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An Analysis of the Inequitable Distribution of Health-Related Goods and Services Impacting Cervical Cancer Rates: A Case Study of Post-Apartheid South Africa

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"The essence of global health equity is the idea that something so precious as health might be viewed as a right"

-Paul Farmer

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College as a whole.

Madison Caufield

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Abstract

In South Africa, cervical cancer is the second most prevalent cancer among women. Despite screening being available and a national screening program having been launched in 2000, the lack of distribution of health-related resources continues to nullify efforts to prevent this form of melanoma. Furthermore, the prevalence of high cervical cancer incidence and mortality rates among black women in rural South Africa is much higher compared to their white counterparts in the urban areas. This study examines the changes in income and socioeconomic status (SES) inequality due to time, race, and geographic locations. The objective of the study is to show that one's race is not the only determinant of the inequality they face, but also their location (i.e. if they live in a rural or urban area). For this, I will apply the Gini coefficient and the concentration index to measure the socioeconomic inequalities that plague the community of South Africa and impact cervical cancer rates. The time periods I will use will allow me to compare the changes that have occurred since the end of Apartheid in 1994 to present day South Africa. The data that was used to perform these measures was collected from the 1996, 2001, 2011, and 2016 South African censuses and community surveys. Using the Gini coefficient to measure income inequalities between provinces and races, I was able to find significant quantitative proof of improved income distribution between each of these groupings. There was more change between racial groups recognized than between provinces. To apply the Concentration Curve and Index, I studied cervical cancer cases across racial groups, the number of cancer diagnosing facilities per province, and the number of individuals uneducated in each racial group. In each of the calculations, the variables were concentrated in the lower income groups; in my calculations the Black African population was the lowest income group so these negative variables impacted this group the most. Each of these variables are negative variables, so that shows that there is still a lot of room for improvement. An individual's income impacts almost every decision they make in life, so South Africa should first focus on ensuring that every individual receives equal opportunities to increase their own personal income-making ability. Once the income distribution is solved, more people will be able to afford an education, greater access to healthcare, and thus will be less likely to develop cervical cancer.

Chapter 1 – Introduction

The purpose of this report is to emphasize the inequitable distribution of care in regards to cervical cancer throughout the various provinces and racial groups of South Africa. Also, this report is to provide empirically backed evidence of this inequality in order to propose a quantifiable solution to this ongoing problem.

As a double major in Economics and Global Health Studies, I am particularly interested in the healthcare industry and international aid programs. During my sophomore year of college, I became interested in the topic of cervical cancer as I watched a close friend's mother struggle and pass away from this disease. Watching her pain and seeing all that her family endured inspired me to research how this cancer develops and to understand what prevention methods are in place to protect women from developing this form of sarcoma. As I researched cervical cancer rates in the United States, I noticed that, since the rollout of the Human papillomavirus (HPV) vaccine and the implementation of effective prevention programs, cervical cancer rates have been rapidly decreasing. With this realization, I decided to focus on areas of the globe where cervical cancer rates had not been impacted by these prevention methods. The areas most in need were located in developing countries, which lack the proper infrastructure and stable political states to properly implement effective prevention programs. Underdeveloped countries do not often provide the proper education settings, access to water or other goods and services that are directly correlated with improved health. The further I looked into cervical cancer rates in low-to-middle-income (LMIC) countries, the more apparent the need for aid in these areas became.

In sub-Saharan Africa, cervical cancer rates are actually increasing, "with more than 75,000 new cases and 50,000 deaths yearly" (Bouassa, 2017, p. 613). For most countries considered part of the sub-Saharan region, it is an unfortunate expectation that individuals are

more at risk there than in other areas. There are some outliers in this region, namely South Africa, that are classified as middle-income countries and are viewed to be on the development frontier of the underdeveloped world. With cities like Cape Town and Johannesburg, South Africa often evokes an image of development and improvement. Despite this, South Africa is one of the regions most impacted by cervical cancer rates in sub-Saharan Africa. This led me to study South Africa and the socioeconomic impact that Apartheid continues to have on the population's health to this day.

In my senior thesis, I plan to discuss a few key components of South Africa's history, politically and socially, in order to lay the foundation for what has caused the great health disparities between the white and black populations in South Africa. After providing some historical background, my study then launches into a brief analysis of the science behind cervical cancer and what behaviors are linked to the development of this sarcoma within women. From this, I will transition into the case study on South Africa, discussing the demographic changes that have occurred since the end of Apartheid in 1994 to present day South Africa. The theoretical framework I will use in order to compute and illustrate the disparities between whites and blacks, and thus urban areas and rural areas, is the concentration curve and index. In explaining the methods, I will address the Gini Coefficient, a standard measure for income inequality, and its direct relation to the concentration index, a measure of socioeconomic-related inequality. After explaining the complete economic process, the results will then be analyzed and clarified to illustrate the health disparities between the provinces that exemplify the clear disparities between the racial groups in South Africa.

I will be analyzing South Africa's socioeconomic data from the 1996, 2001 and 2011 South African censuses along with the 2016 community survey to determine if cervical cancer rates are positively correlated with the economic and social changes that have occurred since the

end of Apartheid between the rich and the poor, the whites and the blacks. This analysis will be centered on the hypothesis that: 1) The Gini coefficient will have decreased significantly since the end of the Apartheid and the establishment of the democratic regime for both the racial groups and the provinces, and 2) The concentration index will show that there are similar disparities between racial groups as there are between urban and rural dwellers, which will reinforce the fact that there remains a need for a redistribution of health-related goods with the target populations and areas in mind. The goal of this thesis is to show that one's racial background as well as geographic location impacts their health outcomes due to the inequitable distribution of health-related goods and services.

Chapter 2 – Historical Background

The white minority group has essentially ruled the political regime of South Africa for centuries. The group's political philosophies have been characterized by segregationist tendencies and prejudiced ruling habits. Since the mid-17th century, both the Dutch and the British have colonized South Africa, from 1652 to 1815 and 1815 to 1910, respectively (Missionary settlement in Southern Africa, 2017). The colonization of the land by these two European powers led to the molding of society around a model of slavery and forced labor (Missionary Settlement in Southern Africa, 2017). It was not until the subsequent establishment of the Union of South Africa in 1910 that the colonization period ended, but the segregationist tendencies and prejudiced ruling habits remained (Missionary Settlement in Southern Africa, 2017). Today, even with the end of colonization, the systematic injustices that were a foundational aspect of the colonial era remain a prominent piece of South African culture.

I. The Colonial Period

During the Dutch rule of South Africa, legislation promoting the segregation of whites and non-whites was implemented, which laid the foundation for the inequitable income and resource distribution based on race. Building onto the legislation that was initially passed by the Dutch, the British continued to oppress non-white individuals and to separate employment opportunities based on race (Missionary Settlement in Southern Africa, 2017). In the beginning of their colonial reign, the British abolished slavery in 1834 (Missionary Settlement in South Africa, 2017). Those who supported slavery protested this, which influenced the British rulers to pass the Masters and Servants Act of 1841 (Missionary Settlement in Southern Africa, 2017). This act made it illegal to break a labor contract, so there was no real change in society and the

enslavement of the black population under these oppressive labor laws continued. Ultimately, the legislation passed and the social structures shaped during the colonial period paved the way for Apartheid.

II. The Union of South Africa

After the end of the colonial period, the Union of South Africa was established in 1910 and continued as a constitutional monarchy until 1948. During this time, as an independent nation-state of the British Empire, several laws were enacted that furthered the segregation of whites and blacks. The division of land and development of the labor market are two key economic elements of a country, as they often determine how well a society functions and economically progresses over time. During the Union of South Africa, these two components of society were greatly impacted. One of the more severe acts that relates to the issue of land ownership was the 1913 Natives' Land Act, which "set aside [a mere] 7.5% of the land in South Africa for black people" with most of this land being rural (Land, Labor, and Apartheid, 2017, n.p.). Inherently, this meant that the white minority that made up only 20% of the population had access to over 90% of South African land ("The Native Land Act is passed", 2015). This is an important factor when discussing why there are such great health disparities between races in this country because location can greatly impact one's access to necessary services. As was pointed out in one of South Africa's censuses, "the separation of rural areas from cities and towns has imposed artificial political and administrative boundaries between areas that are otherwise functionally integrated [and] creates inequity for rural residents who contribute to the towns' economy but don't benefit from its resources" (Statistics South Africa, 2003, p. 2). In 1948, the Union of South Africa disbanded and transitioned into a system of institutionalized racial segregation called Apartheid from 1948 to 1991. South Africa's Apartheid era caused the

black majority to endure a suppressed lifestyle enforced by the white minority. In **Figure 2.1**, the Bastunans, also known as the homelands for blacks, are depicted and this image illustrates the physical form of suppression that continues to impact the lives of black individuals.

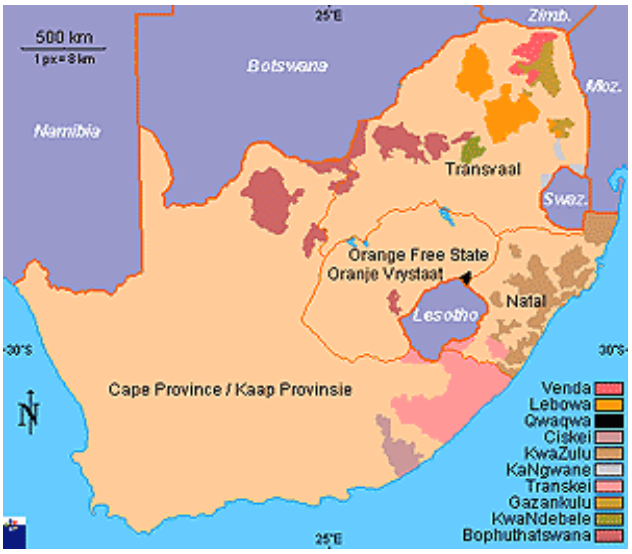


Figure 2.1: The Establishment of the Black Homelands (1951) Pictured is a map of South Africa and the peach color displays all of the land that the white minority was able to acquire, while the colorful pockets map out the areas titled the Bastunans, a.k.a. the black homelands.[1]

This spatial form of segregation has assisted in the sustained inequality of income and health, as it separates the poorest areas from the richer regions, which generally have better public facilities, such as hospitals and clinics. To provide some perspective on the impact that the creation of the black Homelands still has on the resource distribution to these areas, **Figure 2.2** below displays "the headcount index", which is a measure of the proportion of individuals living below the poverty line in a specific population. The differing shades of green show the different rates of poverty throughout the region; the darker the shade of an area is, the more impoverished the population.

[1] The Homelands. (2017). Retrieved from http://www.sahistory.org.za/article/homelands

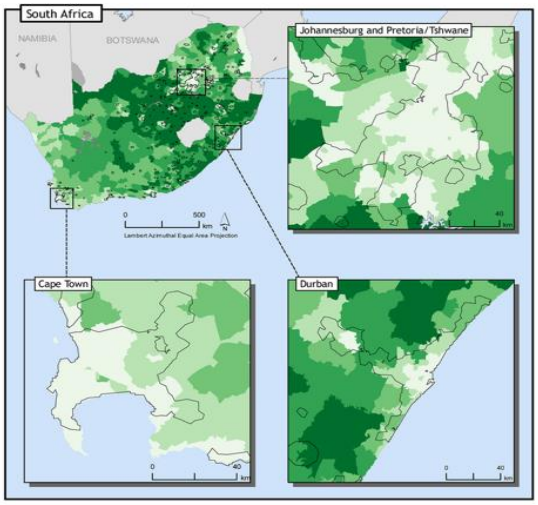


Figure 2.2: The Headcount Index The darker shade of green has, the more impoverished it is on this map of South Africa—in general, the areas that are the darkest are where the Black Homelands were establish[2]

The enlarged areas are the urban centers of South Africa. Each of these areas has the lightest shades of green, which shows a true rural-urban divide in terms of the welfare of each area's people.

Another image that displays the inequality of conditions that remains in South Africa today can be seen in **Figure 2.3**, where a "Map of Generalized Entropy" is presented.

This image effectively shows the different levels of impoverishment between the main city dwellings of South Africa and the rest of the rural areas.

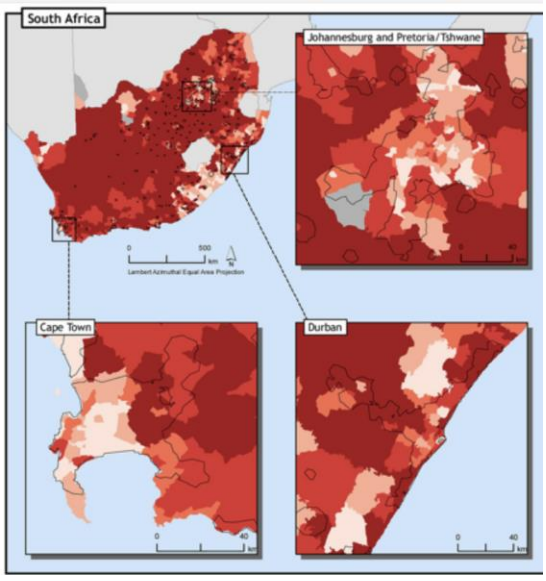


Figure 2.3: Map of Generalized Entropy This map displays the varying levels of inequality throughout South Africa, with the lightest areas having the least inequality and the darkest red having the most inequality[3]

[2] Linford, A. (2011). Inequality Trends in South Africa. Retrieved from http://www.geocurrents.info/economic-geography/inequality-trends-in-south-africa

[3] Linford, A. (2011). Inequality Trends in South Africa. Retrieved from http://www.geocurrents.info/economic-geography/inequality-trends-in-south-africa

As can be seen in the three zoomed-in pictures of South Africa's largest cities (Cape Town, Johannesburg, and Durban), the urban areas are the least impoverished and are generally of equal wealth, whereas in the more segregated regions the impoverishment levels are much greater. These inequalities are "highly correlated with race [as] the system of Apartheid, instituted from 1948-1994, determined economic possibilities and expectations based on race," beginning with the geographic segregation of the population throughout the land (Inequality Trends in South Africa, 2017, n.p.). The Apartheid era not only furthered the geographic separation of races, but also segregated the population among various institutional structures.

Lastly, the image below, **Figure 2.4**, shows where the urban areas are located in South Africa. In comparing this to the maps above, it is clear that the least impoverished areas are those that are urban. Along with this, these urban areas do not correspond with where the black homelands were located (Investigation into appropriate definitions of urban and rural areas for South Africa, 2001). With these two observations, the areas with the highest black populations are the primarily rural and impoverished areas.

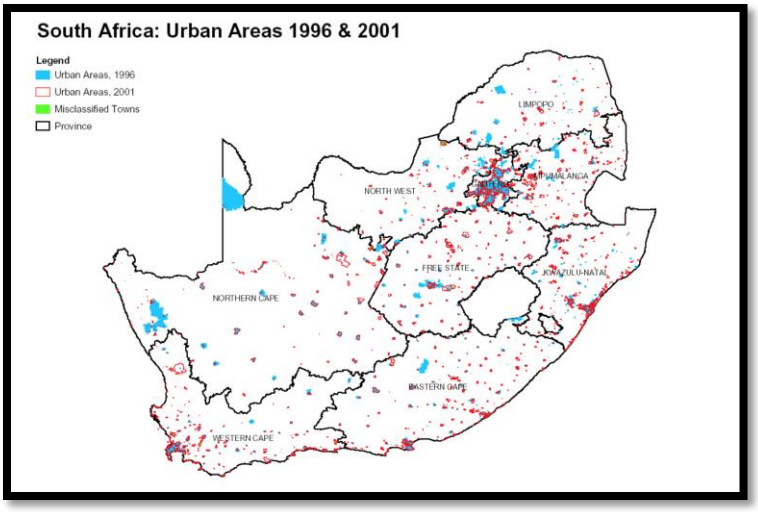


Figure 2.4: Urban Areas of South Africa (1996, 2001) This map, acquired from the 2001 Census data presents where the urban areas are located in South Africa in both 1996 and 2001[4]

[4] Investigation into appropriate definitions of urban and rural areas for South Africa. (2001). *Statistics South Africa*. Retrieved from http://www.statssa.gov.za/census/census_2001/urban_rural/urbanrural.pdf

III. Influential Laws of Apartheid Era

Initially, the South African Apartheid was described as a "petty Apartheid," meaning public facilities and events were segregated. Over time, it developed into what is known as a "grand Apartheid" upon the division of housing and employment based on race. Three notable laws that were implemented during Apartheid were the Population Registration Act (1950), Group Areas Act (1950), and the Bantu Education Act (1953). The Population Registration Act of 1950 formalized how the country classified individuals based on race. Individuals had to identify themselves as white, black, colored, or Indian, and were issued identity cards, including their name and race (Population Registration Act, 2016). Secondly, the Group Areas Act of 1950 further exacerbated the racial separation and "was fashioned as the "cornerstone" of Apartheid policy, aiming to eliminate mixed neighborhoods in favor of racially segregated ones which would allow South Africans to develop separately" (Group Areas Act of 1950, 2017, n.p.). Similar to the Natives' Land Act of 1913, the Group Areas Act worked to have racial groups develop separately from one another and to suppress the property rights of Africans.

