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Brachytherapy and External Beam Radiation and Survival of Jamaicans With Prostate Cancer

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Abstract

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by

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MPH, University of the West Indies, 2009

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Jamaican males are a high-risk population for aggressive prostate cancer (PrCa) due to genetic influences, and identifying empirical data on treatments, which provide survival benefits is a prime challenge for clinicians who manage Jamaican PrCa patients. Thus, the purpose of this investigation was to elucidate treatment effects of brachytherapy and ERBT in the survival of a Jamaican PrCa cohort. Differences in survival outcomes of brachytherapy and ERBT treated Jamaican, and White U.S.-born PrCa patients with localized PrCa were compared. The mechanism of radiation programmed cell death in PrCa carcinogenesis explained in the oxidative stress theory, was the theoretical base for interpreting the research questions. A retrospective cohort design was used, and included survival analysis of secondary data from the Surveillance Epidemiology and End Results database. The sample size was 10,752 Jamaican and White U.S.-born prostate cancer patients diagnosed between 1992 and 2011. Kaplan-Meier and Cox proportional hazard regression models confirmed that brachytherapy resulted in enhanced survival benefits to the Jamaicans, *HR* 0.63, 95% CI [0.55, 0.73], $p < .001$, but ERBT did not, *HR* 1.6, 95% CI [1.38, 1.84] $p < .001$. Hence, brachytherapy may be an appropriate treatment option for Jamaican PrCa patients. Clinicians and health care planners can utilize the results for policy decisions aimed at increasing access to brachytherapy treatments to Jamaicans. Improving access to efficient PrCa treatments could reduce the morbidity and mortality rates of PrCa among Jamaicans, decrease years of potential life lost from PrCa, and enhance the life expectancy of the Jamaican male population.

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Dedication

First, I offer my praises to God who was my greatest source of strength throughout the dissertation journey. I would like to dedicate this study to my husband Hugh who encouraged me to pursue this area of research. I express my sincerest gratitude to you for your enormous sacrifices over the years to ensure that I completed my study. Your prayers, gestures of love, encouragement, and support, particularly when the process was most overwhelming, have not gone unnoticed. I would also like to dedicate this dissertation to my mother Olive who always supported me in my academic pursuits. Finally, I dedicate this dissertation to my academic and professional mentor, former Associate Dean, Professor Hermi Hewitt who encouraged me to pursue my doctoral studies and supported me throughout the process

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Chapter 1: Introduction to the Study

The survival outcome of brachytherapy and external beam radiation treatment (ERBT) for the management of localized PrCa, is understudied among Jamaicans in their native country (Morrison, Aiken, & Mayhew, 2014). The effects of brachytherapy and ERBT are well documented among Europeans (Goldner et al., 2012; Zuber et al., 2015), Canadians (Smith et al., 2015), and in U.S. populations (Alumini et al., 2015; Cendales et al., 2015). However, the findings of current studies may not apply to Jamaican PrCa patients. Jamaican PrCa patients are typically diagnosed with higher prostate-specific antigen (PSA) levels, Gleason scores, and tumor stages when compared with the White and African American PrCa patients (Fedewa & Jemal, 2013; Rich et al., 2013). Jamaicans also have the recessive and dominant genes, which increase their risk for PrCa (Kidd et al., 2012). Kidd et al. (2012) compared the influence of Chemokine-associated single nucleotide polymorphisms (SNPs) in PrCa susceptibility of African Americans and Jamaicans. The findings of Kidd et al. demonstrated that the Jamaican cohort had 1.52 to 1.73 increased for PrCa ($p < .001$), due to the genes *CCR5* rs1799987 AA, *CCR5* rs1799988 GG, and *CCR7* rs 3136685 AG+GG. Hence, conclusions of current literature suggested that Jamaican PrCa patients may have other biological factors which, could support the type of PrCa noted in this cohort. Consequently, ERBT and brachytherapy treatment outcomes of PrCa patients of other populations may not generalize to Jamaicans.

Recent studies have also indicated that higher numbers of Jamaican PrCa patients residing in the United States and Jamaica are diagnosed with Gleason scores 6 and 7

PrCa; when compared with men who are diagnosed with Gleason scores 8 to 10 PrCa (Anderson-Jackson, McGrowder, & Alexander-Lindo, 2012; Kampel, Tse, & Joseph, 2011). In a cohort of 127 Jamaican PrCa patients who were treated at the Memorial Sloan-Kettering Cancer Center in New York, Kampel et al. (2011) recognized that 51 (40%) were diagnosed with Gleason score 6 PrCa, while 57 (45%) had Gleason score 7 PrCa. Fewer PrCa patients (15%) were diagnosed with Gleason scores 8 to 10 (Kampel et al., 2011). In Jamaica West Indies, Anderson et al. (2012), documented similar patterns of PrCa diagnosis among 191 PrCa patients treated at a private diagnostic center in the country. Anderson et al. reported that the highest proportion of PrCa patients (69.7%) who were treated at a radiology center in Jamaica had Gleason scores 6 and 7 PrCa. The findings of Anderson et al. and Kampel et al. suggested that currently Jamaican males are detected at the earlier stages of PrCa. Therefore, it was important to determine the treatment methods, which are most appropriate for Jamaicans with the earlier stages of the disease.

Currently, urologists in Jamaica are challenged with identifying publications, which support evidenced-based decisions for treating Jamaican PrCa patients with localized PrCa (Morrison et al., 2014). Besides, advocates for PrCa treatment in Jamaica are promoting greater use of brachytherapy, ERBT, and active surveillance for managing localized PrCa (Morrison et al., 2014). At present, brachytherapy, ERBT, and active surveillance are underutilized in Jamaica owing to infrastructural and economic constraints (Morrison et al., 2014). Due to the factors which limit the uptake of PrCa treatments among Jamaicans in their homeland, data are needed to base decisions on the

most clinically efficient and cost-effective treatment methods for these PrCa patients with localized disease (Morrison et al., 2014).

It was necessary to determine the efficacy of brachytherapy and ERBT treatment for the management of early stage PrCa among Jamaicans males. Researchers reported increase utilization of brachytherapy treatment in the United States since the 1990s (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013). Investigators have also described the survival benefits and limitations of brachytherapy and ERBT for patients with localized PrCa. Schreiber et al. (2013), cited that brachytherapy provided improved survival outcomes and fewer side effects when compared with other PrCa treatments. On the other hand, Schreiber et al. reported that brachytherapy is associated with socioeconomic constraints resulting in disparities in its use among African American and White PrCa patients. Williams et al. (2011) noted that younger PrCa patients were also more likely to access brachytherapy. Furthermore, when compared with the traditional ERBT, brachytherapy treatment did not demonstrate superior survival benefits for men with the earlier stages of PrCa (Goldner et al., 2012; Nepple et al., 2013; Smith et al., 2015). However, the reports of recent investigations demonstrated no treatment effects of brachytherapy and ERBT in a Jamaican cohort. Hence, additional studies are necessary to elucidate the survival benefits of brachytherapy and ERBT in the management of localized PrCa among Jamaicans.

In existing publications, investigators documented mixed results for PrCa patients who did not receive directive treatment for the disease (Bul et al., 2013; Odom et al., 2014; Selvadurai et al., 2013; Wilt et al., 2012). Current studies showed disparities in

survival outcomes of White and African American PrCa patients who were managed with active surveillance (Bul et al., 2013; Odom et al., 2014; Selvadurai et al., 2013; Wilt et al., 2012). Researchers also indicated that African American PrCa patients who were managed without directive PrCa treatment were more likely to progress to the advanced forms of the disease (Odom et al., 2014). Nevertheless, the survival outcomes of active surveillance as a treatment protocol in White and African American cohorts documented in other studies may not apply to Jamaicans. Investigators documented that small samples of the Black populations in studies on PrCa survival limit extrapolation of the findings to similar groups (Bul et al., 2013; Odom et al., 2014; Selvadurai et al., 2013; Wilt et al., 2012).

Additionally, investigators alluded to the impact of the sociodemographic characteristics of the PrCa patient and smoking in their survival (Crawford, 2013; Fufaa, 2011; Huncharek et al., 2010; Lin, Porter, & Montgomery., 2009; Parris, 2013). Data on the influence of the sociodemographic characteristics in the treatment outcomes of Jamaican PrCa patients were not reported in current publications.

Jamaicans in the 18 participating Surveillance Epidemiology and End Results (SEER) database were chosen for this study to infer findings to their populations. Jamaicans in the SEER database were selected for data analysis because they comprised the largest subgroups of non-U.S.-born Black males of the SEER cancer registries (Fedewa & Jemal, 2013). Besides, Fedewa and Jemal (2013) documented that Jamaicans in the SEER database had Gleason scores, which were comparable with Jamaicans residing in their native country. Moreover, I identified a higher proportion of Jamaican-

born PrCa patients (87.64%) in the SEER database with localized PrCa when compared with PrCa patients who were diagnosed with the distant stage of the disease 21 (7.87 %). Thus, the findings of the SEER database suggested that the cohort of Jamaican-born PrCa patients in that dataset was appropriate for this research.

This study was necessary because current findings on PrCa treatment effects may not generalize to the Jamaican communities owing to differences in the disease characteristic of Jamaicans and other groups of PrCa patients (Fedewa & Jemal, 2013; Kid et al., 2012; Rich et al., 2013). Jamaicans are usually diagnosed with higher stages and grades of PrCa when compared with other populations (Fedewa & Jemal, 2013; Rich et al., 2013), and researchers recommended other studies on the treatment of localized disease among men with this type of PrCa (Klotz et al., 2010). Researchers also endorsed future studies on the relationship between disparities of brachytherapy treatment, race, socioeconomic status and PrCa survival (Schreiber et al., 2013). Furthermore, it was important to understand the role of socioeconomic status in treatment outcomes among the Jamaican cohort because, brachytherapy treatment is not adequately utilized among native Jamaicans without health insurance (Morrison et al., 2014). The reason for this disparity among Jamaicans is not well documented in the literature. Consequently, this dissertation which investigated the effectiveness of treatments for localized PrCa among Jamaicans was relevant.

I anticipate that this dissertation will contribute to public health practice and policies aimed at improving the years of potential life lost (YPLL) of a Jamaican PrCa patient. I also project that this research may provide information to the medical fraternity

of urologists in Jamaica who currently seek data on appropriate treatment choices for Jamaicans with localized PrCa. Additionally, I assume that this study will offer evidence to influence the decision-making of PrCa patients with localized disease about appropriate treatment choices and assist health care planners in increasing access to these PrCa treatments. The efficacy of brachytherapy and ERBT in the management of early and intermediate stages PrCa among Jamaicans, may improve the survival rates of affected males and enhance their survival outcomes (Fufaa, 2011).

In Chapter 1, I presented the background of this dissertation; the research problem statement, questions, and purpose; as well as the theoretical framework, nature of the study, and the definitions of the primary variables. The background summarizes the current literature on the survival outcomes of PrCa patients who were treated with brachytherapy and ERBT. The problem statement discusses the focus of the investigation and the need for new data to guide treatment decisions for the management of low and intermediate stages PrCa among Jamaicans. In Chapter 1, 1 also included the five research questions and hypotheses, which were intended to measure the relationship between brachytherapy treatment and ERBT with PrCa survival. The research questions and hypotheses allowed me to compare differences in PrCa survival with Jamaicans and the White U.S.-born cohort of the SEER 18 research databases. The research questions further assisted me to determine the influence of the sociodemographic characteristics in treatment effects.

Background

Since the 1990s, brachytherapy, and active surveillance are accepted treatment choices among men with low-grade PrCa (Cooperberg & Carroll, 2015; Mahmood et al., 2014; Safdieh, Wong, Weiner, Schwartz, & Schreiber, 2016; Valdivieso et al., 2015; Weiner, Patel, Etzioni, & Eggener, 2015). However, in studies on the management of localized PrCa with brachytherapy, ERBT, and active surveillance, researchers provided mixed results on treatment efficacy (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Smith et al., 2015; Zuber et al., 2015).

Investigators have also documented underutilization of brachytherapy in specific populations (Schreiber et al., 2013; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). Schreiber et al. (2013) confirmed that brachytherapy is more widely utilized among White males when compared with males of African American descent. Williams et al. (2011) revealed that brachytherapy is better accepted among young PrCa patients Alumini et al. (2015), Williams et al., and Zuber et al. (2015) reported that brachytherapy is a safe and efficient treatment for PrCa patients with Gleason scores 6 and 7. On the other hand, Williams et al. indicated that brachytherapy is an expensive treatment option. Moreover, Rodrigues et al. (2014) noted that brachytherapy enhances biochemical free survival for PrCa patients with low and intermediate stage disease, but it does not improve overall survival of PrCa. Additionally, Goldner et al. (2012), Nepple et al. (2013), and Smith et al. (2015) reported similarities in the effectiveness of brachytherapy treatment and ERBT for the management of localized PrCa. Thus, the results of current

studies on the survival advantage of brachytherapy and ERBT provided wide-ranging outcomes in the populations studied (Goldner et al., 2012; Nepple et al., 2013; Smith et al., 2015).

There is a dearth of current publications on the effects of brachytherapy and ERBT in the survival of Jamaican PrCa patients, and current data on treatment effects among Jamaicans are needed (Morrison et al., 2014). In addition, investigators recommended additional research on the effects of ERBT and brachytherapy treatment on PrCa survival (Bannuru et al., 2011; Klotz et al., 2010; Nepple et al., 2013; Schreiber et al., 2013). Klotz et al. (2010) also suggested that further studies on the effects of ERBT and brachytherapy treatment on PrCa survival should include men who are diagnosed with the aggressive forms of PrCa. Besides, Nepple et al. (2013) recommended that further observations on treatment effects should include active surveillance and African-American men with low-risk disease. Moreover, Rand et al. (2014), and Schreiber et al. (2013) endorsed additional inquiries in the disparities of race and socioeconomic status in the relationship between brachytherapy and PrCa survival. Hence, this dissertation was designed to explore the effectiveness of brachytherapy and ERBT PrCa treatments and determine the influence of socioeconomic indicators in treatment effects.

This study is relevant to provide new insights on the effectiveness of PrCa treatments among Jamaicans with localized disease. Jamaicans are diagnosed with localized PrCa, and empirical data on the most effective treatment options for that cohort are lacking. An understanding of the roles of brachytherapy and ERBT, in the prognosis

of Jamaican PrCa patients, could support appropriate treatment decisions, aimed at improving their overall survival.

Problem Statement

Recent publications established that higher numbers of Jamaican males are currently diagnosed with Gleason scores 6, and 7 PrCa, when compared with Gleason scores 8 to 10 PrCa (Anderson-Jackson et al., 2012; Kampel et al., 2011). However, identifying empirical data on appropriate treatments, which will provide greater survival benefits for PrCa patients with early and intermediate stage disease, is a prime challenge for the management of PrCa in Jamaica (Morrison et al., 2014). There is also a need for data on the outcomes of brachytherapy treatment in the Jamaican population (Morrison et al., 2014).

The effect of PrCa treatment on early and intermediate stage disease in the survival of affected males is well studied in many populations (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). However, findings on the treatment methods which offer the best survival benefits for PrCa patients with localized disease require further examination (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Schreiber et al., 2013; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). Several researchers reported favorable treatment outcomes for brachytherapy (Alumini et al., 2015; Cendales et al., 2015; Williams et al., 2011; Zuber et al., 2015). Other investigators suggested that the traditional ERBT may be a better option

for the overall survival of PrCa patients (Goldner et al., 2012; Nepple et al., 2013; Smith et al., 2015). None of the studies which explained the effects of brachytherapy and ERBT was conducted in the Jamaican population.

Recent publications cited the survival benefits of brachytherapy in White populations (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Williams et al., 2011). Results on the survival effects of brachytherapy and ERBT in PrCa survival were identified among German (Zuber et al., 2015), Dutch (Goldner et al., 2012), Canadian (Smith et al., 2015), and the U.S. White populations (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Williams et al., 2011). The conclusions of studies in other populations may not be relevant to the Jamaican cohort. Jamaicans PrCa patients are diagnosed with higher PSA levels, Gleason scores, and tumor stages when compared with the White and African American PrCa patients (Fedewa & Jemal, 2013; Rich et al., 2013). Jamaican PrCa patients also have the recessive and dominant genes which are associated with a two-fold increased risk of PrCa in that cohort (Kidd et al., 2012). Therefore, it was important to elucidate the effects of treatments for early and intermediate stages of PrCa in the Jamaican communities with a similar cohort.

Purpose of the Study

In this quantitative dissertation, I utilized a retrospective cohort study design, and analyses of secondary data with survival models, to examine the survival patterns of Jamaican PrCa patients who were treated with brachytherapy and ERBT for the period 1992 to 2011. The purpose of this dissertation was to determine the survival outcomes of

Jamaican PrCa patients who were diagnosed with early and intermediate stage disease, and ascertain whether there were survival differences among Jamaican PrCa patients and White U.S.-born PrCa patients who were treated with brachytherapy and ERBT. In this investigation, I also aimed to examine the influences of sociodemographic indicators of age, marital status, and health insurance status in the survival outcomes of the PrCa patients. The key independent variables of this research were a history of brachytherapy treatment, history of ERBT, and the stage and grade of PrCa. The dependent variable was the length of time a prostate cancer patient lived with the disease after treatment. The covariates for this study were the sociodemographic indicators of age, marital status, and health insurance status of the PrCa patients.

Research Questions and Hypotheses

In this study, I utilized five research questions with their related hypotheses to compare the treatments effects in the survival of the Jamaican and White U.S.-born cohorts. The smoking variable was not examined because data were not available. The hypothesis of this study speculated a difference in the survival time of the Jamaicans versus the White U.S.-born PrCa patients. The five research questions and hypotheses follow.

Research Question 1**.** Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease?

$H_0$1: There are no differences in the length of time Jamaican-born and U.S.-born White PrCa patients treated with brachytherapy for low and intermediate stages PrCa; live with the disease.

H_a1: There are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease.

Research Question 2**.** Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease?

$H_0$2: There are no differences in the length of time Jamaican-born PrCa patients and U.S.-born White PrCa patients treated with ERBT for low and intermediate stages PrCa, live with the disease.

H_a2: There are differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease.

Research Question 3. Are there differences in 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients, according to treatment received for the period 1992 to 2011?

$H_0$3: There are no differences in 5-year survival intervals of Jamaican-born and U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

H_a3: There are differences in 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

Research Question 4. Are there differences in the length of time brachytherapy treated Jamaican-born PrCa patients, and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

$H_0 4$: There are no differences in the length of time brachytherapy treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa, live with the disease, after controlling for sociodemographic characteristics.

$H_a 4$: There are differences in the length of time brachytherapy treated Jamaican PrCa patients, and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

Research Question 5. Are there differences in the length of time ERBT treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

$H_0 5$: There are no differences in the length of time ERBT treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

H_a5: There are differences in the length of time ERBT treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

Introduction of the Theory

The oxidative stress theory was utilized to explain the relationship between the variables of this dissertation. Denham Harman conceptualized the oxidative stress theory in 1956 as the free radical theory of aging (Preedy, 2014; Sowell, Aluise, & Butterfield, 2010). The oxidative stress theory postulates that accumulation of the production of free radicals and or reactive oxygen species (ROS) affects cellular functioning by impairing the deoxyribonucleic acid (DNA), lipid, and protein biomolecules of the cells of the body (Preedy, 2014; Sowell et al., 2010). Khandrika, Kumar, Koul, and. Maroni. (2009) linked the oxidative stress theory with programmed cell death which occurs because of intracellular and extracellular environmental conditions of the prostate gland. According to Khandrika et al. (2009), radiation is one of the environmental conditions which induces oxidative stress in the prostate gland, increases ROS production and consequently inhibits carcinogenesis. I anticipated that the oxidative stress theory would support the mechanism of radiation in the cellular transformations of the prostate gland in reducing carcinogenesis and consequently influencing the survival of PrCa patients. The major premise of the oxidative stress theory was confirmed where the research hypotheses were accepted. The mechanism of oxidative stress in PrCa survival is further explained in Chapter 2.

Kumar, Koul, Khandrika, and Meacham (2008) established that the cancerous cells of the prostate gland produced high levels oxidative stress which are toxic to these cells. Fang, DeMarco, and Nicholl (2012), and You et al. (2015) also supported the roles of the oxidative stress pathway in inhibiting PrCa carcinogenesis through radiation. Based on the mechanism of oxidative stress and its link with radiation-induced cell death in the prostate gland, this theory was considered appropriate to create the framework for providing a better understanding of the relationship between brachytherapy, ERBT, and survival of the PrCa patients in this study.

Nature of the Study

I utilized a retrospective cohort study design, survival analyses, and secondary data sources to answer the research questions. I selected a retrospective study design for this study to examine survival patterns of PrCa patients that occurred at different intervals between 1992 and 2011. The retrospective design was appropriate to examine both exposures and outcomes historically (Aschengrau & Seage 111, 2008, p. 207) and promote analyses of time to event data because of its historical nature (Frankfort-Nachmias & Nachmias, 2008, p. 277).

The independent variables were PrCa patients diagnosed with localized disease, and PrCa treatments which, included brachytherapy treatment, ERBT, and other radiation treatment (radiation sequenced with surgery). The dependent variable was the length of time that a prostate cancer patient lived with the disease after treatment. The covariates for this study were sociodemographic indicators of age, marital, and health insurance status.

The source of secondary data for analysis was the 18 participating Surveillance Epidemiology and End Results (SEER) registries of the United States, November 2013 submission. I chose this database because the SEER program of the National Cancer Institute (NCI) is a reputable source of data on the incidence and survival of cancer in the United States (NCI, 2017c). The SEER program gathers and publishes cancer rates and survival information from 18 participating population-based registries and covers approximately 28% of the U.S. population (NCI, 2017c). The SEER program is recognized as the only comprehensive population-based registry in the United States, which provides data on the tumor stage at the time of diagnosis as well as survival information (NCI, 2017c). The SEER registries data include the demographics of the PrCa patients and morphology and stage of the tumor at diagnosis (NCI, 2017c). The SEER program information also includes the cancer patients' first course of treatment and the follow-up for their vital status (NCI, 2017c). The National Center for Health Statistics provide the mortality data to the SEER program, and the U.S. Census Bureau the population data. Thus, the SEER database was appropriate for this dissertation.

The analysis of data for this dissertation included preliminary descriptive estimates for each of the variables of the study (Mills, 2011a). In addition, Kaplan-Meier analyses were used to estimate the survival distributions and hazard rates of the PrCa patients for varying intervals during the observation period. Furthermore, the Cox-proportional hazards regression model was utilized to measure differences in the relationship between the independent and dependent variables and to evaluate confounding effects of the covariates in the outcomes of the study. I interpreted the

results of these statistical analyses with alpha level ($p < .05$), and 95% confidence intervals (Rich, 2010). I analyzed the data with the International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) software version 23.

Definitions of Research Variables Relating to the Research Questions

Dependent Variable

The dependent variable of this dissertation is PrCa survival. PrCa survival was defined as the duration that an affected person lived with PrCa from the date of initial diagnosis to the time of the first outcome (death or censoring) (Hu et al., 2014; Lin et al., 2009; Redaniel et al., 2013; Thompson et al., 2013). The time of diagnosis was the month and year of diagnosis which were documented in the SEER registry database (SEER, 2013). The time of death was the period the death of a case was recorded in the registry database (SEER, 2013). The vital status included the SEER cause-specific mortality definition and confirmation of death using death certificate or autopsy information (SEER, 2013). Censored cases were PrCa patients who died of causes other than PrCa (NCI, 2017a). The definition of PrCa survival also included active follow-up of each PrCa patient (SEER, 2013).

Independent Variables

In this study, I classified a prostate cancer patient according to the International Classification of Diseases for Oncology version 10 (ICD-O) code C60, and used the SEER cause-specific death (sequence numbers 01) definition of the 1973 to 2011 submission (National Institutes of Health [NIH], 2017). Additionally, a prostate cancer patient in this research was a confirmed case by histology, or cytology according to the

SEER Research Data Record Description 1973 to 2011 (SEER, 2013). Jamaican PrCa patients were males with Jamaican birthplace who were recorded in 15 of the 18 SEER registries, November 2013 submission (SEER, 2014). The 15 participating SEER cancer registries included in the study were Connecticut, Detroit Metropolitan, San Francisco-Oakland, Seattle (Puget Sound), Atlanta Metropolitan, Los Angeles, New Jersey, Greater California, Rural and Greater Georgia, Kentucky, Louisiana, New Mexico, San Jose-Monterey, and Utah (SEER, 2014). A White PrCa patient was defined as a U.S.-born White PrCa patient of the 15 SEER participating cancer registries which, had Jamaican PrCa patients (SEER, 2014).

The definition for the localized stage PrCa included the tumors which, were confined to the prostate (Young et al., 2000). PrCa patients with localized disease were classified according to Gleason grades G1, G2, and G3 (SEER, 2015, p. 96; Young et al., 2000, p. 224). PrCa patients were also classified according to the TNM stages T1 and T2 of the AJCC 6th Edition tumor node metastases (TNM classification), and the SEER Historic Stage A classification (SEER, 2013; SEER, 2014). According to the AJCC 6th Edition TNM classification, the localized stages T1a, T1b, and T1c, are clinically in-apparent tumors (SEER, 2013; Young et al., 2000). PrCa was defined as stage T2a with the involvement of one lobe; and T2b for involvement of more than one lobe (Young et al., 2000). Stage T2NOS was assigned to each PrCa patient who had no specified TNM stage (SEER, 2013).

Prostate cancer treatments were ERBT, brachytherapy, and other radiation treatments. Brachytherapy was defined as PrCa patients who received radioactive

implants, radioisotopes, and a combination of radioactive implants and radioisotopes (SEER, 2013). ERBT was PrCa patients who received beam radiation as monotherapy (SEER, 2013). Other radiation treatment was PrCa patients who received radiation sequenced with surgery (SEER, 2013). The radiation sequenced with surgery variable included other types of radiation treatments, which were not accounted for in the brachytherapy and ERBT definitions.

Covariates

Covariates for this study were the sociodemographic characteristics of the patient. The sociodemographic characteristics included the marital status, age, and health insurance status of the PrCa patient as recorded in the SEER registries data and reported at diagnosis (SEER, 2013). Marital status was the marital union reported by the patient at the time of PrCa diagnosis (SEER, 2013). Health insurance status was the PrCa patient's primary means of payment for health care, and the health insurance coverage plan at the time of diagnosis as recorded in the SEER data (SEER, 2013). Age was the actual age in years at diagnosis as recorded in the SEER registry database (SEER, 2013). Age also included all PrCa patients who were older than 35 years for the 1973 to 2011 SEER reporting period (SEER, 2013).

Assumptions

One of the assumptions that guided the execution of this dissertation was the secondary data of the SEER registries were appropriate for the exploratory design of this study. The SEER registry data on PrCa patients were collected by federal agencies, which employed trained personnel for data collection processes, and applied quality assurance

measures (Boslaugh, 2010). In addition, the data were deidentified and recoded where appropriate to protect the research participants (SEER, 2013). I also assumed that the SEER registry dataset would provide the cancer-specific information, which was related to the independent and dependent variables of this dissertation because the SEER registry database is a national database (Su & Jang, 2011). Multicenter and national databases are better suited to capture data on specific details about the characteristics of the tumor for comparisons of the outcomes of different treatments a PrCa patient receives (Su & Jang, 2011). Hence, I presumed that the SEER registry database was an appropriate data source for this study.

My supposition that the choice of secondary data for this investigation was appropriate was grounded in the likelihood that it could determine the probable relationships between the dependent and independent variables. The assumption was also based on the concept that secondary data sources are advantageous to examine the variables of an investigation in a socioeconomic, geographic, and historical context (Flowerdew, & Martin, 2013, p. 59). Besides, secondary data are helpful for comparison of a specified cohort with the larger population from which it was taken and facilitate the evaluation of differences and trends (Flowerdew, & Martin, 2013, p. 59).

Additionally, I assumed that the theoretical framework was ideal to explain the relationships between the independent and dependent variables. The oxidative stress theory, which hypothesized that oxidative stress is linked to age-related cancers including PrCa, and radiation-induced programmed cell death in the prostate gland is a biological concept. A biological conceptual framework generates data for defining, evaluating, and

managing clinical problems (Wenzel, 2017, p. 492). Hence, I presumed that the oxidative stress theory was suitable to determine the role of radiation in the oxidative stress pathway and PrCa carcinogenesis.

Scope and Delimitations

The primary focus of this dissertation was to determine survival outcomes of brachytherapy and ERBT treated Jamaican PrCa patients who were diagnosed with localized disease and resided in the United States. The study was important because there were limited publications on PrCa treatment outcomes among Jamaicans and studies on PrCa treatments were primarily conducted in the White populations and with small samples of African Americans. Hence, results of current publications were not applicable to Jamaicans. Subsequently, an enquiry using a Jamaican cohort was necessary to extrapolate the findings to that cohort.

In this study, I included all Jamaicans from the SEER database who met the selection criteria. The Jamaicans in the SEER registries database were the largest non-U.S.-born Black population (87.6%) (Fedewa & Jemal, 2013) and had the similar stage and grade PrCa as the patients residing in Jamaica West Indies (Anderson et al., 2012; Kampel et al., 2011). I balanced the selection of a White U.S.-born comparison group with the Jamaican cohort by excluding three of 18 SEER reporting sites (Hawaii, Iowa and Alaska Native) which had no Jamaican PrCa patients.

The study included all the PrCa patients who satisfied the selection criteria in the SEER registry data set to maximize group differences on the dependent and independent variables and improve generalization of the research findings (Polit & Beck, 2013, p.

246). The inclusion of a White U.S.-born referent group improved the sensitivity of the study to detect the effects observed (Polit & Beck, 2013, p. 246) among the Jamaican and White U.S.-born cohorts. I included the variable, radiation sequenced with surgery, to determine whether the treatment outcomes would differ significantly from brachytherapy and ERBT. The radiation sequenced with surgery variable included other types of radiation treatments that were not accounted for in the brachytherapy and ERBT definitions, hence it was important to determine whether it contributed significantly to the outcomes of the study. Additionally, I chose a biological theoretical framework to conceptualize the findings of the study because the research problem and questions were focused on PrCa treatment effects.

Limitations

One of the primary limitations anticipated in this study was the inability to make causal inferences about the variables from secondary data sources (Smith et al., 2011). Secondary data limits the options to choose appropriate populations for the study and influences the generalizability of the research results (Smith et al., 2011). Nonetheless, the questions of this research were developed to address the limitations on the study's findings (Smith et al., 2011). The research questions were structured based on logical reasoning from the conclusions of the literature reviewed and the recommendations of other researchers. The questions were developed on the premise that although they may not facilitate causal inferences from the data, they can generate findings on the clinical significance of the research (Smith et al., 2011). The SEER registry (a national database)

which collects data from 18 participating cancer registries in the USA was used for the data analysis to enhance generalizations of the research findings.

I utilized survival models for data analysis, and there are limitations of these statistical techniques. The Kaplan-Meier survival method is not effective to quantify the actual effect size of the study and is limited in addressing confounding effects (Flynn, 2012). However, in this study the Cox-proportional hazards model complemented the Kaplan-Meier survival model. The Cox-proportional hazards regression model is robust, flexible, and uses data efficiently (Harrell, 2015). The Cox-proportional hazards regression model also replaced the proposed Ederer 11 and Pohar Perme methods, which were limited in analyzing PrCa patients in the older age group (Lambert, Dickman, & Rutherford, 2015; Roche et al., 2013; SEER*Stat, 2015; Seppa, Hakulinen, & Pokhrel, 2015).

Possible Biases

A potential bias in this study was the threat of maturation of the research participants (Polit & Beck, 2013, p. 247). Some PrCa patients may change their vital status with time, irrespective of the treatment they receive, because of other conditions such as comorbidities, which could not be measured in this study owing to the limitations of the dataset.

Another possible source of bias for this dissertation was sampling bias (Leighton, 2010a, p. 83). In addressing the likelihood of possible selection bias in this dissertation, I used an evidenced based approach to create the selection criteria. I developed the selection criteria for the research participants using their characteristics in the SEER

Research Data Description for PrCa cases who were diagnosed between 1973 to 2011 (SEER, 2013). I also utilized a random selection method to choose the comparison group for the study.

Significance

This dissertation may add new epidemiological data to the current body of knowledge on PrCa in the Jamaican community. While PrCa is a public health problem among Jamaicans, there is limited information on the treatment of localized PrCa in the Jamaican communities (Aiken & Eldemire-Shearer, 2012; Fedewa & Jemal, 2013; Gibson, Hanchard, Waugh, & McNaughton, 2013; Morrison et al., 2014; Rich et al., 2012).

I also expect that this dissertation will contribute to public health practice and policies aimed at improving the years of potential life lost (YPLL) of a Jamaican PrCa patient, by informing clinical interventions and policies that address access to treatments for localized PrCa. If these interventions are effective in managing the early and intermediate stages of this disease, the survival rates of affected males may be improved because earlier stages of PrCa demonstrate better survival outcomes (Fufaa, 2011).

This study has important social change implications for the Jamaican population. The Jamaican population has a high rate of PrCa, and affected males experience disparities in access to PrCa treatment (Aiken & Eldemire-Shearer, 2012; Gibson et al., 2013; Rich et al., 2012). This inequality is primarily due to a combination of social factors such as lack of health insurance and affordable preventive care (Aiken & Shearer, 2012; Morrison et al., 2014). Therefore, this research may provide data, which can be

used to make appropriate decisions for improving the clinical management of PrCa patients, enhance access to health care, improve the health outcomes of PrCa patients, and subsequently reduce the disparities in PrCa survival. Currently, the Jamaican government is seeking to advance the services offered to cancer patients in Jamaica by utilizing assistance from the international organization International Atomic Energy Agency (IAEA) to address the existing epidemiological status of cancers in the country (Ministry of Health Jamaica, 2013). The Jamaican urological society is also seeking information on PrCa treatment effectiveness among Jamaicans, which will support appropriate treatment choices for localized PrCa (Morrison et al., 2014). This research would improve access to empirical data that focused on addressing the PrCa cancer epidemiology among Jamaicans.

Summary and Transition

The treatment of PrCa patients with low and intermediate stage disease using Brachytherapy and ERBT are well documented among the White population of the United States as well as other European cohorts. However, findings of recent publications may not generalize to Jamaicans because of small samples of African Americans, which were included in those investigations. There is also a dearth of information on the relationship between brachytherapy treatment, ERBT, and PrCa survival among Jamaicans. Besides, it was important to study the effects of brachytherapy and ERBT in localized PrCa among Jamaicans because of currently reported trends in the detection of the disease. Additionally, it was relevant to examine for intervening effects of the sociodemographic characteristics in the survival of PrCa patients because of their

relationship with the key variables of the study. Hence, the sociodemographic indicators of the research subjects were studied for their covariate effects in the results of the research. The research utilized a retrospective design and survival models to examine the effects of brachytherapy and ERBT on the survival of Jamaican PrCa patients with low and intermediate stage PrCa. These survival models included the Kaplan-Meier and Cox-proportional hazard models. The oxidative stress theory was chosen to explain the relationship between the main variables of the study. In Chapter 2, I provided a deeper analysis of the literature that clarifies the theoretical framework of the study. Chapter 2 also has the literature synthesis which describes the variables of the study, their roles in the study; and the gaps in the literature.

Chapter 2: Literature Review

Introduction

The outcomes of brachytherapy and ERBT in treating low and intermediate stage PrCa are well reported in retrospective, prospective, and observational studies (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). However, researchers documented diverse conclusions on the effectiveness of brachytherapy, ERBT, and active surveillance for treating localized PrCa (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). Findings of current publications were noted primarily in the White populations (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Williams et al., 2011). Additionally, investigators who examined treatment effects of brachytherapy and ERBT in PrCa survival, documented limitations of small sample sizes of the Black population (Cendales et al., 2015; Goldner et al., 2012; Nepple et al., 2013; Smith et al., 2015; Zuber et al., 2015). Hence, data from current literature may not extrapolate to the Jamaican cohort. Consequently, the intent of this dissertation was to explore the effects of ERBT, and brachytherapy treatment on the survival of Jamaican PrCa with low and intermediate stage disease. This dissertation was also designed to examine the covariate effects of the sociodemographic indicators of age, marital status, and health insurance status in the survival rates of Jamaican and White U.S. PrCa patients. This research investigated the association of PrCa treatment for low

and intermediate stage disease with the survival rates of Jamaican and U.S.-born White PrCa patients, using a retrospective cohort study design, secondary data, and survival models.

A vast number of current retrospective and prospective studies documented disparities in PrCa survival in the African American, and Caribbean Black populations (Antwi, Tucker, Coker, & Fleming, 2013; Mutetwa et al., 2012; Ragin, Mutetwa, Attong-Rogers, Roach, & Taioli, 2011; Tyson & Castle, 2014). Meliker, Goovaerts, Jacquez, AvRuskin, and Copeland (2009), and Tyson and Castle (2014) reported that the White PrCa patients in the United States experienced better survival overall when compared with Black males. Mutetwa et al. (2012) and Ragin et al. (2011) established that men who were born in the Caribbean and lived in the United States had similar five-year survival patterns from PrCa as other African Americans. However, the reasons for the survival disparities in PrCa among racial groups were not well explained in current literature.

Recently, researchers also documented that brachytherapy (with or without ERBT), and active surveillance, were popular treatment choices among PrCa patients who are living in the United States (Hamilton et al., 2010; Weiner, 2015). However, retrospective, prospective and observational studies on brachytherapy treatment and PrCa survival demonstrated mixed results (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Rodrigues et al., 2014; Williams et al., 2011; Zuber et al., 2015). Alumini et al. (2015), Cendales et al. (2015), Smith et al. (2015), Rodrigues et al. (2014), Skowronek (2013), and Zuber et al. (2015) reported survival benefits among brachytherapy treated PrCa patients. On the other hand, Goldner et al. (2012), Nepple et

al. (2013), and Smith et al. (2015) cited no statistically significant differences among PrCa patients who were treated with ERBT as a monotherapy, versus PrCa patients who received brachytherapy with and without ERBT. Moreover, Schreiber et al. (2013) documented disparities in brachytherapy treatment among Whites and African Americans. Furthermore, Williams et al. (2011) established that brachytherapy was a costlier treatment option for localized disease when compared with other PrCa treatments. Hence, current literature provided mixed findings on the survival advantage of brachytherapy treatment and ERBT among PrCa patients with low and intermediate stage disease. Additionally, the outcomes reported in the literature suggested that the effect of brachytherapy treatment for localized PrCa required further exploration particularly among African American males.

