THE SPATIAL DISTRIBUTION OF HIV AND AIDS IN GAUTENG: SOUTH AFRICA

by

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I declare that **THE SPATIAL DISTRIBUTION OF HIV AND AIDS IN GAUTENG: SOUTH AFRICA** is my own work and all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE DATE

MRS. U. N. EZIKE-DENNIS

ACKNOWLEDGEMENTS

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LIST OF ACRONYMS

AIDS:	Acquired Immunodeficiency Syndrome or Acquired Immune Deficiency Syndrome.
CDC:	Centers for Disease Control and Prevention
CDER:	Communicable Diseases Epidemiological Report
CSW:	Commercial Sex Workers
DOH:	Department of Health, South Africa
FHI:	Family Health International
GHS:	General Household Survey
GIS:	Geographical Information System
HIV:	Human Immunodeficiency Virus
HSRC:	Human Sciences Research Council
IES:	Income and Expenditure Survey
LSS:	Labour Source Survey
MMWR:	Morbidity and Mortality Weekly Report
MOH:	Ministry of Health
MRC:	Medical Research Council
PPS:	Population Proportional to Size
SARPN:	Southern African Regional Poverty Network
SIMS:	Spatial Information Management Systems
SIS:	Spatial Information Systems
STATSSA:	Statistics South Africa
STD:	Sexually Transmitted Diseases
STI:	Sexually Transmitted Infections
UNAIDS:	Joint United Nations Programme on HIV/AIDS
UNDP:	United Nations Development Programme
UNESCO:	United Nations Educational, Scientific and Cultural Organization
USAID:	United States Agency for International Development
WHO:	World Health Organization

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ABSTRACT

THE SPATIAL DISTRIBUTION OF HIV AND AIDS IN GAUTENG.

Since the earliest reported cases of HIV/AIDS probably in 1959 in Africa, there has been a consistent progression in the new HIV/AIDS infection cases. In South Africa, Gauteng, records one of the highest HIV/AIDS prevalence rates in the country.

The Department of Health (DOH) South Africa conducts ongoing studies on HIV/AIDS at provincial levels; these studies monitor the prevalence of HIV/AIDS amongst pregnant women attending antenatal clinics, as a tool for determining and monitoring the prevalence, trends, patterns and spread of the disease in the general population.

This study analyses sentinel and spatial data collected from the (DOH) and Statistics South Africa (StatsSA) respectively, and depicts them in the form of spatial maps, and then critically analyses the spatial patterns that occur.

The research findings would hopefully contribute to the overall knowledge of HIV/AIDS and provide framework and relevant literature for further investigation.

KEY TERMS

Acquired Immunodeficiency Syndrome (AIDS); At Risk Sexual Behaviour; Endemic; Endemicity; Epidemiology; Geographical Information System (GIS); Human Immunodeficiency Virus (HIV); HIV incidence; HIV prevalence; Population distribution; Sentinel Survey; Socio-economy; Spatial environment; Spatial Information Management Systems (SIMS); Spatial mapping.

CHAPTER 1

THE GLOBAL PROBLEM OF HIV/AIDS

1   The HIV/AIDS phenomena

The Human Immunodeficiency Virus is an infectious viral disease in humans which specifically damages the immune system, leaving the human body prone to opportunistic infections (Online Medical Dictionary, 1997). Over a period of time, the disease can progress to a stage where the infected person has a collection of symptoms and a variety of infections, this condition is then known as the Acquired Immunodeficiency Syndrome or Acquired Immune Deficiency Syndrome, (Marx, 1982:618).

The Online Medical Dictionary, (1997) defines the Human Immunodeficiency Virus (hereafter referred to as HIV) as a type of retrovirus, which is responsible for the fatal illness Acquired Immunodeficiency Syndrome. Two HIV strains have been identified (Online Medical Dictionary, 1997), namely; type 1 (HIV-1) and type 2 (HIV-2). In the former, the virus is recognized as the agent that induces Acquired Immunodeficiency Syndrome (here after referred to as AIDS); whilst the latter strain is a virus that is closely related to the first strain as it also leads to a type of immune suppression. The HIV-2 is not as virulent as HIV-1 and is considered to be an epidemic only in West Africa (Reeves & Doms, 2002:1253-1265). AIDS is thus an epidemic disease caused by an infection by the Human Immunodeficiency Virus (a combination of HIV-1 & HIV-2). The virus causes immune system failure and debilitation that is often accompanied by a variety of infections.

HIV-1 and HIV-2 are transmitted through direct contact of a mucous membrane or the bloodstream with a bodily fluid containing HIV, such as blood, semen, vaginal fluid, pre-seminal fluid, and breast milk. This transmission can come in the form of anal, vaginal or oral sex, blood transfusion, contaminated hypodermic needles, exchange between mother and baby during pregnancy, childbirth, breastfeeding, or other exposure to one of the above bodily fluids (Centers for Disease Control and Prevention, 2003).

Many researchers (Gao, et al, 1999:436-441) believe that HIV originated in sub-Saharan Africa during the twentieth century. The Chicago Tribune (25 October 1987), summarized a chronology of early AIDS cases, summarized in Table 1.1 mostly in the United States. It should be noted that there are probably several other cases around the world which were never documented prior to 1987. It is important to note that there is no known link between the earlier patients that researchers now assume to have been HIV positive (Zhu, et al, 1998: 594-597).

At the time there was limited information on the disease, and limited medical and social facilities to link any of the occurrences (Garry, et al, 1988: 2085-2087).

Table 1.1: Early AIDS Cases Chronology - 1959 to 1979

(The Chicago Tribune 25 October, 1987:4).

Region	Year	Detail
Zaire (now DRC), Africa	1959	A serum sample is taken in Kinshasa and later tested positive for the antibody to Human Immunodeficiency Virus (HIV).
England	1959	A previously healthy British seaman died in Manchester, England, of *Pneumocystis carinii pneumonia* (PCP). At the time his doctors could not explain his decreased resistance to infection.
New York, USA	1959	A 48-year-old Haitian man died in New York City of *Pneumocystis Carinii Pneumonia* (PCP). At the time of his death there was no evidence of any other cause.
Miami, USA	1966	A 50-year-old black woman died in Miami after three-months of chills, fever, weakness, weight loss. The autopsy found extensive *Kaposi's Sarcoma* (KS), but no apparent immune deficiency.
Ohio, USA	1966	A black man, 54, was admitted to St. Anthony Hospital, Columbus, Ohio, with *Kaposi's Sarcoma* (KS).
St. Louis, USA	February, 1967 - May 1969	A young black man known only as Robert R became sick in St. Louis in 1967, he was only admitted to hospital in 1968. In 1969 he died in a St Louis Hospital. Blood samples taken during the autopsy at the time were stored, and it was later established that these samples tested positive for HIV.
New York, USA	1975	*Pneumocystis Carinii Pneumonia* (PCP) was diagnosed in a previously healthy seven-month-old black infant at Kings County Hospital, Brooklyn, New York.
New York, USA	1979	A white homosexual male aged 44 was diagnosed with *Kaposi's Sarcoma* KS in New York City. Patient was believed to be the first victim of what will later become known as Acquired Immunodeficiency Syndrome. As the first diagnosis of an AIDS patient happened to be a homosexual, the popular theory at the time was that the spread of the disease would be limited to the homosexual population of the world.

The origin of HIV has been documented by various sources. Not all the cases can be geographically linked. However one such case was recorded in 1976 when a Norwegian sailor, his wife and nine-year-old daughter died, and it was later suspected that they died of AIDS (Hooper, 1997). According to the documentation, the sailor had spent two years during 1961 to 1962 in various ports along the West African coastline. Figure 1.1, provides the geographical route that the sailor traveled as well as the geographical proximity of Norway to the West African coast.

Prior to the 1980s there are probably many other incidences that can now be linked to HIV/AIDS, however it was only during this period that AIDS was medically diagnosed.

Figure 1.1: Route of the Norwegian sailor's first voyage, between Oslo fjord (Norway) and Douala (Cameroon), August 1961 to May 1962.
(Hooper, 1997:1689-1691).
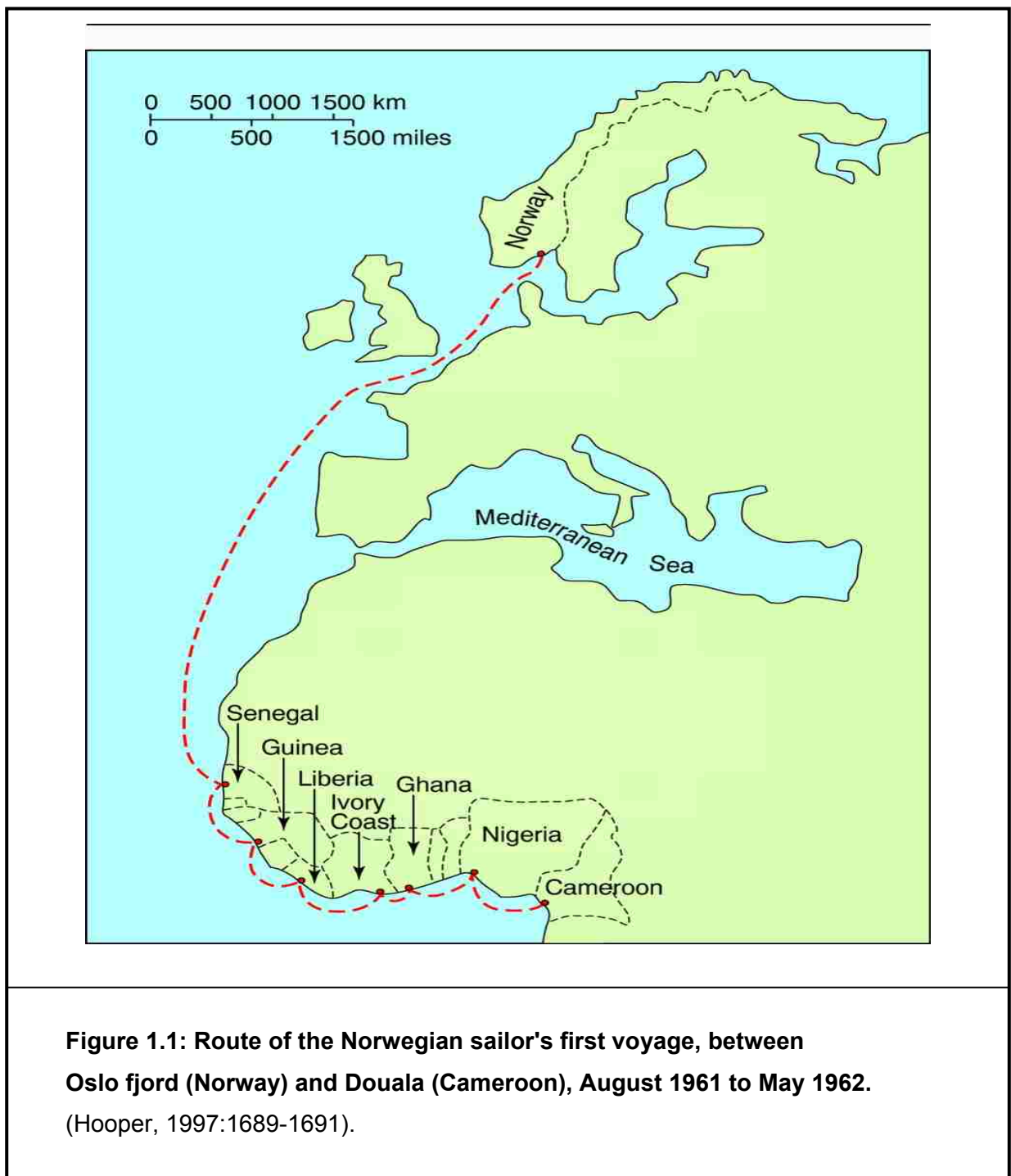
1.1   The global problem of HIV/AIDS

Since the earliest possible HIV cases occurred in different parts of the world during and from the late 1950s, the spread of the disease as well as an increase in the number of affected people has continued progressively into the new millennium (Figure 1.2). According to Centers for Disease Control; CDC (1981), the official date for the beginning of the AIDS epidemic is cited as the 5th of June, 1981. This was determined when their weekly Morbidity and Mortality newsletter, reported that unusual clusters of *Pnemocystis Carinii pneumonia* had been discovered in gay men in Los Angeles in the early 1980s (CDC, 1981:250-252). Figure 1.2 provides a good overview of how the HIV epidemic has grown over less than twenty years. In the figure it can be determined that the growth of the HIV epidemic seems on average to increase by 10 million people per year, with no signs of the global infection rate reducing. The global percentage rate of adults infected from 1990 to 2005 is about 1%.

Number of people living with HIV

% HIV prevalence, adult (15-49)

Figure 1.2: Global HIV epidemic 1990- 2005 (UNAIDS, 2006:7).
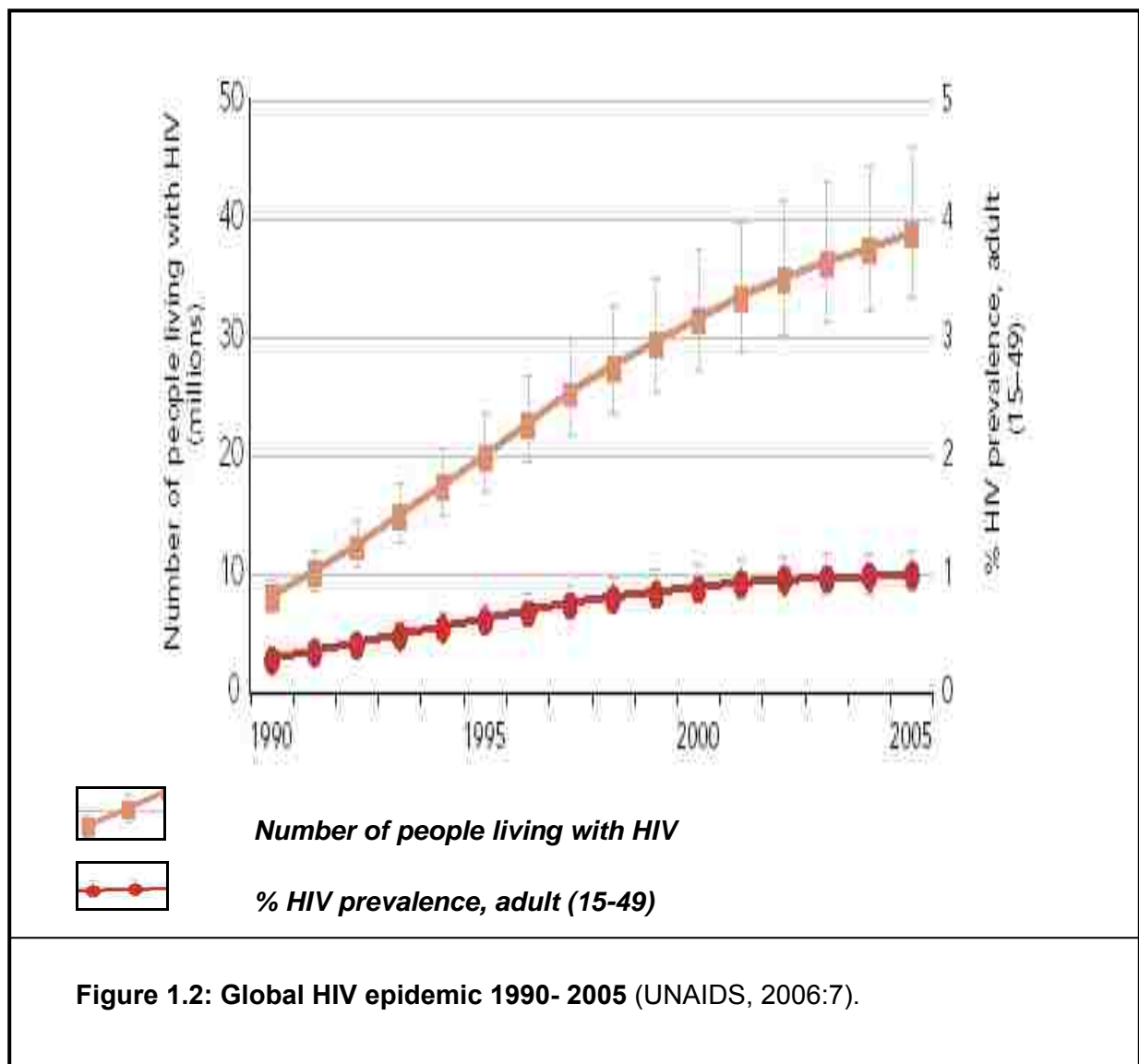
The World Health Organization (WHO: 2005) and Joint United Nations Programme on HIV/AIDS (UNAIDS: 2006) estimated that an average of 38.6 million (that is from the estimated range of between 33.4 million – 46.0 million) people worldwide were living with HIV at the end of 2005.

An estimated 4.1 million (that is from the estimated range of between 3.4 million – 6.2 million) people became newly infected with HIV and an estimated 2.8 million (that is from the estimated range of between 2.4 million – 3.3 million) people lost their lives to AIDS in 2005, (UNAIDS, 2006:8). Figure 1.3, provides a generalized spatial distribution of the percentage of HIV prevalence on a global level for 2006. It is important to take note that according to (UNAIDS, 2006), HIV can only be considered to be an epidemic in an area if the disease has spread through the population and the HIV prevalence is consistently over 1% in pregnant women. In Figure 1.3, the spatial distribution of HIV reveals that it can be divided broadly into two spatial categories, namely; when the adult HIV prevalence is higher than 1%; usually in the developing countries of the world, and secondly when the adult HIV prevalence is lower than 1%, usually in the more developed countries of the world. It can also be noted from Figure 1.3, that similar levels of HIV/AIDS concentration exist within regions of close proximity. What is more important to note is that the majority of countries in Africa have an adult HIV prevalence of above 1%, and are thus according to UNAIDS (2006), considered to have epidemic proportions of HIV prevalence in its adult population.

On a global level, major commercial cities are often characterized by high population numbers due to the influx of migrants such as job seekers to the area. These areas are characterized by a high level of activity within the secondary and tertiary economic activity groups, such as the buying, selling and recreational activities. Unfortunately crime and a decline in socio-economic conditions is often a result of a fast rate of urbanization. The spread of social diseases (of which HIV is merely one) has been a problem in the urban areas. It should however be noted that in more recent times HIV is affecting even the most remote rural areas around the world, (particularly in Africa, China and India) and women are one of the most vulnerable population groups (Du Guerny, et al, 2003 (a) & (b):28).

An important contribution to the rural-urban debate of the spatial distribution of HIV was made by the researchers (Bandyopadhyay & Thomas, 2002:509-521), when they researched the vulnerability of women rural migrant workers to HIV infection in Hong Kong and its' transmission to the rural areas from the urban areas.

Another factor on the global level that can be linked to the spatial distribution of HIV/AIDS is that of migration. In many research reports it is stated that the main cause of the new HIV infections is risky sexual relationships. This has also been the primary factor contributing to the diffusion of the disease into the remote areas of the world, to this effect the factors contributing to risky sexual behavior have been linked to various aspects of the migration process.
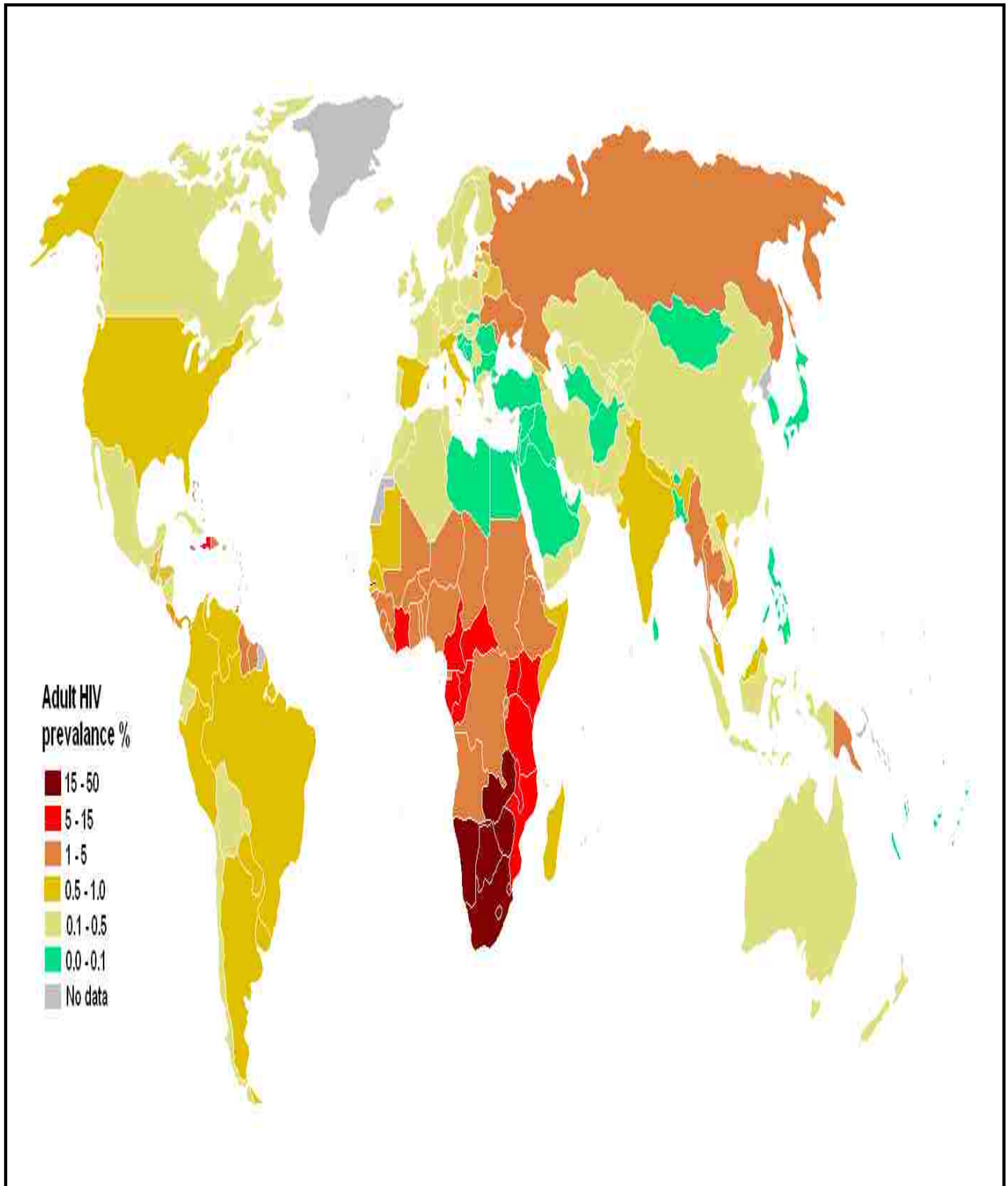
Figure 1.3: A global view of HIV infection in the total adult population, 2006 (UNAIDS, 2006:14).

Mobility and the impact on the spread of HIV have been researched by; (Hope, 2000; Boerma, et al, 2002; Wolff, et al, 2002; Lurie, et al, 2003). Other factors which have been considered to contribute in the spread of HIV/AIDS include:

- Poverty, social and economic factors and the impact on HIV was researched by; (Mac Donald, 1996; Coast, 2002; Zulu, et al, 2004) and
- The vulnerability of certain job types such as mine workers and transport workers to HIV has been researched by; (Fernandez, 1998; Wolff, et al, 2002).
- The vulnerability of female migrant workers and women in the rural areas to HIV infection has been researched by; (Bandyopadhyay & Thomas, 2002; Nishigaya, 2002).

On a world wide scale, there is an increasing awareness on the role of risky sexual behavior in the spread of HIV/AIDS. Recent HIV/AIDS prevention intervention programmes are focusing on creating awareness for the need for behavioral change, however there isn't enough emphasis placed on merging the spatial aspects; population, distance and proximity between areas of high endemicity and poverty in the regions. The need for more research highlighting these aspects of the HIV epidemic is lacking and would certainly add another piece in the solution puzzle of the HIV epidemic.

1.2   The occurrence of HIV/AIDS in Africa

The prevalence of HIV/AIDS in Africa is one of the greatest present and future challenges to the public health sector on the African continent. Data captured in Figure 1.3 above, indicated that many states in Africa have a large percentage of HIV prevalence amongst its adult female population. The fact that most of the African states were described by UNAIDS (2006) to have epidemic proportions of HIV prevalence in its adult population, highlights the problem that faces this continent in terms of HIV/AIDS. The continents' HIV statistics represent over two-thirds of global HIV/AIDS figures, in other words about 64%, with sub-Saharan Africa's rates exceeding that of other parts of the continent by far (WHO, 2002:17). The recent HIV/AIDS trends for many of the states south of the Sahara, is depicted in Table 1.2. In the table it can be noted that there has been a decline in the HIV prevalence in the urban areas of Burkina Faso, Burundi, Ethiopia and Rwanda. Information on the table also depicts that in the majority of the African States listed, there is a definite stabilization of the HIV prevalence while South Africa is the only African state that shows an increase in the trend of HIV prevalence.

The case of Uganda has merit to mention at this point. This African state was considered to be the most affected state in Africa in the 1990s. The HIV prevalence rates began to decline progressively from 1993 and by 2003 the prevalence rate for Uganda had dropped from 15% to 5% decline in the prevalence rates.

According to researchers (Murphy, et al, 2006:379) the drop in HIV prevalence rates in Uganda can been attributed to behavioral change which was motivated by the then President of the country. It is admirable and noteworthy that the percentage of HIV prevalence could be brought down by over 10% in one decade. This is a worthy lesson for the rest of Africa and indeed the world.

Table 1.2: Adult (aged 15–49 years) HIV prevalence (%) in Africa (UNAIDS, 2006).

Country	Median HIV prevalence among women attending antenatal clinics 2003-2004	Population based survey prevalence (%) (year)	2003 HIV prevalence (%) in current report	Adjusted 2003 HIV prevalence (%) in current report	2005 HIV prevalence (%) in current report	Trend in prevalence
Botswana	38.5	25.2 (2004)	38.0	24.0	24.1	Stable
Burkina Faso	2.5	1.8 (2003)	4.2	2.1	2.0	Decline in urban areas
Burundi	4.8	3.6 (2002)	6.0	3.3	3.3	Decline in capital city
Cameroon	7.3†	5.5 (2004)	7.0	5.5	5.4	Stable
Ethiopia	8.5	1.6 (2005)**	4.4	(1.0-3.5)	(0.9-3.5)	Decline in urban areas
Ghana	3.1	2.2 (2003)	3.1	2.3	2.3	Stable
Guinea	4.2	1.5 (2005)	2.8	1.6	1.5	Stable
Lesotho	28.4	23.5 (2004)	29.3	23.7	23.2	Stable
Rwanda	4.6	3.0 (2005)	5.1	3.8	3.1	Decline in urban areas
Senegal	1.9	0.7 (2005)	0.8	0.9	0.9	Stable
Sierra Leone	3.0	1.5 (2005)	-	1.6	1.6	Stable
South Africa	29.5	16.2 (2005)	20.9	18.6	18.8	Increasing
United Republic of Tanzania	7.0	7.0 (2004)	9.0	6.6	6.5	Stable
Uganda	6.2‡	7.1 (2004-5)	4.1	6.8	6.7	Stable

*WHO Africa (2005). HIV/AIDS epidemiological surveillance report for the WHO African region, 2005 Update. Harare.
**Preliminary results. Additional analysis is ongoing. †Estimate based on country report for 2002 (2003). Ministry of Public Health Cameroon. National HIV sentinel surveillance report 2002. ‡Estimate based on country report 2002 (2003). Ministry of Health Uganda. STD/HIV/AIDS surveillance report. STD/AIDS control programme. Kampala.

The spread of HIV/AIDS in Africa has often been closely linked to the migration process (Geelhoed, 1991:45; Husain, 1994:138-139; Brummer, 2002:2). Migration is a geographical phenomenon which affects the population distribution of a place at any given time. It also affects the socio-economic condition of the migrants and it has often assisted in the spread of diseases, as the movement of the people open up avenues for close interaction amongst infected and non-infected people. In Africa, the primary cause of migration is rural-urban migration; forced migration due to war; and labor migration which is not entirely separable from rural to urban migration. (Geelhoed, 1991:45; Girder-Brown, 1998:513-515; Brummer, 2002).