The separate development also assisted the National Party in continuing to "control the African labour needed for rapid industrial development" (Group Areas Act of 1950, 2017, n.p.). The government tried to make this division more appealing by supposing that this would allow the Africans to develop their own areas, but the economic structure of the country simply made this an infeasible goal. Lastly, the Bantu Education Act of 1953 legalized the racial separation of educational facilities. The greatest impact from this law could be seen in the differences between races, in terms of years of education attainment and quality of schools.

This creation of a "separate and unequal system of black education [in place of a] single public schooling system for all South Africans" was a "racist and paternalistic view that the education of blacks was a special responsibility of a superior white race" (Bantu Education Act,

2018, n.p.). Ultimately, this law further divided the employment opportunities for individuals based on race, because, in the black schooling areas, individuals were taught skills specifically to work in servitude of the white man's labor needs regardless of their abilities. This denial of access and systematic supremacy of the white man resulted in a further tipping of the scales between whites and blacks in regards to financial and occupational opportunities. The impact of this act will not simply subside quickly, as this form of bias has been foundational to all systems in South Africa, so to overhaul such fundamental features of a government structure would take years of effort and strong civil engagement. Over twenty years have passed since the end of Apartheid, yet the education systems remain unequal in terms of access to quality education and qualified instructors (Bantu Education Act, 2018). In its continuing state of transition from the Apartheid to a democracy, it is imperative that the education system is properly reformed to ensure the rightful development of all individuals and to create true demographic change.

"Before South Africa's first democratic elections, hospitals were assigned to particular racial groups, [most of which] were concentrated in white areas" (Health Care in South Africa, 2012, n.p.). From 1948 to 1991, the National Party defined South African living by their created system of institutionalized racial segregation, so-called Apartheid. This racial segregation included the division of public facilities, community events, housing, etc. The African National Congress (ANC) fought this for years and, finally, between 1987 and 1993, the National Party began to negotiate reforms of the current government structure with the ANC. In 1990, Nelson Mandela, a prominent ANC leader, was released from detention and in 1991 all Apartheid legislation was abolished with multiracial elections set to begin in 1994. In post-Apartheid South Africa, despite the great strides Nelson Mandela and the rest of the ANC made, there remains great division between white and black, and thus urban and rural, populations in terms of health and well-being. In many ways, the infrastructure of this country continues to promote

segregation, as resources are distributed differently and access to care ranges according to one's socioeconomic background. The political economic state of South Africa ultimately leads to most of the inequitable distribution of resources and leaves a large facet of the population impoverished and unable to afford even the most basic form of care. However, other dimensions of health must be considered as well to fully grasp the issues at hand.

The primary goal of this section is to show that the issues underlying the high cervical cancer rates in one of the most developed countries in Africa are deep-rooted and that the biases between races have a long history. The historical infrastructural inequalities created by the societal norms and laws discussed above have possibly created an "infrastructural-inequality trap", which impacts the livelihood and health of all those not located near better healthcare facilities (Stuckler, 2011). While the idea of uprooting all systems of prejudice is a complex and time-intensive endeavor, it is important to recognize where the true issues lie and to level the playing field that has impaired the non-white population's ability to achieve equality.

South Africa is one of the most unequal countries in the world, primarily due to the historical injustices that have shaped the country. Despite the acknowledgment of the unlawful practices of previous regimes, the South African society continues to play into the hands of prejudice and prevent black individuals from attaining the same level of health as other individuals in society. The key to discerning where the true problems lie is to analyze these socioeconomic issues through a multidimensional lens. To provide a complete view of South Africa and why cervical cancer rates remain high, the case study in the following section will serve to layout the multifaceted landscape of cervical cancer and will provide the necessary information needed to highlight all of the factors that come into play. First, cervical cancer will initially be analyzed in terms of the science behind the disease and the risk factors associated with it. Next, the focus will then be dedicated to the impact that an area's culture can have on

implementing effective preventive care, specifically in sub-Saharan Africa. After this, the ethical dilemma regarding the right to health will be addressed with an in depth analysis of ethnic disparities in access to care in developing areas. Lastly, important economic principles related to the difficulty of implementing effective cervical cancer preventive services, including development economics and cost-effectiveness analyses, will be discussed.

Chapter 3 – Case Study: Differentials in Health Equity between Urban and Rural Provinces of South Africa

South Africa has been in post-Apartheid era for roughly twenty years, yet it continues to struggle to fully transition into a functioning democratic regime due to the continued impact that years of segregation laws have had on the region's populace. Exploring this form of sociopolitical transformation is quite rare, which makes this case much more interesting and complex. The foundational aspects of Apartheid continue to segregate individuals by race, despite the current regime's attempts to reform education, property rights, and healthcare laws to achieve equality amongst the population.

In terms of health, breast cancer is generally the leading type of cancer developed by women in almost every region in the world, but in South Africa, for black women specifically, cervical cancer has higher incidence and mortality rates (Jordaan, 2016). To study why this is so, this section will present South Africa in the form of a case study with a multi-sectorial approach to provide background on the variables that tie the consequences of Apartheid era to continuously increasing cervical cancer rates.

I. About the Provinces

South Africa is divided into nine provinces, each of which with its own legislature, economic conditions, and geographic landscapes. These provinces were all created upon the end of Apartheid in 1994, so each is relatively young in terms of economic and political development. **Figure 3.1** provides a map of South Africa that shows how the nine provinces of South Africa are divided.

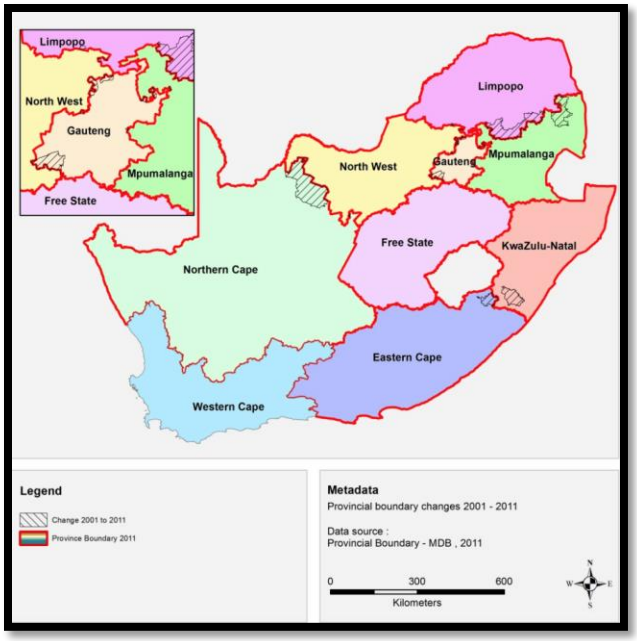


Figure 3.1: Map of the Nine Provinces of South Africa[5]

Overall, in terms of ethnicity, Black Africans constitute 79.2% of the population, while the Coloured and White populations both make up 8.9% (South Africa Census in Brief, 2011). . With the smallest proportion, the Indian/Asian ethnic groups constitute just 2.5% (South Africa Census in Brief, 2011). The most urban and wealthy province, Gauteng, will briefly be described as well as the most rural and poorest province, Limpopo, in order to show the inner-country disparities across South Africa.

Gauteng, in the language of Sesotho, translates to "place of gold" (Facts About Gauteng, 2018). Despite being the smallest province in South Africa, it is a highly urbanized area, has a Human Development Index (HDI) of 0.74, and is considered one of the nation's economic hubs. This province "accounts for just under one-quarter of South Africa's population and generates 35 percent of national economic output" with its "average standards of living and labor productivity [having increased significantly]… over the past fifteen years" (Parilla, 2016, n.p.). Gauteng has

[5] South Africa Census in Brief (2011). *Statistics South Africa.*\

a population of over 14 million people, with 11 million of those individuals living in an urban area (Facts About Gauteng, 2018). In terms of ethnicity, 77% of the population is Black African, 15% is White, 3.45% is Coloured, and 2.91% is India/Asian (South Africa Census in Brief, 2011). Of Gauteng's population, 97.2% live in urban dwellings, while only 2.8% live in rural areas (Statistics South Africa, 2003). The average annual household income of Gauteng is US$156,243, making up 19.21% of the relative percentages of income throughout the nation (South Africa Census in Brief, 2011).

On the other hand, the poorest and most rural region is the Limpopo province. Of its population of 5.4 million people, 96.7% of individuals are Black African, 0.3% are Coloured, 0.3% are Indian/Asian, and 2.6% White (South Africa Census in Brief, 2011). Over 87% of the population in the Limpopo province resides in rural dwellings, with the remaining 13% in the urban areas (Statistics South Africa, 2003). This is the northernmost province and is located at the heart of where the "homelands" were placed, which partially explains the province's economic woes. Over 79% of the population lives below the national poverty line and it is one of the provinces with the largest income gaps between the wealthy and the poor (Provincial Review of Limpopo, 2016). The average annual household income in the Limpopo province is US$56,844, which makes up just 6.99% of the relative percentages of incomes amongst the nine provinces of South Africa (South Africa Census in Brief, 2011).

Through analyzing the trends between the economic capacities of each of the nine provinces, their ethnic make-up, and the percentage of rural land, there is a clear association. Generally, the provinces that are made up of the highest percentages of Black Africans, such as the Limpopo and Eastern Cape, are the ones with the lowest average annual incomes and the highest percentage of rural living spaces. With noticing this, the empirical analysis of all of the

provinces will focus on these associations in attempt to provide quantitative evidence of similar inequities between provinces due to racial and spatial biases.

III. Cervical Cancer Rates in South Africa

Cancer can develop anywhere in the human body and, as the cells grow exponentially and become more abnormal, growths called tumors develop (What is Cancer, 2018). These abnormal growths can be benign or malignant; benign tumors do not spread into surrounding tissues, but malignant growths do (What is Cancer, 2018). A specific form of cancer is cervical cancer, which develops in the cervix (What is Cervical Cancer, 2018). The cervix is on the lower end of a woman's uterus and connects the uterus to the vagina (What is Cervical Cancer, 2018). This type of melanoma was identified long ago, but it was not related to sexual activity until 1842 when Domenico Rigoni-Stern conducted an epidemiological study and "published a series of mortality statistics of women dying of cancer in…Verona…[where he] pointed out [rather simplistically] that 'cancer of the uterus' was much more common in married women and widows than in virgins and nuns" (Reynolds, 2008, p. xix). Despite his research, Rigoni-Stern's observation of the linkage between sexual activity and cervical cancer was overlooked for over a century. It was not until 1980 that researchers reaffirmed the linkage between cervical cancer and sexual activity with the identification of the Human Papillomavirus (HPV). This was a crucial development in the study of cervical cancer because HPV is a Sexually Transmitted Infection (STI), thus affirming the relation of sexual activity with cervical cancer. Researchers have discovered that certain strands of HPV have caused "more than 99% of cervical cancer cases worldwide" (Cervical Cancer, 2017, n.p.). The high-risk strains of HPV include HPV 16 and HPV 18; these two forms alone cause 70% of cervical cancers (What is HPV, 2018).

According to the WHO's discussion of Cervical Cancer (2017), cervical cancer is "the second most common cancer in women worldwide by age-standardized incidence rate", despite it being a highly preventable disease. As discussed above, it is known that cervical cancer is caused by the Human papillomavirus (HPV), as it is "found in about 99% of cervical cancers" (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013, n.p.). This sexually transmitted infection is "estimated to be the most common STI" as "by age 50 approximately 80% of women have been infected with some" strain of HPV (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013, n.p.). In general, the majority of women who have been infected by this virus do not develop cervical cancer, but, if the infection remains, it generally affects women between 35 and 55 (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Thus, it is clear that due to this long period of time needed for development, cervical cancer is one of the most preventable cancers. To provide a visual overview of the general life course and population prevalence of the HPV to precancer to cervical cancer, see **Figure 3.2.**

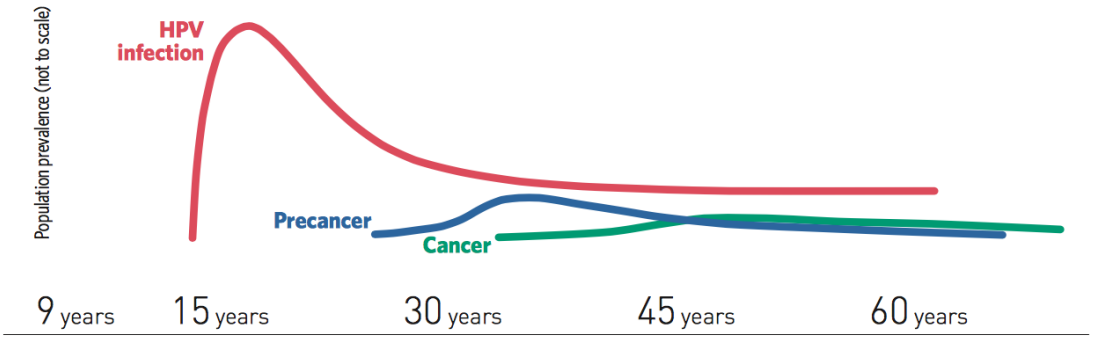


Figure 3.2: The Progression of an HPV Infection into Cervical Cancer In the figure above, the general age one develops one of these illnesses by the population prevalence for each of them is provided.[6]

[6] Comprehensive cervical cancer prevention and control: a healthier future for girls and women . (2013). Retrieved from http://www.who.int/immunization/hpv/learn/comprehensive_cervical_cancer_who_2013.pdf

HPV is the most commonly transmitted sexual disease, infecting both males and females (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Through vaginal, anal, and oral sex, HPV can be spread from an infected individual to another (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Depending on one's immune system and the HPV strain one is infected with, the virus will either become active or remain dormant (HPV Dormant Period, 2018). In general, HPV infections most often will remain dormant within the cells of the body, but when the virus becomes active, it can lead to the development of health issues related to genital warts and cancer (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). It is difficult to recognize when one is infected with HPV, as symptoms often do not develop for several years, at which point they will most likely develop one of these health issues (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). For the relation between HPV and cancer, this virus can cause several forms of cancer: cervical cancer, vulvar cancer, vaginal cancer, penile cancer, and anal cancer (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). For each of these, it takes many years, oftentimes decades to develop after contracting HPV (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Regardless, there are ways of avoiding these health issues via primary, secondary, and tertiary prevention methods (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013).

There are three tiers of prevention: primary, secondary, and tertiary. Until fairly recently, the primary forms of prevention against cervical cancer focused on more general safe-sex ideals, such as practicing abstinence, the mutual monogamy of partners, and the usage of condoms (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Many cultures vary with the practice of abstinence and monogamy, even within marital relationships, so the new form of primary prevention has proved to be much more effective and trustworthy. In 2006, two forms of the human papillomavirus (HPV) vaccine were developed, titled Cervarix and Gardasil.