In current publications, researchers documented favorable survival outcomes among PrCa patients who were diagnosed with low and intermediate risk disease and were managed without directive treatment (Bul et al., 2013; Odom et al., 2014; Selvadurai et al., 2013; Wilt et al., 2012). In three prospective studies, Bul et al. (2013), Klotz et al. (2010), and Selvadurai et al. (2013) reported low death rates among PrCa patients on active surveillance and observation. However, Klotz et al. recommended additional research, which include PrCa patients with the aggressive forms of the disease to verify their findings. Nepple et al. (2013) also suggested that observation should be added as a treatment option in studies, which examine the effects of ERBT and brachytherapy treatment in PrCa survival.

Additionally, findings of the review of the literature revealed that the sociodemographic characteristics of age, grade, and stage of the disease influenced the survival of PrCa patients, particularly the African American population (Antwi et al., 2013; Fufaa, 2011; Lin et al., 2009). Scholars have also identified differences in survival of PrCa according to the sociodemographic characteristics and treatment status of men from varying geographic backgrounds, and indicated that these variables might be responsible for PrCa survival (Parris, 2013; Shafique et al., 2013; Xiao, Warrick, & Wang, 2009). Therefore, the sociodemographic indicators of age, marital, and health insurance status of a PrCa patient were examined in this study for their covariate effects.

Finally, recent studies documented that smoking impacts the survival of PrCa patients (Kenfield et al., 2011; Warren et al., 2012; Watters et al., 2009). Smoking may be related to high death rates among PrCa patients, and the African American population is more likely to be affected (Kenfield et al., 2011; Warren et al., 2012; Watters et al., 2009). Furthermore, data from the Jamaican Lifestyle Survey (453304) indicated that smoking was a common lifestyle factor among Jamaican males and a contributing factor to chronic diseases in that cohort (Wilks, Younger, Tulloch-Reid, Mcfarlane, & Francis, 2008). Hence, smoking was a covariate in this study; but, data were not available for this research to examine its effects on PrCa survival.

Chapter 2 includes the origins of the oxidative stress theoretical framework, its main propositions, and its role in the relationship between the independent and dependent variables. Chapter 2 also comprises the literature search strategy, the synthesized literature of the variables of the study, and the research questions. The main areas of the

literature review were prostate cancer survival, current trends in PrCa survival, differences in survival among ethnic groups, treatment for low and intermediate stage PrCa and survival, and the sociodemographic characteristics and PrCa survival.

Literature Search Strategy

I conducted the literature search using publications from the major databases of the Walden University Library. The primary library resources were ProQuest Dissertations and Theses at Walden University, Google Scholar, EBSCO Host, Academic Search Complete, Thoreau, and Science Direct. The Boolean search engines and phrases were the major search modes used to identify appropriate literature for this dissertation.

The key search terms were *prostate cancer, prostate cancer mortality and survival, prostate cancer and Jamaican males, prostate cancer in the White population of the United States, prostate cancer, and radiation treatment, prostate cancer in the Caribbean, and prostate cancer in the United States.* Search terms also included*, prostate cancer treatment for localized disease, active surveillance and prostate cancer, external beam radiation therapy (ERBT) and localized prostate cancer, and brachytherapy and localized prostate cancer, treatment of prostate cancer and 1973 to 2011.* In addition, search terms included *radiation and the oxidative stress theory, oxidative stress theory and prostate cancer, the mechanism of the oxidative stress theory, and radiation-induced apoptosis.* Other terms used for the literature search were *sociodemographic characteristics and prostate cancer treatment, smoking and prostate cancer survival, smoking among Jamaicans, and the SEER cancer registry.*

I also used the reference listings of current primary research articles to identify other relevant sources of the literature. Publications were sorted by relevance and currency, for those written in English, and included peer-reviewed primary sources. However, both peer-reviewed and non-peer-reviewed articles on the Jamaican population were included because of limited literature. I utilized the studies on the African American population to make deductions about Jamaicans where the data on the variables of interest and the research questions were inadequate. Articles older than five years were included where data were lacking on important variables, and for their relevance to the study.

Theoretical Foundation

The free radical theory of ageing, currently known as the oxidative stress theory (Sowell et al., 2010) was utilized to conceptualize the relationship between treatment for localized PrCa, clinical characteristics of PrCa, and PrCa survival. Denham Harman developed this theory in 1956 (Sowell et al., 2010).

Major Theoretical Propositions

The oxidative stress theory proposed that oxidative stress is an outcome of increased and sustained metabolic processes of the body, which contributes to major age-related chronic diseases, including cancers (Sowell et al., 2010, p. 341). The oxidative stress theory posits that accumulation of the production of free radicals and ROS, affects cellular functioning by impairing the DNA, lipid, and protein biomolecules of the cells of the body (Preedy, 2014; Sowell et al., 2010). Khandrika et al. (2009) linked the oxidative stress theory with programmed cell death, which occurs because of intracellular and

extracellular environmental conditions of the prostate gland. These intracellular and extracellular environmental conditions generate ROS during the metabolic activities of the cell, and ROS subsequently activate signaling pathways to react to the cellular states (Khandrika et al., 2009). According to Khandrika et al. radiation is one of the environmental conditions which induces oxidative stress in the prostate gland and consequently increases ROS production. Radiation also inhibits carcinogenesis by increasing ROS production (Khandrika et al., 2009). Increasing ROS production results in damage to the DNA of the cell and inhibits cell duplication and division (Khandrika et al., 2009). Subsequently, radiation-induced cell death occurs, and the damaged cells are removed from the body through apoptosis (Khandrika et al., 2009; Nakajima, 2008). The process of radiation-induced apoptosis impedes the progression of PrCa carcinogenesis (Nakajima, 2008). Thus, the assumptions of the oxidative stress theory are linked with the mechanism of radiation-induced programmed cell death in halting PrCa carcinogenesis.

Literature and Research-Based Analysis of Theory Application

Findings from studies, which clarified the roles of the oxidative stress pathway in PrCa development, supported a relationship between oxidative stress and PrCa carcinogenesis (Barocas et al 2011, Freitas et al., 2012; Kumar et al., 2008). In the Nashville's Men's Health study Barocas et al. (2011) confirmed that oxidative stress played a role in PrCa development. Barocas et al. identified that F2-Isoprostane level, which is associated with oxidative stress in PrCa, was elevated in men with the disease. In another experimental study, which used the oxidative stress theory as its conceptual framework, Kumar et al. (2008) described the functions of oxidative stress in healthy

cells of the prostate gland and three different types of PrCa cells with varying degrees of aggressiveness. Kumar et al. confirmed that PrCa cells produced higher levels of ROS when compared with normal cells, and subsequently created functional abnormalities of the prostate cells. Freitas et al. (2012) also established that ROS was toxic to PrCa cells in the localized stage of PrCa. However, Freitas et al. indicated that the influence of ROS in low-grade PrCa was less marked when compared with metastatic disease. The finding of Freitas et al. suggested that small increments of ROS also create changes in the cells of the prostate gland.

Experimental studies also supported the roles of the oxidative stress pathway in inhibiting PrCa carcinogenesis (Fang et al., 2012; You et al., 2015). Fang et al. (2012) and You et al. (2015) indicated that the oxidative stress pathway plays a key role in explaining the functions of ROS in stimulating signaling pathways in response to the cellular environment of the prostate gland. Fang et al. and You et al. demonstrated that radiation promotes apoptosis, and decreases cell proliferation in localized PrCa. The findings of these studies suggested that radiation promotes programmed cell death and subsequently inhibits carcinogenesis (Fang et al., 2012; You et al., 2015). The effects of radiation-induced programmed cell death in decreasing PrCa carcinogenesis may determine the length of time individuals who are treated with radiation live with the disease. Therefore, the oxidative stress theory was appropriate to explain the relationship between the primary variables of this dissertation because it clarified the mechanism of radiation- induced PrCa cell death in halting carcinogenesis (Fang et al., 2012; You et al., 2015).

Relationship of the Theory to the Study and the Research Questions to the Theory

The aim of this study and the research questions were to determine the survival intervals of ERBT and brachytherapy treated Jamaican PrCa patients with low and intermediate stages PrCa, and compare survival outcomes with White U.S.-born ERBT and brachytherapy treated PrCa patients. Experimental studies documented the role of the oxidative stress pathway in the development of PrCa, and paradoxically in halting PrCa carcinogenesis (Fang et al., 2012; Khandrika et al., 2009; You et al., 2015). According to the findings of these studies, radiation is an extracellular environmental factor which induces oxidative stress in the prostate gland and damages the cell's DNA structure (Fang et al., 2012; Khandrika et al., 2009; You et al., 2015). Thus, the cell cycle is arrested, radiation-induced apoptosis occurs, and consequently, carcinogenesis of the prostate is halted (Fang et al., 2012; Khandrika et al., 2009; You et al., 2015). The outcome of this process may explain the length of time a PrCa patient lives with the disease. Therefore, this theory was appropriate to test the hypotheses of a relationship between the prime variables of this dissertation.

Literature Review Related to Key Variables and Concepts

In the literature review, I discussed the significant variables and covariates in the context of the study. I also highlighted how the key variables were measured in this dissertation, and the gaps addressed with the research questions.

Prostate Cancer Survival

Prostate cancer survival is the dependent variable in this dissertation and was investigated among Jamaican and White PrCa patients residing in the United States. In

defining PrCa survival, it was necessary to clarify the dates of initial diagnosis and the time of death from PrCa. Researchers who conducted investigations in PrCa survival defined survival as the date of initial diagnosis to the time of the first outcome (death or censoring) (Hu et al., 2014; Lin et al., 2009; Redaniel et al., 2013; Thompson et al., 2013). According to Mills, (2011a) knowledge of the time of the event helps in determining whether continuous or discrete time methods should be used to complete survival analyses. Redaniel et al. (2013) examined PrCa survival with secondary data and used the definitions of the cancer registry that provided the data. Redaniel et al. defined the date of initial diagnosis of PrCa as the date of initial histological or cytological confirmation of the primary tumor. Mills and Redaniel et al. supported the relevance of establishing the parameters, which defined the survival intervals of the PrCa patients in this research.

Another vital element of the definition of prostate cancer survival in this study was specifying the time of death. In survival data, the precise survival times for a variable may be difficult to determine, or data may not be available in the data set (Mills, 2011a). The survival time that is not known is usually accounted for as censoring in survival studies (Mills, 2011a). Hence, censoring was a critical component of the definition of survival in this research. An important consideration for the definition of censoring was variation in its meaning according to the source of data used for an investigation. In examining survival time, Lin et al. (2009) and Thompson et al. (2013) defined censoring of PrCa patients as the date that they were last reported as being alive in the study, based

on available follow-up data. In this dissertation, I used the definition for censored data that was available in the database.

Additionally, an appropriate endpoint was a key aspect of the definition of prostate cancer survival. Prostate cancer-specific and cause-of-death mortality are two important endpoints which are used to estimate PrCa survival (NCI, 2011). However, the NCI (2011) reported that it is usually challenging to choose appropriate sources of information from which to confirm these endpoints for PrCa. Cause of death data is one source of information used for this purpose, but it is limited in providing the correct endpoint for verifying PrCa survival (NCI, 2011). Nonetheless, information from the NCI suggested that despite its limitations, cause-of-death data is useful to establish endpoints to estimate PrCa survival. The cause-of-death data represents the survival from PrCa in the absence of other causes of death and allows for censoring of individuals who die of causes that were not studied (NCI, 2011).

Lin et al. (2009) and Thompson et al. (2013) used cause-specific and all-cause mortality data to measure PrCa survival and described the benefits and limitations of using both data sources. Thompson et al. indicated that there were limitations in using cause-specific data to determine PrCa survival; conversely, Lin et al. highlighted the advantage of using both cause-specific and all-cause mortality data to examine survival. In estimating survival in a treatment versus a placebo group using PrCa specific mortality data, Thompson et al. did not detect an effect in a placebo group because of inadequate information on cancer-specific deaths. On the other hand, Lin et al. identified a difference in overall survival (survival rate 2.1%, 95% [CI 1.38, 3.19]) and PrCa specific survival

(survival rate 0.71%, 95% [CI, 0.54, 0.92]), using cause-specific and all-cause mortality data from the SEER registry. Lin et al. examined PrCa survival in a 55 to 64 age group cohort diagnosed with all stages of PrCa. Although 38% of the data were reported missing in the study, this did not affect the study's outcome (Lin et al., 2009). The studies' results of Lin et al. and Thompson et al. implied that using both cause-specific and all-cause mortality data may be a better choice to estimate PrCa survival when compared with utilizing cause-specific data exclusively.

Lin et al. (2009) relied on the information from death certificates to obtain cause of death data to base endpoints for PrCa survival; however, the NCI (2011) reported limitations in using death certificates for this purpose. According to the NCI, one of the drawbacks of using death certificates to determine death from PrCa is ensuring that the data accurately classify the cases. The precision of the endpoints from death certificates might vary according to the accuracy of the information of the death certificates; this could be problematic when classifying metastatic cases if the death certificates incorrectly list the cause of death (NCI, 2011). Although the NCI reported limitations in the use of death certificates, the organization advocates for its use to ascertain causes of death in population-based survival data obtained from cancer registries. In this dissertation, the definition of prostate cancer survival was developed based on the recommendations of the NCI, the findings of the literature, and the definitions of the cancer registries data description (SEER, 2014).

Differences in Prostate Cancer Survival Among the White U.S.-Born and Ethnic Groups

Investigators who conducted studies on PrCa survival in the United States documented greater survival disadvantage of the U.S.-born ethnic groups when compared with the White population (Antwi et al., 2013; Meliker et al., 2009; Mutetwa et al., 2012; Ragin et al., 2011; Tyson & Castle, 2014). Antwi et al. (2013) explored differences in PrCa survival in a cohort of 18,200 (91.3% Whites, 8.7% African-American) men from the State of Kentucky cancer registry. The results of the enquiry demonstrated that the African American PrCa patients experienced higher mortality (10.9%) from the disease when compared with the Whites (7%), ($p < .001$) (Antwi et al., 2013). The African American men were also more likely to be diagnosed with distant stage PrCa (6.5%) when compared with the White population (4.3%) (Antwi et al., 2013). Additionally, a higher proportion of African American versus White PrCa patients received surgery as the primary treatment (29.6% versus 25.2%, $p < .001$) (Antwi et al., 2013). Additionally, the survival disparities of the White and African American cohorts remained at ten years of follow-up (Antwi et al., 2013). Antwi et al. recommended further exploration of survival differences of African Americans including socioeconomic status, treatment guidelines, underlying biological influences among the races, and comorbidities.

Meliker et al. (2009) examined survival disparities in a sample of 120,615 PrCa patients from the State of Michigan cancer surveillance program and demonstrated mixed results. Using the Space-Time Intelligence System, Meliker et al. estimated racial disparities across Federal and State House Legislative Districts and community-defined

localities. The findings of the study revealed racial differences in PrCa survival in 47% of the Federal State House Legislative Districts (Meliker et al., 2009). However, the survival experience for the State House Legislative Districts and urban communities were mixed (Meliker et al., 2009). One of the high points of this study was the utilization of geographic information systems to quantify the survival outcomes of the PrCa patients (Meliker et al., 2009). On the other hand, Meliker et al. asserted that their study could not determine variations in PrCa survival according to the country of origins of subpopulations of Blacks and Whites.

Tyson and Castle (2014) also documented disparities in PrCa survival among Blacks when compared with Hispanics, Asians, and Whites. Tyson and Castle utilized a cohort of 294,160 PrCa patients from the SEER cancer data registries who were diagnosed between January 1995 and December 2003. The findings of the study conducted by Tyson and Castle revealed that the Black PrCa patients had poorer survival when compared with the White U.S. cohort, *HR* 1.37, 95% [CI 1.33, 1.41], $p < .001$. Tyson and Castle alluded to the problems encountered in determining racial peculiarities due to the broad ethnic classification of the population-based data, and recommended future studies to explain the factors favoring differences in survival.

Additionally, investigators demonstrated survival disparities among Caribbean-born PrCa patients living in the United States and their country of birth (Mutetwa et al., 2012; Ragin, 2011). Mutetwa et al. (2012) investigated the disparities of PrCa among Caribbean ethnic groups who resided in the United States and compared survival patterns with Caribbean men who lived in their native country. Mutetwa et al. utilized three

cancer registries databases in the United States, as well as Caribbean cancer registries data to estimate survival differences among the Afro-Caribbean males, and compare survival patterns with men living in the Caribbean. Mutetwa et al. recognized that males who were born in the Caribbean and resided in the United States had similar five-year survival patterns from PrCa as African Americans. The survival rate for Caribbean men living in their native countries was 78.1%, 95% [CI 70.9, 83.7] and 81.4% for African Americans males, 95% CI [69.5, 89.1] ($p = 0.792$) (Mutetwa et al., 2012).

On the other hand, Mutetwa et al. (2012) reported that the survival rate for the Caribbean-born PrCa patients residing in the Caribbean was 41% when compared with 81% for the men who resided in the United States. According to Mutetwa et al., the disparities in the survival rates of Caribbean-born PrCa patients who lived in their country of birth and the United States may be attributed to the methods of detection of the disease and genetic factors. One of the limitations reported by Mutetwa et al. was missing and incomplete data that defined the ethnic groups. On the other hand, a strong point of the researchers' methodology was data triangulation with the Caribbean cancer registries and three United States cancer databases.

Ragin et al. (2011) conducted further studies on the disparities in PrCa survival in a Brooklyn cohort of Caribbean-born males and PrCa patients living in the Caribbean to determine the underlying factors for their survival differences. Ragin et al. studied the survival differences among men who were currently diagnosed with stages 1 to 111 PrCa. The results of the study confirmed that the Caribbean-born PrCa patients who resided in their home country were three times more likely to die of PrCa, adjusted *HR* 3.6, 95%

[CI 2.8, 5.0] when compared with their Caribbean counterparts residing in the United States (Ragin et al., 2011). Ragin et al. also confirmed that there were significant differences in the treatments that the two cohorts received. The Caribbean-born males in the United States were managed surgically (35%); while, men residing in the Caribbean received hormone treatment (33%) (Ragin et al., 2011). Hence, the survival differences among PrCa patients in the Caribbean and the United States may be explained by treatment differences (Ragin et al., 2011). Ragin et al. recommended additional studies among Caribbean men to validate the results of their study.

The findings of the current literature confirmed that the White U.S. PrCa patients had better survival probability from PrCa when compared with the Black population. Therefore, the White U.S. PrCa patients were suitable for the referent group for this research. The conclusions of studies on disparities in PrCa survival support the need for other research, which examine PrCa treatment outcomes in subpopulations of the African American and other ethnic communities in the United States. Additionally, researchers advocated for the inclusion of the socioeconomic status of PrCa patients in studies, which examine treatment effects in PrCa outcomes. Thus, it was necessary to study PrCa treatment outcomes in a minority population and include their socioeconomic characteristics.

Trends in the Treatment of PrCa 1992 to 2011

The treatment of PrCa evolved since the 1990s, and brachytherapy, ERBT, and active surveillance are widely used to treat localized disease (Cooperberg & Carroll, 2015; Hager et al., 2014; Hamilton et al., 2010; Mahmood et al., 2014; Safdieh et al.,

2016; Valdivieso et al., 2015, Weiner et al., 2015). Hamilton et al. (2010) examined trends in PrCa treatments for localized PrCa for the 1998 to 2002 interval using data from ten cancer registries in the United States. Hamilton et al. identified no significant changes in the number of PrCa patients who utilized radical prostatectomy or ERBT as monotherapy. Nevertheless, the proportion of patients who received brachytherapy treatment as monotherapy or combined with ERBT increased from 14.9% to 17.7% (Hamilton et al., 2010). Hamilton et al. also reported a decline in the number of PrCa patients who chose watchful waiting as an option for managing localized PrCa. Hamilton et al. recommended additional studies on recent trends in PrCa treatments for localized disease, and endorsed further studies which will delineate the subgroup of PrCa patients who would benefit from brachytherapy and ERBT.

Hager et al. (2014) also reported a shift in treatment trends for localized PrCa for the period 2004 to 2011. Hager et al. compared current trends in PrCa treatments among cohorts of United States and German PrCa patients. The sample of U.S. PrCa patients was 132,506 PrCa patients whose data were abstracted from the SEER cancer registry. Hager et al. reported a decline in radical prostatectomy treatment (37.1% to 34.2%, $p = .004$), and radiotherapy (42.8% to 31.8%, $p < .001$) for the period 2004 to 2011. Hager et al. also identified that deferred and defensive treatments were the preferred choices for treating localized PrCa in the United States and there was a steady increase in the utilization of these treatment methods. However, Hager et al. alluded to the influence of physician's preferences and the health care systems in the choice of treatment for men with localized PrCa. On the other hand, the PrCa patient's preferences in treatment

options were not well documented (Hager et al., 2014). Additionally, Valdivieso et al. (2015) reported that brachytherapy was widely used among PrCa patients in the SEER Medicare-linked database for the 1992 to 2009 period. Forty percent of PrCa patients in the SEER Medicare-linked database used brachytherapy as monotherapy, 19% as a combination with ERBT, and 27% as a combination with Androgen Deprivation Therapy (ADT) (Valdivieso et al.,2015). Valdivieso et al. suggested that current investigations which extend beyond 2009 were needed to determine further shifts in PrCa treatment in the United States.

On the other hand, Mahmood et al. (2014) and Safdieh et al. (2016) provided differing data on recent developments in PrCa treatments in the United States. Mahmood et al. investigated current trends in brachytherapy and ERBT utilization for treating localized PrCa for the period 2004 to 2009 using the SEER registry data. Mahmood et al. recognized a decline in brachytherapy treatment of 6.2% for the periods 2004 to 2009 and a similar increase of in ERBT uptake for that period. Brachytherapy utilization decreased according to the SEER geographic sites, race, age, marital status, health insurance status, and income, of the PrCa patients (Mahmood et al., 2014). Safdieh et al. studied a sample 89,413 PrCa patients using the National Cancer Database for the period 2004 and 2012 and reported a reduction in brachytherapy treatment from 62.9% in 2004 to 51.3% in 2012 ($p < .001$). Safdieh et al. indicated that the decrease in brachytherapy use was more evident among PrCa patients who lived furthest from treatment sites and purported that it could be attributed to physician's preferences. Nonetheless, the study was limited by selection bias, coding errors, and incomplete data (Safdieh et al., 2016). Safdieh et al.

recommended further studies on the barriers to brachytherapy treatments. Based on the recommendations from researchers who investigated the current trends in PrCa treatments, this dissertation was necessary.

Treatments for Low and Intermediate Stage PrCa and Survival

In retrospective, observational, experimental, and prospective studies, researchers documented the survival benefits and limitations of ERBT and brachytherapy for treating PrCa patients in different settings (Alumini et al., 2015; Cendales et al., 2015; Goldner et al., 2012; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Smith et al., 2015; Williams et al., 2011; Zuber et al., 2015). Among the benefits described in the literature, brachytherapy treatment provided fewer unpleasant side effects, and better biochemical control for PrCa patients with the localized disease when compared with other PrCa treatments (Alumini et al., 2015; Williams et al., 2011; Zuber et al., 2015). Alumini et al. (2015), Zuber et al. (2015), and Williams et al. (2011) established that brachytherapy is one of the safer methods to treat PrCa patients with early stage disease, and PrCa patients experienced fewer side effects with this treatment. The literature also highlighted that at higher doses, brachytherapy treatment was an equally effective treatment method for localized PrCa (Cendales et al., 2015; Rodrigues et al., 2014; Skowronek, 2013). Cendales et al. (2015), Rodrigues et al. (2014), and Skowronek (2013) confirmed that at high doses, brachytherapy treatment remained a safe and effective treatment for localized PrCa and toxicity among PrCa patients with localized disease was small. Additionally, the literature demonstrated that treatment outcomes for both low-dose and high-dose brachytherapy treatment were comparable (Rodrigues et al.,

2014; Skowronek, 2013). Skowronek documented that at both Low-dose and high doses, brachytherapy treatment was equally cost effective for controlling localized PrCa. Similarly, Rodrigues et al. confirmed that brachytherapy at high and low doses was effective in reducing biochemical failure in both intermediate and low-risk PrCa patient. However, Rodrigues et al. reported that their study was limited by small sample size due to attrition of the study's participants.

On the other hand, researchers highlighted disadvantages with brachytherapy treatment in PrCa survival (Schreiber et al., 2013; Williams et al., 2011). The limitations of brachytherapy treatment included racial, socioeconomic, and age disparities; treatment side effects, and cost (Schreiber et al., 2013; Williams et al., 2011). Schreiber et al. (2013) reported racial and socioeconomic disparities in the use of brachytherapy among African Americans and Whites. Schreiber et al. documented that African American males of lower socioeconomic status were less likely to include brachytherapy in their PrCa treatment when compared with White males. Williams et al. (2011) asserted that brachytherapy is expensive, better accepted among men in the younger age group ($p < .001$), and resulted in bowel complications in PrCa treated patients.

Nonetheless, Schreiber et al. (2013), and Williams et al. (2011) cited limitations of their studies. Schreiber et al. acknowledged that misclassification, which occurred by arbitrarily assigning PrCa patients to socioeconomic groups was an important limitation of their study. Consequently, Schreiber et al. recommended further studies which examine racial and socioeconomic disparities in brachytherapy treatment. Schreiber et al. also indicated that lack of comorbidity data in the SEER cancer registry data was another

limitation, which influenced the results of the study. In addition, Williams et al. asserted that the quality of the clinical information used for their study was a prime limitation. Williams et al. noted that the data used for the study were lacking relevant clinical information about the PrCa patient because they were billing information. On the other hand, Aluwini et al. (2015), and Zuber et al. (2011) utilized prospective designs, reliable SEER coding, and documented that the high-quality Medicare data was one of the strengths of their study.

Researchers have also compared the effectiveness of brachytherapy treatment with ERBT for the management of localized PrCa, and identified no statistically significant differences in overall survival of PrCa patients (Goldner et al., 2012; Nepple et al., 2013; Smith et al., 2015). In a Canadian cohort with low and intermediate stages PrCa, Smith et al. (2015) identified no significant differences in overall survival among men who were treated with brachytherapy versus ERBT. The hazard of death among low risk PrCa patients was, *HR* 1.41, ($p = 0.500$) and *HR* 1.27, ($p = 0.687$) for the intermediate risk cohort (Smith et al., 2015). Nepple et al. (2013) also detected no significant differences in prostate cancer mortality among a cohort of PrCa patients who were treated with ERBT and brachytherapy at the Cleveland Clinic in the United States, *HR* 1.83, 95% CI [0.88, 3.82]. Similarly, in a Dutch cohort, Goldner et al. (2012) confirmed that brachytherapy treatment might not provide a greater survival advantage to PrCa patients with intermediate risk PrCa when compared with ERBT. However, the studies were limited by small sample sizes and did not include an active surveillance group, as one of the treatment options for low-risk PrCa.

The findings of the literature on PrCa treatment outcomes may not generalize to Jamaican PrCa patients because of small samples of African American cohorts, and the study populations used to examine the relationship of the major variables. Additionally, I identified no studies on the outcomes of brachytherapy and ERBT in the Jamaican population.

Survival of PrCa Patients Without Initial Treatment for Low and Intermediate Stage PrCa

In recent publications investigators reported favorable survival outcomes among PrCa patients who were diagnosed with low and intermediate stage disease and were managed without directive treatment (Bul et al., 2013; Odom et al., 2014; Selvadurai et al., 2013; Wilt et al., 2012). Bul et al. (2013), Klotz et al. (2010) and Selvadurai et al. (2013) reported low death rates among PrCa patients who were managed with active surveillance and observation. However, Bul et al., Klotz et al., and Selvadurai et al. suggested that the findings of these studies might be inadequate to make safe assumptions about the impact of active surveillance on PrCa survival because they were limited by short follow-up periods. Klotz et al. recommended further studies on active surveillance for men with the more aggressive forms of the disease.

Conversely, Wilt et al. (2012) identified favorable survival outcomes for PrCa patients who were managed with observation in a 12-year prospective study. Wilt et al. compared survival of PrCa patients managed with observation, versus PrCa patients who received prostatectomy treatment. The death rate for PrCa patients after prostatectomy treatment was 5.8% versus 8.4% for observation, *HR* 0.63, 95% CI [.36, 1.09], $p = .09$

(Wilt et al., 2012). One of the high points of the study conducted by Wilt et al. was its generalizability. Study participants had similar characteristics of age, health status, and PSA values (Wilt et al., 2012). The tumor risk characteristics were also similar for PrCa patients who were eligible to participate in the study but declined (Wilt et al., 2012). Based on the outcomes of this study, Wilt et al. recommended observation for men with localized PrCa.

The findings of Bul et al. (2013), Klotz et al. (2010), Nepple et al. (2013), Selvadurai et al. (2013), and Wilt et al. (2012) indicated that the effects of observation or active surveillance on the survival of PrCa patients with low and intermediate stage disease should be examined in this dissertation. Bul et al., Klotz et al., Selvadurai et al., and Wilt et al. recommended further studies on the effects of observation in PrCa survival among men with the more aggressive forms of the disease. In addition, Nepple et al. suggested that observation is a treatment option, which should be explored in studies, which examine the effects of ERBT and brachytherapy treatment. However, due to data limitations, active surveillance was not measured in this research.

Sociodemographic Characteristics and Prostate Cancer Survival

The literature reviewed demonstrated that sociodemographic characteristics of PrCa patients played a key role in the survival of PrCa patients (Parris, 2013; Xiao et al., 2009). Therefore, it was necessary to determine whether the sociodemographic indicators of age, marital status, and health insurance status were confounders in the treatment outcomes of the PrCa patients in this study. Parris (2013) identified that the sociodemographic indicators of age, racial background, and marital status of PrCa

patients were predictors of PrCa survival in a United States cohort, with localized disease. Likewise, Xiao et al. (2011) demonstrated that PrCa patients without health insurance had the conditions for poorer survival from PrCa because they were more likely to be diagnosed with the later stages of the disease.

Age of the PrCa patient and survival. Current studies have shown that the age of a PrCa patient influences the survival time; and that younger PrCa patients with advanced stage disease are experiencing similar mortality from PrCa as older men (Fufaa, 2011; Lin et al., 2009). Antwi et al. (2013) reported higher mortality from PrCa among the younger African American PrCa patients in the state of Kentucky when compared with White males in that State (African American 10.9% and Whites 7%). Antwi et al. also documented that the African Americans were more likely to be diagnosed with PrCa at a younger age (63.9 years ± 10 years), when compared with the White PrCa patients (66.9 years ± 9.8 years, $p < .001$). This disparity of age in PrCa incidence and mortality among the racial groups of the State of Kentucky, which has a small proportion of African-Americans (8%) (Antwi et al., 2013), suggested that age is a key factor in the survival of PrCa patients. Fufaa (2011) demonstrated that older PrCa (age > 81years) and PrCa patients aged 31 to 40 years with the aggressive forms of the disease had shorter survival times when compared with patients in other age groups. Crawford (2013), Fufaa and Lin et al. (2009) also examined the effects of age and tumor grade in PrCa survival using cancer registry data and recommended additional research to clarify the outcomes of their research. Crawford (2013), documented that misclassification of tumor grade was a limitation of the investigation. Consequently, Crawford was unable to detect a

statistically significant difference in survival outcomes among U.S. Black and White PrCa patients. Fufaa and Lin et al. reported that misclassification of tumor grade and stage, and underreporting of the cancer registry data were limitations of their studies. Fufaa also reported limitations of using death certificates to obtain information about the PrCa patients' characteristics. Antwi et al. documented their inability to measure comorbidities and generalize the findings to other populations. Based on the recommendations of Crawford, Fufaa, and Lin et al., it was important to clarify the influence of age on the treatment outcomes in this study.

Health insurance status and PrCa survival. Current publications highlighted the effects of health insurance of PrCa patients in their survival (Abdalsattar, Hendren, & Wong, 2016; Mahal et al., 2014; Parris, 2013). Paris (2013) examined the effects of the socioeconomic status of a cohort of PrCa patients in the Florida Cancer Data System and identified that the health insurance status of these patients affected their survival. According to Paris, men without health insurance had higher odds of being managed with watchful waiting when compared with surgery, *OR* 2.04, 95% [CI 1.75, 2.38]. The PrCa patients who had no health insurance were also more likely to receive hormonal treatments, *OR* 1.43, 95% CI [1.22, 1.69] and radiation treatments, *OR* 2.32, 95% [CI 1.96, 2.7] when compared with PrCa patients who had privately funded health insurance (Parris, 2013).

Abdalsattar et al. (2016) also identified that the health insurance status of PrCa patients affected their survival outcomes. Abdalsattar et al. studied the extent to which the health insurance status of cancer patients mitigated the social determinants of health

in cancer management. Abdalsattar et al. utilized the SEER data, a retrospective study design, and PrCa patients who were younger than 65 years. The PrCa patients were classified as living in communities that were either least or most disadvantaged (Abdalsattar et al., 2016). The findings of the study confirmed that having health insurance was associated with higher numbers of cancer-directed surgeries for low-risk patients and improved survival for all PrCa patients in both communities (Abdalsattar et al., 2016).

Similarly, Mahal et al. (2014) documented the benefits of health insurance in improving access to favorable PrCa treatments. Mahal et al. compared the odds of survival of U.S. White and African Americans who had localized PrCa and received definitive PrCa treatments according to their health insurance status. The PrCa cohort was taken from the SEER data and had Gleason scores 8 to10, or stage T3a PrCa (Mahal et al., 2014). The study's result demonstrated that the odds of receiving life-saving definitive PrCa treatments were lower for the African American cohort when compared with the White patients, adjusted *OR* 0.60, 95% CI [0.56, 0.64], $p < .001$ (Mahal et al., 2014). Health insurance status and race also interacted significantly ($p < .001$) indicating that having health insurance could reduce the differences identified in the treatment outcomes (Mahal et al., 2014).

Paris (2013) alluded to a large sample size and a culturally diverse population as strengths of that study. However, Paris documented that the use all-cause mortality data to base decisions on survival of the PrCa patient was a limitation of the study. One of the strengths of the study conducted by Mahal et al. (2014) was the utilization of a

population-based cancer registry database. On the other hand, there were missing data on the stage and grade of the disease according to the patient's health insurance status (Mahal et al., 2014). Abdalsattar et al. (2016) reported that the SEER data were limited in providing information on the timing of the patients' enrolment in an insurance plan at initial diagnosis and treatment. Abdalsattar et al. also documented difficulties in interpreting the classification of the PrCa patients' specific insurance because of the broad classification of the insurance information in the SEER data. Nonetheless, Abdalsattar et al., Mahal et al., and Parris illuminated the impact of having health insurance on the survival of PrCa patients. The findings of the studies on the effect of health insurance status on PrCa survival signified the relevance of including this covariate in this dissertation.

Marital status and PrCa survival. The literature reviewed revealed a statistically significant relationship between the marital status of the PrCa patient and their likelihood of surviving the disease (Paris, 2013; Rand et al., 2014). Paris (2013) investigated the relationship between the marital status of PrCa patients and survival among PrCa patients in the Florida Cancer Data System who were diagnosed between 2001 and 2009. The results of this study revealed that unmarried PrCa patients had increased odds of presenting with late stage disease, *OR* 1.24, 95% CI [1.18, 1.30] when compared with married PrCa patients (Parris, 2013). PrCa patients were followed for five years, and at the final year of observation, survival rates declined from 99% in the first year to 80% ($p < .001$) (Parris, 2013). The survival rates were more favorable for married

men (82%) when compared with the unmarried (74%), and the risk of dying was higher for the unmarried cohort, *HR* 1.34, 95% CI [1.27, 1.41] (Parris, 2013).

Rand et al. (2014) also examined the demographic characteristics of a diverse population of PrCa patients and their tumor stage in PrCa mortality. The outcomes of the study showed that most of the PrCa patients (61.6%) were married; 24.3% of the men were single (Rand et al., 2014). The outcomes of the research also revealed that the probability of dying was significantly higher for PrCa patients who were single when compared with patients who were married, *OR* 1.99, 95% CI [1.06, 3.73], $p = .032$ (Rand et al., 2014). Rand et al. asserted that the findings of the study might be limited to the study's cohort because it was conducted in a single population. Nonetheless, Rand et al. recommended future studies on patient demographics, treatment choices and health outcomes. Thus, it was relevant to include marital status as a covariate in this research.

Smoking and PrCa survival. The studies reviewed documented that smoking is related to higher death rates of PrCa patients (Kenfield et al., 2011; Warren et al., 2013; Watters, et al., 2009). Studies revealed higher mortality rates with current smokers when compared with PrCa patients who either were former smokers or had no history of smoking at the time of diagnosis (Kenfield et al., 2011; Warren et al., 2013; Watters, et al., 2009). Warren et al. (2013) identified hazards among smokers and PrCa patients with a history of current tobacco use, and this relationship was consistent in both overall and cancer-specific mortality. Additionally, Kenfield et al. (2011) confirmed a statistically significant relationship with smoking and PrCa mortality, and this relationship remained statistically significant after adjusting for the clinical stages and grades of the disease, *HR*

1.38, 95% CI [0.94, 2.03] and *HR* 1.41, 95% CI [0.80, 2.49]. The significant findings of the studies on smoking and PrCa indicate that PrCa patients with a history of current smoking at the time of diagnosis with the disease have a higher risk of dying from PrCa.

