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The Cost of Treating Human Papillomavirus-Related Oropharyngeal Cancer

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This is to certify that the doctoral study by

Karla Houston

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Walden University
2018

Abstract

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MHA, University of St. Francis, 2014

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Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Healthcare Administration

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Abstract

Human papillomavirus (HPV) is a sexually transmitted infection contributing to 70% of oropharyngeal cancers in the United States. The incidence of HPV-related oropharyngeal cancers is greater in Kentucky's population than in any other state. Research has demonstrated the cost of treating oropharyngeal cancer on a national level, but little information exists as to state-specific costs. The purpose of this quantitative study was to examine radiation therapy costs for treating HPV-related oropharyngeal cancer in Kentucky in relation to age, gender, race, and insurance. A theory by Aday and Andersen was applied to explain the relationship between the independent and dependent variables. Cluster sampling was used to randomly select 130 de-identified men and women age 40-65 years who had been diagnosed with oropharyngeal cancer. The data were collected from an existing database. The study used descriptive analysis with correlational, longitudinal data to examine the relationship of categorical and continuous variables. The mean cost for radiation therapy treatment was \$123,629.14 (*SD*= \$58,697.36). The multiple regression indicated that the null hypothesis was accepted showing that the independent variables were not statistically significant predictors of the z Score of Cost Difference [F (4,122) = 0.972, p = 0.425]. The results showed no significant independent predictor variables ($p > 0.05$); gender [t (127) = -0.943, p = 0.348], race [t (127) = 1.378, p = 0.171], insurance type [t (127) = -1.512, p = 0.133], and age group [t (127) = -0.230, p = 0.818]). The results may contribute to positive social change in the development of cancer prevention strategies and policies.

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Dedication

This study is dedicated to God, who gave me the strength and belief in myself to accomplish my goal. I would like to dedicate this study to my family, my husband Eric; son, Eric Jr. (Kristi); daughter, Erika; and granddaughters, Emilia and Zoey—for all their support. I would also like to dedicate this study to Elizabeth “Liz” Wilson, a coworker and friend who encouraged me and helped with my academic journey.

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All glory and honor to God for seeing me through this journey. There were many late nights devoted to this study. I thank God and am truly blessed to have accomplished this goal.

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Section 1: Foundation of the Study

Introduction

Head and neck cancer is a serious disease that affects many people worldwide. Head and neck cancers account for over 333,000 deaths each year globally and over 11,000 deaths in the United States annually (Jones, Fekrazad, & Bauman, 2013). Cancers originating from the paranasal sinuses, nasal cavity, salivary glands, oral cavity, oropharynx, nasopharynx, hypopharynx, and larynx are referred to as *head and neck cancers* (Denson, Janitz, Brame, & Campbell, 2016; Howard & Chung, 2012; Maasland, van de Brandt, Kremer, Goldbohm, & Schouten, 2014). Oropharyngeal cancer is a form of head and neck cancer that forms in the cells of tissue of the middle part of the throat (pharynx; National Cancer Institute, n.d., 2015). Oropharyngeal cancer rates are increasing, with data suggesting that human papillomavirus (HPV) may be an important causal reason for this rise (D'Souza & Dempsey, 2011). It is estimated that 20 million people are currently infected with HPV (Lewis, Kang, Levine, & Maghami, 2015). Potentially 6.2 million new cases will occur annually worldwide in the coming years (Lewis et al., 2015). Oropharyngeal cancer is the second most common HPV-associated cancer deserving attention for future interventions (Centers for Disease Control and Prevention [CDC], 2017). The impact of HPV on oropharyngeal cancer is of concern. HPV-related oropharyngeal cancer is increasing worldwide, affecting people at a younger age.

The link between HPV and oropharyngeal cancers is currently being researched. Approximately 30,000 people worldwide with oropharyngeal cancers are also diagnosed with HPV, which is detected in 25% of all head and neck cancers in the United States (D'Souza & Dempsey, 2011). HPV contributes to 70% of oropharyngeal cancers in the United States (Lewis et al., 2015). The population with oropharyngeal cancers is younger than those with tobacco-mediated cancers (Lewis et al., 2015). Historically, oropharyngeal cancers were diagnosed in older males who abused tobacco and alcohol, but currently oral cancer is affecting those under the age of 40 years (Lewis et al., 2015). The exact incidence of HPV-positive oropharyngeal cancer is unknown and could be misrepresented because current practice does not support testing all oropharyngeal cancers for HPV status (Boggs, 2015). HPV as a risk factor alone may not be sufficient to cause oropharyngeal cancers. More research is needed to investigate whether other risk factors along with HPV cause oropharyngeal cancers. Although research has occurred worldwide on this topic, little research has been completed using state-specific data in the United States. Kentucky has some of the highest HPV-related cancer rates in the nation, including rates of oropharyngeal cancer (Kaprowy, 2012). Therefore, the problem that I explored in this study was the impact of costs associated with treating oropharyngeal cancer in Kentucky on health systems. Addressing HPV through studies such as this one may help inform efforts to lower the number of HPV-related oropharyngeal cancers and reduce associated cost burdens on health care systems.

Kentucky's population demonstrates a higher incidence of HPV-related oropharyngeal cancer compared to other states (CDC, 2017). Understanding the burden of HPV and oropharyngeal cancer within this population is necessary. The data in this study may provide information on the economic burden of HPV-related oropharyngeal cancer.

Problem Statement

Cancer is a major cost driver in the U.S. health care system. In 2017 in the United States, 1.7 million new cancer cases were diagnosed (American Cancer Society [ACS], 2017). The economic impact of cancers is significant. In 2014, $87.8 billion was spent on cancer in the United States. (ACS, 2017). Health care costs have risen to approximately $2 trillion, with the costs of cancer representing $200 billion (Lyman, 2017). Specific types of cancers, such as oropharyngeal cancer, have a unique impact upon the U.S. health system. The 5-year invasive incidence rates for HPV-related oropharyngeal cancers are 11.0 per 100,000 persons in the United States and 13.6 per 100,000 persons in Kentucky (Kentucky Cancer Registry [KCR], 2016). The mortality rates are 2.5 per 100,000 persons for the U.S. and 2.8 per 100,000 persons for Kentucky (KCR, 2016). These statistics could provide data for policy recommendations for the Kentucky population.

Purpose

The purpose of this study was to use secondary data to examine the costs of radiation therapy for treating HPV-related oropharyngeal cancer based on age, gender, race, HPV status, and insurance in Kentucky. Twenty-five percent of Kentucky's adult population consists of smokers (AE&A, 2017). Tobacco use is linked to 85% of oropharyngeal cancers (AE&A, 2017). The primary risk factor for oropharyngeal cancer is oral HPV (Osazuwa-Peters et al., 2015). Oral HPV is considered a sexually transmitted disease (AE&A, 2017). The disease has been linked to sexual behaviors such as early age at coitus, multiple partners, oral sex, and kissing (Osazuwa-Peters et al., 2015). Males and Blacks have a higher incidence of oropharyngeal cancer compared to females and Whites. Oropharyngeal cancer has not been recognized as an indicator for HPV vaccination (Ward, Mehta, & Moore, 2016). The link between HPV and oropharyngeal cancer could present health care organizations and health care leaders in Kentucky with opportunities to address cost drivers such as HPV in cancer diagnoses.

Research Question

RQ. Is there a significant predictive relationship between patient gender, age, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky?

$H_0$1: There is no significant predictive relationship between patient gender, age, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky.

H_a1: There is a significant predictive relationship between patient gender, age, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky.

The secondary data types considered to answer the research question were deidentified data on newly diagnosed patients with oropharyngeal cancer at a cancer center in Louisville, Kentucky. Data extracted for this study were from 2010 to 2016. These years were chosen because data on HPV-associated oropharyngeal cancer were not collected before 2009. During the period from 2010 to 2016, there were 1,654 newly diagnosed head and neck cancers in this population, and the number of people diagnosed with oropharyngeal cancers was 628. Of the 628 cases of oropharyngeal cancer that were diagnosed, 208 cancers were associated with HPV. For data on costs, I used previous literature and Current Procedural Terminology (CPT) codes from cancer center electronic medical records.

Theoretical Foundation for the Study

The framework for this study was based on a theory by Aday and Andersen (1974) that provides a causal structure for utilization and cost associated with health services. Aday and Andersen's theory may be used to explain costs related to predisposing factors, enabling factors, and need factors. The independent variables for this study were the predisposing factors of age, race, gender, and HPV status; the enabling factor of insurance; and the needs factor of oropharyngeal cancer. The dependent variable was cost. Different versions of the Aday and Andersen model have been used in studies on predisposing factors such as age, marital status, gender/sex, education, ethnicity/nativity, and employment status (Babitsch, Gohl, & von Lengeke, 2012). Enabling factors in these studies have included income/financial situation, health insurance, source of care/family doctor, and availability of medical services/inpatient and outpatient care facilities (Babitsch et al., 2012). Need factors have included health status, self-reported/perceived health, diabetes, depression, hypertension, heart disease, and cancer (Babitsch et al., 2012).

Kepka, Smith, Zeruto, & Yabroff (2014) presented a study using Aday and Andersen's theory as a framework to describe how healthcare utilization is influenced by health policies, delivery systems, and population characteristics as they impact access to health services. The independent variable in the study by Kepka et al. was medical provider. The dependent variables were cancer screening, HPV vaccination, and cancer prevention recommendations. The characteristics used in this study were similar to those used in my study; such as insurance, age, and health status in the utilization of health care. The findings suggested that access to primary care providers was a factor related to health outcome. For this study, a search of literature from previous studies involving HPV and oropharyngeal cancer was performed to examine the costs of the disease. The relationship between HPV and oropharyngeal cancer may provide insight on interventions for these populations.

Nature of the Study

The study was quantitative in nature and used the Aday and Andersen theory as the framework to examine the link between HPV and radiation therapy cost associated with HPV-related oropharyngeal cancer. Cluster sampling was used to randomly select participants from the head and neck database. The samples were composed of 130 men and women aged 40-65 years who had been diagnosed with oral cancer. The G*Power analysis program was used to determine the sample size. The samples included all men and women diagnosed with HPV-related oropharyngeal cancer. The CDC (2012b) provided age-based statistics regarding oropharyngeal cancer diagnosis: 62 years old among women and 59 years old among men. The study assessed the possible relationship between HPV and the cost of HPV-related oropharyngeal cancer among populations based on age, gender, insurance, and race in Kentucky. If there is a correlation between

HPV and increased costs associated with HPV and oropharyngeal cancer, testing and prevention efforts may be addressed.

Deidentified data were used to evaluate the possible relationship between HPV and the cost of HPV-related oropharyngeal cancers. The study used descriptive analysis with correlational, longitudinal data collected over time to examine the relationship of categorical variables (gender, race, HPV status, insurance) and continuous variable (age) for oropharyngeal cancer using SPSS Statistics. Logistics regression was used for the continuous and categorical variables. Multistage random sampling was used to help generalize to the population. Characteristics used to stratify the population included age, gender, race, insurance, and HPV status from the head and neck database gathered from multidisciplinary clinics.

