

Spring 2013

Late Adoption of Antiretroviral Therapy in South Africa and Its Effect on Current HIV/AIDS Infection Rates

Jonathan Wehrend
University of Colorado Boulder

Follow this and additional works at: https://scholar.colorado.edu/honr_theses

Recommended Citation

Wehrend, Jonathan, "Late Adoption of Antiretroviral Therapy in South Africa and Its Effect on Current HIV/AIDS Infection Rates" (2013). *Undergraduate Honors Theses*. 511.
https://scholar.colorado.edu/honr_theses/511

This Thesis is brought to you for free and open access by Honors Program at CU Scholar. It has been accepted for inclusion in Undergraduate Honors Theses by an authorized administrator of CU Scholar. For more information, please contact cuscholaradmin@colorado.edu.

Late Adoption of Antiretroviral Therapy in South Africa and Its Effect on Current HIV/AIDS
Infection Rates

Jonathan K. Wehrend

GENERAL HONORS

From the departments of

INTEGRATIVE PHYSIOLOGY and GERMAN

Examining Committee:

Teresa Foley, Thesis Advisor
Integrative Physiology

E. Christian Kopff
Honors

Andrea Feldman
Writing and Rhetoric

UNIVERSITY OF COLORADO AT BOULDER

APRIL 2013

Table of Contents

Abbreviations & Definitions	3
Abstract	4
Figure 1	5
Introduction	6
Apartheid Era South Africa	8
Apartheid Policy	8
HIV/AIDS during Apartheid	10
The African National Congress	11
Zidovudine (AZT)	13
The Early Response to the Pandemic	14
The Western Cape Province	17
Methods	18
Results	20
Figure 2	21
Table 1	22
Table 2	23
Table 3	23
Discussion	24
References	29

Abbreviations & Definitions

Acquired immune deficiency syndrome (AIDS) – A disease of the immune system caused by HIV infection

African National Congress (ANC) – The ruling political party in South Africa since 1994

AIDS denialism - An international movement beginning in the 1980s that denied the link between HIV and AIDS

National Party (NP) – The ruling political party in Apartheid-era South Africa

Human immunodeficiency virus (HIV) – A virus that compromises the immune system and eventually results in AIDS

Zidovudine (AZT) – An antiretroviral drug used in the treatment of HIV/AIDS

Abstract

As of 2013, there are more people infected with Human immunodeficiency virus (HIV) in sub-Saharan Africa than the rest of the world combined; the vast majority of whom reside in South Africa. The contributions made by a national policy of Acquired immune deficiency syndrome (AIDS) denialism have been well established, however, misinformation alone does not explain the problem entirely. In 1990, the antiretroviral drug Zidovudine (AZT) was approved for human treatment and shown to be effective in reducing viral loads, thereby reducing the risk of HIV transmission. Despite its proven effectiveness, AZT was prohibited throughout South Africa until 2001, with the notable exception of the Western Cape Province, which made AZT available in 1999. Using a t-test analysis on data presented in the *National Antenatal Sentinel HIV and Syphilis Prevalence Survey, South Africa* studies from 1998 to 2011, I show that the percentage of HIV infected individuals in the Western Cape Province is statistically lower than South Africa as a whole ($P \leq 0.0001$). In addition, ANCOVA and regression analysis show values of 65.33 and 0.935, respectively, indicating a high level of covariance and correlation between the Western Cape Province and national infection percentages. A $P \leq 0.0001$ and a high correlation and covariance indicate that even though the infection rates changed similarly (as would be expected within a nation), the actual infection percentages are significantly different. Given that the Western Cape Province was subject to the same propaganda and policies as the rest of South Africa, but differed in the implementation of AZT and has since consistently had the lowest HIV infection rate, it is reasonable to suggest that the early implementation of AZT had a profound effect on infection rate. Had this program been made available nation-wide, it is likely the AIDS epidemic in South Africa would not be a disaster of the same magnitude that it is today.

Figure 1. Map of South Africa Showing Province Geography



Note. Descriptive note. Adapted from GlobalSecurity.org World Military Guide. Copyright GlobalSecurity.org 2013.

Introduction

In the past two decades HIV/AIDS has been one of the greatest problems facing South Africa, influencing everything in the region from everyday life to international politics. With 1.9 million new infections in 2008, sub-Saharan Africa has the highest HIV/AIDS infection rate in the world, accounting for 67% of the world's infected population and 1.4 million annual AIDS-related deaths (UNAIDS, 2009). Within this region, one of the highest infection rates belongs to South Africa, with 11.4% of the population suffering from HIV/AIDS ("South Africa", 2010).

South Africa is the most developed nation in Africa, with a gross domestic product separating it from other African nations by well over 100 billion dollars. Its economy is heavily industrialized, its natural resources are abundant, and its stock exchange is the 17th highest in the world ("South Africa", 2010). Despite the fact it has many characteristics of a developed nation, approximately one in ten individuals are infected with HIV/AIDS. In fact, no other country in the world possesses both a severe infection rate and a developed economy ("South Africa", 2010).