Cervarix, produced by GlaxoSmithKline, is a bivalent vaccination; this means that it protects against two strains of HPV: HPV 16 and 18 (Cervical Cancer Causes, Diagnosis, and Symptoms, 2013). Gardasil, created by Merck and Co., is a quadrivalent vaccination; it protects against four strains of HPV: HPV 6, 11, 16, and 18 (Human Papillomavirus Vaccines, 2018). The World Health Organization (WHO) recommends that boys and girls, ages 9 to 15 years old, should receive a two dose HPV vaccine series to prevent HPV 16 and 18 infections, which are two of the most prevalent strains of HPV associated with cervical cancer (Human Papillomavirus Vaccines, 2017). Since HPV is transmitted sexually, it is requested that girls and boys receive it at an early age, so that individuals receive it prior to their involvement in sexual activity (Human Papillomavirus, 2017). Cervarix is recommended as a single dose series to protect against HPV 16 and 18. According to Harper et al. (2017), Cervarix has been identified as "the easiest and most cost-effective vaccination program over time, especially in low and lower middle income countries (LMICs)" (Harper, 2017, p. 196). If 70% of girls aged 9-12 years old, receive this bivariate vaccination, the lifetime risk of cervical cancer will be reduced by 43% (Goldie, 2004). These vaccinations have each been proven to protect against HPV and reduce the chances of abnormal screening tests. In the developed world, once Gardasil and Cervarix were FDA approved in 2006 and 2007, respectively, the implementation of vaccination programs was rather simple (Human Papillomavirus Vaccines, 2018). This HPV vaccine has been acclaimed as one of the greatest pharmaceutical innovations of this generation and would be incredibly beneficial if everyone had access to it.

Secondary prevention focuses on the early detection of precancerous lesions using various screening techniques. After one is screened, if precancerous lesions are identified then efforts will be made slow or stop the progression of a disease through the use of tertiary prevention practices (Concepts of Prevention, 2015). Essentially, screening assists in

distinguishing unrecognized disease and is "implicitly used when primary prevention has failed" (Concepts of Prevention, 2015, n.p.). There are several types of screening methods, with the most notable being cytology-based, visual inspection, and HPV testing. For developed countries, the Pap smear is the classic mode of secondary prevention, as these regions can afford it and it is one of the most effective means of this level of prevention. For developing regions, though, the Pap smear is not a cost-effective measure for them and it requires a lot of resources (laboratories, technicians, etc.) that these low resource areas simply cannot provide. With this, many of these regions rely on more cost-effective, lower quality means of secondary prevention, such as the Visual Inspection of the cervix with Acetic acid (VIA) or with Lugol's Iodine (VILI) (New Guidelines for the Screening and Treatment of Cervical Cancer, 2018). These do not require as many health workers or laboratories and can be performed almost anywhere, yet there are many limitations to these forms of screening. The screen-and-treat approach has been proven to be a very cost-effective and efficient way of ensuring that more women, regardless of their socioeconomic background, will be able to increase their chances of decreasing their chances of being inhibited by invasive cervical cancer. In a study conducted by Denny et al. (2005), three separate screen-and-treat methods were tested in Cape Town, South Africa: screening with VIA, then treating with cryotherapy; screening with HPV DNA testing, then treating with cryotherapy; and delayed treatment for 6-months for either form of screening (Denny, 2005). The results suggested that HPV DNA testing followed by cryotherapy treatment was "twice as effective in reducing high-grade lesions compared with VIA followed by cryotherapy" (Denny, 2010, n.p.). The HPV DNA test is more accurate than the standard Pap smear, but it is even more expensive. There has been a cheaper version of the HPV DNA test titled careHPV, which should be the future for developing countries, as it is both effective and relatively cheap.

Lastly, tertiary prevention attempts to reduce the damage caused by an individual already affected by the symptoms of cervical cancer through physical, mental, and social rehabilitation. It has been found that only "3,500 preventable deaths from cervical cancer [occur] in the United States and [more than] 200,000 [occur] world wide" (Ramondetta, 2011, n.p.). High rates of incidence and mortality in the United States and other developed countries alike have slowly decreased over time, due to increased surveillance, educational programs, and recommendations of yearly Pap Smears. The most important as well as difficult aspect of providing effective screening programs is ensuring that Pap Smears are repeated regularly, which is something that is not always possible in developing countries. This, then, may strengthen the case for using other methods of screening. Of course, such programs are relatively easy to implement in developed countries, because of their resources, strong economic states, and politically stable governments and healthcare systems. For developing countries with more volatile socioeconomic conditions, implementing cervical cancer programs is a much more difficult feat. Tertiary prevention is the form of care that occurs after a health issue has developed. The objective of this level of prevention is to maximize capabilities and functions post-impairment through rehabilitation. It generally encompasses the prevention of pain, slowing of disease progression, and repairing one's physical, mental, and social health prior to the ailment. For cervical cancer, one receives tertiary preventive care once precancerous lesions are developed in order to reduce the incidence of invasive cervical cancer. First of all, precancerous lesions are abnormalities that can be found in one's screening results and these abnormalities are associated with cervical cancer cells. So, if left untreated, these lesions could develop into cervical cancer, thus leading to one receiving tertiary care. It is crucial that these precancerous lesions are diagnosed in the early phases via screening tests, so as to be able to properly manage and prevent the progression to invasive cervical cancer.

In order to decrease the chances of developing cervical cancer, individuals can take several measures on their own, beginning with the identification and recognition of the risk factors that are associated with cervical cancer (Human Papillomavirus, 2018). A risk factor is a variable positively related to the increased chance of developing a disease (Human Papillomavirus, 2018). There are several risk factors that assist in the development of cervical cancer, but the primary variables that will be focused on this study are the Human papillomavirus (HPV) infection, the human immunodeficiency virus (HIV) socioeconomic factors (i.e. race and its relation to income) (Human Papillomavirus, 2018).

IV. The South African Perspective

South Africa is a country of contrasts, where a white minority has historically patronized the black majority and where the 'right to health' is directly addressed in its constitution yet few are actually guaranteed effective service. To discuss all of the effects Apartheid has had on South Africa's culture and social structures would result in an interminable list of rather adverse ramifications. With this, I plan to highlight the role of cultural awareness and education in society and how it can impact one's health.

A. Awareness and Acceptance of Cervical Cancer Programs in Developing Regions

Cultural understanding as well as acceptance of westernized medicine makes a large impact on how successful prevention programs are, especially in developing countries. In Anorlu et al.'s (2008) analysis of cervical cancer from the Sub-Saharan African perspective, education and awareness of this disease are large reasons as to why Sub-saharan Africa has some of the highest rates of cervical cancer in the world. In another study, this point is taken further

and is the motivation behind Ayissi et al.'s (2012) study. The community of Cameroon was analyzed to address the society's understanding of cervical cancer and the prevention programs that are associated with this disease leading to the implementation of educational programs that address the region's needs.

With this educational and cultural campaign, awareness of HPV and cervical cancer rose. By testing the community, the largest p-values for cervical cancer were the variables: 'sexually active', 'age', and 'level of education' (Ayissi, 2012). A p-value is used in statistical hypothesis testing and it stands for 'probability value', thus it provides the probability of finding the observed results when the null hypothesis is viewed as true. The most important discovery in the Ayissi et al. (2012) study was that increased education lead to improved awareness and thus improved cultural understanding and acceptance of cervical cancer programs. By obtaining this understanding and acceptance, prevention programs can be much more easily implemented into developing regions and thus will improve health outcomes and ultimately lower cervical cancer rates. Culture and education certainly play a large role in the effectiveness of cervical cancer programs, but it remains that economic barriers are the primary reasons why implementation of such programs continues to be difficult for public health workers.

Knowledge of a disease can greatly impact a community's ability to lessen incidence and mortality rates; if a community is aware of a disease and its risk factors, then people will know what behaviors to avoid and what resources are available to prevent a disease from spreading to them. Unfortunately, despite high prevalence rates, many people do not recognize the risks associated with cervical cancer or the prevention methods available to prevent the spread of HPV. According to Ogbanna et al. (2017), in a study of sub-Saharan Africa women enrolled in a British university, it showed that of the 186 African women recruited in the study, only 38.2% of them were aware of cervical screening and even fewer (10.8%) were knowledgeable on the

subject of cervical cancer (Ogbanna, 2017). From this study, "it was evident that student's perception [of cervical cancer] was dependent on their experience of the disease just as their participation in screening programs was dependent on their knowledge of it" (Ogbanna, 2017).

Over the past twenty years, primary and secondary schools have failed "to show significant improvements [which has further exacerbated] the country's high unemployment rate" (Education in South Africa, 2001). Issues with the education system have occurred since the colonial days, with the political movements supporting segregation being at the root of the cause of low national literacy rates. Despite having a promising and emerging market, the unemployment rate has "stood at 26.5 percent overall and [is] even higher among black youth" (Education in South Africa, 2017). The government of South Africa has improved access to education, with upper-secondary enrollment having increased since 2000, but "persistent inequities and poor quality [of education has lead] to low education outcomes" (South Africa Policy Brief, 2015). The OECD has reinforced the fact that improving the equity and efficient of resource distribution and use is key to fixing the current social and vocational inequalities across the population. To provide a visual of the inequalities between races in terms of education attainment, see **Figure 3.3** below.

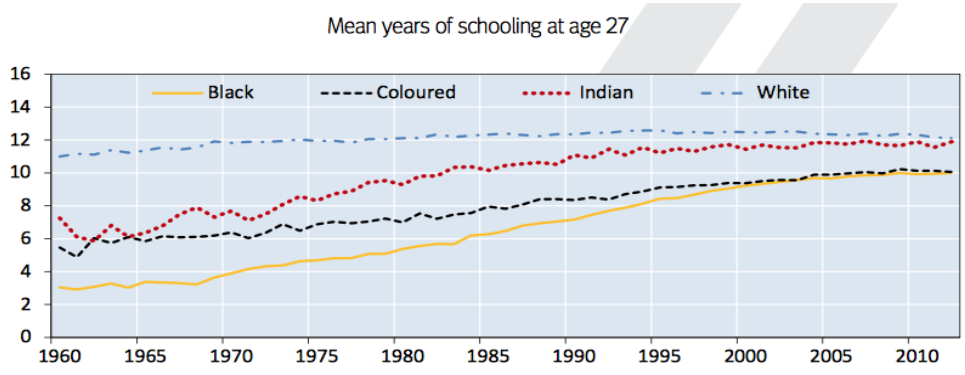


Figure 3.3: Mean Years of School Across Race and Time This graphic, obtained from the OECD's policy brief on South Africa's educational system displays the inequalities in educational attainment since the years of apartheid to today

The black population makes up over 80% of the population, yet it attains the fewest years of schooling compared to the other races. Fortunately, some of the inequality gaps have been closed; it is important to note that, though similar levels of education are being achieved, it does not mean that similar qualities of education are being provided. In the empirical analysis, I plan to analyze inequalities in terms of education quality to see if lower quality education is associated with more impoverished communities.

Education is one of the primary focuses of my empirical analysis, because one's level of education is correlated with their employment (Education in South Africa, 2001). According to a Statistics South Africa report, it was found that "unemployed people generally had lower [education] qualifications than employed people…often having only completed primary school" (Education in South Africa, 2001, p. 2). The Black African and Coloured populations generally had the lowest levels of education, while the Whites and Indians had the highest. Similarly, of the rural population that was unemployed, over 30% of them had not continued past primary school; for urban areas, this number was 12% (Education in South Africa, 2001, p.2). In the 1996 South African Census, roughly 47% of Black Africans were not "economically active, and more than half of rural people had no formal education" (Education in South Africa, 2001, p. 2). Education is also correlated with access to sanitation facilities and piped water, which is directly related to one's overall health (Education in South Africa, 2001, p. 2). Generally, higher education levels are associated with greater access to basic goods and services, which in turn impacts one's health. The South African government is working to ensure that more people are given the opportunity to achieve a higher education. Since the end of Apartheid, the South African government has worked hard to lessen disparities between racial groups. In a legislative document titled "White Paper on Education and Training in Democratic South Africa" dictated

education as a human right so that "all citizens…[have] the opportunity to develop" (Education in South Africa, 2001, p. 5).

V. The Right to Health in South Africa: An Ethical Dilemma

The World Health Organization's (WHO) Constitution of 1946 views "the highest attainable standard of health as a fundamental right of every human being" (Human Rights and Health, 2018). Today, this human right to health is established in international law for most global governing powers, but it remains a difficult promise to fulfill. This is primarily associated with resource constraints and the idea of scarcity, which defines how there will never be a lack of want in the world but there will always be limited resources to fulfill such desires. Essentially, what the goal is for the present is to get every region into a state of functioning where whatever resources are available are actually distributed equitably to any individual regardless of race, location, class, etc. Once global health governance powers can put an end to structural violence, it can be possible to genuinely achieve efficient allocation of resources and begin to fulfill the promise of the human right to health. The efficient allocation of resources is related to the economic idea of Pareto efficiency, which is a state of resource allocation when the reallocation of goods or services to make someone better off is not possible without making another worse off (Osborne, 1997).

There are two different kinds of rights: positive rights and negative rights (Bradley, 2010). Positive rights require action and are the "right to" something, whereas negative rights do not (Bradley, 2010). Examples of positive rights are the right to health and the right to education, whereas an example of a negative right is the right to free speech (Bradley, 2010). The primary issue with positive rights is that one must rely on another to provide them with a good or service to have that right afforded to them regardless of whether they deserve it or not

(Bradley, 2010). Also "[h]ealth care falls into the category of positive rights since its provision by the government requires taxation and therefore redistribution…, [so some do argue that] health care cannot be a true right" (Bradley, 2010, p. 838). When something must be given to someone, the issue of resource allocation must be analyzed, as well as the foundational structures of a society that prevents resources from being equitably distributed and, thus, rights from being provided (Bradley, 2010). Structural violence, especially in South Africa, is one of the key ethical inhibitors preventing women from varying regions of the country from being provided the best standard of care they could possibly receive.

Minorities or those that are located in primarily rural areas are subject to structural violence that is implicitly bestowed upon them by the unjust policies of past political regimes. South Africa perfectly models the impact that structural violence has on an area's population. After centuries of segregation and oppression of the black population, the white faction has the greatest proportion of income in the country. This is due to the fact that the African tribal people were pushed into the poorest parts of the land, thus making employment opportunities even sparser and ultimately suffocated most of them into lives of squalor.

The key to improving the health of women in South Africa and lower the rates of cervical cancer is to redistribute resources to ensure that they are distributed equitably and that the areas that need the most help, primarily the rural regions, are fairly addressed. Unfortunately, it is rather difficult to incentivize companies to redistribute resources more equitably, despite it being a morally beneficial act. There is rarely a profit to gain when a company operates to distribute goods equally across society, because it leads to higher production costs and the lowering of prices of the good sold. Convincing producers to provide their health product in an almost *pro bono* way is a difficult task. If a company is willing to produce at a loss to benefit society, they must then address the significant barriers that prevent those who the ease of access to healthcare

for those who reside in the "rural areas of South Africa face when trying to access health care, including financial barriers, inadequate transport, and distance from the nearest facility" (Gaede, 2011). There are several determinants that affect the outcome of one's health and each is related to an individual's basic rights. For one, there are the social determinants of the right to health, such as poverty, food security, and nutrition as well as the education levels and in rural areas "there are high levels of deprivation" of these basic needs and in some ways these "social determinants have a greater impact on the health status of a nation than the availability of curative healthcare services" (Gaede, 2011). Another issue regarding social determinants is the idea of migrant workers. The agricultural sector for the rural areas is a significant contributor to the South African economy. As analyzed in Afzal et al. (2017), these migrant workers contribute, in a large part, to the high rates of cervical cancer. The study takes into account both migrant farm workers and sex workers and highlights the increased rates of both HIV and HPV and suggests using the VIA to screen HIV+ individuals and include this in the local rural HIV clinic of the Limpopo province. The ethical issue underlying this all is the fact that one's race and thus their geographical location continues to impact their "right to health", which is a right that should be automatically provided to any individual.

VI. Healthcare Economics and Socioeconomic Barriers Preventing Effective Cervical Cancer Prevention Programs

To use a socioeconomic lens on this health issue demands analyzing not simply the economic variables in the context of a country's economic performance, but also the social factors that impact the region's prosperity. There are several socioeconomic theories that come

into play when analyzing the impact that health programs have on a region's population, which include economic development models and cost-effectiveness analyses.

