diagnosed at a younger age compared to African Americans. For RQ3, stage at diagnosis, age at diagnosis, and median household income were shown to significantly predict months of survival; specifically, non-African Americans had a 2-month difference in survival rates compared to African Americans. In Section 4, I reiterate the purpose of the study, summarize findings, and explain how they can contribute to the existing body of knowledge with recommendations for future research.

Section 4: Application to Professional Practice and Implications for Social Change

Previous research has found relationships between race and multiple myeloma. Specifically, African Americans have been known to be at greater risk of multiple myeloma than non-African Americans (Tabuchi, 2020). Those who have varying levels of healthcare experience different health outcomes (Ganguly et al., 2019). There have also been many studies reviewing varying health disparities that exist in multiple myeloma care seen throughout the U.S. There is minimal research investigating health disparities that exist among African Americans suffering from multiple myeloma while also looking at potential effects of sex, age at diagnosis, median household income, and months of survival. Furthermore, how stage at diagnosis influences survival and other potential outcomes has not been broadly studied. I used race as the independent variable, and dependent and covariate variables were sex, age at diagnosis, stage at diagnosis, median household income, and months of survival for multiple myeloma patients between the ages of 18 and 85+.

The social-ecological model was used to consider the complex interplay between individual, relationship, community, and societal factors. Each construct: societal, community, relationship and individual within the social-ecological model allows an understanding of how health disparities shape multiple myeloma care. The social-ecological model is used in complex situations and acts as a foundation for understanding different influences that can positively or negatively influence outcomes. I was able to describe relationships between given variables, which are further explained in this section.

Interpretation of Findings

Analysis of RQ1 showed an association between race (African American, non-African American) and stage at diagnosis (staged/unstaged) of multiple myeloma patients after controlling for age at diagnosis and sex. Race ($p < .001$), stage at diagnosis, age at diagnosis, and sex ($p < .001$) were all significant and found to be consistent with findings from previous research. The findings of my research showed the odds ratio for age at diagnosis being Exp(B)= .977 which reflects that older patients are less likely to be staged for multiple myeloma, specifically for every five-year increase in age, the patient is approximately 2% less likely to be staged for multiple myeloma. This means that younger patients are more likely to be staged (distant - a more advanced disease) compared to older patients. This also means that older patients are mostly unstaged (unknown). This could be due to older patients' perception of risk, maybe they believe that since they are already older that going to the doctor to get diagnosed will do them more harm. The younger generation could be more prone to keeping up with their health compared to the older generation. Deteriorating health or death could also be a factor causing older patients not likely to be staged. The research findings also showed p<.001, B-.093, Exp(B) =.991 for sex reflecting that males were approximately 1% less likely to be staged for multiple myeloma compared to females. This means that females are more likely to be staged (distant - a more advanced disease) compared to male patients for multiple myeloma. Lastly, race had an odds ratio of -12.9, Exp(B)=.871 demonstrating that non-African Americans were approximately 13% less likely to be staged for multiple myeloma compared to their African American counterparts. This means that African

American patients are diagnosed (distant - a more advanced disease) more often than non-African American patients. This can be due to inequities in health care including delays in diagnosis, inadequate screening, also can be attributed to patient perception on cancer diagnosis, financial barriers, lack of insurance or genetic abnormalities.

The findings for my research are consistent with previous research which have shown that African Americans are twice as likely to get multiple myeloma, and outcomes are twice as deadly compared to their non-African American counterparts (Costa et al., 2020). Overall survival rates for multiple myeloma are significantly lower for African Americans compared to Caucasian Americans (ACS, 2019). There has been little to no research done on stage at diagnosis in relation to race, though many studies have shown that African Americans are more likely to get multiple myeloma and suffer more burdensome outcomes. Table 3 shows that 82% of patients were staged (distant - a more advanced disease) for multiple myeloma, while 16% were not staged (unknown). The three stages of diagnosis identified by the SEER program are as follows: Localized where only one tumor is growing in the bone or outside the bone. Regional where according to the ACS, this stage does not apply to multiple myeloma because this type of cancer does not spread to lymph nodes, and distant where many tumors are found inside and outside of the bones. Stage at diagnosis for the purpose of this study includes those patients diagnosed at distant, while unstaged includes those who were not staged at distant. The distant stage is diagnosed when a patient exhibits multiple tumors outside the bones. Doctors stage the disease progression based on results of laboratory tests. The first stage of multiple myeloma does not have symptoms, the second stage has symptoms, and the