For decades, the National Party ruled South Africa under an apartheid system of government – the last few years of which overlapped with the initial outbreak of HIV/AIDS in the country. The response to the outbreak of HIV/AIDS in the early 1990s was a poorly coordinated effort aimed more at gaining good public relations for National Party leadership than stopping the spread of HIV/AIDS (Heywood, 1998). However, during the final years of Apartheid, the HIV/AIDS infection rate was nowhere near its current level, and in fact did not begin to reach pandemic proportions until after Apartheid had been abolished ("History of HIV", 2010). While it can be argued that the massive infection rates of today are attributable to

the National Party's ineffectual response, the United States, Latin American countries, and even other African nations experienced outbreaks of their own during the same years. In the U.S., the response to HIV/AIDS by both the Reagan and the Bush Administrations was lackluster and it was not until the Clinton Administration that the situation began to improve, due primarily to the various HIV/AIDS awareness programs that were implemented (Rimmerman, 1998). When Apartheid officially ended in 1994 with the election of Nelson Mandela, who was head the African National Congress, the first serious HIV/AIDS awareness programs began to take shape with the adoption of "South Africa's National AIDS Plan". However the initiative dissolved quickly to accommodate the African National Congress's vision of a bright, new future for South Africa (Van der Vliet, 2004).

The decision to focus on building up the nation and sweeping away the remnants of the former Apartheid system took focus away stemming the spread of the HIV/AIDS pandemic at a critical time – a decision that proved to be disastrous ("History of HIV", 2010). However, responsibility for the prevalence of HIV/AIDS does not rest solely on this decision. Since 1985, antiretroviral therapy has been the only effective treatment for HIV/AIDS and works by disrupting the mechanism of reproduction in retroviruses such as HIV. Had the African National Congress taken radical action and created a united front against HIV/AIDS, the spread could at least have been slowed down. Instead, many of the highest-ranking officials within the African National Congress repeatedly denied antiretroviral therapy to the public, denied the link between HIV and AIDS, and spread dangerous misinformation about the disease at every opportunity, allowing HIV/AIDS to run rampant in South Africa for the better part of two decades ("History of HIV," 2010).

While the propagation of misinformation concerning HIV/AIDS was no doubt extremely damaging to efforts to slow the progress of the disease, the active campaigning against antiretroviral therapy was the factor that truly set South Africa apart from the many other nations experiencing the epidemic. The effectiveness of antiretroviral therapy in treating HIV/AIDS had been well established by the early 1990s in multiple studies worldwide and as a result had been widely adopted as the only treatment to prevent HIV from developing into AIDS. With a comprehensive plan, a national infection rate <5%, highly qualified AIDS specialists at their disposal and knowledge of the course of the epidemic in other nations, South Africa was prepared to take HIV/AIDS head on. Nevertheless, in 1994, leading members of the African National Congress, now fully in control of the nation, were openly questioning the validity of the treatment, despite the approval of the National AIDS Plan by the National AIDS Committee of South Africa (Crewe, 2000). The refusal to allow the use of antiretroviral therapy in the treatment of HIV/AIDS was a devastating decision that turned the promise of a comprehensive strategy to an ineffectual one and allowed the unchecked proliferation of the virus for the better part of a decade.

Apartheid-Era South Africa

Apartheid Policy

In order to better understand the conditions that led to the rapid rise of HIV/AIDS in South Africa, one has to understand Apartheid and its impact on the country. Apartheid was a form of government sanctioned racism and discrimination that lasted from 1948 until 1994 under the National Party in South Africa. Under the Apartheid system, the South African

population was classified into three distinct and unequal categories: White, Coloured, and Black. The classification of race was the responsibility of the Department of Home Affairs. When assigning an individual to a certain race, the government bureau would take into account not only heritage and appearance, but also factors such as habits, education, speech, and demeanor. "White" referred to anyone of entirely European descent. They enjoyed the most privilege, comprised the ruling government and possessed a disproportionate amount of wealth. The term "Coloured" designated any individual whose ancestry was not entirely white (Indian, Asian, Mixed Race, etc.). The coloured sector of the population were given far fewer rights than the white sector (Chokshi et al, 1995), however, they enjoyed more privilege and social status than the Black population. "Black" referred to the majority of the South African population and designated anyone of native African descent. Blacks were given minimal rights, were the last allowed the right to vote and, in accordance with the Pass Laws Act of 1952, were required to carry "pass books" that contained a photo, fingerprints, and personal information to gain access to "non-black" areas (Chokshi et al, 1995). With the Population Registration Act of 1950, every South African was required to register themselves as a member of one of the three races. Following the Separate Amenities Act of 1953, which aimed to eliminate all contact between separate races, whites and blacks were required to use separate public facilities, transportation, and medical facilities. Apartheid legislation did not stop there, however (Spindle et al, 2007). The Mixed Marriages Act of 1949 forbade marriages between members of different races and was further reinforced by the Immorality Act of 1957 that made illegal not only relationships between different races, but the intention to pursue them as well (Spindle et al, 2007). In addition, the Suppression of Communism Act of 1950 made any opposition to

Apartheid illegal and allowed the government to punish any group or individual they perceived as a threat (Spindle et al, 2007).

HIV/AIDS during Apartheid

In 1982 the first case of HIV in South Africa was reported when two white homosexual men who had recently travelled the United States were diagnosed ("The Origin," 2010). In the following few years the disease spread rapidly within the gay and bisexual community ("The Origin," 2010). Unfortunately, as the true cause of AIDS was yet unknown and gay and bisexual individuals were a widely maligned part of the population, the National Party's response was almost non-existent. The National Party's ambivalent response to the outbreak spawned a variety of human rights initiatives to combat the outbreak. Unfortunately without government support of the movement or even recognition of the disease, the effectiveness of non-government organizations during this period was low.

Apart from the gay community, there were roughly 100 patients suffering from hemophilia who contracted HIV from contaminated blood transfusions from 1983 to 1985. In contrast to other infected individuals, the National Party readily set up funds to compensate the patients and their families for what it considered to be a tragic accident. The separation of those with HIV/AIDS into those who were immoral versus those who were victims extended even to cases where newborns contracted HIV from their mothers. The child was thought of as an innocent, whereas the mother was considered immoral (Karim, 2009).