In studies, which examine differences in smoking and PrCa survival across ethnic groups in the United States, researchers recognized disparities among Black and White PrCa patients (Antwi et al., 2013; Wong, Ettner, Boscardin, & Shapiro, 2009). Antwi et al. (2013) identified that Black males had poorer survival outcomes. In their study, Antwi et al. revealed that 44.7% of the PrCa patients who reported tobacco use were African Americans while 41.4% were White ($p < .001$). In this cohort, African Americans had 53% higher risk of dying from PrCa when compared the White patients, *HR* = 1.53, 95% CI [1.31, 1.79]. Wong et al. (2009) also documented a difference of .05 years in survival from PrCa among White and African Americans in the United States, 95% CI [0.01, 0.09] and indicated that this difference was attributed to tobacco use. Antwi et al. and Wong et al. reiterated that the Black population had similar biological characteristics that could provide reasonable explanations of the differences in survival among the racial groups due to their smoking exposure, and recommended further studies to clarify this supposition.

Smoking is also a high-risk behavior among Jamaicans in their native country (Wilks et al., 2008). Approximately one-fifth of Jamaican males in their country of origin reported a history of smoking greater than 100 cigarettes over the life course, and 21% had a current and history of smoking (Wilks et al., 2008). The frequency of smoking is

also highest among Jamaican males who are in the high-risk age group for PrCa (Wilks et al., 2008).

The results of these studies suggested that PrCa patients with a history of smoking may have differences in survival outcomes according to their racial background. Hence, it was important to control for effects of smoking in the relationship among the variables. However, the effects of smoking on the survival outcomes of the ERBT and brachytherapy treated cohorts were not evaluated in this dissertation because the SEER data does not report patient-level smoking data. Nevertheless, the influence of smoking on survival of the Jamaican PrCa patients should be measured in future studies on PrCa treatment outcomes.

Summary and Transition

The literature reviewed revealed that the African American population of the United States experienced a higher burden of PrCa and poorer survival of the disease in general when compared with other ethnic groups. Researchers also demonstrated that brachytherapy (with or without ERBT) was a widely used treatment option in the United States for PrCa patients with the low-grade disease, but its utilization is declining in recent years. Additionally, some researchers alluded to the survival advantages of brachytherapy in treating PrCa patients who were diagnosed with low and intermediate stage disease. Other investigators indicated that both ERBT and brachytherapy provided similar survival benefits. On the other hand, authors noted that brachytherapy is expensive; widely used in the younger cohort, and is less accessible to African-Americans of lower socioeconomic status. Furthermore, the results in the literature

confirmed that PrCa patients who were diagnosed with low and intermediate stage disease, and were managed with observation or active surveillance for PrCa, demonstrated favorable survival prognosis. Finally, the findings of the literature reviewed demonstrated an association with the sociodemographic indicators age, marital status, and health insurance status, and PrCa survival.

Among the literature reviewed, I identified no studies, which verified the relationship between brachytherapy and ERBT for the treatment of low and intermediate stage PrCa among the Jamaican cohort. Additionally, most studies reviewed were conducted primarily in the White populations of the United States and included small samples of African Americans. Likewise, studies on the relationship between treatment methods for early and intermediate stages PrCa were identified for the Canadian, German, and Dutch cohorts. However, the findings of these studies may not generalize to the Jamaican population because of differences in PrCa characteristics among populaces. Therefore, this study, which used a cohort of Jamaican-born males of the 18 participating SEER cancer registries, may provide new data, which are specific to the Jamaican PrCa patients. This research may also provide new insights on PrCa in the Jamaican cohort, particularly on the relationship between PrCa treatment and survival outcomes.

In Chapter 3, I described the statistical measures used to examine the effects of brachytherapy and ERBT in the survival of PrCa patients and the covariates sociodemographic and smoking status of the PrCa patient. In addition, I provided a description of the study population, the sampling technique for the selecting the sample for this study, and ethical and validity issues of this dissertation.

Chapter 3: Research Method

Introduction

In this dissertation, I aimed to observe the effects of ERBT and brachytherapy treatment on the survival of Jamaican and White PrCa patients with low and intermediate stage disease. I also intended to examine the effects of sociodemographic characteristics of age, marital status, and health insurance status, in the survival outcomes of the PrCa patients. I utilized a retrospective cohort study design, secondary data, and survival models to examine the relationship between the independent and dependent variables.

In Chapter 3, I explained and justified the retrospective study design for exploring the relationship between brachytherapy treatment and ERBT and the survival of Jamaicans and White U.S.-born PrCa patients. I also presented and rationalized the sampling techniques for selecting the study participants and the method employed to determine the sample size for this dissertation. A detailed data analysis plan describing the statistical measures applied to each of the research question was presented in Chapter 3. In addition, I described the method for operationalization of each variable of the study in Tables 1 to 5. The procedures for data collection and possible validity and ethical issues of this research were also highlighted in Chapter 3.

Research Design and Rationale

This dissertation had two key independent variables. The primary independent variables of this study were PrCa treatments (brachytherapy, ERBT, and other radiation treatments), and PrCa patients (the Jamaican and White U.S.-born PrCa cohorts) of the 18 participating SEER registries database, November 2013 submission. The dependent

variable was prostate cancer survival, which is the length of time a PrCa patient treated with ERBT, brachytherapy, and other radiation treatments lived with the disease. The covariates for this study were sociodemographic indicators age, marital status, and health insurance status.

I utilized a retrospective cohort design to examine the relationship between past exposures (treatment for PrCa, and PrCa stage and grade) and the outcome (PrCa survival) (Ashengrau & Seage, 2008, p. 207). The retrospective cohort design was appropriate for the historic nature of this study (Ashengrau & Seage, 2008, p.156). Additionally, I chose the retrospective cohort design because it was cost efficient. The retrospective cohort study design generated large amounts of longitudinal data in a very short period with minimal expenses, and the data were already available. Besides, the retrospective cohort design facilitated the use of existing records on mortality occurrence linked to cancer registries (Szklo & Nieto, 2014, pp. 22-23). These design qualities were consistent with the methodology of this dissertation

Methodology

The Study's Population

I recruited the participants of this research from a population of Jamaican and White U.S.-born PrCa patients of the 18 participating SEER cancer registries database 1973 to 2011, November 2013 submission (SEER, 2014). The total population of Jamaicans and White U.S.-born PrCa patients was 274,201 PrCa patients; this included 273,447 White U.S.-born and 754 Jamaicans.

Sampling and Sampling Procedures

I selected the Jamaican PrCa patients using purposive sampling. Purposive sampling reduced the possibility of eliminating from the study critical information about the research subjects and enhanced the representativeness of the sample (Battalgia, 2008). I chose purposive sampling method because the study required a cohort with specific characteristics (Battalgia, 2008; Polit & Beck, 2013, p. 312; Trochim, Donnelly, & Arora, 2015, p. 87). I selected the comparison group from the White U.S.-born population of the 18 participating SEER cancer registries using a random sampling approach (Trochim et al., 2015, p. 100). The random sampling method provided an equal chance to include the research subjects, and improve generalization of the findings (Trochim et al., 2015, p.100).

A PrCa patient in this dissertation was selected for this study according to the ICD-O version 10, and the site-specific code (C60) (SEER, 2013). PrCa patients in each participating SEER registry with Jamaican birthplace and satisfied the selection criteria for a research participant, were purposively chosen from the SEER 18 registries data set using the birthplace variable. I selected the White U.S.-born PrCa patients from the population of the 18 participating SEER cancer registries using a random sampling technique.

The study included all PrCa patients diagnosed with Gleason scores 6 and 7, and categorized according to the TNM stages T1 and T2, and SEER Historic Stage A classifications at the time of diagnosis. Included in this investigation were PrCa patients who received ERBT, brachytherapy and radiation sequenced with surgery for the period

of the observation. I excluded from the study PrCa patients, who were recommended for surgery only, refused surgery or had contraindications for surgery (SEER, 2013). I included the radiation sequenced with surgery variable in the study. The radiation sequenced with surgery variable comprised other types of radiation treatments that were not accounted for in the brachytherapy and ERBT definitions. Hence, it was important to determine whether radiation sequenced with surgery contributed significantly to the outcomes of the study.

In selecting this sample, I excluded from the sampling population three SEER districts, Hawaii, Iowa, and Alaska Native, which had no Jamaican PrCa patients. Subsequently, I reorganized in descending order the identification numbers of the research participants for the remaining 15 reporting SEER locations. I selected from each of the remaining 15 SEER reporting sites every 50th White U.S.-born PrCa patient who met the criteria for inclusion in the study. Finally, I purposively chose every Jamaican PrCa patient who met the selection criteria for inclusion in the study from the population of Jamaicans. Figure 1, presents the flow chart of the sampling process.

The sample size determination for this study was derived from the criteria for survival analysis using the Log-Rank test (Stats Direct, 2013). The criteria for survival analysis using the Log-Rank test stated that there should be adequate power to detect a real effect, *p*-value estimates, and a median survival time for both experimental and comparison groups (Stats Direct, 2013). I chose an effect size of *HR* 1.6 based on estimates from previous studies on the association of radiation therapy and PrCa survival (Nepple et al., 2013; Smith et al., 2015; Rusthoven et al., 2015). Nepple et al. (2013) and

Rusthoven et al. (2015) demonstrated effect sizes ranging from *HR* 1. 31, 95% CI [1.22, 1.41], $p < .001$, to *HR* 2.02, 95% CI [1.85, 3.15], $p < .001$ for ERBT treated PrCa patients with Gleason scores 6 and 7. Nepple et al. and Rusthoven et al. also provided hazard ratios ranging from *HR* 1.27 to *HR* 1.78, 95% CI [1.37, 2.3] $p < .001$, for overall survival of PrCa patients treated with brachytherapy. I used the hazard ratio estimates as a parameter in the sample size calculation because the results of this research were presented with hazard ratio estimates and accompanying 95% confidence intervals. I chose a median survival period of 7.2 years for the comparison group based on a priori findings (Smith et al., 2015).

Sample size was therefore calculated using the Log-Rank test statistic, two-sided alpha levels $p < .05$ ($Z\alpha/2 = 1.96$), 95% power ($Z\beta, = 1.645$), and effect size (*HR* =1.6). The median survival time was 2.7 years for the PrCa patients with low and intermediate stages PrCa, and 7.2 years for the comparison group (the White U.S.-born PrCa patients). The ratio for the exposed and unexposed group was one Jamaican PrCa patient to four White U.S.-born PrCa patients. The sample size estimation was conducted using the PS: Power and sample size calculation (3.1.2) (Dupont & Plummer, 2014). Based on the sample size estimation, a total sample $N = 1{,}335$ was needed to reject the null hypothesis that the survival curves for PrCa patients in the exposure and the comparison groups were equal (Dupont & Plummer, 2014). The proposed sample included 267 Jamaican PrCa patients, and 1,068 White U.S.-born PrCa patients (Dupont & Plummer, 2014).

However, due to the due to the sampling procedures used for the selection of the PrCa patients and the size of the dataset used for this investigation, the sample size of the

final study was expanded from $N = 1,335$ to $N = 10,752$ (8 times larger than the proposed sample). The dataset had 754 Jamaican PrCa patients; 719 met the criteria for selection and were chosen using purposive sampling. The sample of White U.S.-born PrCa patients was extended to 10,033, with the random sampling technique described in the research protocol. A final sample $N = 10,752$ Jamaican and White U.S.-born PrCa patients was used for the data analysis.

Participant Recruitment

I obtained the dataset for this research following an emailed request to the SEER Cancer Registry Data System for internet access to the November 2013 submission of the 18 participating SEER registries database. I completed the application with the SEER Cancer Registry signed data use agreement form (see Appendix A). On receipt of the signed data use agreement, the SEER Cancer Registry granted approval for internet access to the SEER*Stat client-server system (see Appendix B). Subsequently, I prepared a smaller dataset of the 18 participating SEER Cancer Registry database for the study using a case listing of all the variables of the research. I exported the case listing to the IBM SPSS statistical software version 23 for data analysis.

Operational Definitions of the Research Variables

Dependent Variable

The dependent variable of this dissertation was PrCa survival. PrCa survival was defined as the date of initial diagnosis to the time of the first outcome, death or censoring (Hu et al., 2014; Lin et al., 2009; Redaniel et al., 2013; Thompson et al., 2013). The time of diagnosis was the month and year of diagnosis documented in the SEER registry

database (SEER, 2013). The time of death was the time that the vital status of a case was recorded in the SEER cancer data (SEER, 2013). The definition of the vital status also included the SEER cause-specific mortality definition and confirmation of death using death certificate or autopsy information (SEER, 2013). Censored cases were PrCa patients who died of causes other than PrCa (NCI, 2017a). Additionally, the definition of PrCa survival included the active follow-up of each PrCa patient (SEER, 2013). I recoded and measured PrCa survival as a continuous variable on a monthly or yearly basis according to the research questions.

Independent Variables

The independent variables of the dissertation were the PrCa patients (Jamaican and White U.S.-born) and PrCa treatments (brachytherapy, ERBT, and other radiation treatments). I defined a PrCa patient according to the International Classification of Diseases for Oncology version 10 (ICD-O) code C60, and the SEER cause-specific death for sequence numbers 01 (NIH, 2017). PrCa patients were also classified according to Gleason grades G1, G2, and G3 (SEER, 2015, p. 96). Additionally, a PrCa patient had TNM stages T1 and T2 of the AJCC 6th Edition TNM, and the SEER Historic Stage A classifications (SEER, 2013; SEER, 2014; Young et al., 2000, p. 224). The localized stages T1a, T1b, and T1c PrCa were clinically in-apparent tumor (SEER, 2013; Young et al., 2000, p. 224). Stage T2a PrCa involved one lobe; and stage T2b more than one lobes of the prostate gland (Young et al., 2000, p.224). Stage T2NOS was assigned to each PrCa patient whose TNM stage was not specified (SEER, 2013). A prostate cancer patient in this research was also a confirmed case by histology, or cytology (SEER,

2013). I selected the Jamaican and White U.S.-born PrCa patients from the birthplace variable of the 18 SEER participating cancer registries (SEER, 2014) and measured as a categorical variable.

Prostate cancer treatments were ERBT, brachytherapy and other radiation treatments. I combined radioactive implants, radioisotopes, and radioactive implants and radioisotopes, and recoded as brachytherapy treatment (SEER, 2013). ERBT was the recoded beam radiation variable of the SEER Research Data Record Description 1973 to 2011 (SEER, 2013). The radiation sequenced with surgery variable was a combination of radiation before surgery, radiation after surgery, intraoperative radiation therapy, and radiation and surgery sequence unknown (SEER, 2013). The treatment variables were measured as categorical variables.

Covariates

Covariates for this study included the sociodemographic characteristics of the patient. The sociodemographic characteristics comprised the marital status, age, and health insurance status of the PrCa patient as reported at diagnosis and recorded in the SEER Research Data Description 1973 to 2011 (SEER, 2013). Marital status was the marital union communicated by the patient at the time of PrCa diagnosis (SEER, 2013). Health insurance status was the PrCa patient's primary means of payment for health care and the health insurance coverage plan as recorded in the SEER data (SEER, 2013). Age was the actual age in years at diagnosis as recorded in the SEER registry database and covered all PrCa patients who were older than 35 years for the 1992 to 2011 SEER reporting period (SEER, 2013). I recoded and measured the variables representing the

sociodemographic characteristics of the PrCa patients in the SEER database as categorical and continuous variables. Tables 1 to 5 depict the operationalization of the research variables including the categories of each variable, coding of the variables, and the statistical analyses applied.

Operationalization of the Variables

Table 1

Categorizing, Coding, and Measuring the Dependent Variable of the Research Subjects

Variables and Categories	Operational Concepts of the Variables	Variable Coding	Statistical Analyses
a) Prostate cancer survival in years or months. (measured as a continuous variable)	This is the length of time in months from the time of diagnosis to the time of the event (death or censored) (SEER, 2013). The survival period includes the complete dates of diagnosis and last contact with the PrCa patient (SEER, 2013). This period covered 21 years and indicated that a PrCa patient will die at any time on a continuum of zero to 21 years.	a) Coded according to the survival time in the SEER data as: Survmonths = 0 to 239 (SEER, 2013)	Preliminary descriptive estimations of the hazard rates and cumulative survival probability of the PrCa patients with Kaplan Meier and Life Table estimates. Estimation of the median survival times of the PrCa cohorts. Comparison of the differences in the survival distributions of the
b) Vital Status. (measured as a categorical variable)	The cut-off date of the SEER data set was used for the last contact date if the PrCa patient's recorded vital status was alive (SEER, 2013). Death was the confirmed time of death based on autopsy report or cause of death as recorded in the SEER registry (SEER, 2013).	b) Recoded as Alive = 1 Dead = 2 (SEER, 2013)	Jamaican and White US-born cohorts with Kaplan Meier survival curves, Log-rank, Tarone-Ware, and Breslow's statistics. Comparison of the risk ratios of the Jamaican and White PrCa patients using the Cox-proportional hazards analysis. Hypothesis tests of the Jamaican and White US-born PrCa patients using interaction analyses.

Table 2

Categorizing, Coding, and Measuring the Treatment Types of the Research Subjects

Variables and Categories	Operational Concepts for the Variables	Variable Code	Statistical Analyses
a) Prostate cancer treatments. This includes patients receiving ERBT, brachytherapy treatment, and radiation sequenced with surgery during the period of the study. (measured at the categorical level of measurement.	This was the time of initiation of the different types of treatment for each PrCa patient. 1. No treatment was commenced. 2. Time ERBT commenced to the time of death, or presumed alive (SEER, 2013). 3. The time that brachytherapy commenced to the time of death or presumed alive (SEER, 2013). 4. The time that radiation sequenced with surgery commenced to the time of death or presumed alive (SEER, 2013). 5. It is not known if treatment was given (SEER, 2013). 6. The time of initiation of radiation sequenced with surgery to the time of death (SEER, 2013).	Radioactive implants, radioisotopes, combination of radioactive implants, and radioisotopes (SEER, 2013) recoded as: Brachytherapy = 1 No brachytherapy = 0 Beam radiation recoded as: ERBT = 1 No ERBT = 0 Intraoperative radiation, radiation after surgery, radiation prior to surgery, intraoperative radiation, radiation sequence unknown but both were given (SEER, 2013) was recoded as: Radiation sequenced with surgery = 1 No radiation sequenced with surgery = 2	Preliminary descriptive estimates of the frequencies of treatment utilization among the Jamaican and White U.S.-born PrCa patients. Estimation of the median survival times of the PrCa cohorts according to the treatments received. Comparison of the differences in the survival distributions of the Jamaican and White U.S.-born cohorts according to the treatments received using Kaplan Meier survival curves, Log-rank, Tarone-Ware, and Breslow's statistics. Comparison of the risk ratios of the Jamaican and White PrCa patients according to treatments received using the Cox-proportional hazards analysis. Comparison of the 5-year survival outcomes of PrCa patients according to each treatment received. Hypothesis tests of the association of brachytherapy and ERBT in PrCa patients per treatment using interaction analyses.

Table 3

Categorizing, Coding, and Measuring Clinical Characteristics of the Research Subjects

Variables and Categories	Operational Concepts for the Variables	Variable Code	Statistical Analyses
Gleason grades 1 and 11 PrCa at the time of diagnosis as recorded in the SEER (2013) registry. (measured at the categorical and continuous levels of measurement) (Mills, 2011c)	1. Gleason grade 1 is well-differentiated tumor, differentiated tumor (SEER, 2013). 2. Gleason grade 11 is moderately differentiated tumor, or intermediately differentiated tumor (SEER, 2013). 3. Grade not specified NOS (SEER, 2013).	Coded according to the SEER research data as: 1 = Moderately differentiated, Grade 11 2 = Poorly differentiated, Grade 111 3 = Well differentiated, Grade 1 (SEER, 2013)	Preliminary descriptive estimates of the frequencies of stages and grades of PrCa among the Jamaican and White U.S.-born PrCa cohorts.
PrCa stage is the early and intermediate stages of PrCa according to the Derived AJCC 6th Edition (2004 +) and the SEER Historic Stage A classifications (2013) (measured at the categorical level of measurement) (Mills, 2011c)	The stage of the disease is classified using the SEER AJCC 6th edition (2000) classification as: 1. T1a, T1b, and T1c is clinically inapparent tumor (SEER, 2013). 2. T1 NOS is clinically inapparent tumor not specified (SEER, 2013). 3. T2a, T2b and T2c is tumor confined to the prostate (SEER, 2013). 4. T2 NOS confinement to the prostate is not specified (SEER, 2013). 5. Unknown	Coded according to the first three of the stages of TNM stages 6th Ed of the SEER data as: a) T1a = 12 b) T1b = 15 c) T1c = 18 d) T1NOS = 19 e) T2a = 21 f) T2b = 22 g) T2c= 23 h) T2NOS = 29 (SEER, 2013)	
SEER Historic Stage A (measured at the categorical level of measurement)	The variable description of the SEER dataset was Localized or regionalized prostate cancer (SEER, 2013) was used.	Coded according to the SEER research data as: Blanks =1 Distant = 2 Localized/regionalized = 3 Unstaged = 4 (SEER, 2013)	

Table 4

Categorizing, Coding, and Measuring the Exposure and Comparison Groups

Variables and Categories	Operational Concepts for the Variables	Variable Code	Statistical Analyses
a) Jamaican born PrCa patient. (measured at the categorical and continuous levels of measurement) (Mills, 2011c)	A Jamaican PrCa patient was one whose birthplace was recorded as Jamaica in the SEER research record description (SEER, 2013).	The birthplace-country variable of the SEER data (SEER, 2013) was recoded as: Jamaica = 1 Other = 0	Preliminary descriptive estimates of the frequencies of PrCa patients according to the different variables of the study. Estimation of the median survival times of the PrCa cohorts according to the treatments received.
b) The White U.S.-born PrCa patient. (measured at the categorical and continuous levels of measurement) (Mills, 2011c)	A White U.S.-born PrCa patient is a PrCa patient whose birthplace was recorded as Jamaica in the SEER research record description (SEER, 2013).	The birthplace-country variable of the SEER data (SEER, 2013) was recoded as: United States = 2 Other = 0	Comparison of the differences in the survival distributions of the Jamaican and White U.S.-born cohorts per treatments received using Kaplan Meier survival curves, and the Log-rank, Tarone-Ware, and Breslow's statistics. Comparison of the risk ratios of the Jamaican and White PrCa patients according to treatments received using the Cox-proportional hazards analysis. Development of cohort-treatment contingency tables for each 5-year interval and estimating the survival rates for each interval. Comparison of the 5-year survival outcomes of PrCa patients according to each treatment received. Hypothesis tests of the association of treatment effects and survival of the PrCa patients, using interaction analyses.

Table 5

Categorizing, Coding, and Measuring the Covariates of the Research

Variables and Categories	Operational Definitions for the Variables	Variable Code	Statistical Analyses For all Covariates
a) Age at the time of diagnosis (measured at the categorical and continuous levels of measurement) (Mills, 2011c)	This is the age recode with < 1-year-old variable. This variable was recoded into 4-year age groups in the SEER (2013) and included all age groups.	The original coding of the SEER (2013) was used. Ages 30-34 = 07 Ages 35-39 = 08 Ages 40-44 = 09 Ages 45-49 = 10 Ages 50-54 = 11 Ages 55-59 = 12 Ages 60-64 = 13 Ages 65-69 = 14 Ages 70-74 = 15 Ages 75-79 = 16 Ages 80 +	Preliminary descriptive estimates of the frequencies of the age, marital status, and health insurance status of the PrCa patients. Crude estimations of the hazard ratios for age and health insurance status with Cox proportional hazards regression models. Stratification of the birthplace variable (Jamaica and the United States), per ERBT and brachytherapy treatments with age, health insurance status, and estimations of adjusted hazard ratios. Estimations of the percent change of the crude and adjusted hazard ratios of the birthplace main effects.
b) Health insurance status at the time of diagnosis. (measured at the categorical level of measurement) (Mills, 2011c)	Health insurance status as recorded in the SEER research record description (SEER 2013). This was the primary payer for health care (SEER, 2013) at the time of entering the study and included the recoded uninsured, any Medicaid, insured, and unknown health insurance status.	Coded according to the SEER research data as: Uninsured = 1 Any Medicaid = 2 Insured = 3 Insured/no specifics = 4 Insurance status unknown = 5 (SEER, 2013)	

(Table continues)

Table 5

Categorizing, Coding, and Measuring the Covariates of the Research

Variables and Categories	Operational Definitions for the Variables	Variable Code	Statistical Analyses
c) Marital status at the time of diagnosis. (measured at the categorical level of measurement) (Mills, 2011c)	d) Marital status at the time of diagnosis as recorded in the SEER research record description. - single (never married) - unmarried/ domestic partner - married (including common-law) - separated - divorced - widowed - status unknown (SEER, 2013)	Coded according to the SEER research data as: Single/never married = 1 Married including common-law = 2 Separated = 3 Divorced = 4 Widowed = 5 Unmarried/ domestic partner = 6 Unknown status = 9 (SEER, 2013)	Preliminary descriptive estimates of the frequencies of marital status of the PrCa patients. Crude estimations of the hazard ratios for marital status with Cox proportional hazards regression models. Stratification of the birthplace variable (Jamaica and the United States), per ERBT and brachytherapy and marital status and estimations of adjusted hazard ratios. Estimations of the percent change of the crude and adjusted hazard ratios of the birthplace main effects

Data Analysis Plan

Data Cleaning

The SPSS software version 23 was the statistical package for the analysis of the data. It was important to conduct data cleaning because secondary data were used to answer the research questions. The data cleaning process included an examination of the data distribution with skewness and kurtosis estimates and visual inspections of the data distributions to ascertain and address outliers of the population studied (Osbourne,

2013b). I also checked the data for missing or incomplete information. It was necessary to identify missing or incomplete data because this may occur for justifiable reasons in the secondary database that was used (Osbourne, 2013c) and should be accounted for in the analysis. I analyzed the data with the following five research questions and their hypotheses.

Research Question 1. Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa lived with the disease?

$H_0$1: There are no differences in the length of time Jamaican-born and U.S.-born White PrCa patients treated with brachytherapy for low and intermediate stages PrCa lived with the disease.

H_a1: There are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, lived with the disease.

Research Question 2. Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa lived with the disease?

$H_0$2: There are no differences in the length of time Jamaican-born PrCa patients and U.S.-born White PrCa patients treated with ERBT for low and intermediate stages PrCa lived with the disease.

H_a2: There are differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa lived with the disease.

Research Question 3. Are there differences in 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011?

H_03: There are no differences in the 5-year survival intervals of Jamaican-born and U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

H_a3: There are differences in the 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

Research Question 4. Are there differences in the length of time brachytherapy treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

H_04: There are no differences in the length of time brachytherapy treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa, live with the disease, after controlling for sociodemographic characteristics.

H_a4: There are differences in the length of time brachytherapy treated Jamaican PrCa patients, and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

Research Question 5. Are there differences in the length of time ERBT treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

$H_0$5: There are no differences in the length of time ERBT treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

H_a5: There are differences in the length of time ERBT treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

I conducted preliminary descriptive estimates of the different variables of the study to determine their frequency distributions in the data set. I calculated the survival distributions and cumulative survival probability of the PrCa patients with the Life Table estimators and Kaplan-Meier estimates (Forthofer, Lee, & Hernandez, 2007, p. 306). The Kaplan-Meier method determined the median survival times, and the differences in the cumulative survival curves of the PrCa cohorts. The Log-Rank, Tarone-Ware, and Breslow's statistics confirmed the differences in the survival distributions of the Jamaican and White U.S. PrCa patients at varying periods of the observation (Balakrishnan, & Rao, 2004, p. 283). The Breslow's statistics weighted the observations early in the follow-up, and the Tarone-Ware and Log-Rank statistics estimated the variances at the later intervals of the study (Balakrishnan, & Rao, 2004, p. 283). The Cox proportional hazard regression analyses estimated the differences in the hazard ratios of

the Jamaican and White U.S.-born cohorts (Forthofer et al, 2007, p. 412). Hypotheses tests of mediating effects in the association between brachytherapy and ERBT treatments and survival of the White U.S.-born and Jamaican-born PrCa patients were completed with interaction analyses (Szklo & Nieto, 2014, p.187). Finally, I determined whether the relationship between the treatment cohorts and PrCa survival was a result of the confounding effects of the covariates by stratifying these variables and evaluating the percent changes in the crude and adjusted hazard ratios (Szklo & Nieto, 2014, p.187). A description of the statistical analytical procedures for each research question follows.

Data Analyses Plan for Research Questions 1 and 2

Research Question1 and Research Question 2 focused on the estimation of the differences in the survival distributions of the brachytherapy and ERBT treated Jamaican and White U.S.-born cohorts. I conducted preliminary descriptive estimations of the crude and cumulative hazard rates, censoring intervals, probability density estimates, and the mean and median survival times of the PrCa patients for the 1992 to 2011 follow-up with Life-Table estimates and Kaplan-Meier estimators. The Kaplan-Meier estimator generated cumulative survival curves of the distributions of the brachytherapy and ERBT treated Jamaican and the White U.S.-born cohorts. The survival intervals of the PrCa patients were estimated on a month-by-month basis (SEER, 2015). Differences in the distributions of the survival curves were confirmed using the Log-Rank (Mantel-Cox), Breslow (Generalized Wilcoxon), and Tarone-Ware statistics. I conducted further comparisons of the survival experiences of the brachytherapy and ERBT treated Jamaican and White U.S.-born cohort with the multivariate Cox-proportional hazards

regression model. The Cox-proportional hazards model estimated the differences in the hazards ratios for the Jamaican and White U.S.-born PrCa patients based on the assumption that the hazards among the Jamaican and the White U.S.-cohort were constant throughout the follow-up (Forthofer et al., 2007, p. 412).

I performed interaction analysis to determine whether there were modification effects in the association between brachytherapy and ERBT and survival among the Jamaican and White U.S.-born PrCa cohorts (Szklo & Nieto, 2014, p.187). The assumption for the hypothesis test was the relationship between brachytherapy and ERBT and the risk of death among Jamaican, and the White U.S.-born PrCa patients were of similar magnitude across subgroups of both cohorts. The alpha level for accepting a significant interaction was $p < .05$. A significant interaction indicates modification effect among the birthplace variable and PrCa treatment. A non-significant interaction effect confirmed that there were no modification effects in the association identified. Consequently, the first main effects of the differences in the hazard ratios were interpreted as the outcome of the analysis (Green & Salkind, 2011, pp. 205-206). I did further analysis of significant interaction effects with pairwise comparison of the second main effect (Green & Salkind, 2011, pp. 205-206). Two Cox proportional hazard regression models were created for the interaction analysis. The first model had the first main effect (birthplace) and the second main effect (PrCa treatments). The second model had the interaction terms (birthplace and PrCa treatments) with the interaction effect.

Data Analysis Plan for Research Question 3

Research Question 3 focused on estimating the 5-year survival of PrCa patients who received brachytherapy, ERBT, and other radiation treatments (radiation sequenced with surgery). I developed cohort-treatment contingency tables for each 5-year interval and estimated the hazard rates and median survival times of the PrCa cohorts according to the treatments they received. I compared the differences in the survival distributions of the Jamaican and White U.S.-born cohorts per treatments received using the Log-Rank statistics. Further comparisons of the risk ratios of the Jamaican and White U.S.-born PrCa patients according to treatments received for each 5-year interval were estimated using the Cox-proportional hazards analysis.

I performed interaction analyses for each 5-year interval to determine whether there were modification effects in the magnitude of the risk ratios of both cohorts (Szklo & Nieto, 2014, p.187). The assumption for the hypothesis test was the association between brachytherapy, ERBT, and other radiation treatments and the risk of death among Jamaican and the White U.S.-born PrCa patients were of similar magnitude in subpopulations of both cohorts. The alpha level for accepting a significant interaction was $p < 0.05$. A significant interaction indicated that there was modification effect among the birthplace variable and PrCa treatment. I conducted further analyses of all significant interaction effects with pairwise comparisons of the second main effects of each treatment group to determine where the differences were (Green & Salkind, 2011, pp. 205-206). A non-significant interaction effect confirmed that there no modification effects in the association identified (Szklo & Nieto, 2014, p.187) and the first main

effects of the differences in the hazard ratios among the treatment groups were interpreted as the outcome of the analysis (Green & Salkind, 2011, pp. 205-206).

Data Analyses Plan for Research Questions 4 and 5

The data analysis for Research Question 4 and Research Question 5 focused on determining whether the association identified between brachytherapy treatment and ERBT were due to confounding effects of the covariates in the study. First, I estimated baseline hazard ratios of the birthplace variable, PrCa treatment variables, and the covariates with Cox regression analysis. Subsequently, I stratified the Jamaican and U.S.-born White PrCa patients according to brachytherapy and ERBT treatment, marital status, health insurance status, and age and estimated the adjusted hazard ratios. Finally, I compared the crude hazard ratios of the brachytherapy and ERBT treated Jamaican, and White U.S.-born PrCa patients with the adjusted hazard ratios to determine percent changes in the magnitude of effects observed. I estimated the percent difference between the crude and adjusted hazard ratios of the birthplace main effects to determine the degree of confounding using the expression: Percent Excess Risk Explained = (Crude *HR*-Adjusted *HR*)/Crude *HR*-1×100 (Szklo & Nieto 2014, p.161). Changes in the hazard ratios of less than 10% were interpreted as minimal confounding and the crude or adjusted hazard ratios accepted. The adjusted hazard ratios were interpreted where the excess risk was greater than 10%. Changes in the crude and adjusted hazard ratios that were close to one indicated that the confounder influenced the direction and magnitude of the effect observed, and there was no association with the PrCa treatments and survival (Szklo & Nieto 2014, p.171)

In this dissertation, I examined the covariate effects of the sociodemographic indicators age, marital status, and health insurance of the PrCa patients because studies have shown that these variables impacted the survival of PrCa patients (Parris, 2013; Xiao et al., 2009). Therefore, in examining the relationship between treatment outcomes and PrCa survival, it was important to evaluate whether these variables confounded the effects observed in this dissertation.

Data Presentation and Interpretation

The results of this study were presented using tables and graphs. I displayed descriptive analysis of baseline characteristics of the prostate cancer cases, cumulative hazard rates, censoring intervals, and probability density estimate in tables. I also used tables to present hazard ratios with accompanying 95% confidence intervals and alpha levels ($p < 0.05$). The cumulative incidence of prostate cancer-specific deaths was demonstrated with Kaplan-Meier survival curves (Kenfield et al., 2011). Statistical significance was interpreted using *p*-values ($p < .05$) and 95% confidence intervals (Rich, 2011). Counts fewer than 10 for specific SEER location were suppressed and not presented in tables or graphs.

Threats to Validity

The internal validity of this dissertation may be influenced by the non-randomization of the exposure group (Leighton, 2010c, p. 621). The Jamaican PrCa patients were purposively selected for this dissertation because the study required a cohort with specific characteristics for investigation, thus making it difficult to randomize the selection of this group (Trochim et al. 2015, p. 87). The threat of maturation of the

research participants was another consideration to the internal validity of the study (Leighton, 2010c, p. 620). The study spanned 20 years, and the research participants may experience developmental changes or comorbidities which influence their treatment outcomes (Leighton, 2010c, p. 620). Therefore, to enhance the internal validity of the study, I selected the participants based on similarities in their characteristics and the criteria specified for inclusion in this dissertation (Leighton, 2010c, p. 622). Another approach to improve the internal validity of the study was randomizing the comparison group to ensure that the characteristics of the research participants had the probability of being equally distributed among this group (Leighton, 2010c, p. 622).

A potential threat to the external validity of the study was the likelihood of history and treatment interactions (Leighton, 2010b, p. 468). The observation spanned the 1992 to 2011 interval, and it was important to determine whether trends in PrCa treatments and diagnosis impacted the treatment effects (Leighton, 2010b, p. 468). The data analysis included interaction analysis to detect interaction effects, which would indicate that the treatment effects varied with time (Leighton, 2010b, p. 468).

Ethical Procedures

The provisions of the Health Insurance Portability and Accountability Act (HIPAA) privacy rule (45 CFR 164.514 [e]), which established the conditions for the use of protected health of individuals using the limited data sets with a data use agreement, guided this research (US Department of Human Services [USDHS], 2003). I obtained approval for the conduct of this study from the Institutional Review Board (IRB) Walden University on April 16, 2016. The IRB approval number is 04-11-16-0179761. Approval

for access to the SEER program's database was also granted prior to the conduct of the research (see Appendices A and B). The inclusion and exclusion criteria for the selection of the research participants were developed on the ethical principle that the harms and benefits of the research were distributed equally among all PrCa patients who are selected for the study (NIH, 2011).

The research participants' identifiable data were not used for this study, and no linkages were required to identify any of the research subjects during the investigation (NIH, 2011). In presenting the data, rates fewer than ten for PrCa patients of any of the SEER reporting locations were suppressed and not shown in figures and tables. This approach was taken to protect the research subjects from social harms.

Confidentiality of the data was maintained by restricting its access to all individuals, except the members of my dissertation research committee (NIH, 2011). The data set was stored using a secured system (NIH, 2011) in zipped files on my personal computer. The use my personal computer and its log on information were not shared while accessing the SEER data set. The file name was disguised and file sharing options disabled. The data was used only for the purposes indicated in the dissertation proposal.

I will share the research findings with the populations from which the sample was taken using journal publications for scholars and professionals, conferences for professional and special interest groups, the cancer societies for the cohorts, local organizations, public forums, and newsletters.

Summary and Transition

Chapter 3 described the research methods for examining the relationship between the independent and dependent variables of this study. The research questions were answered using the SEER research data, a retrospective cohort design, Kaplan-Meier estimators, and the Cox proportional hazards regression model. The sample for this study was the Jamaican and White U.S.-born PrCa patients of the 18 U.S. participating SEER registries. A sample of N =10,572 research participants was selected from the SEER 18 registries database 2013 submission, and this sample included all PrCa patients with and without a history of ERBT and brachytherapy treatment. The sample also comprised PrCa patients who were diagnosed with Gleason scores 6 and 7 PrCa, TNM stages T1 and T2 PrCa, and SEER Historic Stage A classification. The variables were defined primarily with the definitions provided in the variable listing of the SEER Research Data Record 1973 to 2011 (SEER, 2013).