Literature Search Strategy

I searched literature on the prevalence of oropharyngeal cancer and HPV in Kentucky. I reviewed existing literature on oropharyngeal cancer associated with HPV based on age, gender, race, and insurance status. Interventions based on knowledge of HPV as a contributing factor could lower oropharyngeal cancer rates and reduce the burden of associated costs on health care systems.

I conducted a review of current literature, using the Walden University Library to access the CINAHL, PubMed, ProQuest, Science Direct, and MedLine databases. Google Scholar was used to search for literature from the CDC, ACS, National Cancer Database (NCDB), and National Cancer Institute, Surveillance, Epidemiology, and End Results

Program (SEER). Key terms used in the literature search included *oropharyngeal cancer*, *HPV*, *health care costs,* and *oropharyngeal cancer and HPV*.

Literature Review

The purpose of this literature review is to summarize the relationship between the independent variables (age, gender, race, and insurance) and the dependent variable (cost) associated with HPV-related oropharyngeal cancer. The research problem was that HPV-related oropharyngeal cancer poses an economic burden on health systems in Kentucky. Based on a review of literature addressing the cost of treating HPV-related oropharyngeal cancer and relevant factors; the following sections focus on the topics of HPV prevalence, oropharyngeal cancer, age, gender, race, insurance, and cost.

HPV Prevalence

HPV is the most commonly diagnosed sexually transmitted disease in the United States (Haddad, 2017). HPV is a DNA virus that infects skin and wet surfaces of the body (Mount Sinai Hospital [MSH], 2017). There are more than 100 types of HPV and at least 40 HPV types that affect the genital areas. Some cause genital warts and are low risk, whereas high-risk types cause cervical and other genital cancers. An estimated 492,800 cervical cancers are caused by HPV each year (D’Souza & Dempsey, 2011). HPV 16, 18, 31, and 33 are high-risk genotypes for cervical cancer (Haddad, 2017), and of these high-risk types, HPV 16 accounts for 90% of oral infections (Lewis et al., 2015). Most sexually active men and women will acquire HPV in their lifetime. HPV, known to cause cervical cancer, is now being linked to an increase in oropharyngeal cancers.

According to the National Cancer Institute (NCI, 2017), cancers of the tonsil or base of tongue are affecting people who are usually at low risk of HPV-related infections. The epidemiology of oral HPV infection is not quite understood, even though the virus has been known to cause cancers of the cervical, vulvar, penile, and ano-genital areas (Osazuwa-Peters et al., 2015). The belief is that there is an increase in people engaging in sexual activity with multiple partners and an increase in oral sex practices resulting in contracting HPV in the neck region (Osazuwa-Peters et al., 2015).

Approximately 39,000 newly diagnosed HPV-related cancers were seen between 2008 and 2012 in the United States (CDC, 2016). The most common were cervical carcinomas and oropharyngeal carcinomas. Of the 39,000 cancers in the United.States, approximately 30,700 could be associated with HPV (Viens et al., 2016). The CDC reported that Utah has the lowest rate of HPV-related cancers, with 7.5 cases per 100,000 persons, while Kentucky has the highest, with 14.7 cases per 100,000 persons (CDC, 2016). A study was conducted in Appalachia showing higher incidence rates for HPV-related cancers for males and females than non- Appalachia males and females (Reiter et al., 2013). The study suggests that there exist disparities beyond cervical incidence rates, including oral cavity and pharyngeal cancers.

Oropharyngeal Cancer

Cancers of the oropharynx are on the rise. According to the ACS (2016), oral cancer is the sixth most common form of cancer in the United States. Areas affected by oral cancers include the nasal cavity, sinuses, lips, mouth, thyroid glands, salivary glands, larynx, and pharynx, which are divided into the nasopharynx, oropharynx, and hypopharynx (CDC, 2017). In 2013 in the United States, 41,717 people (29,693 men and 12,024 women) were diagnosed with oral cancers (CDC, 2017). Approximately 8,850 people (6,227 men and 2,523 women) died from these diseases (CDC, 2017).

More than 90% of oral and oropharyngeal cancers are squamous cell carcinomas. The most common locations for these cancers are the tongue, tonsils, oropharynx, gums, and floor of the mouth. The risk factors for oropharyngeal cancer are tobacco use, alcohol, prolonged sun exposure, and HPV. Cancers of the tonsils and base of tongue have become more common due to HPV exposure. Sexual activity, including oral sex, is the most common way to get HPV.

A U.S. study reported that oral sex was common among women and men but was most common among people 30-49 years old (D’Souza & Dempsey, 2011). Oral sex was reported by 86% of 30- to 40-year-old men, 74% of men aged 50-69 years, and 62% of men aged 70 years or older, compared to 82%, 77%, and 43% of women aged 30-49 years, 50-69 years, and 70 years or older, respectively (D’Souza & Dempsey, 2011; Herbenick et al., 2010). The progression from HPV infection to malignancy can take up to 10 years (D’Souza & Dempsey, 2011). A change is sexual behavior could explain the increase in oral cancers several decades later.

A study conducted in Oklahoma examined trends in oral cancer and oropharyngeal cancer. The study used data from the Oklahoma Central Cancer Registry and Surveillance, Epidemiology, and End Results program to compare people diagnosed from 1997-1999 to those diagnosed from 2010-2012 (Denson et al., 2016). The study observed differences by race, gender, and age. The findings showed an increase in oropharyngeal cancer over time. There was an age-adjusted increase in oropharyngeal cancer incidence from 3.2 (95% CI: 2.6, 3.8) per 100,000 in 1997 to 5.1 (95% CI: 4.4, 5.8) per 100,000 in 2012 (Denson et al., 2016). The explanation for the increase in oropharyngeal cancer rates was an increase in HPV prevalence.

Race

Rates of human papillomavirus oropharyngeal cancer vary by race. Cole, Polfus, and Peters (2012) provided evidence that HPV-associated cancers disproportionately affect certain age, sex, and race/ethnicity groups. Non-Hispanic Blacks present with higher incidence of oropharyngeal cancers compared to women and individuals of other races (Cole et al., 2012). White men have been reported as having the highest rate of cancers of the oral cavity, followed by Black men (CDC, 2017). There was a significant increase in HPV-associated neck cancers, whereas non-HPV-associated neck cancers declined (Cole et al., 2012). The results indicated that Non-Hispanic Whites and Hispanics represented with greater increases in incidence for HPV-associated sites, whereas incidence declined among non-Hispanic Blacks independent of HPV association (Cole et al., 2012).

Human papillomavirus oropharyngeal cancer affects more Whites (21-64%) than Blacks (0-35%; Rettig, Ponce Keiss, & Fakhry, 2015). Findings from a population-based study indicated that Whites are more likely to perform oral sex, have more sexual partners, and engage in sex at a younger age than Blacks (Rettig et al., 2015). Although oral infections were higher among Blacks in the United .States (10.5%) compared to Whites (6.5%, $p = 0.06$), there was no significant difference in the prevalence of infections by race (Rettig et al., 2015). Only oral HPV among men showed higher incidence in Whites.

Age

Oropharyngeal cancer has been proven to be more prevalent in younger adult populations without histories of drinking and smoking (Minassian, 2014). A cross-sectional study of men and women 14 to 69 years old found that HPV DNA prevalence in oral exfoliated cells was 6.9%, and the prevalence of HPV 16 was 1% (Jones et al., 2013). HPV-positive oropharyngeal cancer patients are younger when compared to HPV-negative oropharyngeal cancer patients. The median age was 57 years for HPV-positive patients, compared to 61 years for HPV-negative patients (O'Sullivan et al., 2016). The population-level burden is currently unknown for HPV-related oropharyngeal cancer. This may have important implications for cancer prevention through HPV vaccination and education.

The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) population study examined data from 2002 to 2012. It included 149,301 head and neck cancer cases, with 37,965 being oropharyngeal cancer (Mourad et al., 2017). The study concluded that patients under 60 years of age made up 59.2% of HPV-related cancer (Mourad et al., 2017).

Gender

Twice as many men as women are diagnosed with oropharyngeal cancers (CDC, 2017). The SEER population study of data from 2002 to 2012 concluded that the male-to-female ratio was 4:1 for HPV-related oropharyngeal cancer. The HPV-related oropharyngeal cancer rate for men increased by 2.89% per year compared to an insignificant increase of 0.57% for women (Mourad et al., 2017). A Portugal study reported an increase of 3.5 annual percentage change (APC) in men with oropharyngeal cancer (Mourad et al., 2017). Korea reported similar results with an APC of 2.65% increase for men (Mourad et al., 2017). The findings suggest that more men are developing HPV-related oropharyngeal cancer, potentially skewing gender distribution. In contrast, a study in England found increased incidence in men and women (47.1% and 37.5%, respectively; Mourad et al., 2017).

Human papillomavirus is associated with an increase in oropharyngeal cancer in the United States and other countries. Combes, Chen, and Franceshi (2014) assessed the results of 63 studies reporting oropharyngeal cancer data by gender. The United States had the highest male to female ratio of HPV oropharyngeal cancer, while Asia and some European countries were the lowest (Combes et al., 2014). HPV oropharyngeal cancer for men was 65.8% in North America and 28.9% in Asia (Combes et al., 2014). In contrast, Asian women presented highest (61.5%) for HPV oropharyngeal cancer. The confirmation that HPV oropharyngeal cancer data differ by gender is relevant.

Insurance

The Kentucky Department of Insurance regulates the market that includes Medicare, Medicaid, commercial insurers, and payment/reimbursement. Kentucky ranks 18th nationally in access to health care, and 9.8% of Kentucky's population is uninsured (Bowling, 2016). Kentucky was one of two states to increase Medicaid coverage following passage of the Affordable Care Act. Approximately 268,000 people gained coverage; the majority were adults 19-64 years old, with Medicaid coverage increasing by 80% (Bowling, 2016). In 2017, Kentucky's state-based exchange transitioned to a federal exchange.

Cancer prevention and screening services are covered under the Affordable Care Act. Screening services for breast, cervical, colon, lung, and HPV vaccinations for males and females 11-26 years of age are covered in Kentucky. Routine screening for head and neck cancer is not covered. A study conducted on patients with neck cancer showed that Medicaid patients presented with advanced cancer and higher rates of treatment delays compared to non-Medicaid patients (Naghavi et al., 2016). Oropharyngeal cancer treatment poses a significant cost for Medicaid, suggesting that early detection may reduce the economic burden of the disease.

Costs

High treatment costs for oropharyngeal cancer often involve a combination of surgery, radiation, and chemotherapy. A review of 299 patients diagnosed with oropharyngeal cancer between 2011 and 2015 revealed 72 patients available for evaluation to determine costs associated with treatment (Pinheiro & Krama, 2016). Forty-two patients were treated with surgery and twenty-nine patients were treated without surgery. Patients treated with surgery alone relative to no surgery had the lowest cost ($38,462, $83,222; Pinheiro & Krama, 2016). Patients who had surgery followed by chemotherapy/radiation had similar costs compared to patients treated with primary chemotherapy/radiation ($84,598 vs. $83,222; Pinheiro & Krama, 2016).