The study of the geography of HIV/AIDS is essential to understanding and revealing a true picture of the disease patterns as it is today. The area necessary for consideration is the mechanism which causes the growth and variation of HIV within a spatial unit. It is considered that the main factor governing the variation of HIV is the socio-economic condition and the behavioral factors of individuals, however, these factors are highly neglected by medical scientists (Lurie, 2001:26; Pashupati, 2002).

The new geography of the HIV pandemic should also bring the disease in relation to the levels of poverty and development of a spatial region. Although migration has been identified as a major factor for the spread and acquisition of HIV, poverty with specific reference to Africa's poverty and underdevelopment provide the ideal conditions for the spread of HIV. For this reason the development of AIDS and the link between poverty and HIV should be considered (Whiteside, 2001; Gezahegne, 2002).

A common theme of analysis in the existing literature (Brummer, 2002; Lurie, et al, 2003; UNDP, 2003(b); Zuma, et al, 2003) is the interaction between HIV vulnerability of migrants and poverty, this interaction involves factors such as: exploitation; stress; isolation; increased alcohol consumption; as well as gender imbalances. Migrants are vulnerable in the sense that when people migrate they are exposed to behavior and norms that tend to be different from those of their place of origin (Coast, 2002:2). However by attributing the explosion of the HIV epidemic to just sexual behavior which may have been induced by migration is not consistent with the realities of the epidemic. The poor-socio economic status of migrants may in many instances have directly influenced their involvement in high risk sexual behavior (Evian, 1993:635-636; Whiteside, 2001:1-5). Poverty or economic need is often the underlying reason for rural-urban migration, as the main reason for rural-urban migration is the employment opportunities available in the urban areas. Poverty often promotes risky sexual behavior; as evidenced by the increasing vulnerability of rural women. Rural women living in poverty are under pressure to engage in high risk sexual behavior as there is a continual demand for and patronage of commercial sex workers, suffice it to say that rural women and under aged girls end up selling sex for livelihood and engage in unprotected sexual activity (Tarantola, 1999:6-10).

Poverty could also foster: unhealthy and unsafe living conditions which creates vulnerability to sexual related crimes (Carballo, & Solby, 2001:26-28); increased alcohol and substance usage; fear of stigma which translates into poor response to education on mother - to - child HIV transmission prevention; limited access to recreation services and a higher access to commercial sex workers; a general nonchalance to life and the information and education on HIV prevention.

1.3   The HIV/AIDS epidemic in South Africa

According to the World Health Organization (CDER/WHO, 2003), Antenatal Sentinel Surveys (these are surveys that are conducted prior to the birth of a baby) is the recommended surveillance tool for monitoring HIV prevalence and trends. It is also recommended as the tool to estimate the prevalence of HIV in the generalized population. Whilst this tool (as is the case with any other tool) has a few inherent limitations, the international consensus remains that this is still the most useful tool to assess HIV prevalence in areas of high HIV endemicity (CDER/WHO, 2003:1; UNAIDS/WHO, 2000:11).

The epidemiology of HIV in South Africa has been monitored by the Department of Health (DOH), since 1990, the Department monitors the epidemic by means of Annual Sentinel Surveys of pregnant women attending antenatal clinics in the various provinces (Table 1.3).

The estimated HIV prevalence in the country is depicted in Table 1.3. Kwazulu-Natal consistently records the highest HIV prevalence in the country with an average increase of 3.8% between 2000 and 2004.

The Gauteng province has the second largest HIV prevalence in the country with an average increase of 2.4% between 2000 and 2004.

Mpumalanga, Free State and North West provinces have relatively lower HIV prevalence on a national level and recorded the lowest average percentage increase of below 1% each.

The Eastern Cape showed the highest average percentage increase of 3.9% whilst the remainder of the provinces; Limpopo, Northern Cape and Western Cape have the lowest HIV prevalence's in the country with an average percentage increase of between 2% and 3% between 2000 and 2004.

Table 1.3: Estimated HIV prevalence among antenatal clinic attendees, by province (Department of Health, 2004 (b)).

Province	2000 prevalence %	2001 prevalence %	2002 prevalence %	2003 prevalence %	2004 prevalence %
KwaZulu-Natal	36.2	33.5	36.5	37.5	40.7
Gauteng	29.4	29.8	31.6	29.6	33.1
Mpumalanga	29.7	29.2	28.6	32.6	30.8
Free State	27.9	30.1	28.8	30.1	29.5
Eastern Cape	20.2	21.7	23.6	27.1	28.0
North West	22.9	25.2	26.2	29.9	26.7
Limpopo	13.2	14.5	15.6	17.5	19.3
Northern Cape	11.2	15.9	15.1	16.7	17.6
Western Cape	8.7	8.6	12.4	13.1	15.4
National	**24.5**	**24.8**	**26.5**	**27.9**	**29.5**

From the national Annual Sentinel Surveys (Table 1.4), women in South Africa aged 25-29 recorded the highest HIV prevalence rates. This is very closely followed by the women in the age groups of 20-24 years and over 30 years but under 39 years. The women under 20 years of age recorded the lowest HIV prevalence rates.

Table 1.4: Estimated HIV prevalence among antenatal clinic attendees, by age (Department of Health, 2004 (b)).

Age group (years)	2000 prevalence %	2001 prevalence %	2002 prevalence %	2003 prevalence %	2004 prevalence %
<20	16.1	15.4	14.8	15.8	16.1
20-24	29.1	28.4	29.1	30.3	30.8
25-29	30.6	31.4	34.5	35.4	38.5
30-34	23.3	25.6	29.5	30.9	34.4
35-39	15.8	19.3	19.8	23.4	24.5
40+	11.0	9.8	17.2	15.8	17.5

Internationally women are believed to be more vulnerable to HIV/AIDS than their male counterparts due to severe socio-economic conditions; as they are more likely to engage in risky sexual behavior (CDER/WHO, 2003:1). On the average, women aged 15 to 49 years are 1.4 times more likely to be infected with HIV than men of the same age also among young people aged 15 to19 years, the differences between the sexes were substantially larger, with women having, on average 2.7 times higher infection rates than men. (CDER/WHO, 2003:1). In South Africa this particularly holds true as many women are living in poverty. The historic past of South Africa also created a disintegration of the family unit hence many homes are currently being headed by women or children and this has further enforced the vulnerability of women to HIV as a result of poverty.

A research paper, based on the South African Demographic and Health Survey in 1998, however disagreed that there is a relationship between poverty and risky sexual behavior (Booysen, 2004:57-67). According to the Survey findings, poverty played a very small part in explaining differences in risky sexual behavior. Risky sexual behavior was associated with differences in age, urban residence and marital status. According to Booysen (2004), Colored, Asian and White women were less likely than African women to have engaged in risky sexual behavior. Violence and coercion were also associated with risky sexual behavior. Although the argument here associates risky sexual behavior to variables other than poverty, the impact of poverty on these variables should not be undermined or underestimated.

The high levels of risky sexual behavior associated with the African population could indeed be as a result of the same population experiencing the highest levels of poverty in South Africa. The African population group records the highest percentage of migrants usually unskilled, which end up living in poverty in the urban areas. Furthermore, poverty can create a situation where people cannot afford to get married. Finally on this note, African women living in the poor rural and urban areas of the country are usually the victims of sexual violence and coercion (Booysen, 2004:57-67).

The relationship between HIV and poverty is a complex one, more so in South Africa, where the socio-cultural and historical past plays an intricate and continuing role. Large portions of HIV-related research (Evian, 1993; Crush, 1995; Lurie, 2001; Booysen, et al, 2002) have dealt with factors contributing to the epidemic in isolation. Such factors include: migration; vulnerability of migrants; the role of truck workers in the diffusion of HIV; and the role of poverty in the prevalence of HIV, as useful as these studies have been, an isolated approach is followed in these studies. The HIV-issue needs to be studied from a more holistic approach.

The holistic approach being used for the current study on the HIV epidemic in Gauteng, takes the following into cognizance:

- the spatial attributes such as the distance between the areas of high and low endemicity
- the population of the areas under study
- Poverty in other words the socio-economic condition of the population.

It is the intention of this study to follow a more holistic approach which attempts to address the above shortcoming in HIV/AIDS research.

1.3.1   The HIV/AIDS epidemic in Gauteng

The Medical Research Council report (2001) suggests that in the year 2000, 16% of the Gauteng population were infected with the HIV virus. This translates to approximately 1, 4 million people in the province, in addition approximately 97 000 of those people have the Acquired Immune Deficiency Syndrome (AIDS). HIV/AIDS research and study in Gauteng (Medical Research Council Report, 2001) shows the sections of the populations most vulnerable to the disease are:

- people living in an urban informal settlement who are between the ages of 25 – 34; and
- females living under these conditions are more at risk than their counterpart males. (Medical Research Council Report, 2001)

The HIV prevalence for Gauteng increased from 12.5% in 1995 to 29.8% in 2001 (Department of Health, 2002). The average increase in South Africa during this period was estimated to be 24.8% (Figure 1.4 and Figure 1.5).

The increase of HIV prevalence in Gauteng between 1995 and 2001 was higher than that of the country as a whole by about 5%. Various factors could have contributed to this representation:

- the increase in poverty and unemployment in Gauteng
- the constant influx of migrants and the transient nature of the Gauteng population.

The increase in poverty and HIV prevalence in Gauteng is therefore not entirely independent of each other and should not be separated when studied.
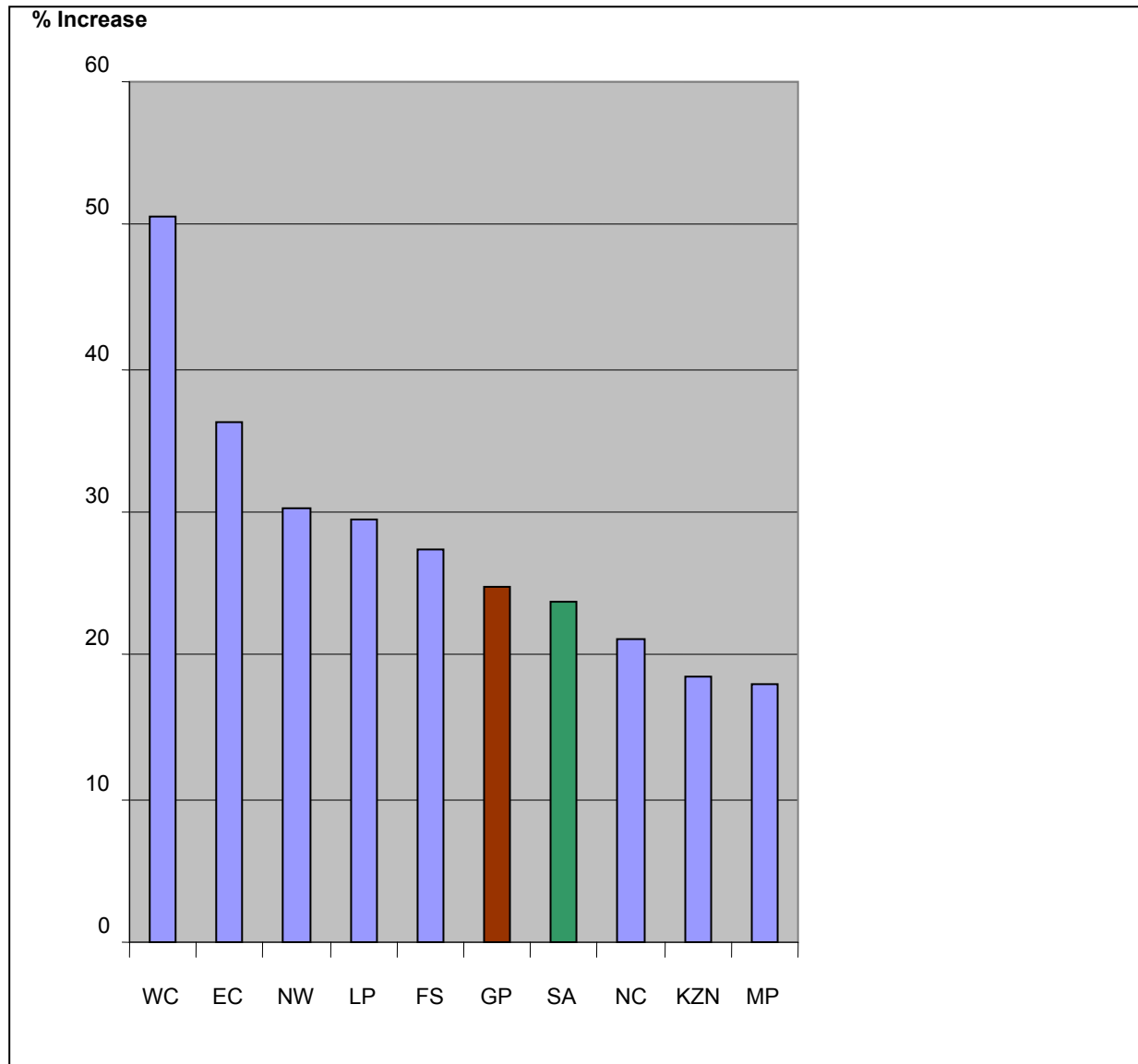
% Increase

Figure 1.4: Percentage increase in HIV prevalence among women at antenatal clinics between 1995 and 2001 (Adapted from Department of Health, 2001).

Provinces:

WC- Western Cape	NW-North West	FS- Free State	SA- South Africa
KZN- KwaZulu Natal	EC- Eastern Cape	LP-Limpopo	GP- Gauteng
NC-Northern Cape	MP- Mpumalanga		

Figure 1.5: HIV prevalence of women attending ante-natal clinics in South Africa, 1995-2001 (Department of Health, 2001).
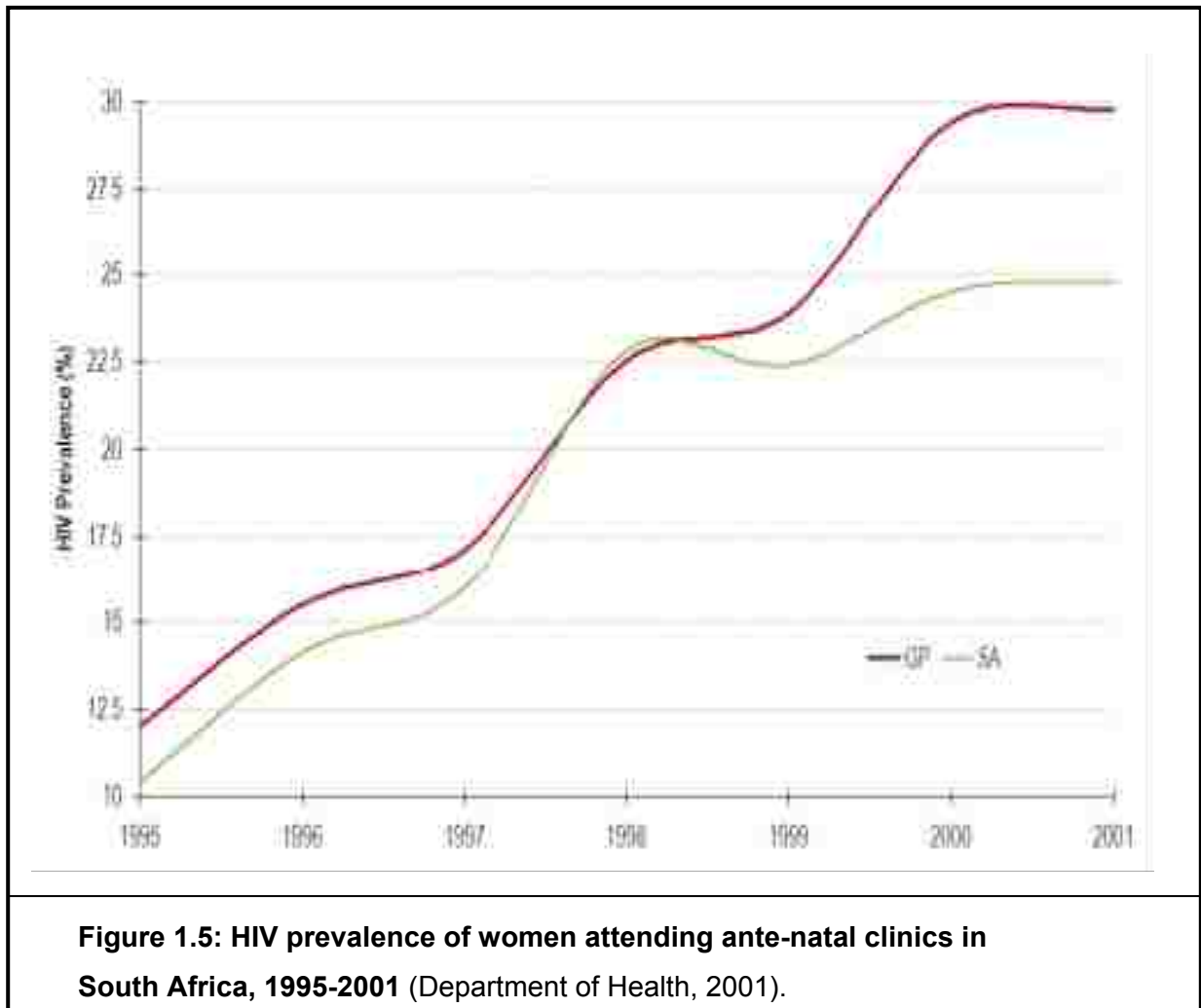
1.4   The research problem

The current study was undertaken because very little had been done to show the holistic nature of the HIV/AIDS epidemic; in other words utilizing a more inclusive approach which takes the spatial aspects of the HIV epidemic into consideration. The spatial aspects necessary for consideration include:

- the population and its distribution in an area of study,
- the distance between the areas of high endemicity and low endemicity; and
- the socio-economic condition of the population under study.

As mentioned earlier in the chapter, other research studies have focused on specific aspects of the epidemic such as:

- the diffusion of HIV/ AIDS (Decosas, et al, 1995: 826);
- the vulnerability of mobile populations such as migrant workers to HIV/AIDS (Brummer, 2002);

- the prevalence of HIV/AIDS in the work place and certain work groups:
  - longitudinal truck drivers, (Kulis, et al, 2002); (Haler, 2003)
  - and on mine workers, (Brummer, 2002); and
- the socio-economic factors influencing the spread of HIV/AIDS (Marcus & Ebrahim-Vally, 2005) and (Evian, 1994).

Further more, the annual sentinel antenatal HIV surveys being conducted by the South African Department of Health are being conducted at a national/provincial level. The annual HIV sentinel survey is currently the only existing national surveillance activity for determining HIV prevalence in South Africa.

The focus of the Annual Sentinel Surveys is to show the temporal and the prevalence trends by age group of the disease at a national level. While these anecdotal surveys on the prevalence, pattern and trends of the epidemic have viewed each of the factors contributing to the spread of HIV/AIDS as separate entities, this study intends to use a more holistic approach in representing the HIV distribution in Gauteng.

To this effect, a geographical information system will be utilized to layer the data on HIV/AIDS by bringing it into relation with various socio-economic conditions. This can then be used to represent a variety of spatial data (population and distance) to produce the relevant maps. The HIV spatial distribution data in Gauteng will then be tested with the socio-economic data in order to determine possible relationships between the variables.

1.5   The research questions and aims of the study

As mentioned in Sections 1.3 and 1.4 of this chapter, the only current HIV surveillance being conducted in South Africa is by the Department of Health and is being done at a provincial level. It has also been stated in Section 1.4 that more research is required to establish the extent of the HIV/AIDS epidemic on the micro level, i.e., various districts, smaller regions, places and towns. It was also established that Gauteng's level of HIV prevalence is higher than the countries average, and for this reason this study will investigate the phenomena in Gauteng.

The data will be analyzed and presented at the municipal and provincial level, and is one of the first preliminary detailed work on HIV/AIDS in Gauteng. While it has been established that there is undoubtedly the need for more research on HIV/AIDS that provides a more holistic view to the HIV/AIDS problem, it is hoped that this study would create the awareness on this need and hence motivate further study on the spatial aspects of the HIVAIDS epidemic.

1.5.1 The research questions

At this point the following relevant research questions can be posed:

- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the population distribution of Gauteng?
- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the proximity of the areas of high endemicity to the areas of low endemicity?
- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the socio-economic condition of Gauteng residents?

1.5.2 Aims of the study

The factors surrounding HIV/AIDS are very complex. At this stage of the epidemic the way HIV has diffused into various areas is no longer of prime importance, as the HIV epidemic is now more generalized and spread throughout the world. Rural populations are now having equally high HIV representations as the urban areas. This is particularly true in South Africa more specifically in Gauteng.

The focus of research should shift from viewing the contributing variables; such as HIV vulnerability, migration and poverty independently and should rather include a more holistic approach and include spatial aspects. These variables being complex and interrelated should not be studied in isolation; an approach should be used which brings together variables such as socio-economy and population to the spatial variables such as the proximity of the areas and the population distribution.

Viewing HIV/AIDS from a more spatial context could reveal the populations that are most vulnerable to the disease. An area of neglect within present HIV/AIDS research is the current spatial distribution and representation of the disease. This is specifically the case in Gauteng. This is the motivation behind this study, as the research aims to contribute to the overall knowledge of the HIV/AIDS epidemic by suggesting the possible relationships between the spatial distribution of HIV in Gauteng and a variety of the socio-economic aspects.

The research aims to create awareness on the need to approach the HIV/AIDS problem with a more holistic view thus encouraging the utilization of GIS software to bring together different pairs of data on HIV/AIDS including distance, population and socio-economic factors, and representing them on maps. The research aims to show the distribution of HIV/ AIDS at a micro level and in this way show the minute variations of HIV distribution which would otherwise have been non-evident.

In summary, the study aims to achieve the following:

- Place the spatial distribution of HIV/AIDS in Gauteng within a national and international perspective.
- Represent the spatial distribution of HIV/AIDS on a municipal level in the Gauteng Province in 2005.
- Use data from the Department of Health (DOH) and the Department of Statistics (STATS SA), and a GIS application to establish if there is a relationship between various socio-economic factors responsible for the spatial distribution of HIV/AIDS on municipal level in the Gauteng Province.
- To establish the relationship between the population, distance and various factors representing the socio- economic conditions of the residents in Gauteng and the spatial distribution of HIV/AIDS.

1.5.3   Professional significance of the study

It is hoped that the proposed study of the spatial distribution of HIV/AIDS in Gauteng will make a contribution by suggesting the possible existence or non-existence of relationships between HIV/AIDS and the spatial dynamics in Gauteng. While there have been many anecdotal surveys on the prevalence, pattern and trends of the epidemic, these studies have viewed each of the factors contributing to the spread of HIV/AIDS as separate entities (chapter 2). Although all these studies have proven to be quite useful in understanding the epidemic, little is known on the relationship between some of these variables and the distribution of HIV/ AIDS.

The spread is not necessarily the focus here, rather the relationship between these variables. The research might be able to reveal future trends should the variables remain constant over time. It is also hoped that the research would create a better usage of geographical information systems in correlating and displaying spatial data. Various studies have focused on using statistical techniques to analyze and display data some of which are mentioned in Section 1.4 above. In addition, the research work by the Department of Health in (1999, 2002, 2004 (a) & (b) & 2005) were all analyzed, displayed and represented statistically. Ironically, the entire GIS data representation for the current study was done with the assistance of the Geographical Information Systems Department of the Department of Health, Johannesburg, South Africa.

The current research will make a contribution by promoting the use of spatial analysis software packages such as the GIS and Geo Arc packages to display spatial data. The representation of the research findings of the current study, would hopefully create a more identifiable and visual representation of the HIV/AIDS epidemic in Gauteng.

Finally, focus of most HIV/AIDS research have been at the macro level, with several work being done on the entire continent and on the individual country's; such as is being undertaken annually by the South African Department of Health. While this type of research have contributed immensely to the global and continental perspective of the epidemic, more work is required at the micro level; representing districts, regions, main places and towns, these would undoubtedly be the most in-depth studies available on the HIV/AIDS epidemic in Africa.

1.6 The Study Area

South Africa has nine provinces, one of which is the Gauteng Province. Gauteng borders on provinces of North West, Limpopo and Mpumalanga (Figure 1.6).