A. Healthcare Economics

Healthcare markets are generally difficult to analyze due to the fact that the typical assumptions associated with typically defined markets do not apply (Morrisey, 2008). The ideal market structure is a perfectly competitive market. When analyzing a perfectly competitive market, there are five key assumptions one makes: the market has many sellers, many buyers, freedom of entry to and exit from the market, homogenous products, and both the buyer and the seller have perfect knowledge regarding the good or service (Morrisey, 2008). Should a market be structured within this framework, Pareto efficiency at equilibrium between supply and demand is theoretically claimed to be achieved (Osborne, 1997). Essentially, consumers pay the least for the highest quantity, producers produce the most at the lowest cost, and there is no reallocation possible that can make anyone better off without making someone else worse off. Healthcare markets are predisposed to allocating resources sub-optimally due to the fact that there are few producers and each has the power to set prices that primarily benefit them over the consumer. Take, for instance, Big Pharma, a small collection of large pharmaceutical companies that operate globally and freely dictate how pharmaceuticals are priced, thus making the firms "price makers" instead of "price takers" (Boundless Economics, n.d.). This ability to determine the price based on the company's needs allows for corruption and unethical behavior by charging high prices at low quantities to maximize profits similar to how a monopoly would operate.

Another aspect that differentiates the healthcare market from a perfectly competitive market is the asymmetric information in the relationships between patients, providers, and payers. Due to their training and educational pursuits, doctors inherently know more about

illness and disease prevention than patients, thus the patient must place a great deal of trust in the doctor. There is a conflict of interest involved in these relationships, which is related to the principle-agent problem of economics (Agency Theory, 2018). This "agency dilemma" occurs when the agent (doctor/producer) has more knowledge than the principal (patient/consumer) and thus makes decisions on their behalf (Agency Theory, 2018). The principal has a clear interest in becoming healthy, while the agent may be more motivated by making more money, spending less time working, etc. leading to an issue of moral hazard (Agency Theory, 2018). Moral hazard, which is a form of market failure, occurs in a principal-agent relationship when a doctor abuses the fact that they are more knowledgeable on the subject and acts more for their own self-interest than for the patient's (The Failure of Market Failure, 2001). Markets fail when information is asymmetric, because it causes an imbalance of power between the consumer and producer, which then results in adverse selection (The Failure of Market Failure, 2001). Adverse selection is a "process by which the price and quantity of a good in a market is altered due to one party having the necessary information," which is a detrimental change for the other (Boundless Economics, n.d.). This often occurs in healthcare markets, because only the producers (doctors or pharmaceutical suppliers) have the advanced knowledge of medicine to be able to determine the pricing of goods or services. There is a severe knowledge problem between the consumer and the producer in the health market, which is why the healthcare market rarely benefits the consumer and favors the producer due to differing incentives.

These are issues within the healthcare market that occur too often even in the developed world, so the developing world has even more of a deficit when it comes to distributing health resources throughout a region.

B. Theories of Economic Development

According to Giang Dang, a development economist, The primary goal "of economic development in its simplest form is to create the wealth of a nation," but this is often easier said than done as addressing development issues are often impacted by a wide range of factors (Dang et al., 2015, p. 12). Initially, until the 1970s, the gross national product (GNP) and the gross national income (GNI) per capita were viewed as the most effective measures for evaluating a country's development progress annually. Unfortunately, solely focusing on this measure of income resulted in many crucial social and environmental structures of society being ignored. Standards of living remain below average, income inequalities have grown, and poverty has been regarded as simply a cruel, yet unavoidable aspect of life.

Over time, the perspective of what the ultimate goal of economic development should be evolved with the realization that social factors are as important as economic variables when examining a country's actual progress. Amartya Sen, an Indian economist, explained that the ultimate goal of development should be to enhance human capabilities, in terms of what they are able to do and what they have the means to do (Sen, 1985). This movement towards focusing on the population's quality of life introduced a multidimensional analysis into the study of economics and helped economists to realize that assisting a region in its development requires deep-rooted economic, political, and social change altogether.

C. The Impact of Poverty and Unemployment on the Health of South Africans

In Van der Hoeven et al. (2012), differences in healthcare seeking behavior were analyzed in South Africa between rural and urban communities. The study found that there were large differences in employment rate between urban and rural communities, which "indicated that participants of urban communities were more likely to be employed" thus impacting their

healthcare seeking behavior (Van der Hoeven, 2012). These differences in employment led to "participants from rural communities [having] a significantly lower available weekly budget, not only for health care itself, but also for transport to the health care facility" (Van der Hoeven, 2012). In the end, Van der Hoeven et al. (2012) recommended advancements of "infrastructure in rural communities, quality of health care and its perception, improvement of household socio-economical status and further research on the consequences of delay in health care seeking behavior" (Van der Hoeven, 2012).

"When extreme poverty affects a large proportion of the population, as in South Africa, health is predominantly affected by a lack of access to the basic requirements for life" (Bogani, 2017). There are a vast number of disparities in income between whites and blacks in South Africa and "[e]ven though South Africa is considered an upper-middle-income country, a large percentage of its residents live in poverty" (Kon et al., 2008). It has been found that "27.9% of black African people were unemployed in comparison to 7% of white people", so there also remains a clear divide in the job market in terms of availability of opportunities based on race. In a study conducted by Kon et al. (2008) using both bivariate and multivariate analyses to study the differences across racial lines, it was found that 40.8% of Blacks reported going without medical care at some point in the past year compared with only 10.9% of whites. This result coincided with other disparities in terms of education, income, and health infrastructures. The largest predictors of how often one goes without medical care were "how often they had gone without food and how often they had gone without water" thus one's socioeconomic status plays a large role in determining health outcomes. (Kon, 2008).

South Africa is a prime example of a dual economy, where two separate economic sectors exist within one country, divided by different levels of development, technology, and different patterns of demand. Due to the division between races that has marred

the foundational structure of South Africa, the country has experienced dualistic development. This dualism is exhibited in various "social indicators", as May et al. points out, "of the early 1990s with the Human Development Index [that revealed] significant spatial and racial differences" (May et al., 2007, p. 20). When discussing "spatial" differences, that tends to highlight the difference in geographical location in terms of rural versus urban. In May et al. (2000), the study found that in 1991 "white South Africans had an HDI similar to that of Canada or Israel… [with] the neighboring Limpopo Province [having an HDI] lower than that of Zimbabwe" (May et al., 2000, p. 20). To further the point of South Africa having one of the most unequal economies, in 1993 it had a Gini coefficient of 0.58, which "at [that] degree of inequality, [South Africa had] one of the highest in the world" (May et al. 2000). With Apartheid ending over twenty years ago, the country has made strides in creating a more equal society, but the Gini coefficient has remained fairly consistent (Income Inequality in South Africa, 2013). In terms of consumption, "the poorest 20% of the South African population consume less than 3% of total expenditure, while the wealthiest 20% consume 65%" (The World Bank in South Africa: Overview, 2017). As discussed prior, the amount one eats as well as the amount of water consumed is directly related to one's health, so with the poorest percentage of the country having access to so few goods, it is almost guaranteed that they will develop various diseases, such as cervical cancer.

D. Health Care in South Africa

Healthcare inequalities have plagued the land of South Africa for centuries, due to spatial segregation laws, which detached the poorest areas from the regions that were provided more quality care and that were more capable of implementing effective health programs. Upon the end of Apartheid in 1994, Nelson Mandela and the African National Congress officially

addressed the issue of health equity and researched ways to efficiently redistribute health resources (Stuckler, 2010). Under the new democratic rule, a constitution was created with health deemed a universal right (Stuckler, 2010). With this guarantee came plans for new and improved health facilities, education programs, and basic needs programs (Stuckler, 2010).

"The proposed National Health Insurance (NHI) by the government of South Africa is recognized as one of the best and the most responsive ways to improve the life expectancy of a population. However, this proposed free access and low cost health service in South Africa is now threatened by lack of infrastructure and shortage of human resources, particularly medical doctors." This is a highly publicized issue, yet, despite the clear inequitable distribution of health resources, nothing has been done to fix it.

Chapter 4 – Literature Review

Initially, I came upon an American Journal of Public Health article titled "Health Care Capacity and Allocations Among South Africa's Provinces: Infrastructure-Inequality Traps After the End of Apartheid" which piqued my interest in terms of health inequalities in South Africa and how cervical cancer is related. In economics, the most prominent measure of distribution is the Gini coefficient, which analyzes the income distribution of a population. With the plan to focus more specifically on health-related resources, I searched to see if there were socioeconomic measures of distribution. Through this research, I discovered the concentration index, which is a bivariate version of the Gini coefficient and accounts for the distribution of health resources.

I. The Literature of the Economic Measures

To find the best methods to analyze inequalities of society, a World Bank Institute guide on researching health equity data became a prominent source of information on which measures to choose and how to apply them to the household data I have collected. The guide, titled "Analyzing Health Equity Using Household Survey Data" provides a systematic layout on how to acquire the proper data, how to describe certain health equities, and how to choose which measure of equity that is most relevant and practical for the issues being examined. It is from this guide that I discovered the concentration index and curve. The seventh and eighth chapters are dedicated to the concentration index and curve and they detail what they are, how to graph them, and how to calculate them. The economic and theoretical framework of my paper, presented in the next section, will largely be taken from this World Bank Institute health equity manual.

II. Recommendations

When looking for what health variables to focus on when using the concentration index, I came upon three articles that assisted in the development of the focus of my topic. May et al. (2007), Kon et al. (2008), and Van der Hoeven (2012) each made recommendations at the end of their works for where researchers should continue their studies, which helped me choose which economic theory would best illustrate this public health dilemma.

May et al. (2007) analyzed the political and economic state of South Africa from 1994 through 2007. This research made it apparent that Apartheid regulations continue to impact the growth of the country and have led to a dualistic form of development in post-Apartheid era that is resulting in the underdevelopment of certain parts of the country. At the conclusion of the study, the authors emphasize the importance of redistributing resources to level the playing field as well as to reform education and land regulations. The concentration curve directly focuses on the redistribution of health sources, thus after reading this study; I chose to further this research by conducting this socioeconomic measure of inequality.

In Kon et al. (2008), the researchers analyze the differences in access to care based on one's ethnicity in post-Apartheid South Africa. From this analysis it was explained that even ten years past the end of Apartheid, the inequities between whites and blacks remained very apparent, especially in terms of health care. In Kon et al.'s further research section, it is urged that research should be done to examine the differences in access to care based on geographic areas and that comparing Apartheid-era data with today is critical to note any societal developments. In the analysis section, the nine provinces will be examined comparing the time periods immediately after the end of Apartheid and present day.

Lastly, in Van der Hoeven (2012), differences in healthcare seeking behaviors were compared between rural and urban dwellers. The results of the study illustrated the differences in socioeconomic status, health status, among other socio-demographic variables between the two types of dwellings. At the end of the analysis, the authors pushed for increased infrastructure investments (i.e. public transport), improved quality of care, and the development of a multidimensional approach to improve socioeconomic status and improve employment rates (Van der Hoeven, 2012). This study directed me towards the Gini coefficient by focusing on analyzing various socioeconomic statuses across the region as well as choosing employment as one of the important variables that impact one's health status.

As discussed previously, despite the end of Apartheid, South Africa remains divided. The current two-tiered health system adheres to the underlying racial division and further separates these groups. The black population is at the greatest risk for cervical cancer because, despite being in the Post-Apartheid era, racial division continues to impact resource distribution and health equity. To address this inequity, I plan to use the Concentration Index and Curve to answer the question of how changes in resource distribution in post-Apartheid South Africa can lessen the divide between individuals of differing socioeconomic, racial, and geographical backgrounds.

III. The Acquired Data

Conducting my research, I came across several useful databases for data on South Africa: the government-run "Statistics South Africa" site that provides all of the census data and the "National Cancer Registry" of South Africa.

On the "Statistics South Africa" website, I was able to obtain access to data from the 1996, 2001, and 2011 censuses as well as to data from the 2007 and 2016 community surveys.

The majority of the data I used came from these censuses and surveys. I was able to pair some of the data I retrieved from the censuses to the data from the National Cancer Registry.

The most detailed piece of literature from the National Cancer Registry was the "Incidence of Histologically Diagnosed Cancer in South Africa, 1998-1999. This publication provided data on all forms of cancer and on the health facilities used specifically for cancer treatment.

Chapter 5 – Economic and Theoretical Framework

Over the past few centuries, economists have identified several measures to analyze the inequitable distribution of variables. There are two primary groups that these methods can be divided into: the graphical representation group and the quantitative measure group. The first group includes graphs such as the Lorenz curve and the concentration curve. The second group includes measures like variance, headcount index, Theil index, and the Gini coefficient (Greslin, 2017). The Gini coefficient and the corresponding Lorenz curve are two of the best-known distribution measuring duos, due to their accuracy in representing the income inequality of a region. Less well known and relatively newly created is the concentration index and its corresponding curve, which measures socioeconomic inequalities. The framework of my senior thesis centers around these two measures of inequality: the Gini coefficient and the concentration index. These measures rank the population to analyze how income or some other health variable is distributed throughout society. The factors that I will explore in each measure are socio-economic determinants of health. These socioeconomic determinants include factors such as income, poverty, gender, ethnicity, occupation, and lifestyle choices (alcohol consumption, drug abuse, etc.). The determinant that the Gini coefficient focuses on is income. Income falls under the general category of public goods. This umbrella term also includes security (i.e. water, sanitation, nutrition), environmental factors (justice), shelter, access to healthcare, and education. These five other public goods will be measured when conducting the concentration curve and index. By using both the Gini coefficient and the concentration index to measure the distribution of these public goods, I plan to demonstrate the impact that one's location and race can have on health status. To measure the Gini coefficient and the concentration index, I will use the data from 1996, 2001 and 2011 South African census data as well as the 2016 community survey of South Africa. This chapter will explain how to compute the Gini coefficient and the

concentration index. After each measure is explained, the next chapter will apply them to the public goods listed above.

I. The Gini Coefficient

The Gini coefficient, a measure of income distribution, studies how the income of a nation is dealt to the members of society and the measures of it focus on the equality of this allocation. To measure the degree of income distribution equality in a society, economists apply the Gini coefficient. It measures the income distribution by calculating the percentage of national income of different segments in society, such as the richest 20%, the second 20%, the middle 20%, the fourth 20%, and the bottom 20%. This measure is not limited to grouping by 20%; economists can choose to divide the population into number of segments best represents the populace. Once the population is segmented, must calculate the percentage of total income each segment makes is calculated by conducting a part-over-whole calculation of each segment's earnings (Measuring Inequality, 2016). The cumulative percentage of household income is on the x-axis with the cumulative percentage of income on the y-axis (Measuring Inequality, 2016). This then allows one to calculate the proportion of the population living in absolute poverty, i.e. unable to satisfy their basic needs.

If the Gini coefficient is equal to zero then it represents perfect equality (0%). An example of this is if everyone in a region receives the same income (Measuring Inequality, 2016). On the other hand, if the Gini Coefficient equals one, then the region is marred by maximum inequality (100%) (Measuring Inequality, 2016). For instance, this occurs if one person earns all of the income while the rest of the large population receives none. The Lorenz curve represents the Gini coefficient graphically, which is shown below in **Figure 4.1.**

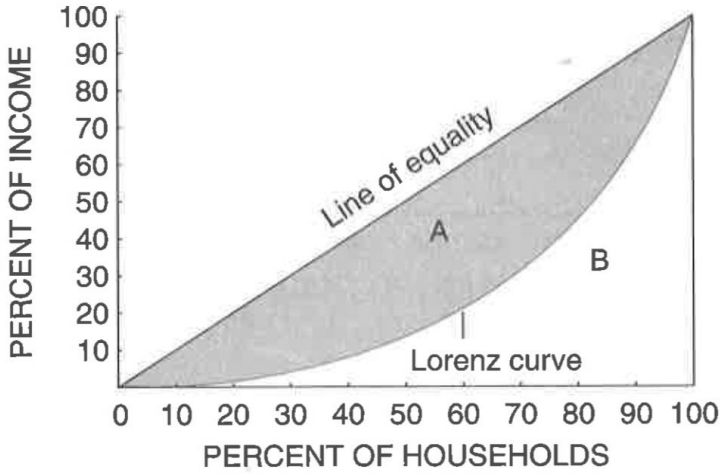


Figure 5.1: Gini Coefficient and Lorenz Curve[7]

Featured above is a simple example of the Lorenz curve, with the Gini coefficient represented as the area bound by the line of equality and the Lorenz curve divided by the lower right triangle. Essentially, the formula is:

(5.1) Gini coefficient = A/ (A+B)

In regards to the diagram, the cumulative percentage of households is on the x-axis, while the cumulative percentage of income is one the y-axis. This allows economists to demonstrate the distribution of income from the bottom 10% to the top 10%. Often, models of the Lorenz curve and Gini coefficient use a standard 20% increment, but this percentage can change to best represent the natural groupings of a population. In my analyses, I will be dividing the population

[7] Morton, J. S., & Goodman, R. J. (2003). *Advanced placement economics: microeconomics*. New York: National Council on Economic Education.

into ninths (11.1%) and quarters (25%), to represent the nine provinces or the four acknowledged races, respectively.