A 2-year study in Texas found the cost of treating oropharyngeal cancer to be $139,749. The data were extracted from Truven MarketScan Commercial Claims and Encounter Database from 2011-2004. The data included 467 patients with oropharyngeal cancer and a control group of 467 noncancer patients. Age, comorbidity, mental health, prediagnostic cost, and time were predictors of cost (Cavallo, 2017). The findings showed that the cost of care for oropharyngeal cancer was higher than in previous studies. The mean cost was $6,693 for people with cancer and $870 for those without cancer (Cavallo, 2017). The majority of the cost was from outpatient services ($106,604); inpatient costs and drug costs were $42,341 and $3,550, respectively (Cavallo, 2017).

Ward et al. (2016) provided information on costs associated with HPV-related oropharyngeal cancer. With 13,000 new cases annually, the estimated mean lifetime cost per new case of HPV-related cancer is $43,000, which translates to a total cost for the United States of $306 million (Ward et al., 2016). By vaccinating boys and men, it would be possible to prevent 5,416 and 43,168 cases of HPV-related oropharyngeal cancer in 50 and 100 years, respectively, due to the latent period between HPV infection and the development of oropharyngeal cancer (Ward et al., 2016). The costs to vaccinate for HPV are predicted to be below the $50,000/quality-adjusted life year threshold that determines the cost-effectiveness of public health initiatives (Ward et al., 2016).

Chesson et al. (2012) provided information on direct costs attributed to HPV. Their report provided estimated annual costs for screening, follow-up care, and treatment. Cervical and oropharyngeal cancers account for $1 billion of total costs for HPV-related cancers (Chesson et al., 2012). A study in France provided by Borget, Abramowitz, &

Mathevet (2011) provided data on the economic burden of HPV-associated cancers. The study assessed the annual costs of cancers of the vulva, vagina, anus, penis, and head and neck. The costs for men were $107.2 million caused by head and neck cancers. The costs for women were $83.9 million due to cervical cancer. This information is important to consider for evaluating HPV vaccines for men and women.

A retrospective study consisting of 365 patients 20 years or older assessed median monthly costs as follows: $2,199 for diagnosis, $4,161 for treatment, $6,614 for end-of-life care, and median total cost $110,793 (Reveles, Reveles, Frei, Frei, & Koeller, 2017). Costs were driven by outpatient costs (23%), inpatient costs (18%), and radiation therapy (16%; Reveles et al., 2017).

Data offered by Vanderpool (2016) on Kentucky's oropharyngeal costs and HPV vaccination rates suggest that the United States spends approximately $8 billion annually on HPV-associated disease (Vanderpool, 2016). The average number of oropharyngeal cancers in the United States each year is 12,638 for males and 3,100 for females (CDC, 2012a; Vanderpool, 2016). The number of oropharyngeal cancers caused by HPV each year in the United States is 9,100 for males and 2,000 for females (CDC, 2012a; Vanderpool, 2016). The 5-year invasive incidence rate is 11.0 for the United States and 13.6 for Kentucky. The mortality rates are 2.5 for the United States and 2.8 for Kentucky. These statistics could provide data for policy recommendations for the Kentucky population.

Definition of Terms

Terms operationalized by this study include the following*:*

Cancer center: Cancer centers carry out laboratory, clinical, and population-based research. Although most cancer centers provide care for people with cancer, some only conduct laboratory research (American Society for Clinical Oncology [ASCO], 2017).

Carcinoma: Cancer that begins in the skin or in tissues that line or cover body organs (Medicine Net, 2018).

Human papillomavirus (HPV): An infection caused by a DNA virus that is spread through sexual contact and is associated with a range of diseases and cancers (NCI, 2015).

Medicaid: Medicaid provides health coverage to millions of Americans, including eligible low-income adults, children, pregnant women, elderly adults, and people with disabilities. Medicaid is administered by states according to federal requirements. The program is funded jointly by states and the federal government (Centers for Medicare and Medicaid Services [CMS], 2018).

Medicare: Medicare is a health insurance program for people 65 years of age or older, people under age 65 with certain disabilities, and people of all ages with end-stage renal disease (permanent kidney failure requiring dialysis or a kidney transplant; CMS, 2018).

Oropharyngeal cancer: Oropharyngeal cancer is a form of head and neck cancer that forms in the cells of tissue of the middle part of the throat (pharynx; NCI, n.d., 2015).

Race: A category whereby an individual or group is classified according to physical features such as skin color that is associated with ancestry and geographic origin (Templeton, 2013).

Radiation therapy: Radiation therapy is a type of cancer treatment that uses beams of intense energy to kill cancer cells (Mayo Clinic, 2018).

Sexually transmitted diseases: Diseases that are passed from one person to another through intimate physical contact and sexual activity, including vaginal, oral, and anal sex (CDC, 2017).

Assumptions

In this study, I relied on the following assumptions: The head and neck database on Kentucky residents included the variables needed to complete the study. I assumed that there would be enough participants; that all the data is complete; that access would not be difficult.

Limitations

This study is limited to existing data collected from a Louisville, Kentucky cancer center between 2010 and 2016. Age, gender, race, insurance, and HPV were the variables used for the study. Other variables that are associated with oropharyngeal cancer, such as smoking and drinking were not considered.

Delimitations

I used data from a cancer center in Louisville, Kentucky. No other oropharyngeal cancer data was used. Men and women in the study are 40-65 years of age. The participants are residents of Kentucky diagnosed with HPV related oropharyngeal cancer receiving cancer treatment in Louisville, Ky.

Significance

The significance of this study was to examine the possibility that HPV vaccination may impact cost resulting from HPV related oropharyngeal cancers in Kentucky. Oropharyngeal cancer treatment therapies used to treat oropharyngeal cancer can result in substantial cost to our healthcare system (Ward et al., 2016). The oropharynx is the most common site for HPV infection (OCF, 2017). Oral cancers that were commonly associated with older males and alcohol consumption are now affecting younger populations regardless of alcohol or tobacco use (OCF, 2017). By 2020, HPV oral pharyngeal squamous cell carcinoma is projected to outnumber HPV mediated cervical cancer in the United States (Lewis et al., 2015).

Summary

Oropharyngeal cancer rates are increasing with data suggesting that Human Papillomavirus (HPV) may be an important causal reason for this rise (D'Souza & Dempsey, 2012). Oropharyngeal cancers were diagnosed in older males who abuse tobacco and alcohol, but currently oral cancer is affecting those under the age of 40 (Lewis et al., 2015). Kentucky has some of the highest HPV related cancer rates in the nation; including oropharyngeal cancer (AE&A, 2017). Therefore, the problem was to examine the burden of costs associated with treating oropharyngeal cancer in Kentucky. This study could contribute to a positive social change by addressing HPV and the impact on health care costs associated with HPV related disease

Conclusion

Human Papillomavirus that is associated with oropharyngeal cancer is closely associated with cervical cancer. Ceravix is an approved vaccine that protects against HPV 16. The vaccine was developed to reduce the incidence of ano-genital neoplasms and may be possible to reduce the incidence of HPV related oral cancers. By 2020, HPV oral pharyngeal squamous cell carcinoma is projected to outnumber HPV mediated cervical cancer in the United States (Lewis et al., 2015). Addressing human papillomavirus as a contributing factor in the increase of oropharyngeal cancers may develop interventions for cancer prevention strategies.

Section 2: Research Design and Data Collection

Introduction

The cost associated with radiation therapy treatments for HPV-related oropharyngeal cancer is substantial. The purpose of this study was to use secondary data to determine the impact that age, gender, race, and insurance have on the cost of treating HPV-related oropharyngeal cancer. Section 2 contains explanations of the research design and data collection method used to examine HPV-related oropharyngeal cancer costs. In this section, I address the research design, rationale, methodology, data analysis plan, threats to validity, and ethical procedures in detail.

Research Design and Rationale

For this quantitative research study, I used a head and neck cancer database to determine the radiation therapy cost for HPV-related oropharyngeal cancer based on age, gender, race, and insurance. This methodology was appropriate for testing my theory by examining the relationship among variables. Creswell (2009) stated that quantitative research design can be used to evaluate relationships among variables. I conducted a correlational, longitudinal descriptive analysis to evaluate the possible relationship between HPV-related oropharyngeal cancers and the cost of treating these cancers based on age, gender, race, and insurance. Retrospective data were used from a head and neck cancer database. All data were deidentified to avoid ethical concerns and to protect confidentiality.

In this study, the data allowed for evaluating the extent to which factors affected the cost of treatments. The independent variables were age, gender, race, and insurance.

The dependent variable was cost. The use of quantitative methodology was appropriate to assess the cost of radiation therapy treatments because it provided information about the relationships between the variables.

There were no resource constraints for this study. There were time constraints affecting data collection. No data collection took place prior to Institutional Review Board (IRB) approval.

For this study, there was one research question and two hypotheses:

RQ: Is there a significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky?

H1: There is no significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky.

H0: There is a significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky.

Methodology

Secondary Dataset Management

A secondary database from a regional cancer center was used to complete this study. The data came from a head and neck cancer database. All participants whose information was included in these data were HPV positive and had been diagnosed with oropharyngeal cancer between the ages of 40 and 65. I was granted permission to access the dataset from the University Medical Center (UMC) Research Office. Researchers using the database, which contains protected health information, must read and agree to all terms and conditions relating to the dataset. Consent to use the data was given by the UMC Research Office.

Sampling and Sampling Procedure

The data were produced from a dataset using a stratified sampling technique. The multiple strata included HPV, diagnosis of head and neck cancer of the oropharynx, age, gender, race, insurance, and radiation treatments.

Sample and Population Size

In total, data for 1,654 cases of head and neck cancers were collected. Of the 1,654 head and neck cancers, 628 were diagnosed with oropharyngeal cancer. Out of the 628 cases, 208 tested positive for HPV or p16. The final sample size of 130 participants was determined by G*Power analysis. A systematic random sampling technique was used to select the participants based on strata, with equal opportunity of selection within each stratum.

Inclusion and Exclusion Criteria

All participants in this data collection were HPV positive and had been diagnosed with oropharyngeal cancer between the ages of 40 and 65. The original data included all head and neck cancers regardless of HPV status or age. Participants who were under the age of 40 years, over the age of 65 years, and/or HPV negative were excluded.

Data Collection Tools

The participants were seen in a multidisciplinary clinic with a positive diagnosis of head and neck cancer. The data were driven by physicians. The data were assessed using the National Comprehensive Cancer Network (NCCN) guidelines for the head and neck cancer workup. The original data included name, medical record number, consultation, pathology, HPV status, stage, treatment, protocol, vitals, treatment start and completion date, ears, nose, and throat (ENT) specialist referral, expiration date, and comments. Testing for HPV and p16 is done as part of the workup that determines treatment and prognosis. Data have been collected from 2009 to the present to assess the status, diagnosis, and treatment regimens of participants.

For this study, the participants were selected from the head and neck cancer database. The data collected for participants that met the selection criteria were from 2010 to 2016. Data were collected on every head and neck cancer patient seen in the head and neck clinic. The patients had a positive biopsy for cancer diagnosis.

The data collected came from the outpatient electronic medical record (EMR). For data collection purposes, information was put into a deidentified format with a master list stored in a separate, password-protected location.