Key	
1	Western Cape
2	Eastern Cape
3	Northern Cape
4	Free State
5	KwaZulu-Natal
6	Mpumalanga
7	Gauteng
8	Limpopo Province (Northern Province)
9	North West

Figure 1.6: Map of South Africa, showing the 9 provinces (Wikipedia free Encyclopedia).
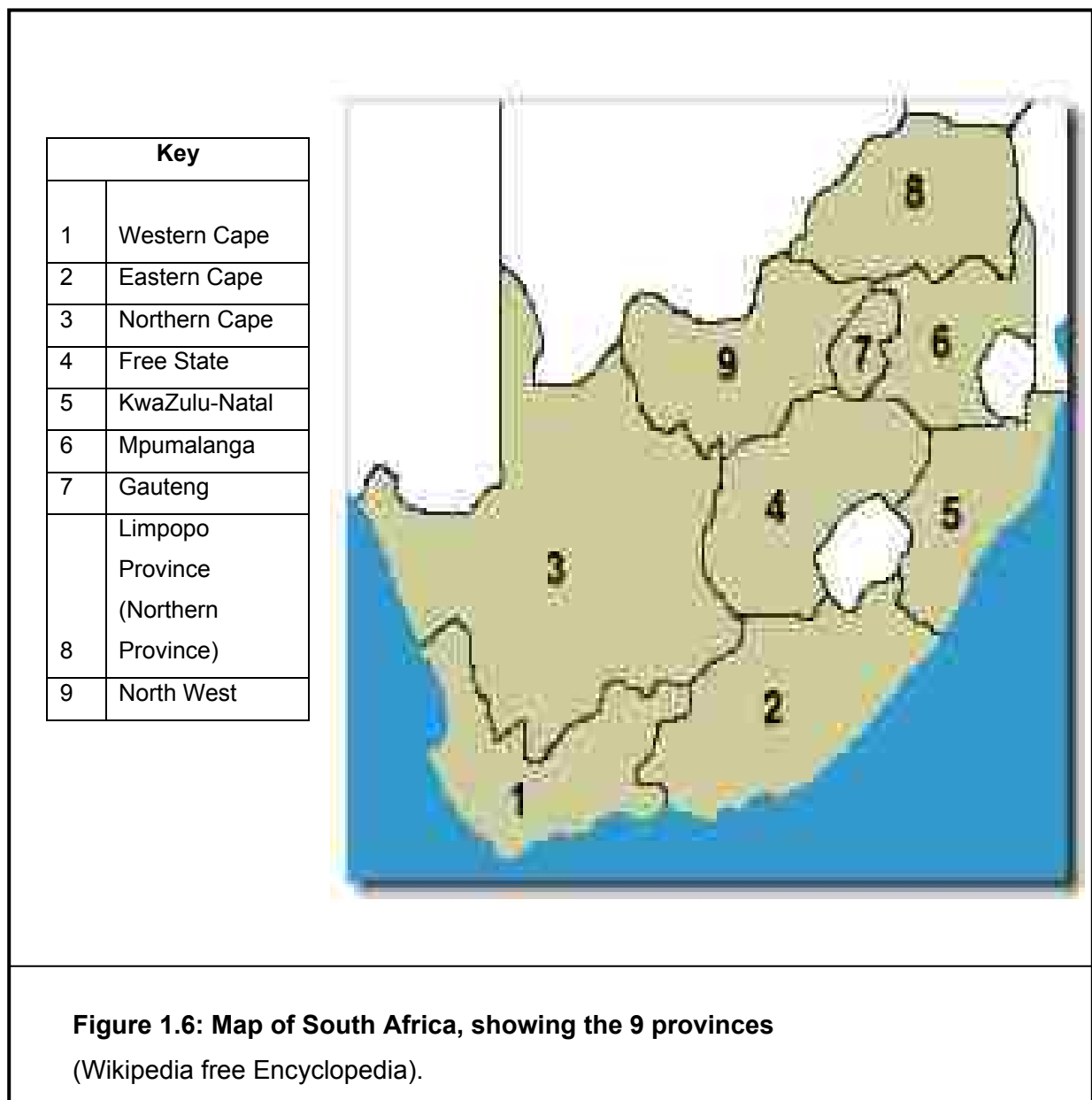
Gauteng has about 1.4% of the nations land area hence making it the smallest province. It has the second largest population, and accounts for almost 20% of the total South African population. This is largely due to the rapid urbanization rates. The rate of urbanization together with a natural population growth makes this province the fastest growing province in South Africa. Between the 1996 and the 2001 censuses, this province experienced a population growth of over 20%. With a growth rate this high, Gauteng may soon have the largest population of all the provinces in South Africa. Gauteng is also the most densely populated province by far in South Africa. The last population figures for province, from the 2001 census, reveals the current population of Gauteng stands at 8,837,178 (Statistics South Africa, 2001) (Figure 1.7). The population density in Gauteng demonstrates that the highest densities of people in the province are found in and around the cities of Johannesburg and Pretoria. This concentration may be attributed to the constant in flux of job seekers and migrants. Many of the low-income suburbs, such as Alexandra, Soweto, Tembisa and Mamelodi, are situated on the periphery of urban centers; they in turn have population densities which denote overcrowding in these areas (Statistics South Africa, 2001). The concentration of migrants in close proximity to residents of low income suburbs and informal settlements is the reason for the increased urban population density (Van Aardt, 2002:310).
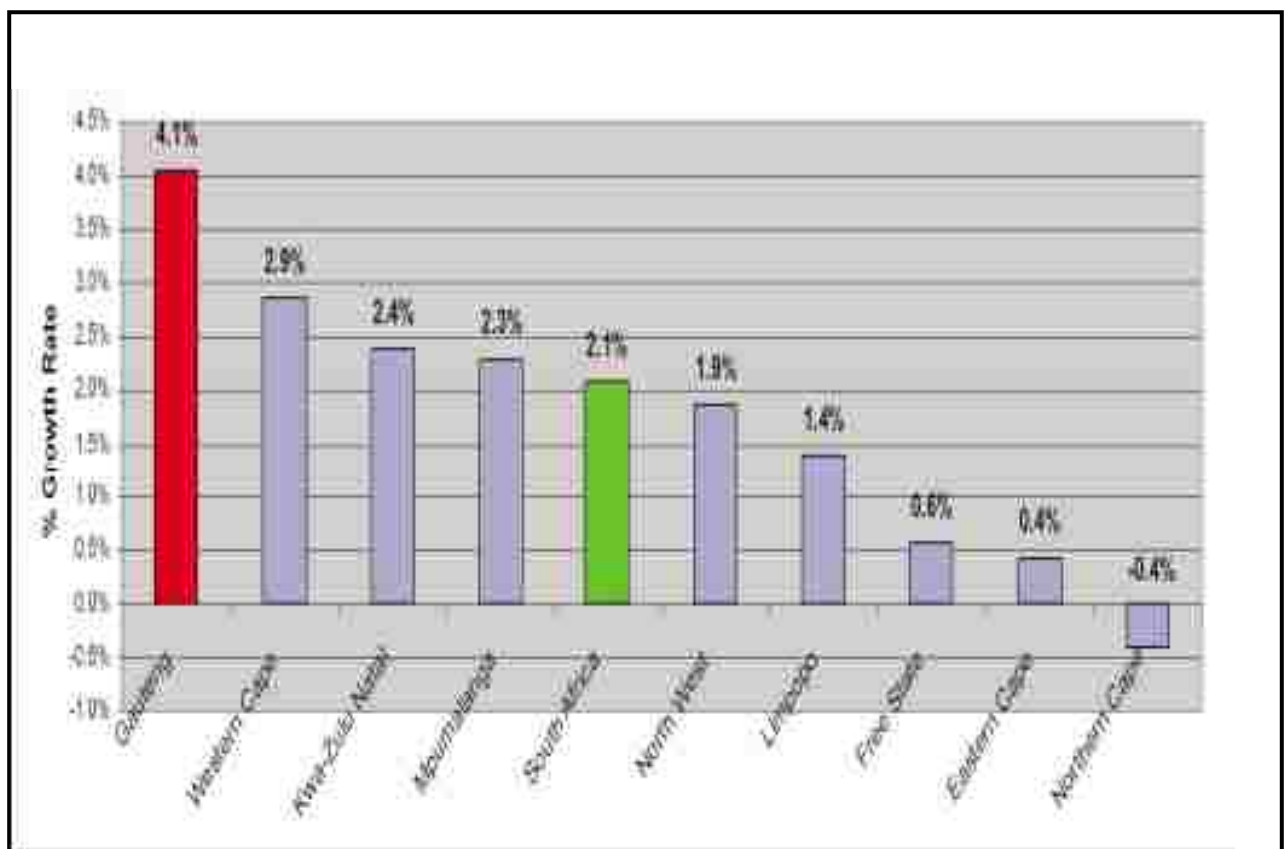
Figure 1.7: Average Annual Population Growth Rate, 1996 – 2001

(Statistics South Africa, 2001).

1.6.1   The Socio-Economy of Gauteng

Gauteng is considered the economic hub of South Africa because it contributes significantly to the national financial, manufacturing, transport, and technology and tele-communications sectors, amongst others. The province has also served as a gateway to a number of international and overseas companies by providing the required commercial base for them to function.

Socially however, the discovery of gold in Johannesburg in 1886, led to several African and other minority race groups being moved to Gauteng as mine workers. Most of these workers eventually formed the basis of the future black population in present day Gauteng. Working as a mine worker under tedious and regimented conditions as well as long separation from their families eventually fostered sexual promiscuity and infidelity. The strenuous mine work may have also led to the abuse of alcohol and other substances.

Today the effects of this on the family unit is great, many family values and units appear to be destroyed, many homes are headed by women only or other relatives. The role of Gauteng's past on the current HIV/AIDS epidemic is uncertain, the specific time frame for the outbreak of HIV/AIDS is also unknown however the spread and diffusion of the epidemic over time has been studied and linked to various factors. The major factors being migration, migrant workers, laborers, mobile workers and population growth. Although the past has been put behind, the scars from the past is undoubtedly still being felt in various aspects of the Gauteng socio-economic environment.

The opening up of the Gauteng economy also created economic opportunities which in turn attracted more migrants than the province is able to cater for. The increasing population densities is creating various social challenges such as housing problems, a rise in informal settlements and squatter camps, high unemployment rates and an increase in crime. According to the State of the Cities Report; Gauteng Provincial Government (2006), the urban portion of Gauteng - comprised primarily of the cities of Johannesburg, Ekurhuleni (the East Rand) and Tshwane (Pretoria) - will be a polycentric urban region with a projected population of some 14.6 million people by 2015, making it one of the largest cities in the world. (Gauteng Provincial Government, 2006).

1.6.2   Unemployment in Gauteng

With population numbers and its growth as high as they are in Gauteng the rate of unemployment in Gauteng has spiraled, the current rate being about 25.7% (Figure 1.8). The unemployment rates in Gauteng can also be linked to the increasing poverty in the province. According to various studies, the number of households living in poverty in Gauteng (defined as those households with an income of less than R1200 per month) increased by 8 % from 25 to 33 % from 1999 to 2000 (CASE, 2003).
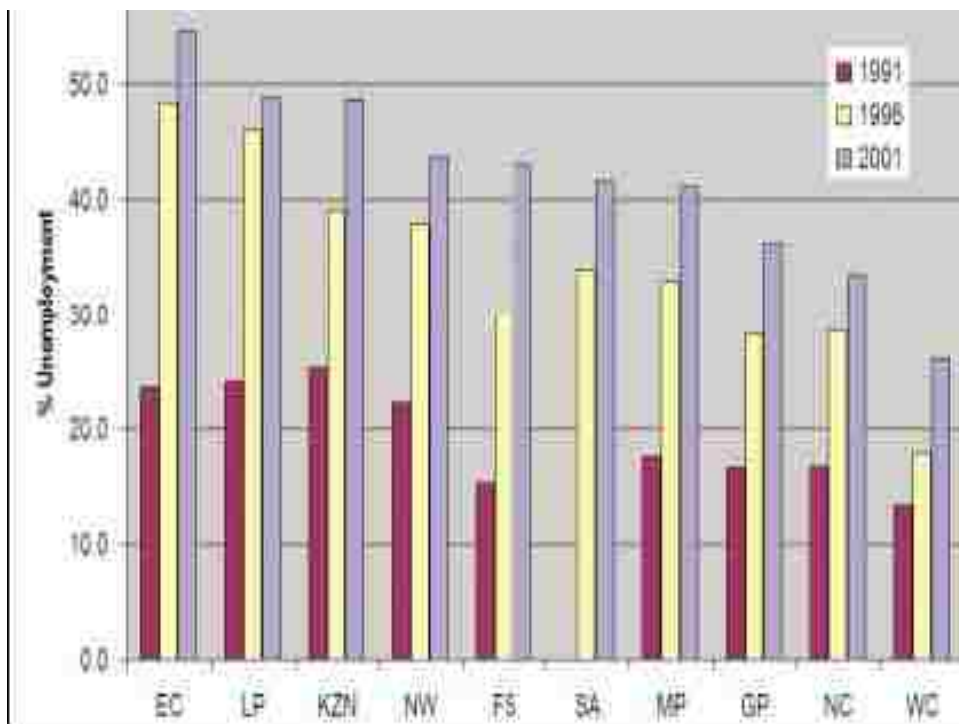
Figure 1.8: Percentage unemployment per province for 1991, 1996 and 2001 (Statistics South Africa 2001).

Unemployment in Gauteng is steadily on the rise with labour absorption rates below 1%. This has led to decreasing living standards and increasing poverty levels every year between 1985 and 1995 (CASE, 2003). This increase in the unemployment rates may have also translated into the rising trends of violence, crime and unrest within the province. The unemployment rates may also translate into despondency which many translate in adults turning to sex and alcohol for comfort. The need for sex is a basic human need providing satisfaction and can also provide a short lived escape; an individual emotionally battered by unemployment and poverty again may not take initiative of their own health and may not make the right decisions with regards to sex and HIV prevention.

1.7   Chapter Outline

Chapter one consists of an introduction to the HIV/AIDS phenomenon from a global perspective and provides a brief introduction to geography of the Gauteng Province. Chapter two will provide an overview of a literature survey of the research already done on the HIV/AIDS epidemic within the spatial context. Chapter three provides a more in-depth review on the research methodology used in this study as well as the method for determining the population clusters, the data collection process and the data analysis process.

Chapter four is a detailed analysis of the data by means of the statistical techniques discussed in chapter three. Chapter five provides a discussion on and a conclusion to the research findings, a summary of the study and provides useful recommendations for further study.

1.8   Conclusion

In this chapter it was reported that HIV/AIDS cases probably first occurred in 1959 in Africa. There was a gradual progression in the new HIV infection and some could be linked as in the case of a Norwegian sailor in 1969 who contracted the disease from West Africa. During this period and until the early 1980s the words HIV/AIDS were not used to describe the disease.

The HIV/AIDS statistics in Africa is the highest with Southern Africa's rates exceeding the other parts of the continent by far. In South Africa, Gauteng has one of the highest HIV/AIDS prevalence rates in the country. From ongoing studies on the spread of HIV/AIDS it was noted that risky sexual behavior was the main reason cited for the continual spread of HIV/AIDS, this is a complex factor as risky sexual behavior is often induced by poverty, migration, various professions as well as age.

It was noted that HIV/AIDS is now widely represented in the population of the world and Gauteng in a generalized manner, research on HIV/AIDS should no longer be primarily focused on diffusion.

The socio-economy of Gauteng was then reviewed and the growing poverty and unemployment problem was highlighted.

The aims and objectives of the study have been highlighted as a more holistic study bringing together the HIV/AIDS distribution in a spatial context. The need for this research is crucial as other studies have dealt with the factors contributing to the HIV epidemic in isolation. In addition, such studies are usually at a macro scale. This study is therefore on a micro scale and would view the spatial factors responsible for the HIV distribution in Gauteng in a more holistic manner.

Secondary data was collected from the Department of Health and the Department of Statistics. Data from these state departments were chosen as the data was available, is detailed, and is accurate and comprehensive data.

The data was analyzed for specific clusters. These clusters were determined by means of the population proportion to size sampling method. The GIS software used to represent the data in spatial form and bi-variant analysis and tests also enabled the establishment of the relationships between HIV/AIDS and related spatial factors such as population, distance and socio-economy.

CHAPTER 2

THEORETICAL FRAMEWORK ON THE HIV/AIDS PHENOMENA

In Chapter One, the HIV/AIDS phenomenon was introduced from the global perspective, followed by a more magnified perspective of the Gauteng province. This chapter provides the literature overview on relevant studies in this field. This includes a review of the literature on the research done on various aspects of the HIV/AIDS epidemic globally, in South Africa and in Gauteng. In addition there is an overview on the spatial distribution of HIV/AIDS in Gauteng with specific reference to the population distribution, the distance/proximity of the areas to HIV/AIDS and the socio-economic status of the province. The final aspect of this chapter would cover previous research done on the spatial distribution of HIV/AIDS and the use of GIS software to conduct such research; globally, within the African continent and in Gauteng.

2.1 The need for holistic HIV/AIDS research on the micro level

Due to the vast number of sources on the HIV/AIDS phenomenon globally, this chapter will concentrate its focus on African studies including work done on the subject in South Africa, and more specifically the work completed for the Gauteng province. The literature available on the spatial aspects of the HIV/AIDS epidemic in Gauteng, as a province, is very limited and in many instances almost non-existent.

In South Africa, the research that is available on the HIV/AIDS epidemic, normally focuses on a national scale, and only occasionally provide brief references to the Gauteng province. A holistic approach to the HIV/AIDS research is very limited in the literature and available researched case studies.

From the literature study conducted, the research focus has primarily been on diverse issues surrounding the spread of HIV/AIDS. Phenomenon receiving prominent attention in the current research includes:

- migration,
- vulnerability and
- poverty

The literature review touches on some of the general studies on the topic in South Africa and where available research on the Gauteng province is also discussed. With limited studies utilizing a holistic approach in the study of the HIV/AIDS epidemic in Gauteng, it has became clear during the literature survey that there is a need for more HIV/AIDS studies on a micro-level in South Africa.

During this research it was established by the researcher that a more holistic approach in the study of the HIV/AIDS epidemic is crucial for the process of understanding and preventing the spread of the disease.

From the available literature it is evident that most HIV/AIDS intervention programmes require holistic approaches to research to be undertaken at a micro level in order to provide a clearer picture on the HIV/AIDS situation in general, and in the case of this study, in Gauteng. One of the current HIV/AIDS intervention programmes being undertaken in Gauteng includes the Joint AIDS programme being facilitated by the provincial government of Gauteng in partnership with some NGO's such as *'The Men as Partners'* (MAP) program launched in 1998 by the Engender Health and the Planned Parenthood Association of South Africa (PPASA) and the *"HIV/AIDS/STD Strategic Plan for South Africa: 2000 – 2005".* (Mail & Guardian, 2001:1, The Star**,** 2005:5). Whilst these efforts are commendable, the focus of the above strategic plan is to establish poverty alleviation projects to address the root causes of HIV/AIDS (Mail & Guardian, 2001:1, The Star**,** 2005:5).

In this way the plan insinuates that poverty is the only factor enhancing the spread of the disease in the country. Factors promoting the spread of HIV/AIDS may differ from province to province; hence if micro scale studies are conducted the minute variations would alight. This is definitely an important factor to consider which has unfortunately often been neglected in research thus far. This study attempts to be a necessary starting point in addressing this need.

2.2 The current focus of HIV/AIDS research globally

Since the initial outbreak of HIV/AIDS, much research has been conducted to determine the world HIV/AIDS statistics. The trends and patterns have been and are still being monitored at a global level (UNAIDS, 2006:8-9).

Globally the HIV/AIDS incidence rate is believed to have peaked in the late 1990's and to have stabilized subsequently. There have been positive changes in the global HIV/AIDS incidence (UNAIDS, 2006:8-9):

- among the notable new trends are the recent declines in the national HIV prevalence in the Sub-Saharan countries of Kenya and Zimbabwe;
- declines in HIV prevalence have also been reported in Burkina Faso, Haiti;
- four states in India including Tamil and Nadu have also recorded a decline;
- decline in the rates within Cambodia and Thailand.

On the contrary, some notable increases have also been reported in
(UNAIDS, 2006:9):

- China,
- Indonesia,
- Papua New Guinea
- Vietnam
- Bangladesh and Pakistan.

The ongoing research by UNAIDS, WHO and other international bodies provide a general perspective on the global HIV/AIDS issue. UNAIDS have provided regional HIV statistics for North America, Western and Central Europe, Eastern Europe and Central Asia, Caribbean, Latin America, Oceania, Asia, North Africa, Middle East and Sub-Saharan Africa. Figure 2.1 presents the estimated number of adults and children globally living with HIV as at 2006; and Figure 2.1, shows the estimated number of adult and children newly infected with HIV/AIDS in 2006 (UNAIDS/WHO, 2006).

Figure 2.1: Adults and Children estimated to be living with HIV in 2006
(UNAIDS/WHO, 2006).

Total: 4.3 (3.6–6.6) million

Figure 2.2: Estimated number of adults and Children newly infected with HIV during 2006 (UNAIDS/WHO, 2006).
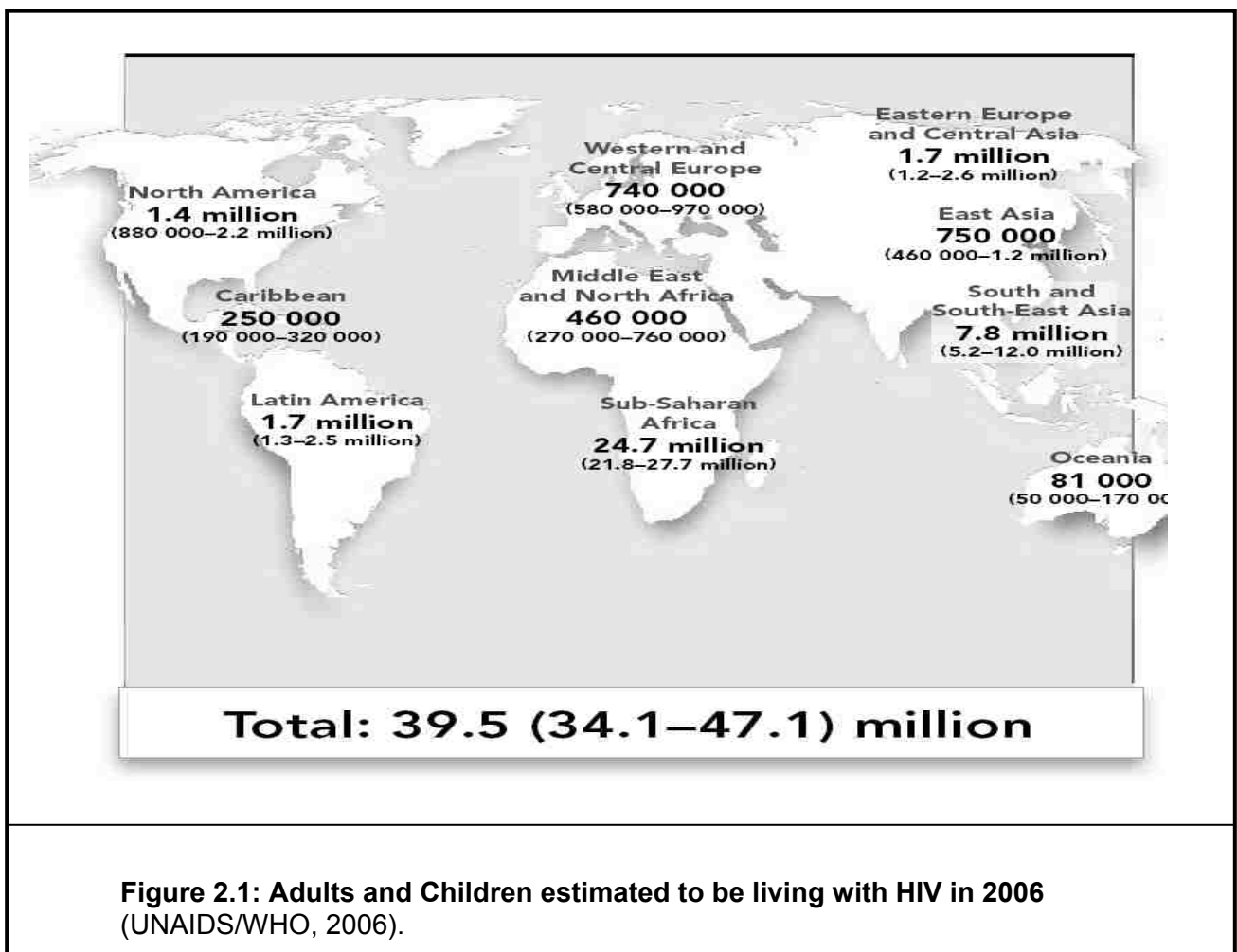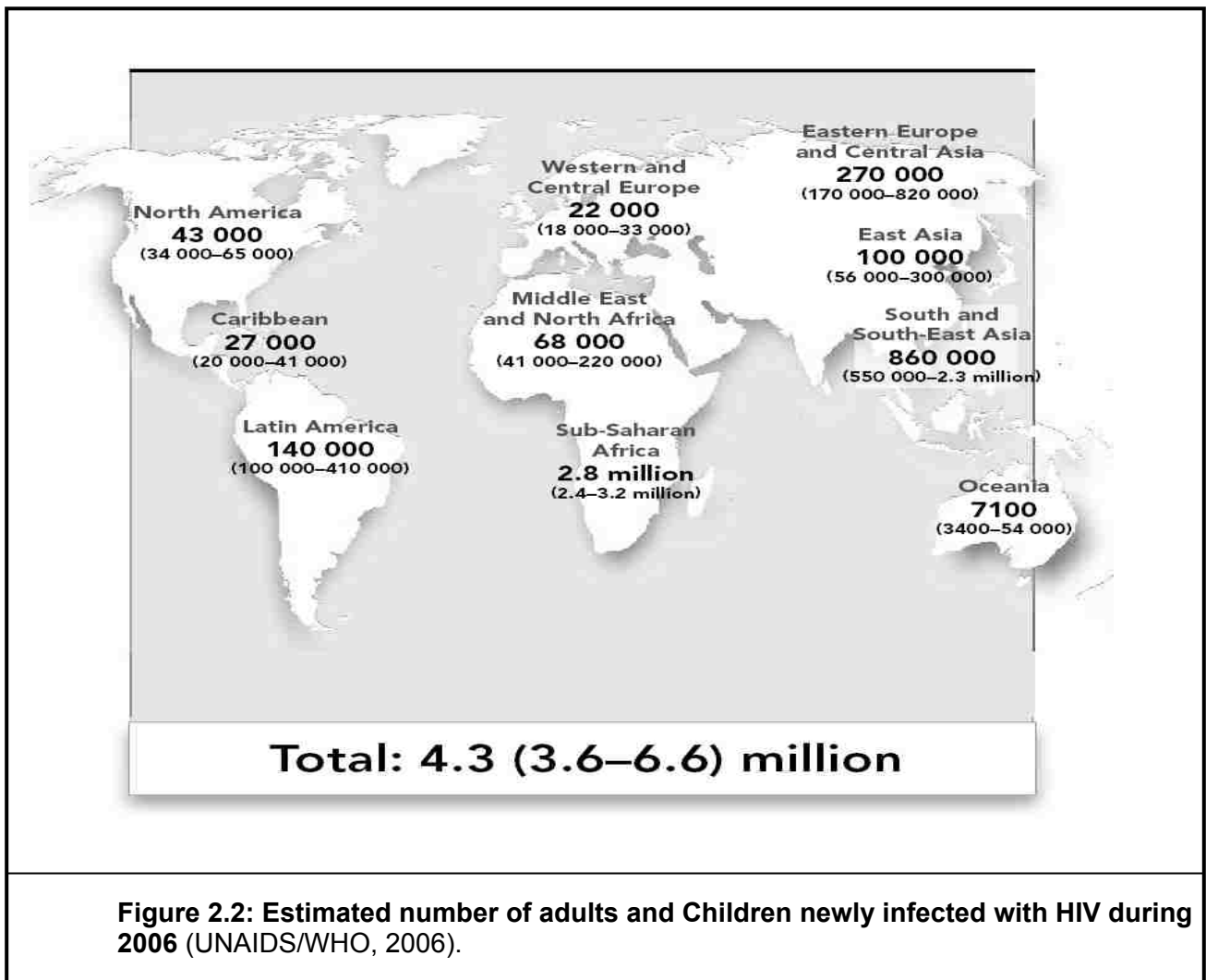
Oceania, Western Central Europe and the Caribbean recorded the lowest new HIV infections in 2006, while South & South East Asia and Sub-Saharan Africa recorded the highest new HIV infections globally, with Sub-Saharan Africans figures exceeding the others by far (UNAIDS/WHO, 2006).

At a national level, various African countries have conducted surveys to determine the HIV/AIDS prevalence in their countries. In 2002 the Cameroon the Public Health Department and in the same year the Uganda's Ministry of Health also conducted a survey. (WHO Africa, 2005). According to this source various surveys are also being conducted to monitor the trends and patterns of HIV/AIDS in Sub-Saharan Africa. Since 2000 the Ministry of Health in Zimbabwe have actively conducted surveys (Ministry of Health, Zimbabwe 2002), surveys in South Africa have been conducted since 1990, (Department of Health, 2004(a); Department of Health, 2004(b)).

WHO Africa (2005) conducted recent population based HIV/AIDS surveys in the African countries of Botswana, Burkina Faso, Burundi, Cameroon, Ethiopia, Ghana, Guinea, Lesotho, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania and Uganda.

The global and national surveys and reports by UNAIDS, WHO and other international bodies have provided the foundation for more research on HIV/ AIDS. In Africa, the more recent research issues on the topic are related to migration and the role it plays in the spread of HIV/AIDS, these include:

- In Western Africa the role of migration in the spread of HIV/AIDS into the rural areas was provided in a comprehensive report by Largarde, et al (2003:744-752).
- In Eastern Africa, mobile populations and the HIV/AIDS epidemic was surveyed by Kalipeni, et al (2004).
- Research on the rural-urban migration in South-Western Nigeria and the implications of this phenomenon for HIV/AIDS transmission was conducted by Ososanya & Brieger (1994).
- The seasonal migration and its risk for HIV/AIDS transmission in Senegal was researched by Pison, et al (1993).
- In the Southern African region, studies have also been conducted on migration and HIV/AIDS. More specifically, migration and the spread of HIV/AIDS in the region was studied by Lurie, et al (2000) and in South Africa the impact of migration on HIV-1 transmission was reviewed by Lurie, et al (2003).

Further focus within HIV/AIDS research has been on poverty, socio-economic and cultural factors. The research is taken further by establishing the role these factors play in the spread of HIV/AIDS or how they impact on spread of HIV/AIDS and the socio-economic livelihood of those affected. Various case studies in Africa have been carried out in this regard, some of which include:

- Establishing the socio-economic and cultural factors which influence the transmission of HIV/AIDS in Botswana. This was researched in the study by Mac Donald (1996)
- Identifying the levels of urbanization and poverty and the relationship of these on sexual behavior (so-called *risky sexual behavior*) and HIV/AIDS transmission in Kenya was the focus of the research of   Zulu, et al (2004)
- At a symposium on communicable diseases and poverty in Southern Africa, presenters Colvin & Sharp (2001), established links between poverty, socio-economic conditions and the spread of HIV/AIDS, in their paper.
- Whiteside (2001) established a link between HIV/AIDS and poverty in Africa as a whole
- HIV/AIDS, hunger and vulnerability (and thus poverty) in Southern Africa was reviewed by the Southern African Regional Poverty Network (SARPN, 2006(a) and SARPN, 2006(b)).

Similarly in South Africa, studies on socio-economy and the role it plays in the spread of HIV/AIDS have been conducted:

- The socio-economic determinants of the AIDS/AIDS epidemic in South Africa is detailed in the work of Evian (1993)
- In South Africa the socio-economic impact of HIV/AIDS on households in South Africa is the focus of the work of Booysen, et al (2002).