The Gini coefficient only displays the inequalities regarding income, but a bivariate measure of this, the concentration index, measures inequalities in terms of socioeconomic variables and offers a solution on how to redistribute the specific goods or services that are being analyzed.

II. The Concentration Curve and Index

As to why I have chosen to analyze South African inequality by computing the bivariate extension of the Gini Coefficient, the CI and concentration curve (CC) rather than the general "measures of dispersion", revolves around the socioeconomic focus of my study, which is to gain a more specific perspective on how great the health disparity between urban and rural areas really is. A "measure of dispersion", in economics, includes ideas like variance and standard deviation. As helpful as these measures are, they do not provide much insight into the true nature of inequality in areas and it is necessary to conduct more specific methods of measuring inequality, such as the Gini coefficient and the related concentration curve and Index. The CI, a statistical measure of distribution, can be applied to socioeconomic-related inequality with the analysis of certain health variables. This form of economic measure can compare the inequality of some health sector variable at a specific point in time or in one area or another. The CI is directly related to the CC and it works to quantify "the degree of socioeconomic-related inequality in a health variable," while the CC graphically represents the inequality (O'Donnell, 2007, p.83). In order to dictate effectively and portray the inequitable distribution of health resources in regards to cervical cancer prevention in South Africa, I plan to apply this concept.

This idea, originally developed by Nanak Chand Kakwani, is based on the Gini coefficient and Lorenz curve.

A. The Concentration Index

The bivariate extension of the Gini coefficient is titled the concentration index (CI). A "bivariate" measure is a form of analysis that compares the data of two separate variables. The concentration index is different from the Gini coefficient, as it uses more of a socioeconomic school of thought and analyzes "economic and institutional factors, such as sex, age, occupation, geographical differences, and the distribution of [income]" (Dagum, 1986). Two variables must be used in order to properly quantify the concentration index: the first being a health variable of interest and the second being a living standard variable that properly represents the population. For the sake of simplicity, I will continue to use income as my living standards variable. Along with this, the data obtained to measure the concentration index can be at the individual level or grouped. If the data is grouped, and the data used here will be, then the mean value of the health variable is what will be observed (O'Donnell, 2007).

The concentration index equals twice the area between the concentration curve, denoted as L (p) and the Line of Equality. To compute the concentration index for grouped-data, a simple equation is applied:

(5.2) $$CI = (p_1L_2 - p_2L_1) + (p_2L_3 - p_3L_2) + \ldots + (p_{T-1}L_T - p_TL_{T-1})$$

In this equation, the "p" is the cumulative percent of income and the "L (p)" is the corresponding concentration curve ordinate, with "T" being the number of income groups (O'Donnell, 2007).

There have been several economic studies performed which used the CI to compare the socioeconomic inequality in regards to child illnesses, adult health, and subsidization of health programs. In my empirical analysis, the health factors that will be analyzed center around access to health facilities, sanitation, education, and immunization to provide a more macro-view of the inequalities that impact cervical cancer rates in South Africa.

The South African government has tried to address this inequitable distribution, yet their healthcare provisions appear to be rather inefficient. Through the use of the concentration index and curve, first introduced by Kakwani, I plan to highlight this unequal distribution of health-related goods and compute the percentage of these goods that need to be redistributed in order to achieve equity.

B. The Concentration Curve

The concentration curve is the graphical representation of the inequality across a population in terms of a specific health variable.

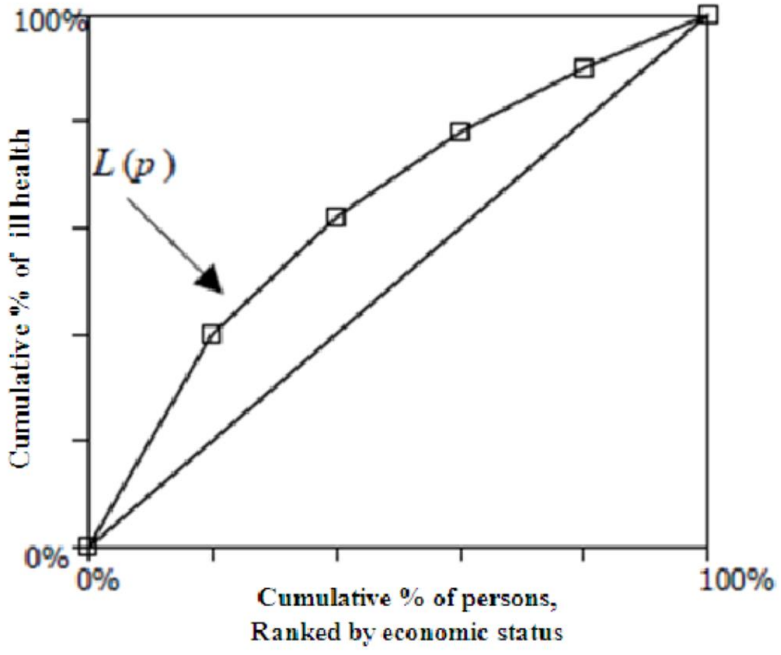


Figure 5.2: The Concentration Curve Above is an example of the concentration curve for ill health,
with cumulative income on the x-axis and ill health on the y-axis [8]

To plot this graph, the variable representing the living standards of a population should be placed on the x-axis and the health variable of interest should be on the y-axis, thus the "shares of the health variable will be plotted against the groups of the living standards variable" (O'Donnell, 2007). With this, the titles of the axes will be the "cumulative percentage of a certain health variable" against the "cumulative percentage of population ranked by socioeconomic status". As seen above, the graph includes both the concentration curve and the line of equality. The line of equality, similar to in the graph of the Lorenz curve, is a 45-degree line that represents a perfectly equal distribution of the variable being analyzed across the population. For the concentration curve, the curve may lie above or below the line of equality. If the curve lies above the line of equality, there is a higher concentration of the health variable being analyzed among the poor. For example, using the graph above, the health variable being studied is "ill health"; since the curve is above the line of equality, then there is a higher concentration of ill health occurring in the poorer populations. Oppositely, if the curve lies below the line of equality, then there is a lower concentration of the health variable among the poor.

If a comparison must be made, the graph for the concentration curve is not subject to just one curve. It is possible to plot curves for different time periods or regions on the same graph (O'Donnell, 2007). Similarly, concentration curves comparing different health variables can also be plotted against each other on the graph as long as the data is obtained from the same time

[8] O'Donnell, O., Doorslaer, E. V., Wagstaff, A., & Lindelow, M. (2007). Analyzing Health Equity Using Household Survey Data. doi:10.1596/978-0-8213-6933-3

period or region (O'Donnell, 2007). If the concentration for one time period/country/variable lies above the other curve, then the former curve dominates the latter and "the ranking by degree of inequality is unambiguous" (O'Donnell, 2007). This means that a comparison, aside from the visual on the graph, cannot be made and there will be a singular degree of inequality obtained. If the curves cross, neither of the curves dominate the other and a comparison by degree of inequality can be made based upon the observer's own judgments of the weight at different points in the scatter plot (O'Donnell, 2007).

When graphing the grouped-data case, I used Microsoft Excel to input the data and create a graph using the scatter plot option with the smoothed lines. Each axis ranges from 0 to 100 percent, thus each of the cumulative sections of the data begins with a 0 to ensure that each of the lines begin at the center point of the graph.

In the next chapter, these two measures of inequality will be applied to the nine provinces as well as the four races of South Africa to analyze what inequalities are impacting cervical cancer.

Chapter 6 – Empirical Analysis

In this chapter, the two related theories that I discussed above would be applied to the issue of inequitable distribution of income and health-related resources across racial groups and urban-rural locations in post-Apartheid South Africa. What I am trying to show in this empirical analysis is that one's geographic location is as much of a determinant of their health status as one's ethnicity. To show this, I will be calculating both the Gini coefficient and the concentration index using the population and income group data of the nine provinces and of the four recognized races of South Africa. If the numbers calculated for these indexes are near the same for each group of data, I will suggest that a redistribution of resources is not only needed, but also a relocation of individuals trapped in poorer areas.

First, I would like to detail the limitations of this research thesis. While conducting my study, there were several limitations that prevented me from being able to go as in-depth on my research, to the extent I would have preferred. For the most part, I was able to find relevant data, but there were certain aspects of society, such as vaccine up-take and follow-up rates for cervical cancer screening, that I could not access. This lack of available and reliable research in terms of the effectiveness of cervical cancer prevention programs restricted the scope of my analysis and impacted my ability to discover relevant trends pertaining to my topic. Along with this, each census I acquired included different information, especially for the censuses that were published right around the end of Apartheid era. Generally, the general economic data was available, but finding data related to cervical cancer or melanoma in general was difficult. South Africa has provided yearly summary statistics of histologically diagnosed cancer, but these only provide the number of observed cancers and does not include variables related to the resources necessary to ensure that each province's healthcare facilities have all of the provisions necessary to care for their patients. Another limitation to this study is the usage of grouped data.

I. The Gini Coefficient of South Africa

In this first section of the empirical analysis, I will be conducting two separate Gini coefficients for South Africa: one comparing income inequality among the provinces and another comparing income inequality among the races of South Africa. Two calculations will be performed in order to show that geographical location and race are similarly related to the issue of equitable distribution of goods and services. The Gini coefficient of South Africa is a relatively well-researched topic, but I wanted to compute it for a specific timeline between regions and races to highlight any important changes that have occurred since the end of Apartheid.

A. Comparing Income Inequality between Provinces

First, the Gini coefficient calculations for income equality in South Africa will be conducted, using the group data collected from the provinces. Since there are nine provinces, the relative percentage of population for each province will be 11.1% (100 / 9 = 11.1) Using an Excel spreadsheet, I was able to compare each of South Africa's nine provinces based on average annual income data provided by the 2011 census data. In **Table 6.1** presented below the cumulative percent of population and cumulative percent of income for each of the nine provinces in South Africa during 2001 have been calculated. The cumulative percent of population and cumulative percent of income are the x-axis and y-axis for the Lorenz curve depicted below, respectively. These calculations of the Gini coefficient are represented by the Lorenz curve, which is exhibited on **Figure 6.1** (below) as the blue line.

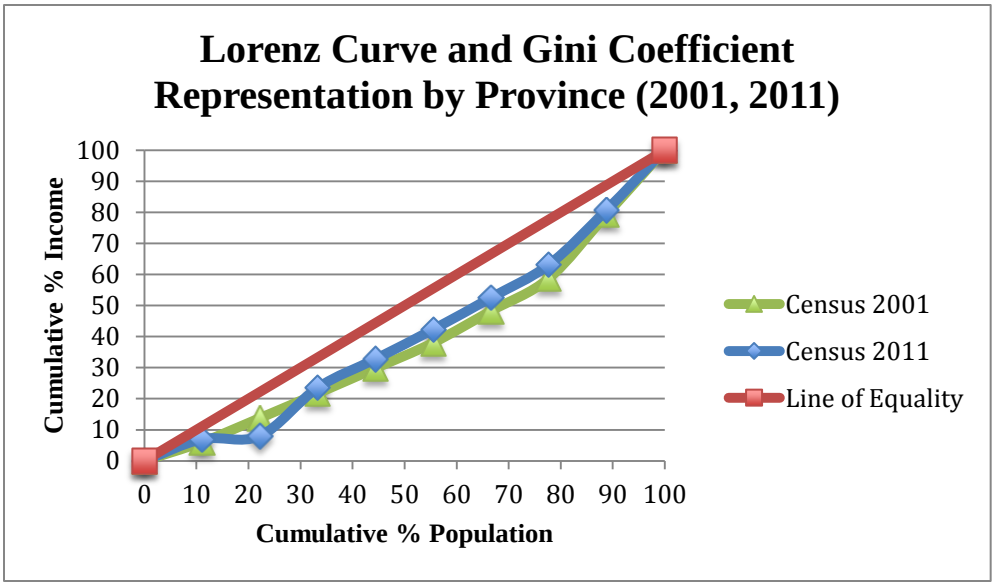


Figure 6.1: Lorenz Curve and Gini Coefficient Representation by Province The data from **Table 6.1** and **Table 6.2** above have been placed onto this graph to represent the change in income inequality since the end of Apartheid to the relative present

Table 6.1 illustrates the data collection from the 2001 census of South Africa. The cumulative percent of population and cumulative percent of income for this time period have also been calculated in this table and are represented by the green line on **Figure 6.2.**

	Lorenz Curve Construction for South African Provinces (2001)				
Province	**Income**	**% Population**	**% Income**	**Cumulative % Income**	**Area Under the LC**
	0	0.000	0	0	
Limpopo	22,985	11.100	6.0522	6.0522	0.33590
Eastern Cape	29,334	22.200	7.7239	13.7761	1.10047
North West	30,189	33.300	7.9491	21.7252	1.97032
Free State	30,726	44.400	8.0905	29.8157	2.86052
Mpumalanga	31,186	55.500	8.2116	38.0273	3.76528
KwaZulu Natal	38,905	66.600	10.2441	48.2714	4.78957
Northern Cape	39,757	77.700	10.4684	58.7398	5.93912
Western Cape	78,157	88.800	20.5795	79.3193	7.66228
Gauteng	78,541	99.900	20.6807	100.0000	9.95222
		379,780		100.0000	38.37570

Table 6.1: Lorenz Curve Construction for South African Provinces (2001) From the 2016 Community Survey Census data for South Africa, the cumulative percentages of income and population have been provided and these calculations will then be used to create the Lorenz curve and exhibit the Gini coefficient

Lorenz Curve Construction for South African Provinces (2011)					
Province Ranked by Income	**Income**	**% Income**	**Cumulative % Income**	**% Population**	**Area under the LC**
	0	0	0.000	0	
Limpopo	56,849	0.070	6.991	11.1	0.387990519
Eastern Cape	64,539	0.079	8.006	22.2	0.832344665
North West	69,955	0.086	23.530	33.3	1.750256973
Free State	75,312	0.093	32.791	44.4	3.125804881
Mpumalanga	77,609	0.095	42.335	55.5	4.169480198
KN	83,053	0.102	52.548	66.6	5.265987309
N. Cape	86,175	0.106	63.145	77.700	6.420956782
W. Cape	143,460	0.176	80.787	88.8	7.988199878
Gauteng	156,243	0.192	100.000	99.9	10.03365226
	813195	1.000			39.97467347

Table 6.2: Lorenz Curve Construction for South African Provinces (2011) The cumulative percent of population and the cumulative percent of income for each province have been calculated for the 2001 census data

The comparison of the census data from 2001 and 2011 illustrates what changes in terms of income have been made from the end of Apartheid to 2011. In each of these figures, there is an extra column titled "Area Under the Lorenz Curve." This column provides the numbers necessary to be able to compute the Gini coefficient. To calculate the Area Under the Lorenz Curve, the **Equation 6.1** is utilized e for each income ordinate. To reiterate, the Gini coefficient equals Area A over Area A plus Area B. As simple as this sounds, the area under the Lorenz curve is a relatively difficult calculation as it is usually shaped like a trapezoid (see Area B in **Figure 5.1**). The official equation for computing the "Area Under the Lorenz Curve" is:

(6.1) Area Under the Lorenz Curve = ½ x [b1 + b2] x (the fraction of population groups)

To give an example of what "[t]he fraction of population groups" would be, if there are five population groups then 100 divided by 5 equals 20, which expressed in decimal form is 0.2. In the province calculation, as there are nine provinces, the fraction of population groups will equal 0.111; the fraction of population groups for the races will be 0.25, since there are four. Once this is computed, the next step is to subtract the area under the Line of Equality from the area under the Lorenz curve. The area under the Line of Equality is always 0.5, so that is what will be subtracted from the area under the Lorenz curve. Then take the number that was just computed and divide it by the area under the Lorenz curve (0.5). Once this is completed, the Gini coefficient will have been calculated. Please see the Appendix for the full calculations for the area under the Lorenz curve for each Gini coefficient.