Justification for the Effect Size, Alpha Level, and Power Level

The minimum effect size was chosen to allow for greater external validity due to this being a stratified multistage cluster study. To reduce Type 1 error, the alpha level was 0.3, with a power level of 80 to reduce Type 2 error.

Proposed Data Analysis Plan

I planned to conduct a simple descriptive analysis. Bivariate and multivariate analyses were used to identify associations between the dependent and independent variables. A multiple regression analysis was used to reduce statistical errors. I developed the research question using Aday and Anderson's theory as a guide for the study.

Research Question and Hypothesis

RQ: Is there a significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky?

Ha1: There is no significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky?

Ho1: There a significant predictive relationship between patient age, gender, insurance type, and race and the increased cost of radiation therapy associated with HPV-related oropharyngeal cancer in Kentucky?

Threats to Validity

A limitation was the number of variables available for this analysis. A potential threat to internal validity was the selection of variables and data collection. To reduce threats to statistical conclusion validity, a significance value of $p < .05$ was used to assess the association between variables. The reduction of threats was validated using SPSS. There was no threat to external validity. Data were collected from one regional Kentucky cancer center and can be generalized to a larger population.

Ethical Considerations

This study contains an analysis of a secondary dataset observing variable collected from the head and neck clinic at a regional cancer center. All participants are anonymous, and I had no direct contact with the participants in this study. IRB approval was obtained for this study from the University Medical Center on May 30, 2018, with the approval number of 18.0500. IRB approval was also given from Walden University on June 6, 2018, with the approval number of 06-04-18-0637405.

Summary

In this chapter, I explained the research design, rationale, and methodology of the study. The sampling and sampling procedures, data collection, secondary data management, and data analysis plan were explained.

Section 3: Presentation of the Findings and Results

Introduction

The purpose of this quantitative correlational research design was to evaluate the relationship between age, gender, race, insurance, and radiation therapy cost for HPV-related oropharyngeal cancer in Kentucky. HPV has been linked to an increase in oropharyngeal cancers. A dataset covering the years 2010-2016 was collected from a head and neck cancer database. A review of literature revealed few studies assessing state-specific costs of treating HPV-related oropharyngeal cancer.

Descriptive Statistics

The study included four independent variables and one dependent variable. The independent variables were patient gender, patient race, type of insurance for the patient, and age. Originally, the dependent variable was the cost difference, computed as the difference between the total cost for the patient and the estimated cost.

Table 1 shows the gender of the patients. Of the 130 patients, most were male (83.1% male, 16.9% female).

Table 1

Frequency Table for Gender of Patient

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Male	108	83.1	83.1	83.1
	Female	22	16.9	16.9	100.0
	Total	130	100.0	100.0	

Nearly three-fourths of all patients (74.8%) were covered by private insurance. Another 15.7% paid for treatment using Medicare or Medicaid, and 9.4% were covered by other government insurance (see Table 2).

Table 2

Frequency Table for Insurance Type Used by Patient

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Medicare/Medicaid	20	15.4	15.7	15.7
	Private insurance	95	73.1	74.8	90.6
	Other government insurance	12	9.2	9.4	100.0
	Total	127	97.7	100.0	
Missing	-1.00	3	2.3		
Total		130	100.0		

Table 3 shows that over 9 of 10 patients were White (91.5%); while (8.5%) were members of racial/ethnic minority groups.

Table 3

Frequency Table for Race of Patient

		Frequency	Percent	Valid percent	Cumulative percent
Valid	White	119	91.5	91.5	91.5
	Minority	11	8.5	8.5	100.0
	Total	130	100.0	100.0	

Table 4 shows the percentages for age groups.

Table 4

Frequency Table for Patient Age Group

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Under 50 years old	13	10.0	10.0	10.0
	50 to 59 years old	55	42.3	42.3	52.3
	60 years and older	62	47.7	47.7	100.0
	Total	130	100.0	100.0	

Descriptive statistics for cost difference are listed in Table 5. The mean cost for radiation therapy treatment was $123,629.14 (*SD* = $58,697.36).

Table 5

Descriptive Statistics for Cost Difference Variable

Variable		Value
N	Valid	129
	Missing	1
Mean		123629.14
Std. error of mean		5168.02
Median		142376.00
Std. deviation		58697.36
Variance		3445379605.61
Skewness		-.60
Std. error of skewness		.21
Kurtosis		.58
Std. error of kurtosis		.42
Range		320537.76
Minimum		198.24
Maximum		320736.00
Percentiles	25	92586.50
	50	142376.00
	75	156984.00

Figure 1 provides a boxplot of the cost difference dependent variable. There was one outlier, and it was evident that the mean value was not part of a normal distribution. The boxplot provided evidence of the need to normalize the dependent variable using the *z* score of cost difference.

Figure 1. Boxplot of cost difference.

Another method to test the dataset for normality was to create a histogram and evaluate the skewness and kurtosis values associated with the frequency distribution/histogram (see Figure 2). The histograms and skewness value indicated that the distribution for cost difference variable was slightly skewed to left.

After the visual inspection of the distribution, the statistical method to test for normality of the dependent variable is the Kolmogorov-Smirnoff test (K-S) when the sample size is 50 or greater.

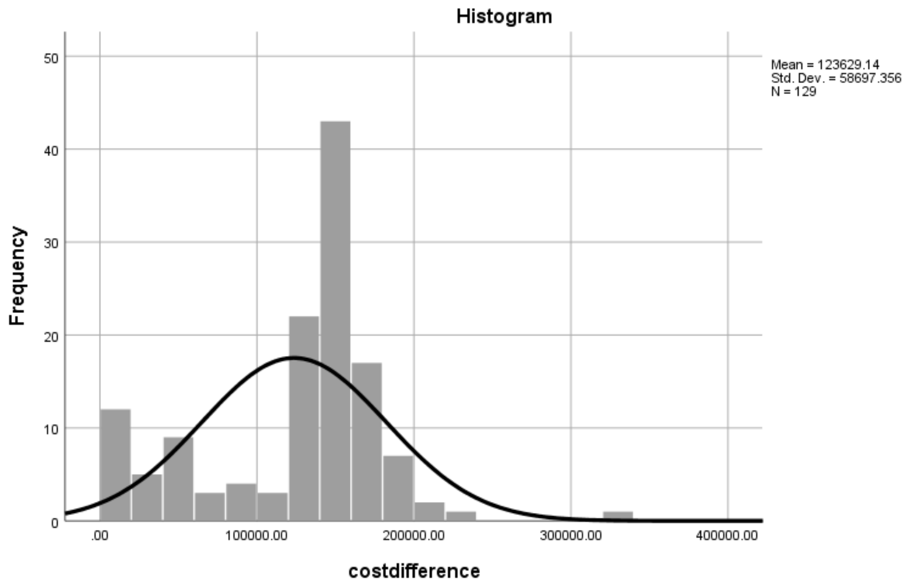

Figure 2. Histogram for cost difference.

The *z* score for cost difference was developed because the distribution for cost difference was not normally distributed [*K-S* (129) = 0.215, $p < 0.01$] (see Table 6).

Table 6

Tests of Normality for Dependent Variable

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	Sig.	Statistic	*df*	Sig.
Sum of charge—Total charge	.239	129	.000	.856	129	.000
Sum of estimated-charge payments	.192	129	.000	.802	129	.000
Cost difference	.215	129	.000	.881	129	.000

[a]Lilliefors significance correction.

In Figure 3, the *z* score for cost difference appears normally distributed. In the next section, I begin inferential statistics to test the hypotheses for each research question.

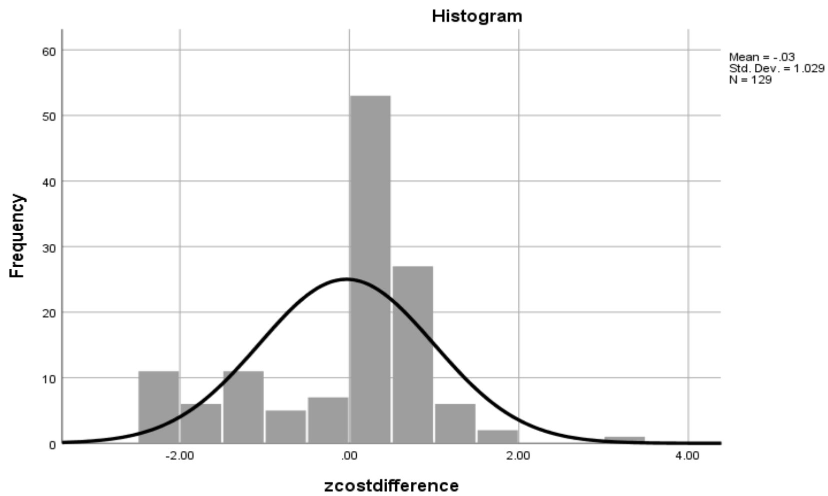

Figure 3. Histogram for *z* score of cost difference.

Inferential Statistics: Testing the Hypotheses

RQ. Is there a significant predictive relationship between patient gender, age, insurance type, and race and the increased patient cost associated with HPV-related oropharyngeal cancer in Kentucky?

$H_0$1: There is no significant predictive relationship between patient gender, age, insurance type, and race and the increased patient cost associated with HPV-related oropharyngeal cancer in Kentucky.

H_a1: There is a significant predictive relationship between patient gender, age, insurance type, and race and the increased patient cost associated with HPV-related oropharyngeal cancer in Kentucky.

To test the hypotheses for the research question, a multiple regression was performed to predict the dependent variable *z* score of cost differences from a set of independent predictor variables for patient gender (male/female), patient age (under

50/50-65/over 65), type of insurance (Medicare-Medicaid/private insurance/other government insurance), and race (minority/White).

There were 130 patients studied, with 127 valid responses without missing data. From Table 7, the dependent variable of *z* score of cost difference was normally distributed, with mean = 0 and standard deviation = 1.0.

Table 7

Descriptive Statistics of z Score of Cost Difference

	Mean	Std. deviation	*N*
z score of cost difference	.0000	1.00000	127

The residual results are shown in Figures 4-8. These include a plot of normality, a scatterplot of the predicted and standardized residuals, and a histogram of the standardized residuals. Figure 4 presents a histogram of the residuals with a normal curve superimposed. The residuals appear close to normally distributed in Figure 5. The standardized residual plots show a random scatter of points with constant variability (see Figure 6 and 7). This was verified in Figure 8 with the linearity of the scatterplot. In fact, the range of values predicted by the model was wide (minimum predicted value = -0.318, maximum = 0.457).