Government and societal prejudice against those who were HIV/AIDS positive was not only limited to homosexuals and those deemed immoral however. In 1987 the first black South

African was diagnosed with HIV (Van der Vliet, 2004) and HIV/AIDS began to spread within South Africa's black majority population. With this turn of events, the National Party labeled HIV/AIDS as a "black disease" and set to rest any responsibility for implementing national treatment and prevention programs (Karim, 2009). Despite refusing to accept responsibility for the epidemic on a nationwide scale, the National Party had created a network of AIDS treatment centers with highly skilled medical professionals. As expected, these centers were located in predominantly white areas and only accessible to white individuals (Crewe, 2000). Even with extreme government bias and stratified compensation for victims of HIV/AIDS, the incidence of the disease remained relatively low for the remainder of the National Party's rule of South Africa and did not reach epidemic proportions until well after the African National Congress had taken power (Karim, 2009).

The African National Congress

The African National Congress is South Africa's current ruling political party and has been in control of the nation since 1994. The party was formed in 1912, with the initial goal of expanding the rights of black South Africans. However, when the National Party came to power in 1948 and implemented the Apartheid system, the African National Congress adjusted its focus nearly exclusively to the abolition of Apartheid, allying itself with other minority group congresses ("Umzabalazo," n.d.). In the late 1940s and through the late 1950s, South Africa saw the rapid enactment of a series of racial restrictions and laws by the National Party under the Leadership of Prime Minister Daniel Francois Malan ("Daniel," 2010). The majority of the laws he enacted persisted until the end of Apartheid in 1994 and his actions during the early

days of Apartheid laid the groundwork for its longevity (“Daniel,” 2010). However the success of Apartheid was also heavily dependent on Malan’s successor, Henrik Verwoerd. After being elected prime minister in 1958, Verwoerd passed further legislation segregating the population and diminishing the rights of black South Africans (“Henrik,” 2010). He was also instrumental in transforming South Africa from a British commonwealth to a republic in 1961, further removing foreign influences (“Henrik,” 2010). The comprehensive and inflexible legislation passed in less than a decade caused the African National Congress to lose significant ground in the fight against Apartheid. Amidst ever more pressure, harsh policies, and brutal acts by the National Party, the African National Congress was banned and forced to go underground.

In the 1970s, with the influence of the African National Congress diminished, the National Party took the opportunity to extend its control over the South African population. However this proved to be ineffective, and resulted in strikes by workers and protests by thousands of students. The momentum of the African National Congress’s cause increased through the 1980s, becoming increasingly popular both domestically and abroad. This was due in no small part to the actions of Oliver Tambo, who served as the president of the African National Congress from 1969 to 1991. During his leadership of the African National Congress, the organization made immense progress towards the goal on an Apartheid-free South Africa, transforming from a fringe liberation movement into a contender for the ruling party (“Umzabalazo,” n.d.).

It was not until 1990 when decades of protest, overwhelming domestic support, and international pressures forced the National Party to repeal the ban on the African National Congress. Even though the African National Congress did not officially come to power until

1994, this marked the downfall of the National Party and the African National Congress's meteoric rise to power. In 1991 Nelson Mandela was elected president of the African National Congress and started negotiations with the National Party that resulted in South Africa's first "one person, one vote" elections. In 1994 Nelson Mandela won as the African National Congress's candidate with a 62.6% majority and the African National Congress has been South Africa's ruling party since ("Umzabalazo," n.d.).

Zidovudine (AZT)

The transition of power to a new political party opened up the possibility of change for a variety of pre-existing social policies, including the use of antiretroviral therapy to treat HIV positive individuals. Zidovudine, also known as AZT, is an antiretroviral drug used primarily in the treatment of HIV/AIDS. Originally intended as a cancer treatment, AZT was developed in 1964. However, after showing no significant results on clinical trials in mice, the drug never progressed to human trials. It was not until 1984, in the middle of the AIDS pandemic, that clinical research on AZT resumed (Broder, 2009).

After rigorous testing, AZT was found to be an effective inhibitor of reverse transcriptase, the mechanism by which HIV replicates. In 1985, the trials culminated in a double-blind, placebo-controlled randomized trial, which definitively proved that AZT was safe for human consumption and extended the life expectancy of those individuals infected with the virus (Emmons, 1993). It was not until 1990 that AZT was approved for infants and children by the Food and Drug Administration ("AZT Approved", 1990).

In the first few years following the Food and Drug Administration's approval of AZT for human use, the drug garnered controversy due to its rather severe side effects. Patients on the antiretroviral therapy took 2400 mg of AZT every day, and would often experience anemia, cardiomyopathy and hepatotoxicity ("Side Effects", 2013). While the side effects were certainly severe, the treatment was deemed acceptable, as the only alternative was to slowly die of AIDS.

Despite the various studies that proved AZT's effectiveness, many AIDS denialists, including President Thabo Mbeki, centered their criticism of the treatment on the drug's side effects and used it as justification for refusing treatment. It was not until several years after AZT's unanimous approval, that the therapy was found to still be effective at a much lower dosage (600 mg per day), thereby greatly reducing the severity of the side effects. Currently, AZT is still used as a treatment for HIV/AIDS; however, the drug is now one of three drugs combined in a cocktail, which greatly increases the treatment effectiveness and hinders HIV's propensity for dangerous mutations (De Clercq, 1994).