(6.2) **Gini Coefficient (2001)**: 0.3840 → 0.5 – 0.3840 = 0.1160 →

0.1160/0.5 = **0.2320**

(6.3) **Gini Coefficient (2011)**: 0.4432 → 0.5 – 0.4432 = 0.0568 →

0.0568/0.5 = **0.1136**

From the final calculation above, the Gini coefficient for the grouped data of 2001 is equal to 0.2320. Due to having to use grouped data from the South African census, this calculation does not fully represent how great the inequality is in South Africa. Grouped data generally leads to a downward bias, but the only data available for analysis was in this form. More important for this section of the empirical method is to be able to see the small amount of change that has occurred since the end of Apartheid in 1994. Again, though there is a downward bias of how great the inequalities are, the differences between the two Gini coefficients show

significant change and signify that the new interracial democratic government has been working to achieve equitable living standards for its population over the past twenty years. **Figure 6.1** provides the Lorenz Curve for both the 2001 and the 2011 data. Though there is not a great amount of change, for a nation as young and fragile as South Africa, it remains a significant improvement.

To reiterate the limitations of these calculations, the only data available provided the group average for each province, so the true income inequality is not displayed. It appears that there has been some change over the years in inequality between provinces, but the government needs to continue to fairly provide educational and employment opportunities to its population to close the gap between the rich and the poor. In this next section, the Gini coefficient will now be calculated using the average annual household income of each of the races to display the similarity in inequalities between one's racial background and spatial location.

B. Comparing Income Inequality between Races

Now, I will be calculating the Gini coefficient based off of the income data for each of the four racial groups in 2001 and 2016 to see if there are similarities between this distribution and that of the distribution between urban and rural provinces. Below, in **Table 6.3** and **Table 6.4**, the cumulative percentages of income for each year have been calculated. The races were ranked based on income; the ethnic group with the lowest average household income is first (Black) and the highest average household income is last (White).

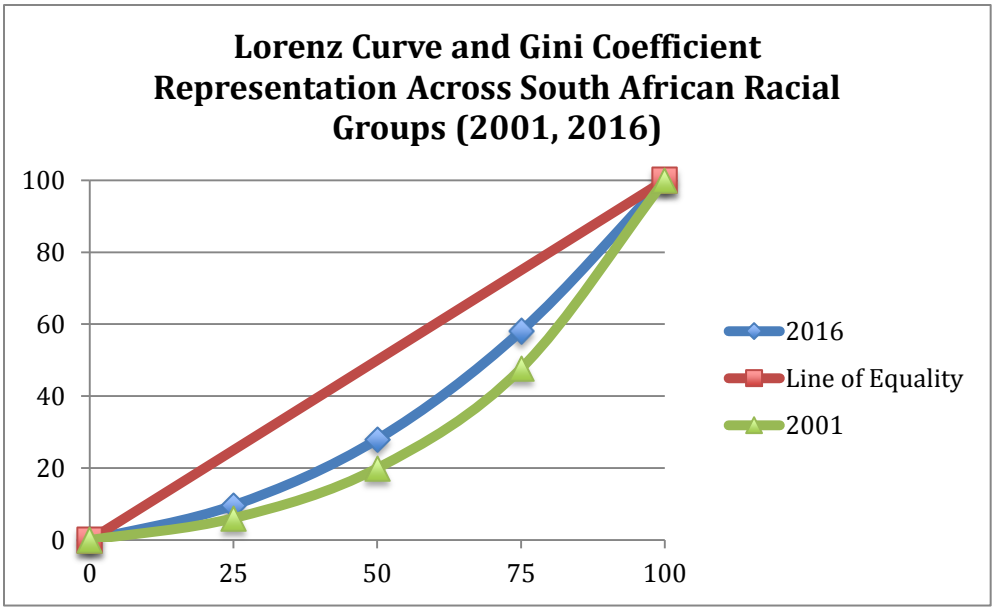


Figure 6.2: Lorenz Curve and Gini Coefficient Representation Across South African Racial Groups (2001, 2016) The data from **Table 6.3** shows the calculations for the cumulative percentage of income for the four recognized races of South Africa.

Lorenz Curve Construction for South African Racial Groups (2001, 2016)						
	2001			2016		
Racial Groups Ranked by Income	**Income**	**Relative % Income**	**Cumulative % Income**	**Income**	**Relative % Income**	**Cumulative % Income**
			0			0
Black	22,522	6.08	6.08	69,094	9.64	9.64
Coloured	51,440	13.89	19.96	131,633	18.36	28
Indian/Asian	102,606	27.70	47.66	215,784	30.09	58.09
White	193,820	52.33	99.99	300,498	41.91	100
	370,388			717,009		

Table 6.3: Lorenz Curve Construction for South African Racial Groups (2001, 2016) In this table, I calculated the cumulative percentage of income for both 2001 (the red line above) and 2016 (the purple line)

These calculations for the Gini coefficient and the representation of the Lorenz Curve for 2001 and 2016 show more inequality between races and change over the years than the calculations using the provincial data had.

(6.4) **Gini Coefficient (2001)** = 0.2782 → 0.5 – 0.2782 = 0.2218 → 0.2218/ 0.5 = **0.4436**

(6.5) **Gini Coefficient (2016)** = 0.3654 → 0.5 – 0.3654 = 0.1346 = 0.1346/0.5 = **0.2692**

According to these calculations of the Gini coefficient using the group data of the racial groups, the Gini coefficient of South Africa decreased by 0.1744. Again, there is a downward bias when using group data, but it still shows that there have been some significant changes over the past twenty years in regard to inequities between racial groups. Comparing this to the Gini coefficients found using provincial data there has been more changes to income distribution between the specific races than between all of the provinces.

C. Analysis

In my comparison of the Gini coefficient between the provincial data and the racial group data, I planned to show how there are similar inequalities between these two characterizations of an individual. The reasoning behind this is to show that the land segregation that occurred during Apartheid still plays a role in the inequalities between races. The Gini coefficients of the provincial data were 0.2320 in 2001 and 0.1136 in 2011. The larger the number is, the more inequitable the distribution of income is. With the Gini coefficient having decreased over these ten years, there has been some improvement in regards to providing more opportunities to those in the rural, poorer areas. As for the inequality of income between the racial groups, the Gini coefficient for 2001 was 0.4436 and 0.2692 in 2016. As I was able to use the 2001 for each of the calculations, that is something that can be directly compared. The income inequality between

provinces was much lower than between racial groups. So, even in the early years after Apartheid, the divide between urban and rural areas was not as great as the divide between races in terms of income. The later years for each calculation (2011 for the provincial data and 2016 for the racial data) each displayed a lessening of inequality between the high-income earners (more urban provinces / the White population) and the low-income earners (more rural provinces/ the Black African population). The inequalities between each of these forms of characterizations are relatively similar, but the Gini coefficient was higher for the racial group data than for the provincial data; this means that one's race is more of a determinant of their ability to have a decent income than one's geographic location.

Analyzing the Lorenz curves that correspond to these Gini coefficients, in **Figure 6.1**, the gap between each curved line (i.e. the Lorenz curves) and the line of inequality is what is being measured when calculating the Gini coefficient. In comparing **Figure 6.1** and **Figure 6.2**, the Lorenz curves have much more space between them and the Line of Inequality in **Figure 6.2**. This shows that one's racial group determines their ability to have a higher income more than one's living in a rural area.

II. The Concentration Curve and Index

To apply the Concentration Curve and Index, I studied cervical cancer cases across racial groups, the number of cancer diagnosing labs in each province, and the number of uneducated individuals in each province.

A. Cervical Cancer Rates

The first Concentration Index that will be conducted will be the number of cervical cancer cases per racial group. This will serve to show how heavily this affects the black population as opposed to the other racial groups. Note, however, because the black population is much larger than the others, which does relatively alter the results and causes a heavier concentration

Cervical Cancer Cases Across Racial Groups (2011)						
Racial Groups Ranked by Income	**# of Observed Cases of Cervical Cancer**	**Relative % of Cervical Cancer Cases**	**Cumulative % of Cervical Cancer Cases**	**Income**	**Relative % of Income**	**Cumulative % of Income**
			0			0
Black	4,056	82.65	82.65	60,613	7.68	7.68
Coloured	359	7.32	89.97	112,172	14.21	21.89
Indian	55	1.12	91.09	251,541	31.86	53.75
White	437	8.91	100	365,134	46.25	100
	4,907			789,460		

Table 6.4: Cervical Cancer Cases Across Racial Group (2011) Here is the data collected from the 2011 South African Census data that was used to create the Concentration Curve and calculate the CI

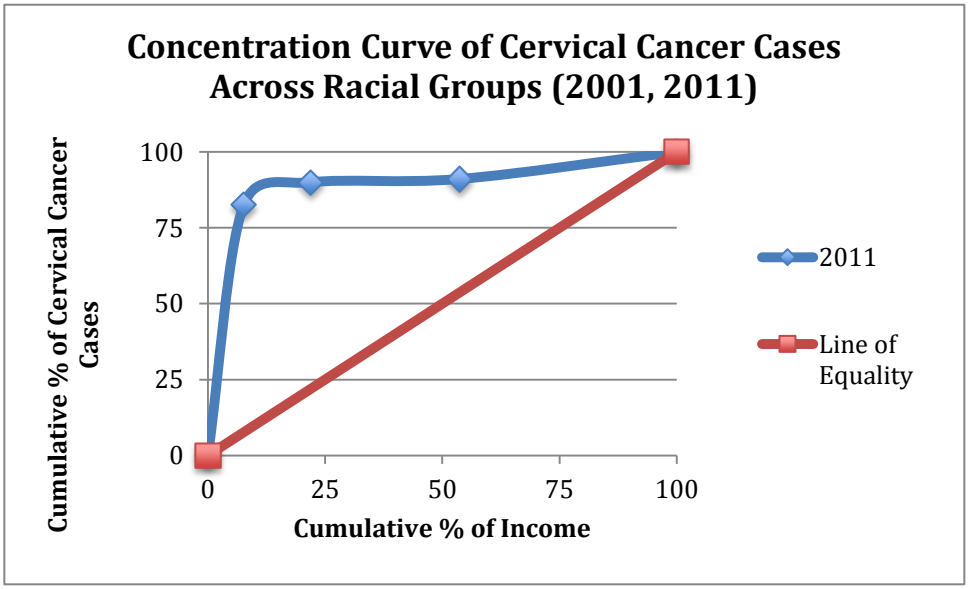


Figure 6.3: Concentration Curve of Cervical Cancer Cases Across Racial Groups (2001,2011)

(6.6) **CI (2011)** = [(.0768)(.8997) – (.2189)(.8265)] + [(.2189)(.9109) – (.5375)(.8997)] +

[(1)(.9109 – (.5375)(1)]

= -.1118 - .2842 + .3784 = **-0.7794**

In **Figure 6.3**, in year 2011, cervical cancer cases were heavily concentrated in the poorer population, specifically that of the black population. Through the calculation of the Concentration Index, -0.7794 was produced. As was mentioned in the previous chapter a negative integer signifies that the being analyzed is more heavily concentrated in the poorer population (O'Donnell, 2007) It has been proven that multiplying this value of the CI by 75 provides the percentage of the health variable that would have to be "redistributed" to the richer half from the poorer half, and vice versa, in order to have a more equitable distribution (Doorslaer, 2004). Applying this theory, -0.7794 x 75 = 58.45% of the cases of cervical cancer must be redistributed to the richer half (the Whites, Coloureds, and Indians/Asians) in order to have an equal impact of cervical cancer across South Africa.

B. Availability of Cancer Diagnosing Labs

For this analysis, using data for the 2011 South African Census, I am analyzing the concentration of those who do not have access to cancer diagnosing facilities. The ranking of the income group was based off of the annual household income per province. Cervical cancer rates are not only impacted by the health of the population, but also by the facilities available. Without a cancer diagnosing lab near by, the chances are that one will not get diagnosed. This directly impacts the number of cases reported and the number of people that are actually treated for cervical cancer.

Concentration Curve of Number of Cancer Diagnosing Labs per Province (2011)						
Province Ranked by Income	**# of Cancer Diagnosing Labs**	**Rel. % of # of Cancer Diagnosing Labs**	**Cum. % of # of Cancer Diagnosing Labs**	**Income**	**Rel. % of Income**	**Cum. % of Income**
			0	0	0.000	0
Limpopo	1	1.19	1.19	0.070	0.070	10.44
E. Cape	14	16.67	17.86	0.079	0.149	23.12
N. West	2	2.38	20.24	0.086	0.235	29.89
Mpumalanga	3	3.60	23.84	0.093	0.328	35.2
Free State	10	11.90	35.74	0.095	0.423	43.01
KZN	11	13.09	48.84	0.102	0.525	62.84
N. Cape	2	2.40	51.24	0.106	0.631	65.05
W. Cape	16	19.00	70.24	0.176	0.807	76.3
Gauteng	25	29.80	100.04	0.192	0.999	100.01
	84			0.999		

Table 6.5: Concentration Curve for Number of Cancer Diagnosing Labs per Province The data in this table corresponds with **Figure 6.4**

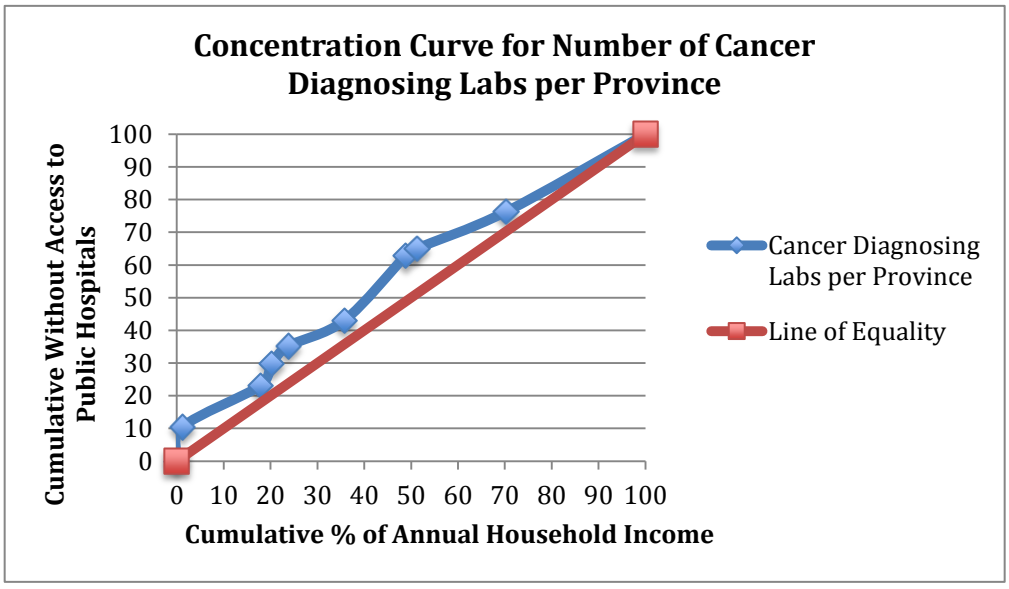


Figure 6.4: The Concentration Curve for the Number of Cancer Diagnosing Labs per Province

(6.7) CI = **-0.143** (full equation in Appendix)

The concentration index for number of cancer diagnosing labs per province is -0.143. The concentration of cancer diagnosing labs is relatively equal throughout the provinces, so the concentration index is quite close to 0. Applying the Koolman and Doorslaer theory from earlier, multiplying this number by 75, the percentage of cancer diagnosing labs that would need to be redistributed across the provinces is 10.75%. This means that there needs to be 10.75% of the current number of cancer diagnosing labs redistributed across the provinces to have a perfectly equitable distribution of cancer diagnosing labs.

C. Education Levels

Education is one of the variables related to cervical cancer rates. Without having an education, one would not be included in the school HPV vaccination programs provided by the government or even know about cervical cancer in general. With this, attendance at secondary institutions will be the variable of focus in this calculation. The distribution of education is important for the welfare of a population as well as for the production possibilities for a community. Simply looking at averages does not assist policymakers in analyzing the issue of low education attainment rates. To measure the concentration index for education, variables such as enrollment, attendance, or attainment are fair indicators of dispersion. If there is a higher average enrollment, then there is less educational inequality. To see if there is a relation between cervical cancer rates and a lack of education, this is applied to income data for racial groupings.