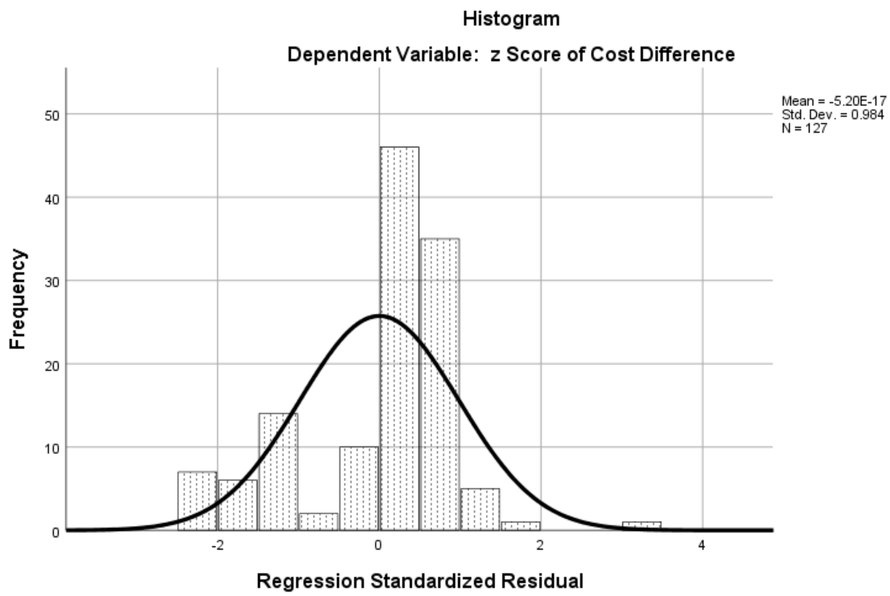

Figure 4. Histogram of *z* score of cost difference as dependent variable.

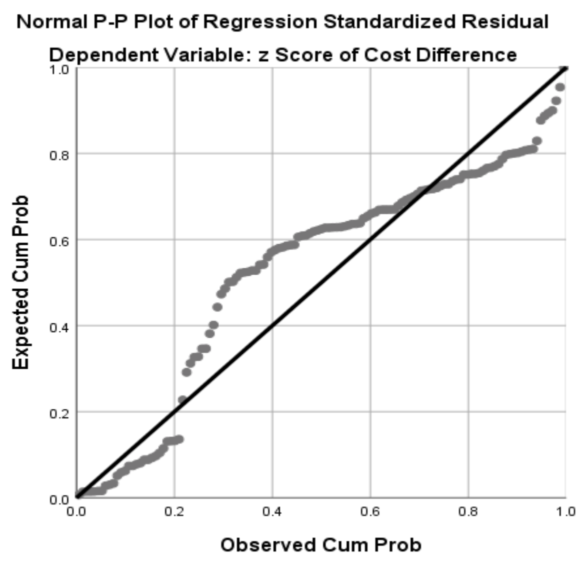

Figure 5. Normal P-P plot of standardized residuals: *z* score of cost difference as dependent variable.

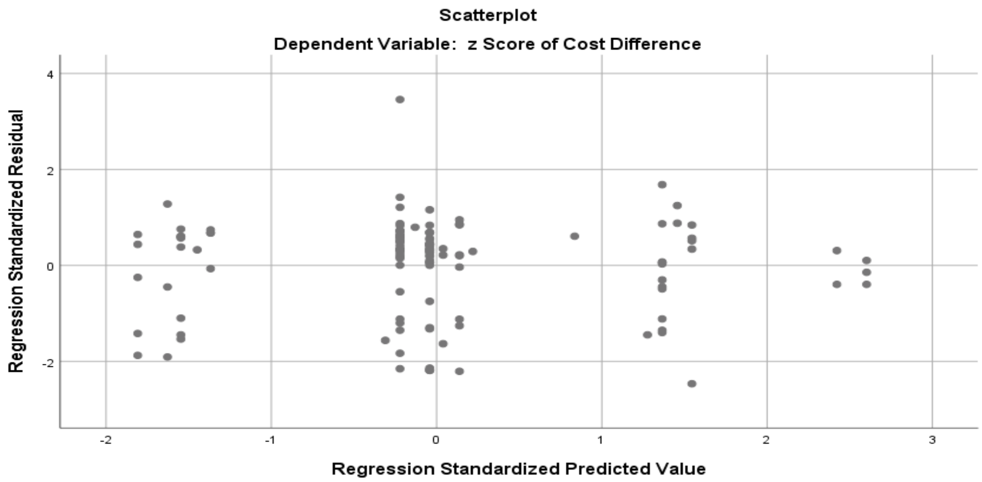

Figure 6. Scatterplot of standardized predicted value by standardized residuals.

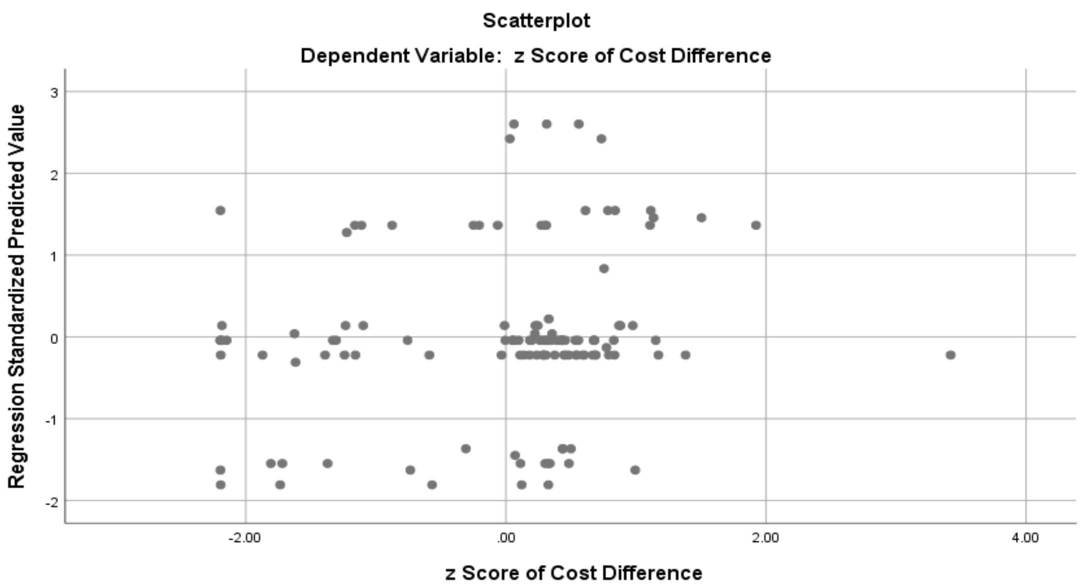

Figure 7. Scatterplot of standardized predicted value by *z* score of cost difference (dependent variable).

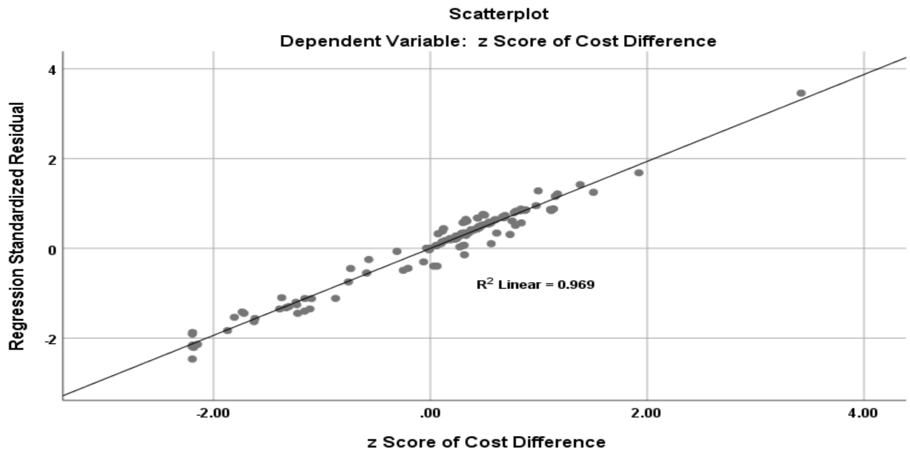

Figure 8. Scatterplot of standardized residuals by *z* score of cost difference (dependent variable).

A correlation matrix (see Table 8) was part of the multiple regression output so that preliminary issues with multicollinearity between independent predictor variables could be determined. Based on the correlations, it does not appear to be an issue. However, only the evaluation of tolerance values or VIF values can determine multicollinearity concerns in the final model.

The multiple regression model was built using the *Enter* method for entering and removing variables from the equation. The summary table (Table 9) indicated various diagnostic results for the multiple regression model including the coefficient of determination R^2. The coefficient of determination R^2 demonstrates that only 3.1% of the change in the variance of the *z* score of cost difference can be explained by the independent predictor variables of gender, age, insurance type, and race.

Table 8

Correlation Matrix

		Gender	Race with two groups	Insurance reduced to three categories	Recode age into groups
z score of cost difference	Pearson correlation	-.051	.085	-.106	-.021
	Sig. (1-tail)	.283	.171	.117	.407
	N	127	127	127	127
Gender	Pearson correlation		.240	-.029	.002
	Sig. (1-tail)		.003	.374	.491
	N		127	127	127
Race with two groups	Pearson correlation			.208	-.175
	Sig. (1-tail)			.010	.024
	N			127	127
Insurance reduced to three categories	Pearson correlation				-.166
	Sig. (1-tail)				.031
	N				127

Table 9

Multiple Regression Model Summary: z Score of Cost Difference as Dependent Variable

					Change statistics				
Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate	*R* square change	*F* change	df1	df2	Sig. *F* change
1	.176[a]	.031	-.001	1.00044	.031	.972	4	122	.425

Note. Predictors: (Constant), Recode age into groups, Gender, Insurance reduced to three categories, Race with two groups.

Table 10 indicates that the regression model was not statistically significant. The null hypothesis was accepted that the independent variables were not statistically significant predictors of the *z* Score of Cost Difference [F (4,122) = 0.972, p = 0.425].

Table 10

Multiple Regression ANOVA Table: z Score of Cost Difference as Dependent Variable

Model		Sum of squares	*df*	Mean square	*F*	Sig.
1	Regression	3.892	4	.973	.972	.425[a]
	Residual	122.108	122	1.001		
	Total	126.000	126			

Note. Predictors: (Constant), Recode age into groups, Gender, Insurance reduced to three categories, Race with two groups.

The model coefficients and significance level for each of the independent variables are displayed in Table 11. There were no significant independent predictor variables (p > 0.05); gender [t (127) = -0.943, p = 0.348], race [t (127) = 1.378, p = 0.171], insurance type [t (127) = -1.512, p = 0.133], and age group [t (127) = -0.230, p = 0.818]. The model constant was also not statistically significant [t (127) =0.582, p = 0.561]. The table also shows that the tolerance values are close to 1 and not near zero so there was no multicollinearity.

The standardized regression coefficients (β) are used to express the relationship between each significant predictor variable and the dependent variable. The β values were not statistically significant for any predictor independent variables.

Table 11

Multiple Regression Coefficients: z Score of Cost Difference as Dependent Variable

Model	Unstandardized coefficients *B*	Unstandardized coefficients Std. error	Standardized coefficients Beta	*t*	Sig.	95.0% confidence interval for *B* Lower bound	95.0% confidence interval for *B* Upper bound	Collinearity statistics Tolerance	Collinearity statistics VIF
(Constant)	.382	.656		.582	.561	-.916	1.680		
Gender	-.233	.247	-.087	-.943	.348	-.722	.256	.935	1.070
Race	.465	.337	.131	1.378	.171	-.203	1.132	.876	1.141
Insurance type	-.279	.184	-.139	-1.512	.133	-.644	.086	.934	1.071
Age group	-.032	.137	-.021	-.230	.818	-.303	.240	.950	1.052

A summary of the residuals that result from the predictor model are found in Table 12. The value for the residuals (*M* = 0.00, *SD* = 0.984) relates to the low R^2 value, the lack of predictability; however, it does show that the residuals are normally distributed, which supports the regression assumption of homoscedasticity.