third stage indicates advanced cancer which has spread to other parts of the body (Chun, 2021). It is often difficult for physicians to diagnose multiple myeloma, and many patients experience more prolonged periods from initial symptom reporting to complete diagnosis (Koshiaris et al., 2018). Patients with multiple myeloma are also known to have the most consultations before referral, which speaks to difficulties in terms of overall diagnosis (Koshiaris et al., 2018). Many participants were diagnosed at the distant stage of multiple myeloma, which caused deviations from the original plan. Descriptive statistics in Table 3 show the number of patients staged to be 86,443 and the total of unstaged patients 16,096. It is unclear why most multiple myeloma patients are diagnosed at a distant stage.

One factor contributing to this disproportion could be insurance. Insurance type and status which play a significant role in terms of overall survival of multiple myeloma (Joshi et al., 2021). Patients with no insurance or Medicaid compared to those with private insurance have a lower chance of survival (Joshi et al., 2021). Those with no insurance and a cancer diagnosis have fewer resources than those who do have insurance and are less likely to be staged or diagnosed early. An association between the independent variable race and dependent variable stage at diagnosis, as well as the covariates age and sex was also found. Older patients are less likely to be staged (distant - a more advanced disease) for multiple myeloma compared to younger patients ($P<.001$, $B=-.023$, $Exp(B) = .977$), this output specifically demonstrates that for every five-year increase in age, the patient is approximately 2% less likely to be staged for multiple

myeloma. Padala et al. (2021) found multiple myeloma is greater among those 65 years and older and less common among those under 55 years of age.

The results from RQ 2 suggest that sex, median household income (<$35k-$75k+), and race were statistically significant predictors of age at diagnosis. There is an association between race and age at diagnosis for multiple myeloma after controlling for sex and median household income. Table 3, descriptive statistics showed that the older the patient, the more likely they are to be diagnosed with multiple myeloma (15-19 years, N = 6; 50-54 years, N = 6,974; 80-84 years, N = 11,496). Results for my study showed that males were more likely to be diagnosed at a younger age for myeloma compared to females (β= -.147, p<.001). This means that females are more likely to be diagnosed at an older age compared to males. Table 3 showed there are more men diagnosed with multiple myeloma (N = 56,535 [55.1%]) than females (N = 44,6004 [44.9%]). Bird et al. (2021) found that not only are men more prone to developing multiple myeloma, but genetic differences may influence cancer susceptibility, and sex hormones may play a role in cancer development. Median household income was found to play a role in ones age at diagnosis (p<.001, B=-.008), specifically, patients with higher median household income, are more likely to be diagnosed at a younger age. Considering a patient's ability to cover the financial obligations that come with a cancer diagnosis, the demographic results of my study found that 28.96% of multiple myeloma patients make $55k or less per year, while 71.04% of multiple myeloma patients have a median household income of $60k+. This finding suggests that patients with lower household income are more likely to be diagnosed at an older age. Household income has been shown to directly impact

one's quality of life. Persons with more income typically have access to more or better resources, patients with more income can afford cancer specialist and other preventative care resources in healthcare and may have better healthcare insurance overall.

Race was found to be a significant predictor of age at diagnosis ($\beta = -.523$, $p < .001$); specifically, the results show that non- African Americans were diagnosed a younger age than African Americans, in contrast, this means that African Americans are diagnosed at an older age for multiple myeloma compared to non-African Americans. These findings stand in similarity with previous research which suggest that an increase in age plays a role in one's diagnosis and overall survival for multiple myeloma (Ailawadhi et al., 2018). This can be attributed to healthcare inequities; for example, inadequate screening and care, inequities in health coverage, access to care, economic factors or individual decision making. Descriptive data shown in Table 3 reflect that 18.90% of cases were African American, and 81.10% were non-African American. Previous findings also suggest that African Americans are diagnosed with multiple myeloma at higher rates than non-African American patients. By contrast, my data analysis showed that non-African American are more likely to be diagnosed at a younger age compared to African American multiple myeloma patients. Considering the US census, African Americans represent a smaller portion of the US population, however there was an imbalance in proportion of representation for African Americans vs non-African Americans in the sampling population. According to Rajkumar (2022), overall

survival for multiple myeloma is dependent on stage, biology, and one's response to therapy.