2.3   Population mobility and its relationship with HIV/AIDS: a global perspective

Migration has played a major role in the diffusion of HIV/AIDS by facilitating the spread from one community to another. Migrants bridge various populations since they interact across populations and communities. Migrants link areas of low HIV endemicity to areas of high HIV prevalence thereby enhancing the spread of the disease (Fages, 1999:40). Although migrants move between populations and so may be transmitters of HIV between communities, this could also be reflective of the fact that migrants are exposed to various conditions which in fact makes them more vulnerable to HIV (Brummer, 2002:2). Migrants are less likely to access healthcare and HIV/AIDS prevention messages and are more likely to adopt 'risky' behavioral patterns which put them at risk of contacting HIV/AIDS. Probably the main behavioral change of migrants is the patronage of commercial sex workers (ELDIS, 2005).

The vulnerability of migrants to HIV/AIDS is a more recent research focus which aims at establishing migrant populations as 'vulnerable populations' to the disease and no longer the 'bridging' populations which assisted in the initial diffusion of HIV/AIDS from one location to the other. In Tanzania, the interaction between rural-urban migration and HIV/AIDS risk revealed that the perception existed that migrants are a bridging population (i.e. bridging urban to rural). The research found that most of the migrants in this area avoided sex in the urban areas because they believed it to be 'risky' sex. In addition the research established that the sexual behavior of the rural migrants differs from that of their urban counterparts (Coast, 2005). The role of migration in the diffusion of HIV/AIDS is therefore no longer regarded as relevant as migrants are now the populations at risk of being infected. (Brummer, 2002: 2). With the new focus on HIV/AIDS, studies on various aspects of HIV vulnerability and the mapping of HIV vulnerability have been conducted globally, a few examples are:

- Cambodia (Phalla, et al, 2004)
- China (Du Guerny, et al, 2003(a))
- China, Thailand and Vietnam; (Du Guerny, et al, 2003(b))
- Brunei, Indonesia, Malaysia, Philippines & Singapore (UNDP, 2002).

Undoubtedly new focus on HIV/AIDS research is on the HIV vulnerability of a population and not so much on diffusion and the role played by mobile populations. Geographical Information Systems has recently been introduced as an important tool in determining HIV vulnerability. The United Nations Development Programme, (UNDP) in South East Asia, used the system to bring together various aspects of HIV/AIDS in the form of overlaying phenomenon in order to determine vulnerability (UNDP, 2004) this work will be elaborated on later in the chapter.

2.3.1 Population mobility and HIV/AIDS in South Africa and Gauteng

In South Africa, mobility played a significant role in the initial spread of HIV /AIDS. Some of the marked and traceable corridors in which HIV/AIDS was transmitted in South Africa have been linked to migration (Fages, 1999; Gilgen, et al, 2001). Gauteng also has a long history of cross-border and local migration. Most of the movement in the province was and still is related to labour, for example, as mine workers from neighboring countries seeking employment; informal traders seeking better opportunities; and general job seekers.

Within South Africa, various migration studies in relation to HIV/AIDS have been researched, some of which include:

- the seasonal migration of labour workers and the risk of HIV/AIDS (Lurie, 2001);
- migration and HIV/AIDS with case studies on South African mines (Crush, 1995; Williams & Campbell, 1996; Gilgen, et al, 2001; Zuma, et al, 2003)
- longitudinal truck drivers and their role in the diffusion of HIV/AIDS (Family Health International, 2004);
- the vulnerability of truck workers to HIV/AIDS (Mathe, 2002);
- perceptions of truck workers regarding HIV/AIDS (Marcus, 2001).

2.3.1.1   HIV/AIDS in South Africa and Gauteng – A focus on truck workers

Research undertaken by (Decosas, et al, 1995; Mathe, 2002; Haler, 2003), on longitudinal truck workers revealed that truck drivers, played a major role in the diffusion of HIV/AIDS from the more commercial areas to the more rural areas. According to this study, truck workers are one of the main instruments for the diffusion of the disease due to their access to both areas. Highways linking the commercial cities to the rural areas, border posts and neighboring small towns have become areas of high HIV prevalence. Although the HIV/AIDS epidemic is now more generalized, some migratory routes and surrounding towns in South Africa still have significantly higher rates than the general population. A study was conducted by Abdool, et al, (1992) to report the Sero prevalence of HIV/AIDS in rural South Africa.

The role of truck workers in the spread of HIV/AIDS is further evidenced from findings in a study conducted at the Messina border post of South Africa (Family Health International, 2004). The Family Health International (2004) estimated the HIV prevalence in the then Northern Province (now Limpopo Province) to be 11.5% (based on surveillance at Nance Field Clinic) in 1998. This is significantly lower than the 20% recorded in Messina for the same year. In addition, fifty three percent (53%) of the Sexually Transmitted Infection (STI) patients tested at the Messina Hospital were HIV-positive (Family Health International, 2004).

The town of Messina is situated in the northern region of the Limpopo Province, by far South Africa's poorest and most rural province (Family Health International, 2004). It lies 530 kilometers north of Johannesburg, 18 kilometers south of the Beit Bridge border with Zimbabwe and 545 kilometers south of Zimbabwe's capital, Harare. It is estimated that approximately 7,000 truck driver's visit the Messina borders on a monthly basis. About 3,000 of these drivers spend the night in the area.

The Family Health International report (2004), indicate that there is a high incidence of sex partner sharing; commercial sex workers and sexual promiscuity in the area. From population estimates for the town, there are from 19,500 to 26,000 residents of which 65% of the population comprises of women. The high female population is a ripple effect of poverty which in turn promotes a high level of migration of their male partners to labour centers in Gauteng. The high female population and the absence of their partners in conjunction with the regular visits of longitudinal truck workers perhaps creates the ideal environment for 'risky sexual behavior' and subsequently a high HIV prevalence in the area.

From another study Marcus (2001) carried out on longitudinal truck workers in South Africa in 1999, it was revealed that a majority (42%) of the truck workers were working on the Gauteng route. Approximately 65% of all truckers included in the study earned below 2500ZAR. A total of 95% of those interviewed admitted to having sex during truck stops and about 75% never used or occasionally used condoms (Marcus, 2001:114-115). The low income, strenuous nature of the job, long hours of loneliness, the absence of their sex partners/spouse and a passive attitude towards 'safe sexual practices'; (abstinence, faithfulness and the use of condom), undoubtedly account for the high prevalence rate of HIV/AIDS amongst truck workers nationally.

In the study by Haler (2003:5) it is stated that a particular trucking company reported that 38% of their truck workers were HIV/AIDS positive. The research of Haler, (2003) cautioned that South Africa could loose 50% of truck workers by 2010, as the HIV/AIDS mortality rate of truck workers had increased dramatically.

The high concentration of the disease along migratory, specifically longitudinal transport routes, the role of commercial sex workers and the 'at risk sexual behavior' imbibed by a good representation of truck workers, has been attributed to the work environment which has been tagged an 'at risk work environment. According to Fernandez (1998:11) loneliness, fatigue and isolation exposes individuals' to "at risk" sexual behavior. In another study Geelhoed (1991) established that HIV/AIDS has diffused from these areas away from the main roads and large towns into the rural and remote areas

2.3.1.2   HIV/AIDS in South Africa and Gauteng – A focus on mine workers and other at risk professions

HIV/AIDS and labour migration has shown similar trends and distribution to those observed along migratory routes. According to research done by Brummer (2002), at risk professions such as mine workers, truck workers, military personnel and other personnel with jobs exposing them to at risk sexual behaviors, were more prone and have higher concentrations of HIV/AIDS, than workers required to do less traveling away from home. Mineworkers, in particular, have often been viewed as instruments for the spread of HIV/AIDS and now have become one of the most vulnerable populations to HIV/AIDS (Brummer, 2002). The parts of South Africa notorious for receiving labour migration are mainly the mining areas, and to complicate the matter, about half the percentage of workers in the mining industry in South Africa is comprised of foreign nationals (Crush, 1995:20). The impact of HIV/AIDS on the mining industry in South Africa is difficult to estimate (Elias, et al, 2001) however the prevalence of HIV/AIDS amongst mine workers is significantly higher than that in the overall population in general (Brummer, 2002:10). Research (Williams, et al, 2000) done in the Carletonville region (one of the major gold mining areas in South Africa) in 1998, stated the total HIV prevalence amongst mine workers was 28%. In another publication by the same author 49% of the mine workers attending sexually transmitted diseases (STD) clinics tested HIV positive (Williams & Campbell, 1998).

As noted above, mineworkers have been identified as a group of workers that are vulnerable to HIV infection. This can be attributed to high levels of mobility and the tendency to have more than one sexual partner, often including sex workers. However, according to the (AIDS Foundation South Africa, 2005), the infection rates among other workers, such as educators and health professionals have risen alarmingly. Respective Unions of these professions have individually and collectively sought workplace testing, counseling and treatment programmes, and have fought for the legal rights of infected and affected workers (AIDS Foundation South Africa, 2005). Military personal are also considered to be one of the "at risk professions'. According to unconfirmed reports in 2006, although contested by the South African National Defense Force (SANDF), it is estimated that 40% of South African soldiers may be infected with HIV (AIDS Foundation South Africa, 2005).

The (Family Health International, 2006) estimates that the work force in general have an HIV positive rate of between 10% to 20%, it should be noted that the professions reported above as more prone to 'at risk' sexual behaviors and infected partners, all have an infection rate of above 20%.

The research focus of HIV/AIDS is gradually moving away from the diffusion of HIV/AIDS to the vulnerability of migrants to HIV. There are natural links between each of these unique factors. The links can be better appreciated when each of these factors are viewed in a more holistic manner.

2.4   Socio-economic factors and HIV/AIDS – A global summary

Economic development is a major factor enhancing HIV vulnerability. The link between HIV vulnerability and the migration of HIV is very close. The cycle which has been explained in this Chapter reveals that the primary reason for voluntary migration is mainly economic prospects (Du Guerny, et al, 2003(a):28). Poverty has implications on increasing 'risky' behavior in relation to the HIV/AIDS transmission. Arguably poverty also leads to migration often from rural areas to urban areas. The people that migrate to the urban centers are often low-skilled, farm laborers, who often cannot find formal work in the cities. Many people in this predicament often resort to informal sector work for example prostitution, dealing and/or selling drugs, or work in other sectors but ultimately resort to risky behavior due to poor economic circumstances.

These activities are seen as 'high risk' in terms of HIV/AIDS contraction, transmission and possible exposure (Fernadez, 2006). Furthermore migrants usually end up in complex social situations which impact on their economic resources, emotional state and their vulnerability to HIV (Decosas, 1998:6-7).

The factors promoting risky sexual behavior, poverty and the effects of poverty on HIV affected households have been summed up by two bi-causal relationships these include:

- The relationship between poverty and HIV/AIDS. This relationship includes the spatial and socio-economic distribution of HIV infection in African populations; and
- The consideration of poverty-related factors which affect the households and communities ability to cope with the disease. The consideration means understanding the processes through which the experience of HIV/AIDS by households and communities leads to an intensification of poverty. It also means the consideration of the gender dimensions of poverty, since the poorest households are often female headed (Hasnain, 2004; Desmond, 2006).

2.4.1 Socio-Economic Factors and HIV/AIDS in South Africa and Gauteng

South Africa has the sixth highest prevalence of HIV in the world (UNAIDS, 2006), with 18.8% of the population estimated to be infected. The UNAIDS 2006 Global Report, estimated that 320 000 people died of AIDS related deaths in South Africa during the year 2005. South Africa is regarded as having the most severe HIV epidemic in the world. New infections in the country are still increasing without any signs of the disease reaching a natural limit. (AIDS Foundation South Africa, 2005).

The immediate determinants of the HIV/AIDS epidemic in South Africa include:
- behavioral factors such as unprotected sexual intercourse/ multiple sexual partners; and
- biological factors such as the high prevalence of sexually transmitted diseases.

The following statistics from the (Department of Health, 2004(b):9) highlights the overall South African problem:
- Young women aged 20-30 have the highest prevalence rates; and
- Young women under age 20 had the highest percentage increase compared to other age groups in 1998 when compared to the same rates in 1997.

According to the current trends a combination of factors seem to be responsible for this including:

- poverty and social instability,
- high levels of sexually transmitted infections,
- the low status of women,
- sexual violence,
- high mobility (particularly migrant labour), and
- lack of good governance.

2.4.2 Socio-Economic Factors – Sexual Violence and HIV/AIDS in South Africa and Gauteng

In Gauteng, the underlying causes of HIV/AIDS spread include socio-economic factors such as poverty, migrant labour, commercial sex workers, and the relatively lower status of women, illiteracy, and lack of formal education, stigma and discrimination. (HIV/AIDS/STD Strategic Plan for South Africa, 2000 – 2005). The high poverty rate in Gauteng has subsequently led to a higher rate of sexual crimes; currently South Africa has the highest per-capita rate of reported rape cases in the world (Floyd, 2007).

According to Artz, et al (2003), child sexual abuse in South Africa, is aggravated by widespread poverty, migration, social and economic insecurity, and inadequate childcare arrangements. The high prevalence of HIV/AIDS in poor communities is also generally linked to the high risk of infection through sexual violence. An unexpected HIV-positive test diagnosis may lead to violence against one's spouse or children, or alternatively, non-disclosure. Economic dependency further increases risk because of disempowerment which extends to sexual choice-making. In the South African context, gender-based violence is not limited to men as 'perpetrators' and women as 'victims', nor is it exclusive to heterosexual relationships (Artz, et al, 2003).

2.4.3 Socio-Economic Factors – Heterosexual behavior, poverty and HIV/AIDS in South Africa and Gauteng

The data in section 2.41 above clearly evidences that the HIV/AIDS epidemic is severely affecting the young and economically active populations in South Africa. The spread seems to revolve around heterosexual behavioral factors. There are growing links between the socio-economic situation of an individual, heterosexual behavior and the patterns of HIV/AIDS infection. This is further supported by the higher prevalence levels observed amongst the lower socio-economic group of South Africans consisting mainly of black South Africans (Evian, 1994: 6-7). The prevalence levels from a study by (Evian, 1994: 6-7) revealed:

- 3.22% of HIV prevalence amongst black women,
- 0.09% amongst whites and
- 0.33% amongst Asians and 'colored's' (coloured- in the South African context refers to any mixture of races).

Furthermore, a survey conducted by the South African Institute of Race Relations in 1999 showed that black Africans have the highest rate of unemployment 51.9% followed by colored women at 28.4%. According to the arguments above this would thus increase their vulnerability to risky sexual behavior. (Marcus & Ebrahim-Vally, 2005: 217-235).

2.4.4 Socio-Economic Factors – Impact of Poverty on HIV/AIDS affected household in South Africa and Gauteng

The factors that predispose people to HIV infection such as poverty, illiteracy, and gender inequalities and the like cannot be addressed in the short term. Vulnerability to, and the impact of the HIV/AIDS epidemic in South African communities and individual household levels cannot be measured; hundreds of people of all ages dying every day from AIDS related diseases; the untold hardship being experienced by those infected and their families; the pain they have to live in long before they die and a host of others issues such as the:

- stigma attached to suspected infection
- fear and despair that often follows diagnosis
- loss of income and support when a breadwinner or caregiver becomes ill
- diversion of household resources to provide care
- terrible burden upon family members, particularly children caring for terminally ill parents
- trauma of bereavement and orphan hood.

This is all happening in a society where approximately 61% of South Africa's 18 million children already live in poverty and 7.9 million people are unemployed (unemployment rate of 40.9%) thus compounding the impact and the effects of the epidemic. (AIDS Foundation South Africa, 2005).

The impact of poverty on HIV affected households is further aggravated as the increasing levels of HIV/AIDS morbidity and mortality induces severe adverse effects on the supply of food, security and nutrition. Families affected lose income earners; household expenditure is often redirected to cover non-food items such as medical costs and funerals; children are taken out of school for lack of fees to care for their sick relatives; workers have to take time off to provide terminal care; resources may have to be shared with more dependents and productive assets are sold off. Invariably the burden of coping falls on women, particularly girls and grandmothers (AIDS Foundation South Africa, 2005).

Much of this deepening poverty is invisible to donors and policy makers. Local organizations find themselves overwhelmed with requests for support at the same time as they lose staff and volunteers to the epidemic (Artz, et al, 2003:2). The lack of social security, net and high levels of unemployment mean that poor HIV affected households and communities would continue to slip further and further into poverty and deprivation.

2.4.5   Determination of socio-economy/poverty/deprivation and indices for classification.

According to Townsend (1979:31), people are defined as poor if "they lack the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary or at least widely encouraged or approved in the societies to which they belong". In addition, Townsend (1987: 131 & 140) defined deprivation in the following manner "people are deprived if they lack the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which are customary".

Deprivation therefore refers to peoples' unmet needs, whereas poverty refers to the lack of resources required to meet those needs.

To this effect the levels of poverty in Gauteng could be subjectively determined by the employment, unemployment and economical in-activity of Gauteng residents.

The multiple indices namely: (access to energy for: heating, lighting, cooking; access to medical cover; access to sanitation/toilet/refuse removal, access to portable water; access to education) can be used to determine poverty (Statistics South Africa, 2000).

The inclusion of deprivation as an equally important factor should be considered when dealing with poverty in the country. According to the (African National Congress, 1994), the lack of income is not enough to determine poverty. There are a huge proportion of very basic needs which are presently unmet. Therefore to deal with poverty, deprivation must be attacked. The (Reconstruction and Development Programme (RDP), 1994) therefore aims to set South Africa firmly on the road to:

- eliminating hunger,
- providing land and housing,
- providing access to safe water and sanitation,
- ensuring the availability of sustainable energy sources,
- eliminating illiteracy, providing quality education,
- improving the health services,
- protecting the environment and
- providing access to all the above factors to all.

2.4.6 Previous research measuring poverty at the micro-level in South Africa

Previous research measuring poverty at a micro-scale in South Africa has primarily been based on national and sub-national population surveys. The main datasets at a national used in research measuring poverty on a micro-level include:

- Income and Expenditure Surveys (1995 IES and 2000 IES),
- October Household Surveys (OHS 1995)
- Labour Force Surveys (LFS 1995)
- 1996 and 2001 Censuses.

At a sub-national level, similar surveys have also been undertaken, such as: the (KwaZulu-Natal Income Dynamics Study- K.I.D.S, 2000) and the (Cape Area Panel Study, 2002). Although studies have been conducted in parts of South Africa, nothing has been done specifically in the Gauteng province.

In a research study by Alderman, et al (2000), the households living in poverty at various geographical levels in South Africa was determined by using a combination of the 1995 (Income and Expenditure Surveys), 1995 (October Household Surveys) and 1996 (Census data) sets respectively (Alderman, et al, 2000). In another study (Hirschowitz, et al, 2000), expected expenditures, were imputed in the construction of a provincial level 'development indices' for Statistics South Africa (Stats SA).

The average monthly household expenditure was joined by ten indicators from the 1996 Census in a factor analysis; from the study two indices were identified: a 'Household Infrastructure Index' and a 'Household Circumstances Index' (Hirschowitz, et al, 2000).

Statistics South Africa (2000), utilizes indices which encompass a wider range of indicators of social deprivation and inequality than those analyses restricted to measuring income, expenditure or consumption alone. However, the Statistics South Africa indices are not an articulation of any explicit model of multiple deprivations. Five of the eleven variables entered into the factor analysis relate to access to services, while the remaining six relate to housing, education, employment, expenditure and household demographics. This results in far greater weight being given to the issue of access to services than to the other aspects of social disadvantage.

McIntyre, et al, (2000) in a research study utilized data from the 1996 Census in order to look at the relationship between deprivation and health inequalities in South Africa, according to this study, four alternative deprivation indices at a magisterial district level were identified:

- A general index of deprivation; using principal component analysis (PCA) of a number of variables relating to socio-economic, demographic and physical household characteristics.
- A policy-perspective index of deprivation, using 'groups identified by policymakers as being particularly disadvantaged or as groups who should receive priority in social service delivery'.
- A single index of deprivation (SID), which was a single variable: access to piped water.
- And a health-related index of deprivation, again using PCA. These indices, with the exception of the SID, could be regarded as indices of multiple deprivations since they each contain variables relating to different aspects of deprivation. However, they were not designed to conform to any particular model of multiple deprivations.

Klasen (2000) utilized data from the 1995 Project for Statistics on Living Standards and Development, to construct a deprivation index.

The index comprised of: education, income, wealth, housing, water, sanitation, energy, employment, transport, financial services, nutrition, health care, safety and perceived well-being indicators. The index was based on survey data at a national level and did not allow for the identification of small area multiple deprivations.

Bhorat, et al, (2004) attempted to provide recent data sets on poverty counts based on the changes between the 1996 and 2001 census data respectively. Although the study attempted to provide a good indication of asset and services deprivation; economic activity, health and safety; the data presented for that study were only for discrete indicators rather than for dimensions of deprivation or composite indices, furthermore there was no presentation at the provincial levels.

The South African Human Development Report 2003 (UNDP, 2003(c):47) constructed and calculated a Service Deprivation Index (SDI) 'to provide a more encompassing measure of the distribution of progress, and to measure the backlog of deprivation that still exists in seven dimensions of basic services. The seven basic services used for the calculation of the SDI include: housing, energy for cooking, energy for heating, energy for lighting, water, toilet facilities and refuse removal.

The Social Research and Population Development Unit, 1999 of the Department of Health and Social Services in the Western Cape created a Human Development Index (HDI) specifically for the Western Cape Province (Department of Health and Social Services, 1999). The index utilized a combination of four indicators with equal weight to form a composite index. The indices include: income, employment status, literacy and water supply.

The above micro studies utilized a combination of indices to determine deprivation. Deprivation in turn was a direct effect of the lack of financial resources and was used to determine poverty.

2.5 Legislative attempts of the South African government to prevent discrimination of HIV/AIDS Victims

The South African government has an objective to improve the quality of life of all South Africans due to the levels of poverty and social inequality which was created by the apartheid era (Bhorat, & Kanbur, 2005:2). In addition the government stipulates that poverty must be tackled in a broader perspective. It is not merely dealing with the extent of low income or low expenditure in the country but dealing with the root of the problem which is the denial of opportunities, the power of choices and basic human developmental needs which lead to a long healthy, creative life and the enjoyment of a decent standard of living, freedom, dignity, self-esteem and respect for others (Statistics South Africa, 2000).

The South African Constitution Act, No. 108 of 1996 prevents unfair discrimination; which could either be due to ones race, gender, socio-economic status/poverty, HIV/AIDS or any other reason. The following is a list of some of the legislations regarding discrimination and HIV/AIDS:

1. Code of Good Practice on Key Aspects of HIV/AIDS and Employment

This Code is issued in terms of Section 54(1)(a) of the Employment Equity Act, No 55 of 1998. It is based on the principle that no person may be unfairly discriminated against on the basis of his or her HIV status. In order to assist employers and employees to apply this principle consistently in the workplace, the Code refers to the Constitution, the Labour Relations Act and other pieces of legislation.

2. Employment Equity Act, No. 55 of 1998

Section 6(1) of the Employment Equity Act provides that no person may unfairly discriminate against an employee, or an applicant for employment, in any employment policy or practice, on the basis of his or her HIV status. In any legal proceedings in which it is alleged that any employer has discriminated unfairly, the employer must prove that any discrimination or differentiation was fair. The Act also prohibits HIV testing without Labour Court authorization.

3. Labour Relations Act, No. 66 of 1995;

Section 187(1)(f) of the Labour Relations Act, No. 66 of 1995, provides that an employee with HIV/AIDS may not be dismissed simply because he or she is HIV positive or has AIDS. However where there are valid reasons related to their capacity to continue working and fair procedures have been followed, their services may be terminated in accordance with Section 188(1)(a)(i).

4. Occupational Health and Safety Act, No. 85 of 1993

Section 8(1) of the Occupational Health and Safety Act, No. 85 of 1993 requires an employer to provide, as far as is reasonably practicable, a safe workplace. This may include ensuring that the risk of occupational exposure to HIV is minimized.

5. Compensation for Occupational Injuries and Diseases Act, No. 130 of 1993

An employee who is infected with HIV as a result of an occupational exposure to infected blood or bodily fluids may apply for benefits in terms of Section 22(1) of the Compensation for Occupational Injuries and Diseases Act, No. 130 of 1993.

6. Basic Conditions of Employment Act, No. 75 of 1997

In accordance with the Basic Conditions of Employment Act, No. 75 of 1997, every employer is obliged to ensure that all employees receive certain basic standards of employment, including a minimum number of day's sick and family leave.

7. Medical Schemes Act, No. 131 of 1998.

In accordance with Section 24(2)(e) of the Medical Schemes Act, No 131 of 1998, a registered medical aid scheme may not unfairly discriminate directly or indirectly against its members on the basis of their "state of health." In terms of s 67(1)(9) regulations may be drafted stipulating that all schemes must offer a minimum level of benefits to their members. Currently, regulations require that schemes provide treatment for HIV.

8. Promotion of Equality and Prevention of Unfair Discrimination Act, No. 4 of 2000.

In accordance with both the common law and Section 14 of the Constitution of South Africa Act, No. 108 of 1996, all persons with HIV or AIDS have a right to privacy, including privacy concerning their HIV or AIDS status. Accordingly there is no general legal duty on an employee to disclose his or her HIV status to their employer or to other employees.

Thus the Parliament uses the acts to ensure equal opportunities and equitable distribution of financial resources among provincial and sub-provincial governments, based partly on levels of poverty and disadvantage.

2.6   The Spatial Distribution of HIV/AIDS and the use of GIS software

The spatial distribution of HIV/AIDS will differ from one place to another. Spatial differences could be interpreted to show the different attitudes to sex and faithful sexual relationships, both monogamous and polygamous (UN AIDS, 2002). For instance, in Zimbabwe the spatial distribution of HIV estimated from sentinel surveys of pregnant women attending antenatal clinic in Zimbabwe revealed highest concentrations in the commercial areas and the lowest concentration in the rural areas (Figure 2.3). This arrangement may be linked to the factors generally viewed as role players in the spread of the disease.

Spatial factors have also been used to map and interpret HIV vulnerability. The mapping guide developed by UNDP (2004) deals extensively on HIV vulnerability and the use of maps to display and interpret HIV vulnerability in studies. The work provides a guide to understanding and identifying the spatial links related to HIV vulnerability. According to the research, HIV vulnerability is important because it allows the researcher to look beyond the risk behaviors to the risk factors which enhance the risk behaviors.