Table 12

Multiple Regression Collinearity Table: z Score of Cost Difference as Dependent Variable

				Variance proportions				
Model	Dimension	Eigenvalue	Condition index	(Constant)	Gender	Race with two groups	Insurance reduced to three categories	Recode age into groups
1	1	4.770	1.000	.00	.00	.00	.00	.00
	2	.090	7.294	.00	.08	.10	.03	.53
	3	.081	7.662	.00	.64	.01	.26	.00
	4	.044	10.357	.00	.20	.72	.40	.02
	5	.014	18.281	1.00	.08	.17	.31	.45

Table 13

Multiple Regression Residuals: z Score of Cost Difference as Dependent Variable

	Minimum	Maximum	Mean	Std. deviation	*N*
Predicted value	-.3178	.4573	.0000	.17574	127
Residual	-2.46661	3.45904	.00000	.98444	127
Std. predicted value	-1.808	2.602	.000	1.000	127
Std. residual	-2.466	3.458	.000	.984	127

Gender was analyzed using an independent samples *t*-test to determine whether there was a significant difference in the mean *z* score for cost difference for between male and female patients. First, Figure 9 was prepared to display an error bar plot of the mean *z* score of cost difference by gender of the patient. The error bar plot was used prior to the independent *t*-test as a preliminary determination of whether there was no difference in the means and variances between the two groups. The *x*-axis represents the two groups from the independent variable (no/yes) and the *y*-axis represents the mean value of the dependent variable.

In each error bar, the dot represents the mean of the group. The mean was read by placing a horizontal line across to the left to the *y*-axis and reading the value for that group. The vertical distance between the two horizontal lines in each error bar was the variance.

The closer in value the means the more likely the assumption of equal means will prove true when conducting the *t*-test. The more similar the vertical distance between the horizontal bars for each group, the more likely Levene's test of homogeneity of variance holds true. From the error bar plot, it appears that the means are slightly different. It also appears that the variance for the *z* score of cost difference in the *female* group was greater than in the *male* group. It was thought that the independent *t*-test might show significant differences in means and variances.

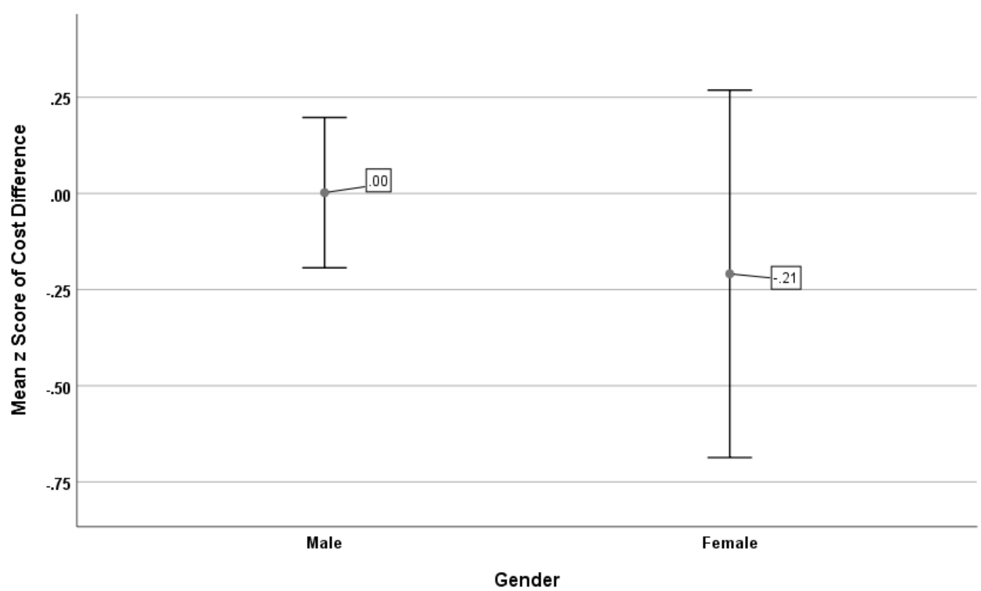

Figure 9. Error bar plot of mean *z* score of cost difference by gender.

Next, a table of summary descriptive statistics was constructed for the level of the dependent variable for male and female patients. These results are found in Table 14 below.

Table 14

Group Descriptive Statistics: z Score of Cost Difference by Patient Gender

	Gender	*N*	Mean	Std. deviation	Std. error mean
z score of cost difference	Male	107	.0021	1.01976	.09858
	Female	22	-.2091	1.07738	.22970

Table 15 presents the results from the Levene's test of equal variances and the independent sample *t*-test for testing the null hypothesis that mean *z* score for cost difference for both male and female patients are equal.

The Levene's test of homogeneity of variance exhibits that there was no significant difference in the level of variance between male and female patients [F (127) =1.177, p = 0.280]. Therefore, equal variances are assumed. Based on the results of the independent samples *t*-test in Table 15, there was no statistically significant difference in the mean *z* score of cost difference between male and female patients. The null hypothesis was accepted [t (127) =-0.876, p = 0.383].

Table 15

Independent Samples Test and Levene's Test: z Score of Cost Difference by Patient Gender

		Levene's test for equality of variances		*t* test for equality of means						
									95% confidence interval of the difference	
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Upper
z score of cost difference	Equal variances assumed	1.177	.280	.876	127	.383	.21116	.24100	-.26575	.68806
	Equal variances not assumed			.845	29.253	.405	.21116	.24996	-.29988	.72219

To test the hypotheses of age, a one-way ANOVA was constructed because there were three groups for patient age. The dependent variable was the *z* score for cost differences in treatment. First, an error bar plot was created.

Figure 10 displays an error bar plot of the mean *z* score of cost difference by age group of the patient. An error bar plot was used prior to the independent *t*-test as a preliminary determination of whether there was no difference in the means and variances between the two groups. From the error bar plot in Figure 10, it appeared that the mean *z* scores for cost difference were slightly different. It also appears that the variance for the *z* score of cost difference in the *under 50-year old* group was greater than in the other two age groups. We might expect that the independent *t*-test might show a significant difference in the variances between the three age groups.

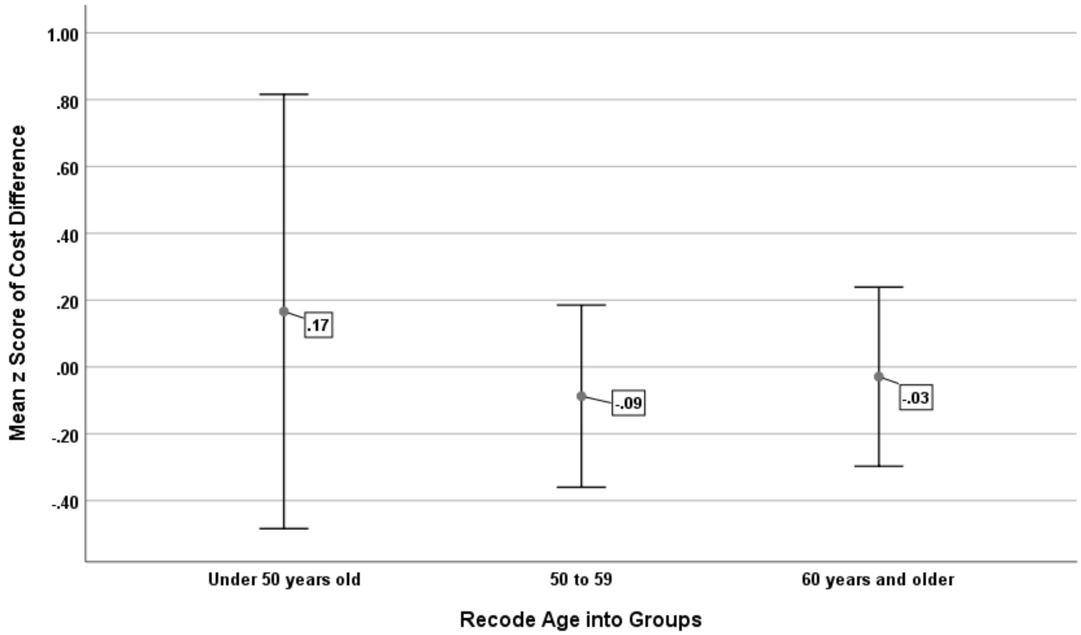

Figure 10. Error bar plot of mean *z* score of cost difference by age group.

Next, the one-way ANOVA provided a table of summary descriptive statistics for the level of the dependent variable for the three patient age groups. These results were found in Table 16.

Table 16

Group Descriptive Statistics: z Score of Cost Difference by Patient Age

		N	Mean	Std. deviation	Std. error	95% confidence interval for mean Lower bound	Upper bound	Minimum	Maximum
Under 50 years old		13	.1660	1.07571	.29835	-.4841	.8160	-2.18	1.50
50 to 59		54	-.0875	.99887	.13593	-.3602	.1851	-2.20	1.15
60 years and older		62	-.0291	1.05565	.13407	-.2972	.2390	-2.19	3.42
Total		129	-.0339	1.02858	.09056	-.2131	.1453	-2.20	3.42
Model	Fixed effects				1.03412	.09105	-.2141	.1463	
	Random effects					.09105[a]	-.4257[a]	.3578[a]	

Levene's test indicated the difference in the variation of *z* score cost differences based on age group was not statistically significant [F (2, 126) = 0.007, p = 0.993] (see Table 17). The one-way ANOVA assumption of equal variances held (see Table 18).

Table 17

Levene's Test of Equal Variances: z Score of Cost Difference by Patient Age

		Levene statistic	df1	df2	Sig.
z score of cost difference	Based on mean	.007	2	126	.993
	Based on median	.169	2	126	.845
	Based on median and with adjusted *df*	.169	2	124.815	.845
	Based on trimmed mean	.041	2	126	.960

Table 18 indicated that the one-way ANOVA was not statistically significant and that there was no significant difference in the mean *z* score of cost differences based on the patient's age. Therefore, the null hypothesis was accepted [F (2,126) = 0.316, p = 0.730].

Table 18

one-way ANOVA Results for z Score of Cost Difference by Patient Age Group

			Sum of squares	*df*	Mean square	*F*
Between groups	(Combined)		.676	2	.338	.316
	Linear term	Unweighted	.409	1	.409	.382
		Weighted	.094	1	.094	.088
		Deviation	.582	1	.582	.544
Within groups			134.745	126	1.069	
Total			135.421	128		

This is also verified by the means plot in Figure 11. The effect size, calculated using eta squared which was calculated as the sum of squares between groups divided by total sum of squares, was .005. According to Cohen (1988), there was only a small effect of the one-way ANOVA.