For RQ 3, there is an association between race and months of survival after diagnosis (p <. 001) after controlling for stage and median household income. This means that race is a significant predictor when analyzing months of survival for someone diagnosed with multiple myeloma. Specifically, non-African Americans with multiple myeloma have approximately a two-month shorter survival compared to African Americans with multiple myeloma ($p<.001$, $\beta=-2.057$). This shows that African Americans survive approximately 2 months longer than non-African American patients with multiple myeloma. Could be due to genetics, adherence to treatment, or associated with access to adequate care. Similarly, median household income significantly predict months of survival whereas when median household income increases, months of survival decrease by approximately 2 weeks ($p<.001$, $B=-.697$) this could be due to a patient's attitudes and beliefs about multiple myeloma, or treatment compliance. Multiple myeloma survivors in the U.S. have a 5-year survival rate of 55% *(American Cancer Society, 2018)*. There is a 77% 5-year survival rate for people who are diagnosed early, meaning that routine blood test has shown an abnormally high amount of protein in the blood *(American Cancer Society, 2018)*. In cases of cancer that have spread to a distant part of the body, the 5-year survival rate exceeds 54% (Patel, 2023). The descriptive analysis for demographic variables found in Table 3 showed that most patients with multiple myeloma did not survive. However, a total of 155 patients survived for 199 months (10 years) compared to only 19 patients who survived for 239 months (20 years).

This data indicates that the survival rate for multiple myeloma is short, but there is a chance for greater longevity. Most patients who survive longer with multiple myeloma have adequate resources, not limited to insurance, support, and finances. When considering insurance, the cost of care can play a significant role in overall disparities. Padala et al. (2021) found that total charges claimed for patients with multiple myeloma increase significantly by year of diagnosis. Median drug claims for the first 6 months were highest among African Americans ($1,300, $p <. 009$) and lowest among Asian Americans ($630, $p <. 009$) (Padala et al., 2021).

Similarly, total claims were found to be the highest among African American ($15,800, $p<.001$) compared to the lowest amongst Asian American ($12,300, $p<.001$), supporting the idea that finances or median household income indeed play a role in overall survival (Padala et al., 2021). Stage at diagnosis (staged vs unstaged) was shown to be a significant predictor of survival months, consistent with current research. For the purpose of this study, staged is defined as a patient being diagnosed at the distant stage whereas unstaged is defined as a patient having an unknown diagnosis. Typically, the third stage, also known as distant staging, represents a more challenging outcome. Multiple tumors inside or outside the bones are a classic sign of distant stage multiple myeloma. Approximately 53% of patients with distant multiple myeloma survive five years (National Cancer Institute, 2019). A review conducted by Shrestha et al., 2019 entitled Quality of life versus length of life considerations in cancer patients: A systematic literature review studied the difficulties that cancer patients have when faced with the decision regarding treatment and the possibility of trading quality of life (QoL)

for length of life (LoL). The aim of the review was to highlight whether patients prioritize QoL or LoL and the determining factors that influence the decision-making process for cancer treatment. The researchers found that older age, which may be linked to declining physical status, was associated with a preference for QoL over LoL. Younger patients were more likely to undergo aggressive treatment to increase survival years. Patients with better health valued LoL and inversely those with poorer physical status preferred QoL. This article showed great debate in that extended months of survival may or may not be of benefit to a patient, it would truly depend on the patient and their preference for quality of life over length of life.

Limitations

Several limitations must be considered when implementing this study's results into public health research. Given that this was a cross-sectional secondary analysis study, the findings were limited to the data that existed in the Surveillance, Epidemiology, and End Results database. The findings were limited to the different associations based on the available variables rather than trying to identify specific cause-and-effect relationships between variables. It's also important to note that while the demographic information mirrors that of national statistics, there was an imbalanced proportion of representation for African Americans compared to non -African Americans in the sampling population. The SEER database represents 48% of the U.S population, it specifically represents 31 population-based registries from nine different states. The database is representative of the population, however due to the imbalance proportion of African Americans (19%) and non-African Americans (82%) there could be sampling

bias which occurs when some members of a population are systematically more likely to be represented in a sample than others. Lastly, the stage at diagnosis variable resulted in a deviation from the original plan, altering this variable to become a binary (staged/ unstaged), causing a different measuring outcome for stage at diagnosis.