IRB approval from the Walden University was obtained before the start of this study. I anticipated potential threats to the validity of this study according to the limitations of using secondary data. The validity threats were addressed using appropriate measures to reduce their effects in the findings of the research. The execution of the study was guided by the provisions of the HIPAA privacy rule (45 CFR 164.514 [e]) (USDHS 2003), which established the conditions for the use of protected health of individuals using the limited data sets with a data use agreement. Appropriate data security measures were employed to protect the research participants.

In Chapter 4, I reported the results of the data analysis for the research questions and related hypotheses. I also provided descriptive statistics of the demographic characteristics of the study's participants, and tests of the statistical assumptions of the Cox proportional hazard regression model. Additionally, in Chapter 4, I displayed the findings of univariate and bivariate analyses with tables of the hazard ratios and related 95% confidence intervals and alpha levels for each variable. Furthermore, Chapter 4 highlighted the results of hypothesis tests of the relationships between the dependent and independent variables and the tests for confounding effects.

Chapter 4: Results

Introduction

My primary goal of this quantitative dissertation was to examine survival patterns of brachytherapy, and ERBT treated Jamaican and White U.S.-born PrCa patients for the period 1992 to 2011. I also aimed to ascertain whether there were survival differences among brachytherapy and ERBT treated Jamaican and U.S.-born White PrCa patients who had a diagnosis of early and intermediate stage disease. Additionally, I intended to determine whether specific sociodemographic characteristics and a history of smoking in the ERBT and brachytherapy treated Jamaican and U.S.-born White PrCa patients affected their survival. I used a retrospective cohort study design, and analyses of secondary data with survival models to answer the research question. This study's five research questions with their hypotheses are:

Research Question 1. Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease?

$H_0$1: There are no differences in the length of time Jamaican-born and U.S.-born White PrCa patients treated with brachytherapy for low and intermediate stages PrCa live with the disease.

H_a1: There are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease.

Research Question 2. Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease?

$H_0$2: There are no differences in the length of time Jamaican-born PrCa patients and U.S.-born White PrCa patients treated with ERBT for low and intermediate stages PrCa, live with the disease.

H_a2: There are differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease.

Research Question 3**.** Are there differences in 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients per treatment received for the period 1992 to 2011?

$H_0$3: There are no differences in the 5-year survival intervals of Jamaican-born and U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

H_a3: There are differences in the 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

Research Question 4**.** Are there differences in the length of time brachytherapy-treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

$H_0$4: There are no differences in the length of time brachytherapy-treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa, live with the disease, after controlling for sociodemographic characteristics.

H_a4: There are differences in the length of time brachytherapy-treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

Research Question 5. Are there differences in the length of time ERBT treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

$H_0$5: There are no differences in the length of time ERBT-treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics and history of smoking.

H_a5: There are differences in the length of time ERBT-treated Jamaican PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics.

In Chapter 4, I provided descriptive statistics of the demographic characteristics of the study's participants, and tests of the statistical assumptions of the Cox proportional hazard regression model. Subsequently, I presented a summary of the statistical analyses for each research question. The findings of univariate and bivariate analyses with tables of the hazard ratios and related 95% confidence intervals and *p*-values for each variable

are also described. Additionally, I displayed the Kaplan-Meier survival curves of the overall prostate cancer mortality for the Jamaican and White U.S.-born prostate cancer cohorts, and associated statistical tests of equality of survival of the two groups. Finally, the Chapter highlights the results of hypothesis tests of the relationships between the dependent and independent variables and the tests for confounding effects.

Data Collection

The 18 participating SEER registries of the United States (November 2013 submission for the reporting years 1973 to 2011) was the secondary data used for data analysis. I chose the 1973 to 2011 version of the SEER cancer registries for data analysis because it had the Jamaican-born cohort for the study (SEER, 2013). I obtained the dataset with an emailed request to the SEER Cancer Registry Data System for internet access to the November 2013 submission of the 18 participating SEER registries database. The application was completed with the SEER cancer registry signed data use agreement form (see Appendix A). On receipt of the signed data use agreement, the support team of the SEER cancer registry granted approval for internet access to the SEER*Stat client-server system (see Appendix B). Subsequently, I prepared a smaller dataset of the 18 participating SEER cancer registries database for the study using a case listing of all the variables of the research. I exported the case listing into the IBM SPSS statistical software version 23 for data analysis.

I modified the study's protocol based on the limitations of the dataset. The cut-off age of the research participants was extended to include PrCa patients older than 65 years. The proposed age-group for the data analysis was 30-64 years, and the cut-off age

age-group was 60-64 years. However, the dataset had fewer PrCa patients aged 30 to 64 years when compared with the 65 and older age-group. The younger to older age-group comparisons were 48.1% versus 51.9% for the Jamaicans and 31.7% versus 68.2% for the U.S.-born Whites. Additionally, the highest proportion of Jamaican PrCa patients (292 or 39%) and U.S.-born Whites (4021 or 40.1%) were 65 to 74 years old. Consequently, the cut-off age was extended to include PrCa patients aged 65 years and older.

The sample size of the research was expanded from $N = 1,335$ to $N = 10,752$ (8 times larger) due to the sampling procedures used for the selection of the PrCa patients. The sample described in the research protocol included 267 Jamaicans and 1,068 White U.S.-born PrCa patients. However, the dataset had 754 Jamaican PrCa patients and 719 met the criteria for selection; these PrCa patients were selected for the study using purposive sampling. The sample of White U.S.-born PrCa patients was extended to 10,033, with the random sampling technique described in the research protocol. The samples of Jamaicans and White U.S.-born PrCa patients were taken from 15 of the l8 the SEER participating locations.

Additionally, I excluded three of the SEER reporting sites from the dataset, the smoking variable was removed from the variable listing, and the SPSS version 23 software package was used instead of the Pohar Perme and Ederer 11 for data analysis. The SEER reporting sites, Hawaii, Iowa, and Alaska Native were excluded from the data to balance the selection of research participants for the Jamaicans and White U.S.-born cohorts. The three excluded SEER locations had no Jamaican PrCa patients. The smoking

variable was removed from the list of variables because the SEER cancer registry does not report patient-level smoking data. The smoking data were available in the SEER registry dataset as County-level attributes, which were not applicable to the research questions. The Pohar-Perme and Ederer 11 statistical methods were not used for the data analysis because the sample of the study was expanded to include PrCa patients who were older than 65 years and these methods do not perform well in survival analyses involving the older age groups (Seppa et al., 2015). Furthermore, it was indicated in the SEER*Stat software, version 8.3.2 (SEER*Stat, 2016), that the Pohar-Perme survival method is still in development. Therefore, the IBM SPSS statistical software package (one of the alternative statistical software described in the research protocol) was used to analyze the data.

The comparison group (U.S.-Born Whites) was selected with a simple random sampling technique to attain representativeness of the sample. In choosing this sample, the three SEER districts, Hawaii, Iowa, Alaska Native, which had no Jamaican PrCa patients were excluded from the sample frame. Subsequently, the identification numbers of the research participants for the remaining 15 reporting SEER locations were reorganized in descending order. Finally, every 50th White U.S.-born PrCa patient who met the selection criteria for inclusion in the study was selected from each of the 15 SEER reporting sites. I selected every Jamaican PrCa patient who met the selection criteria for the sample. Figure 1, presents the flow chart of the sampling process.

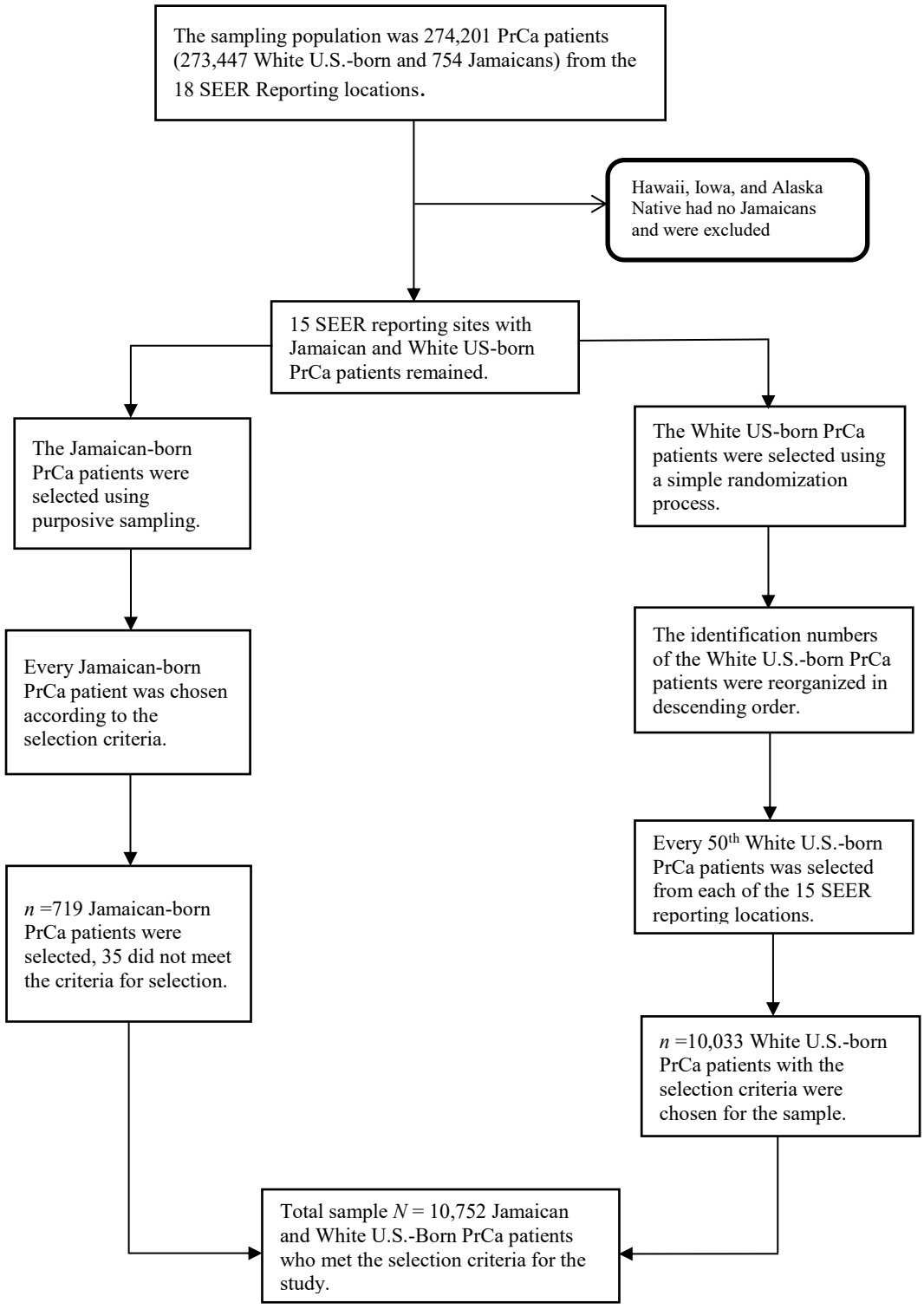

Figure 1. Flow-chart of the sampling process for the prostate cancer patients.

Additionally, proportions of PrCa patients in the sample were compared with proportions in the sampling population using the main variables of the study. The findings of the comparative analysis showed that the proportions of PrCa patients in the sample and sampling frame were similar (see Table 6). Furthermore, 95.4 % of the Jamaican PrCa patients (the exposure group) were included in the sample; a small percentage (4.6 %) of the Jamaican PrCa patients did not meet the criteria for inclusion. Therefore, the samples of Jamaican and White US-born PrCa patients were representative of their sampling populations.

Table 6

Comparison of the Proportions of the Sample and the Sampling Population of the Prostate Cancer Patients

		US-Born Whites		Jamaicans	
		Sample Frame *n* (%)	Sample *n* (%)	Sample Frame *n* (%)	Sample *n* (%)
Treatment	Brachytherapy	28,149 (13.3)	1,323 (13.2)	112 (14.8)	112 (14.8)
	ERBT	48,335 (22.9)	2,449 (24.4)	185 (24.5)	185 (24.5)
Gleason Grades	Moderately Differentiated	119,712 (56.7)	6,149 (61.3)	419 (55.6)	415 (57.7)
	Well Differentiated	10,470 (5.0)	517 (5.2)	23 (3.1)	23 (3.1)
	Poorly Differentiated	80,968 (38.3)	3,369 (33.6)	312 (41.4)	281 (39.1)
Vital Status	Alive	11,3358 (53.7)	5,393 (53.7)	531 (70.4)	524 (72.9)
	Dead	97,792 (46.3)	4,642 (46.3)	223 (29.6)	195 (27.1)
*Age Groups	35-39	59 (0.0)	3 (0.0)	2 (0.3)	2 (0.3)
	40-44	676 (0.3)	31 (0.3)	5 (7%)	5 (7%)
	65-69	41,319 (19.6)	2,037 (20.3)	173 (22.9)	165 (22.9)
	70-74	41,657 (19.7)	1,984 (19.8)	123 (16.3)	116 (16.1)
SEER Historic Stage A	Localized	173,342 (82.1)	8,397 (83.7)	637 (84.5)	637 (84.5)
	Un-staged	5,574 (2.6)	251 (2.5)	11 (1.5)	11 (1.5)

Note: * The comparison included the age-groups with the lowest and highest proportion of prostate cancer patients from the sample and sample frame.

Descriptive Statistics that Characterize the Sample

The sample for this study comprised *N* = 10,752 PrCa patients selected from 15 of the 18 SEER reporting sites. The exposure sample consisted of 677 (94.2 %) Jamaican-born Black and 42 (5.8 %) Jamaican-born White PrCa patients. The comparison group included 10,033 U.S.-born White PrCa patients. All PrCa cases were actively followed during the study period, at the end of 2011, 72.9 % of the Jamaican PrCa patients were censored, and 27.1 % died. Among the White U.S.-born PrCa patients in the study, 53.8% were censored, and 46.2 % were deceased. The diagnosis for all PrCa cases was histologically confirmed. Table 7 presents the findings of the baseline characteristics of the sample.

Table 7

Baseline Characteristics of the Prostate Cancer Patients From 15 SEER Reporting Locations Reported for the Period 1992 to 2011

Baseline Characteristics of the Sample									
Birthplace	PrCa Patients	Actively Followed		Censored		Deceased		Histologically Confirmed	
	n	*n*	(%)	*n*	(%)	*n*	(%)	*n*	(%)
Jamaica	719	719	100%)	524	(72.9%)	195	(27.1%)	719	100%
United States	10,033	10,033	(100%)	5,393	(53.8%)	4,640	(46.2%)	10,033	100%
Total	10,752	10,752		5,917	(55.0%)	4,835	(45.0%)	10,752	

Note: *N* = 10,752

Among the 15 SEER reporting locations of the study, Greater California had the highest proportion of PrCa patients (16.3%) followed by Connecticut (15%) and Los Angeles (14.7%). The least number of PrCa patients were reported for the Greater and rural Georgia (3.0%) and Kentucky (3.1%) areas. Table 8 shows the frequency of the

Jamaican and White US-born PrCa patients of the 15 SEER reporting locations included in the study.

Table 8

Frequency of Prostate Cancer Patients for Each of the 15 SEER Reporting Locations for the Period 1992 to 2011

SEER Registry	Frequency (*n*)	%
Atlanta (Metropolitan)	535	5.0
California Excluding SF/SJ /LA	1,749	16.3
Connecticut	1,614	15.0
Detroit (Metropolitan)	557	5.2
*Georgia (Rural and Greater)	328	3.0
Kentucky	338	3.1
Los Angeles	1,581	14.7
Louisiana	342	3.2
New Jersey	879	8.2
New Mexico	393	3.7
San Francisco-Oakland SMSA	600	5.6
San Jose-Monterey	365	3.4
Seattle (Puget Sound)	1,031	9.6
Utah	440	4.0
Total	10,752	100

Note: N=10,752. *Georgia includes the research participants from rural and greater Georgia.

The frequency of PrCa patients for the 20-year period of observation ranged from 367 (3.4 %) in 1994 to 822 (7.6%) cases in 2001. As shown in Table 9, higher numbers of PrCa patients were reported between 2000 and 2002, and in 2004. In the 1990s, except for 1992, the frequency of PrCa cases was lower than the number of PrCa cases reported

between 2000 and 2004. However, the rate of PrCa patients declined gradually for the reporting periods 2005 to 2011. In 2011, the number of PrCa patients was comparable with the low prevalence period 1995 to 1999.

Table 9

Frequency of Jamaican and White U.S.-Born Prostate Cancer Patients of the SEER Registry Database per Year for the Period 1992 to 2011

Year	Frequency (*n*)	Percent (%)	Cumulative (%)
1992	664	6.2	6.2
1993	425	4.0	10.1
1994	367	3.4	13.5
1995	402	3.7	17.3
1996	381	3.5	20.8
1997	410	3.8	24.6
1998	414	3.9	28.5
1999	398	3.7	32.2
2000	720	6.7	38.9
2001	822	7.6	46.5
2002	776	7.2	53.7
2003	575	5.3	59.1
2004	720	6.7	65.8
2005	583	5.4	71.2
2006	619	5.8	77.0
2007	577	5.4	82.3
2008	514	4.8	87.1
2009	496	4.6	91.7
2010	490	4.6	96.3
2011	399	3.7	100.0
Total	10,752	100.0	

Note: N = 10752

PrCa patients aged 55 to 79 years were well represented in the study's sample. Fewer PrCa patients were 35 to 54 years, and the lowest number of PrCa patients (5%)

was in the 35 to 39 age group. The highest proportion of PrCa patients for both Jamaican and the White U.S.-born cohort was 65 to 69 years old; this included 165 (22.9%) Jamaican and 2027 (20.3%) White U.S.-born PrCa patients. A higher proportion of Jamaican PrCa patients were 55 to 69 years old when compared with the White U.S.-born (57.2% versus 45.2%), and fewer were in the 70 years and older age groups (29% versus 47.9%) (see Table 10).

Table 10

Age Distribution of the Jamaican and White U.S.-Born Prostate Cancer Patients

			Age Groups										
			35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 +
Birth-Place	Jamaica	*n*	2	5	27	65	119	127	165	116	63	19	11
		%	0.3	0.7	3.8	9.0	16.6	17.7	22.9	16.1	8.8	2.6	1.5
	United States	*n*	3	31	162	490	981	1,519	2,037	1,984	1,579	845	402
		%	0	0.3	1.6	4.9	9.8	15.1	20.3	19.8	15.7	8.4	4.0
Total (*n*)			5	36	189	555	1,100	1,646	2,202	2,100	1,642	864	413
Total %			0	0.3	1.9	5.2	10.2	15.3	20.5	19.5	15.3	8.0	3.8

Note: N=10752.

Higher proportions of the PrCa patients were married (66.5% Jamaicans and 72.4% White U.S.-born). However, the marital status of 15.2% of the PrCa patients was unknown. Lower proportions of PrCa patients were either widowed (11.2 %) or separated (2.7%) (see Table 11).

Higher numbers of Jamaican PrCa patients (56.9%) and White U.S.-born (80.5%) had health insurance. There were no specific details of the type of health insurance coverage for 19% of the Jamaican and 15.9% of the U.S.-born cohorts. The health

insurance status was unknown for 7.2% of the Jamaican PrCa patients and missing for 6% of both cohorts (see Table 11).

Table 11

Marital and Health Insurance Status of the Jamaican and White U.S.-Born Prostate Cancer Patients

	Jamaicans		White U.S.-Born	
	n	%	*n*	%
		Marital Status		
Married	478	66.5	7,267	72.4
Divorced	49	6.8	642	6.4
Separated	16	2.2	53	0.5
Unmarried	86	12.0	691	6.9
Widowed	32	4.5	671	6.7
Unknown	58	8.1	709	7.1
Total	719	100	10,033	100
		Health Insurance Status		
Insured	111	56.9	8,073	80.5
Insured/No Specifics	37	19.0	1,594	15.9
Any Medicaid	20	10.3	222	2.2
Uninsured	13	6.7	14	1.3
Unknown	14	7.2	0	0
*Total	195	100	9,903	100

Note: * Data on the health insurance status for 654 (6.0%) of the PrCa patients were not available for the analysis.

Thirty-eight percent of the sample was treated with one or more types of radiation; however, high numbers of PrCa patients (59.1%) received no radiation treatment, and the treatment status of 3% of PrCa patients was unknown. Among the White U.S.-born and Jamaican PrCa patients, ERBT was the most widely used PrCa treatment, and its use was reported for 2630 (24.5%) of the PrCa cohorts. Brachytherapy

was used among 1,435 (13.3%) of the PrCa patients. Table 12 describes the distribution of radiation treatment types among the PrCa patients.

Table 12

Distribution of Prostate Cancer Treatments Among the Jamaican and White U.S.-Born Prostate Cancer Patients

			ERBT	Brachytherapy	Radiation (NOS*)	None	Unknown	Refused	Total
Birthplace	Jamaica	*n*	181	112	0	400	16	10	719
		%	25.2	15.5	0	55.6	2.3	1.4	100
	USA	*n*	2,449	1,323	20	5,951	201	89	10,033
		%	24.4	13.2	0.2	59.3	2.0	0.9	100
Total (*n*)			2,630	1,435	20	6,351	217	99	10,752

Note: N=10752. * The method of radiation is not specified. ERBT combined is combination of beam radiation with implants or isotopes.

High numbers of PrCa patients in the study were classified with Gleason grades 1 and 11 PrCa, localized PrCa, and T1c and T2c PrCa. Higher proportions of the White US-born PrCa patients when compared with Jamaicans were classified with Gleason grade 1 PrCa (5.2% versus 3.2%) and Gleason grade 11 PrCa (61.3% versus 57.7%). On the other hand, a higher percentage of Jamaican PrCa patients had Gleason grade 111 PrCa (39.1%) when compared with the White U.S.-born cohort (33.6%). The highest proportions of Jamaican (45.6%) and U.S.-born (38.6%) PrCa patients were categorized with T1c PrCa. There were no data for 23.7% of the PrCa patients of the SEER Historic Stage A classification. Table 13 describes the Gleason grades, SEER Historic Stage A classification, and TNM staging of the PrCa patients.

Table 13

Distribution of Jamaican and White US-Born Prostate Cancer Cases According to Gleason Grades, SEER Historic Stage A, and TNM Staging

	Jamaicans		White U.S.-Born	
	n	%	*n*	%
		Gleason Grades		
Grade 1	23	3.2	517	5.2
Grade 11	415	57.7	6,148	61.3
Grade 111	281	39.1	3,368	33.6
Total	719	100	10,033	100
		SEER Historic Stage A		
Localized	637	88.6	8,397	83.7
Un-staged	11	1.5	251	2.5
Blanks	71	9.9	1,385	13.8
Total	719	100	10,033	100
		SEER TNM Staging		
T1a	3	1.5	225	2.2
T1b	1	0.5	121	1.2
T1c	89	45.6	3,871	38.6
T1 NOS	0	0	41	0.4
T2a	17	8.7	813	8.1
T2b	5	2.6	252	2.5
T2c	55	28.2	2,631	26.2
T2 NOS	25	12.8	2,069	20.6
*Total	195	100	10,023	100

Note: *The number of PrCa patients classified with the TNM Staging was reported for the period 2004 to 2011.

An Evaluation of Statistical Assumptions Appropriate to the Study

The assumption of proportionality of the Cox Regression model was evaluated with the graphical presentation of the Log Minus Log (LML) survival function versus the

log of survival time; and statistical modelling with the time-dependent Cox model which introduced time as a linear variable. The assumption of proportionality of the Cox regression model was tested for each PrCa cohort per ERBT and brachytherapy prostate cancer treatments. The White U.S.-born PrCa cohort was the referent category because the research questions aimed at evaluating survival differences between the birthplace covariate and PrCa treatment. The cumulative hazard functions for each treatment group were plotted against time and the constancy of the ratios of the hazards determined (Forthofer et al., 2007). The assumption of proportionality of baseline hazards was accepted for each treatment cohort, on the basis that the cumulative survival curves for the Jamaican and White U.S.-born cohorts remained parallel for the period of observation. The results of the LML analysis demonstrated that the hazard of death for the brachytherapy treated Jamaican PrCa patient was significantly lower than the risk of death for the White U.S.-born brachytherapy treated PrCa patients, *HR* 0.63, 95% CI [0.55, 0.73], $p < .001$ (see Table 14). The graph of the LML survival curves for the Jamaican and White U.S.-born PrCa patients showed that both curves were parallel throughout the period of observation, and indicated that hazards for both cohorts were constant throughout the period of follow-up. The parallelism of the survival curves signified that the assumption of proportionality of the survival distributions for the Jamaican and White U.S.-born brachytherapy treated PrCa patients was met. Figure 2, illustrates the survival curves of the LML survival analysis.

Table 14

Log Minus Log Analysis of the Proportionality of the Hazards of the Prostate Cancer Patients Treated With Brachytherapy

Variables in the Equation											
							95% CI for Exp (*B*)				
Birthplace	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*	Covariate Mean	$\chi 2$	-2 Log Likelihood
(Reference = USA)											
Jamaica	-0.46	0.07	39.39	1	.000	0.63	0.55	0.73	0.07	45.49	78,169.61

Note: *LL* is lower limits and *UL* is upper limits.

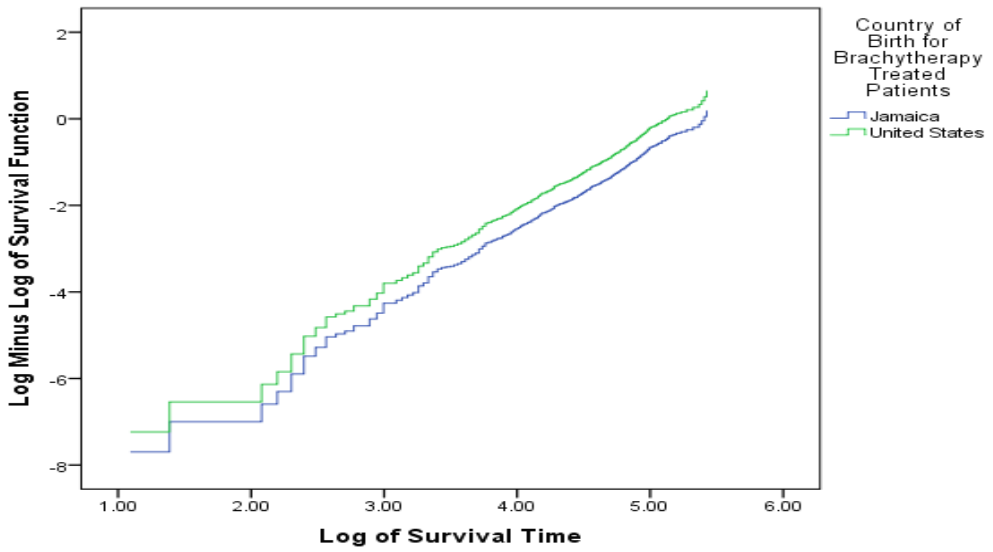

Figure 2. Plot of Log Minus Log survival function for brachytherapy.

The LML analysis of the hazard ratios for the ERBT Jamaican versus the ERBT U.S.-born PrCa patients showed that Jamaicans had a significantly lower hazard of death, *HR* 0.62, 95% CI [0.54, 0.72], $p < .001$ (see Table 15). The graph of the LML survival curves for the ERBT treated Jamaican, and White U.S.-born PrCa patients revealed that

both curves were divergent throughout the period of observation (see Figure 3). The parallelism of the survival curves indicated that the assumption of proportionality of the survival distributions for the ERBT treated Jamaican and White U.S.-born PrCa patients was met.

Table 15

Log Minus Log Analysis of the Proportionality of the Hazards of the Prostate Cancer Patients Treated With ERBT

Variables in the Equation											
							95% CI for Exp (*B*)				
Birthplace	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*	Covariate Mean	$\chi 2$	-2 Log Likelihood
(Reference = United States)											
Jamaica	-0.46	0.07	40.28	1	.000	0.62	0.54	0.72	0.07	46.59	75,649.87

Note: *LL* is lower limits and *UL* is upper limits.

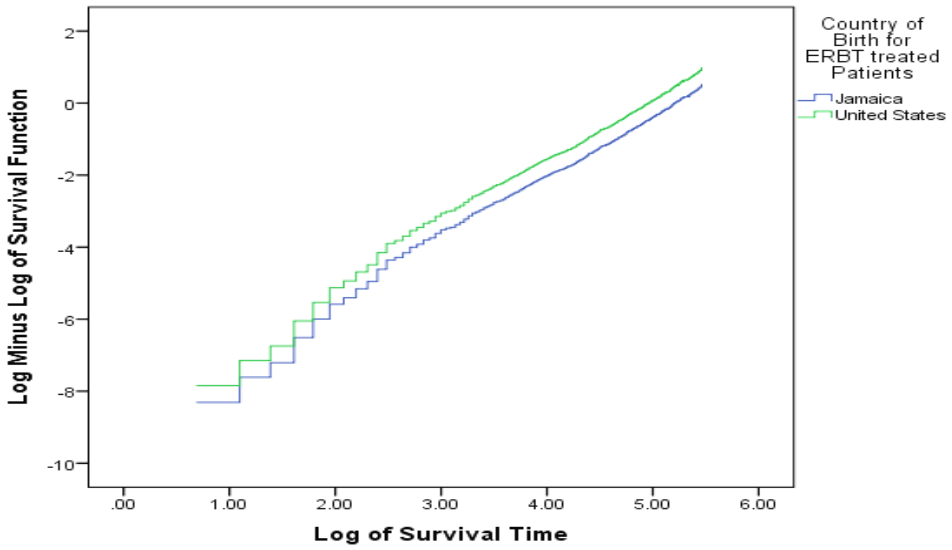

Figure 3. Plot of Log Minus Log survival function for ERBT.

Cox regression analysis with time-dependent variable confirmed that the assumption of proportionality of the hazards was met for both brachytherapy and ERBT treated PrCa cohorts. At the inclusion of the time-dependent covariate with the country of birth and brachytherapy variables in the Cox regression model, the hazard ratio differed from the crude hazard ratio and was no longer statistically significant, *HR* 1.0, 95% CI [0.99, 1.01], $p = 0.93$. The lack of statistical significance in the analysis indicated that time did not interact with covariates brachytherapy and country of birth. Hence the hazard ratios for brachytherapy were proportional with time. Table 16 demonstrates the interaction with time analysis for the brachytherapy treated PrCa patients

Table 16

Time-Dependent Analysis of the Proportionality of the Hazards of the Prostate Cancer Patients Treated With Brachytherapy

Variables in the Equation										
							95% CI for Exp (*B*)			
	B	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*	χ^2	-2 Log Likelihood
Birthplace	-0.76	0.14	31.06	1	.000	2.15	1.64	2.81	170.96	81339.73
Brachytherapy	-0.91	0.09	93.66	1	.000	0.40	0.33	.48		
Birthplace* T_Cov_	-0.00	0.00	7.81	1	.005	0.99	0.99	0.99		
Brachytherapy* T_Cov_	0.01	0.01	2.18	1	.139	1.01	0.99	1.02		
Birthplace *brachytherapy* T_Cov_	0.00	0.00	0.00	1	0.927	1.00	0.99	1.01		

Note: * Indicates the interaction terms in the model. *LL* is lower limits *UL* is upper limits.

The hazard ratio for the ERBT treated PrCa patients also differed from the crude hazard ratio and was no longer statistically significant with the introduction of the time-

dependent covariate with the country of birth variable and ERBT to the model, *HR* 0.99, 95% CI [0.99, 1.00], $p = 0.84$. The lack of statistical significance of the time-dependent covariate confirmed that time did not interact with covariates ERBT and country of birth. Hence the hazard ratios for ERBT were proportional with time. Table 17 shows the interaction with time analysis for the ERBT treated PrCa patients.

Table 17

Time-Dependent Analysis of the Proportionality of the Hazards of the Prostate Cancer Patients Treated With ERBT

Variables in the Equation										
							95% CI for Exp (*B*)			
	B	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*	$\chi 2$	-2 Log Likelihood
Birthplace	0.78	0.14	32.29	1	.000	2.18	1.67	2.85	148.15	81339.73
ERBT	-0.33	0.06	29.86	1	.000	0.72	0.64	0.81		
Birthplace* T_Cov_	-0.00	0.00	7.45	1	.006	0.99	0.99	0.99		
ERBT* T_Cov	0.01	0.00	2.39	1	.122	1.01	1.00	1.01		
Birthplace*ERBT* T_Cov_	0.00	0.00	0.04	1	0.839	1.00	0.99	1.00		

Note: * Indicates the interaction terms in the model. *LL* is lower limits, *UL* is upper limits.

The LML estimate of the cumulative survival function versus the log of survival times of both brachytherapy and ERBT Jamaican and White U.S.-born PrCa patients confirmed that the survival curves were parallel. The time-dependent analyses verified that the hazards of both ERBT and brachytherapy treated Jamaican and White U.S.-born cohorts were constant throughout the period of observation. Therefore, the assumption of proportionality of the Cox proportional hazard regression model was met, and this model

was appropriate to examine survival differences of the brachytherapy and ERBT treated Jamaican and U.S.-born PrCa patients.

Statistical Analyses for the Research Questions

Research Question 1 Analysis

Research Question 1: Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease? H_o1: There are no differences in the length of time Jamaican-born and U.S.-born White PrCa patients treated with brachytherapy for low and intermediate stages PrCa; live with the disease. H_a1: There are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease.

Univariate analyses using the Life-Table estimates and Kaplan-Meier estimators provided preliminary descriptive statistics of the cumulative survival probability for the brachytherapy treated White U.S.-born and Jamaican PrCa patients. The Kaplan-Meier survival curves and the Log-Rank (Mantel-Cox), Breslow (Generalized Wilcoxon), and Tarone-Ware statistics were used to determine whether there were differences in the survival distributions of the brachytherapy treated Jamaican and the White U.S.-born cohorts. The Cox proportional hazards regression model was used to estimate the differences in the hazards ratios for the Jamaican and White U.S.-born PrCa patients based on the assumption that the hazards between both cohorts were constant throughout the follow-up. Hypothesis testing with interaction analysis was carried out to determine

modification effects in the magnitude of the risk ratios of the brachytherapy treated Jamaican and White U.S.-born cohorts. Tables 18 through 20, and Figure 4 present the statistical analyses for Research Question 1.

Table 18, demonstrates the Life-Table estimates of the cumulative survival for the Jamaican and U.S.-born PrCa patients of the study. The death rates were stable for most of the period of observation but the number of Jamaican PrCa patients in the study declined markedly at 150 months and the White U.S.-born PrCa patients at 160 months. All Jamaican PrCa patients experienced the event at 190 months and the U.S.-Cohort at 230 months of follow-up.

Table 19 depicts the Kaplan-Meier comparison of the survival periods of the Jamaican and White U.S.-born PrCa patients and the overall comparisons of the survival distributions. The survival times for the Jamaican PrCa patients were similar (195 months) for the first and second percentiles of the follow-up period. The median survival for the Jamaicans was undefined because more than 50 % of these PrCa patients survived beyond half the observation period. The median survival interval for the U.S.-born cohort was 142 months, *SE* 3, 95% CI [134.8, 147.1]. The Log-Rank, Breslow's, and Tarone-Ware comparisons of the survival distributions confirmed that the survival experiences for both cohorts were significantly different ($p < .001$).

Table 18

Life-Table Estimates of Survival Times for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy for the Period 1992 to 2011

Life Table										
Birth Place	Start Time	Started	At Risk	Censored	Died	Cum Survival %	*SE* *	PD	*HR* %	*SE***
Jamaica	0	112	110	5	0	100	.00	.000	0	.00
	10	107	104	6	1	99	.01	.001	0	.00
	20	100	97	6	0	99	.01	.000	0	.00
	30	94	92	5	1	98	.01	.001	0	.00
	40	88	86	4	0	98	.01	.000	0	.00
	50	84	80	9	2	95	.02	.002	0	.00
	60	73	69	8	2	93	.03	.002	0	.00
	70	63	61	4	1	91	.03	.002	0	.00
	80	58	56	4	0	91	.03	.000	0	.00
	90	54	52	4	1	89	.04	.002	0	.00
	100	49	47	4	0	89	.04	.000	0	.00
	110	45	42	7	3	83	.05	.004	1	.00
	120	35	31	9	4	72	.07	.005	1	.01
	130	22	18	8	2	64	.08	.005	1	.01
	140	12	11	2	1	58	.09	.006	1	.01
	150	9	8	3	1	50	.11	.007	1	.01
	160	5	4	3	0	50	.11	.000	0	.00
	170	2	2	0	0	50	.11	.000	0	.00
	180	2	2	1	0	50	.11	.000	0	.00
	190	1	1	0	1	0	0	.011	2	.00
United States	0	1,323	1,314	19	4	100	.00	.000	0	.00
	10	1,300	1,285	30	19	98	.00	.001	0	.00
	20	1,251	1,234	34	36	95	.01	.003	0	.00
	30	1,181	1,156	50	26	93	.01	.002	0	.00
	40	1,105	1,081	47	41	90	.01	.004	0	.00
	50	1,017	988	58	38	86	.01	.003	0	.00
	60	921	885	72	38	83	.01	.004	0	.00
	70	811	782	58	35	79	.01	.004	0	.00
	80	718	686	65	37	75	.01	.004	1	.00
	90	616	580	73	34	70	.01	.004	1	.00
	100	509	484	51	29	66	.02	.004	1	.00
	110	429	394	70	31	61	.02	.005	1	.00
	120	328	292	72	24	56	.02	.005	1	.00
	130	232	205	55	20	50	.02	.005	1	.00
	140	157	144	26	18	44	.02	.006	1	.00
	150	113	103	20	7	41	.02	.003	1	.00
	160	86	74	24	7	37	.03	.004	1	.00
	170	55	47	17	5	33	.03	.004	1	.01
	180	33	30	7	2	31	.03	.002	1	.00
	190	24	21	7	0	31	.03	.000	0	.00
	200	17	15	5	1	29	.04	.002	1	.01
	210	11	11	1	2	23	.05	.005	2	.01
	220	8	7	2	2	17	.05	.007	3	.02
	230	4	2	4	0	17	.05	.000	0	.00

Note: N = 10,752= *SE** is the standard error for the cumulative survival and *SE***is the standard error for the hazard rate. PD is probability density of survival estimate; *HR* is the hazard rates.