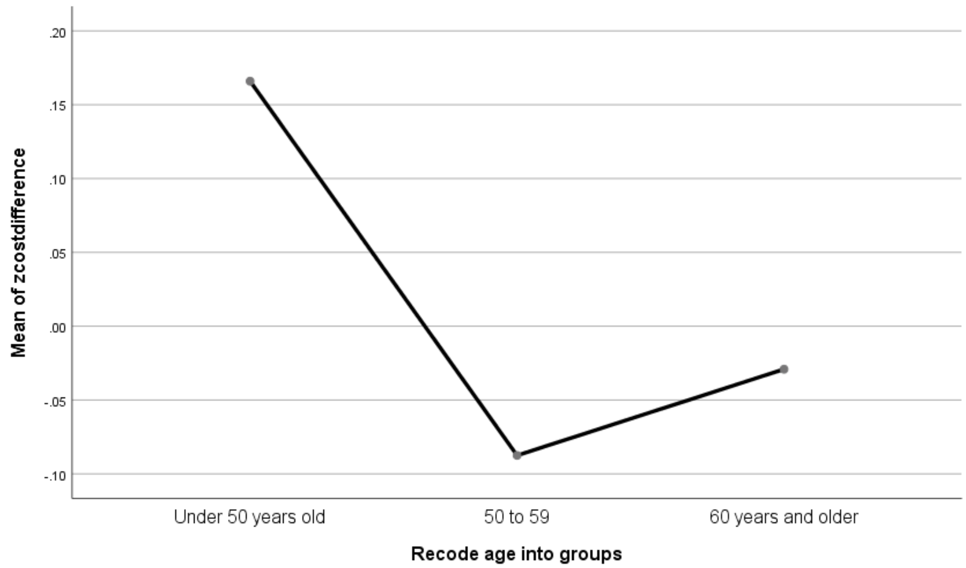

Figure 11. Means plots for *z* score of cost difference by patient age group.

To test insurance type, a one-way ANOVA was constructed because there were three groups for patient insurance type. The dependent variable was the *z* score for cost differences in treatment. First, an error bar plot was created.

Figure 12 displays an error bar plot of the mean *z* score of cost difference by the patient's type of insurance. An error bar plot was used prior to the independent *t*-test as a preliminary determination of whether there was no difference in the means and variances between the two groups. Evaluating Figure 12, it appeared that the mean *z* scores of cost difference were slightly different based on the patient's insurance. It also appears that the variance for the *z* score of cost difference for the *other government insurance* group was greater than for the private insurance or Medicare/Medicaid insurance groups. We might expect that the independent *t*-test might show significant differences in variances but not the means for *z* score of cost differences.

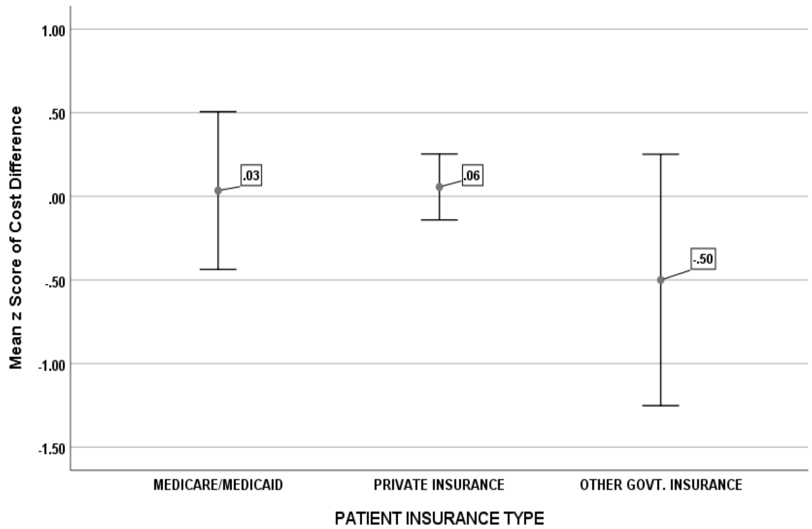

Figure 12. Error bar plot of mean *z* score of cost difference by insurance type.

The next table, Table 19, provided descriptive statistics for the *z* score of cost differences for each of the three types of patient insurance.

Table 19

Group Descriptive Statistics: z Score of Cost Difference by Patient Insurance Type

		N	Mean	Std. deviation	Std. error	95% confidence interval for mean Lower bound	Upper bound
Medicare/Medicaid		20	.0342	1.00793	.22538	-.4375	.5059
Private insurance		95	.0560	.96740	.09925	-.1411	.2531
Other government insurance		12	-.5003	1.18330	.34159	-1.2521	.2515
Total		127	.0000	1.00000	.08874	-.1756	.1756
Model	Fixed effects			.99464	.08826	-.1747	.1747
	Random effects				.15249	-.6561	.6561

The one-way ANOVA assumption of equal variances held (see Table 20). Levene’s test indicated the difference in the variation of *z* score cost differences based on patient insurance type was not statistically significant [$F(2, 124) = 1.278$, $p = 0.282$].

Table 20

Levene's Test of Equal Variances: z Score of Cost Difference by Patient Insurance Type

		Levene statistic	df1	df2	Sig.
z score of cost difference	Based on mean	1.278	2	124	.282
	Based on median	1.417	2	124	.246
	Based on median and with adjusted *df*	1.417	2	122.062	.246
	Based on trimmed mean	1.344	2	124	.265

Table 21 showed that the One-Way ANOVA was not statistically significant and that there was no significant difference in the mean *z* score of cost differences based on the patient's type of insurance. Therefore, the null hypothesis was accepted [F (2,126) =1.663, p = 0.191].

Table 21

One-Way ANOVA Results for z Score of Cost Difference by Patient Insurance Type

			Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	(Combined)		3.325	2	1.663	1.680	.191
	Linear term	Unweighted	2.143	1	2.143	2.166	.144
		Weighted	1.420	1	1.420	1.436	.233
		Deviation	1.905	1	1.905	1.925	.168
Within groups			122.675	124	.989		
Total			126.000	126			

This is also verified by the means plot in Figure 13. The effect size, calculated using eta squared which was calculated as the sum of squares between groups divided by total sum of squares, was 0.03. According to Cohen (1988), there was only a small effect of the one-way ANOVA.

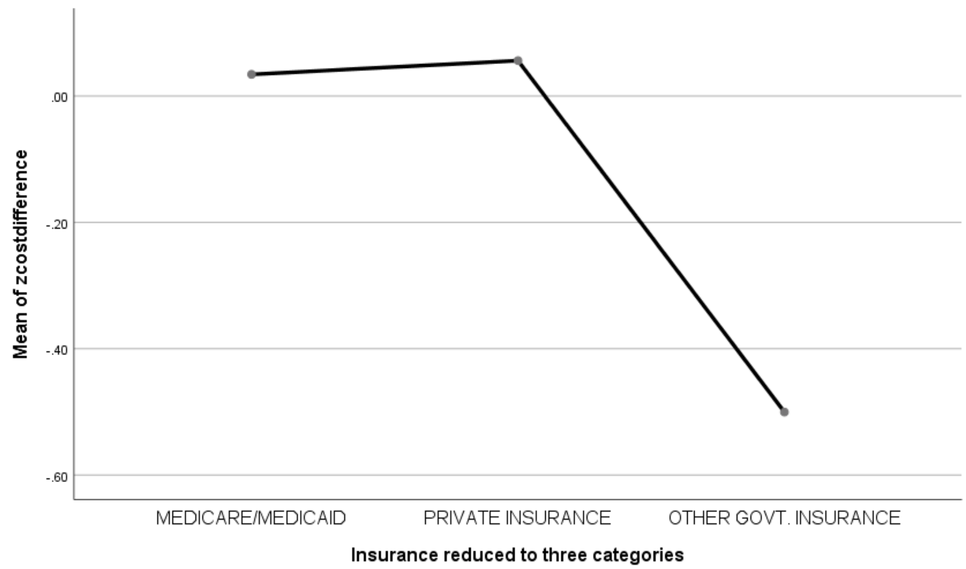

Figure 13. Means plots for *z* score of cost difference by patient insurance type.

Race was analyzed using an independent samples *t*-test to determine whether there was a significant difference in the mean *z* score for cost difference based on patient race. Prior to this inferential test, Figure 14 was generated to provide an error bar plot of the mean *z* score of cost difference by race of the patient. An error bar plot was used prior to the independent *t*-test as a preliminary determination of whether there was no difference in the means and variances between the two groups. From the error bar plot, it appears that the means for minority and white patients are slightly different. It also appears that the variance for the *z* score of cost difference in the *minority patient* group was greater than in the *white patient* group. We might expect that the independent *t*-test shows no significant difference in means but a significant difference in variances.

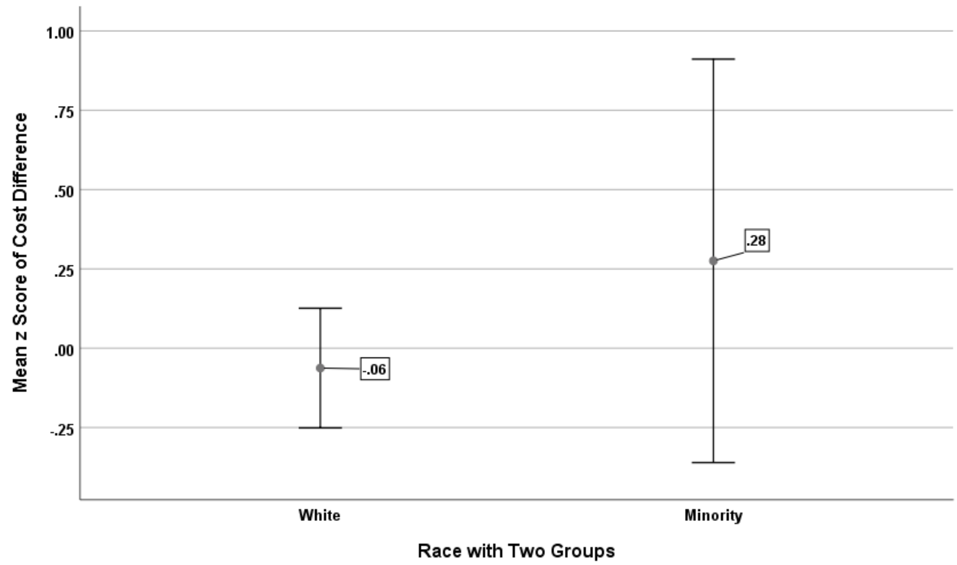

Figure 14. Error bar plot of mean *z* score of cost difference by race.

Next, I provided a table of summary descriptive statistics for the level of the dependent variable for white and minority patients. These results are found in Table 22 below.

Table 22

Group Descriptive Statistics: z Score of Cost Difference by Patient Race

	Race with two groups	*N*	Mean	Std. deviation	Std. error mean
z score of cost difference	White	118	-.0627	1.03491	.09527
	Minority	11	.2753	.94649	.28538

Table 23 presents the results from the Levene's test of equal variances and the independent sample *t*-test for testing the null hypothesis that mean *z* score for cost difference for both minority and white patients are equal.