The Early Response to the Pandemic

1994 was a pivotal year for South Africa. The National Party had been supplanted by the African National Congress and with that change came the possibility to make a new nation – blessedly free of the injustices of the past. Restructuring of the government began on every level, with greater autonomy than ever before granted to the provincial governments. However, this transfer of power, while initially welcomed, proved to be a double-edged sword for the new nation. On one hand, the transfer of power to provincial governments allowed for

the incredible diversity of the South African population to be better represented and the many minority groups to have a voice, where they previously had none. On the other hand, in the face of a national epidemic, the lack of national unity in implementing an effective plan against HIV/AIDS proved to be extremely counter-productive.

With a national strategy and a variety of non-governmental organizations prepared to show a united front against HIV/AIDS, South Africa had a real chance to stop the epidemic before it became the catastrophe it is today. Instead, power – specifically concerning the agency of healthcare administration – was transferred to the provincial governments; in effect, there ceased to be a National AIDS Plan. In addition to the transfer of power, the National AIDS Programme Director, who oversaw the implementation of the National AIDS Plan, was placed in the Ministry of Health instead of the office of the president. Similarly, provincial governments transferred authority to their own ministries of health – all of which had significantly less power to coordinate a nationwide response as AIDS had become exclusively a health problem (Nattrass, 2008). While the National AIDS Plan still existed as the official policy of the African National Congress, there were also nine other competing strategies at the provincial level (Crewe, 2000). A different plan for each province resulted in extreme disparities between the responses of the provinces to the epidemic.

Another disastrous measure that hindered the nation's ability to effectively fight the proliferation of HIV was the focus on a prevention program as opposed to a treatment program for those already infected. The decision was made by the Minister of Health, Dr. Nkosazana Dlamini-Zuma, who under the African National Congress administration had assumed full control of HIV prevention in South Africa. Dlamini-Zuma argued, against extreme opposition

from health professionals and AIDS activists, that antiretroviral therapy should not be used because the government wanted to focus on prevention of HIV/AIDS rather than treatment. In 1998, shortly after Dlamini-Zuma made the decision to shut down a national program for AZT designed to prevent mother-to-child transmission; she is quoted as saying: "AZT treatment will have a limited effect on the epidemic, as we are treating individuals already infected" (Nattrass, 2008). This rationale indicates a severe misunderstanding in the way that HIV spreads through populations. While exclusively preventative measures such as education and condom use are certainly important, ignoring those already infected is an ineffectual way to prevent the spread of the virus, since treatment of infected individuals substantially lowers the risk of transmission and prevents them from spreading the virus.

Dlamini-Zuma also cited cost of a nationwide antiretroviral therapy program as a major determining factor in the decision to deny the treatment to the general population. It was argued that the cost of testing every pregnant mother for HIV, as well as providing the necessary counseling and care should they be found HIV-positive, was too great for the administration to bear. Nevertheless, medical and economic research showed that the cost of testing and treatment pregnant mothers was significantly lower than treating children infected with HIV (Nattrass, 2008).

The true reasoning behind this decision to deny antiretroviral therapies to the population for so long is still unknown; however it is likely that Dlamini-Zuma felt hesitant to make her country dependent on antiretroviral therapies, since Western pharmaceutical companies produced the majority of them. Although, if this was the case, Dlamini-Zuma never directly expressed it as such and instead credited the refusal of allowing AZT to the general

public to the high cost of the drug. After nearly 50 years of an oppressive government favoring those of European descent, being at the mercy of yet another Western government would be tantamount to economic imperialism, an unacceptable scenario given the African National Congress's recent struggle (Nattrass, 2008).

The Western Cape Province

In 1999, well after the AIDS epidemic had been given years to spread with a national infection rate of 7%, the Western Cape Province decided to follow the international model and provide AZT to HIV-positive pregnant women (Nattrass, 2008). The pilot program was based upon a similar antenatal study performed in Uganda that showed a 50% reduction in the transmission of HIV from mother to child, provided that the mother was taking AZT (Guay, 1999). The decision to implement the antiretroviral therapy program was partially made due to a calculation that found it was more cost-effective to provide pregnant mothers with AZT than to treat HIV-positive babies with the variety of conditions that often result from an HIV infection (Viall, 1999). According to Viall (1999), "The cost of treating HIV -infected women with AZT in the Western Cape was lower than treating infected babies. Furthermore, the infant mortality rate is elevated in the region and could increase up to 30% without the AZT program." Although the use of AZT was banned throughout South Africa at the time, the Western Cape Province was not fully under African National Congress control and the national decision to ban antiretroviral therapies (which superseded provincial authority) did not apply, which allowed the Western Cape to continue their highly effective AZT program (Viall, 1990).

The success of the program in turn convinced the provincial Minister of Health, Nick Koornhof, to extend the AZT program to rape victims. Recognizing that rape victims are at an especially high risk for contracting HIV, the provincial administration decided that the annual R2 million (approximately \$218,000) cost of extending the program was a necessary measure in the ongoing battle against HIV/AIDS. The program allocated R400 (approximately \$44) per victim, which would cover the cost a four-week course of the treatment and substantially reduce the risk of HIV infection (Caelters, 2000).

Beginning in 2001, the Western Cape Department of Health in collaboration with Doctors Without Borders began a program that would provide necessary treatment for all individuals in the province infected with HIV (Abdullah, 2005). It was not until 2004 that the program had the means to begin providing treatment for the thousands of infected individuals within the province. However, since the program has been in place, individuals who are at risk for HIV-infection or know that they are HIV-positive can go to one of 36 sites within the province where they can receive treatment. Unfortunately, antiretroviral therapy is not available at every clinic and hospital within the province (Abdullah, 2005). Even with the limiting factor of the number of trained professionals able to provide the expertise the care requires, the program is still by far the best in the nation.