Figure 2.3: HIV prevalence of Ante-natal Clinic attendees by women aged 15-44, Zimbabwe 2000 (Ministry of Health, Zimbabwe, 2002).
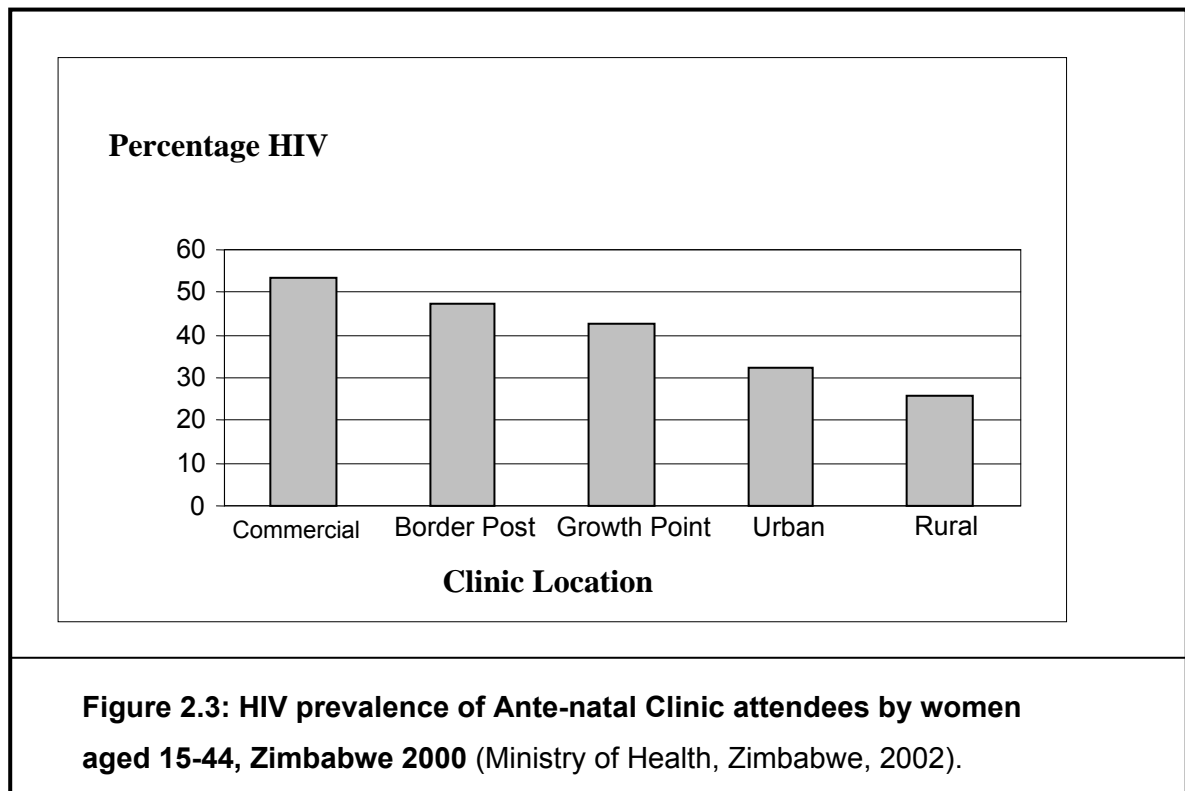
Mapping as a research tool provides a visual representation of the 'space' under study, it demonstrates the spatial relationships of a 'space' visually and allows layers of information to be added which enables complex information to be communicated easily. The vulnerability mapping, similarly, shows the spatial distribution of vulnerability whilst the mapping of HIV sero-prevalence shows the spatial distribution of HIV for the area of study.

Mapping is a growing tool being used in research of HIV vulnerability. Some studies which have utilized spatial mapping as a tool globally include:

- Vulnerability mapping in Zambia (Figure 2.4)
- Programme coverage for female sex workers along major highways in Nepal (Family Health International, 2004);
- Mapping of Thailand's HIV prevalence from 1989-2002 (UNESCO, 2004);
- The location of HIV programme activities and hotspots in Myanmar (USAID, 2004);
- Mapping of Vulnerability, mobility & HIV prevalence in Guangxi, China (UNDP, 2003(b));
- Mapping HIV vulnerability along Kampong Thom, Siem Reap, Odor Meanchey and Preah Vihear, Cambodia. (Phalla, et al, 2004).
- Mapping HIV vulnerability, prevalence & population flow in Lao PDR (UNDP, 2003(a)).

Figure 2.4: A vulnerability map for Matero, Zambia (Wilson, 2001:10).

2.6.1   The use of Geographical Information Systems (GIS) software

Geographic Information Systems (GIS) is primarily computer software that allows the user to stack, or layer, multiple pieces of information for a specific geographic region. GIS is a technology traditionally used for resource development and management it can be very useful when working on information with spatial attributes. For a survey on HIV/AIDS, GIS and the resultant spatial thinking can be extremely useful. It can be used to evaluate and interpret the HIV/AIDS epidemic in specific regions and provides the ability to see spatial relationships between data layers that may not be apparent when databases and maps are visually compared hence GIS allows you to maintain and compare spatial and attribute datasets (Mapping & Service Directory, 2005). In a research survey conducted in the Wake County (Law et al, 2003), Spatial analysis and STD disease mapping was done by GIS software systems (Figure 2.5).

KEY: (A) Wake County, North Carolina; (B) Wake County STD services; (C) population density of Wake County; (D) location of STD services relative to population density.

Figure 2.5: Characteristics of the Wake Country, North Carolina in the year 2000 (Law, et al, 2003).
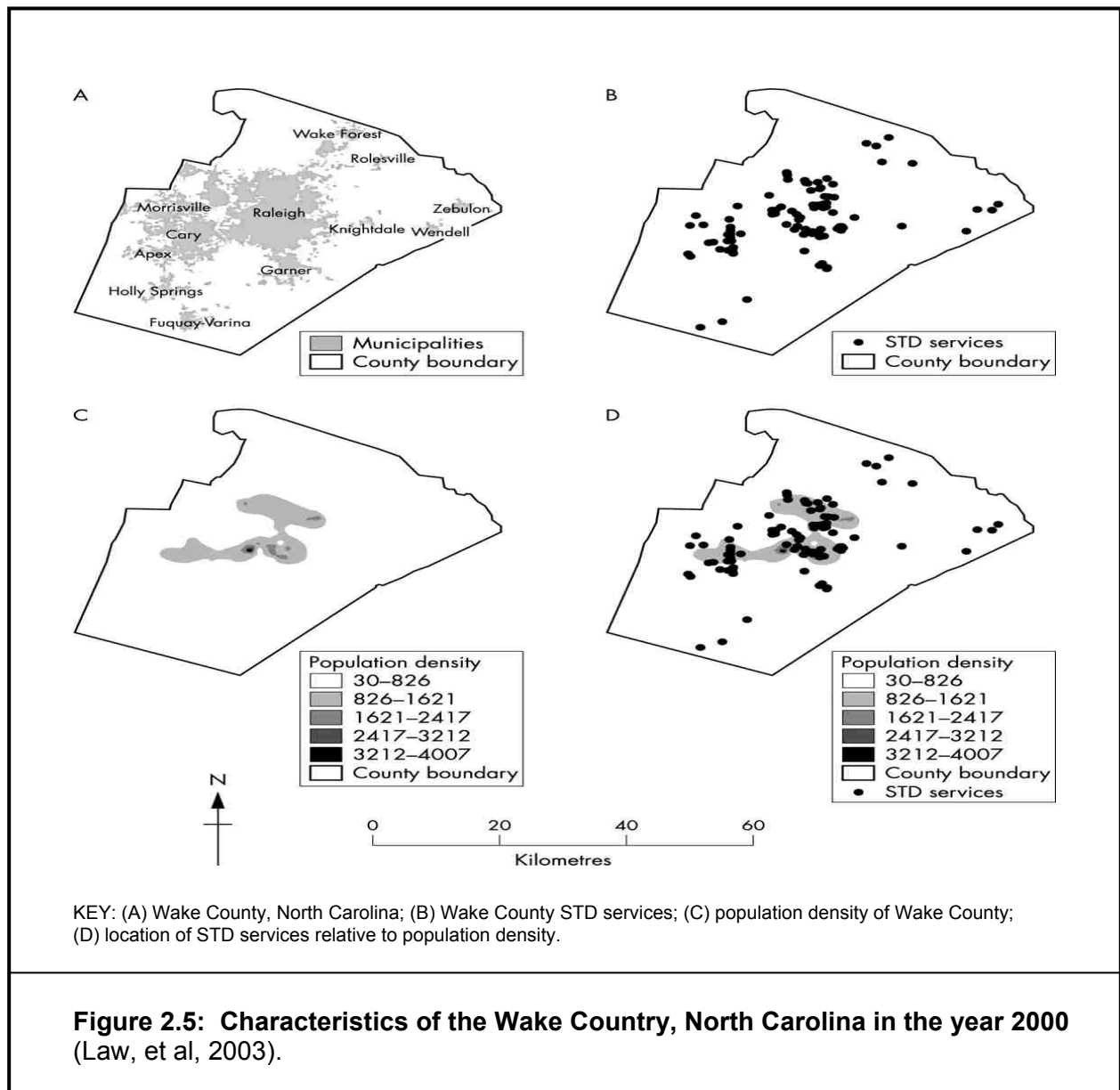
2.6.2 Mapping Spatial Data Using Exact Geographic Coordinates

In a study conducted by Siegfried, (2004) an attempt was made to identify and describe randomized controlled trials on HIV/AIDS in Africa and then to map their spatial distribution using exact geographic coordinates. The data was analyzed by representing the data as numbers and simple frequencies calculated in MS Excel and descriptive statistics and qualitative information were presented when appropriate. The data mapping was done by recording the geographic coordinates of each trial and the mapping software (MapInfo) was used to plot the position of each trial (Figure 2.6). The challenge encountered in the study was keeping up to date data base records, they therefore recommend that those responsible for trial registers should consider including geographic coordinates for the trial to allow graphical display of geographic data (Siegfried, 2004).

KEY: Circles indicate site of trial based on geographic coordinates. N=42

(some trials have more than one country location)

Figure 2.6: Randomized controlled trials of prevention of HIV/AIDS, 1987-2003 (Siegfried, 2004).
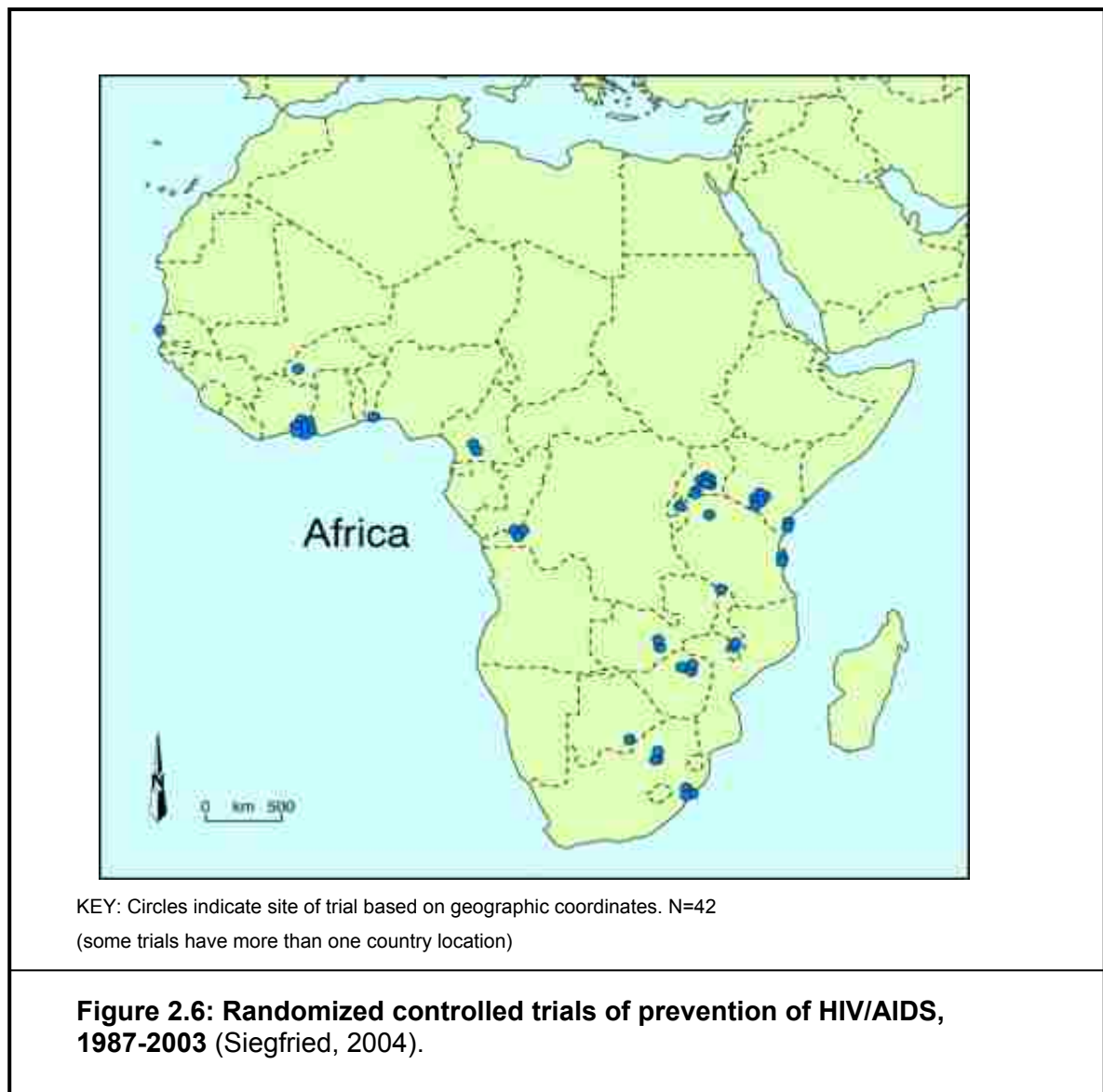
2.6.3   Spatial Information Systems (SIS) and Spatial Management System (SIMS)

Another increasingly important method being utilized to analyze and display spatial data is Spatial Information Systems (SIS) and Spatial Management Systems (SIMS). This has been used in some research studies on HIV/AIDS. The use of a spatial information system in the management of HIV/AIDS in South Africa was used in study on the spatial distribution of HIV patients in Gugulethu near Cape Town (Busgeeth & Rivett, 2004).

The main purpose of the study was to design and develop a HIV/AIDS database, which is embedded in a Spatial Information Management System, in order to be able to analyze and manipulate data within the HIV data base. This facilitated the management of HIV/AIDS patient data and provided visual feedback and the display of the HIV/AIDS database of the Gugulethu community clinic. Another study used the SIM systems to analyze the interaction between HIV/AIDS and community-based natural resources management (Freeman, 2002).

A further study consulted was a research project (Radkhoshnoud, 2002) which examined the spatial and temporal distribution of HIV/AIDS and TB for 1997 and 1999 within the African continent as a whole. The study investigated whether similar clustering of disease rates could be observed between the two diseases for the two years of study.

In the study, choropleth maps were used to reveal the spatial distribution of the two diseases. Pearson and Spearman correlations, descriptive statistics, and the Mann-Whitney U-test were used to assess temporal changes in disease rates. Pearson and Spearman Correlation and linear regression were used to assess the relationship between HIV/AIDS and TB for each year.

Spatial Information System (SIS) is a computer system for capturing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the earth's surface. Typically, a Geographical Information System (or Spatial Information System) is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature.

Each feature is linked to a position on the graphical image of a map. Layers of data are organised to be studied and to perform statistical analysis. Uses are primarily government related, town planning, local authority and public utility management, environmental, resource management, engineering, business, marketing, and distribution. Spatial Information Management System (SIMS) is a system which delivers the complete requirements for a data-driven information system; the SIMS features the following functionalities:

- The visualization of the HIV/AIDS distribution. The spatial distribution provides a clear representation of HIV/AIDS people.

- The identification of areas, which are more prone to the pandemic. The 'hot spots' are earmarked and health professionals can initiate strategies as to how to curb the further spread of the disease.

- The display of the existing infrastructure provides an insight into the lifestyles of the HIV infected patients in terms of availability of basic amenities and means of transport.

- Comparisons and relationships relating to the spatial distribution of HIV/AIDS patients can be drawn between areas with infrastructure and other areas with non-adequate infrastructure. In addition, decisions can be made concerning the allocation of resources in underprivileged regions.

- The spatial distribution of the population in relation to health centre positions assesses the accessibility to appropriate health services. Health officials can utilize this information to site additional health centers with the aim of minimizing the distances that patients need to travel to obtain care and services.

- The distance that the therapeutic counselors need to travel for their regular house visits can also be calculated. This information is useful in coordinating the roles and responsibilities of the therapeutic counselors so that they counsel patients living in the same vicinity rather than miles away.

- It is a powerful management and decision-making support system that enables decision-makers to identify and prioritize population health needs, configure health care delivery systems, and evaluate service utilization and health outcomes.

- Last but not least, SIMS can be regarded as a virtual information bank that allows focused, long-term and cost effective HIV/AIDS management thus contributing to health development. (Busgeeth & Rivett, 2004:13)

2.7 The Spatial Distribution of HIV/AIDS in Gauteng – A focus on the need for GIS systems.

Various research representations of HIV/AIDS in past research have often presented complex spatial information and data in descriptive, tabular and graphical manner. There is a growing recognition of the need to represent spatial data in map form.

From studies done in various parts of the world representing the data in map form, some of which have been discussed earlier, the emphasis has usually been on mapping vulnerability; some of these have been noted earlier in the section.

These studies which have contributed immensely to the growing knowledge of HIV/AIDS have basically focused on one aspect of the epidemic such as vulnerability. The lack of research work providing useful spatial information in map form is lacking.

This study therefore attempts to utilize mapping by GIS software and methods, to represent the spatial information on Gauteng. This study also attempts to layer specific spatial data (population, distance/proximity and the socio-economic situation of Gauteng) in order to determine the existence of possible relationships between each of these variables and the distribution of HIV/AIDS in the province. Before the spatial mapping can be fully understood, a summary of the spatial dynamics of the Gauteng province needs to be considered.

2.7.1 The spatial distribution of HIV/AIDS in Gauteng

In Gauteng, it is estimated Green (2005) that at least one in three people are infected with HIV, thus making the province one of the worst affected in the country. This means 34% of the Gauteng population is HIV-positive a 14% increase since 1998 (Green, 2005). Gauteng features a number of conditions which are associated with the rapid increase of HIV, for instance the role of long distance truck workers. In one small sample of long-distance truckers in Johannesburg, 19 out of 24 (79%) were reportedly HIV-positive (Green, 2005). Haler (2003:5) stated in a study that a particular trucking company reported that 38% of their truck workers were HIV/AIDS positive.

Further more, the province is situated in a region where HIV infection is pervasive, a large proportion of the population live in socially unstable circumstances, bringing in the role poverty may have on the spread of the disease. There is also the socio-economic factor of sprawling informal settlements which have grown rapidly and constantly, these settlements are usually home for the poorer members of the society.

The infrastructure here is also poor, other services such as clinics and social services is generally poor. There is a high rate of family breakdown, more sexual misconduct and more risky sexual behaviors in general (Green, 2005). Another factor to consider with regards to the distribution of HIV in the Gauteng province is the high level of migrant workers and laborers.

A sizeable population of migrant workers go to Gauteng to seek for work. Johannesburg is one of Gauteng's inner city areas with a large transient population, there is a large population of mobile workers, migrant workers and a good representation of industries which depend almost entirely on migrant labor. An estimated 65% of Messina's population is female, reflecting male migration to the larger labor center in Gauteng (Family Health International, 2006). The role of migrant workers and the spatial distribution of HIV hence come into play here.

In conclusion, this chapter provided an executive summary on various HIV/AIDS research focus globally and in South Africa with specific reference to the Gauteng province. The aspects considered included; migration, poverty and HIV vulnerability. These all inter-related in complex relationships have further been made more understandable by the use of GIS/SIMS. The chapter concluded by focusing on aspects of the HIV epidemic in Gauteng and the need for mapping in the understanding of the complex spatial relationships which may exist.

The next chapter would discuss the data which would be required and utilized for the study and the methods for analyzing and interpreting the data.

CHAPTER 3

THE RESEARCH SURVEY METHODOLODY

3.1   INTRODUCTION

In chapters one and two, the study provided a platform supporting the research methodology and data type which would be required for the study. Chapter two specifically provides a general literature review on previous and current research focus on HIV/AIDS globally, in Africa and in South Africa with specific reference to Gauteng. Available literature was reviewed, and it was established that the focus of existing research was on the prevalence and spread of HIV/AIDS, including a major concentration of the research on the factors enhancing the spread and the 'agents of diffusion' of the disease. More recent research focus attempts to create awareness on the vulnerability of the so called 'agents of diffusion' to HIV/AIDS. Furthermore the geographical tool, GIS, is becoming more and more useful in representing spatial HIV/AIDS data. Literature reviewed showed that maps representing HIV/AIDS data as well as the emphasis on mapping HIV vulnerability are increasingly important.

This chapter includes the research methodology from within the perspective of the purpose of the study including the research objectives; the significance of the study; the research focus and how the study differs from other studies in South Africa and Gauteng. Furthermore, this chapter provides a detailed record of the research processes including what data sets were required for the study; determination of the clusters for data collection; the methodology for analyzing and representing the data and the rationale behind the methods selected.

3.1.1   The purpose of the study

This study is being undertaken because little work has been done in South Africa and in particular Gauteng to show the spatial dynamics of the HIV/AIDS epidemic. Although several research projects have been done and are currently being undertaken on the HIV/AIDS epidemic in South Africa, the research focus has usually been on specific aspects of the epidemic. The annual sentinel antenatal HIV-surveys have been conducted by the South African Department of Health since 1990, these Annual Sentinel Surveys have been conducted at a national/provincial level and are currently the only existing national surveillance activity for determining HIV-prevalence in South Africa (Department of Health, 2005:1). The focus of these Annual Sentinel Surveys however have been to show the temporal trends and the prevalence of the disease in the country. Although this is significant in the monitoring of the HIV/AIDS epidemic it does not cover the spatial aspects of the epidemic which is of similar significance in monitoring the epidemic.

As mentioned in chapters' one and two, other research foci have included various aspects of the epidemic such as the:

- diffusion of HIV/AIDS (Decosas, et al, 1995: 826);
- vulnerability of mobile populations such as migrant workers to HIV/AIDS (Brummer, 2002);
- impact on longitudinal truck drivers, (Kulis, et al, 2002; Haler, 2003);
- impact on mine workers, (Crush, 1995; Williams, et al, 2000; Elias, 2001; Brummer, 2002) and
- impact on military personnel (Family Health International, 2006).

In addition, the socio-economic factors influencing the spread of HIV/AIDS were reported in the research of (Marcus, et al, 2005) and (Evian, 1994).

3.1.2   The research objective

As highlighted in Chapter 1, section 1.5.2, this research aims to contribute to the overall knowledge of the HIV/AIDS epidemic by suggesting the possible relationships between the spatial distribution of HIV in Gauteng and the various related spatial aspects. The research aims to create awareness on the need to approach the HIV/AIDS problem from within a more holistic viewpoint, and to encourage the utilization of GIS-software to bring together different pairs of data such as HIV, distance, population and socio-economy onto one map.

The research aims to show the distribution of HIV/AIDS at a micro level, and in this way will show the minute variations of HIV distribution which would otherwise have been non-evident. This research thus covers an aspect of the HIV/AIDS epidemic which has been neglected by previous and current research foci in South Africa.

This research differs from other studies, in that it does not provide data or extrapolate data to show the prevalence of HIV/AIDS in Gauteng. This is already being undertaken annually by the Department of Health. Nor will the research provide the geographical and temporal trends of the HIV epidemic as this is also being provided by the Department of Health, Statistics South Africa and other government research bodies.

This research will utilize the data collected by the Department of Health, with the purpose of representing existing data in a spatial form to establish any relationships between HIV and the present socio-economic environment of Gauteng. Further more this research differs from other research that focus on establishing how the socio-economic factors influence the spread of HIV/AIDS, in that the other studies focus on the determining the factors and reasons for the relationship between HIV and socio-economic conditions of a geographical area.

This study on the other hand will attempt to establish the possible relationships between the socio-economic aspects of the Gauteng environment in relation to other special attributes (proximity between areas of high to low HIV prevalence & population) and HIV/AIDS. In addition, the study does not attempt to give the factors responsible for the relationships which may be evident between the socio-economy, population distribution and proximity between areas of Gauteng and the spatial distribution of HIV/AIDS.

Finally, this research will represent HIV/AIDS in the following spatial terms:

- population;
- socio-economy/poverty; and
- proximity between areas of high HIV endemicity to areas of low HIV endemicity.

Although the possible relationships of the above will be established, the factors responsible for these relationships do not form part of the focus of this research.

An outline of the research study aims have been highlighted in Chapter 1, section 1.5; In order to achieve the aims, a specific research methodology is required, and is thus explained in the rest of this chapter.

3.1.3 Data sets required for the study

The data sets for the study consist primarily of archival secondary data. The first data set is the HIV/AIDS data. This data comprises of HIV/AIDS un-manipulated anonymous statistics of pregnant women attending antenatal clinics in Gauteng. The data was collected during the Department of Health's annual sentinel HIV surveys conducted in October 2005. This data is currently the most suitable for this type of research.

The data collected and used in this study, covers the entire Gauteng province and was obtained from the provincial Department of Health's Information Services department, in June 2006. Due to the highly sensitive and confidential nature of HIV/AIDS data, approval had to be obtained prior to the data being provided. The necessary steps followed included:

- Obtaining a cover letter from the University of South Africa (UNISA) (Appendix 1).
- A personal application letter by the researcher requesting the data.
- A general protocol for the research drafted by the researcher (this could also be the research proposal or relevant chapters from the study showing the need for the data).

These applications had to be submitted to the provincial Department of Health in advance. The application was then scrutinized by the ethic's clearance committee, in this case approval was provided to the researcher to use the data. The due procedure was followed by the researcher and the specified information was provided within the stipulated time frame. The ethics committee approved the utilization of the HIV/AIDS data for this research purpose on the 30th of March, 2007 (Appendix 1). The committee also placed restrictions on the information by prohibiting the publication of the un-manipulated data and/or insinuating any individual's identity as being infected with HIV/AIDS.

The second dataset used in the study was obtained from the Statistics Department of South Africa (STATS SA). The data comprised of the population size per municipality in Gauteng and the socio-economic status of Gauteng residents. The socio-economic data is based on the Departments' Annual Labor survey, and the General Household surveys. The annual Labour Source Survey (LSS) is conducted nationally around the month of September and is currently the most reliable and only available data in any part of the country, on the economic condition of Gauteng residents.

The General Household Survey (GHS) is also conducted nationally around the months of September and October. It is the most reliable data on the socio-condition of Gauteng residents. The Department of Statistics, on the request of the researcher provided the LSS and GHS data in Municipal summaries for Gauteng. The LSS and GHS data were obtained from STATS SA in March 2006 and are available in the public domain, thus no clearance is required for their utilization. However, they are copyrighted and must be utilized within the confines of the copyright laws.

3.2   The Research design

The research has been designed in a manner where by the research process would ultimately lead to the research objective. The quantitative approach was selected as the primary method which would be used to analyze the secondary data collected. This is a recommended method for analyzing large numerical data, and is thus the reason for selecting it as the primary research methodology.

The type of data being utilized for the study is numerical in nature. The numerical data was collected on the three sets of information required:

- HIV/AIDS sero-prevalence data,
- Socio-economic data (Labor data & deprivation data); and
- Population statistics.

The data as mentioned earlier in the chapter is collected from the Departments of Health of Gauteng and Central Statistics Office respectively. The data collected was analyzed by means of statistical techniques as well as by means of geographical information systems whilst the research findings are interpreted and evaluated by quantitative mathematical and statistical tests.

The research type was mainly co-relational, that is the research was designed to analyze the relationship between HIV/AIDS prevalence in Gauteng and the spatial attributes of each selected municipality studied. The spatial attributes in terms of the socio-economic status of Gauteng residents (i.e. poverty determined from the labour data and socio-condition from the household data), the population distribution as well as the proximity between areas of high to low HIV endemicity.

The following variables were correlated; HIV/AIDS prevalence to poverty, population distribution and proximity/distance. The research does not attempt to show the bi-causal relationships between the distribution of HIV in Gauteng and the spatial environment; however it attempts to show the distribution of HIV/AIDS in Gauteng within the spatial environment of Gauteng, and by so doing provide a clearer picture on the HIV epidemic from the spatial perspective.

The research methods used in order to correlate the relationship between the HIV/AIDS distribution and the spatial variables are statistical tests, measurements, scientific observations and the use of reliable documentation. The association between HIV sero-prevalence in specific areas of Gauteng and poverty, socio-condition, distance and proximity and population are tested using 2 sample T-tests.

The data used for the study was collected on selected district municipalities in Gauteng. The selection of these municipalities was determined by the proportional to size sampling method for the province as a whole. The selected municipalities in Gauteng represent the research areas in terms of the population clusters which provide a good spatial representation for the province. The sample size used per district municipality was determined by statistical calculations with approximately a 20% confidence level.

This confidence level was estimated by the researcher based on the Department of Health's 2004 HIV prevalence calculations. The months of September and October were selected as the study period because this is the period the two data sets were collected in the national surveys. According to previous Department of Health surveys the month of October was adopted based on the October Household surveys (OHS) annual research findings by Statistics South Africa (SSA) which reveals that the population of South Africa tends to be more stable in terms of mobility during the month of October (Statistics South Africa, 1997).