Recommendations for Future Research

This study provides useful evidence that public health leaders can use to lower the rate of multiple myeloma and improve survival rates. Providing multiple myeloma patients with the proper education about their diagnosis and possible treatment options is essential. This education can be disseminated through various avenues, such as social media, support groups, and community advocates. This study aimed to investigate health disparities in the diagnosing stage among African Americans suffering from multiple myeloma while also looking at the potential effect of sex, age at diagnosis, median household income, and months of survival. Overall, the study shown that African Americans represented a small percentage of the overall multiple myeloma population. This can be due to access to care which takes away the ability to be diagnosed or attributed to personal choice to not seek care. Future recommendations for this research study would be to ensure that populations found at higher risk as displayed in my findings; African Americans, older patients, older females and populations with higher household income. multiple myeloma patients are provided the proper education about their diagnosis and possible treatment options. Incorporating community- based participatory research in African American communities to understand and target the underrepresentation found in clinical studies is important when discussing multiple

myeloma outcomes especially considering minorities are socially disadvantaged. The findings of my research suggested that male patients are diagnosed at a younger age than females for multiple myeloma, a recommendation for intervention would be to increase or improve health education programs specific to older female multiple myeloma patients. In relation to my findings, reaching females, African Americans, older patients, and economically disadvantaged people early on is the goal. A proactive approach to their health could improve their quality of life if they were given the resources. My study found that median household income is a significant predictor of survival months, specifically the more money a patient makes, their survival decreases by approximately two weeks. This could be due to a patient's attitudes and beliefs about multiple myeloma, or treatment compliance. A recommendation for this finding would be to have policies and compliance standards reviewed by public health leaders to ensure that patients are provided the adequate resources so that patients can overcome barriers preventing them from complying to specific treatment. While differences may exist between the results of this study and current research, an important insight was gained based on the results: there are health disparities that exist in stage at diagnosis (staged vs unstaged) among those suffering from multiple myeloma. Cognizant to the social-ecological theory in which this study was grounded, the individual, relationships, community, and society that persons reside, contribute value in the quest to reduce the rate of multiple myeloma and improve survival.

Implications for Professional Practice and Social Change

Multiple myeloma is a type of blood cancer that develops from bone marrow plasma cells. Experts are not sure about the cause of multiple myeloma; however, certain risk factors make you more susceptible to it, such as age, gender, and race (Lichtman, 2018). Understanding and targeting the underrepresentation found in clinical studies is important when discussing multiple myeloma outcomes because minorities are socially disadvantaged. Individuals from diverse racial backgrounds are underrepresented in clinical trials and in cancer research studies (Asare et al., 2017). Disseminating resources and education to address this lack of representation in cancer research can directly impact the survival rates of African Americans in cancer research (Asare et al., 2017). Addressing the lack of representation in cancer research could improve the delivery of staging and outcomes for multiple myeloma patients. Based on the social-ecological model, this study can significantly impact cancer outcomes for patients with multiple myeloma; by using a multi-care approach specifically, policies and procedures for diagnoses and care for multiple myeloma patients can then be examined.

The findings in this study have implications for how health disparities directly affect African American multiple myeloma patients in the United States. The findings give insight into how the social-ecological constructs; individual, relationships, community, and society impact the complex interplay of differences seen throughout the progression of multiple myeloma. The findings imply that race is predicted to heavily influence stage at diagnosis (staged vs unstaged), age at diagnosis, sex, median household income, and months of survival directly associated to multiple myeloma. The finding

suggests the need to create targeted approaches for finding more African American multiple myeloma cases, enhance and review current healthcare policies specific to healthcare cost, review compliance standards and create programs for outreach and education for multiple myeloma patients and their families. The findings also suggest the need for future research on this topic, which should aim towards investigating more on how specific disparities impact the overall survival and outcome for African Americans. By raising awareness and implementing programs specifically for populations found at higher risk as displayed in my findings; African Americans, older patients, older females and populations with higher household income, researchers will have a better understanding of multiple myeloma outcomes.

The methodological analysis can be improved by controlling for other variables that may influence multiple myeloma outcomes. Other statistical approaches could be useful in finding correlations between the variable as well as descriptive data concerning health disparities and multiple myeloma. In this study, I controlled for sex, age at diagnosis, and median household income, when other factors could have been controlled for if other variables were available, such as geographic location by region in the United States, insurance type, or access. These variables could potentially give more insight into how health disparities in multiple myeloma influence patient outcomes within different regions.