Methods

Given that the program employed by the Western Cape Province was comprehensive and fundamentally only differed in the accessibility of antiretroviral therapy to the general population, there must then be a significant difference between the province and the nation as

a whole. The associations between the two are demonstrated through several statistical tests using data provided by the South African Department of Health from 1990 until 2011. Data for each year is typically released in the year following, although the data for 2012 has not yet been published. Three tests chosen to analyze the data, including a one-tail t-test, an analysis of covariance and an analysis of correlation. The t-test was chosen because the independent variable (Western Cape or South Africa) was categorical, while the dependent variable (infection rate) was continuous. In addition, it was important to exhibit the difference in mean infection rates between the two populations. The analysis of covariance was chosen based on the same grounds; however, the aim was to show how the variance in infection rates of the two populations was linked. The analysis of correlation similarly shows how the change in infection rates of the two populations are linked, but gives an R^2 value that is easier to interpret than the covariance value.

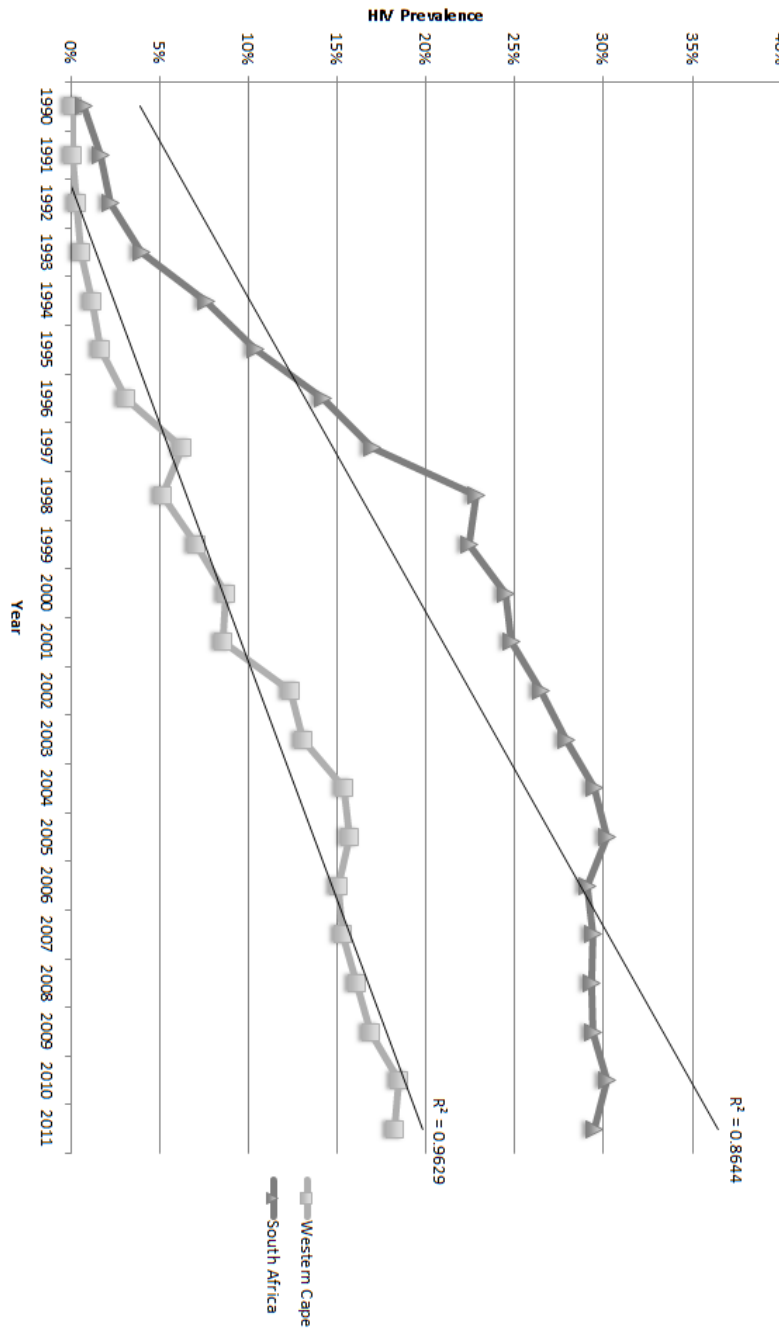
One thing to note is that these data represent antenatal (before birth) data collected by the South African Department of Health, and as such is not directly representative of the general population. Antenatal data is collected as an alternative to infection rates for the whole population due to both cost and practicality, since it is relatively easy and cost effective to test women for HIV who are coming in for antenatal doctor visits. Nevertheless, estimates about the HIV infection rate are made based on the antenatal data and can be used as a good indicator of where the actual infection rate lies (i.e., typically between one half to one third of the antenatal value). A further problem that makes analyzing antenatal data the only viable option is that while HIV infection rate data is available for the general population since 1990, estimates on the provincial level are not available from the Department of Health. Several studies have been

done to map this data (i.e. *The Demographic Impact of HIV/AIDS in South Africa. National and Provincial Indicators for 2006*), however, there is no standard for the measurement and estimation of the data, which increases the risk of bias and makes the data unsuitable for comparison.

Results

In Figure 1, the course of HIV infection in both the South African population and the Western Cape population is mapped from 1990 to 2011. Both curves exhibit a dramatic initial rise beginning in 1990 and lasting until the early 2000s, after which both begin to level off. The R^2 values of the infection rates with respect to year for the Western Cape Province and South Africa are 0.96 and 0.86 respectively, indicating in both cases a high correlation between infection rate and year. One key difference between the two data sets is the infection rate as of the year 2011. By this time, both South Africa and the Western Cape had a fully implemented antiretroviral therapy program that had been ongoing for several years, but the HIV infection rate nationally was 11.3% higher than in the Western Cape.