Table 19

Kaplan-Meier Comparison of the Survival Times for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy

	Percentiles						95% CI for the Median		Overall Comparisons					
									Log-Rank		Breslow		Tarone-Ware	
	25%		50%		75%				χ^2	Sig	χ^2	Sig	χ^2	Sig
	Est	*SE*	Est	*SE*	Est	*SE*	*LL*	*UL*						
Jamaica	195	-	195	-	128	6	-	-	40.3	.000	36.6	.000	40.7	.000
United States	219	15	142	3	89	3	134.8	147.1						
Overall	219	12	142	3	92	3	135.8	148.1						

Note: $N = 10752$. * No precision estimates were calculated for the median survival time for the Jamaicans because more than 50% of the patients survived beyond the 50th percentile of the observation period. Percentiles are the quartiles of the follow-up period in months. *LL* is lower limits, *UL* is upper limits. Est is estimate. Sig is the *p-value.*

Figure 4 illustrates the Kaplan-Meier survival curves for the brachytherapy treated cohorts. The cumulative survival curves showed visible differences in the survival distributions of the Jamaican and White U.S.-born PrCa patients. The Kaplan-Meier survival curve for the brachytherapy treated Jamaican PrCa patients had higher survival probability overall when compared with the White U.S.-born PrCa patients. Both PrCa cohorts had similar survival probability at baseline, but at approximately 30 months of follow-up the survival curve for the Jamaican PrCa patients diverged from the U.S. cohort and assumed a parallel form throughout the rest of the study. Brachytherapy treatment demonstrated more favorable survival outcome for the Jamaican PrCa patients for the first 150 months of follow-up and the curve declined sharply at 190 months. The step-like appearance of the curve at 190 months of observation, indicated that fewer participants were in the study at that period. This shift in the survival curve correlated

with the descriptive statistics in Table 18. The small *p*-values ($p < .001$) of the comparative analysis shown in Table 19 confirmed that the cumulative survival curves were significantly different.

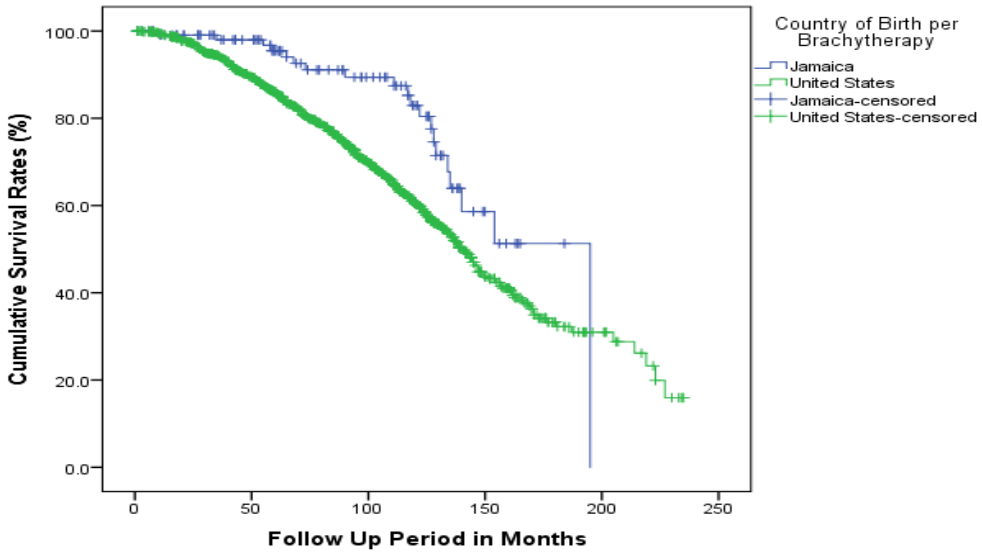

Figure 4. Kaplan-Meier survival curves for the brachytherapy treated patients.

I examined for differences in the hazards of the brachytherapy treated Jamaicans and White U.S.-born PrCa patients with Cox regression hazards analysis (see Table 20). I followed up with interaction analysis to determine whether the magnitude of the risk ratios of the Cox regression model were similar across subgroups of the Jamaican and White U.S.-born brachytherapy treated cohorts. The result of the interaction analysis is presented in Table 20. I created two Cox regression models to examine the independent and interaction effects of brachytherapy and birthplace in the survival outcomes of the PrCa patients. An interaction term was modelled with the birthplace variable and brachytherapy; the White U.S.-born cohort was the referent category. The hypothesis that

the association identified was of similar magnitude across subgroups of the brachytherapy treated Jamaican and White U.S.-born cohorts was accepted where there were no significant interaction effects and rejected where there were significant interaction effects in the model (Szklo & Nieto, 2014, p. 187). Alpha level ($p < .05$) was the basis for accepting or rejecting the null hypothesis. I accepted the main effect for the model with a non-significant interaction effect and a significant or non-significant birthplace main effect. Table 20 presents the two models with the hazard ratios of the main and interaction effects of brachytherapy and the birthplace variable. Model one depicts the analysis of the independent effects of the predictor variable brachytherapy on the outcome PrCa survival without interaction, and model two presents the analysis of the main and interaction effects.

The result of the Cox regression analysis in model one showed a statistically significant difference with the birthplace variable, *HR* 0.63, 95% CI [0.55, 0.73], $p < .001$ and brachytherapy, *HR* 0.69, 95% CI [0.63, 0.76], $p < .001$. At the introduction of the interaction covariate in model two, the main effects for birthplace, *HR* 0.65, 95% CI [0.56, 0.76], $p < .001$ and brachytherapy, *HR* 0.69, 95% CI [0.63, 0.77], $p < .001$ were statistically significant. However, the interaction effect of brachytherapy and the birthplace variable was not significant, *HR* 0.81, 95% CI [0.50, 1.23], $p = .38$. The main effect of the birthplace variable was accepted because of the non-significant interaction effect. The findings of the birthplace main effect indicate that brachytherapy reduced the risk of death by 37% for the Jamaican cohort when compared with the White U.S.-born PrCa patients, *HR* 0.63, 95% CI [0.55, 0.73], $p < .001$.

The focus of the study was to determine differences in the survival of the Jamaican versus the White U.S.-born PrCa patients who were treated with brachytherapy. The statistically significant main effect for the birthplace variable and non-significant interaction effect suggest that the coefficients were not modified by the interaction of brachytherapy and country of birth. The non-significant statistical interaction also indicates that brachytherapy treatment effects did not vary across subpopulations of the brachytherapy treated cohorts of the study (Leighton, 2010b, p. 468; Szklo & Nieto, 2014). Hence, there is a significant difference in the survival times of the brachytherapy treated Jamaicans and White U.S.-born PrCa patients.

Table 20

Main and Interaction Effects of the Differences in the Hazard Ratios for Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy

Variables in the Equation									
	Covariates	*B*	*SE*	Wald	*df*	*p*-value	Exp *B*	95% CI for Exp (*B*) *LL*	*UL*
	Main Effects of Brachytherapy and Birthplace								
Model 1	Birthplace Reference = United States	-0.45	0.07	38.97	1	.000	0.63	0.55	0.73
	Brachytherapy	-0.37	0.04	59.39	1	.000	0.69	0.63	0.76
	Main and Interaction Effects of Brachytherapy and Birthplace								
Model 2	Birthplace (Reference = United States)	0.43	0.07	31.44	1	.000	0.65	0.56	0.76
	Brachytherapy	-0.36	0.04	54.03	1	.000	0.69	0.63	0.77
	Birthplace *brachytherapy	-0.21	0.02	0.77	1	.378	0.81	0.50	1.29

Note: N = 10,752. * is the interaction covariate of brachytherapy and country of birth. *LL* is lower limits, *UL* is upper limits.

The Life-Table estimates and Kaplan-Meier estimators of Research Question 1 demonstrated that the Jamaican PrCa patients had a longer initial event-free period (100 months) when compared with the White U.S.-born PrCa patients (60 months), but experienced the event earlier (190 months versus 230 months) (see Table 18 and Figure 4). The median survival time for the U.S.-born PrCa patients was 142 months, *SE* 3, 95% CI [134.8, 147.1], $p < .001$, while more than 50% of the Jamaicans survived beyond half the period of follow-up (see Table 19). The Log-Rank, Breslow, and Tarone-Ware tests of equality of the survival distributions for the brachytherapy treated the White U.S.-born, and Jamaican PrCa patients confirmed that the survival curves for both cohorts were significantly different ($p < .001$) (see Table 19).

Cox regression analysis of the differences in the hazard ratios of the brachytherapy treated Jamaicans and White U.S.-born PrCa patients confirmed that there were significant differences in their survival times (see Table 20). The hypothesis of a modification effect in the magnitude of the risk ratios across subpopulations of the brachytherapy treated Jamaican and White U.S.-born cohorts showed a non-significant interaction effect. The brachytherapy treated Jamaicans were 0.63 times less likely to die from PrCa at any given time during the 1992 to 2011 period of observation when compared with the White U.S.-born PrCa patients, 95% CI [0.55, 0.73], $p < .001$. Therefore, the alternative hypothesis that there are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with brachytherapy for low and intermediate stages PrCa, live with the disease was accepted.

Research Question 2 Analysis

Research Question 2**:** Are there differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease? $H_0$2: There are no differences in the length of time Jamaican-born PrCa patients and U.S.-born White PrCa patients treated with ERBT for low and intermediate stages PrCa, live with the disease. H_a2: There are differences in the length of time Jamaican-born PrCa patients compared with U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa, live with the disease.

I obtained preliminary descriptive statistics, and crude and cumulative estimates of the survival probability of the ERBT treated cohorts, using Life-Table estimates and Kaplan-Meier estimators. The Log-Rank, Tarone-Ware, and Breslow's statistics were used to determine the equality of the survival distributions for the ERBT treated cohorts. The Cox proportional hazards model was used to estimate the differences in the hazards ratios for the ERBT treated Jamaican and White U.S.-born PrCa patients based on the assumption that the hazards of both cohorts were constant throughout the follow-up. Hypothesis testing with interaction analysis was carried out to determine modification effects in the association identified between ERBT treatment and survival of the PrCa patients. The findings of the statistical analyses for research question two are shown in Table 21 through Table 23, and Figure 5.

Table 21 presents the Life-Table estimates of the ERBT treated PrCa cohorts. The cumulative hazard rates were stable at one percent for the first 180 months of follow-up

for the Jamaicans and 160 months for the White U.S.-born PrCa patients but increased to 2% at 190 and 170 months respectively. At 190 months, the number of ERBT treated PrCa patients in the study declined significantly. All Jamaicans experienced the event at 210 months of follow-up and the White cohort at 230 months.

Table 21

Life-Table *Estimates of Survival Times for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With ERBT for the Period 1992 to 2011*

Life Table										
Birth Place	Start Time	Started	At Risk	Censored	Died	Cum Survival %	*SE**	PD	*HR* %	*SE***
Jamaica	0	181	173	16	2	99	.01	.001	0	.00
	10	163	159	8	4	96	.01	.002	0	.00
	20	151	146	10	2	95	.02	.001	0	.00
	30	139	135	8	2	94	.02	.001	0	.00
	40	129	124	11	4	91	.02	.003	0	.00
	50	114	110	9	4	87	.03	.003	0	.00
	60	101	98	6	4	84	.03	.004	0	.00
	70	91	88	6	5	79	.04	.005	1	.00
	80	80	77	7	6	73	.04	.006	1	.00
	90	67	64	6	4	68	.04	.005	1	.00
	100	57	54	5	1	67	.05	.001	0	.00
	110	51	49	5	5	60	.05	.007	1	.00
	120	41	37	9	1	58	.05	.002	0	.00
	130	31	29	5	3	52	.06	.006	1	.01
	140	23	21	4	0	52	.06	.000	0	.00
	150	19	19	1	1	49	.06	.003	1	.01
	160	17	16	3	2	43	.07	.006	1	.01
	170	12	11	3	1	39	.07	.004	1	.01
	180	8	8	0	0	39	.07	.000	0	.00
	190	8	7	3	1	33	.08	.006	2	.02
	200	4	4	1	1	24	.10	.009	3	.03
	210	2	2	0	2	00	.00.	.024	0	.00
United States	0	2,449	2,413	72	21	99	.00	.001	0	.00
	10	2,356	2,323	67	76	96	.00	.003	0	.00
	20	2,213	2,167	92	85	92	.01	.004	0	.00
	30	2,036	2,008	57	90	88	.01	.004	0	.00
	40	1,889	1,857	64	99	83	.01	.005	1	.00
	50	1,726	1,692	68	91	79	.01	.004	1	.00
	60	1,567	1,533	69	73	75	.01	.004	0	.00
	70	1,425	1,389	72	101	70	.01	.005	1	.00
	80	1,252	1,214	77	103	64	.01	.006	1	.00
	90	1,072	1,039	69	72	59	.01	.004	1	.00
	100	931	900	62	85	54	.01	.006	1	.00
	110	784	743	83	78	48	.01	.006	1	.00
	120	623	589	69	60	43	.01	.005	1	.00
	130	494	465	58	54	38	.01	.005	1	.00
	140	382	360	45	40	34	.01	.004	1	.00
	150	297	283	29	33	30	.01	.004	1	.00
	160	235	224	22	31	26	.01	.004	1	.00
	170	182	169	26	26	22	.01	.004	2	.00
	180	130	122	17	19	18	.01	.003	2	.00
	190	94	85	18	14	15	.01	.003	2	.00
	200	62	60	4	5	14	.01	.001	1	.00
	210	53	47	12	8	12	.01	.002	2	.01
	220	33	27	12	5	10	.01	.002	2	.01
	230	16	9	14	2	7	.02	.002	3	.02

Note: N = 10,752. *SE** is the standard error for the cumulative survival and *SE*** is the standard error for the hazard rate. PD is probability density of survival estimate; *HR* is the hazard rates.

Table 22 shows the Kaplan-Meier comparison of the survival periods of the Jamaican and White U.S. cohorts. At the first percentile, Jamaicans survived the greater portion of the observation period (209 months). The median survival was 154 months for the Jamaicans, *SE* 14.6, 95% CI [125.2, 182.8] and 116 months for the White U.S.-born PrCa patients, *SE* 2.2, 95% CI [111.6, 120.4]. The Log-Rank, Breslow's, and Tarone-Ware tests of equality of the survival distributions confirmed that the survival experiences of the Jamaican and White U.S.-born PrCa patients were significantly different ($p < .001$).

Table 22

Kaplan-Meier Comparison of Survival Times for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With ERBT

	Percentiles						95% CI for the Median		Overall Comparisons					
									Log-Rank		Breslow		Tarone-Ware	
	25%		50%		75%				χ^2	Sig	χ^2	Sig	χ^2	Sig
	Est	*SE*	Est	*SE*	Est	*SE*	*LL*	*UL*						
Jamaica	209	8	154	15	89	7	125.2	182.8	41.2	.000	42.5	.000	45.5	.000
United States	173	3	116	2	70	2	111.6	120.4						
Overall	175	3	117	2	71	2	112.5	121.5						

Note: N = 10,752. *LL* is lower limits, *UL* is upper limits. Est is estimate. Percentiles are the quartiles of the follow-up period in months. Est is estimate. Sig is the *p-value.*

Figure 5 illustrates the cumulative survival probability for the ERBT treated Jamaican and White U.S.-born PrCa. The Kaplan-Meier curves demonstrated perceptible differences in the survival experiences of both cohorts. The curves shifted after 30 months of follow-up and remained parallel throughout the observation. The cumulative survival curves showed that ERBT was more beneficial to the Jamaican PrCa patients

throughout the observation when compared with the White U.S.-born cohort. Fewer Jamaican and White U.S. PrCa patients were in the study between 160 and 200 months of follow-up. All Jamaican PrCa patients experienced the event earlier than the White U.S.-born patients. The frequency of the ERBT treated Jamaicans presented Table 21 corresponded with the shifts in the survival curves and confirmed that the number of PrCa patients declined at the latter months of the follow-up. The cumulative survival curve for the White U.S.-born cohort terminated at a later period (230 months) of follow-up. The comparison analysis of the survival distributions demonstrated in Table 22 verified that the survival curves for the Jamaicans and the White U.S. PrCa patients were significantly different.

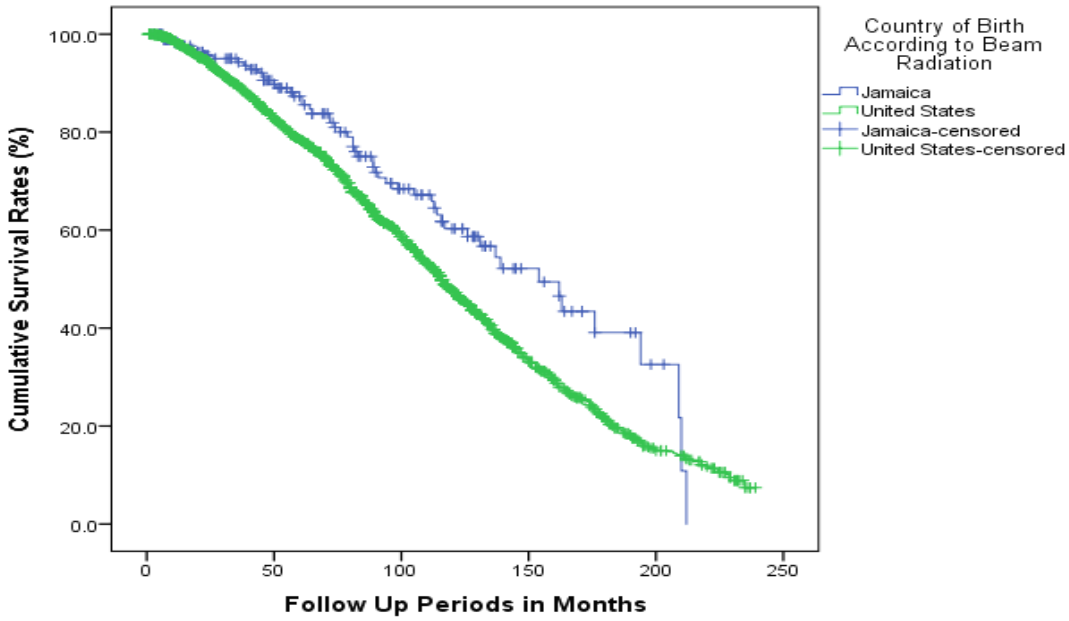

Figure 5. Kaplan-Meier survival curves for the ERBT treated patients.

The differences in the hazards of Jamaicans and White U.S.-born PrCa patients were examined further in Cox regression hazards analysis (see Table 23). The Cox-proportional hazards model was used to estimate the differences in the hazards ratios for the ERBT treated Jamaican and White U.S.-born PrCa patients based on the assumption that the hazards among both cohorts were constant throughout the follow-up. I conducted hypothesis test with interaction analysis to determine modification effects in the magnitude of the association identified in the Cox regression analysis for the Jamaican and White U.S.-born ERBT treated cohorts. The differences in the hazard ratios of the main and interaction effects of ERBT and the birthplace variable were examined in two separate Cox regression models. An interaction term was modelled with the birthplace variable and ERBT; the White U.S.-born cohort was the referent category. The hypothesis that the association identified was of similar magnitude across subgroups of the ERBT treated Jamaican and White U.S.-born cohorts was accepted where there were no significant interaction effects and rejected where there were interaction effects in the model (Szklo & Nieto, 2014, p. 187). Alpha level ($p < .05$) was the basis for accepting or rejecting the null hypothesis. I accepted the main effect for the model with a non-significant interaction effect and a significant or non-significant birthplace main effect. In Table 23, model one depicts the analysis of the independent effects of the predictor variable ERBT on PrCa survival without the interaction term, and model two presents the analysis of the main and interaction effects.

The result of the Cox regression analysis in model one showed a statistically significant difference with the birthplace variable, *HR* 1.6, 95% CI [1.38, 1.84],

$p < .001$ and ERBT, *HR* 0.89, 95% CI [0.84, 0.95], $p = .001$. In model two, the Cox regression analysis showed a significant main effect for birthplace, *HR* 1.50, 95% CI [1.27, 1.78], $p < .001$ but ERBT did not, *HR* 1.14, 95% CI [0.61, 2.13], $p = 0.69$. The interaction effect of ERBT and the birthplace variable was also not significant *HR* 1.03, 95% CI [0.75, 1.41], $p = 0.88$. The birthplace main effect was accepted because of the non-significant interaction effect. The ERBT treated Jamaican PrCa patients were 1.6 times more likely to die of PrCa when compared with the ERBT treated U.S.-born White PrCa patients, *HR* 1.6, 95% CI [1.38, 1.84], $p < .001$.

The intent of the study was to determine differences in the survival of the Jamaican versus the White U.S.-born PrCa patients who were treated with ERBT. The birthplace main effect was statistically significant, and the interaction effect was not significant. The statistically significant main effect for the birthplace variable and non-significant interaction effect confirmed that the coefficients were not modified by the interaction of ERBT and country of birth. The non-significant statistical interaction also indicates that ERBT treatment effects were similar in magnitude across subpopulations of the cohorts studied (Leighton, 2010b, p. 468; Szklo & Nieto, 2014, p. 187). Hence there is a significant difference in the survival of the ERBT treated Jamaicans and White U.S.-born PrCa patients

Table 23

Main and Interaction Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With ERBT

Variables in the Equation								95% CI for Exp (*B*)	
	Covariates	*B*	*SE*	Wald	*df*	*p*-value	Exp (*B*)	*LL*	*UL*
		Main Effects of ERBT and Birthplace							
Model 1	Birthplace (Reference = United States)	0.46	0.07	40.62	1	.000	1.59	1.38	1.84
	ERBT	0.11	0.03	11.73	1	.001	0.89	0.84	0.95
		Main and Interaction Effects of ERBT and Birthplace							
Model 2	Birthplace (Reference =United States)	0.40	0.08	22.04	1	.000	1.50	1.27	1.78
	ERBT	0.13	0.32	0.16	1	.685	1.14	0.61	2.13
	ERBT* Country of Birth	0.02	0.16	0.02	1	.881	1.03	0.75	1.41

Note: N = 10,752. * is the interaction covariate of ERBT and Country of Birth. *LL* is lower limits and *UL* is upper limits.

The analyses for Research Question 2 demonstrate that the Jamaican PrCa patients had a longer event-free period at the start of the follow-up when compared with the White U.S.-born PrCa patients (60 months versus 30 months). Both ERBT treated groups survived more than 200 months of follow-up (see Table 21). Kaplan-Meier statistics showed that the Jamaican ERBT treated PrCa patients had higher median survival time when compared with the White U.S.-born PrCa patients (154 months), *SE* 15, 95% CI [125.2, 182.8], versus (116 months), *SE* 2, 95% CI [111.6, 120.4] The Kaplan-Meier cumulative survival curve showed that the ERBT treated Jamaican PrCa patients had higher survival probability when compared with the White U.S.-born cohort

(see Figure 5). The Log-Rank, Breslow's, and Tarone-Ware tests of equality of the survival distributions for the ERBT treated White U.S.-born, and Jamaican PrCa patients confirmed that the survival curves were significantly different ($p < .001$) (see Table 22).

Cox regression analysis of the differences in the hazard ratios of the Jamaican and White U.S.-born ERBT treated PrCa patients confirmed that the hazard ratios of both cohorts were significantly different (see Table 23). The hypothesis of a difference in the magnitude of the risk ratios across subgroups of the ERBT treated Jamaican and White U.S.-born cohorts demonstrated no interaction or modification effects. Hence, at any given time during the during the 1992 to 2011 period of observation the ERBT treated Jamaican PrCa patients were 1.6 times more likely to die of PrCa when compared with the White U.S.-born PrCa patients, 95% CI [1.38, 1.84], $p < .000$. Thus, the alternative hypothesis that there are differences in the length of time Jamaican-born PrCa patients versus U.S.-born White PrCa patients who were treated with ERBT for low and intermediate stages PrCa live with the disease was accepted.

Research Question 3 Analysis

Research Question 3: Are there differences in the 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients per treatment received for the period 1992 to 2011? $H_0$3: There are no differences in the 5-year survival intervals of Jamaican-born and U.S.-born White PrCa patients per treatment received for the period 1992 to 2011. H_a3: There are differences in the 5-year survival intervals of Jamaican-born PrCa patients compared with U.S.-born White PrCa patients according to treatment received for the period 1992 to 2011.

In analyzing Research Question 3, I developed cohort-treatment contingency tables for each 5-year interval and estimated the hazard rates and median survival times of the PrCa cohorts according to the treatments they received. I compared the differences in the survival distributions of the Jamaican and White U.S.-born cohorts per treatments received using the Log-Rank statistics. The findings of the Kaplan-Meier statistical analyses are presented in Tables, 24, 28, 32, and 36. I computed further analyses with the Cox proportional hazards regression model to test the differences in the survival experiences of the PrCa patients for each 5-year interval. Hypothesis testing with interaction analysis was conducted to determine interaction or modification in the magnitude of the risk ratios of the treatment cohorts. Each PrCa treatment (brachytherapy, ERBT, and radiation sequenced with surgery) was modelled separately with the birthplace variable and an interaction term which included birthplace and treatment type. The hypothesis that the magnitude of the risk ratios of the Cox regression model was comparable in subpopulations of the Jamaican and White U.S.-born cohorts was accepted for each model with a non-significant interaction outcome and a significant or non-significant birthplace main effect. In contrast, the hypothesis that the magnitude of the risk ratios was similar among subgroups of the cohorts was rejected for each model with a significant interaction effect. Alpha level ($p < .05$) was the basis for accepting or rejecting the null hypothesis. Follow-up tests using pairwise comparisons of the second main effects (the treatment groups and their corresponding non-treated groups) were completed for each model with a significant interaction effect. The main outcomes of the treatment and birthplace variables for each 5-year interval are presented in three separate

models in Tables 25, 29, 33, and 37. The interaction effects of the birthplace covariate and the PrCa treatments were modelled in Tables 26, 30, 34, 38. Tables 27, 31, 35, and 39 present the results of the pairwise comparisons for the significant interaction effects.

Survival interval 1992 to 1996. One thousand seven hundred and sixty-nine Jamaican and U.S.-born PrCa patients received brachytherapy, ERBT, and other radiation treatment for the 1992 to 1996 period of observation. Among the treatment groups, the brachytherapy treated Jamaican PrCa patients had the highest number of censored cases (55.2%) and higher median survival time (three years) when compared with the other treatments. Fifty percent of the Jamaican cohort survived two years of follow-up, and fewer received other types of radiation. Half of the U.S.-born PrCa patients who received all three treatments were alive at two years of follow-up. Table 24 demonstrates that the results of the Kaplan-Meier estimates of the 1992 to 1996 sample.

Table 24

Summary of Kaplan-Meier Estimates for the Sample of 1,769 Jamaican and U.S.-Born Prostate Cancer Patients per Treatment Received Between 1992 and 1996

Birthplace	Treatment	Number at Risk (*n*)	Died	Censored (%)		Median Survival	95% CI for Median		χ^2	*p*-value
							LL	*UL*		
Jamaica	Brachytherapy	29	13	16	(55.2)	3	2.43	3.58	8.04	.005
	ERBT	66	44	22	(33.3)	2	1.67	2.33	8.58	.003
	Other	19	10	9	(47.4)	2	1.01	2.98	8.68	.003
United States	Brachytherapy	355	206	149	(42.0)	2	1.86	2.14	8.04	.005
	ERBT	1,080	837	243	(22.5)	2	1.91	2.08	8.58	.003
	Other	220	159	61	(27.7)	2	1.80	2.19	8.68	.003

Note: Median survival was estimated in years. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery. χ^2 is the Log-Rank comparison.

Table 25 describes the main effects of the birthplace covariate and brachytherapy, ERBT, and other radiation treatments for the period 1992 to 1996 period. The birthplace main effects were statistically significant for all treatments types. Model one focused on the difference between PrCa patients who were treated with brachytherapy, model two demonstrates the differences among the ERBT treated cohorts, and model three presented the differences among the PrCa patients who received other types of radiation. The Jamaican PrCa patients were 1.2 times more likely to die of PrCa when compared with the White U.S.-born ($p < .001$). Further analyses for the interaction or modification effects in the association of the treatments and PrCa survival were completed.

Table 25

Main Effects of the Differences in the Hazard Ratios for the Jamaicans and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 1992 and 1996

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
	Brachytherapy Main Effects								
Model 1	Birthplace (Reference = United States	0.18	0.08	4.40	1	.036	1.20	1.01	1.42
	Brachytherapy	-0.18	0.07	7.20	1	.007	0.82	0.72	0.95
	ERBT Main Effects								
Model 2	Birthplace (Reference = United States)	0.18	0.08	4.64	1	.031	1.20	1.02	1.43
	ERBT	0.15	0.04	15.1	1	.000	1.16	1.08	1.26
	Other Radiation Treatment Main Effects								
Model 3	Birthplace (Reference = United States)	0.19	0.08	4.85	1	.028	1.21	1.02	1.44
	Other	-0.07	0.07	0.86	1	.354	0.92	0.79	1.09

Note: N = 1,769. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery.

Table 26 shows the results of the interaction analyses for the PrCa patients who were treated with brachytherapy, ERBT, and other radiation for the period 1992 to 1996. In model one, which examined the effects of brachytherapy, the birthplace main effect, *HR* 1.19, 95% CI [0.99, 1.42], $p = .063$, brachytherapy main effect, *HR* 0.64, 95% CI [0.20, 2.03], $p = 0.452$ and the birthplace and brachytherapy interaction effect, *HR* 1.14, 95% CI [0.63, 2.05], $p = 0.664$ were not statistically significant.

In model two, which focused on treatment effects of ERBT, the birthplace main effect, *HR* 1.14, 95% CI [0.99, 1.40], $p = .058$ and the main effect for ERBT were not significant, *HR* 0.98, 95% CI [0.54, 1.78], $p = 0.941$. However, the interaction effect for ERBT and birthplace, *HR* 1.08, 95% CI [1.04, 1.13], $p < .001$ was statistically significant.

In model three, which estimated the effects of other radiation treatment, the birthplace main effect, *HR* 1.31, 95% CI [1.04, 1.66], $p = .021$ and other radiation treatment main effect, *HR* 0.78, 95% CI [0.62, 0.98], $p = .036$ were significant. The interaction effect of birthplace and other radiation treatment was not statistically significant, *HR* 0.96, 95% CI [0.89, 1.04], $p = .296$.

The non-significant interaction effects for brachytherapy and other radiation treatment indicate that the third variable (the interaction term) did not modify the main effects observed. The brachytherapy treated Jamaicans and the Jamaican PrCa patients who were treated with other radiation had 1.2 times higher risk of dying of PrCa when compared with the White U.S.-born patients ($p < .001$). The main effect for ERBT was not interpreted for this analysis because of the significant interaction effects.

A follow-up, pairwise comparison of the hazard ratios of Jamaican and White U.S.-born PrCa patients who received and did not receive ERBT for 1992 to 1996 interval was completed. The referent group was the PrCa patients who received no ERBT (see Table 27). The findings indicate that the hazard ratios were significant for the White U.S.-born PrCa patients but not for the Jamaicans. The risk of death for the ERBT treated Jamaican PrCa patient was 1.5 times greater than the risk for the non-ERBT treated patients, 95% CI [0.99, 2.20], $p = .057$. The risk of death for the White ERBT treated PrCa patients was 1.14 times higher than the non-ERBT treated White cohort, 95% CI [1.05, 1.25], $p < .003$. Hence, there was a significant difference among the ERBT treated versus the non-ERBT treated White U.S.-born PrCa patients. There were no significant treatment differences among the Jamaicans.

Table 26

Interaction Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 1992 and 1996

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
	Brachytherapy with Interaction Variable								
Model 1	Birthplace (Reference = United States)	0.17	0.09	3.45	1	.063	1.19	0.99	1.42
	Brachytherapy	-0.44	0.58	0.56	1	.452	0.64	0.20	2.03
	Brachytherapy *Birthplace	0.13	0.30	0.18	1	.664	1.14	0.63	2.05
	ERBT with Interaction Variable								
Model 2	Birthplace (Reference = United States)	0.16	0.08	3.60	1	.058	1.14	0.99	1.40
	ERBT	-0.02	0.30	0.01	1	.941	0.98	0.54	1.78
	ERBT*Birthplace	0.08	0.02	14.34	1	.000	1.08	1.04	1.13
	Other Radiation Treatment with Interaction Variable								
Model 3	Birthplace (Reference = United States)	0.27	0.11	5.32	1	.021	1.31	1.04	1.66
	Other	-0.25	0.11	4.38	1	.036	0.78	0.62	0.98
	Other*Birthplace	-0.04	0.04	1.09	1	.296	0.96	0.89	1.04

Note: N = 1,769. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery, * is the interaction term.

Table 27

Pairwise Comparison of the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With ERBT for the 1992 to 1996 Period

Variables in the Equation									
								95% CI for Exp (*B*)	
	Treatment	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Reference = (No ERBT)					
Jamaicans	ERBT	0.39	0.20	3.63	1	.057	1.48.	0.99	2.20
White U.S.-Born	ERBT	0.13	0.04	8.86	1	.003	1.14	1.05	1.25

Note: *N* = 1,769. *LL* is lower limits, *UL* is upper limits.

Survival interval 1997 to 2001. Kaplan-Meier estimates of the cumulative survival of 1,271 Jamaican and U.S. PrCa treated cohort who were followed between 1997 and 2001 demonstrated that the median survival was undefined for the brachytherapy and ERBT treated Jamaicans. However, an estimated 50% of the Jamaican and White U.S.-born PrCa patients who received other radiation were alive at three years of follow-up, 95% CI [2.18, 3.81] and [2.45, 3.54] respectively. Half of the U.S.-born PrCa patients who received brachytherapy also survived beyond three years of treatment, 95% CI [2.79, 3.21], $p = .010$. On the other hand, 50% of the ERBT treated U.S.-born PrCa patients were alive at two years of treatment ($p = .004$). Table 28 demonstrates that the results of the Kaplan-Meier estimates of the 1997 to 2001 treatment groups.

Table 28

Summary of Kaplan-Meier Estimates for the Sample of 1,271 Jamaican and White U.S.-Born Cancer Patients per Treatment Received for the Period 1997 to 2001

Birthplace	Treatment	Number at Risk (*n*)	Died	Censored (%)		Median Survival	95% CI for Median		χ^2	*p*-value
							LL	*UL*		
Jamaica	Brachytherapy	39	14	25	(64.1)	-	-	-		
	ERBT	42	17	25	(60.0)	-	-	-		
	Other	10	3	7	(70.0)	3	2.18	3.81	1.79	.005
United States	Brachytherapy	409	200	209	(51.1)	3	2.79	3.21	6.61	.010
	ERBT	667	418	249	(37.3)	2	1.85	2.14	8.23	.004
	Other	104	48	56	(53.8)	3	2.45	3.54	1.79	.005

Note: Median survival was estimated in years. No median survival was estimated for Brachytherapy and ERBT treated Jamaicans because; more than 50% of the Jamaicans survived beyond the 50th percentile of the observation period. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery. χ^2 is the Log-Rank comparison.

Table 29 describes the main effects of the birthplace covariate and brachytherapy, ERBT, and other radiation treatments for the period 1997 to 2001 period. The birthplace main effects were statistically significant for all treatments types. Model one which focused on the difference between PrCa patients who were treated with brachytherapy confirmed that the Jamaican PrCa patients were 1.29 times more likely to die of PrCa when compared with the White U.S.-born, 95% CI [1.02, 1.66], $p = .036$. Model two which demonstrated the survival experience differences among the ERBT treated cohorts demonstrated that the hazard among the Jamaican PrCa patients was 1.33 times greater than the White U.S.-born, 95% CI [1.05, 1.71], $p = .018$. In model three which presented the differences among the PrCa patients who received other radiation treatments, the Jamaican PrCa patients had 1.32 times higher risk of dying of PrCa when compared with

the White U.S.-born, 95% CI [1.04, 1.70], $p = .022$. Further hypothesis testing was conducted with interaction analysis to determine modification effects in the survival outcomes observed in the 1997 to 2001 cohort (see Table 30).

Table 29

Main Effects of the Differences in the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 1997 and 2001

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Brachytherapy					
Model 1	Birthplace (Reference = United States)	0.26	0.12	4.39	1	.036	1.29	1.02	1.66
	Brachytherapy	-0.31	0.07	17.40	1	.000	0.73	0.64	0.85
				ERBT					
Model 2	Birthplace (Reference = United States)	0.29	0.12	5.55	1	.018	1.33	1.05	1.71
	ERBT	0.14	0.05	6.30	1	.012	1.15	1.03	1.29
				Other Radiation Treatment					
Model 3	Birthplace (Reference = United States)	0.28	0.12	5.25	1	.022	1.32	1.04	1.70
	Other	0.28	0.14	4.07	1	.043	1.33	1.01	1.76

Note: N = 1,271. *LL* is lower limits, *UL* is upper limits. Other is other types of radiation treatments.

Table 30 demonstrates the results of the interaction analysis for the PrCa patients who were treated with brachytherapy, ERBT, and other radiation for the period 1997 to 2001. In model one, which shows the effects of brachytherapy, the birthplace main effect, *HR* 1.35, 95% CI [1.06, 1.72], $p = .017$ and interaction effect, *HR* 0.86, 95% CI [0.80,

0.92], $p < .001$ were significant. The main effect for brachytherapy was not statistically significant, *HR* 0.38, 95% CI [0.13, 1.08], $p = .072$.