Concentration Index Calculations for Uneducated Individuals in South Africa, 2011						
Ethnicities Ranked by Income Level	**No. Uneducated**	**Relative % Uneducated**	**Cumulative % Uneducated**	**Income**	**Relative % of Income**	**Cumulative % of Income**
			0			0
Black	2,192,860	0.9187	91.87	60,613	7.68	7.68
Coloured	102,948	0.04313	96.183	112,172	14.21	21.89
Indian	32,468	0.0136	97.543	251,541	31.86	53.75
White	58,534	0.02452	99.96	365,134	46.25	100
	2,386,810			789,460		

Table 6.6: Concentration Index Calculations for Uneducated Individuals in South Africa per Race, 2011 Using the South African Census Data from 2011, I acquired this data and the calculations of the cumulative percentages of those uneducated and income are on **Figure 6.5**

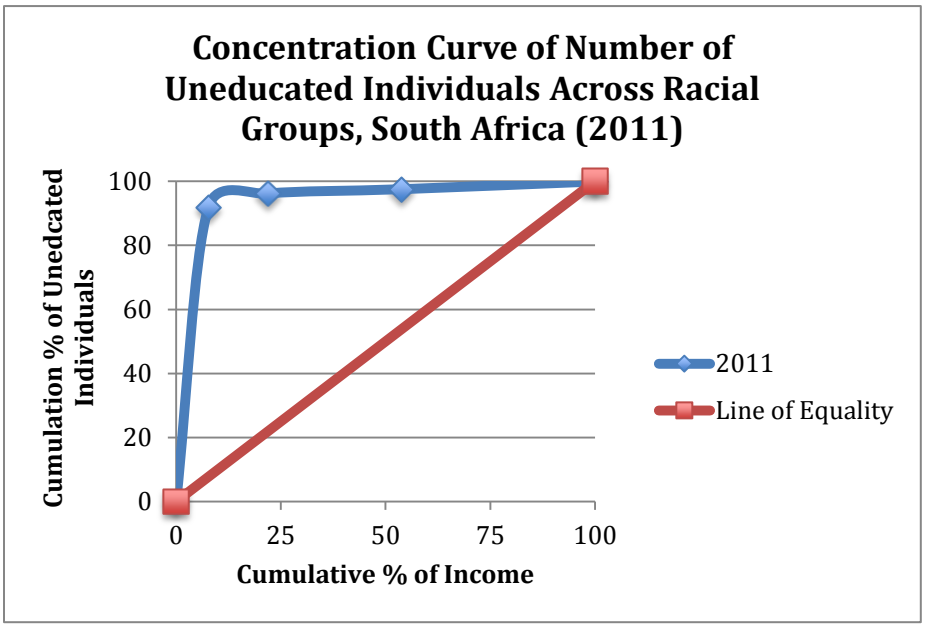


Figure 6.5: Concentration Curve of Number of Uneducated Individuals Across Racial Groups, South Africa (2011) This graph of the concentration curve corresponds to **Table 6.6** and shows the number of uneducated individuals per race

(6.8) CI = **-0.8689**

From **Figure 6.5**, it is clear that the poorest population, the Black African population, is the most uneducated population of all four recognized races. Almost as high of a concentration index as that of cervical cancer cases across the racial groups, -0.8689 is a very heavy concentration on the poorer population. Applying the Koolman and Doorslaer (2004) theory again, if -0.8689 is multiplied by 75, 65.17 is calculated. This means that, in order to achieve a more equal distribution of uneducated individuals, the other groupings would have to increase their numbers by 65.17%. This is, again not something that would be good for society and the recommendation would be target these populations instead of trying to keep other factions of society from receiving an education. One cannot state that there is causation between the cervical cancer cases and the number of individuals uneducated, but there is a slight correlation. It is imperative that the South African government focuses on improving education for all individuals to ensure that all South Africans are able to receive the same educational, economic, and societal opportunities to increase the standard of health. The proportion of cervical cancer cases among Black African women as compared to the other races is a public health crisis and the only way to address it is to have major socioeconomic and educational reform across the nine provinces with every race included.

D. Analysis

The comparisons for the concentration curve and index are a bit more difficult to make than for the Gini coefficient and Lorenz curve. This is because the available data for each of the variables I chose to analyze was either only provided in terms of province or in terms of racial group. This means that I was not able to make any direct comparisons between provincial data

and racial data for each of the variables individually, but there are still some trends that are important to notice.

Beginning with cervical cancer cases per racial group in 2011, the concentration index I calculated from this data was -0.7794 (**Equation 6.6)**. This is an incredibly high number and, since it is negative and the concentration curve was above the line of equality in **Figure 6.3**, the number of cervical cancer cases was heavily concentrated in the population with the lowest annual household income. **Table 6.4** shows the rankings of races from lowest income to highest, and the population with the lowest annual household income was that of the Black Africans. So, cervical cancer rates are most prevalent amongst the Black African population. Unfortunately, the data I acquired that provided the cervical cancer numbers only provided it by racial group so I was unable to calculate the concentration index of this health variable for the provinces. I was, however, able to calculate the number of number of people without access to public hospitals in 2011 across the provinces.

Though this is not directly related to cervical cancer, as was discussed in the case study, most South Africans' main ways of receiving care is through the public sector. When access to a public health facility is prevented, that is directly related to their health status as well as awareness of a disease such as cervical cancer. In my calculation of the concentration index for number of cancer diagnosing labs per province (**Equation6.7)**, the number I got was 0.1430. This number is relatively confusing when looking at the graph of the curve, since the curve is primarily over the line of equality. There are some spots that go below the line of equality, though, so this number means that there are slightly more cancer diagnosing labs in the richer provinces than in the poorer regions. This is an incredibly low number compared to the number of cervical cancer cases across racial groups. Though these numbers are not completely comparable, as stated above, there can be trends that are realized. Looking at **Figure 6.3** and

Figure 6.4, there are clear differences in the way each of the concentration curves are curved and how far away they are from the line of equality. What shows a much more stark contrast between provinces than the graph or the calculation is the data on **Table 6.5**. In the Limpopo province, the poorest province, there is only one cancer-diagnosing lab, so even if there were data provided on cervical cancer cases per province in the same year as for the racial group, the accuracy of the data would be questionable. There are probably many women in these poorer regions that have cervical cancer that do not have the education or the access to care to even know. These simple trends hint that these poorer regions need to be targeted for public health initiatives to both educate and provide better access (whether through mobile clinics or the creation of another cancer lab) even if the concentration numbers do not reflect this.

The final health variable analyzed was the number of uneducated individuals across racial groups in 2011. This had an extremely high concentration index of -0.8689 (**Equation 6.8).** From **Figure 6.5** and **Table 6.6**, the calculations for the concentration index and curve are provided as well as the graphical representation. Similar to the concentration index and curve of cervical cancer cases, this calculation also shows that the poorest group, the Black African population, also struggles with very low education rates as opposed to the other racial groups. Though this does not directly correlate cervical cancer and education, it certainly shows that there are some trends between the two. Without a proper education, one will not have proper knowledge of disease or the available prevention methods. Education is related to employment opportunities and employment is often related to health insurance, so that in it of itself is a direct relation to health.

For each of these health variable's concentration indexes, I was able to multiply them by 75 to calculate the percentage of the variable that would need to be redistributed to the rest of the population to achieve an equitable distribution of health related goods and services. For cervical

cancer cases, there would need to be 58.45% more cervical cancer cases in the racial groups with higher income to have an equitable distribution of cervical cancer, which shows just how prevalent this is amongst the Black Africans compared to the three other racial groups. For the number of cancer diagnosing labs, there would need to be 10.75% more cancer diagnosing labs in the poorer regions to provide more equitable access to cancer facilities in each province. Lastly, for the number of uneducated individuals, there would need to be 65.17% more uneducated individuals across the racial groups to have an equitable distribution. Of course, more ethically, the want should be to improve the education of the most inflicted population, so that should be the focus. All in all, the target population for cervical cancer cases and the most uneducated population is the Black African population. There is a positive trend between the two, meaning when one of the variables is high the other is as well and vice versa. In regards to cancer diagnosing labs, with the prevalence rates of not only cervical cancer but also breast cancer in developing regions, this is crucial. There not only needs to be a more equitable distribution of these facilities across the provinces, but also just more in general if there cervical cancer rates are to decrease.

In regards to my hypothesis, I was correct in assuming that the Gini coefficient had decreased since the end of Apartheid, but the amount the inequalities decreased for racial groups and provinces was different. In regards to the use of the concentration curve, I was not able to show that one's geographic location and one's ethnicity are equal determinants of one's potential of developing cervical cancer; this is partially due to lack of data, but also due to the fact that a rural location does not implicitly impact one's health status as much as their race does.

Chapter 7 – Conclusion

The aim of this study is to analyze the change in income inequality and the inequitable provision of health resources to rural communities since the end of Apartheid. From the beginning of this paper, I have described how knowing the history of South Africa can assist one in understanding why there are such large disparities between groups today. In the second chapter, I discussed the "homelands", which were areas that the black population was forced to live in and these areas were characterized by rural lands of little opportunity. This is where I began to analyze the inequalities between provinces and how it related to racial group disparities. With this initial interest, I decided to use both provincial data and racial group data to see if there were similarities between the two. If the inequalities were similar, it would show that, to lessen the impact of cervical cancer, or any disease for the matter, there would need to be a redistribution of resources *and* a relocation of those that were trapped in the rural areas. With this, I decided to use measures of socioeconomic inequality to analyze the trends between these two characterizations. The Gini coefficient showed significant improvement between the early years after the end of Apartheid and today. Unfortunately, there remain significant differences of earning capability based on where one lives and what race they are. The only way to fix this is to ensure that there are more employment opportunities available for everyone and that begins with education. In the calculation of the concentration curve for education, there was a vastly large concentration of the uneducated among the Black African population. The concentration of cervical cancer cases and the number of uneducated individuals among the Black African population is a serious socioeconomic issue. The education of an individual is key to almost every health issue. Without an education, one is not aware of disease, does not have the resources to access proper care, and is trapped in a poverty trap. My hypothesis was only partially correct, as I thought that the inequitable distribution across provinces would be similar

to that of across races; the concentration of negative variables, though, clearly impacted the Black population across the board and not just in one province. With this, the rural-urban divide is not significantly associated with the black-white divide.

For the calculations of the Gini coefficient, the income inequality was more pronounced when comparing races. From 2001 to 2011, the provincial annual income data had a Gini coefficient that went from .232 to .1136. This is an improvement and the racial grouping data also showed an improvement, but the income inequality was much heavier. From 2001 to 2016, the Gini coefficient went from0.4436 to .2692. This is a much more substantial improvement, but there remains more inequalities based on race than on one's location.

The amount one makes directly impacts every decision they make. Without substantial funds, proper heath care and education is simply not feasible to obtain, especially in a LMIC country. When analyzing cervical cancer cases amongst the different racial groups, the concentration of incidence rates amongst the Black Population was very significant as compared to the Whites, Coloureds, and Indians/Asians. Similarly, the number of uneducated individuals was also very high amongst the Black population, with having represented for over 90% of those uneducated. This highlights the Black population as the clear target population for any educational programs in the future, as they are the most in need. In trying to see if there were any substantial relations between high cervical cancer rates across racial groups and access to care across provincial groups, I calculated the concentration index for the number of cancer diagnosing facilities. The concentration index, though, was quite low comparatively, thus showing that one's living in a more rural area does not impact their chances of developing cervical cancer than one's racial background does in post-Apartheid South Africa.

The next studies that focus on health-related goods and services inequality in post-Apartheid South Africa should ensure that there is up-to-date data on health facilities throughout

the region and that more information is provided on all forms of melanoma. Also, upon obtaining more specific data on cervical cancer and the Human Papillomavirus, conduct the Concentration Curve to analyze HPV rates amongst the provinces and races. Lastly, another area to study is the realm of the spillover effect between breast cancer screening and cervical cancer screening.

The purpose of this report was to emphasize the inequitable distribution of care in regards to cervical cancer throughout the various provinces and racial groups of South Africa. Through my empirical analysis, I was able to show the similar trends in inequalities between provinces and racial groups that similarly impact the possibility of developing cervical cancer.

Appendix

1. Area Under the Lorenz Curve (2001) = (0.5)(0 + 0.0605)(0.111) + (0.5)(0.0605 + 0.1378)(0.111) + (0.5)(0.1378 + 0.2173)(0.111) + (0.5)(0.2173 + 0.2982)(0.111) + (0.5)(0.2982 + 0.3803)(0.111) + (0.5)(0.3803 + 0.4827)(0.111) + (0.5)(0.4827 + 0.5874)(0.111) + (0.5)(0.5874 + 0.7932)(0.111) + (0.5)(0.7932 + 1)(0.111)

2. Area Under the Lorenz Curve (2011) = (0.5)(0 + 0.07)(0.111) + (0.5)(0.07 + 0.1490)(0.111) + (0.5)(0.1490 + 0.2350)(0.111) + (0.5)(0.2350 + 0.3280)(0.111) + (0.5)(0.3280 + 0.4230)(0.111) + (0.5)(0.4230 + 0.5250)(0.111) + (0.5)(0.5250 + 0.6310)(0.111) + (0.5)(0.6310 + 0.8070)(0.111) + (0.5)(0.8070 + 0.9990)(0.111)

3. Concentration Curve Calculation = [(.1044)(.1786) – (.2132)(.0119)] + [(.2132)(.2024) – (.29898)(.1786)] + [(.2989)(.2384) – (.3520)(.2024)] + [(.3520)(.3574) – (.4301)(.2384)] + [(.4301)(.4884) = (.6284)(.3574)] + [(.6284)(.5124) – (.6505)(.4884)] + [(.6505)(.7024) – (.763)(.5124)] + [(.763)(1) – (1)(.7024)]

References

Abate, S. M. (2015, December 16). Trends of Cervical Cancer in Ethiopia. Retrieved September 19, 2017, from https://www.omicsonline.org/open-access/trends-of-cervical-cancer-in-ethiopia-ccoa-1000103.php?aid=64881

Afzal, O., Lieber, M., Dottino, P., & Beddoe, A. M. (2016). Cervical cancer screening in rural South Africa among infected migrant farm workers and sex workers. *Gynecologic Oncology Reports,* 18-21.

Anorlu, R. (2008, November 21). "Cervical Cancer: The Sub-Saharan African Perspective". Retrieved from http://www.tandfonline.com/doi/full/10.1016/S0968-8080(08)32415-X

Ayissi, C. A., Wamai R. G., Oduqo, G. O., Perlman, S., Welty, E., Welty, T., Ogembo, J. G. (2012). Awareness, acceptability, and uptake of human papilloma virus vaccine among Cameroonian school-atending female adolescents. *Jounral of Community Health, 37*(6), 1127-35.

Bailie, R. S., Selvey, C. E., Bourne, D., & Bradshaw, D. (1996). Trends in Cervical Cancer Mortality in South Africa. *International Journal of Epidemiology, 25*(3), 488-493. doi:10.1093/ije/25.3.488

Binagwaho, A., Ngabo, F., Wagner, C. M., Mugeni, C., Gatera, M., Nutt, C. T., et al. (2013). Integration of comprehensive women's health programmes into health systems: Cervical cancer prevention, care and control in Rwanda. *World Health Organization. Bulletin of the World Health Organization, 91*(9), 697-703. Retrieved from http://search.proquest.com/abicomplete/docview/1443354021/abstract/B8C7CD2139D64981PQ/14

Bishop, J. D. (1995). Adam Smiths invisible hand argument. *Journal of Business Ethics, 14*(3), 165-180. doi:10.1007/bf00881431

Bradley, A. (2010, December). Positive rights, negative rights and health care. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/20935318

Bonati, M., & Garattini, S. (2009). Controlling cervical cancer. *PharmacoEconomics, 27*(2), 91-3. Retrieved from http://search.proquest.com/abicomplete/docview/222358666/abstract/B8C7CD2139D64981PQ/11

Bosch, F. (2008). Evaluating the potential benefits of universal worldwide human papillomavirus vaccination. *Therapy*. 5(3). 305-312.