Figure 2. Antenatal HIV Prevalence in South Africa and Western Cape 1990-2011



Note. Descriptive note. Adapted from the *National Antenatal Sentinel HIV and Syphilis Prevalence Survey, South Africa* studies from 1998 to 2011.

Table 1 provides the t-test values between the antenatal infection rates of South Africa and the Western Cape. Considering that the only fundamental difference in the two AIDS programs of the nation and the Western Cape was the accessibility of antiretroviral therapy, the mean difference if antiretroviral therapy had no effect on the outcome of infection rate should be zero. However, the results of the t-test strongly indicate this is not the case, resulting in a t statistic of -4.07, corresponding with a $p \leq 0.0001$. Even though the general trend of the two curves are similar, the infection rate values – especially in the later years – differ substantially, resulting in a low p value and indicating that chance alone does not account for the massive difference in infection rate among antenatal clinic patients.

Table 1. One-tail t-Test between Antenatal Infection Rates in South Africa and Western Cape 1990-2011

	<i>Western Cape</i>	<i>South Africa</i>
Mean	9.077272727	20.15
Variance	45.61422078	117.3540476
Observations	22	22
Pooled Variance	81.4841342	
Hypothesized Mean Difference	0	
Df	42	
t Stat	4.068313558	
P(T<=t) one-tail	0.000102037	
t Critical one-tail	1.681952357	

Despite the significant difference in mean values of infection rate, the two data sets were expected to vary similarly, as they were taken from samples within the same nation. The results of the analysis of covariance, displayed in Table 2, give a value of 65.33. The positive covariance value indicates that the values of the two data sets tended to vary together, where

high values of one corresponded to high values of the other (same for low values). However, the magnitude of the covariance value is not easy to interpret, which made the analysis of correlation between the data sets a desirable statistical test. The results of the analysis of correlation are shown in Table 3, and give an R^2 value of 0.935. A perfect correlation between the two data sets would give a value of 1; therefore, a value of 0.935 indicates a high correlation between antenatal infection rates in South Africa and the Western Cape.

Table 2. Analysis of Covariance between Antenatal Infection Rates in South Africa and Western Cape 1990-2011

	<i>Western Cape</i>	<i>South Africa</i>
Western Cape	0.004354085	
South Africa	65.32931818	0.011201977

Table 3. Analysis of Correlation between Antenatal Infection Rates in South Africa and Western Cape 1990-2011

	<i>Western Cape</i>	<i>South Africa</i>
Western Cape	1	
South Africa	0.935432264	1

The fact that the two samples of antenatal infection rate had a high correlation and covariance was expected, and indicate that as the national HIV infection rate increased so did the rate within the Western Cape. However, the key difference between the two was the mean difference in infection rate – shown to be statistically significant at a p value of ≤ 0.0001 . This

result strongly indicates that a factor beyond chance was responsible for the 11.3% difference in infection rates between South Africa and the Western Cape.

Discussion

While the statistics performed indicate that the discrepancy in infection rate between the Western Cape and the South African national average is significant, it is important to note that lack of adoption of AZT is not the only factor that contributed to the extremely successful proliferation of HIV. Beginning with the Mandela administration and lasting all the way through to the current Zuma administration, damaging and false statements about the nature of HIV and AIDS have been spread continuously. The failure to accept antiretroviral therapy as the only viable treatment for HIV has already been thoroughly discussed; however, this was not just the national policy of Dlamini-Zuma. In fact, in the following administration, led by President Thabo Mbeki, dangerous myths about HIV persisted (e.g. sex with a virgin will cure HIV, antiretroviral therapy is poison, HIV does not cause AIDS ("AIDS Myths", 2009)) and were more often than not reinforced by the office of the president. Even though the national policy was to make antiretroviral therapy available, as mandated by a court ruling, President Mbeki and his Minister of Health, Manto Tshabalala-Msimang, continued to deny the link between HIV and AIDS and the effectiveness of antiretroviral therapy. While this dissonance between accepted scientific knowledge and the African National Congress leadership may have had a less damaging effect on the Western Cape, which had already clearly seen the effectiveness of antiretroviral therapy on the HIV infection rate, the effect on the other provinces was no doubt more profound. With an HIV infection rate that was continuously rising, the sustained denial of

the truth about HIV in addition to a conspicuous lack of a true national plan to combat the virus, it is no wonder that the disease has been so devastating.

In both the Western Cape and the nation, within a few years of the implementation of antiretroviral therapy a distinct leveling off the HIV infection rate can be seen. One thing to note is that the infection rate for both populations never experiences a sustained decrease, even though effective treatment had been implemented in both cases. This is due to two reasons: The first reason is a consequence of the momentum the infection had built up. Even though antiretroviral therapy effectively treats HIV and minimizes the chances of the infection being passed on, they do not eliminate it and with approximately 10% of the nation's population infected, the infection would have continued to spread even if everyone infected had been undergoing treatment. The second reason is that HIV is currently incurable and antiretroviral therapy only treats the infection. This means that an individual who is placed on antiretroviral therapy is still HIV positive and thus will still contribute to the infection rate (more so than if they were not on antiretroviral therapy since the therapy extends life expectancy).

Had antiretroviral therapy been introduced in the early to mid-1990s instead of the mid-2000s, the infection rate would no doubt have leveled off sooner and HIV in South Africa would likely be a managed problem much as it is in other industrialized nations. The majority of the research concerning antiretroviral therapy in South Africa today addresses the nation's inability to provide the therapy to all those who are HIV positive. Despite the nation's considerable resources and scientific minds, no viable solution has been found for this problem. The logistics of testing a population of 50,600,000 for HIV and providing the estimated 5,600,000 infected individuals with daily antiretroviral therapy is immense. With approximately 10% of the

population HIV positive, many of whom live in desperate poverty, there is no way currently to provide people with the treatment and care that they require. While poverty would no doubt have been an obstacle for treatment regardless of the infection rate, treating 2% of the population as opposed to 10% would have been surmountable.