Positive Social Change

This study's findings help promote social change by providing valuable information as a resource to promote better policies and procedures for diagnoses and

care for multiple myeloma patients found at higher risk as displayed in my findings; African Americans, older patients, older females and populations with higher household income. The aim is to use these results as insight to create different approaches that could help improve multiple myeloma care and outcomes. These results will encourage community-based participatory research in African American communities, which can ensure a community's needs are met. These results also encourage future researchers to continue research in this realm by possibly incorporating a qualitative analysis for multiple myeloma, providing a more in-depth understanding of how multiple myeloma impact patients directly. Based on the combined knowledge gained through these strategies, public health leaders, policymakers, and physicians could strategically influence decisions and outcomes around multiple myeloma care. At the individual level, multiple myeloma patients may not be aware of the resources or adequate treatment needed to ensure the best care and improved quality of life. At the relationship level, support from family, physician, and friends can help reinforce better outcomes. At the community level, these findings can help build a bridge between agencies, which will help build a stronger alliance between stakeholders and encourage more training for physicians, thus improving the quality of life for multiple myeloma patients. At the societal level, these findings can help create stronger policies around care for multiple myeloma patients, so they can live their life knowing they are receiving the best care and that they are not alone in their battle.

Conclusion

Public health research has become increasingly focused on health disparities because they specifically lead to inadequate health outcomes. There is a disparity if a health outcome is seen to a greater or lesser extent between populations. Disparities can be found within different races/ethnicities, ages, sexual orientation, socio-economic status, or gender (CDC, 2020). The examination of multiple myeloma conducted in this study showed that there are many things to consider when looking at one's staging category along with other respective factors such as age at diagnosis, race, median household income and months of survival. My research found that there is an association between race and stage at diagnosis (staged vs unstaged) for multiple myeloma. Specifically, non- African Americans were approximately 13% less likely to be staged for multiple myeloma compared to African Americans (P<.001, B=-.138, Exp (B) = .871). Non-African Americans with multiple myeloma have approximately a two-month shorter survival compared to African Americans with multiple myeloma ($p<.001$, β=-2.057) and non- African Americans were diagnosed a younger age than African Americans (β= -.523, p<.001). This disparity can be due to inequities in health care including delays in diagnosis, inadequate screening, or can be attributed to patient perception on cancer diagnosis, financial barriers, or lack of insurance. Males were approximately 1% less likely to be staged for multiple myeloma compared to females (P<.001, B=-.093, Exp (B) = .991). Males were also shown to be diagnosed at a younger age for multiple myeloma compared to females. Socially speaking, females are known to adhere to doctor visits, keep up with their health and make more informed decisions

about their health compared to men. Older patients were less likely to be staged for multiple myeloma compared to younger patients, specifically for every five-year increase in age, the patient is approximately 2% less likely to be staged for multiple myeloma ($P<.001$, $B=-.023$, $Exp(B) = .977$). This could be due to deteriorating health, causing the older patient not likely to follow up for staging, death may be a factor or the patients' perception of risk. The output shown that stage at diagnosis significantly predicts survival months; if a person is staged, their months of survival decreases by approximately 9 months ($p<.001$, $\beta=-9.636$). Research findings showed that median household income decreases, months of survival decreases by approximately two weeks ($p<.001$, $B=-.697$). Lastly, median household income was found to be a statistically significant predictor, showing that there is an association between median household income and age at diagnosis, specifically patients with higher median household income, are more likely to be diagnosed at a younger age ($\beta= -.008$, $p<.001$). With that, we can conclude that certain health disparities exist. The predictors: race, median household income, sex, and age at diagnosis were all shown to significantly impact multiple myeloma outcomes. This research could aid in finding more multiple myeloma cases, it also can help to improve myeloma outcomes by encouraging preventative strategies which ultimately can improve current and future research. It must be noted that the ratio of African American patients to non- African American patients were distinctly different (African American 18.9% vs. non-African American 81.10%); therefore, the results should be interpreted cautiously.

It is imperative that continued research focuses on health disparities among African American multiple myeloma patients in the United States. Researchers should

also continue to dive deeper into the staging of multiple myeloma. Building on previous research for multiple myeloma, it is paramount that public health leaders, professionals, and community members develop strategic partnerships to explore ways to reduce the number of new cases and properly manage those already diagnosed. Public health leaders will need to be innovative in creating interventions and educational programs and provide financial assistance to those who do not have the means to afford multiple myeloma specialist. Furthermore, exploring health disparities and how they influence outcomes for those who have been diagnosed with multiple myeloma may result in new innovative approaches for how public health and healthcare professionals address cancer health disparities throughout the United States.

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