In model two, which focused on the effects of ERBT, the birthplace main effect *HR* 1.31, 95% CI [1.03, 1.67], $p = .029$ and interaction effect *HR* 1.08, 95% CI [1.02, 1.14], $p = .010$ were statistically significant. However, the main effect for ERBT was not statistically significant, *HR* 0.50, 95% CI [0.19, 1.29], $p = .149$.

In model three, which explains the effects of other radiation treatment the birthplace main effect, *HR* 1.00, 95% CI [0.69, 1.46], $p = 0.982$, other radiation treatment main effect, *HR* 0.93, 95% CI [0.66, 1.32], $p = 0.687$, and interaction effects, *HR* 1.16, 95% CI [1.00, 1.33], $p = .049$ were not statistically significant.

The main effect for other radiation treatment was accepted, *HR* 1.32, 95% CI [1.04,1.70], $p = .022$. The main effects of the birthplace covariate for brachytherapy and ERBT were not interpreted for this analysis because of the significant interaction effects in the two models. Further evaluations were conducted for brachytherapy, ERBT and their correspondent control groups to determine whether there were differences in the second main effects. The referent groups were PrCa patients who received no brachytherapy and no ERBT.

Table 31 presents the pairwise comparisons of the hazard ratios of the different treatment groups. The findings demonstrated that the treatment effects were significant for the White U.S.-born PrCa patients but not for the Jamaicans. Among the White cohort, brachytherapy treated PrCa patients had 33% lower risk of death when compared with patients who did not receive brachytherapy, 95% CI [0.66, 0.90). The ERBT treated

patients were 1.14 times more likely to die of PrCa when compared with their control groups 95% CI [1.01, 1.28). The results showed that the White U.S.-born PrCa patients who were treated with brachytherapy, and ERBT between 1997 and 2001 had significant differences in their hazard ratios when compared with the groups that did not receive these treatments.

Table 30

Interaction Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 1997 and 2001

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
		Brachytherapy with Interaction Variable							
Model 1	Birthplace (Reference = United States)	0.29	0.12	5.72	1	.017	1.35	1.06	1.72
	Brachytherapy	-0.97	0.54	3.24	1	.072	0.38	0.13	1.08
	Brachytherapy *Birthplace	-0.16	0.03	16.08	1	.000	0.86	0.80	0.92
		ERBT with Interaction Variable							
Model 2	Birthplace (Reference = United States)	0.27	0.12	4.77	1	.029	1.31	1.03	1.67
	ERBT	-0.70	0.48	2.07	1	.150	0.49	0.19	1.29
	ERBT*Birthplace	0.07	0.02	6.60	1	.010	1.08	1.02	1.14
		Other Radiation Treatment with Interaction Variable							
Model 3	Birthplace (Reference = United States)	0.00	0.19	0.00	1	.982	1.00	0.69	1.46
	Other	-0.07	0.18	0.16	1	.687	0.93	0.66	1.32
	Other*Birthplace	0.14	0.07	3.88	1	.049	1.16	1.00	1.33

Note: N = 1,271. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery, * is the interaction term.

Table 31

Pairwise Comparison of the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy, and ERBT, for the Period 1997 to 2001

Variables in the Equation									
								95% CI for Exp (*B*)	
	Treatment	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Reference = (No brachytherapy, No ERBT,)					
Jamaicans	Brachytherapy	-0.41	0.32	1.69	1	.193	0.66	0.36	1.23
	ERBT	-0.10	0.31	0.10	1	.743	0.90	0.49	1.66
White U.S.-Born	Brachytherapy	-0.26	0.08	10.65	1	.001	0.77	0.66	0.90
	ERBT	0.13	0.06	4.50	1	.034	1.14	1.01	1.28

Note: N = 1,271. *LL* is lower limits, *UL* is upper limits. Other is other types of radiation treatments.

Survival interval 2002 to 2007. At the third 5-year interval of the study (2002 to 2007), 1,461 Jamaican and U.S. PrCa patients were treated with ERBT, brachytherapy, and other radiation. More than 50% of the PrCa treatment groups, except the White U.S.-born ERBT treated cohort, survived beyond half of the 2002 to 2007 period of observation (see Table 32). Cox regression analysis of the differences in the risk ratios among the Jamaican and White U.S.-born cohort for 2002 to 2007 was completed (see Table 33).

Table 32

Summary of Kaplan-Meier Estimates for the Sample of 1,461 Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received for the Period 2002 to 2007

Birthplace	Treatment	At Risk (*n*)	Died	Censored	(%)
Jamaica	Brachytherapy	34	2	32	(94.1)
	ERBT	48	9	39	(81.3)
	Other	4	0	4	(100)
United States	Brachytherapy	562	169	393	(70.0)
	ERBT	701	272	42	(61.2)
	Other	112	41	71	(63.4)

Note: The median survival times were undefined for the PrCa patients because more than 50% survived beyond the 50th percentile of the observation period. Other is radiation sequenced with surgery.

Table 33 demonstrates the main effects of the birthplace variables, brachytherapy, ERBT, and other radiation treatments for the 2002 to 2007 interval in three models. Model one focused on the difference between PrCa patients who were treated with brachytherapy, model two demonstrates the differences among the ERBT treated cohorts, and model three presented the differences among the PrCa patients who received radiation sequenced with surgery. The birthplace main effects were statistically significant for all treatments types. The Jamaican PrCa patients were treated with brachytherapy, ERBT, and other radiation treatments were 2.4 times more likely to die of PrCa when compared with the White U.S.-born ($p < .001$). Hypothesis testing with interaction analysis was completed to determine modification effects in the association between the three PrCa treatments and PrCa survival among the 2002 to 2007 cohort (see Table 34).

Table 33

Main Effects of the Differences in the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 2002 and 2007

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Brachytherapy					
Model 1	Birthplace (Reference = United States)	0.89	0.17	26.17	1	.000	2.43	1.73	3.43
	Brachytherapy	-0.27	0.08	10.34	1	.001	0.76	0.65	0.90
				ERBT					
Model 2	Birthplace (Reference = United States)	0.88	0.17	25.73	1	.000	2.41	1.72	3.40
	ERBT	0.08	0.06	1.51	1	.218	1.08	0.95	1.24
				Other Radiation Treatment					
Model 3	Birthplace (Reference = United States)	0.88	0.17	25.7	1	.000	2.42	1.72	3.40
	Other	0.04	0.16	0.07	1	.791	1.04	0.76	1.42

Note: N = 1,461. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery. CI is confidence interval.

Table 34 presents the results of the interaction analysis for the PrCa patients who were treated with brachytherapy, ERBT, and other radiation for the period 2002 to 2007. In model one, which examined the effects of brachytherapy and the birthplace main effect, *HR* 2.48, 95% CI [1.76, 3.48], $p < .001$, the main effect for brachytherapy, *HR* 0.03, 95% CI [0.00, 0.52], $p = .015$, and the interaction effect of brachytherapy and birthplace, *HR* 0.88, 95% CI [0.81, 0.95], $p = .002$ were significant.

In model two, which focused on the treatment effect of ERBT on PrCa survival, the birthplace main effect, *HR* 2.39, 95% CI [1.70, 3.37], $p < .001$ and ERBT main effect,

HR 0.23, 95% CI [0.06, 0.87], $p = .030$ were significant. The interaction effect of ERBT and birthplace was not significant, *HR* 01.04, 95% CI [0.97, 1.12], $p = .230$.

Model three, which estimated other radiation treatment effects in PrCa survival, showed that the birthplace main effect, *HR* 2.33, 95% CI [1.48, 3.67], $p < .001$ and other radiation treatment main effect, *HR* 0.43, 95% CI [0.28, 0.68], $p < .001$ were statistically significant. The interaction effect of birthplace and other radiation was not statistically significant, *HR* 1.02, 95% CI [0.87, 1.19], $p = 0.809$.

The non-significant interaction effects of ERBT and other radiation treatment in models two and three confirmed that the interaction terms did not mediate the birthplace main effects. The findings indicate that the ERBT treated Jamaican PrCa patients and those who received other radiation treatment had 2.41 and 2.42 times higher risk of death when compared with the White U.S.-born patients. Further evaluation of the significant interaction effects in model one was conducted using pairwise comparisons of the brachytherapy treated and non-brachytherapy treated PrCa patients.

Table 35 presents the pairwise comparisons of the hazard ratios of brachytherapy-treated and non-brachytherapy treated PrCa patients. The brachytherapy treated Jamaican PrCa patients had a 63% lower risk of dying from PrCa when compared with PrCa patients who did not receive brachytherapy, 95% CI [0.09, 1.55], $p = .172$. On the other hand, the brachytherapy treated White U.S.-born PrCa patients experienced 21% reduced risk when compared with the PrCa patients who did not receive brachytherapy, 95% CI [0.66, 0.93], $p = .005$. Although the brachytherapy treated cohorts experienced better

survival when compared with the non-brachytherapy treated group, the finding was not significant for the Jamaicans.

Table 34

Interaction Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 2002 and 2007

Variables in the Equation									
								95% for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
Model 1	Brachytherapy with Interaction Variable								
	Birthplace (Reference = United States)	0.91	0.17	27.11	1	.000	2.48	1.76	3.48
	Brachytherapy	-3.44	1.41	5.89	1	.015	0.03	0.00	0.52
	Brachytherapy *Birthplace	-0.13	0.04	9.78	1	.002	0.88	0.81	0.95
	ERBT with Interaction Variable								
Model 2	Birthplace (Reference = United States)	0.87	0.17	25.10	1	.000	2.39	1.70	3.37
	ERBT	-1.46	0.67	4.71	1	.030	0.23	0.06	0.87
	ERBT*Birthplace	0.04	0.03	1.43	1	.230	1.04	0.97	1.12
	Other Radiation Treatment with Interaction Variable								
Model 3	Birthplace (Reference = United States)	0.85	0.23	13.22	1	.000	2.33	1.48	3.67
	Other	-0.84	0.23	12.87	1	.000	0.43	0.28	0.68
	Other*Birthplace	0.02	0.08	0.05	1	.809	1.02	0.87	1.19

Note: N = 1,461. *LL* is lower limits, *UL* is upper limits. Other is radiation sequenced with surgery. CI is confidence interval, * is the interaction term.

Table 35

Pairwise Comparison of the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy for the Period 2002 to 2007

Variables in the Equation									
								95% CI for Exp (*B*)	
	Treatment	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Reference = (No brachytherapy)					
Jamaicans	Brachytherapy	-1.01	0.73	1.86	1	.172	0.37	0.09	1.55
White U.S.-born	Brachytherapy	-0.24	0.08	7.98	1	.005	0.79	0.66	0.93

Note: *N* = 1,461. *LL* is lower limits, *UL* is upper limits.

Survival interval 2007 to 2011. Fewer White U.S.-born and Jamaican PrCa patients (899) were observed for survival outcomes for the 2007 to 2011 treatment period when compared with the other follow-up periods. All PrCa patients survived beyond 50% of the interval for the 2007 to 2011 period of observation. More than 80% of the U.S. cohort and all Jamaicans were censored. Table 36 demonstrates the results of the Kaplan-Meier cumulative survival estimates for the 2007 to 2011 period of observation. Cox regression analysis confirmed the differences in the survival experiences for the 2002 to 2011 treatment cohorts (see Table 37).

Table 36

Summary of the Kaplan-Meier Estimates for the Sample of 899 Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received for the Period 2007 to 2011

Birthplace	Treatment	Number at Risk (*n*)	Died	Censored	(%)
Jamaica	Brachytherapy	34	0	34	(100)
	ERBT	55	0	55	(100)
	Other	7	0	7	(100)
United States	Brachytherapy	258	17	241	(93.4)
	ERBT	480	60	420	(87.5)
	Other	65	7	58	(89.2)

Note: The median survival times were undefined for the PrCa patients because more than 50% survived beyond the 50th percentile of the observation period. Other is radiation sequenced with surgery.

Table 37 describes the main effects of the birthplace covariate and brachytherapy, ERBT, and other radiation treatments for the period 2007 to 2011 period. The birthplace main effects were statistically significant for all treatments types. Model one focused on the differences in treatment effects for the PrCa patients who were treated with brachytherapy. The findings showed that the Jamaican PrCa patients were 3.72 times more likely to die of PrCa when compared with the White U.S.-born, 95% CI [1.84, 7.51], $p < .001$. Model two which demonstrates the differences in treatment effects among the ERBT treated cohorts indicated that the Jamaican PrCa patients were 3.78 times more likely to die of PrCa when compared with the White U.S.-born, 95% CI [1.88, 7.64], $p < .001$. Model three which presented the differences in treatment outcomes among the PrCa patients who received other types of radiation showed that the Jamaican PrCa patients were 3.79 times more likely to die of PrCa when compared with the White

U.S.-born, 95% CI [1.88, 7.67], $p < .001$. Further analyses with hypothesis tests were conducted to determine the interaction effects in the association between the three PrCa treatments and PrCa survival among the 2007 to 2011 cohort (see Table 38).

Table 37

Main Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 2007 and 2011

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Brachytherapy					
Model 1	Birthplace (Reference = United States)	1.31	0.35	13.45	1	.000	3.72	1.84	7.51
	Brachytherapy	-0.74	0.25	8.9	1	.003	0.47	0.29	0.77
				ERBT					
Model 2	Birthplace (Reference = United States)	1.33	0.35	13.80	1	.000	3.78	1.88	7.64
	ERBT	-0.12	0.14	0.79	1	.374.	0.88	0.66	1.17
				Other Radiation Treatment					
Model 3	Birthplace (Reference = United States)	1.33	0.35	13.87	1	.000	3.79	1.88	7.67
	Other	0.27	0.38	0.51	1	.473	1.31	0.62	2.78

Note: $N = 899$. *LL* is lower limits, *UL* is upper limits. Other is other types of radiation treatments. CI is confidence interval.

Table 38 showed the findings of the interaction analysis for the PrCa patients who were treated with brachytherapy, ERBT, and other radiation for the period 2007 to 2011. Model one, which examined the treatment effects of brachytherapy, demonstrated that the birthplace main effect, *HR* 3.85, 95% CI [1.91, 7.76], $p < .001$, and interaction effect, *HR*

0.69, 95% CI [0.54, 0.89], $p = .003$ were statistically significant. Brachytherapy main effect, *HR* 0.00, 95% CI [0.00, 4.32], $p = .776$ was not significant.

In model two, which estimated the treatment effect of ERBT, the birthplace main effect, *HR* 3.84, 95% CI [1.89, 7.74], $p < .001$ was significant but the ERBT main effect was not, *HR* 0.87, 95% CI [0.66, 1.16], $p = .341$. The interaction effect of birthplace and ERBT was also not significant, *HR* 0.95, 95% CI [0.82, 1.09], $p = .445$.

In model three, which presented the treatment outcomes for other radiation treatment the birthplace main effect, *HR* 2.93, 95% CI [1.05, 8.15], $p = .040$ was statistically significant. Other radiation treatment main effect, *HR* 0.36, 95% CI [0.13, 0.99], $p = .049$ and interaction effect were not statistically significant, *HR* 1.14, 95% CI [0.78, 1.66], $p = .493$.

The non-significant interaction effects for ERBT and other radiation treatment in models two and three confirmed that the interaction terms did not modify the main effects observed and demonstrated that there was a difference in the survival outcomes of the PrCa patients who received ERBT and other radiation treatments for the 2007 to 2011 period. The risk of death was 3.8 times higher for the Jamaicans who received ERBT and other forms of radiation when compared with the White U.S.-born patients ($p < .001$). The main effect of brachytherapy and the birthplace covariate were not interpreted in this analysis because of the significant interaction effect. Further evaluation of the significant interaction effects for brachytherapy was conducted using pairwise comparisons of the brachytherapy treated and non-treated groups. Table 39 presents the pairwise comparisons of the hazard ratios of brachytherapy-treated PrCa patients. The results of

the comparison showed that brachytherapy reduced the risk of death for the Jamaicans and the White U.S.-born PrCa patients, but the findings were not significant for the Jamaicans. The brachytherapy treated Jamaican PrCa patient was 0.02 times less likely to die of PrCa patients when compared with patients who did not receive brachytherapy, 95% CI [0.00, 285.5], $p = .429$. The White U.S.-born PrCa brachytherapy treated patients had 53% reduced risk of death when compared with the White cohort that did not receive brachytherapy, 95% CI [0.29, 0.78], $p = .003$. Therefore, the U.S.-born brachytherapy treated PrCa patients demonstrated more favorable survival benefits when compared with the Jamaicans.

Table 38

Interaction Effects of the Differences in the Hazard Ratios of the Jamaican and White U.S.-Born Prostate Cancer Patients per Treatment Received Between 2007 and 2011

Variables in the Equation									
								95% CI for Exp (*B*)	
	Variables	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
		Brachytherapy with Interaction Variable							
Model 1	Birthplace (Reference = United States)	1.35	0.35	14.13	1	.000	3.85	1.91	7.76
	Brachytherapy	-15.51	54.48	0.08	1	.776	0.00	0.00	4.32
	Brachytherapy *Birthplace	-0.37	0.12	8.50	1	.003	0.69	0.54	0.89
		ERBT with Interaction Variable							
Model 2	Birthplace (Reference = United States)	1.34	0.35	14.05	1	.000	3.84	1.89	7.74
	ERBT	-0.14	0.14	0.90	1	.341	0.87	0.66	1.16
	ERBT*Birthplace	-0.06	0.07	0.58	1	.445	0.95	0.82	1.09
		Other Radiation Treatment with Interaction Variable							
Model 3	Birthplace (Reference = United States)	1.08	0.52	4.23	1	.040	2.93	1.05	8.15
	Other	-1.04	0.52	3.89	1	.049	0.36	0.13	0.99
	Other*Birthplace	0.13	0.19	0.47	1	.493	1.14	0.78	1.66

Note: N = 899. *LL* is lower limits*, UL* is upper limits. Other is radiation sequenced with surgery. CI is confidence interval, * is the interaction term.

Table 39

Pairwise Comparison of the Hazard Ratios for the Jamaican and White U.S.-Born Prostate Cancer Patients Treated With Brachytherapy for the Period 2007 to 2011

Variables in the Equation									
								95% CI for Exp (*B*)	
	Treatment	*B*	*SE*	Wald	*df*	Sig	Exp (*B*)	*LL*	*UL*
				Reference = (No brachytherapy)					
Jamaicans	Brachytherapy	-3.820	4.83	0.62	1	.429	0.022	0.000	285.5
White U.S.-born	Brachytherapy	-0.742	0.25	8.66	1	.003	0.476	0.291	0.781

Note: $N = 899$. *LL* is lower limits, *UL* is upper limits.

The analyses for research question three revealed statistically significant differences in the median survival for the Jamaican and U.S. PrCa patients who received brachytherapy, ERBT, and other radiation treatments for the 5-year periods 1992 to 1996 and 1997 to 2001. At the first 5-year interval, the Jamaicans who were treated with brachytherapy had a median survival of three years, 95% CI, [2.43, 3.58], $p = .005$ and two years for ERBT and other treatments ($p = .003$). The median survival for the White U.S.-born cohort was two years for all treatment types ($p < .001$) (see Table 24).

At the second 5-year period (1997 to 2001), 50% of the Jamaican brachytherapy and ERBT treated PrCa patients survived beyond half of the period of follow-up, and those who received other treatments were alive at three years of follow-up. The U.S. cohort had a median survival of three years ($p = .010$) after receiving brachytherapy and other radiation treatment and two years post ERBT treatment ($p = .004$) (see Table 28). At last two 5-year intervals, the survival time for 50% of all PrCa patients exceeded half of the observation periods (see Table 32 and Table 36).

The hypothesis tests of a modification effect in the differences in the hazard ratios of the Jamaican-born and White U.S.-born PrCa patients demonstrated interaction effects for ERBT (1992 to 1996), brachytherapy and ERBT (1997 to 2001), and brachytherapy (2002 to 2011). There were significant differences among the birthplaces for the 1992 to 1996 brachytherapy and radiation sequenced with surgery cohorts. Between 2002 and 2011, the birthplace cohorts differed significantly in treatment outcomes for ERBT and radiation sequenced with surgery, but not brachytherapy. Pairwise comparisons of the brachytherapy treated patients revealed significant differences among the White PrCa patients but not among the Jamaicans (see Tables 31, 35 and 39). Similarly, pairwise comparisons of the ERBT treated groups (see Tables 27 and 31) demonstrated significant differences among the White U.S.-born patients but not among the Jamaicans. There were no significant interaction effects for the cohorts that received other radiation treatment. Therefore, the hypothesis that there are differences in the 5-year survival intervals of Jamaican-born and U.S.-White PrCa patients according to treatment received for the period 1992 to 2011 was accepted.

Research Question 4 Analysis

Research Question 4: Are there differences in the length of time brachytherapy treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

In determining the confounding effects of age, marital status, and health insurance status in the outcome of brachytherapy and PrCa survival, the baseline hazard ratios of

the birthplace variable, brachytherapy, and the covariates were first estimated with Cox regression analysis. Subsequently, the brachytherapy and ERBT treated Jamaican, and White U.S.-born White PrCa patients were stratified with the covariates marital status, health insurance status, and age, and the adjusted hazard ratios estimated. The results demonstrated that the crude hazard ratio for the birthplace variable was, *HR* .34, 95% CI [0.14, 0.82]. When the covariates were examined in separate models, the estimates for the adjusted hazard ratios for the birthplace variable for marital status, *HR* 0.26, 95% CI [0.11, 0.63] and health insurance status, *HR* 0.28, 95% CI [0.12, 0.68] reflected a decrease from the baseline. The adjusted hazard ratio for age increased minimally, *HR* 0.37, 95% CI [0.15, 0.88]. Table 40, shows the Cox regression analysis of the birthplace covariate and brachytherapy treatment with all covariates; then separately with each covariate.

In defining the degree of confounding effects of the covariates marital and health insurance status, I estimated the excess risk in the crude and adjusted hazard ratios of the birthplace main effects with the expression: Percent Excess Risk Explained = (Crude *HR*-Adjusted *HR*)/Crude *HR*-1×100 (Szklo & Nieto 2014, p.161). Less than 10% change in the hazard ratios were interpreted as minimal confounding, and the crude or adjusted hazard ratio was accepted as the outcome. A change in the hazard ratio of the birthplace main effect that was greater than 10% was a confounding effect and the adjusted hazard ratios for the birthplace variable were interpreted in the results. Besides, a shift in the magnitude of the hazard ratios, which was close to one was interpreted as no association with the outcome of interest (Szklo & Nieto 2014, p.161).

The results of the analysis for confounding revealed that the excess risk for marital status was 12.8%, ([0.344-0.260]/ [0.344-1]), health insurance status was -9.6%, ([0.344-0.260]/ [0.344-1]), and age was 3.3 % ([0.344-0.366]/ [0.344-1]). Furthermore, the magnitude and direction of the adjusted hazard ratios did not change greatly from the baseline estimates. Therefore, based on the percent change in the adjusted and crude hazard ratios, the association between brachytherapy treatment and PrCa survival was not explained by the patients' marital status, health insurance status, and age. Thus, the alternate hypothesis that there are differences in the length of time brachytherapy treated Jamaican-born PrCa patients and U.S.-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics was accepted.

Table 40

Cox Regression Analysis Adjusting for the Covariate Effects of Marital, Health Insurances Status, and Age of the Jamaican and White U.S.-Born Patients Treated With Brachytherapy

	Model 1			Model 2			Model 3			Model 4		
Covariates	*HR*	95% CI		*HR*	95% CI		*HR*	95% CI		*HR*	95% CI	
		LL	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*
Birthplace (Reference = United States)	0.34	0.14, 0.82										
Brachytherapy	1.43	1.19, 1.73										
Marital Status	1.09	1.04, 1.16										
Health Insurance Status	0.88	0.79, 0.99										
Age Groups	1.49	1.44, 1.54										
Birthplace (Reference = United States)				0.26	0.11, 0.63							
Brachytherapy				1.51	1.25, 1.82							
Marital Status				1.30	1.23, 1.38							
Birthplace (Reference = United States)							0.28	0.12, 0.68				
Brachytherapy							1.53	1.27, 1.84				
Health Insurance Status							0.95	0.85, 1.07				
Birthplace (Reference = United States)										0.37	0.15, 0.88	
Brachytherapy										1.45	1.20, 1.75	
Age at Diagnosis (Age Groups)										1.50	1.45, 1.55	

Note: N =10,752. *HR* is hazard ratio. CI is confidence interval.

Research Question 5 Analysis

Research Question 5: Are there differences in the length of time ERBT treated Jamaican-born PrCa patients and US-born White PrCa patients with low and intermediate stages PrCa live with the disease, after controlling for sociodemographic characteristics?

In estimating the effects of age, marital status, and health insurance status in the association of ERBT and PrCa survival, the baseline hazard ratios of the birthplace variable, ERBT, and the covariates were first estimated with Cox regression analysis. The

ERBT treated Jamaican and U.S.-born White PrCa patients were then stratified with the covariates marital status, health insurance status, and age and the hazard ratios estimated. The findings revealed that crude hazard ratio for the birthplace variable was *HR* 0.34, 95% CI [0.14, 0.82]. Estimation of the stratified covariates demonstrated a reduction in the adjusted hazard ratios of the birthplace covariates for the marital status, *HR* 0.26, 95% CI [0.11, 0.61], and health insurance status, *HR* 0.27, 95% CI [0.11, 0.66] of the PrCa cohorts. The adjusted hazard ratio for age showed a slight increase from the crude estimate, *HR* 0.36, 95% CI [0.15, 0.88]. Table 41, presents the Cox regression analysis of the birthplace covariate and ERBT treatment with all covariates; then separately with each covariate.

Further analysis of the percent change in the crude and adjusted hazard ratios were carried out to determine the degree of confounding using the expression: Percent Excess Risk Explained = (Crude *HR*-Adjusted *HR*)/Crude *HR*-1×100 (Szklo & Nieto 2014, p.161). An excess risk of greater than 10% in the hazard ratios was interpreted as confounding, and the adjusted hazard ratios were accepted. Less than 10% change in the birthplace variable was minimal confounding, and the crude or adjusted hazard ratios for the birthplace variable were interpreted in the results. Furthermore, changes in the magnitude of the hazard ratios which was close to one were measured as no association with the outcome of interest (Szklo & Nieto 2014, p.161).

The findings showed that the percent change for marital status was 13.2%, ([0.342-0.255]/ [0.342-1]), health insurance status was 10.3%, ([0.342-0.274]/ [0.342-1]), and age was 3.1 % ([0.342-0.366]/ [0.363-1]). Additionally, the magnitude and direction

of the adjusted hazard ratios did not change greatly from the crude estimates. The percent change in the adjusted and crude hazard ratios suggested that the covariates marital, health insurance status and age did not explain the association between brachytherapy treatment. Thus, the alternate hypothesis that there are differences in the length of time ERBT treated Jamaican-born PrCa patients and White U.S.-born PrCa patients with low and intermediate stages PrCa lived with the disease, after controlling for sociodemographic characteristics was accepted.

Table 41

Cox Regression Analysis Adjusting for the Covariate Effects of Marital, Health Insurance Status, and Age of the Jamaican and White U.S-Born Patients Treated With ERBT

	Model 1			Model 2			Model 3			Model 4		
Covariates	*HR*	95% CI		*HR*	95% CI		*HR*	95% CI		*HR*	95% CI	
		LL	*UL*		*LL*	*UL*		*LL*	*UL*		*LL*	*UL*
Birthplace (Reference = United States)	0.34	0.14, 0.82										
ERBT	1.19	1.03, 1.38										
Marital Status	1.10	1.04, 1.17										
Health Insurance Status	0.88	0.78, 0.98										
Age at Diagnosis (Age Groups)	1.49	1.45, 1.55										
Birthplace (Reference = United States)				0.26	0.11, 0.61							
ERBT				0.96	0.83, 1.11							
Marital Status				1.31	1.23, 1.39							
Birthplace (Reference = United States)							0.27	0.11, 0.66				
ERBT							0.93	0.80, 1.07				
Health Insurance Status							0.95	0.85, 1.07				
Birthplace (Reference = United States)										0.36	0.15, 0.88	
ERBT										1.19	1.03, 1.38	
Age at Diagnosis (Age Groups)										1.51	1.46, 1.57	

Note: N = 10752. *HR* is hazard ratio. CI is confidence interval.

Summary and Transition

Chapter 4 presents the results of the statistical analyses related to the research questions and hypotheses. The Kaplan-Meier statistical methods and Cox regression hazard model estimated the survival differences of the Jamaican and White U.S.-born brachytherapy and ERBT treated PrCa patients.

A sample of 10752 (719 Jamaicans and 10,033 White U.S.-born) PrCa patients was used to complete the data analysis. Preliminary descriptive statistics showed that higher proportions of the PrCa patients were reported from the SEER reporting locations of Connecticut (22%) and Seattle (15.1%), but there were no outliers for the Jamaican population. PrCa patients were more likely to be in the 55 to 79 age-group, married, and had health insurance. Higher numbers of the PrCa patients 415 (57.7%) were diagnosed with Gleason grade 11 PrCa. A greater proportion of the Jamaicans had Gleason grade 111 PrCa (Jamaicans 39% versus U.S. Whites 34%). ERBT was the most widely used PrCa treatment among the Jamaicans and White U.S.-born PrCa patients.

Univariate analyses revealed that brachytherapy and ERBT treated Jamaican PrCa patients had higher median survival when compared with the U.S. cohort. More than 50% of the brachytherapy treated Jamaican PrCa patients survived beyond the 50^{th} percentile of the observation period. The median survival for the brachytherapy treated White U.S.-born PrCa patients was 142 months, *SE* 3, 95% CI [134.8, 147.1], $p < .001$. The median survival for the ERBT treated Jamaican and White U.S.-born PrCa patient was 154 months and 116 months respectively ($p < .001$).

Hypothesis test for interaction effects in the association of brachytherapy and ERBT in the survival of the PrCa patients showed no modification effects. Cox proportional hazards analyses confirmed that the Jamaican brachytherapy treated PrCa patients experienced lower hazard of death when compared with the brachytherapy treated White U.S.-born PrCa patients, *HR* 0.63, 95% CI [0. 55, 0.73], $p < .001$. On the other hand, the ERBT treated Jamaicans had a higher risk of death when compared with the ERBT treated White U.S.-born PrCa patients, *HR* 1.6, 95% CI [1.38, 1.84], $p < .001$.

The Kaplan-Meier analyses for the 5-year survival intervals for brachytherapy, ERBT, and radiation sequenced with surgery showed significant differences in the survival times for the brachytherapy treated White U.S.-born and Jamaican PrCa patients. At the initiation of the observation period (1992 to 1996), brachytherapy treatment demonstrated higher survival probability for the Jamaicans (median survival three years) when compared the White U.S.-born and PrCa patients who received ERBT and radiation sequenced with surgery (median survival two years) ($p < .001$). As the follow up progressed into the second 5-year interval (1997 to 2001) the median survival for the brachytherapy treated White U.S.-born PrCa and all males who received other types of radiation increased to three years, ($p < .001$). The White U.S.-born PrCa patients experienced no change in their median survival for ERBT treatment (median survival two years) ($p < .001$).

Cox regression analysis of the differences in 5-year survival of the Jamaican and White U.S. PrCa cohorts confirmed that brachytherapy, when compared with ERBT, was more beneficial to the survival of the Jamaican PrCa patients for the first 5-year interval

(1992 to 1996) and other types of radiation treatments at ten years of follow up. The risk was 1.2 times higher ($p < .001$) for the brachytherapy treated Jamaicans versus the White U.S.-born and those who received other types of radiation for the 1992 to 1996 interval. The hazard doubled for the Jamaicans for all treatments at ten years of follow-up and continued to increase for the subsequent 5-year intervals, *HR* 2.4 to *HR* 3.8, $p < .001$. The risk was 2.4 times greater for the Jamaicans who received ERBT and other radiation treatments between 2002 and 2007 and increased to *HR* 3.7 and *HR* 3.8 ($p < .001$) for 2007 to 2011 follow-up. The White U.S.-born PrCa patients benefited from brachytherapy treatment for the 1997 to 2001 follow-up, *HR* 0.77, 95% CI [0.66, 0.90], $p < .001$. The White U.S.-born PrCa patients also had improved survival from brachytherapy during the last decade of therapy, *HR* 0.78, 95% CI [0.66, 0.93], $p = .005$ and *HR* 0.48, 95% CI [0.29, 0.78], $p = .003$. Overall, the treatment effects waned with each 5-year interval.

Cox regression analysis for confounding effects of the covariates demonstrated minimal confounding for marital status (brachytherapy 12% and ERBT 13%) and no confounding effects for age and health insurance status. The percent change in the crude and adjusted hazard ratios for age and health insurance status was less than 10%. The adjusted hazard ratios for the covariate main effect remained less than one, did not vary greatly from the crude estimates, and remained statistically significant ($p < .001$). The percent change in the crude and adjusted hazard ratios signified that there were no real deviations in the magnitude and direction of the effects identified.

The findings of all research questions satisfied the alternative hypotheses of the research questions that there are differences in survival outcomes of Jamaican and White U.S.-born PrCa patients. Hence, the alternative hypotheses were accepted for the five research questions. In Chapter 5, I corroborated the findings of Chapter 4 with the peer reviewed literature and discussed the results in the context of the theoretical framework of the study. Additionally, in Chapter 5, I provided the limitations of the dissertation, the implications of the findings, recommendations for further research, and the conclusion of the research

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

This dissertation was designed to examine the survival patterns of brachytherapy, and ERBT treated Jamaican PrCa patients in the SEER 18 registries database for the period 1992 to 2011. I also aimed to ascertain whether there were survival differences among brachytherapy and ERBT treated Jamaican and U.S.-born White PrCa patients who had a diagnosis of early and intermediate stages PrCa. Additionally, I intended to determine whether specific sociodemographic characteristics affected the survival outcomes of the ERBT and brachytherapy treated Jamaican and White U.S.-born PrCa patients. The research utilized quantitative methods, a retrospective cohort study design, and analyses of secondary data with survival models.

The study was conducted to generalize findings on the outcomes of brachytherapy and ERBT to the Jamaican communities. Studies on the effectiveness of brachytherapy in other populations may not extrapolate to the Jamaican population because researchers documented that this cohort has a higher risk for PrCa due to genetic influences (Kidd et al., 2012). Additionally, Jamaicans are usually diagnosed with higher PSA levels, Gleason scores, and tumor stages when compared with other widely studied populations (Fedewa & Jemal, 2013; Rich et al., 2013). Furthermore, brachytherapy treatment has been acclaimed as an appropriate option for earlier stage PrCa among the White populations in the United States (Schreiber et al., 2013). However, brachytherapy is not well utilized among Jamaican PrCa patients (Morrison et al., 2014). There is also a lack of information on the efficacy of brachytherapy in PrCa patients who received the

treatment in Jamaica (Morrison et al., 2014). Additionally, ERBT is more widely used to treat PrCa patients in Jamaica when compared with brachytherapy (Morrison et al., 2014). However, the treatment effect of brachytherapy and ERBT in the survival of the Jamaican PrCa patient is understudied. Hence, it was necessary to conduct this research.

The study's findings demonstrated that the Jamaican PrCa patients who received brachytherapy treatment and ERBT had a significantly higher cumulative survival probability when compared with the White U.S.-born PrCa patients ($p < .001$). Cox proportional hazards regression analyses confirmed that brachytherapy reduced the risk of death by 37% for the Jamaicans, *HR* 0.63, 95% CI [0. 55, 0.73], $p < .001$. On the other hand, the ERBT treated Jamaicans were 1.6 times more likely to die of PrCa when compared with the White PrCa patients 95% CI [1.38, 1.84], $p < .001$. Hypothesis testing for interaction effects in the survival outcomes of brachytherapy and ERBT among the Jamaican and White U.S.-born PrCa patients confirmed that there were no modification effects in the association identified.

Significant differences in the hazard ratios of the Jamaican-born and White U.S.-born PrCa patients at 5-year survival intervals were confirmed. For the period 1992 to 1996, there were significant differences among the birthplace cohorts for brachytherapy and radiation sequenced with surgery. Between 1997 and 2011, brachytherapy treatment was effective for the White U.S. PrCa patients but not for the Jamaicans. Pairwise comparisons of the ERBT treated groups showed significant differences among the White U.S.-born patients but the effects were not significant for the Jamaicans.

Analyses for confounding effects of marital status, age, and health insurance status confirmed that age and health insurance status did not explain the effects observed (percent change less than 10%), and there was minimal confounding for marital status. The adjusted hazard ratios of the covariates did not vary significantly, indicating that there was no change in the direction of the association identified. Hence the alternative hypotheses that there are survival differences among the brachytherapy and ERBT treated Jamaican, and White U.S.-born PrCa patients were accepted for the five research questions.

Interpretation of the Findings

Descriptive Findings

The study utilized a sample of 719 Jamaican and 10,033 White U.S.-born PrCa patients from a population of 274, 201 PrCa patients of the 18 SEER registries database 2013 submission. The PrCa cohorts had positive microscopic confirmation of the disease, and they were actively followed for the 1992 to 2011 period of observation. The sample size was eight times larger than the proposed sample of the research due to the sampling technique used to select the research participants. The large sample size of this study was one of the strengths of the data analysis; it enabled the detection of the survival differences observed among the cohorts. The sampling technique also provided a sample in which the important characteristics of the White PrCa patients were represented proportionately and this facilitated ease of comparison with the Jamaican cohort.

The sample of Jamaicans used in this study will be beneficial to infer findings of the analysis to the Jamaicans in their homeland because of its size and characteristics.