Even though antiretroviral therapies are currently available nationwide, delaying the rollout until 2004 (on a limited basis no less) was too little too late. Had a comprehensive plan with antiretroviral therapies been deployed in the early 1990s when the African National Congress first came to power, the infection could have been controlled as it was in North America and Europe. Not only could the people who were infected have gotten treatment, saving millions of lives, but the effectiveness of the drug and the legitimacy of HIV science could have been demonstrated nationally far sooner, thereby not allowing the many dangerous myths concerning HIV to take root in the nation's psyche.

A pertinent question that arises from these results is why the leading politicians of the African National Congress continually denied antiretroviral therapies to South Africa even though they had repeatedly been proven safe and effective. One possible answer has already been discussed by Nattrass, who believes that Dlamini-Zuma and Thabo Mbeki considered the acceptance of and dependence on antiretroviral therapy a form of economic imperialism. Given the African National Congress's long struggle against the Apartheid regime, this explanation certainly seems plausible. However, what it does not take into account is that South Africa could have produced antiretroviral drugs domestically. In 1994, the infrastructure and scientific expertise was already in place to provide that nation with all the AZT required to treat the infected population – a number miniscule in comparison to what it would later become. The

fact that this solution was not even considered indicates that the problem was more complex than fear of an economic dependence. Refusal to produce the medication domestically may have been the result of distrust of Western nations. After decades of oppression and exile for many prominent African National Congress members, accepting aid from nations that had allowed Apartheid to continue until the 1990s may have been unacceptable. Unfortunately, this is only speculation, as Thabo Mbeki and Dlamini-Zuma never refuted their controversial opinions on HIV and antiretroviral therapy.

As of 2013, awareness concerning the truth about HIV and antiretroviral therapy is widespread throughout South Africa, although there are still significant obstacles that must be overcome. Misinformation about HIV is still prevalent and awareness campaigns have finally begun to effectively address the discrepancy between scientific fact and common beliefs about the virus. This increased scientific awareness opens up the possibility for groundbreaking new treatments to combat HIV/AIDS; including a gene therapy developed at the Stanford University School of Medicine, which makes T cells resistant to HIV infection (Richter, 2013). Also, the recent evidence from the Institute Pasteur in France indicates that early treatment with antiretrovirals can functionally cure HIV (Gallagher, 2013), which could potentially put a massive dent in the HIV infection rate if treatment is successfully carried out nationwide. However, given the time it has taken to adopt a treatment regimen that is more than two decades old, it is uncertain whether or not these advancements will benefit the people of South Africa in the near future. In addition, President Jacob Zuma, who in recent years made highly publicized comments about preventing HIV infection by taking a shower, has apparently reformed and is currently backing the most effective HIV program the nation has ever seen.

Despite the many factors currently working in the nation's favor, the HIV infection rate is unlikely to decrease for many years and will continue to be one the most profound problems the nation faces for many years to come.

References

- 1998 National HIV sero-prevalence survey of women attending public antenatal clinics in South Africa. (1999). National Department of Health. Retrieved from http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_1998.pdf
- 2008 National Antenatal Sentinel HIV & Syphilis Prevalence Survey. (2009). National Department of Health. Retrieved from http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2008.pdf
- Abdullah, F. (2005). The ARV Programme in the Western Cape: Best Practice. *CME* 23(5), 261-263. Retrieved from www.cmej.org.za/index.php/cmej/article/download/658/454
- AIDS Myths and Misunderstandings* (2009). Retrieved from http://www.aidsinonet.org/fact_sheets/view/158
- AZT Approved for AIDS Children. (1990). *Los Angeles Times*. Retrieved from http://articles.latimes.com/1990-05-03/news/mn-603_1_azt-approved-for-aids-children
- AZT (zidovudene, Retrovir) – Side Effects. (2013). *AIDS Map*. Retrieved from <http://www.aidsmap.com/Side-effects/page/1730907/>
- Broder, S. (2009). The development of antiretroviral therapy and its impact on the HIV/AIDS pandemic. *Antiviral Research*, 85(1), 1-18. Retrieved from <http://www.sciencedirect.com/science/article/pii/S0166354209004896>
- Caelers, D. (2000, Oct 17). IOL News. Retrieved from <http://www.iol.co.za/news/south-africa/western-cape-sponsors-azt-for-rape-survivors-1.49811#.USk1nXmFx-I>

- Chokshi, M., Carter, C., Gupta, T., Martin, T., Robert, A. (1995). *Computers and the Apartheid Regime in South Africa*. Retrieved from <http://www-cs-students.stanford.edu/~cale/cs201/apartheid.hist.html>
- Crewe, M. (2000). South Africa: Touched by the Vengeance of AIDS – Responses to the South African Epidemic. *South African Journal of International Affairs*, 7(2), 23-37. Retrieved from <http://www.tandfonline.com/doi/pdf/10.1080/10220460009545311>
- Daniel Francois Malan (2010). *South African History Online*. Retrieved from <http://www.sahistory.org.za/pages/people/bios/malan-df.htm>
- De Clercq, E. (1994). HIV resistance to reverse transcriptase inhibitors. *Biochemical Pharmacology*, 47(2), 155-169. Retrieved from <http://www.sciencedirect.com/science/article/pii/0006295294900019>
- Emmons, W. (1993). Burroughs Wellcome and AZT. *Harvard Business Review*. Retrieved from <http://hbr.org/product/burroughs-wellcome-and-azt-c/an/793115-PDF-ENG>
- Gallagher, J. (2013). Early HIV drugs “functionally cure about one in 10”. *BBC News Health*. Retrieved from <http://www.bbc.co.uk/news/health-21783945>
- Guay, L., et al. (1999). Intrapartum and neonatal single-dose nevirapine compared with zidovudine for prevention of mother-to-child transmission of HIV-1 in Kampala, Uganda: HIVNET 012 randomised trial. *The Lancet*, 354(9181), 795-802. Retrieved from <http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2899%2980008-7>
- Henrik Frensch Verwoerd (2010). *South African History Online*. Retrieved from <http://www.sahistory.org.za/pages/people/bios/verwoerd-hf.htm>