The study data was collected on the data sets aforementioned by means of documentation and archival examinations. In this study, the researcher reviewed all the documented raw data collated by the Department of Health's information services department for the 2005 sentinel survey. The data is then organized on Excel tables as frequencies and percentages. From this initial organization, frequency charts are plotted to reduce the data size. The data is displayed in the form of graphs, charts, and spatial maps. A set of spatial variables is also collected from existing summaries from the Department of Statistics. These include:

- population summaries per district municipality
- poverty rates per district municipality (in terms of employment/ unemployment/ economically inactivity) and
- poverty rates per district municipality (in terms of deprivation: access to sanitation and basic amenities).

The spatial variables collected were reduced and displayed in the form of graphs, charts, and spatial maps. The research data was then analyzed by means of bi-variate correlations and the associations tested using the 2-sample T test. This method was selected because of the co relational dimension of the data; where two or more variables are analyzed in order to determine possible relationships (Rossiter, 2006).

3.2.1   HIV/AIDS data

The HIV/AIDS data comprises of numerical information covering sixteen different headings:
- the lab number;
- name (number coded names only; the names starts with number one);
- the ward, clinic location,
- patient ID (not disclosed);
- the age;
- race;
- sex;
- test date;
- region;
- district;
- clinic name;
- HIV status;
- four coded information representing the presence of syphilis and other sexually transmitted diseases;
- the gestation period and the volunteer's pregnancy number (number of previous births).

The total number of volunteers used for the study in Gauteng by the Department of Health was three thousand one hundred and seven (3,107). This was collected from approximately seventy four (74) clinics from the six (6) municipalities of Gauteng. The information required for the study comprised of two (2) headings: the clinic location where the volunteer was monitored and the HIV status of the volunteer.

The clinic where the volunteer attended was used as the area where the volunteer lived permanently. According to the Department of Health's clinic policy, pregnant women are required to attend antenatal and any other health issue at a clinic within the catchments area determined by their area of permanent residence (Randburg Clinic General Enquires, 2006). The HIV status of each of the clinic volunteers was also collected in order to establish the HIV prevalence within each of the specified locations.

3.2.2   Socio-economic data

The socio-economic data used for this research are the Labour Source Survey and the General Household data respectively (LSS & GHS), obtained from Statistics South Africa. The LSS & GHS are annual household surveys conducted by collecting detailed information on the labour market and the household living situation in South Africa. This includes approximately 69,000 adults of working age (15-65 years) living in 30,000 households across the country. The data comprises of numerical information collected on the South African labour force and house holds bi-annually and annually. This research utilized the LSS and the GHS data survey conducted in September/October 2005.

The LSS data consists of Labour Supply statistics, Labour Supply in South Africa, Unemployment in South Africa, Informal Sector Economics, Formal Sector Economics, The Labour Market in September 2005 (Unemployment and other rates) and Employment patterns in September 2005 (Employment by industry, employment by occupation, Employment in the formal and informal sectors), comparison of formal employment figures and unemployment patterns in September 2005 (Provincial employment/ unemployment rates, unemployment by population group and discouraged work –seekers, economically in-active). The information required is on the Gauteng province; hence the provincial employment/unemployment data and the economically inactive population data are the only information captured.

The GHS data comprises of numerical data which shows the levels of deprivation in Gauteng. Eight variables are utilized: access to energy for cooking; energy for lighting; refuse removal; clean portable water; education; energy for heating; medical aid cover and sanitation. These represent the socio-condition of Gauteng residents per municipality for 2005.

3.2.3 Population data

The population data used in this study is based on the 2001 census figures. The data is broken down into 6 district municipalities, 15 local municipalities, 165 main places and 2,222 sub-place names. From the 2001 population statistics, the population distribution for each district municipality, local municipality, main-place and sub-place are obtained. Due to the volume of the data, the Department of Health's Geographical Information Systems division assisted with the representation of the population data as a layer on the various GIS maps for the study.

Population size is used for the study rather than the population densities due to the fact that the study only required the general representation of the population of Gauteng and not the actual densities. Population size signifies the total number of people living in an area; in other words 'quantity' on the contrary, population density signifies the total number of people living per hectare in a specified area; that is the population size per hectare. The population size does not establish how densely or sparsely distributed the population is.

3.2.4 Data relationships

The study requires various data sets to be collected and analyzed. The data sets include the HIV-data, Socio-economic data and Population statistics. The data sets were not collected on the same sentinel population/people, the HIV sentinel data was collected on pregnant females only; whilst the socio-economic data covered both males and females. The variance in the data sets collected was minimized by the utilization of a confidence level which is derived mathematically; this is discussed later in the section. The study period for both the HIV and Socio-economic data sets coincides, as both data sets represented the 2005 September/October period.

3.2.5 Critique of the use of the various data sets

In research it is often advised to collect primary data. This is also a lot more beneficial when carrying out a qualitative research. In quantitative research studies, collecting primary data, testing and manipulating can be quite expensive and time consuming. Although some argue that primary data is better, having considered the strengths and weaknesses of the secondary data required for this study, (Table 3.1), in addition to the secondary data being the only reliable data available, the researcher concludes that the secondary data is the most suitable data required in order to achieve the research objective. The tables below show the strengths, weaknesses and further reasons for accepting the secondary data's; the HIV/AIDS data obtained from the Department of Health (Table 3.2) and the Labor Surveys (LSS) and General House Hold Surveys (GHS) obtained from Stats SA respectively (Table 3.3).

Table 3.1: The Strengths and Weaknesses of Secondary Data (Flowerdew, et al, 1997:59).

S/N	Strengths	Weaknesses
1	It exists and so it is cheaper and quicker to obtain than primary data	It is inflexible hence you cannot customize it to suit your needs
2	It provides the solo researcher with unrivaled contextual material	It's quality is unverifiable since it is not replicable
3	It is usually of proven quality and reliability	It may cost money to obtain
4	Its scope in terms of the aspects of the topic which it illuminates may be impressive	It is a cultural artifact, produced by administrators with priorities and ways of seeing the world which may be different from those who underpin the dissertation

Table 3.2: Reasons for accepting the validity of secondary HIV/AIDS data.

HIV/AIDS Data	Reasons For Acceptance
The HIV/AIDS data is being collected by Country's National Department of Health	The data required need not be tailor made to suit the research, as the research focus is not to determine the prevalence of HIV/AIDS in Gauteng but to represent it in spatial terms
There are set protocols to ensure that international standards are maintained	The set protocols further assured the researcher that the data being collected is of top quality and of international standard
The infrastructure is in place and supports the collection of unmatched quantity of blood samples from pregnant women all over the country	The research would have cost the researcher an unbearable amount of money as the cost of collecting blood samples, storing and transporting it is definitely huge. In addition, the cost of hiring, training and equipping the research assistants is huge
The time taken to collect the blood specimen from some thousands of patients in Gauteng alone was more realistic due to the availability of the required infrastructure	The research would have spanned into years due to the logistics, an unrealistic time frame would have been required to collect the data
	The alternative would have been to render questionnaires: a number of disadvantages surfaced here: • The sensitivity of the required information may cause the respondents to falsify information • The data required was for the month of October, so the researcher would have had to collect for another period or wait till that time of the year • The language and communication barrier • The logistics required to cover the whole of Gauteng • The cost implications: transport and perhaps payment of interviewers used

Table 3.3: Reasons for accepting secondary LSS & GHS data.

LSS & GHS Data	Reasons For Acceptance
The OHS and LSS data is being collected by the Country's Department of Statistics Annually	The data required need not be tailor made to suit the research, as the data required is for correlational reasons alone
They are the national body responsible for several other surveys including the National Census.	The department being the recognized instrument for most National surveys in South Africa assured the researcher that the data being collected is of top quality and of international standard
The infrastructure is in place and supports the collection of unmatched quantity of data from the residents	The research would have cost the researcher an unbearable amount of money.
The costs of these surveys is definitely huge	The cost of hiring, training and equipping the research assistants is huge
The time taken to obtain data from each of the thousands of Households surveyed and the labor force is huge	The research would have spanned into years due to the logistics, an unrealistic time frame would have been required to collect the data
	The alternative would have been to render questionnaires: a number of disadvantages surfaced here: • The sensitivity of the required information may cause the respondents to falsify information • Access to the respondents home may not be possible • The data required was for the month of October, so the researcher would have had to collect for another period or wait till that time of the year • The language and communication barrier • The logistics required to cover the whole of Gauteng • The cost implications: transport and perhaps payment of interviewers used

3.3   Sampling methodology for the study

Probability sampling is essential in statistical surveys as it assists in estimating how closely the results of a survey will reflect the views of the whole population. The methods considered for this study include: random sampling, cluster sampling and the Probability Proportional to Size (PPS) sampling methods. Random sampling has strength in that it avoids the pitfalls associated with convenience or purposeful sampling processes by limiting systematic bias. That does not mean that a random sample will necessarily accurately reflect the views of the population as a whole. Any sample selected in research will differ from the population in some unknown ways; however it will not be a systematic bias. The cluster sample on the other hand, is used when the population is widely dispersed and/or expensive to locate and survey. The most common use of clustering is in national samples.

The PPS sampling technique is commonly used in multi-stage cluster sampling, in which the probability that a particular sampling unit will be selected in the sample is proportional to some known variable for example, in a population survey, the population size of the sampling unit.

The PPS sampling method is used in this research in conjunction with the cluster sample, because the populations of sampling units varies in size, in addition the sampling units are selected with equal probability and the likelihood of elements from a sampling unit with a large population being selected for the survey is less than the likelihood of elements from a sampling unit with a small population being selected. The systematic random cluster sample design is used with proportional probabilities size (PPS) where each municipality represents a primary sampling unit or cluster. (Centers for disease control and prevention, 2004).

3.4 Sampling Size and Duration of Sampling

To provide estimates which are reasonably accurate, the standard statistical approach requires that the number of specimens used be proportional to the size of the population. The DOH recommends the following sample size at a provincial level:

Table 3.4: Proposed sample size by province for the annual antenatal HIV sero-prevalence survey based on the 1996 census (Department of Health, 2004(a)).

Province	Population Estimate (in Thousands)	Proportional sample size	Proposed sample size
Kwa-Zulu Natal	7 672	3 648	3 500
Gauteng	7 171	3 409	3 500
Eastern Cape	5 865	2 789	2 500
Northern Province	4 128	1 963	2 000
Western Cape	4 118	1 958	2 000
North West	3 043	1 447	1 500
Mpumalanga	2 646	1 258	1 200
Free State	2 470	1 174	1 200
Northern Cape	7 46	354	600
Total	37 859	18 000	18 000

3.4.1 The sampling size utilized for Gauteng

In order to determine the sampling size required on a municipal level, a confidence level of 20% is used. The sampling size is estimated in the following manner:

Let the true proportion of HIV positive women be   P

Let the sample size be   n

Let the % error level be c

c =   0.2

$\hat{P} \sim N \ (P, P(1-P)/n)$

$1.96 \times 2 \times \sqrt{P(1-P)/n}$

$= P \times c$

$(1.96 \times 2)^2 \times P(1-P)/n$

$= P^2 \ c^2$

.: $n = (1.96 \times 2)^2 \times P(1-P)/P^2 \ c^2$

       $= (1.96 \times 2)^2 \times (1-P)/P \ c^2$

=   896 . 373

3.4.2 The proportion to population size sampling technique

The proportion to population size sampling technique is used to determine the municipalities to be selected as the study areas.

The PPS sampling method is used to sample the large sets of population data. It ensures a reasonable representation of samples is obtained from the entire Gauteng province.

3.4.3 Method for PPS Cluster Sampling

The main steps followed by the researcher in the PPS Sampling include:

Creating a list of clusters with cumulative population size and range. Selecting a systematic sample from a random sample (using a sampling interval). Selecting elements within the cluster and choosing the population clusters for Gauteng.

In order to create a list of clusters with a cumulative population size, the 12 municipalities of Gauteng are listed with their population size (Table 3.5) (column 2). For effective PPS sampling, the municipalities are listed randomly. This is done by listing the 12 municipalities in alphabetical order. The cumulative population size (column 3) is then created by adding the population of the current cluster to the population of all the previous clusters in the cumulative list.

Table 3.5: Cumulative population size for Gauteng - metropolitan municipalities and district municipalities (Data obtained from Statistics South Africa, (2001).

Municipality	Population Size	Cumulative population size
Ekurhuleni Metropolitan Municipality	2480277	2480277
Johannesburg: City of Johannesburg Metropolitan Municipality	3225812	5706089
Pretoria: City of Tshwane Metropolitan Municipality	1527023	7233112
Metsweding District Municipality	126436	7359548
Sedibeng District Municipality	794605	8154153
West Rand District Municipality	683025	8837178

3.4.4 Selecting a systematic sample from a random sample

In order to select a Systematic Sample from a Random sample, the starting point is to determine the sampling interval for the population. The sampling interval is a standard distance by which elements are selected in the sample. The sampling interval is obtained by dividing the total cumulative population size by the number of clusters to be selected. The total cumulative population size for this study is 8837178. The number of clusters to be selected is twelve representing the 12 municipalities in Gauteng (Table 3.6).

Table 3.6: How to obtain a sampling interval

Total Cumulative population size	÷	Number of clusters	=	Sampling interval
8837178		12		736431.5 *736432 (*rounded to nearest whole number)

A random number between 1 and the sampling interval had to be chosen. For the survey the random number is easily selected by means of an interval generator.

Random Number =   509244 (Centers for disease control and prevention, 2004)

Looking at the cumulative population list, the cluster in which the random number falls is chosen. Another column is then added to the table showing the cumulative population range. This makes it easier to find the cluster in which the number falls (Table 3.7).

Table 3.7: Cumulative population range for Gauteng-metropolitan municipalities and district municipalities

Municipality	Population Size	Cumulative population size	Cumulative population Range
Ekurhuleni metropolitan Municipality	2480277	2480277	1 - 2480277
Johannesburg Metropolitan Municipality	3225812	5706089	2480278 - 5706089
Pretoria: City of Tshwane Metropolitan Municipality	1527023	7233112	5706090 - 7233112
Metsweding District Municipality	126436	7359548	7233113 - 7359548
Sedibeng District Municipality	794605	8154153	7359549 - 8154153
West Rand District Municipality	683025	8837178	8154154 - 8837178

The random number will lie between 1 and 28,571, so either municipality 1 or municipality 2 is chosen as the first cluster. The rest of the clusters are obtained by adding the sampling interval to the initial random number; the resulting number is used to determine which municipality would be the next cluster (Table 3.8).

Table 3.8: Choosing Population Clusters for Gauteng.

Initial Random Number	+	Sampling Interval	=	Result
509244		736432		1245676

The rest of the clusters are chosen by adding the sampling interval to the result obtained until all the clusters needed are obtained (Table 3.9).

Table 3.9: Population clusters for Gauteng- for 12 municipalities

Initial random number	Sampling interval	Result
509244	736432	1245676
		1982108
		2718540
		3454972
		4191404
		4927836
		5664268
		6400700
		7137132
		7873564
		8609996
		9346428

The population clusters are approximated for the 12 municipalities from the cumulative population range (Table 3.10).

Table 3.10: Population clusters approximated for Gauteng- for the selected 12 municipalities

Municipality	Population Size	Cumulative population range	Population clusters
Ekurhuleni Metropolitan Municipality	2480277	1 – 2480277	2
Johannesburg Metropolitan Municipality	3225812	2480278 - 5706089	4
Pretoria: City of Tshwane Metropolitan Municipality	1527023	5706090 – 7233112	2
Metsweding District Municipality	126436	7233113 – 7359548	1
Sedibeng District Municipality	794605	7359549 – 8154153	1
West Rand District Municipality	683025	8154154 – 8837178	2

3.4 Methods for data analysis

The statistical tests used for the study are calculated by means of Ms Excel program (Appendix 2). The sections below provide details on the calculation theory, determinants for measurement and the interpretation of the results.

3.5.1 Bi-variate analysis

Bi-variate analysis is used for the simultaneous analysis of two variables; in order to determine the empirical relationship between the two variables. In this research, bi-variate analysis is used to determine the association or relationship between each pair of variables; HIV/AIDS, poverty, population and the proximity between areas of the Gauteng environment (Table 3.11), details the level of measurement in order to answer the research questions.

Table 3.11:   Level of measurement of Nominal/Ordinal and Interval/ Ratio

Level of Measurement	IV: nominal/ordinal DV: nominal/ordinal	IV: nominal/ordinal DV: interval/ratio	IV: Interval/ratio (Nominal/Ordinal) DV: interval/ratio
Statistical Technique	Chi-Square	Difference of Means (T-test)	Regression
Null Hypothesis	$X^2 = 0$ No r/t b/t the vars	$Mean_1 = mean_2$ or $mean_1 - mean_2 = 0$	B = 0 (no slope) X & Y are not linearly correlated
Interpretation	$X^2 = \#$ if p-value < .05, must reject $H_O.$	$T = \#$ if p < .05, must reject $H_O.$	$T = \#$ if p < .05, must reject $H_O.$ R= "goodness of fit" and direction R^2 = explained variance

The test of statistical significance is used to determine the degree of confidence which was used in accepting or rejecting the hypothesis. The hypothesis is tested with the 2 sample T-test, this helps to determine if the two sets of different samples are different enough in some characteristic or aspect of their behavior; which means that some generalizations from the data samples can be made. Thus the populations from which the data samples are drawn are also different in their behavior or characteristic.

3.5.2   The Research questions

Bivariate analysis is used to analyze the research questions, from (Chapter 1, section 1.5.1), the research questions are as follows:

- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the population size of Gauteng?
- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the proximity of the area of high endemicity to the area of low endemicity?
- Is there a relationship between the distribution of HIV/AIDS in Gauteng and the socio-economic condition of Gauteng residents?

The 2 sample T-test is used to determine the associations between the variables and the research questions answered based values.

3.6   A review of the study area

Human geography in the past has been able to establish relationships between humans, their activities and the environment they live in. Various relationships, cycles, webs have been established over centuries of study and research. There have been different communicable disease outbreaks and epidemics in the history of mankind; the HIV/AIDS epidemic like the others at the time is now a major research concern. This research has attempted to give a more holistic perspective on the HIV epidemic with specific reference to Gauteng.

In Chapter one, the Gauteng area was reviewed with particular reference to the economy and population. In this section, the following factors would be reviewed in greater detail: the population dynamics, poverty and un-employment, access to basic amenities and the HIV/AIDS prevalence in Gauteng. These aspects of the Gauteng environment reviewed in this section provide a clearer view on the spatial context of this study.

3.6.1   The geography of Gauteng

The Gauteng environment consists of different layers which overlap, influence, interact and impact on each other. The different layers of the Gauteng environment include the; social, physical, economic and natural environments, they strongly influence one another either positively or negatively. A buoyant economy with low unemployment rates may be directly proportional to the preservation of the natural environment such as illegal tree felling; over exploitation of the environment and environmental degradation may in turn reduce. Similarly the way HIV/AIDS is represented may also be a direct reflection of the condition of the social and economic environments. In Gauteng the HIV/AIDS rates is about the third highest in the country; are there aspects of the environment; social, physical, economic and natural, which contribute to this representation?. Does the spatial distribution of the disease tell us anything about the general environment of Gauteng? As further investigation is conducted on the issues surrounding HIV/AIDS in Gauteng, the study attempts to evidence relationships between these factors.

3.6.2   Population dynamics of Gauteng

Gauteng is the most densely populated Province by far in South Africa, the last population figures for Province shows the population of Gauteng is approximately 8.8 million people (Statistics South Africa, 2001). The Gauteng Province is the fastest growing province and currently has a population growth rate of over 20% between the 1996 and 2001 censuses. This is also the largest population growth rate in South Africa; with a growth rate this high, Gauteng may soon have the largest population in any province, in South Africa.

The population density in Gauteng demonstrates that the highest densities of people in the province are found in and around the cities of Johannesburg and Pretoria. This concentration may be attributed to the constant in flux of job seekers and migrants.

Many of the low-income suburbs, such as Alexandra, Soweto, Tembisa and Mamelodi, are situated on the periphery of urban centers and in turn have population densities which denote overcrowding. (Statistics South Africa, 2001). The concentration of migrants in close proximity to residents of low income suburbs and informal settlements is the reason for the increased urban population density (Van Aardt, 2002). The demographics of Gauteng range (Table 3.12) from about 73.8% of the population which is of African heritage, 19.9% of Caucasian heritage, 3.8% Coloured, and 2.5% Asian (Gauteng Provincial Government ,2006).

Table 3.12: Percentage breakdown of the population by province and population group, 1996. (Statistics South Africa, 2001).

Province	African	Coloured	Indian	White	Total
Western Cape	22	56	1	21	100
Eastern Cape	86	8	0	5	100
Northern Cape	38	48	0	13	100
Free State	83	3	1	14	100
KwaZulu-Natal	83	1	9	6	100
North West	90	1	0	8	100
Gauteng	**71**	**4**	**2**	**23**	**100**
Mpumalanga	89	1	0	10	100
Limpopo	98	0	0	2	100
South Africa	**77**	**9**	**3**	**11**	**100**

Note:
Due to rounding, some rows may not add up to 100%. The old apartheid classification is still used to track development issues.

3.6.3   The socio-economic environment of Gauteng

The rapid growth rate in Gauteng is primarily due to mass urbanization. Urbanization in Gauteng has created economic opportunities which have in turn attracted more migrants than the Province is able to cater for. The increasing population densities have created various social challenges; for instance, the housing problems have given rise to informal settlements and squatter camps.

These areas are void of basic amenities such as portable water, electricity, and a decent environment. In addition, problems of transportation, heavy and overloaded roads which translate into traffic congestions and limited access to basic amenities such as health care, education and recreation. According to the (Gauteng Provincial Government, 2006), the urban portion of Gauteng comprising primarily of: the city of Johannesburg, Ekurhuleni (the East Rand) and Tshwane (Pretoria), will be a polycentric urban region with a projected population of some 14.6 million people by 2015, making it one of the largest cities in the world.

a   Unemployment rates in Gauteng

With populations this high the rates of unemployment in Gauteng have spiralled, the current rate being about 25.7%. The unemployment rates in Gauteng can also be linked to the increasing poverty in the Province. According to studies, the number of households living in poverty in Gauteng (defined as those households with an income of less than R1200 per month) increased by 8 % from 25 to 33 % from 1999 to 2000 (CASE, 2003). Poverty is closely associated with other socio-economic and environmental variables. The main variable is the Province's inability to absorb the constant influx of job seekers from other Provinces as well as informal migrant workers hence the provinces inability to provide access to basic amenities thus leading to deprivation.

The employment and the employment growth by sector for Gauteng reveals the Manufacturing, other producers and Community/Social services sectors accounted for 75% of Gauteng's employment in 2001. The Transport/Communication and Finance/Business Services sector recorded the highest employment growth during the same period. The Trade and Industry Strategy revealed an economy on an unsustainably low growth trajectory (average 1, 4% p.a. from 1985 to 1995). With unemployment levels steadily on the rise, labour absorption rates below 1% and the standard of living decreasing every year, the Gauteng province faces a potential increase in poverty. Whilst the Trade and Industry Strategy is coming up with plans on how to combat this problem the reality remains that the unemployment rate in Gauteng is on the increase (CASE, 2003).

The unemployment rate may have also translated into the rising trends of violence, crime and unrest within the province. The increase in crime could jeopardise the efforts being made on the prevention of HIV/AIDS through educating individuals to take initiative of their own health. The unemployment rates may also translate into despondency which many translate in adults turning to sex and alcohol for comfort. The need for sex is a basic human need providing satisfaction and can also provide a short lived escape; an individual emotionally battered by unemployment and poverty again may not take initiative of their own health and may not make the right decisions with regards to sex and HIV prevention (CASE, 2003).

b   *Access to basic amenities and household standards of living*

The development of informal settlements, squatter camps and shack housing is causing majority of the African Gauteng residents to live in conditions far below the basic standards of living. An estimated 24% of the approximately 2, 65 million Gauteng households live in informal dwellings. Between 1999 and 2001 there was an average annual increase of 2% in households living in informal dwellings.

Many of these informal settlements do not have the access to the basic amenities and services such as sanitation, safe drinking water and electricity, and these residents are usually the low-income group of the Economy.

The basic services and amenities required for proper survival such as health care facilities, education and recreation are not easily accessible to most residents of these settlements. Some 630 000 households do not have access to basic water supplies and 706 000 households to basic sanitation and an estimated 857 000 households are without electricity (Figure 3.1).

In addition a number of these informal settlements are situated on the peri-urban areas of Gauteng towns and cities far from employment opportunities (such as informal labour opportunities), adequate recreation facilities and other amenities (Statistics South Africa, 2001).

There have been some positive progress according to the Census, by 2001; approximately 90% of households had access to piped water (Figure 3.2) and 82% to a flush toilet (Figure 3.3). In 1999, 83% of all the households in Gauteng lived within 2 km of primary schools, 73% within the same proximity to secondary schools and 75% within 2 km of a clinic. About 89% have access to bus and train services. (Statistics South Africa, 2001).

The progress being made is commendable however; there is still a significant backlog in service provision, housing and public amenities. Access to basic amenities in Gauteng is an aspect of the social environment which may contribute to the spatial distribution of HIV/AIDS in Gauteng.

The research question addressing the possibility of a relationship between the spatial distribution of HIV/AIDS and the social environment of Gauteng, would hopefully reveal if indeed the spatial representation of HIV/AIDS is more concentrated in suburbs with informal settlements than in the more affluent suburbs. The relationship between the social environment of Gauteng and HIV in Gauteng would be represented in terms of deprivation; this representation should reveal the existing relationships if any, between the variables.