Anderson et al. (2012), Fedewa and Jemal (2013), and Kampel et al. (2011) asserted that despite their place of residence, Jamaicans in the SEER database demonstrated characteristics of PrCa that were homogeneous with PrCa patients in Jamaica. Fedewa and Jemal documented that Jamaicans were the largest non-U.S.-born Black population in the SEER databases. Fedewa and Jemal also cited that the Jamaican PrCa patients in the SEER databases had Gleason scores that were comparable with native Jamaicans. Anderson et al. and Kampel et al. established that a high proportion of Jamaicans in the SEER database (87.6%) had localized disease, and this is a current trend among Jamaicans in their country of birth and the United States. Additionally, the proportion of Jamaican PrCa patients in this study (719) was almost ten times larger than the number of Jamaican PrCa patients (75 PrCa patients) who were treated in Jamaica with brachytherapy since 2004 (Morrison et al. 2014). Morrison et al. (2014) documented their inability to make inferences about the effectiveness of brachytherapy treatment among native Jamaicans who received this treatment due to lack of information on treatment outcomes. Thus, the sample of Jamaicans in this study is a useful proxy for PrCa patients living in their native country to provide data on PrCa treatment outcomes.

In this dissertation, I intended to measure both cause-specific and all-cause mortality according to the conclusions of Lin et al. (2009) and Thompson et al. (2013). However, the SEER cause-specific mortality was estimated as the appropriate endpoint in this study because of its comprehensive definition. The SEER cause-specific mortality was fitting for the analysis because the PrCa patients in this dissertation were selected using the SEER cause-specific definition of the ICD-O version10 site-specific code for

prostate cancer (C60) (NCI, 2017). The SEER program defined the PrCa patients who died of the disease as having the event, the PrCa patients who died of other causes were censored (NCI, 2017a). The SEER program also accounted for causes of death according to the tumor sequence, site, and other diseases associated with the site-specific disease, and used the ICD classification codes for specific cancer sites (NCI, 2017b). In this dissertation, the PrCa patients who died of the disease had the event of interest, and the censored cases were PrCa patients who died of other causes. The outcomes of this research demonstrated that higher proportions of Jamaican PrCa patients were censored when compared with the White U.S.-born PrCa patients (72% versus 53.8%). The Jamaican PrCa patients also had a lower death rate when compared with the White U.S.-born PrCa patients (27.1%) versus (46.2%). Based on the definition of PrCa used in this study, the results established that higher numbers of Jamaican PrCa patients when compared with the White U.S.-born cohort died of causes other than PrCa.

The differences in the death rates among the Jamaicans and U.S.-born White PrCa patients in this study contrasted with findings of studies in the Black population of the United States (Hernandez et al., 2010; Ragin et al., 2011; Tyson & Castle, 2014). Hernandez et al. (2010) documented that the incidence of PrCa among the U.S. Black and White male populations was higher for the Blacks (38.8% versus 26.4%). Ragin et al. (2011), and Tyson and Castle (2014) confirmed that among the different races in the United States, the White U.S. population had better survival rates for PrCa. The differences in the death rates of the Jamaicans and White U.S.-born PrCa patients in this study inferred that although Jamaicans are a subgroup of the African American

population in the United States the death rates for the general Black U.S. population of may not apply to them.

Three of 18 SEER reporting sites (Hawaii, Iowa and Alaska Native) were excluded from the study because no Jamaican PrCa patients were identified in the SEER database for these locations. Iowa and Hawaii were two of eight SEER sites, which reported cancer cases to the SEER program since the inception of its data collection on cancer cases in January 1973 (NCI 2017c). Subsequently, the SEER program extended its coverage of Blacks and other minority groups between 1978 and 1992 and added ten predominantly Black rural counties (NCI 2017c). Thus, the lack of information on Jamaicans for Hawaii, Iowa, and Alaska suggests that these three geographic areas may not report data on these PrCa patients for the period of observation. Therefore, the three reporting sites, which had no Jamaican PrCa patients were removed from the study to balance the selection of PrCa patients for the comparison group.

Higher proportions of PrCa patients were reported from the SEER locations of Greater California (16.3%), Connecticut (15%), and Los Angeles (14.7%). The Greater California and Los Angeles areas had the highest total populations reported by the U.S. Bureau of Census (2010) and accounted for 20,585,610 and 9,818,605 residents respectively (NCI 2017d). Hence, the rate of the disease in Greater California and Los Angeles may be a result of the populace of these two areas. The frequency of PrCa cases reported for Connecticut could be attributed to its duration in the SEER program because its total population 3,574,097 (NCI 2017d) was lower than many of the SEER reporting locations. The State of Connecticut participated in the SEER program since the initiation

of its data collection for cancer patients in 1973 and remained in the program throughout the years (NCI 2017c). However, none of the SEER locations, which reported higher numbers of PrCa patients were outliers for the Jamaican population.

Higher numbers of PrCa patients were reported for the 2001 and 2002, reporting periods but the incidence of PrCa declined in 2011. The increase in the occurrence of PrCa patients between 2001 and 2002 was concurrent with the expansion of the SEER program at that period. In 2001, the SEER program added four reporting sites including Greater California, which had a high number of PrCa patients (NCI 2017c). Thus, the extended coverage in 2001 may have contributed to the increase in the frequency of PrCa cases reported between 2001 and 2002. In 2011, the reduction in the rate of the PrCa patients coexisted with a decrease in the use of radical prostatectomy combined with ERBT to treat PrCa in the United States (Hager et al., 2014), and an increase in the utilization of active surveillance (Cooperberg & Carroll, 2015). Additionally, in 2011 and 2012 brachytherapy utilization declined significantly and the usage of ERBT increased (Safdieh et al., 2016). Thus, the population size of the SEER reporting locations, changing trends in the SEER program and PrCa treatments, were interrelated with the shifts in the PrCa reporting patterns of the SEER registries for the observation period.

The results of this research indicated that the Jamaican PrCa patients were more likely to be diagnosed with earlier stage PrCa. Sixty percent of Jamaican PrCa patients were diagnosed with Gleason grade 11 PrCa, and 88.6% had localized PrCa. The results of this study supported the conclusions of Anderson et al. (2012) and Kampel et al. (2011) which, purported that increasing numbers of Jamaicans are currently diagnosed

with earlier stages PrCa. Although a high proportion of Jamaicans had localized PrCa and Gleason grades 1 and 11 in this research, the proportion of Jamaican PrCa patients with Gleason grade 111, T1c and T2c PrCa was higher than the percentage of the White US-born cohort. Fifty-two-point one percent of the Jamaican PrCa patients had T1c PrCa, and 39.2% was diagnosed with T2c. On the other hand, 41.4% of the White US PrCa had T1c PrCa, and 36.8% had the T2c stage of the disease. The proportions of Jamaican and White U.S.-born PrCa patients with Gleason grade 111 were 39.1% and 33.6% respectively. The results indicate that while Jamaicans were diagnosed with earlier stage PrCa, they had higher Gleason scores and TNM stage when compared with the White U.S.-born patients. Fedewa and Jemal (2013) and Rich et al. (2013) documented similar findings in their studies. According to Fedewa and Jemal and Rich et al., the frequency of Gleason grades and tumor stage among the Jamaicans and the White population was higher for the Jamaicans

The Research Questions

Research Questions 1 and 2 compared the differences in the survival of the brachytherapy treated Jamaicans and the White U.S.-born PrCa patients. The alternate hypotheses that there are differences in the survival of the brachytherapy treated and ERBT treated Jamaicans versus the U.S.-born White PrCa patients were accepted. A higher proportion of the Jamaican PrCa patients (15.5%), when compared with the White U.S.-born PrCa patients (13.2%) utilized brachytherapy treatment. The Jamaican PrCa patients also had higher survival probability. The median survival time for the White U.S.-born brachytherapy treated PrCa patients was 142 months, *SE* 3, 95% CI [134.8,

147.1], $p < .001$; while more than 50% of the Jamaicans survived beyond half the period of follow-up ($p < .001$). The socioeconomic indicators age, marital status, and health insurance status, of the Jamaicans in this dissertation, may explain the higher uptake of brachytherapy treatment in this cohort. In this study, among the Jamaicans and White U.S.-born PrCa patients, a higher proportion of the Jamaicans was younger than 69 years old (71% versus 52%). Additionally, the highest proportions of Jamaican PrCa patients in this research were married (66.5%) and had health insurance (80.5%). The results were consistent with the findings of Williams et al. (2011), Schreiber et al. (2013), and Morrison et al. (2014).

Williams et al. (2011) established that PrCa patients in the younger age group were more likely to be treated with brachytherapy. Schreiber et al. (2013), cited that PrCa patients of lower socioeconomic status in the United States had poorer utilization of brachytherapy treatment. Morrison et al. (2014) indicated that in Jamaica, PrCa patients who had health insurance had greater access to brachytherapy treatment. Despite the limitations of small samples, misclassification, and the quality of the secondary data used for their studies, the patterns of brachytherapy use among PrCa patients identified by Morrison et al., Schreiber et al., and Williams et al. compared with the results of this study.

The study's findings also demonstrated that brachytherapy treated Jamaican PrCa patients had a lower risk of death from PrCa when compared with the brachytherapy treated White US-born PrCa patients, *HR* 0.63, 95% CI [0.55, 0.73], $p < .001$. The treatment effects of brachytherapy in this study corroborated with the findings of Aluwini

et al. (2015), Cendales et al. (2015), Rodrigues et al. (2014), Skowronek (2013), Williams et al. (2011), and Zuber et al. (2015). Aluwini et al. (2015), Williams et al. (2011), and Zuber et al. (2015) documented that brachytherapy treatment was beneficial for maintaining biochemical control in PrCa patients with the earlier stage disease. Cendales et al., Rodrigues et al., and Skowronek, established that brachytherapy was equally effective at both high and low doses for treating localized PrCa. The effects of brachytherapy treatment in this research, as well as other prospective and retrospective studies, which used reliable SEER coding and high-quality Medicare data were similar (Aluwini et al., 2015; Zuber et al., 2011).

ERBT was prevalent among the PrCa patients in this study when compared with brachytherapy treatment (49.6% versus 28.7%). The difference in ERBT utilization among the Jamaicans and White U.S. born PrCa was marginal (25.2% versus 24.4%). The trend in ERBT uptake in this dissertation differed with recent findings of Valdivieso et al. (2015) and Safdieh et al. (2016). In observational studies, Valdivieso et al. and Safdieh et al. identified that ERBT as a monotherapy was less popularly used to treat low-risk PrCa when compared with brachytherapy. Valdivieso et al. reported that 40% of PrCa patients in a sample of 2701 PrCa patients in the 1992 to 2009 SEER Medicare-Linked database used brachytherapy as monotherapy for low-risk disease; 33% used ERBT in combination with other PrCa treatments. In a sample of 89413 PrCa patients taken from the National Cancer Database, Safdieh et al. established that 58.4% of the patients used brachytherapy and 41.6% received ERBT as monotherapy. On the other hand, Mahmood et al. (2014) cited a 6.2% increase in ERBT usage and a similar decrease

in brachytherapy between 2004 and 2009. Despite the decline in brachytherapy use reported by Mahmood et al., Safdieh et al. indicated that the utilization of ERBT for treating localized PrCa is less prevalent in recent years.

In this research, the ERBT treated Jamaican PrCa patients had a higher a median survival time when compared with the White U.S.-born PrCa patients (154 months versus 116 months, $p < .001$). However, Cox regression analysis revealed that the risk of dying from PrCa among the ERBT treated Jamaican and White U.S. cohort was 1.6 times higher for the Jamaican PrCa patients, 95% CI [1.38, 1.84], $p < .001$. Current studies on the outcomes of ERBT focused on the effects of ERBT with surgery and other types of radiation in the survival of PrCa patients (Nepple et al., 2014; Hoffman et al., 2013). There were limited recent peer-reviewed literature on the effects of ERBT as monotherapy to validate findings with the results of this dissertation. Hence, I corroborated the ERBT outcomes of this research with studies which compared the effects of ERBT with surgery, and brachytherapy. Nepple et al. (2014) and Hoffman et al. (2013) showed that ERBT was associated with increased risk of death from PrCa. Nepple et al. compared the hazard of death among PrCa patients who were treated with ERBT, surgery, and brachytherapy. The findings of Nepple et al. showed that the ERBT cohorts versus patients who received surgery (radical prostatectomy) had a higher risk of death, *HR* 1.66, 95% CI [1.05, 2.63]. However, the difference in the risk for the brachytherapy and the surgery cohort was not significant, *HR* 1.83, 95% CI [0.88, 3.82]. In another study which examined the survival differences of a surgery and ERBT treated cohort, Hoffman et al. observed that higher numbers of ERBT treated PrCa patients died (ERBT

464, surgery 104), *HR* 0.35, 95% CI [0.26, 0.49], $p < .001$. The conclusions of Nepple et al. and Hoffman et al. confirmed that ERBT might be associated with higher risk of death when compared with the hazard associated with surgery and brachytherapy. The findings also demonstrated that ERBT may not be as effective as other forms of PrCa treatments.

The Jamaican PrCa patients also demonstrated greater survival benefits from brachytherapy treatment versus ERBT. Brachytherapy reduced the risk of death for the Jamaicans by 37% ($p < .001$). On the other hand, the hazard for ERBT treated Jamaicans was 1.6 times higher when compared with the White U.S. ERBT treated patients ($p < .001$). The brachytherapy treatment outcomes for the Jamaican and White U.S. PrCa patients were not consistent with the effects observed in a Canadian cohort (Smith et al. 2015), the Cleveland Clinic PrCa cohort (Nepple et al., 2013), and a Dutch cohort (Goldner et al., 2012). Smith et al. (2015), Nepple et al. (2013), and Goldner et al. (2012) identified no significant differences in the treatment effects of brachytherapy versus ERBT treatments among the United States, Canadian, and Dutch PrCa patients with localized disease ($p > .05$). However, the findings of Smith et al., Nepple et al., and Goldner et al. may not apply to Jamaicans because of the small samples of African American PrCa patients in their studies.

The differences in treatment outcomes of brachytherapy and ERBT identified among the Jamaican PrCa patients in this study varied with finding in other populations (Goldner et al., 2012; Smith et al., 2015; Nepple et al., 2013), and suggest that the results may be unique to the Jamaicans. However, the findings on the treatment outcomes require further explorations among Jamaicans in their homeland because differences in

the delivery of treatments to PrCa patients in the United States and the Caribbean may create survival advantages for Jamaicans residing in the United States. Example, in the United States, radiotherapy is widely utilized to treat PrCa, and there are advancements in other treatment methods for PrCa (Hager et al., 2015). Furthermore, integrated prostate cancer centers are being implemented in the United States, and the expansion of deferred and defensive treatment strategies for PrCa patients in this country is well documented (Hager et al., 2015).

On the other hand, while Jamaicans residing in the United States are in an environment where the management of PrCa is constantly evolving, they may be less likely to receive appropriate treatments. Moses, Orom, Brasel, Gaddy, and Underwood (2017) alluded to disparities in access to PrCa treatments for African Americans and other minority groups. Jamaicans comprise the African American and minority populations of the United States and may experience similar disparities in treatment access. Although the findings of the study may not extrapolate to Jamaicans in their homeland because of differences in the settings in which the study was conducted, considerations should be given to similarities in the characteristics of Jamaicans living in Jamaica and the United States. Furthermore, data on the Jamaican population were collected from a wide cross section of SEER reporting locations (15 SEER sites) improving the representativeness of the sample. Thus, the findings of this study indicate that there are treatment effects of brachytherapy and ERBT, which require follow-up studies among Jamaicans in their homeland.

Research Question 3 focused on the 5-year survival probability of the Jamaican versus the White U.S.-born PrCa patients who were treated with brachytherapy, ERBT, and radiation sequenced with surgery (other radiation). The study's outcome demonstrated that brachytherapy was more active in the survival of the Jamaican PrCa patients at five years of follow-up when compared with ERBT and radiation sequenced with surgery (median survival three years versus two years, $p < .001$). At ten years of observation, radiation sequenced with surgery demonstrated greater survival probability for the Jamaicans and the White U.S. PrCa cohorts (median survival three years, $p < .001$). Additionally, at the 10-year follow-up brachytherapy improved the median survival time for the White U.S.-born patients. ERBT provided no tangible changes in the median survival times for the White U.S.-born cohorts for both 5-year and 10-year intervals.

Cox regression analysis confirmed that brachytherapy was more beneficial to the Jamaicans for the first 5-year interval (1992 to 1996) and radiation sequenced with surgery at ten years of follow-up. The White U.S.-born brachytherapy treated PrCa patients had enhanced survival for the 1997 to 2001 follow-up and at the last decade of the study. The hazard doubled for all treatment groups at ten years of follow-up and continued to increase for the subsequent 5-year intervals, *HR* 2.4 to *HR* 3.8, $p < .001$.

The survival outcomes for brachytherapy identified among the PrCa patients in this study contrasted with the findings of Valdivieso et al. (2015). In a sample of 2701 low-risk U.S. PrCa patients of the SEER-Medicare-linked database, Valdivieso et al. reported that fewer than 50% of the brachytherapy-treated PrCa patients survived ten

years of follow-up. The conclusions of this dissertation may differ with Valdivieso et al who used the SEER Medicare data exclusively for their study. In this study, the sample included PrCa patients from varying health insurance providers in the United States. On the other hand, in a 5-year prospective study (2002 and 2007) Dickinson et al. (2014) cited favorable survival outcomes among three U.K. PrCa cohorts with localized PrCa who were treated with brachytherapy. Dickinson et al. identified 94.2% biochemical relapse-free survival (p = .033) for the 5-year observation period. Similarly, in a follow-up study on low-risk PrCa patients, Parekh et al. (2016) confirmed that brachytherapy as a monotherapy provided good 5-year and 8-year survival advantage for PrCa patients with localized disease (96.6% PSA failure-free survival). Although the endpoints for PrCa survival were different in the studies conducted by Dickinson et al., Parekh et al., and this dissertation, the findings established that brachytherapy is advantageous for treating localized PrCa at 5-year and 10-year intervals. Hence, the 5-year and 10-year survival advantage among the brachytherapy treated Jamaicans in this study may infer to Jamaicans.

The 5-year survival outcomes of the ERBT treated patients in this dissertation were lower than the effects observed for those who received brachytherapy, and men who were treated with radiation sequenced with surgery. The findings differed with Kibel et al. (2017) but related with the results of Vassil (2010). Vassil compared the 5-year survival rates for PrCa patients who received ERBT, permanent seed implants, and surgery and identified lower survival rates for patients who received ERBT (85.7%) versus permanent seed implant (89.5%). Conversely, Kibel et al. demonstrated no

significant differences in the survival rates of the ERBT versus brachytherapy treated PrCa patients (82.6% versus 81.7%) at 10 years of follow-up. The survival rates of ERBT identified by Kibel et al. did not differ markedly and suggested that ERBT may not be more efficient at five years and ten years of treatment. Kibel et al reported limitations of small samples in their study. In this study, the pairwise comparisons showed survival differences among the ERBT treated and non-ERBT treated White patients for ten years of follow-up, but not the Jamaicans. The treatment effects identified among the White cohort may be due to their consistently larger sample sizes for each 5-year interval. Hence, the survival differences reported in the interaction effects of the 5-year and 10-year survival outcomes among the ERBT treated cohorts in this dissertation require follow-up with larger samples of Jamaicans in future studies on 5-year treatment effects among Jamaicans.

Research Question 4 and Research Question 5 evaluated for confounding effects of the sociodemographic indicators of the Jamaican and White U.S.-born PrCa patients. The findings showed minimal percent changes in the crude and adjusted hazard ratios for health insurance status (brachytherapy -9.6%, ERBT 10.3%) and age of the PrCa patients (brachytherapy 3.3%, ERBT 3.1%). The excess risk for marital status was greater than 10% (brachytherapy 12.8%, ERBT 13.2%). However, the hazard ratios for the main effects of all covariates remained less than one and did not vary considerably after adjustment ($p < .001$), indicating that there was an effect and there were no changes in the direction of the effects observed (Szklo & Nieto, 2014, p.171).

The covariate effects of age in this investigation contrasted with the relationship of age and PrCa survival in studies conducted by researchers Antwi et al. (2013), Fufaa (2011), and Lin et al. (2009). In a predominantly White U.S. community, Antwi et al. reported higher mortality from PrCa among a cohort of young African American PrCa patients. Antwi et al. also documented that African American PrCa patients were more likely to be diagnosed at younger ages. Fufaa demonstrated that older PrCa (age > 81years) and PrCa patients aged 31 to 40 years had shorter survival intervals when compared with patients in other age groups. Lin et al. reported that younger PrCa patients with advanced disease had higher probability of dying of PrCa. However, the study conducted by Fufaa was limited by underreporting and the use of death certificates to provide data on patient's characteristics. Additionally, the investigation carried out by Antwi et al. applied to the population of a predominantly White U.S. PrCa cohort. Besides, Lin et al. cited misclassification of tumor grade and stage. Furthermore, Antwi et al. and Lin et al. documented that their inability to measure comorbid conditions affected the findings of their studies. The differing conclusion of this research with the studies conducted by Antwi et al., Fufaa, and Lin et al. could be attributed to the large sample size of this study. Moreover, in the design of this dissertation, all age-groups of the participants were included.

The covariate effects of marital status and health insurance status in this study also demonstrated minimal confounding and may not explain the association between brachytherapy, ERBT, and PrCa survival among the Jamaicans and White U.S-born cohorts. The results also contrasted with the relationships documented in studies

conducted by Abdelsattar et al. (2017), Mahal et al. (2014), Mahmood et al. (2014), Parris (2013), Rand et al. (2014), and Xiao et al. (2011). Paris identified that the health insurance of a cohort of the Florida Cancer Data System was a determining factor in the choice of PrCa treatments, which improved survival from the disease Likewise, Abdelsattar et al. revealed that having health insurance reduced survival disparities of PrCa patients living in communities with differing socioeconomic conditions. Similarly, Mahal et al. alluded to the advantages of health insurance in improving access to favorable PrCa treatments among African American PrCa patients. Furthermore, Xiao et al. documented that White U.S. PrCa patients who had no health insurance progressed to the later stages of PrCa ($p < .001$). Mahmood et al. confirmed that age and marital status were significant predictors of PrCa survival in a U.S. cohort with localized disease ($p < .001$). Additionally, Paris and Rand et al. documented a statistically significant relationship between the marital status of the PrCa patient and their likelihood of surviving the disease.

Although peer-reviewed literature established that the health insurance and marital status are linked to survival outcomes of PrCa patients, the investigators alluded to limitations, which may explain the results of their studies (Abdelsattar et al. 2017; Mahal et al. 2014; Parris, 2013). According to Mahal et al. (2014), data were missing on important characteristics such as the grade and stage of the PrCa patients and their health insurance status. Abdelsattar et al. (2017) utilized the SEER registry dataset and documented that data on health insurance of the PrCa patients were classified broadly and increased the likelihood of misclassification in their study. Paris (2013) used data on all-

cause mortality to determine differences in PrCa survival and marital and health insurance status because cancer-specific data were not available in the dataset used for that study. The findings of this dissertation may contrast with Abdelsattar et al., Mahal et al., and Parris, because missing information was minimal (six percent for health insurance). However, the health insurance variable did not explain the association identified in this dissertation. Furthermore, the definition of PrCa in this research included both cause-specific and all-cause mortality. Additionally, the characteristics of the PrCa patients were distributed among the study's participants reducing the risk of misclassification.

Theoretical Framework

The oxidative stress theory was chosen for this dissertation because of its assumptions that oxidative stress contributes to age-related cancers such as PrCa and promotes radiation-induced programmed cell death in the prostate gland (Khandrika et al., 2009; Nakajima, 2008). The treatment effects of this study relate to the assumptions of this theory because the alternative hypotheses of the research questions were accepted and in this dissertation, and the incidence of PrCa increased as men aged. The mechanism of radiation-induced cell death of the oxidative theory explains the effects of brachytherapy, ERBT, and radiation sequenced with surgery in the survival outcomes of the Jamaican and White U.S.-born PrCa patients. Khandrika et al. (2009), posited that radiation induces oxidative stress in the prostate gland and causes an increase in ROS production in the gland. Continuous increases in ROS production damage the cell's DNA of the prostate and inhibit duplication and cell division (Khandrika et al., 2009).

Subsequently, programmed cell death occurs and stops the progression of carcinogenesis (Khandrika et al., 2009; Nakajima, 2008).

The results of this study demonstrated that brachytherapy reduced the risk of death for the Jamaican PrCa patients and ERBT improved the survival outcomes of the White U.S. cohort. The radiation treatments were also effective at varying 5-year intervals for the 20-year observation. Brachytherapy was effective in the survival of Jamaicans and the White PrCa patients. ERBT and radiation sequenced with surgery were effective for the first ten years of follow-up. Additionally, the treatment differences in treatment effects observed among the Jamaicans and White U.S.-born PrCa patients remained significant after controlling for the sociodemographic characteristics of the PrCa patients. Hence, the alternative hypotheses for the research questions were accepted.

The relationship among the variables of this study confirmed the mechanism of radiation-induced PrCa cell death in halting carcinogenesis and subsequently improving the survival times of the PrCa patients. The treatment effects observed among the PrCa patients of this study correlated with findings in experimental studies conducted by Fang et al. (2012), You et al. (2015) and Khandrika et al. (2009) on the functions of the oxidative stress pathway in interrupting PrCa carcinogenesis. Fang et al., You et al., and Khandrika et al. established that radiation is an extracellular environmental factor, which induces increased oxidative stress in the prostate gland and damage the cell's DNA structure. Fang et al. and You et al. confirmed that radiation promotes apoptosis, and decreases cell proliferation in localized PrCa. Thus, the assumption of the oxidative

theory that radiation-induced programmed cell death halts carcinogenesis in the prostate gland was accepted for this study.

The oxidative stress theory also links the role of ageing in the development of PrCa. The oxidative stress theory proposed that oxidative stress contributes to significant age-related chronic diseases, including cancers (Sowell et al., 2010, p. 341). Ageing causes cellular dysfunction of the prostate gland, which results in abnormal signaling, genotoxic alterations, and subsequently cancer of the prostate gland (Khandrika et al., 2009). In this dissertation, fewer PrCa patients were in the younger age-group (30 to 64 years) when compared with the 65 and older age-group. The highest proportion of Jamaican PrCa patients (73.3%) and the White U.S.-born PrCa patients (60.7 %) were older than 55 years. The frequency of PrCa patients who were in the older age-group in this dissertation indicates that age may have contributed to the disease. Thus, the assumption of the oxidative theory that increasing age plays a role in PrCa development is a consideration for the PrCa patients in this dissertation.

Limitations and Strengths of the Study

This dissertation utilized secondary data, which had its limitations. Due to the data limitations, the smoking variable was not measured in this study because the SEER registry reports the smoking data at the County level. I recommended that follow-up studies in the Jamaican population should examine the covariate effects of smoking. Additionally, the definition for the covariate age was expanded to include men who were 30 years and older. Fewer PrCa patients in the data set were in the age group (30 to 64 years) which was proposed for data analysis. Hence, I changed the focus of the study

from the younger cohort. Due to the expansion of the age group of the PrCa patients, the Pohar-Perme and Ederer 11 statistical methods were not used for the data analysis because these methods do not perform well in survival analyses involving the older age groups (Seppa, et al., 2015). However, the alternative statistical software, SPSS version 23, that was indicated in the research protocol was used for data analysis.

Another limitation of the dataset was the broad classification of the PrCa patients in the SEER dataset according to their health insurance status. PrCa patients who were classified as uninsured, having private insurance or had unknown health insurance status were also Medicare eligible; the PrCa patients who were diagnosed before 65 years old were not. Therefore, the likelihood of misclassifying the PrCa patients who were older than 65 years according to their health insurance status at the time of diagnosis was a consideration for this study. However, I stratified the PrCa patients in age groups greater and younger than 65 years and conducted statistical adjustments to examine for intervening effects of age. Age was not a confounder in this study.

The research was also limited by unavailable patient-level data on the PrCa patient's primary means of payment for health care and the health insurance coverage plan at the time of diagnosis (SEER, 2013). Similarly, if the PrCa patient's health insurance plan was different between the time of diagnosis and treatment initiation, information on the health insurance coverage at the time that the PrCa patient started treatment was not available (SEER, 2013). Additionally, the SEER program began reporting data on the health insurance status of the PrCa patients in 2007 (Abdelsattar et al., 2017; Mahal et al., 2014); hence, data for prior years in this study were not available

for the analysis. These limitations were reported by other researchers as well (Abdelsattar et al., 2017; Mahal et al., 2014) and should be considered in the interpretation of the findings and included in follow-up investigations.

It was difficult to determine the patients who had the lowest grade disease from the SEER Historic Stage A classification. The PrCa patients with the lower grade PrCa were categorized with localized or regionalized PrCa, and this classification was not disaggregated. Thus, the Gleason grades 1, 11, and 111 categorizations for PrCa were used in combination with the SEER Historic Stage A, and the AJCC's 6th edition of the TNM staging to make conclusions about the effects of stage and grade of the disease.

The study used the 1973 to 2011 version of the SEER 18 SEER registries to examine the relationship between the variables. The SEER program released its most recent version of the 18 SEER registries database in 2016. However, the later version of the SEER 18 registries research data did not include the Jamaican cohort which was needed for this study. Subsequently, the SEER 18 registries Research data, November 2013 submission was used for the data analysis instead of the current version of the SEER dataset. Hence, I could not make deductions on the current trends of PrCa treatments.

There were limited current peer-reviewed sources on the relationship between radiation treatment sequenced with surgery and the use of ERBT as a monotherapy in PrCa survival in the Jamaican cohort. Consequently, it was difficult to corroborate the findings of other studies with the results of the relationships identified for this variable in

this dissertation. Hence, I used current studies that compared treatment effects of ERBT, with brachytherapy and surgery for validation where data were lacking.

I was unable to measure comorbidities in this research. In this study, PrCa patients may change their vital status with time, irrespective of the treatment they receive, because of comorbidities. The SEER research data did not include comorbidities; hence this could not be measured in the data analysis. However, this may not impact the results greatly because the SEER program includes other diseases that are associated with the site-specific disease in their definition of PrCa.

The findings of this dissertation may be limited for extrapolation to the Jamaicans living in their homeland due to differences in the delivery of PrCa treatments among Jamaicans residing in the United States and the Caribbean. Ragin et al. (2011) documented that there are differences in access to and utilization of PrCa treatments among Caribbean-born males residing in their country when compared with PrCa patients living in the United States. The differences in access to treatments influence the survival outcomes of the Caribbean-born males residing in their homeland (Ragin, 2011). Mutetwa et al. (2012) also reported differences in PrCa survival among the Caribbean-born males in the United States and asserted that the disparities may be due to differences in screening interventions between countries. Although the findings of the study may be limited to generalize to Jamaicans in their homeland because of differences in the setting in which the study was conducted, there are some important inferences of the results. The Jamaican population of this study has similar characteristics as Jamaicans living in Jamaica and the United States. Additionally, the data on the Jamaican population of this

study were collected from a wide cross section of SEER reporting locations (15 SEER sites) improving the representativeness of the sample of Jamaicans. Thus, the findings of this study have clinical and practical significance for treatment decisions for Jamaican PrCa patients and may function as a baseline for follow-up investigations in that cohort.

One of the strengths of this research was the representativeness of the sample used. The study used the SEER registries database, which is a comprehensive national database that covered approximately 27.8% of the U.S. population (NCI, 2017e). The SEER 18 registries database comprised different ethnicities and expanded its inclusion of many minority groups over the years (NCI, 2017c). Thus, the SEER 18 registries coverage of PrCa cases in the United States may be representative of the general United States population. Additionally, the characteristics of the sample and the sampling frame were similar (see Table 6). The proportions of the PrCa patients in the sample corresponded with the sampling frame. The proportionality of the sample enhanced its representativeness and facilitated comparisons of both cohorts. Additionally, although I selected the Jamaicans using purposive sampling, a large percentage (93. 4%) of these patients met the criteria for inclusion. Thus, the sample of the study was appropriate for generalization to Jamaican and White US-born communities.

Another high point of this study was the statistical methods applied to determine whether the association identified was explained by mediating and confounding factors. First, I tested the differences in the survival experiences among the Jamaican and White U.S.-born PrCa patients that were observed in the Kaplan-Meier analysis with the Cox Proportional hazard regression analysis. The Cox regression model satisfied the

proportional hazards assumption that the hazards were constant for the period of observation. Subsequently, I conducted hypothesis testing with interaction analysis to identify interaction or mediating effects in the association of brachytherapy and ERBT treatments in the survival outcomes of the PrCa patients. There were fewer significant interactions in the analysis when compared with non-significant interactions. The non-significant interactions were important for generalizing the findings among subgroups of the cohorts studied and over the period of observation. Finally, I adjusted for confounding effects of covariates of this dissertation which were defined a priori and determined the excess risk between the crude and adjusted hazard ratios. The statistical analyses revealed that the association identified in this investigation was not influenced by mediating or confounding factors.

Recommendations

Findings of this dissertation provide the foundation for additional studies in PrCa treatments for the Jamaican males. Future research should be conducted on the effects of radiation treatment among Jamaicans using prospective designs and covering a current period. This research spanned the 1992 to 2011 reporting periods of the SEER 18 research registries due to the limitations of the dataset used for the study. PrCa treatment trends, incidence patterns, and diagnostic approaches are changing (Cooperberg & Carroll, 2015; Hager et al., 2014; Safdieh, et al. 2016) and current data are needed for further investigations on the treatment effects of brachytherapy and ERBT in PrCa survival.

Further research on the effects of ERBT and brachytherapy treatments among the Jamaican males should include PrCa patients who are managed with active surveillance. Klotz et al. (2010) recommended future studies on the effects of active surveillance on PrCa patients with the aggressive forms of the disease. Additionally, Nepple et al. (2013) suggested that active surveillance should be included in studies that examine the effects of ERBT and brachytherapy. Active surveillance was not measured in this dissertation because the variables that comprise the specific criteria for this variable were not available in the data set. Comparison of active surveillance, brachytherapy, and ERBT treatment effects among the Jamaicans could provide substantial evidence to generalize findings to this population, because Jamaicans demonstrate similar characteristics of PrCa staging irrespective of their geographic locations.

Future studies on the effects of ERBT and brachytherapy in PrCa survival should include the smoking variable. The smoking variable was not measured in this dissertation because smoking data were reported at the County level in the SEER registries databases. Studies have shown that smoking may be associated with high death rates among PrCa patients particularly among the African American population (Antwi et al., 2013; Wong et al., 2009). Smoking is a prevalent lifestyle factor among Jamaicans in their homeland and contributed to chronic diseases in the country (Wilks et al., 2008). Thus, it is important to determine its influence on PrCa treatment outcomes.

Additional research on the effects of ERBT and brachytherapy in PrCa survival should compare the treatment effects in PrCa patients who are younger and older than 65 years. Fufaa (2011) and Lin et al. (2009) documented that the age of the PrCa patient may

affect survival outcomes. In this dissertation, all PrCa patients older than 30 years were included in the analysis due to limitations of the data set.

Implications

Positive Social Change

This dissertation has important social change implications for the Jamaican population. Studies have shown that the Jamaicans have a high rate of PrCa, and experience disparities in access to PrCa treatment and preventive care (Aiken & Eldemire-Shearer, 2012; Gibson et al., 2013; Morrison et al., 2014; Rich et al., 2012). In Jamaica, the population without health insurance experiences challenges in utilizing brachytherapy and there is a need for improving access to ERBT (Morrison et al., 2014). This study may create social change by revealing opportunities for expanding PrCa treatments and reducing mortality from prostate cancer among Jamaicans. Currently, the Jamaican Government is seeking to advance the services offered to cancer patients in Jamaica and is promoting research activities in prostate cancer in the country (Ministry of Health, 2013; Reynolds-Baker, 2013). Therefore, this investigation is timely, and its objectives align with the government's goals to address cancer epidemiology among Jamaicans.

Clinicians in Jamaica are also challenged with providing PrCa treatments which are accessible and affordable to Jamaicans, and they need data on treatment outcomes to make informed decisions (Morrison et al., 2014). The results of this study will enlighten health care providers in Jamaica about the effectiveness of brachytherapy and ERBT in treating a Jamaican PrCa cohort. Additionally, health care planners may use the data for

cost-benefit analysis for policy decisions aimed at increasing access to brachytherapy and ERBT treatments to Jamaicans. Improving access to affordable PrCa treatments is likely to reduce morbidity and deaths from the disease, reduce the years of potential life lost (YPLL) from PrCa, and enhance the life expectancy (LE) of the country.

I anticipate that this dissertation will provide important contributions to public health practice and policies through patient education, advocacy, and policy development. Based on the results of this research, I recommend that there should be a greater focus on educating Jamaican PrCa patients with localized disease and their families about the benefits of brachytherapy as an option for managing localized disease. I also propose that greater prominence should be given to collaborative efforts of the privately funded health care facilities, government-funded hospitals, the Radiation Oncology Center of Jamaica and the Jamaica Cancer Society to increase access to brachytherapy and ERBT use among the Jamaican PrCa patients. Additionally, I suggest that cost-benefit evaluations on brachytherapy and ERBT use among the Jamaican PrCa patients should be conducted to inform policy making decisions in the redirection of resources to improve access to these PrCa treatments. I anticipate that the findings of this study will be useful for cost-benefit determinations aimed at increasing access to brachytherapy and ERBT for the Jamaican cohort.

The findings of this dissertation will add new information to the existing body of knowledge on the treatment outcomes of ERBT and brachytherapy treatment in PrCa survival specifically in the Jamaican population. Extensive studies of PrCa treatment effects were carried out among the White populations and in the general population of

African Americans (Alumini et al., 2015; Cendales et al., 2015; Marshall et al. 2014; Nepple et al., 2013; Rodrigues et al., 2014; Williams et al., 2011). Currently, I have not identified publications which examined the effects of brachytherapy and ERBT in the survival of a subgroup of the African American population or the Jamaican PrCa patients. Hence, I anticipate that the findings of this study will be vital to the scholar practitioners who are engaged in PrCa studies on PrCa treatment effects, particularly in the Jamaican population.