Boundless Economics. (n.d.). Retrieved April 01, 2018, from https://courses.lumenlearning.com/boundless-economics/chapter/sources-of-inefficiency/

Bouassa, R. M., Prazuck, T., Lethu, T., Jenabian, M., Meye, J., & Bélec, L. (2017). Cervical cancer in sub-Saharan Africa: a preventable noncommunicable disease. *Expert Review of Anti-infective Therapy, 15*(6), 613-627. doi:10.1080/14787210.2017.1322902

Bruni, L., Barrionuevo-Rosas, L., Albero, G., & Serrano, B. (2017). Human Papillomavirus and Related Diseases: Ethiopia. *ICO Information Center*, 1-66.

Cervical cancer. (2017) Retrieved from http://www.who.int/cancer/prevention/diagnosis-screening/cervical-cancer/en/

Cervical Cancer Causes, Diagnosis and Symptoms. (2013). Retrieved October 17, 2017, from http://www.nccc-online.org/hpvcervical-cancer/cervical-cancer-overview/

"Cervical cancer prevention cost-effectiveness in developing countries". (2014). *PharmocoEconomics & Outcomes News.* (695). 3-5.

"Cervical cancer screening in developing countries". (2002). Retrieved from http://www.who.int/cancer/media/en/cervicalcancer.37321.pdf"

Chocontá-Piraquive, L. A., Alvis-Guzman, N., & De la Hoz-Restrepo, F. (2010). How protective is cervical cancer screening against cervical cancer mortality in developing countries? the colombian case.*BMC Health Services Research, 10,* 270. doi://dx.doi.org/10.1186/1472-6963-10-270

Chung, J., Abedin, J., Berger, D., Clark, A., & Jimenez, V. (2017). Spillover effects on health outcomes in low- and middle-income countries: a systematic review. *Int J Epidemiol, 46*(4).

Clifford, G. M., Gonçalves, M. A., & Franceschi, S. (2006). Human papillomavirus types among women infected with HIV: a meta-analysis. *Aids, 20*(18), 2337-2344. doi:10.1097/01.aids.0000253361.63578.14

Concepts of Prevention. (2015). Retrieved from https://www.med.uottawa.ca/sim/data/Prevention_e.htm

Corral, F., Cueva, P., Yépez, J., & Montes, E. (1996, December). Limited education as a risk factor in cervical cancer. Retrieved March 02, 2018, from https://www.ncbi.nlm.nih.gov/pubmed/9041743

Dagum, C., & Kakwani, N. C. (1986). Income Inequality and Poverty, Methods of Estimation and Policy Applications. *Journal of Business & Economic Statistics, 4*(3), 391. doi:10.2307/1391579

Denny, L. (2010). Cervical cancer in South Africa: An overview of current status and prevention strategies. *CME,28*(2), 70-73.

Doorslaer, E. V., & Koolman, X. (2004). Explaining the differences in income-related health inequalities across European countries. *Health Economics, 13*(7), 609-628. doi:10.1002/hec.918

Education in South Africa. (2017, September 18). Retrieved from https://wenr.wes.org/2017/05/education-south-africa

Education in South Africa. (2018). Retrieved from https://www.expatica.com/za/education/education-in-south-africa_803205.html

Facts about Gauteng. (2018). Retrieved from https://www.gauteng.net/pages/facts_about_gauteng

The Failure of Market Failure. (2001). *Economic Efficiency in Law and Economics*. doi:10.4337/9781843761488.00010

Farmer, P. E., Nizeye, B., Stulac, S., & Keshavjee, S. (2006). Structural Violence and Clinical Medicine. *PLoS Medicine, 3*(10). doi:10.1371/journal.pmed.0030449

Gaede, B., & Versteeg, M. (2011). The State of the Right to Health in Rural South Africa. 100-106.

GAVI Alliance Country Eligibility, Graduation, and Prioritization. (2018). Retrieved from https://www.r4d.org/resources/presentation-gavi-alliance-board-country-eligibility-graduation-procedures/

Gender Discrimination South Africa. (1998). *Inter Press Service*.

Ginsberg, G. M., Edejer, T. T., Lauer, J. A., & Sepulveda, C. (2009). Screening, prevention and treatment of cervical cancer--A global and regional generalized cost-effectiveness analysis. *Vaccine, 27*(43), 6060-6079.

Goldie, S. J., Kohli, M., Grima, D., Weinstein, M. C., Wright, T. C., Bosch, F. X., & Franco, E. (2004). Projected Clinical Benefits and Cost-effectiveness of a Human Papillomavirus 16/18 Vaccine. *JNCI Journal of the National Cancer Institute, 96*(8), 604-615. doi:10.1093/jnci/djh104

Greslin, F., Pellegrino, S., & Vernizzi, A. (2017). Gini versus Zenga Inequality Index: A New Approach to Measuring Personal Income Tax Redistribution and Progressivity. *University of Milan,* 1-20.

Group Areas Act of 1950. (2017, August 16). Retrieved March 01, 2018, from http://www.sahistory.org.za/article/group-areas-act-1950

Harper, D. M., & Demars, L. R. (2017). HPV vaccines – A review of the first decade. *Gynecologic Oncology, 146*(1), 196-204. doi:10.1016/j.ygyno.2017.04.004

Health care in South Africa. (2012). Retrieved from https://www.brandsouthafrica.com/south-africa-fast-facts/health-facts/health-care-in-south-africa

HPV Dormant Period: How Long Can HPV Stay In Body - 20 Years? (2018, March 09). Retrieved March 16, 2018, from http://ahcchpv.com/hpv-dormant-period/

Human papillomavirus (HPV). (2017). Retrieved from http://www.who.int/immunization/topics/hpv/en/

Human Papillomavirus (HPV) Vaccines. (2018). Retrieved from https://www.cancer.gov/about-cancer/causes-prevention/risk/infectious-agents/hpv-vaccine-fact-sheet

Jordaan, S., Michelow, P., Richter, K., Simoens, C., & Bogers, J. (2016). A Review of Cervical Cancer in South Africa: Previous, Current and Future. *Health Care : Current Reviews, 04*(04). doi:10.4172/2375-4273.1000180

Key Concepts: Economics of Vaccine Production. (n.d.). Retrieved from http://www.who.int/immunization/programmes_systems/financing/analyses/en/briefcase_vacproduction.pdf

Kon, Z. R., & Lackan, N. (2008). Ethnic Disparities in Access to Care in Post-Apartheid South Africa. *American Journal of Public Health*, *98*(12), 2272–2277. http://doi.org/10.2105/AJPH.2007.127829

Kuhn, L., Wang, C., Tsai, W., Wright, T. C., & Denny, L. (2010). Efficacy of human papillomavirus-based screen-and-treat for cervical cancer prevention among HIV-infected women. *Aids, 24*(16), 2553-2561. doi:10.1097/qad.0b013e32833e163e

Labeit, A., & Peinemann, F. (2015). Breast and cervical cancer screening in Great Britain: Dynamic interrelated processes. *Health Economics Review, 5*(1). doi:10.1186/s13561-015-0065-3

Land, Labour and Apartheid. (2017, November 17). Retrieved from http://www.sahistory.org.za/article/land-labour-and-apartheid

Lince-Deroche, N., Phiri, J., Michelow, P., Smith, J. S., & Firnhaber, C. (2015). Costs and Cost Effectiveness of Three Approaches for Cervical Cancer Screening among HIV-Positive Women in Johannesburg, South Africa. Retrieved September 06, 2017, from http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0141969

May, J., Woolard, I., & Klasen, S. (2000). The Nature and Measurement of Poverty and Inequality. *Poverty and Inequality in South Africa: meeting the challenge*, 9-48.

May, J., & Meth, C. (2007). Dualism or underdevelopment in South Africa: what does a quantitative assessment of poverty, inequality and employment reveal? *Development Southern Africa, 24*(2), 271-287. doi:10.1080/03768350701327178

Mayosi, B. M., & Benatar, S. R. (2014). Health and Health Care in South Africa — 20 Years after Mandela. *New England Journal of Medicine, 371*(14), 1344-1353. doi:10.1056/nejmsr1405012

Measuring Inequality. (2016). Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTPOVERTY/EXTPA/0,,contentMDK:20238991~menuPK:492138~pagePK:148956~piPK:216618~theSitePK:430367,00.html

The Native Land Act is passed. (2015, October 14). Retrieved from http://www.sahistory.org.za/dated-event/native-land-act-passed

New guidelines for the screening and treatment of cervical cancer. (2018). Retrieved from http://www.who.int/reproductivehealth/topics/cancers/guidelines/en/

O'Donnell, O., Doorslaer, E. V., Wagstaff, A., & Lindelow, M. (2007). Analyzing Health Equity Using Household Survey Data. doi:10.1596/978-0-8213-6933-3

Ogbanna, F. (2017). Knowledge, Attitude, and Experience of Cervical Cancer and Screening among Sub-saharan African Female Students in a UK University. *Annals of African Medicine, 16*, 1st ser., 18-23. doi:10.4103/aam.aam_37_16

Osborne, M. J. (1997). Pareto Efficiency. Retrieved from https://www.economics.utoronto.ca/osborne/2x3/tutorial/PE.HTM

Parilla, J., & Trujillo, J. L. (2016, August 18). South Africa's global gateway: Profiling the Gauteng City-Region's international competitiveness and connections. Retrieved from https://www.brookings.edu/research/south-africas-global-gateway- profiling-the-gauteng-city-regions-international-competitiveness-and-connections/

Plotkin, S., Robinson, J. M., Cunningham, G., Iqbal, R., & Larsen, S. (2017). The complexity and cost of vaccine manufacturing – An overview. *Vaccine, 35*(33), 4064-4071. doi:10.1016/j.vaccine.2017.06.003

Population Registration Act. (2016, February 22). Retrieved from http://www.sahistory.org.za/archive/population-registration-act,-act-no-30-of-1950

Price Discrimination. (2011). Retrieved from http://people.hss.caltech.edu/~mshum/ec105/matt9.pdf

Rispel, L. C., Jager, P. D., & Fonn, S. (2015). Exploring corruption in the South African health sector. *Health Policy and Planning, 31*(2), 239-249. doi:10.1093/heapol/czv047

SDGs .:. Sustainable Development Knowledge Platform. (2018). Retrieved from https://sustainabledevelopment.un.org/sdgs

Statistics South Africa. (2003). *Census 2001: investigation into appropriate definitions of urban and rural areas for South Africa: discussion document*. Pretoria: Statistics South Africa.

Social institutions and gender index (SIGI). (2014). doi:10.1787/eco_surveys-ind-2014-graph18-en

Soetan, R. O. (2001). Culture, Gender, and Development. *The Centre for Gender and Social Policy Studies*.

South Africa Census in Brief. (2011). *Statistics South Africa*

South Africa, Department of Health. (2017). *National Guideline for Cervical Cancer Screening*. Western Cape.

South Africa Policy Brief. (2015). *OECD Economic Surveys: South Africa*. https://www.oecd.org/education/south-africa-improving-quality-and-relevance-of-skills.pdf

Stuckler, D., Basu, S., & Mckee, M. (2011). Health Care Capacity and Allocations Among South Africas Provinces: Infrastructure–Inequality Traps After the End of Apartheid. *American Journal of Public Health, 101*(1), 165-172. doi:10.2105/ajph.2009.184895

Van der Hoeven, M., Kruger, A., & Greeff, M. (2012). Differences in health care seeking behaviour between rural and urban communities in South Africa. International Journal for Equity in Health, 11, 31. http://doi.org/10.1186/1475-9276-11-31

Visser, R., Bhana, R., & Monticelli, F. (2012). National Health Care Facilities Baseline Audit, South Africa. *National Department of Health*.

Visser, M., & Ferrer, S. (2015). Farm Workers' Living and Working Conditions in South Africa: key trends, emergent issues, and underlying and structural problems. *The International Labor Organization*,1-252.

Western Cape Economic Overview. (2010). Retrieved from https://web.archive.org/web/20101225192451/http://wesgro.co.za/internationalbuyers/index.php?readnews 1967

What Is Cancer? (2018). Retrieved from https://www.cancer.gov/about-cancer/understanding/what-is-cancer

What Is Cervical Cancer? (2018). Retrieved March 29, 2018, from https://www.cancer.org/cancer/cervical-cancer/about/what-is-cervical-cancer.html

What Is HPV? (2018). Retrieved from https://www.webmd.com/sexual-conditions/hpv-genital-warts/hpv-virus-information-about-human-papillomavirus#1

Womens Health Care Physicians. (n.d.). Retrieved from https://www.acog.org/Patients/FAQs/Cervical-Cancer-Screening

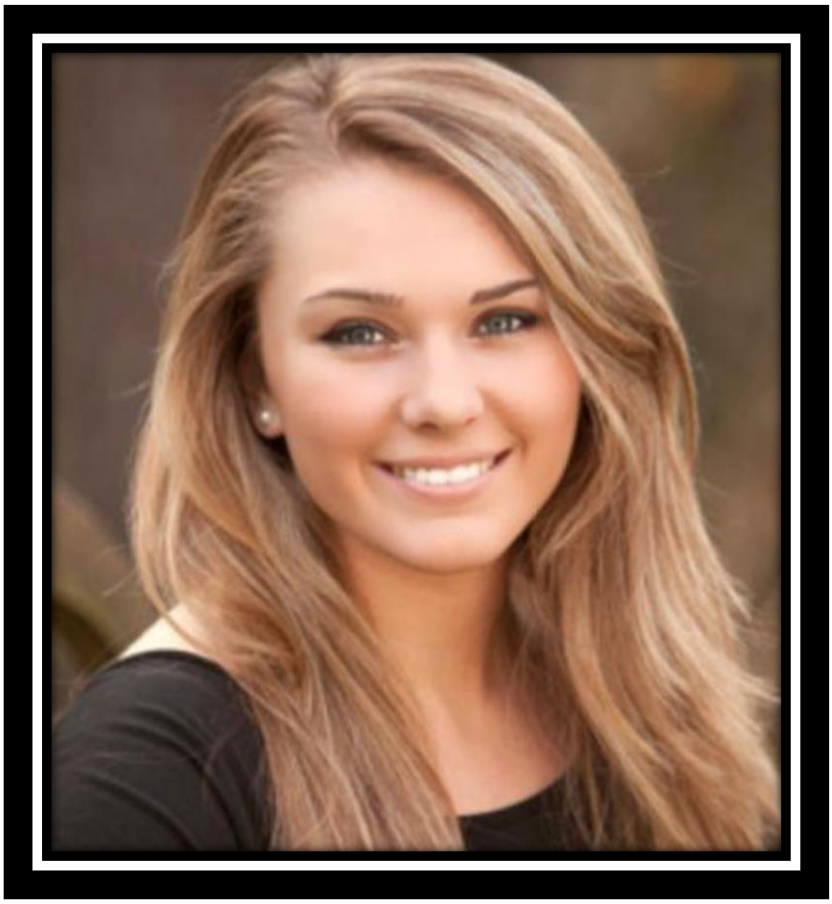
The World Bank in South Africa: Overview. (2017). *World Bank*.

Xu, X., Grossetta Nardini, H. K., & Ruger, J. P. (2014). Micro-costing studies in the health and medical literature: protocol for a systematic review. *Systematic Reviews, 3,* 47. http://doi.org/10.1186/2046-4053-3-47

Yitzhaki, S., & Schechtman, E. (2012). The Lorenz Curve and the Concentration Curve. *Springer Series in Statistics The Gini Methodology,* 75-98. doi:10.1007/978-1-4614-4720-7_5

Young, M. (2016). *Private vs. Public Healthcare in South Africa* (Unpublished master's thesis, 2016). Western Michigan University.

About the Author



Madison Caufield

Madison Caufield is a student at Allegheny College, double majoring in Economics and Global Health Studies. She anticipates graduating in May of 2018. Through her interdisciplinary studies, she has learned how many factors come into play when financing health care and addressing public health issues. Along with her academics, she also played for the Allegheny Women's Basketball Team for four years and was the head captain for her junior and senior year.

Upon graduating, she plans to move back to Pittsburgh, Pennsylvania, and anticipates working for a large financial institution. In the future, Madison intends to pursue a Masters degree in either Public Administration or Health Care Administration.