Figure 3.1: Gauteng Households Access to Electricity for Lighting in 2001
(Statistics South Africa, 2001).
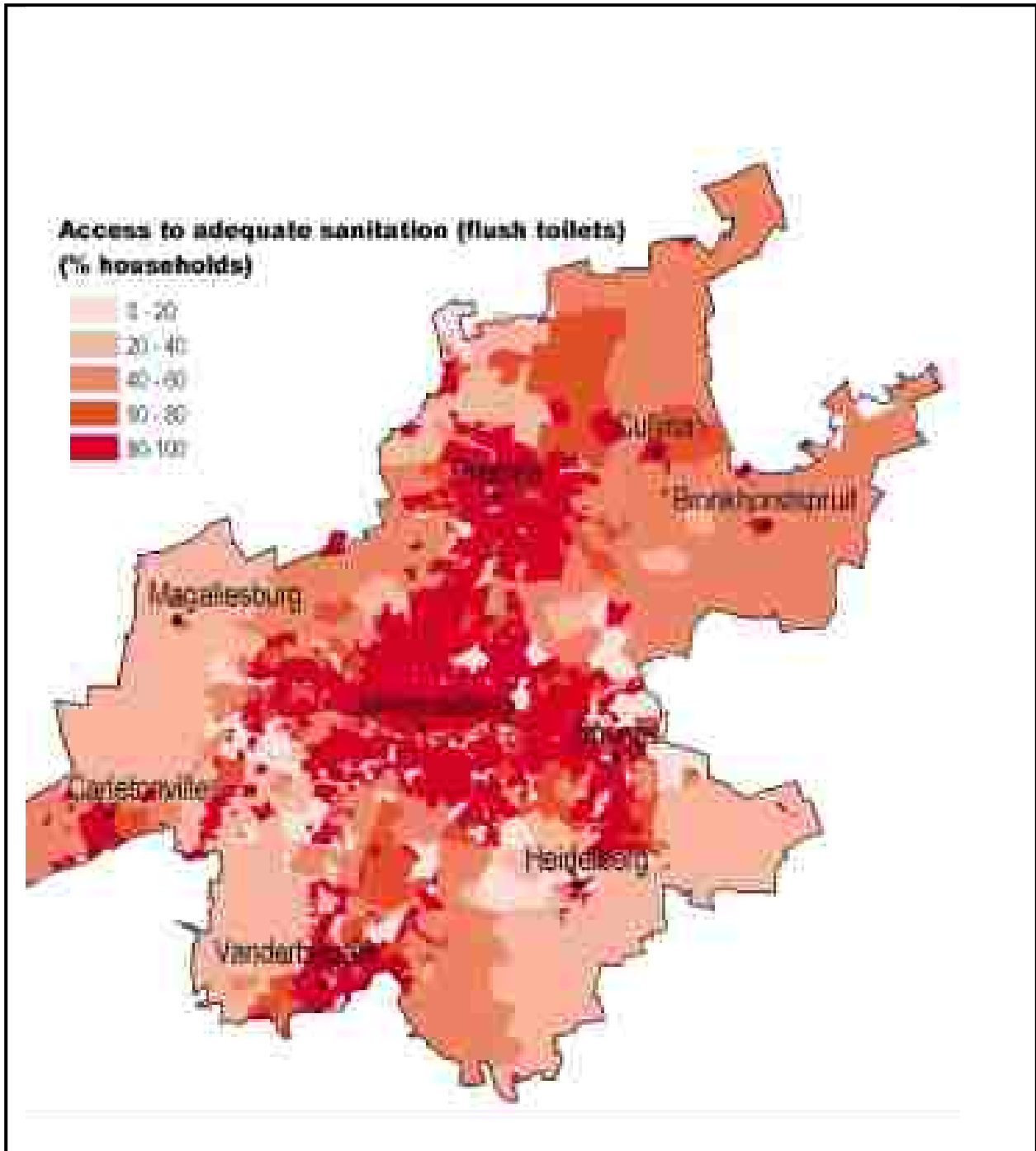
Figure 3.2: Gauteng household's access to adequate sanitation 2001
(Statistics South Africa, 2001).
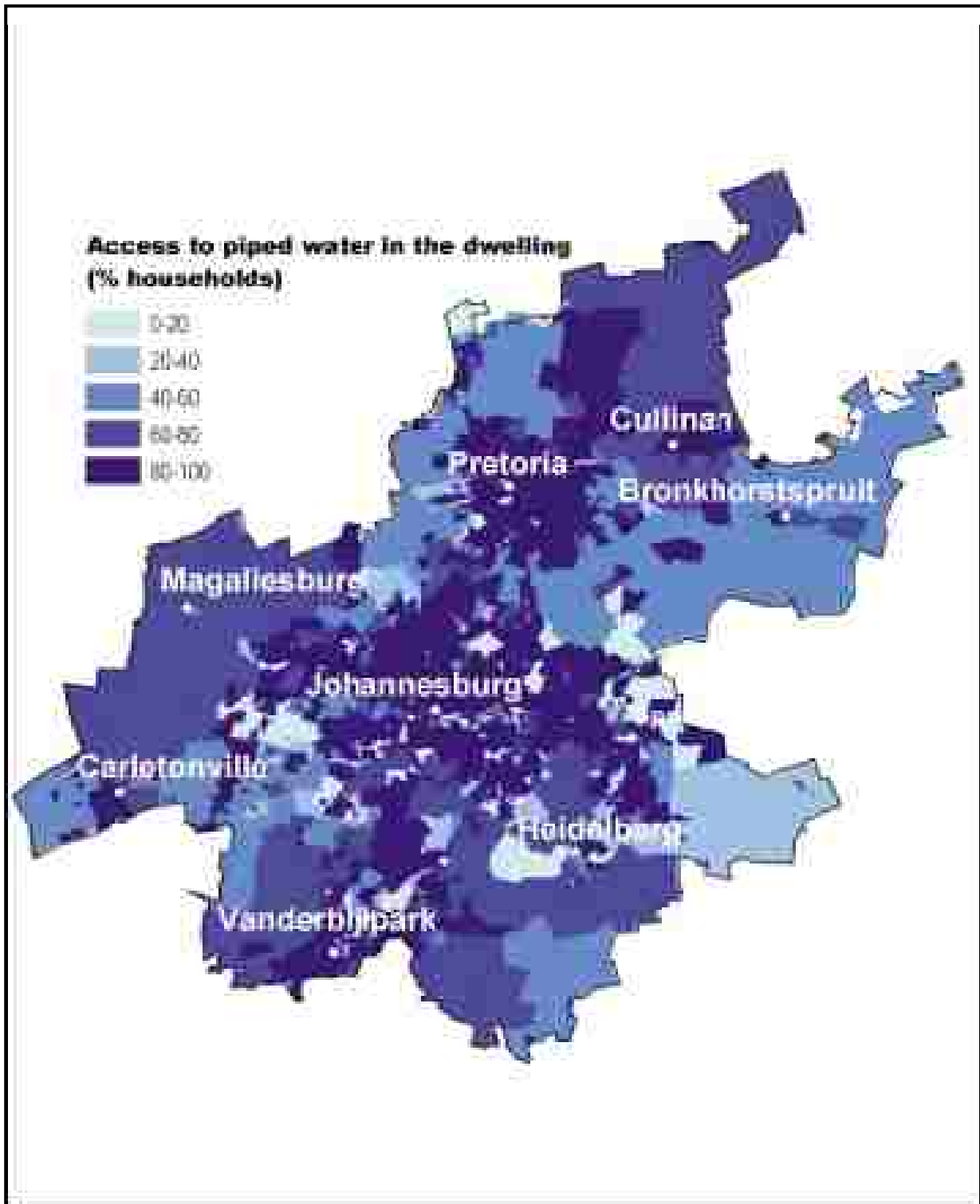
Figure 3.3: Gauteng household's access to portable water in 2001
(Statistics South Africa, 2001).

3.6.4 HIV/AIDS in Gauteng

In Gauteng, the health system also faces challenges due to the impact of migration. The private/public medical health care dispensation, legislative changes, retention of health professionals and developing appropriate service levels are a few of the major challenges being faced. The HIV/AIDS pandemic is proving to be one of the biggest challenges being faced by the health system. Health services are particularly challenged by the phase of the epidemic where more people are becoming sick with AIDS, anecdotal evidence from health service managers and providers suggest that up to 60% of hospital admissions to medical and paediatric wards are for HIV/AIDS related diseases leading to displacement of care for other illnesses. In addition, the October Household Survey found that the medically uninsured population increased from 60% to 73% between 1995 and 1999. Latest estimated census figures show an increase in the percentage uninsured to approximately 77%, these additional pressure are being put on the public health care system, which is the care provider for the majority of the population (Statistics South Africa, 2001).

In Gauteng, the HIV prevalence increased from 23.9% in 1995 to 29.8% in 2001, and the prevalence of HIV in Gauteng between 1995 and 2001 was higher than that of the country as a whole with about 5%. Various factors could have contributed to this representation; the increase in poverty and un-employment in Gauteng, the constant influx of migrants and the transient nature of the Gauteng population.

3.7   Conclusion

This chapter began by providing a recap on the purpose of the study. The research objectives were referred to with the aim of keeping the research purpose in view through out this chapter. Some of the key points noted were; other research focus, the significance of the current study and the ways in which the current survey differed from other studies on HIV/AIDS especially the Annual Sentinel Surveys of the Department of Health. The chapter proceeded to discuss the data sets required for the study; the HIV, poverty and population data's; the methods used to collect the data as well as the protocol followed before the data could be obtained.

The chapter then reported the methodology used for this study; the sampling methodology and the methodology for data analysis. The PPS and Cluster sampling methods were used to create the sampling clusters, based on the clusters, the HIV and population data's were obtained for the selected clusters (i.e. the municipalities and areas); these were then analyzed using the bi-variate analysis and the associations tested using 2 sample T-tests.

The final section of this chapter provided details on the Gauteng environment; the poverty, HIV/AIDS situation and the overall state of the municipality were discussed. One of the important issues reported were the high levels of un-employment and poverty which possibly resulted from the fast growing population in the Municipality. The population growth was also introduced and it was noted that the province experienced the highest rates of population increase and migration; all these factors ultimately had a role in the prevalence of HIV/AIDS in the municipality.

In conclusion, Chapter 4 provides the data analysis, interpretation and presentation. The HIV/AIDS data, poverty data, population data and proximity information are analyzed, subjected to statistical tests and the results displayed in the form of graphs, charts and GIS maps. The chapter concludes by accepting or rejecting the possibility of relationships between the variables based on the test results.

CHAPTER 4

RESEARCH ANALYSIS, PRESENATION, INTERPRETATION

4.1   INTRODUCTION

In Chapter 3, the purpose of the study, the research objectives and research questions were reviewed and used to introduce the study methodology. It was noted that although the study utilized secondary data collected from previous research by the Department of Health and Statistics South Africa respectively, it differed significantly from their surveys in its objective. The Department of Health's National Sentinel survey focuses on providing HIV prevalence data.

The data is extrapolated to plot the Geographical and temporal trends of the HIV/AIDS epidemic in Gauteng and the other Municipalities of South Africa. Furthermore it was noted that many research focus in recent time have been on various aspects of the HIV/AIDS epidemic; the diffusion of HIV/AIDS, migration and its role in the spread of HIV/AIDS, poverty, socio-economy and the spread of HIV/AIDS and more recent research focus being on vulnerability such as: the vulnerability of migrants, migrant labour and HIV/AIDS and vulnerability mapping.

The studies reviewed (Chapter 2), were usually carried out on a macro-scale; national, international and global. Finally on that note, previous studies usually represented the study findings in the form of graphs and charts.

Having noted this, the research focus was not to duplicate what has already been done neither was it aimed at carrying out an existing research focus in greater detail, from chapter 1, section 1.5.2, the study's aims include:

- Providing a more holistic picture on the HIV/AIDS epidemic by bringing the spatial aspects together with the HIV epidemic in the study area; Gauteng, by means of GIS maps. The spatial aspects were discussed in chapter 3, section 3.2, they include; the population distribution, the socio-economic situation and the proximity of the areas of Gauteng.

- Carrying out a micro-scale research. The research scope covered the Gauteng province and selected areas of the Municipality.

- Investigating the possible relationships between the spatial aspects and the HIV/AIDS epidemic in Gauteng. In order to establish the existence of relationships, from chapter 1, section 1.5.1, the research questions are as follows:

  o Is there a relationship between the distribution of HIV/AIDS in Gauteng and the population size of Gauteng?
  o Is there a relationship between the distribution of HIV/AIDS in Gauteng and the proximity of the area of high endemicity to the area of low endemicity?
  o Is there a relationship between the distribution of HIV/AIDS in Gauteng and the socio-economic condition of Gauteng residents?

This chapter will focus on the application and analysis of the methods and data described in chapter 3. The HIV/AIDS data, poverty data, population data and proximity information are analyzed, subjected to statistical tests and the results displayed in the form of graphs, charts and GIS maps. The chapter concludes by accepting or rejecting the possibility of relationships between the variables based on the test results.

4.2   Spatial mapping as a research tool in HIV/AIDS studies.

At the start of the study, it was noted that recent research focus has been on HIV/AIDS vulnerability. The mapping of HIV/AIDS vulnerability was also evidenced to be a growing tool being used in research; some of the studies available have been around the globe at national levels: programme coverage for female sex workers along major highways in Nepal (Family Health International, 2004); the mapping of Thailand's HIV prevalence from 1989-2002 (UNESCO, 2004); The location of HIV programme activities and hotspots in Myanmar (USAID, 2004); Mapping of Vulnerability, mobility & HIV prevalence in Guangxi, China (UNDP, 2003(b)); Mapping HIV vulnerability in Svay Rieng province, Cambodia (UNDP, 2000); Mapping HIV vulnerability, prevalence & population flow in Lao PDR (UNDP, 2003(a)).

Other research studies that used mapping as a tool, as reviewed in (Chapter 2, section 2.4.3), of the study include the spatial analysis and mapping of STD disease conducted in the Wake County (Law, et al, 2003); the spatial mapping of HIV/AIDS in Africa using exact geographic co-ordinates (Siegfried, et al, 2004); The use of a spatial information system in the management of HIV/AIDS in South Africa, (Busgeeth & Rivett, 2004) and the spatial patterns of HIV/AIDS and Tuberculosis within the African Continent, (Radkhoshnoud, 2002). These studies seem to be the only studies available utilizing spatial mapping as a research tool therefore making the current study a preliminary study utilizing spatial mapping as a tool to represent existing HIV/ AIDS data at a micro level in the Gauteng province.

The spatial maps being qualitative in nature would be analyzed in a descriptive manner in conjunction with the HIV/ AIDS data for Gauteng, summarized in the form of tables, graphs and charts. For more deductive interpretations, the research questions would be evaluated and the associations tested by means of the 2 sample-T-test.

4.2.1 Spatial mapping of HIV/AIDS in Gauteng

Four spatial maps are produced to show the spatial distribution of HIV/AIDS in Gauteng. The maps are produced by the South African Department of Health, using the Department of Health's HIV/AIDS data obtained from their Annual Sentinel Surveys of 2005, as summarized by the researcher.

The spatial maps are more descriptive than deductive in nature thus specific figures and interpretations cannot be obtained by means of the maps. The 2 sample T-statistical test is required and used to produce deductive results from the research data analysis.

4.2.2   The spatial distribution of HIV positive cases in Gauteng

The distribution of HIV positive cases in Gauteng is depicted in Figure 4.1 (page 79). This map comprises of 12 Local Municipalities of Gauteng. The HIV/AIDS positive cases data range, depicts that 0-3 percent of the total HIV positive cases were represented in that location, the rest of the data range is summarized in the table below (Table 4.1).

Table: 4.1. HIV/AIDS positive cases; map data range and actual data range.
(Data summarized by researcher using data obtained from the
South African Department of Health, (2006).

Data Range	Actual Range
0-3	0-3 percent of total HIV positive cases
3-8	3-8 percent of total HIV positive cases
8-12	8-12 percent of total HIV positive cases
12-16	12–16 percent of total HIV positive cases
16-23	16–23 percent of total HIV positive cases

From Figure 4.1, the prevalence of HIV positive cases in Gauteng in the spatial context revealed that the highest HIV positive cases were located in the following regions: Vlakfontein region; Meadowlands region; Diepkloof region; Vosloorus region and the Ventersport, Bekkersdal region. Although the highest HIV positive cases are represented in Figure 4.1, this does not represent the actual HIV prevalence figures but the highest data range on the map.

4.2.3   The spatial distribution of HIV negative cases in Gauteng

The distribution of HIV negative cases in Gauteng is depicted in Figure 4.2 (page 80). This map comprises of 12 Local Municipalities of Gauteng. The HIV/AIDS negative cases data range depicts that 0-5 percent of the total HIV negative cases were represented in that location the rest of the data range is shown in Table 4.2. From Figure 4.2**,** the highest HIV negative cases were in found in the following regions: Vlakfontein region, Meadowlands region, Diepkloof region and the Vosloorus regions respectively.

Table: 4.2 HIV/AIDS negative cases; map data range and actual data range.
Data summarized by researcher using the data obtained from the
South African Department of Health, (2006).

Data Range	Actual Range
0-5	0-5 percent of total HIV negative cases
5-15	3-8 percent of total HIV negative cases
15-22	8-12 percent of total HIV negative cases
22-30	12 – 16 percent of total HIV negative cases
30-52	16 – 23 percent of total HIV negative cases

4.2.4   The prevalence of HIV in Gauteng- spatially represented by means of the distribution of HIV positive and negative cases in Gauteng

The prevalence of HIV in Gauteng is spatially represented by means of the distribution of HIV positive and negative cases in Gauteng (Figure 4.3; page 81). The map comprises of 12 Local Municipalities of Gauteng. The HIV positive and HIV negative cases are super-imposed on the spatial maps. From the map, there is a close representation of both HIV positive and negative cases in the following areas: the Vosloorus, Diepkloof, Vlakfontein and Meadowlands areas respectively.

The high level of HIV positive and negative cases in all the areas above indicates a mid- range HIV prevalence in the areas. Mid- range from the data range as depicted in Tables 4.1 & 4.2 not being deductive, implies there are more HIV negative people in the area than positive, and the HIV prevalence for the areas is average.

In the Venterspost, Bekkersdal area however, there is relatively High representation of HIV positive cases and a low representation of HIV negative cases. From this data representation, the Venterspost, Bekkersdal area has the highest prevalence of HIV in Gauteng.

4.3   The prevalence of HIV in Gauteng, spatially represented and the population size of Gauteng

The population size of Gauteng represented in Figure 4.4(a)(page 82) & Figure 4.4 (b) (page 83) depicts the total size of population per municipality. The population size is highest in: Temba, Garankuwa, Soshanguwe, Tshwane and Nelmapius areas of the Tshwane Municipality and lowest in Vlakfontein, Ventersport Bekkersdal. The Vosloorus, Diepkloof and Meadowland areas have a mid-range population size.

The distribution of HIV when compared to the population size of the municipalities shows that the area with Highest HIV prevalence in Gauteng; the Ventersport Bekkersdal area had the lowest population size. The areas in Tshwane metropolitan municipality, which recorded the lowest HIV positive prevalence rates, had the largest population size. In addition, the Johannesburg and Ekurhuleni municipalities respectively had mid-range HIV prevalence and a low population size (Table 4.3).

In summary, from Figures 4.4(a), 4.4(b) & Table 4.3 and the descriptive interpretations thereof, there is no evident relationship between the prevalence of HIV in Gauteng and the population size of the municipalities.

Table 4.3: Population range in parts of Gauteng.
Data summarized by researcher from data obtained from
Statistics South Africa, (2001) & Department of Health, GIS department in 2006.

Region	Municipality	*Population Range	HIV positive population range
Ventersport Bekkersdal	Westonaria	0-421	16-23
Vlakfontein	Johannesburg	0-421	16-23
Vosloorus	Ekurhuleni	846-1305	16-23
Diepkloof	Johannesburg	846-1305	16-23
Meadowlands	Johannesburg	846-1305	16-23
Temba	Tshwane	2679-8092	3-8
Soshanguwe	Tshwane	2679-8092	3-8
Nelmapius	Tshwane	2679-8092	3-8

* Population here refers to the population size. Population size denotes the number of people in an area, in other words basic head count. Population density denotes the number of people per square hectare; that is the no of people per unit area and the concentration of the population.
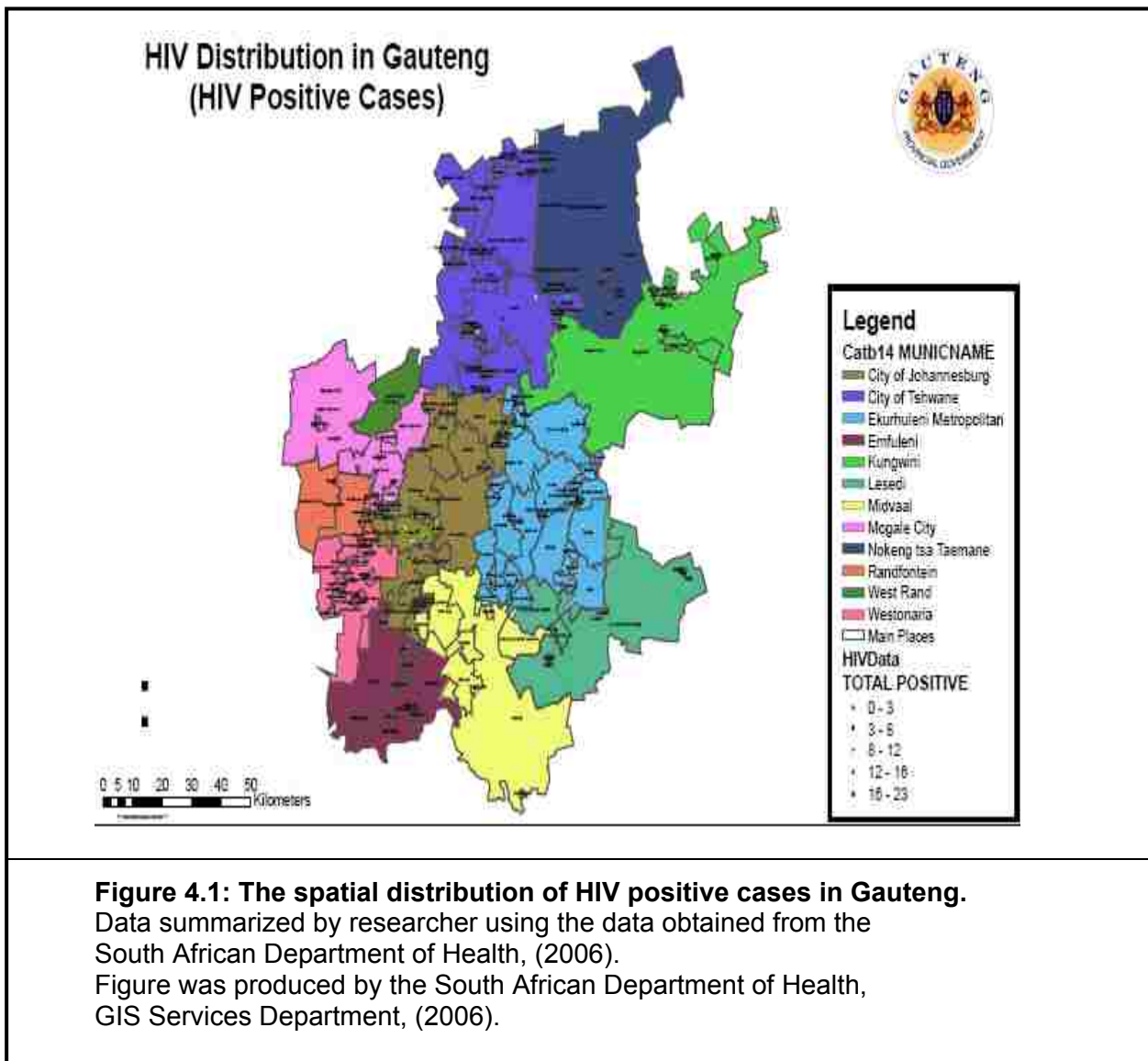
Figure 4.1: The spatial distribution of HIV positive cases in Gauteng.
Data summarized by researcher using the data obtained from the
South African Department of Health, (2006).
Figure was produced by the South African Department of Health,
GIS Services Department, (2006).
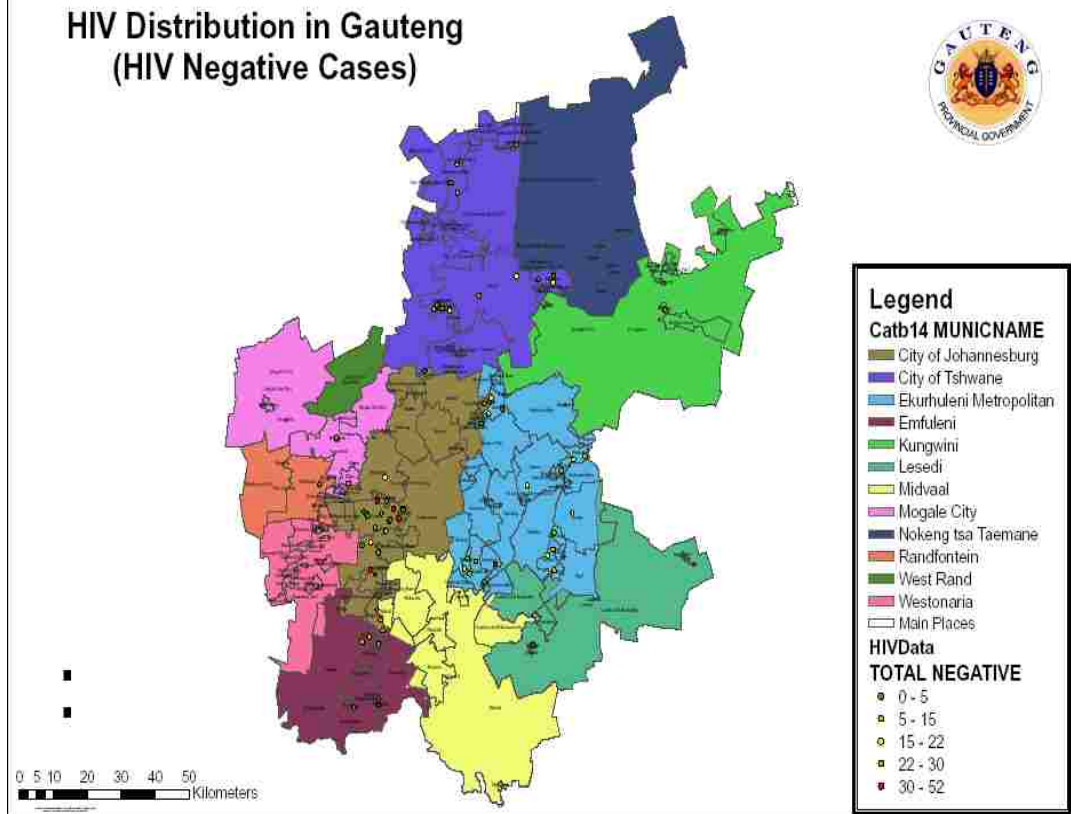
Figure 4.2: The spatial distribution of HIV negative cases in Gauteng.
Data summarized by researcher using the data obtained from the
South African Department of Health, (2006).
Figure was produced by the South African Department of Health,
GIS Services Department, (2006).
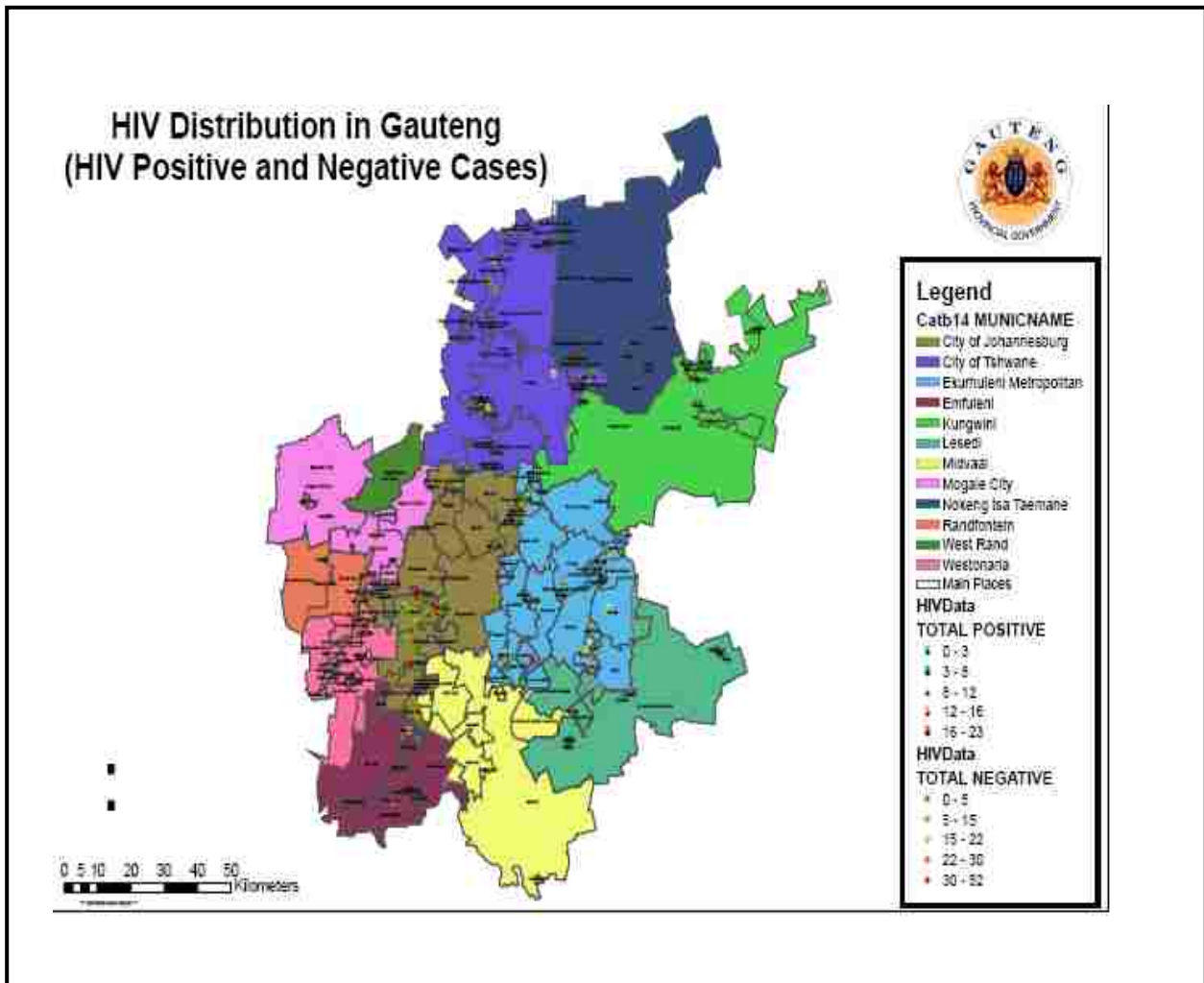
**Figure 4.3: The spatial distribution of HIV positive and HIV negative cases
in Gauteng.** Data summarized by researcher using the data obtained from
the South African Department of Health, (2006).
Figure was produced by the South African Department of Health,
GIS Services Department, (2006).
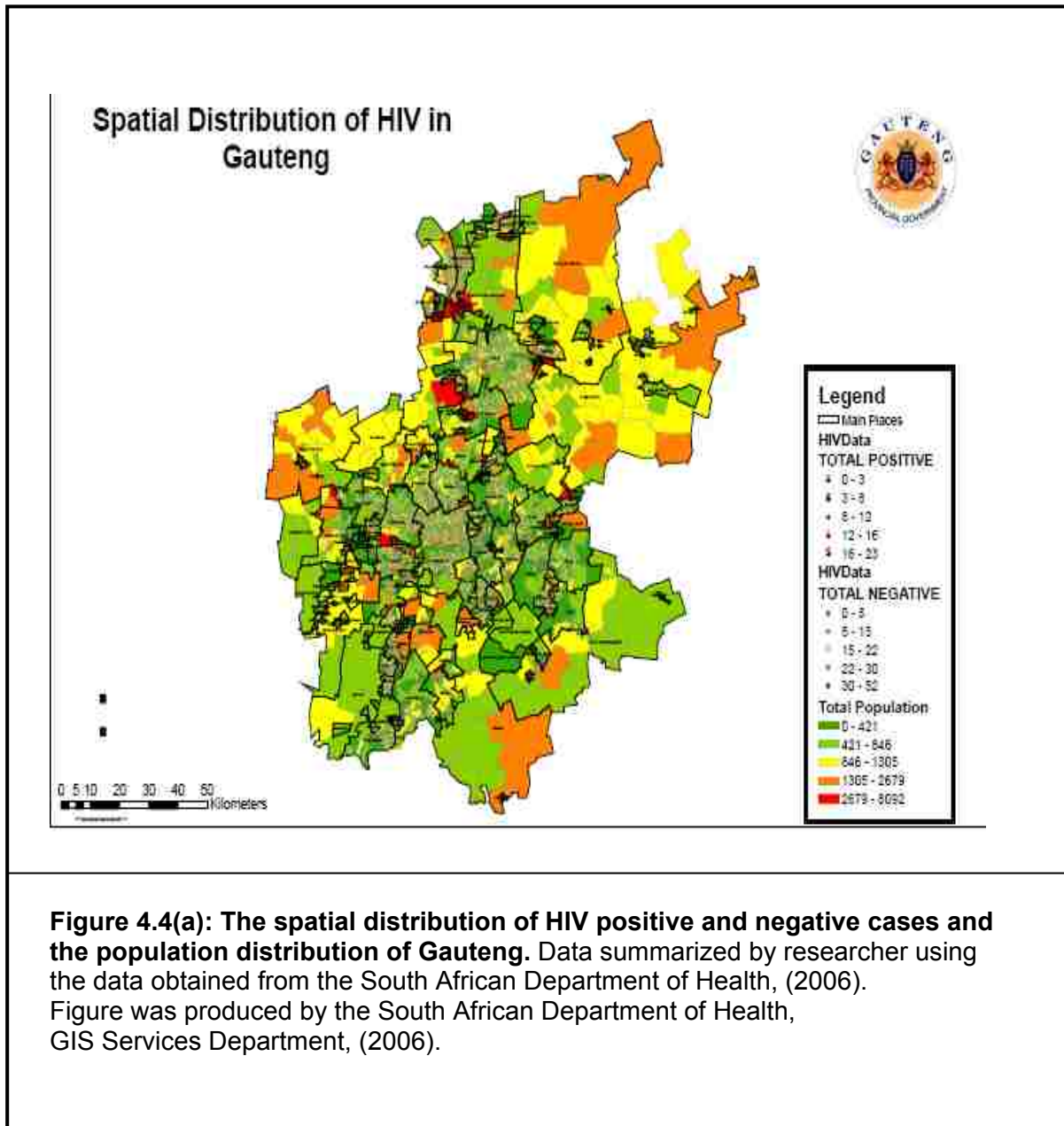
Figure 4.4(a): The spatial distribution of HIV positive and negative cases and the population distribution of Gauteng. Data summarized by researcher using the data obtained from the South African Department of Health, (2006). Figure was produced by the South African Department of Health, GIS Services Department, (2006).
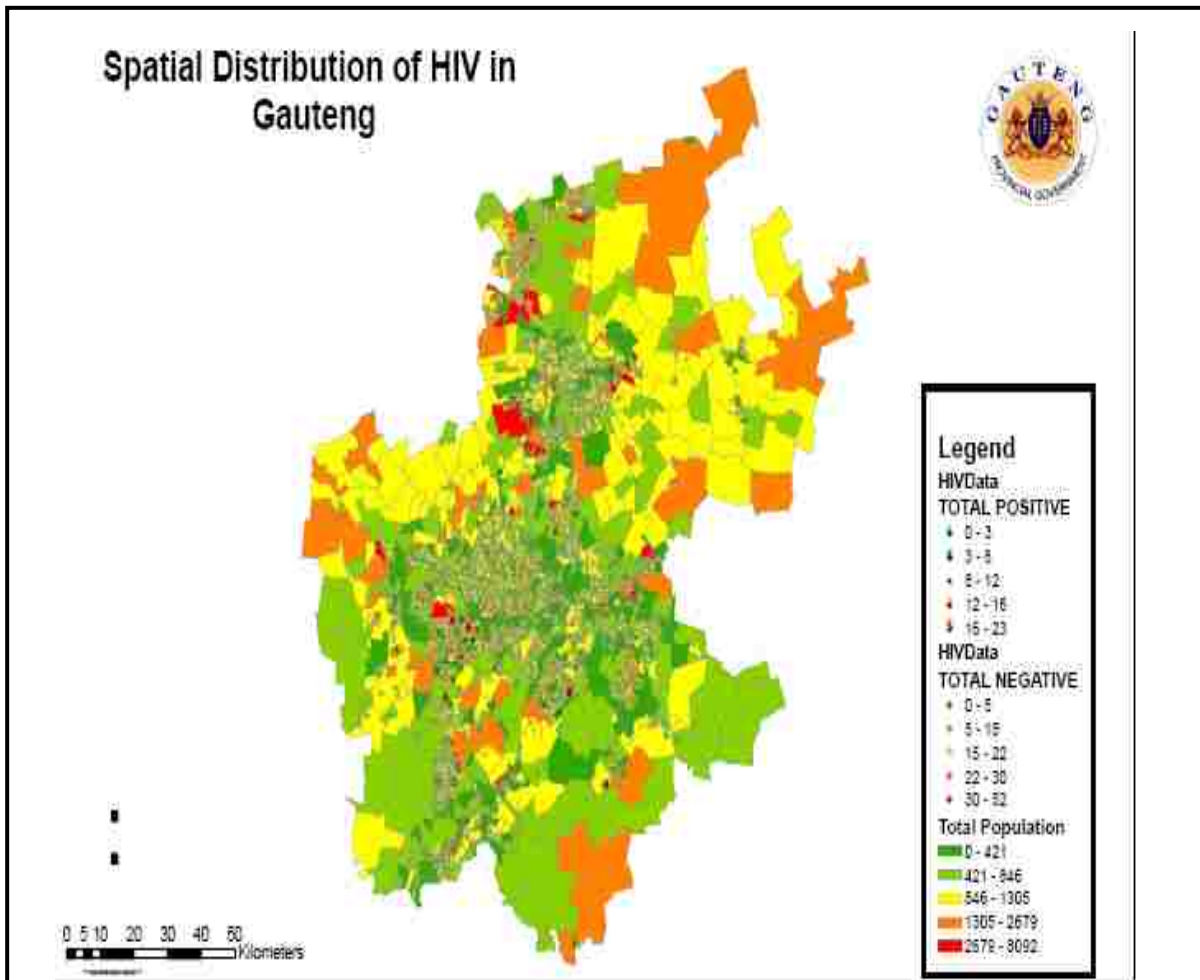
Figure 4.4(b): The spatial distribution of HIV positive and negative cases and the population distribution of Gauteng, (Map without geographic boundaries).
Data summarized by researcher using the data obtained from
the South African Department of Health, (2006).
Figure was produced by the South African Department of Health,
GIS Services Department, (2006).