Heywood M., Cornell, M. (1998). Human Rights and AIDS in South Africa: From Right Margin to

Left Margin. *Health and Human Rights*, 2. Retrieved from

<http://www.hhrjournal.org/archives-pdf/4065187.pdf.bannered.pdf>

History of HIV & AIDS in South Africa. (2010). Retrieved from [http://www.avert.org/history-](http://www.avert.org/history-aids-south-africa.htm)

[aids-south-africa.htm](http://www.avert.org/history-aids-south-africa.htm)

Karim, S., Churchyard, G., Karim, Q, & Lawn, S. (2009). HIV infection and tuberculosis in South

Africa: An urgent need to escalate the public health response. *The Lancet*, 374(9693),

921-933.

Makubalo L., Levin J., Muluma R. (1999). Survey of HIV prevalence among women attending

antenatal clinics in South Africa – 1999. National Department of Health, South Africa.

Retrieved from

Makubalo L, Netshidzivhani P, Mahlasela L, du Plessis R. National HIV and Syphilis Antenatal

sero-prevalence survey in South Africa 2003. (2004). National Department of Health,

South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2003.pdf

National Antenatal Sentinel HIV and Syphilis Prevalence Survey in South Africa, 2009. (2010).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2009.pdf

National HIV and Syphilis Antenatal Sero-Prevalence Survey in South Africa 2004. (2005).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2004.pdf

National HIV and Syphilis Antenatal Sero-Prevalence Survey in South Africa 2005. (2006).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2005.pdf

National HIV and Syphilis Antenatal Sero-Prevalence Survey in South Africa 2006. (2007).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2006.pdf

National HIV and Syphilis Sero-Prevalence Survey of Women Attending Public Antenatal Clinics

in South Africa 2000. (2001). National Department of Health, South Africa. Retrieved

from http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2000.pdf

National HIV and Syphilis Sero-Prevalence Survey of Women Attending Public Antenatal Clinics

in South Africa 2001. (2002). National Department of Health, South Africa. Retrieved

from http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2001.pdf

National HIV and Syphilis Sero-Prevalence Survey of Women Attending Public Antenatal Clinics

in South Africa 2002. (2003). National Department of Health, South Africa. Retrieved

from http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2002.pdf

Nattrass, N. (2008). AIDS and the Scientific Governance of Medicine in Post-*Apartheid South*

Africa. *African Affairs*, 107. Retrieved from

<http://afraf.oxfordjournals.org/cgi/reprint/adm087v1>

Richter, R. (2013). Immune cells engineered in lab to resist HIV infection, Stanford study shows.

Stanford University School of Medicine. Retrieved from

<http://med.stanford.edu/ism/2013/january/porteus.html>

Rimmerman, C. A. (1998). *Presidency, U.S.* Retrieved from

<http://www.thebody.com/content/art14034.html>

South Africa (2010). In *The World Factbook*. Retrieved from

<https://www.cia.gov/library/publications/the-world-factbook/index.html>

South Africa – Maps. (2012). *Global Security World Military Guide*. Retrieved from

<http://www.globalsecurity.org/military/world/rsa/images/map-provinces-1995.gif>

Spindle, T., Shafer, R., Jolliff, K., Henderson, S., Bradford, S., Weigman, D. (2007). *Laws/Effects of Apartheid*. Retrieved from

<http://home.snu.edu/~dwilliam/f97projects/apartheid/laws.htm>

The 2010 National Antenatal Sentinel HIV & Syphilis Prevalence Survey in South Africa. (2011).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2010.pdf

The 2011 National Antenatal Sentinel HIV & Syphilis Prevalence Survey in South Africa. (2012).

National Department of Health, South Africa. Retrieved from

http://www.healthlink.org.za/indicators/HIV_AIDS/antenatal_2011.pdf

The National HIV and Syphilis Prevalence Survey South Africa 2007. (2008). National

Department of Health, South Africa. Retrieved from

http://www.unaids.org/en/dataanalysis/knowyourepidemic/countryreportsonhivestimates/20080904_southafrica_anc_2008_en.pdf

The Origin of AIDS and HIV and the first cases of AIDS (2010). Retrieved from

<http://www.avert.org/origin-aids-hiv.htm>

Umzabalazo (n.d.). Retrieved from <http://www.anc.org.za/ancdocs/about/umzabalazo.html>

UNAIDS (2009). *AIDS Epidemic Update: November 2009*. Retrieved from

http://data.unaids.org:80/pub/Report/2009/JC1700_Epi_Update_2009_en.pdf

Van der Vliet, V. (2004). South Africa Divided Against AIDS: A Crisis of Leadership. In Kauffman, K.D. & Lindauer, D.L. (Eds.), *AIDS and South Africa: The Social Expression of an Epidemic* (pp. 48-96). New York: Palgrave Macmillan.