Conclusion

The management of PrCa is a prime challenge for Jamaican clinicians, and the disease pattern among Jamaicans is a public health concern in the country. The efforts of clinicians to provide effective treatment interventions for PrCa patients in Jamaica are constrained by a lack of the physical infrastructure that will enable access to PrCa treatment. Clinicians are also limited in accessing current empirical data on treatment effectiveness in the Jamaican society and are consequently challenged to make informed decisions for treatment. This study confirms that brachytherapy is efficacious for managing PrCa in the Jamaican communities and this treatment option should be given priority by health care planners and treatment facilities that deliver treatments to Jamaican males.

References

Abdelsattar, Z.M., Hendren, S., & Wong, S.L. (2017). The impact of health insurance on cancer care in disadvantaged communities. *Cancer, 123*, 1219-1227. doi:10.1002/cncr.30431

Aiken, W.D., & Eldemire-Shearer, D. (2012). Prostate cancer in Jamaica and the wider Caribbean: It is time to consider screening. *West Indian Medical. Journal., 61*(1), 90-93. Retrieved from www.ncbi.nlm.nih.gov/pubmed/22808573

Aluwini, S., Busser, W.M.H., Alemayehu, W.G., Boormans, J.L., Kirkels, W.J., Jansen, P.P...Kilkman-Deurloo, I.K. (2015). Toxicity and quality of life after high-dose-rate brachytherapy as monotherapy for low-and intermediate risk prostate cancer. *Radiotherapy and Oncology,117*(2), 252-257. doi: http://dx.doi.org/10.1016/j.radonc.2015.09.019

Anderson-Jackson, L., McGrowder, D., & Alexander-Lindo, R. (2012). Prostate specific antigen and Gleason score in men with prostate cancer at a private diagnostic radiology center in western Jamaica. *Asian Pacific Journal of Cancer Prevention, 13*(4)*,* 1453-1456. doi:10.7314/APJCP.2012.13.4.1453

Antwi, S., Tucker, T.C., Coker, A.L., & Fleming, S.T. (2013). Racial disparities in survival after diagnosis of prostate cancer in Kentucky, 2001-2010. *American Journal of Men's Health, 7*(4), 306-316. doi: 10.1177/1557988312473774

Ashengrau, A., & Seage 111, G.R. (2008). *Essentials of epidemiology in public health.* Sudbury, MA: Jones and Bartlett.

Bagiella, E. (2008). The log rank test. In *Encyclopedia of Epidemiology*. 616-617. doi:

http://dx.doi.org/10.4135/9781412953948.n269

Balakrishnan, N., & Rao, C.R. (2004). Statistical methods for the comparison of crossing survival curves. *Handbook of statistics 23: Advances in survival analysis.* Netherlands: Elsevier. doi:10.1016/S0169-7161(03)23015-7

Bannuru, R.R., Dvorak, T., Obadan, N., Yu, W.W., Patel, K., Chung, M., Ip, S. (2011). Comparative evaluation of radiation treatments for clinically localized prostate cancer: An updated systematic review. *Annals of Internal Medicine, 155*(3), 171-178. doi:10.7326/0003-4819-155-3-201108020-00347

Barocas, D.A., Motley, S., Cookson, M.S., Chang, S.S., Penson, D.F., Dai, Q…Fowke, J.H. (2011). Oxidative stress measured by urine F2-Isoprostane levels is associated with prostate cancer. *Journal of Urology, 185*(6), 2102-2107. doi: 10.1016/j.juro.2011.02.020

Battaglia, M.P. (2008). Nonprobability sampling. In *Encyclopedia of Survey Research Methods*. 524-527. doi: http://dx.doi.org/10.4135/9781412963947.n337

Boslaugh, S. (2010). Secondary data source. *Encyclopedia of Research Design. SAGE Research Methods.* doi: http://dx.doi.org/10.4135/9781412961288.n406

Bul, M., Zhu, X., Valdagni, R., Pickles, T., Kakehi, Y., Rannikko, A…Roobol, M.J. (2013). Active surveillance for low-risk prostate cancer worldwide: The PRIAS study. *European Urology, 63*(4), 597-603. doi: http://dx.doi.org/10.1016/j.eururo.2012.11.005

Cendales, R., Alwers, E., Cifuentes, J., Bobadilla, I., Torres, F., Arbelaez, J…Vasquez, J. (2015). High-dose-rate Brachytherapy delivered in two fractions as monotherapy

for low-risk prostate cancer. *Journal of Contemporary Brachytherapy, 7*(1)*,* 10-16. doi: 10.5114/jcb.2015.48838

Cooperberg, M.R., Carroll, P.R. (2015). Trends in management for patients with localized prostate cancer, 1990-2013. *Journal of the American Medical Association. 314*(1), 80-82. doi:10.1001/jama.2015.6036

Crawford, F.C. (2013). *Disparities in survival of prostate cancer between African American and Caucasian men.* (Doctoral dissertation). Retrieved from Walden University database, ProQuest Central. UMI number 1527309.

Creswell, J.W. (2009). *Research design: qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, California, CA: SAGE Publications Inc.

Dickinson, P.D., Malik, J., Mandall, P., Swindell, R., Bottomley, D., Hoskin, P…Wylie., J.P. (2014). Five-year outcomes after iodine-125 seed brachytherapy for low risk prostate cancer at three cancer centers in the UK. *British Journal of Urology International, 113*(5)*,* 748-753. doi:10.1111/bju.12358

Dupont, W.D. & Plummer, W.D. (2014). PS: Power and sample size calculation (3.1.2). University of California, San Francisco. Department of Epidemiology and Biostatistics. Division of Biostatistics. Power and sample size programs. Retrieved from http://www.epibiostat.ucsf.edu/biostat/sampsize

Fang, Y., DeMarco, V.G., & Nicholl, M.B. (2012). Resveratrol enhances radiation sensitivity in prostate cancer by inhibiting cell proliferation and promoting cell senescence and apoptosis. *Cancer Science, 103*(6), 1090-1098. doi: 10.1111/j.1349-7006.2012. 02272.x

Fedewa, S.A., & Jemal, A. (2013). Prostate cancer disease severity and country of origin among black men in the United States. *Prostate Cancer and Prostatic Diseases 16,* 176-180. doi: 10.1038/pcan.2012.53

Flowerdew, R., & Martin, D.M. (2013). Methods in human geography: *A guide for students doing a research project*. London and New York. NY: Routledge Taylor & Francis Group

Flynn, R. (2012). Approaches for data analysis. Survival analysis. *Journal of Clinical Nursing*, *21*(19), 2789-2797. doi: 10.1111/j.1365-2702.2011. 04023.x

Forthofer, R.N, Lee, E.S., & Hernandez, M. (2007). *Biostatistics a guide to design, analysis, and discovery.* London: Elsevier Inc.

Frankfort-Nachmias, C., & Nachmias, D. (2008). *Research methods in the social Sciences*. New York: N.Y. Worth.

Freitas, M., Baldeiras, I., Provençal, T., Alves, V., Motta-Pinto, A., & Sarmento-Ribeiro, A. (2012). Oxidative stress adaptation in aggressive prostate cancer may be counteracted by the reduction of glutathione. *Federation of European Biochemical Societies Open Bio 2,*119-128. doi: http://dx.doi.org/10.1016/j.fob.2012.05.001

Fufaa, G.D. (2011). Determinants of prostate cancer survival in Arizona: Demographic and clinical characteristics. *Journal of Social, Behavioral, and Health Sciences, 5*(1), 67-82. doi: 10.5590/JSBHS.2011.05.1.07

Gibson, T.N., Hanchard, B., Waugh, N. & McNaughton, D. (2013). Age-specific

incidence of cancer in Kingston and St Andrew, Jamaica, 2003-2007. *West Indian Medical Journal., 59* (5). 456-464. Retrieved from https://www.mona.uwi.edu/fms/wimj/article/

Goldner, G., Pötter, R., Battermann, J.J., Kristi's, C., Schmid, M.P., Slivic, S, Vulpen, M.V. (2012). Comparison between external beam radiotherapy (70 Gy/74 Gy) and permanent interstitial brachytherapy in 890 intermediate risk prostate cancer patients. *Radiotherapy and Oncology, 103*(2)*,* 223-227. doi: 10.1016/j.radonc.2012.01.016

Green, S.B., & Salkind, N. J. (2011). *Using SPSS for windows and macintosh: Analyzing and understanding data.* Boston, M.A: Prentice Hall.

Hager, B., Kraywinkel, K., Keck, B., Katalinic, A., Meyer, M., Zeissig, S.R... Huber, J. (2015). Integrated prostate cancer centers might cause an overutilization of radiotherapy for low-risk prostate cancer: A comparison of treatment trends in the United States and Germany from 2004 to 2011. *Radiotherapy and Oncology, 115*(1)*,* 90-95. doi: http://dx.doi.org/10.1016/j.radonc.2015.02.024

Hamilton, A.S., Albertsen, P.C., Johnson, T.K., Hoffman, R., Morrell, D., Deapen, D., & Penson, D.F. (2010). Trends in the treatment of localized prostate cancer using supplemented cancer registry data. *British Journal of Urology International. 107*(4)*,* 576-584. doi:10.1111/j.1464-410X.2010. 09514.x

Harrell, F. (2015). *Regression modeling strategies: With applications to linear models, logistic and ordinal regression, and survival analysis.* Switzerland: Springer International Publishing. doi: 10.1007/978-3-319-19425-7-3

Hernandez, M., Fleming, L., Mackinnon, J., & Lee, D. (2010). Cancer in Florida persons of African descent 1988-2007 [Monograph]. Miami: FL. Florida Cancer Data System. Retrieved from http://fcds.med.miami.edu/downloads/PAD/Cancer%20Among%20Persons%20of%20African%20Descent%201988-2007.pdf

Hoffman, R.M., Koyama, T., Fan, K., Albertsen, P.C., Barry, M.J., Goodman, M…Penson, D.F. (2013). Mortality after radical prostatectomy and or external beam radiation therapy for localized prostate cancer. *Journal of the National Cancer Institute. 105,* 711-718. doi: 10.1093/jnci/djt059

Hu, Y., Zhao, Q., Rao, J., Deng, H., Yuan, H., & Xu, B. (2014). Longitudinal trends in prostate cancer incidence, mortality, and survival of patients from two Shangai city districts: A retrospective population-based cohort study, 2000-2009. *BioMed Central.14,* (356). doi:10.1186/1471-2458-14-356

Huncharek, M., Haddock, K.S., Reid, R., & Kupelnick, B. (2010). Smoking as a risk for prostate cancer: A meta-analysis of 24 prospective cohort studies. *American Journal of Public Health, 100*(4), 693-701. doi: 10:2105/AJPH.2008.150508

Kampel, L.J., Tse, K., Joseph, M. (2011). Clinicopathologic findings in Jamaican men with prostate cancer [Abstract]. *Journal of Clinical Oncology 2011; 29* (7) *Abstract 214-214.* doi: 10.1200/jco.2011.29.7_suppl.214

Kenfield, S.A., Stampfer, M.J., Chan, J.M., & Giovannucci, E. (2011). Smoking and prostate cancer survival and recurrence. *Journal of American Medical Association, 305*(24), 2548-2555. doi: 10.1001/jama.2011.879

Khandrika, L., Kumar, B., Koul, S., Maroni, P., & Koul, H. (2009). Role of oxidative stress in prostate cancer. *Cancer Letters, 282*(2), 125-136. doi: 10.1016/j.canlet.2008.12.011

Kibel, A.S., Ciezki, J.P., Klein, E.A., Reddy, C.A., Lubahn, J.D., Haslag-Minoff…Kallogjeri, D. (2012). Survival among men with clinically localized prostate cancer treated with radical prostatectomy or radiation therapy in the prostate specific antigen era. *Journal of Urology, 187* (4), 1259-1265. doi: http://doi.org/10.1016/j.juro.2011.11.084

Kidd, L.R., Jones, D.Z., Rogers, E.N., Kidd, N.C., Beache, S., Rudd, J.E…Kimbro, K.S. (2012). Chemokine ligand 5 (CCL5) and chemokine receptor (CCR5) genetic variants and prostate cancer risk among men of African descent: a case-control study. *Hereditary Cancer in Clinical Practice, 10* (16). http://www.hccpjournal.com/content/10/1/16

Klotz, L. (2010). Active surveillance for prostate cancer: patient selection and management. *Current Oncology,17*(2). S11-S17. Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935703/

Kumar, B., Koul, S., Koul, H.K, Khandrika, L., & Meacham, R.B. (2008). Oxidative stress is inherent in prostate cancer cells and is required for aggressive phenotype. *Cancer Research, 68*(6), 1777-1785. doi: 10.1158/0008-5472.CAN-07-5259

Lambert, P.C., Dickman, P.W., & Rutherford, M.J. (2015). Comparison of different approaches to estimating age standardized net survival. *Biomed Central, 14*(64). doi: 10.1186/s12874-015-0057-3

Leighton, J.P. (2010a). Bias. In Salkind, N. *Encyclopedia of Research Design.* (pp. 83-85). Thousand Oaks, California: SAGE publications, Inc.

Leighton, J.P. (2010b). External validity. In Salkind, N. *Encyclopedia of Research Design.* (pp. 466-469). Thousand Oaks, California: SAGE publications, Inc.

Leighton, J.P. (2010c). Internal validity. In Salkind, N. *Encyclopedia of Research Design.* (pp. 620-623). Thousand Oaks, California: SAGE publications, Inc.

Lin, D.W., Porter, M., & Montgomery, B. (2009). Treatment and survival outcomes in young men diagnosed with prostate cancer. *Cancer 115,* 2863-2871.doi: 10.1002/cncr.24324

Mahmood. U., Pugh. T., Frank. S., Levy. L., Walker. G., Haque, W… Lee. A. (2014). Declining use of brachytherapy for the treatment of prostate cancer. *PubMed 13*(2):157-162. doi: 10.1016/j.brachy.2013.08.005

Mahal, B.A., Ziehr, D.R., Aizer, A.A., Hyatt, A.S., Sammon, J.D., Schmid, M…Nguyen, P.L. (2014). Getting back to equal: The influence of insurance status on racial disparities in the treatment of African American men with high risk prostate cancer. *Urologic Oncology: Seminars and Original Investigations. 32*(8), 1285-1291. doi: http://dx.doi.org/10.1016/j.urolonc.2014.04.014

Marshall, R.A., Buckstein, M., Stone, N.N. & Stock, R. (2014). Treatment outcomes and morbidity following definitive brachytherapy with or without external beam radiation for the treatment of localized prostate cancer: 20-year experience at Mount Sinai Medical center. *Urologic Oncology, 32,* 38. e1-38. e7. http://dx.doi.org/10.1016/j.urolonc.2013.03.004

Meliker, J.R., Goovaerts, P., Jacquez, G.M., AvRuskin, G.A. & Copeland, G. (2009). Breast and prostate cancer survival in Michigan. *Cancer, 115,* 2212-2221. doi: 10.1002/cncr.24251

Mills, M. (2011a). The fundamentals of survival and event history analysis. In *Introducing survival and event history analysis. SAGE Research Methods* (pp. 1-18). Retrieved from http://dx.doi.org.ezp.waldenulibrary.org/10.4135/9781446268360

Mills, M. (2011b). Non-parametric methods: The Kaplan Meier estimator. In *Introducing survival and event history analysis. SAGE Research Methods* (pp. 62-86). Retrieved from http://dx.doi.org/10.4135/9781446268360.n4

Mills, M. (2011c). Model-building and diagnostics. In *Introducing survival and event history analysis. SAGE Research Methods* (pp.141-164). Retrieved fromhttp://dx.doi.org/10.4135/9781446268360.n7

Ministry of Health Jamaica. (2013). Major boost for Jamaica's cancer program. Retrieved from: http://moh.gov.jm/general/latestnews/1-latest-news/584-major-boost-for-jamaicas-cancer-programme

Morrison, B. F., Aiken, W.D., & Mayhew, R. (2014). Current state of prostate cancer treatment in Jamaica. *Ecancer, 8,*(456). doi: 10.3332/ecancer.2014.456

Moses, K.A., Orom, H., Brasel, A., Gaddy, J., & Underwood 111, W. (2017). Racial/ethnic disparity in treatment for prostate cancer: Does cancer severity matter? *Urology, 99,* 76-83. http://dx.doi.org/10.1016/j.urology.2016.07.045

Mutetwa, B., Taioli, E., Attong-Rogers, A., Layne, P., Roach, V., & Ragin, C. (2012).

Prostate cancer characteristics and survival in males of African ancestry according to place of birth: Data from Brooklyn-New York, Guyana, Tobago, and Trinidad. *Prostate, 70*(10), 1102-1109. doi: 10.1002/pros.21144

Nakajima, T. (2008). Positive and negative regulation-induced apoptosis by protein kinase C. *Journal of Radiation Research, 49*(1), 1-8. doi:10.1269/jrr.07053

National Cancer Institute (NCI). (2017). ICD-10 SEER cause-specific death for sequence 01. Retrieved from https://seer.cancer.gov/causespecific/icd10seq01.html

National Cancer Institute (NCI). (2017a). Surveillance research cancer control and population sciences: Measures of cancer survival. Retrieved from https://surveillance.cancer.gov/survival/measures.html

National Cancer Institute (NCI). (2017b). SEER cause-specific death classification. Retrieved from https://seer.cancer.gov/causespecific/

National Cancer Institute (NCI). (2017c). About the SEER registries. Retrieved from https://seer.cancer.gov/registries/index.html

National Cancer Institute (NCI). (2017d). Number of persons by race and Hispanic ethnicity for SEER participants Retrieved from https://seer.cancer.gov/registries/data.html

National Cancer Institute (NCI). (2017e). Overview of the SEER program. Retrieved from https://seer.cancer.gov/about/overview.html

National Institute of Health Office of Extramural Research [NIH]. (2011). Protecting human research participants. Retrieved from http://phrp.nihtraining

Nepple, K.G., Stephenson, A.J., Kallogjeri, D., Michalski, J., Grubb 111, R.L., Strope,

S.A…Kibel, A.S. (2013). Mortality after prostate cancer treatment with radical prostatectomy, external-beam radiation therapy, or brachytherapy in men without comorbidity. *European Urology, 64*(3)*,* 372-378. http://dx.doi.org/10.1016/j.eururo.2013.03.005

Odom, B.D., Mir, M.C., Hughes, S., Senechal, C., Santy, A., Eyraud, R…Miocinovic, R. (2014). Active surveillance for low-risk prostate cancer African American men: A multi-institutional experience. *Urology, 83*(2), 364-368. http://dx.doi.org/10.1016/j.urology.2013.09.038

Osbourne, J.W. (2013a). Using large data sets with probability sampling frameworks: Debunking the myth of equality. Best practices in data cleaning: A complete guide to everything you need to do before and after collecting data. *Sage Research Methods*, (pp. 71-85). doi: http://dx.doi.org/10.4135/9781452269948.n4

Osbourne, J.W. (2013b). Screening your data for potential problems: Debunking the myth of perfect data. Best practices in data cleaning: A complete guide to everything you need to do before and after collecting data. *Sage Research Methods*, (pp. 87-105). doi: http://dx.doi.org/10.4135/9781452269948.n5

Osbourne, J.W. (2013c). Dealing with missing or incomplete data: Debunking the myth of emptiness. Best practices in data cleaning: A complete guide to everything you need to do before and after collecting data. *Sage Research Methods*, (pp. 87-105). Retrieved from http://dx.doi.org/10.4135/9781452269948.n6

Osbourne, J.W. (2013d). Extreme and influential data points: Debunking the myth of

equality. Best practices in data cleaning: A complete guide to everything you need to do before and after collecting data. *Sage Research Methods*, (pp. 87-105). Retrieved from http://dx.doi.org/10.4135/9781452269948.n7

Parekh, A., Nguyen, P.L., West, LJ., Duarte, C., Graham, P.L., Larosk, D.R …Hurwitz, M.D. (2016). Feasibility of brachytherapy as monotherapy for high volume, low-risk prostate cancer. *Journal of Cancer Research and Therapeutics, 12*(1), 406-410. doi: 10.4103/0973-1482.180083

Parris, D. L. Jr. (2013). *Sociodemographic and clinical factors associated with the diagnosis, initial treatment selection and survival of prostate cancer in Florida.* (Doctoral dissertation). Retrieved from Walden University database, ProQuest Central. UMI number 3594408

Polit, D.F., Beck, C.T. (2013). *Essentials of nursing research*. *Appraising evidence for nursing practice.* China: Lippincott Williams & Wilkins

Preedy, V.R. (2014). Prostate cancer and oxidative stress. *Cancer oxidative stress and dietary antioxidants*. London, UK: Elsevier. Retrieved from http://books.google.com.jm/books

Ragin, C., Mutwetwa, B., Attong-Rogers, A., Roach, V., & Taioli, E. (2011). Geographic and outcome variation among Black men diagnosed with prostate cancer. *Infectious Agents and Cancer, 6*(2), S2. doi: 10.1186/1750-9378-6-S2-S2

Rand, A.E., Agarwal, A., Ahuja, D., Ngo, T., Qureshi, M.M., Gupta, A…Hirsch, A.E.

(2014). Patient demographics and disease stage as drivers of disparities in mortality in prostate cancer patients receiving care at a safety net academic center. *Clinical Genitourinary Cancer 12*(6), 455-460. doi: 10.1016/j.clgc.2014.04.005

Redaniel, M.T., Martin, R.M., Gillatt, D., Wade, J., & Jeffreys, M. (2013). Time from diagnosis to surgery and prostate cancer survival: a retrospective cohort study. *BioMed Central*, *13*(559). doi:10.1186/1471-2407-13-559

Reynolds-Baker, A. (2013, June 21). Re: Health ministry pledges $25 million for prostate cancer research [Online forum comment]. Retrieved from: http://www.jis.gov.jm/news/leads/3430

Rich, J.T., Neely, G.J., Paniello, R.C., Voelker, C.C.J., Nussenbaum, B. & Wang, E.W. (2010). A practical guide to understanding Kaplan-Meier curves. *Otalaryngology-Head and Neck Surgery, 143* (3), 331-336. doi: 10.1016/j.otohns.2010.05.007

Roche, L., Daniel, C., Blot, A., Grosclaude, P., Bouie, A., Velten, M…Bossard, N. (2013). Cancer net survival on registry data: Use of the new unbiased Pohar-Perme estimator and magnitude of the bias with the classical methods. *International Journal of Cancer,132*(10), 2359-2369. Retrieved from: http://onlinelibrary.wiley.com/doi/10.1002/ijc.27830/epdf

Rodrigues, G., Smith, G., Crook, J.M., Martin, A., Vigneault, E., Souhami, L…Pickles, T. (2014). Comparison of LDR brachytherapy versus external beam radiation therapy for low and intermediate-risk prostate cancer: A propensity-score matched analysis. *Radiation Oncology, 90*(1), S414-S415. doi: http://dx.doi.org/10.1016/j.ijrobp.2014.05.1316

Rusthoven, C.G., Waxweiler, T.V., DeWitt, P.E., Flaig, T.W., Raben, D., & Kavanagh, B.D. (2015). Gleason stratifications prognostic for survival in men receiving definitive external beam radiation therapy for localized prostate cancer. *Urologic Oncology, 33*(2), 71. e11-71. e19. doi: https://doi.org/10.1016/j.urolonc.2014.07.010

Safdieh, J., Wong, A., Weiner, J., Schwartz, D., & Schreiber, D. (2016). Utilization of prostate brachytherapy for low risk prostate cancer: Is the decline overstated? *Journal of Contemporary Brachytherapy, 8*(4), 289-293. doi: 10.5114/jcb.2016.61942

Schreiber, D., Chen, S., Rineer, J., Weiss, J., Rotman, M., & Schwartz, D. (2013). Racial and socioeconomic disparities in the selection of prostate brachytherapy. *Journal of Contemporary Brachytherapy, 5*(3), 139-143. doi: 10.5114/jcb.2013.37563

SEER*Stat. (2015). *Surveillance research program, National Cancer institute SEER*Stat software, version (8.2.1).* [Data file and code book]. Retrieved from: www.seer.cancer.gov/seerstat

SEER*Stat. (2016). *Surveillance research program, National Cancer Institute SEER*Stat software, version (8.3.2).* [Data file and code book]. Retrieved from: www.seer.cancer.gov/seerstat

Selvadurai, E.D., Singhera, M., Thomas, K., Mohammed, K., Woode-Amissah, R.,

Horwich, A…Parker, C.C. (2013). Medium-term outcomes of active surveillance for localized prostate cancer. *European Urology, 64*(6)*,* 981-987. doi: http://dx.doi.org/10.1016/j.eururo.2013.02.020

Seppa, K., Hakulinen, T., & Pokhrel, A. (2015). Choosing the net survival method for cancer survival estimation. *European Journal of Cancer, 51*(9)*,* 1123-1129. doi: http://dx.doi.org/10.1016/j.ejca.2013.09.019

Shafique, K., Proctor, M.J., McMillan, D.C., Leung, H., Smith, K., Sloan, B…Morrison, D.S. (2013). Modified Glascow prognostic score in prostate cancer: results from a retrospective clinical series of 744 patients. *BioMed Central, 13*(292). Retrieved from http://www.biomedcentral.com/1471-2407/13/292

Skowronek, J. (2013). Low-dose-rate or high-dose-rate brachytherapy in treatment of prostate cancer-between options. *Journal of Contemporary Brachytherapy*, *5*(1), 33-41. doi: 10.5114/jcb.2013.34342

Smith, A.K., Ayanian, J.Z., Covinsky, K.E., Landon, B.E., McCarthy, E.P., Wee, C.C…Steinman, M.A. (2011). Conducting high-value secondary dataset analysis: An introductory guide and resources. *Journal of General Internal Medicine, 26*(8), 920-929. doi: 10.1007/s11606-010-1621-5

Smith, G.D., Pickles, T., Crook, J., Martin, A., Vignealt, E., Cury, F.L…Rodrigues, G. (2015). Brachytherapy improves biochemical failure-free survival in low-and intermediate -risk prostate cancer compared with conventionally fractionated external beam radiation therapy: A propensity score matched analysis.

*International Journal of Radiation Oncology *Biology* Physics, 91*(3), 505-516. doi: 10.1016/j.ijrobp.2014.11.018

Sowell, R., Aluise, C.D., Butterfield, D.A. (2010). Acetyl-l-Carnitine and ferulic acid action in aging and neurodegenerative diseases. *Micronutrients and Brain Health*. Taylor & Francis Group. Retrieved from http://books.google.com.jm/books?

StatsDirect. (2013). Sample size for survival analysis. Retrieved from http://www.statsdirect.com/help/default.htm#sample_size/survival.htm

Su, D. & Jang, T.L. (2011). Using large institutional or national databases to evaluate prostate cancer outcomes and patterns of care: Possibilities and limitations. *The Scientific World Journal, 11,* 147-160. doi: 10.1100/tsw.2011.19

Surveillance, Epidemiology, and End Results (SEER). (2013). *Seer research data record description. Cases diagnosed in 1973 2011* submission: November 2013. Follow-up cutoff date: December 31, 2011. Documentation Version.* Retrieved from: https://seer.cancer.gov/data/seerstat/nov2013/TextData.FileDescription.pdf

Surveillance, Epidemiology, and End Results Program (SEER). (2014). SEER*Stat Database: *Incidence - SEER 18 Regs Research Data + Hurricane Katrina Impacted Louisiana Cases, Nov 2013 Sub (1973-2011 varying) - Linked to County Attributes - Total U.S., 1969-2012 Counties* (8.3.2) [Data file and code book]. National Cancer Institute, DCCPS, Surveillance Research Program, Surveillance Systems Branch. Retrieved from: www.seer.cancer.gov

Surveillance, Epidemiology, and End Results (SEER). (2015). *SEER program coding and staging manual 2015. Section IV: Description*

of this neoplasm. Retrieved from: seer.cancer.gov/manuals/2015/SPCSM_2015_maindoc.pdf

Szklo, M., & Nieto, F. J. (2014). *Epidemiology: Beyond the Basics* (3rd Ed.). Sudbury, MA: Jones and Bartlett.

Thompson, I.M., Goodman, P.J., Tangen, C.M., Parnes, H.L., Minasian, L.M., Godley, P.A…Ford, L.G. (2013). Long-term survival of participants in the prostate cancer prevention trial. *The New England Journal of Medicine, 369*(7). 603-610. doi: 10.1056/NEJMoa1215932

Trochim, W.M.K., Donnelly, J.P., & Arora, K. (2015). *Research methods: The essential knowledge base*. Retrieved from https://books.google.com/books?

Tyson, M.D., & Castle, E.P. (2014). Racial disparities in survival for patients with clinically localized prostate cancer adjusted for treatment effects. *Mayo Clinic Proceedings, 89*(3), 300-307. Retrieved from http://dx.doi.org/10.1016/j.mayocp.2013.11.001

United States Census Bureau. (2010). Number of persons by race and Hispanic ethnicity for SEER Participants 2010 Census Data. *U.S. Bureau of Census, Census 2010, Summary File 1, Table DP-1.* Retrieved from: http://seer.cancer.gov/registries/data.html

United States Department of Human Services. [USDHS] (2003). *OCR HIPAA privacy: Research.* [*45 CFR 164.501, 164.508, 164.512 (i)*]. Retrieved from: http://www.hhs.gov/sites/default/files/ocr/privacy/hipaa/understanding/special/research/research.pdf

Valdivieso, R., Boehm, K., Meskawi, M., Larcher, A., Tian, Z., Parent, M… Karakiewicz, P. (2015). Patterns of use and patient characteristics: Brachytherapy for localized prostate cancer in octo-and nonagenarians. *World Journal of Urology, 33*(12), 1985-1991. doi: 10.1007/s00345-015-1553-0

Vassil, A.D., Murphy, E.S., Reddy, C., A., Angermeier, K. W., Altman, A., Chehade, N… Ciezki, J.P. (2010). Five-year biochemical recurrence free survival for intermediate risk prostate cancer after radical prostatectomy, external beam radiation therapy or permanent seed implantation. *Urology, 76*(5), 1251-1257, doi: 10.1016/j.urology.2010.01.010

Warren, G.W., Kasza, K.A., Reid, M.E., Cummings, K.M. & Marshall, J.R. (2013). Smoking at diagnosis and survival in cancer patients. *International Journal of Cancer.132*(2)*,* 401-410. doi: 10.1002/ijc.27617

Watters, J.L., Park, Y., & Hollenbeck, A., Schatzkin, A., & Albanes, D. (2009). Cigarette smoking and prostate cancer in a prospective U.S. cohort study. *Cancer Epidemiology Biomarkers, 18*(9)*,* 2427-2435. doi: 10.1158/1055-9965.EPI-0901252

Weiner, A.B., Patel, S.G., Etzioni, R., & Eggener, S.E. (2015). National trends in the management of low and intermediate risk prostate cancer in the United States. *Journal of Urology, 193*(1), 95-102. doi: 10.1016/j.juro.2014.07.111

Wenzel, A. (2017). Biological theoretical framework. *The sage encyclopedia of abnormal and clinical psychology* (p.492)*.* Retrieved from https://books.google.com/books?=biological%20theoretical%20framework&f=false

Wilks, R., Younger, N., Tulloch-Reid, M.K., Mcfarlane, S., & Francis, D. (2008). *Jamaica healthy lifestyle survey* (453304). Epidemiology Research Unit, Tropical Medicine Research Unit, University of the West Indies, Mona. Retrieved from http://www.paho.org/hq/index.php?gid=18305&option=com_docman&task=doc_view

Williams, S.B., Lei, Y., Nguyen, P.L., Gu, X., Lipsitz, S.R., Yu, H…Hu, J.C. (2011). Comparative effectiveness of cryotherapy versus brachytherapy for localized prostate cancer. *British Journal of Urology International, 110*(2b), E92-E98. doi:10.1111/j.1464-410X.2011. 10775.

Wilt, T.J., Brawer, M.K., Jones, K.M., Barry, M.J., Aronson, W.J., Fox, S…Wheeler, T. (2012). Radical prostatectomy versus observation for localizes prostate cancer. *The New England Journal of Medicine, 367* (3). 203-213. doi: 10.1056/NEJMoal113162

Xiao, H., Warrick, C., & Huang, Y. (2009). Prostate cancer treatment patterns among racial/ethnic groups in Florida. *Journal of National Medical Association, 101*(9), 936-943. Retrieved from http://europepmc.org/abstract/MED/19806852

Xiao, H., Tan, F., & Goovaerts, P. (2011). Racial and geographic disparities in late-stage prostate cancer diagnosis in Florida. *Journal of Health Care for the Poor and Underserved, 22,* 187-199.doi: 10:1353/hpu.2011.0155

Xiao, H., Tan, F., Goovaerts, P., Ali, A., Adunlin, G., Gwede, C.K…Huang, Y. (2014).

Multilevel factors associated with overall mortality for men diagnosed with prostate cancer in Florida. *American Journal of Men's Health, 8*(4), 316-326. doi: 10.1177/1557988313512862

You, D., Kim, Y., Jang, M.J., Lee, C., Jeong, I, G., Cho, Y.M…Kim, C. (2015). KML001 induces apoptosis and autophagic cell death in prostate cancer cells via oxidative and stress pathway. PLoS One 10(9), e0137589. doi: 10.1371/journal.pone.0137589

Young, L., Roffers, S.D., Gloecker Ries, L.A., Fritz, A.G., & Hurlbutt, A.A. (2001). *SEER summary staging manual-2000: Codes and coding instructions.* National Cancer Institute, NIH Pub. No. 01-4969, Bethesda, MD Retrieved from: http://seer.cancer.gov/tools/ssm/SSSM2000-122012.pdf

Zuber, S., Weiß, S., Baaske, D., Schöpe, M., Stevens, S., Bodis, S, Zwahlen. D.R. (2015). Iodine-25 seed brachytherapy for early stage prostate cancer: a single-institution review. *Radiation Oncology, 10*(49), doi: 10.1186/s13014-015-0349-0

Appendix A: The SEER Data Use Agreement Form

Last Name: BROWN-WILLIAMS
SEER ID: 12126-Nov2014
Request Type: Internet Access

SURVEILLANCE, EPIDEMIOLOGY, AND END RESULTS PROGRAM
Data-Use Agreement for the SEER 1973-2012 Research Data File

It is of utmost importance to protect the identities of cancer patients. Every effort has been made to exclude identifying information on individual patients from the computer files. Certain demographic information - such as sex, race, etc. - has been included for research purposes. All research results must be presented or published in a manner that ensures that no individual can be identified. In addition, there must be no attempt either to identify individuals from any computer file or to link with a computer file containing patient identifiers.

In order for the Surveillance, Epidemiology, and End Results Program to provide access to its Research Data File to you, it is necessary that you agree to the following provisions.

1. I will not use - or permit others to use - the data in any way other than for statistical reporting and analysis for research purposes. I must notify the SEER Program if I discover that there has been any other use of the data.
2. I will not present or publish data in which an individual patient can be identified. I will not publish any information on an individual patient, including any information generated on an individual case by the case listing session of SEER*Stat. In addition, I will avoid publication of statistics for very small groups.
3. I will not attempt either to link - or permit others to link - the data with individually identified records in another database.
4. I will not attempt to learn the identity of any patient whose cancer data is contained in the supplied file(s).
5. If I inadvertently discover the identity of any patient, then (a) I will make no use of this knowledge, (b) I will notify the SEER Program of the incident, and (c) I will inform no one else of the discovered identity.
6. I will not either release - or permit others to release - the data - in full or in part - to any person except with the written approval of the SEER Program. In particular, all members of a research team who have access to the data must sign this data-use agreement.
7. I will use appropriate safeguards to prevent use or disclosure of the information other than as provided for by this data-use agreement. If accessing the data from a centralized location on a time sharing computer system or LAN with SEER*Stat or another statistical package, I will not share my logon name or password with any other individuals. I will also not allow any other individuals to use my computer account after I have logged on with my logon name and password.
8. For all software provided by the SEER Program, I will not copy it, distribute it, reverse engineer it, profit from its sale or use, or incorporate it in any other software system.
9. I will cite the source of information in all publications. The appropriate citation is associated with the data file used. (Please see either Suggested Citations on the SEER*Stat Help menu or the Readme.txt associated with the ASCII text version of the SEER data.)

My signature indicates that I agree to comply with the above stated provisions.

J E Brown-Williams
Signature

August 11th, 2015
Date

Please print, sign, and date the agreement. Send the form to The SEER Program:

- **By fax to 301-680-9571**
- **Or, e-mail a scanned form to seerfax@imsweb.com**

Last Name: BROWN-WILLIAMS | SEER ID: 12126-Nov2014 | Request Type: Internet Access

Appendix B: The SEER Data Request Approval

From: Seertrack <seertrack@imsweb.com>
Date: Wed, 12 Aug 2015 12:04:16 +0000

Subject: SEER Data Request Approved

Thank you for your interest in the SEER Research Data. Your signed Research Data Agreement is on file at SEER. Your username and password have been generated for Internet access. These will allow you to utilize the SEER*Stat client-server system and/or download the files which make up the SEER Research Data DVD. These options are described at the following URL:

http://seer.cancer.gov/data/options.html

You can change your password once you log into SEER*Stat from the "Client Server User Information" option located under the Profile menu.

A recent preliminary evaluation of SEER data uncovered problems with the quality of the PSA value and PSA interpretation variables. As data quality is our primary concern, PSA values have not been included in the current data file (November 2014 submission) on the SEER website and in the SEER*Stat software while a more complete evaluation of these data is underway to explore the full magnitude of the problem. While this problem also exists in prior submissions of the SEER data, we have not removed the fields from earlier submissions at this time and will reevaluate this decision when we have a better understanding of the magnitude of the problem. However, we do not recommend using these fields for analyses. For more information, see http://seer.cancer.gov/data/psa-values.html.

Send questions or comments to:
- **seertrack@imsweb.com -- regarding access to SEER Research Data**
- **seerstat@imsweb.com -- for SEER*Stat technical support**
- **seerweb@imsweb.com -- general questions regarding SEER or SEER data**

Thank you,
SEER*Stat Technical Support
IMS, Inc.