The Levene's test of homogeneity of variance exhibits that there was no significant difference in the level of variance between minority and white patients [*F*

(127) = 0.256, *p* = 0.614]. Therefore, the assumption of homogeneity of variances holds. Based on the results of the independent samples t-test in Table 24, there was no statistically significant difference in the mean z score of cost difference between minority and white patients. The null hypothesis was accepted [*t* (127) =--1.043, *p* = 0.299].

Table 23

Independent Samples Test and Levene's Test: z Score of Cost Difference by Patient Race

		Levene's test for equality of variances		*t* test for equality of means						
									95% confidence interval of the difference	
		F	Sig.	*t*	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Upper
z score of cost difference	Equal variances assumed	.256	.614	-1.043	127	.299	-.338	.324	-.9795	.3033
	Equal variances not assumed			-1.124	12.34	.283	-.338	.301	-.9916	.3154

Summary

The results presented in this quantitative retrospective study were an analysis of the head and neck dataset. A total population of 1654 cases of head and neck cancers was collected. Of the 1654 head and neck cancers, 628 were diagnosed with oropharyngeal cancer. Out of the 628 cases, 208 tested positive for HPV or p16. I used a multiple regression analysis to identify and evaluate the associations between the dependent and independent variables. The analysis revealed that the null hypothesis was accepted and the alternate hypothesis was rejected. There was not a statistically significant relationship between cost and gender [t (127) = -0.943, p = 0.348], race [t (127) = 1.378, p = 0.171], insurance type [t (127) = -1.512, p = 0.133], and age group [t (127) = -0.230, p = 0.818]. Chapter 4 includes the interpretation, limitation, recommendations, implications for social change, and conclusions of the study.

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

Introduction

Human papillomavirus has been linked to an increase in oropharyngeal cancers. The cost associated with radiation therapy treatments for HPV-related oropharyngeal cancer is substantial. The purpose of this quantitative correlational research was to evaluate the relationship between age, gender, race, insurance, and radiation therapy cost for HPV-related oropharyngeal cancer in Kentucky.

Concise Summary of Results

I used secondary data from a regional cancer center to complete this study. The participants were selected from a head and neck cancer database for the period 2010 to 2016. A total of 1,654 cases of head and neck cancers were collected; of the 1,654 head and neck cancers, 628 were diagnosed with oropharyngeal cancer. Out of the 628 cases, 208 tested positive for HPV or p16. There were 130 patients studied, with 127 valid responses without missing data. The data were collected and analyzed using logistic regression, *t* test, and one-way ANOVA. The research question and hypotheses were developed to find any association between the dependent variable (cost) and independent variables (age, gender, race, and insurance). The null hypothesis was accepted, in that the independent variables were not statistically significant predictors of the *z* score of cost difference [F (4,122) = 0.972, p = 0.425]. The results showed no significant independent predictor variables ($p > 0.05$); gender [t (127) = -0.943, p = 0.348], race [t (127) = 1.378, p = 0.171], insurance type [t (127) = -1.512, p = 0.133], and age group [t (127) = -0.230, p = 0.818]).

Interpretation of the Findings

Oropharyngeal cancer is the second most common HPV-associated cancer deserving attention for future interventions (CDC, 2017). Research has demonstrated the cost of treating oropharyngeal cancer on a national level. Little research has been completed on state-specific data. Kentucky's population demonstrates a higher incidence of HPV-related oropharyngeal cancer compared to other states (CDC, 2017).

The interpretations of the results were generated from a correlation matrix and multiple regressions to test the hypothesis concerning whether the independent variables were statistically significant predictors of cost difference for treatment. To test the hypotheses for the research question, a multiple regression was performed to predict values on the dependent or criterion variable, the z score of cost differences, from a set of independent predictor variables for patient gender (male/female), patient age (under 50/50-65/over 65), type of insurance (Medicare-Medicaid/private insurance/other government insurance), and race (minority/White).

Although the findings were not significant, previous literature demonstrated similar factors pertaining to HPV-related oropharyngeal cancer. This study showed that 9 of 10 patients were aged under 50 (10%), 50 to 59 years old (42.3%), and 60 years and older (47.7%) compared to the median age of 57 years for HPV-positive patients in other studies (O'Sullivan et al., 2016). The NCI SEER population study examined data from 2002 to 2012. The study concluded that patients under 60 years of age make up 59.2% of HPV-related cancers (Mourad et al., 2017).

Over 9 of 10 patients were White (91.5%), while (8.5%) were members of racial/ethnic minority groups. In a previous study, Cole et al. (2012) provided evidence that HPV-associated cancers disproportionately affect certain age, sex, and race/ethnicity groups. White men had the highest rate of cancers of the oral cavity, followed by Black men (CDC, 2017). Human papillomavirus oropharyngeal cancer affects Whites (21-64%) to a greater extent than Blacks (0-35%; (Rettig et al., 2015).

SEER population study data for the period 2002 to 2012 indicated a male-to-female ratio of 4:1 for HPV-related oropharyngeal cancer. A Portugal study reported an increase of 3.5 APC in men with oropharyngeal cancer (Mourad et al., 2017). Korea reported similar results, with an APC of 2.65% increase for men (Mourad et al., 2017). In contrast, a study in England found increases in incidence in men and women (47.1% and 37.5%, respectively; Mourad et al., 2017). The percentage of HPV oropharyngeal cancer cases occurring in men has been reported as 65.8% in North America and 28.9% in Asia (Combes et al., 2017). In Asia, women had the highest incidence of HPV oropharyngeal cancer, representing 61.5% of cases. Of the 130 patients in this study, most were male (83.1% male, 16.9% female).

Nearly three-fourths of all patients (74.8%) were covered by private insurance. Another 15.7% paid for treatment using Medicare or Medicaid, and 9.4% were covered by other government insurance. Kentucky ranks 18th in access to health care, and 9.8% of Kentucky's population is uninsured (Bowling, 2016). From 2013 to 2014, approximately 268,000 people gained coverage, increasing Medicaid coverage by 80%; the majority of these newly insured individuals were adults 19-64 years old (Yelowitz, 2016). A study conducted on patients with neck cancer showed that Medicaid patients present with advanced cancer and higher rates of treatment delays compared to non-Medicaid patients (Naghavi et al., 2016). Oropharyngeal cancer treatment poses a significant cost for Medicaid, suggesting that early detection may reduce the economic burden of the disease.

The mean cost for radiation therapy treatments in this study was $123,629.14 (*SD* = $58,697.36). A review of 299 patients diagnosed with oropharyngeal cancer between 2011 and 2015 revealed 72 patients available for evaluation to determine costs associated with treatment (Pinheiro & Krama, 2016). The average cost for radiation treatments was $83,222. A study in Texas found that the cost of treating oropharyngeal cancer was $106,604. The findings showed that the cost of care for oropharyngeal cancer was higher than in previous studies. The mean adjusted monthly health care cost for those with oropharyngeal cancer was $6,693 and $870 for those without cancer (Cavallo, 2017). Age, comorbidity, mental health, prediagnostic cost, and time were predictors of cost (Cavallo, 2017). A retrospective study consisting of 365 patients 20 years or older assessed median monthly costs as follows: diagnosis ($2,199), treatment ($4,161), end of life ($6,614), and total ($4,167; (Reveles et al., 2017). Costs were driven by outpatient costs (23%), inpatient costs (18%), and radiation therapy (16%; (Reveles et al., 2017).

The findings of this study demonstrated that age, gender, race, and insurance do not influence the cost of radiation therapy treatments for HPV-related oropharyngeal cancer. The statistical analysis from this study demonstrated no relationship between the independent variables (age, gender, race, and insurance) and the dependent variable (cost). There were no significant independent predictor variables ($p > 0.05$); gender [*t*(127) = -0.943, *p*=0.348], race [*t*(127) = 1.378, *p*=0.171], insurance type [*t*(127) = -1.512, *p*=0.133], and age group [*t*(127)= -0.230, *p*=0.818].

Aday and Andersen's (1974) theory may be used in explaining costs related to predisposing factors, enabling factors, and need factors. The independent variables for this study were the predisposing factors of age, race, gender, and HPV status; the enabling factor of insurance; and the needs factor of oropharyngeal cancer. The dependent variable was cost. The findings disconfirm the theory that cost is influenced by predisposing, enabling, and need factors.

Limitations of the Study

The objective of this study was to determine whether age, gender, race, and insurance affected radiation therapy costs associated with treating HPV-related oropharyngeal cancer. Some limitations of the study were the sample size, selection of variables, and data from one regional cancer center in Kentucky. A larger sample size, expansion of the sample to include additional facilities, and consideration of other factors such as alcohol and tobacco as casual factors in oropharyngeal cancer might have led to different results. Inclusion of these factors might have supported the findings by making it possible to generalize to a population outside the sample.

Recommendations

This retrospective study did not examine all factors that could lead to increased cost associated with treating HPV-related oropharyngeal cancer. Cancer staging and treatment cost for chemotherapy and surgery were not considered for this study. In the future, a study with a larger sample size representing other cancer centers in Kentucky could be helpful in assessing the cost of radiation therapy treatments for HPV-related oropharyngeal cancer. In addition, future studies comparing smoking, alcohol, and HPV status among oropharyngeal cancer cases by gender, race, and age are recommended to help in understanding these risk factors. There is a need for future studies to evaluate all HPV-related cancers and the issue of HPV vaccinations.

Implications for Professional Practice and Social Change

Professional Practice

Therapies used to treat oropharyngeal cancer can result in substantial cost to the healthcare system (Ward et al., 2016). Oral cancers that were commonly associated with older males and alcohol consumption are now affecting younger populations regardless of alcohol or tobacco use (OCF, 2017). HPV-positive cancers have a different clinical presentation compared to HPV-negative cancers. The treatment response and survival outcome have a favorable prognosis (Chung & Gillison, 2009). Understanding clinical behavior of HPV-positive cancers may improve disease prevention and strategies for head and neck cancer patients (Chung & Gillison, 2009). Knowledge and experiences involving HPV vary across health professionals (Dodd, Foster, Waller, & Marlow, 2017). Addressing gaps in knowledge among health professionals may help with discussions and minimize negative psychosocial consequences of the disease.

Social Change

By 2020, cases of HPV oral pharyngeal squamous cell carcinoma are projected to outnumber HPV-mediated cervical cancer in the United States (Lewis et al., 2015). The importance of this finding involves the evaluation of HPV vaccination for prevention of oropharyngeal cancer. From a health perspective, vaccinating boys has the potential to reduce the risk of HPV infection of sexual partners. Lowering HPV infection rates in the general population could lead to lower rates of HPV-related diseases for both genders (Lee & Garland, 2017). This study could contribute to positive social change by addressing HPV and the impact on health care costs associated with HPV-related disease.

Conclusion

This quantitative, correlational study examined whether age, gender, race, and insurance were associated with increased cost of radiation therapy treatments for HPV-related oropharyngeal cancer. The results of the logistic regression showed no statistically significant correlation between age, gender, race, and insurance on radiation therapy cost. While this study did not show an association between these factors and cost, addressing human papillomavirus as a contributing factor in the increase of oropharyngeal cancers may promote the development of interventions for cancer prevention while reducing the economic burden of oropharyngeal cancers.

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