4.4   The first research question and statistical testing

The first research question aims at providing a more holistic picture on the HIV/AIDS epidemic by bringing the spatial aspects of Gauteng together with the HIV epidemic in the area. The first spatial aspect considered is the population size. As mentioned above in section 4.3; Figures 4.4(a), 4.4(b) & Table 4.3, the municipality with the largest population size did not have the highest HIV prevalence, therefore leading to the descriptive interpretation that there is no evident relationship between the prevalence of HIV and the population size of the municipalities. The first research question is further statistically tested to verify the interpretations above.

4.4.1   Test of association

To determine the existence of an association between the prevalence of HIV and the spatial attribute; population size of the municipalities in Gauteng, a 2-sample T-test is performed (Appendix 3).

Under this T-test, unequal variances is considered and set at the 95% level of significance.

It is assumed that the number of HIV positive people in Gauteng is independent from the population size of each of the regions.

HIV positive versus the population size of Gauteng municipalities

The first research question states: is there a relationship between the spatial distribution of HIV/AIDS in Gauteng and the population size of Gauteng?

i)   Equal variance
Running a two sample T-test and assuming unequal variances at 95% significance level, the
P- Value = 0.3976667

This is greater than 0.05 hence in this study, it is accepted that there is no significant relationship between the spatial distribution of HIV in Gauteng and the population size of the municipalities.

ii)   Un-equal variance
Running a two sample T-test and assuming unequal variances at 95% significance level, the
P- Value = 0.4793292

From the tests done, there is no relationship between the spatial distribution of HIV in Gauteng and the population size of the Municipalities.

4.5 The spatial distribution of HIV and the proximity of the areas of high to low HIV endemicity

From Figures 4.1 & 4.2, the distance between the areas high HIV endemicity to low endemicity is descriptively analyzed. The spatial distribution of HIV positive cases from Figure 4.1 reveals no evident pattern as the HIV positive cases are notably sparsely distributed and proximity sporadically distributed between the locations.

Two areas are selected: the Ventersport Bekkersdal area, which has the highest prevalence of HIV in Gauteng and the Vlakfontein area, which is the closest area to the Ventersport Bekkersdal area in kilometers (km). The distance calculated and used is the geographic distance, however the road network, presence of rivers or mountains are not taken into account, thus the actual distance to travel from Ventersport Bekkersdal to Vlakfontein as well as the other areas, might be more or less than the calculations obtained.

The average distance between Vlakfontein region and each of the other areas is summarized in Table 4.4. Further interpretation of Figure 4.3 shows that the proximity between the areas of high to low HIV endemicity does not impact on the distribution of HIV in Gauteng. From Figure 4.3 & Table 4.5 Venterspost Bekkersdal with the highest prevalence of HIV is situated closest to the Vlakfontein region, which has a mid-range HIV prevalence level.

Table 4.4: Approximate distance between specific areas in Gauteng.

(Estimation of distance by the researcher)

From Vlakfontein* Region	To	Region	Municipality	Approximate distance between the areas in (km)**
Vlakfontein	to	Diepkloof	Johannesburg	48km
Vlakfontein	to	Meadowlands	Johannesburg	50.1
Vlakfontein	to	Ventersport Bekkersdal	Westonaria	53.3
Vlakfontein	to	Vosloorus	Ekurhuleni	107.3
Vlakfontein	to	Vlakfontein	Johannesburg	0

* Vlakfontein was randomly selected as the base point from which the distance to the other regions was obtained

** The distance is the Geographic distance, however the road network, presence of rivers or mountains were not taken into account; hence the actual distance to travel to the regions would be significantly more.

Table 4.5: Approximate distance between specific areas in Gauteng.
(Estimation of distance by the researcher)

From Ventersport Bekkersdal* Region	To	Region	Municipality	Approximate distance between the areas in (km)**
Ventersport Bekkersdal	to	Diepkloof	Johannesburg	65.2km
Ventersport Bekkersdal	to	Meadowlands	Johannesburg	56.1
Ventersport Bekkersdal	to	Vlakfontein	Johannesburg	53.3
Ventersport Bekkersdal	to	Vosloorus	Ekurhuleni	152.4
Ventersport Bekkersdal	to	Ventersport Bekkersdal	Westonaria	0

* Vlakfontein was randomly selected as the base point from which the distance to the other regions was obtained

** The distance is the Geographic distance, however the road network, presence of rivers or mountains were not taken into account; hence the actual distance to travel to the regions would be significantly more.

4.5.1 The second research question and statistical testing.

The second research question states:

Is there a relationship between the distribution of HIV/AIDS in Gauteng and the proximity of the areas of high endemicity to the areas of low endemicity?

The descriptive interpretations of the second research question (section 4.5) above is further statistically tested to determine the existence or non-existence of a relationship between the distribution of HIV and the proximity of the areas of high endemicity to the areas of low endemicity.

The two areas selected above are tested; the Ventersport Bekkersdal area, which has the highest HIV prevalence in Gauteng and the Vlakfontein area, which is the closest area to the Ventersport Bekkersdal area in kilometers (km).

4.5.2 Test of association

To determine the existence of an association between the highest rates of HIV positive population in Gauteng and the spatial attributes in terms of distance/proximity of the area, a 2-sample T-test is performed (Appendix 4).

Under this T-test, unequal variances are considered and set at the 95% level of significance. It is then assumed that the number of HIV positive people in Gauteng is independent from the distance between each of the regions.

HIV positive cases versus geographical closeness of the various areas

Association to be tested: Is there a significant relationship between the prevalence of HIV positive population in Ventersport Bekkersdal, Gauteng and its distance/proximity to Vlakfontein?

i)   Equal variance

Running a two sample T-test and assuming equal variances at 95% significance level, the

P- Value = 0.2254534

This is greater than 0.05 hence the study can accept that there is no relationship between the proximity of high HIV endemity to low HIV endimicity in Gauteng.

From the test done, there is no relationship between the closeness of Ventersport Bekkersdal, to Vlakfontein and the spatial distribution of HIV in the areas.

ii)   Un-equal variance

Running a two sample T-test and assuming unequal variances at 95% significance level, the

P- Value = 0.3333778

This is greater than 0.05, hence we can accept that there is no relationship between the highest prevalence of HIV positive people in Gauteng and the distance between the regions.

In Chapter 2, section 2.1.2, it was noted that population mobility contributes in the diffusion of HIV/AIDS. In Gauteng there is rapid population growth which is influenced by the constant influx of migrants. The Gauteng municipality also has the highest population size and growth rate in South Africa. Although HIV/AIDS is a communicable/transferable disease, it does not spread through air, water and touching an infected person; the majority of HIV new cases reveals HIV is transferred mainly through sexual means. Hence although there may be constant migration into and from the Gauteng province, there is no relationship between the spatial distribution of HIV in Gauteng and the proximity between the areas of high endemicity to the areas of low endemicity.

4.6   Graphical representation of the prevalence of HIV in Gauteng.

In addition to the spatial maps used to summarize the data, tables and graphs are used. The data tables and graphs presented in this section provide the same information presented by the spatial maps however in a different form. From Table 4.6 & Figures 4.5 & 4.6**,** the municipality with the highest HIV prevalence compared to the HIV negative prevalence is the West Rand municipality.

This is followed by the Sedibeng municipality which has the second highest. On the other hand, the lowest HIV prevalence recorded for Gauteng is in the Tshwane municipality followed by the Johannesburg municipality, which is however significantly higher than Tshwane when the figures are compared.

Table 4.6: HIV Percentages per district in Gauteng. Data obtained from the South African Department of Health: Annual Sentinel Survey (2005).
(Calculations by researcher)

Place	Neg (-)	Pos (+)	Total	Place	% Neg (-)	% Pos (+)
Johannesburg	446	213	659	Johannesburg	67.67	32.32
Ekurhuleni	354	219	573	Ekurhuleni	61.78	38.21
Sedibeng	76	52	128	Sedibeng	59.37	40.62
Tshwane	258	90	348	Tshwane	74.13	25.86
West Rand	79	72	151	West Rand	52.31	47.68
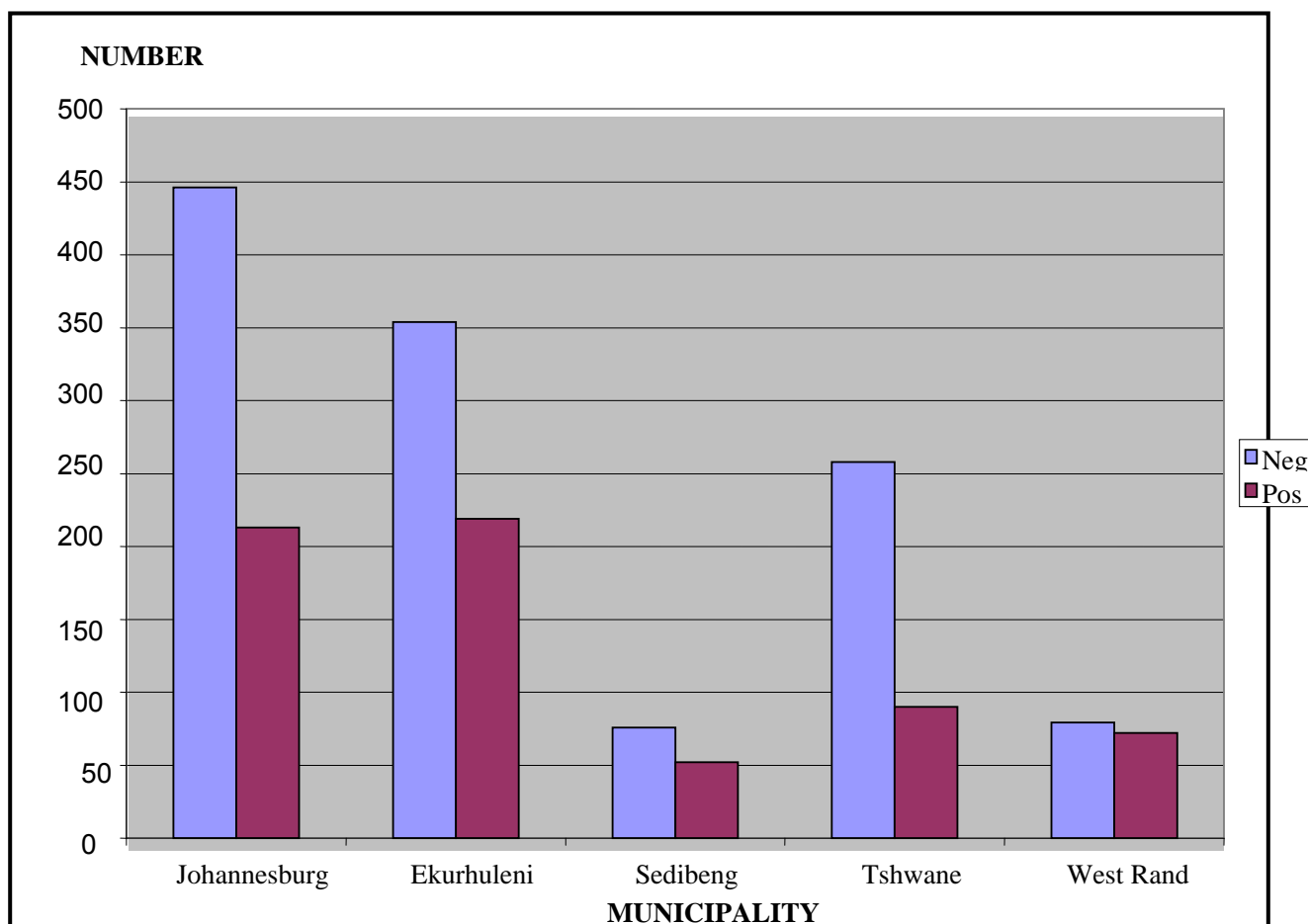
Figure 4.5: HIV prevalence per municipality in Gauteng.

Analyzed by researcher from data from the Department of Health antenatal survey (2005).

Figure 4.6: Percentage HIV prevalence per municipality in Gauteng.
Analyzed by researcher from data from the Department of Health antenatal survey (2005).
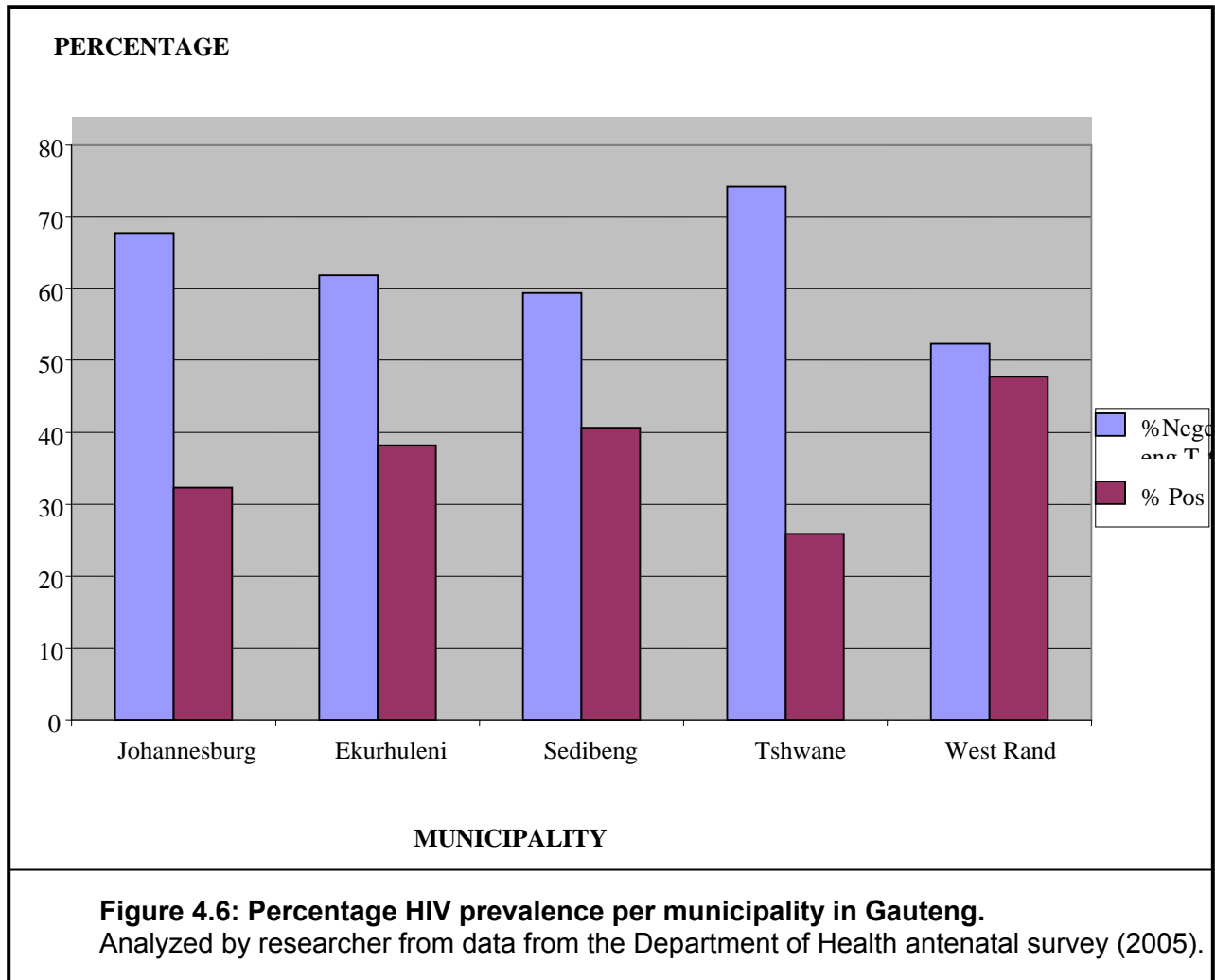
4.7 The distribution of HIV in Gauteng and the poverty level

In chapter 2 section 2.3.1, various studies were reviewed which have linked the prevalence of HIV/AIDS to poverty. Poverty increases vulnerability and reduces an individual's ability to make the right behavioral choices. Women living in conditions of poverty are particularly vulnerable to the disease as they often turn to the option of trading sex for income.

In Gauteng, the Department of Statistics carries out annual labour source surveys which primarily locate the industrial sector accounting for the employment of the population. In this study the level of poverty is determined from the employment and un-employment levels.

The Department of Statistics also carries out General Household Surveys which provide indices to determine the standard of living in households in the country. The indications of employment and the standard of living provide the socio-economic levels for the province. The rates of employment and unemployment can be directly linked to the level of poverty.

Unemployment often translates into populations turning towards drugs, crime and sex to fill in for idle time. In chapter 2 section 2.3.2, poverty is defined as 'the lack of the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or at least widely encouraged or approved in the societies in which people belong' (Townsend, 1979:31).

Conversely deprivation is defined as "the lack of the types of diet, clothing, housing, household facilities and fuel and environmental, educational, working and social conditions, activities and facilities which people are customary to" (Townsend, 1987:131 & 140). Using employment or 'the availability of resources to people' as a criteria to determine poverty has been argued to be subjective, such arguments suggest multiple indices be used to determine poverty (African National Congress, 1994 & Statistics South Africa, 2000:54).

The level of poverty in Gauteng in the current study is therefore considered and expressed in the form of employment and unemployment in the Gauteng province. Later in the chapter poverty in Gauteng, expressed in terms of deprivation using the indices as obtained from Statistics South Africa is analyzed.

4.7.1 The implications of the prevalence of HIV and the poverty level in Gauteng expressed in terms of employment and access to basic amenities.

The rates of employment/unemployment and HIV positive and negative cases is summarized and discussed in this section. The following figures and discussions provide a clearer indication as to existence or non-existence of a relationship between the variables. In the study a number of assumptions are made in order to achieve the set objective. The employed population represents the population of Gauteng not living in poverty.

The unemployed, economically inactive, and a combination of the two represent the population of Gauteng living in poverty. In addition, the HIV prevalence data is used to represent the prevalence of HIV in the general population; although in reality the prevalence in the actual population is usually slightly higher (DOH Protocol, 2004(a)).

The municipality with the highest un-employment rate is the Ekurhuleni municipality. The combination of unemployment and not economically active population gives an indication of the population in Gauteng living in poverty*.

The highest unemployment and not economically active population rate is recorded in the Sedibeng Municipality (Tables 4.7, 4.8 and Figures 4.7, 4.8, 4.9, 4.10, 4.11).

Table 4.7: Employment status per Municipality in Gauteng. Data obtained from Statistics South Africa, 2001 (Calculations by researcher).

Municipality	Employed	Unemployed	Not economically active
Metsweding District Municipality	46600	15146	28822
West Rand District Municipality	243968	116409	143232
Sedibeng District Municipality	198813	155429	204959
East Rand: Ekurhuleni Metropolitan Municipality	761048	516011	514444
City of Johannesburg Metropolitan Municipality	1085546	647039	640059
City of Tshwane Metropolitan Municipality	558802	209578	346149

Table 4.8: Percentage Employment Status per municipality in Gauteng.
Analyzed by researcher from data from Statistics South Africa, (2001).

Municipality	Percentage employed	Percentage unemployed	Percentage not economically active	Percentage un-employed/not economically active
Metsweding District	51.4530519	16.72334599	31.82360216	48.54694815
West Rand District	48.4439317	23.11495625	28.44111205	51.5560683
Sedibeng District	35.553048	27.79483585	36.65211614	64.44695199
Ekurhuleni Metropolilitan	42.4809783	28.8032451	28.71577664	57.51902174
Johannesburg Metropolitan	45.7525866	27.2708	26.97661343	54.24741343
Tshwane Metropolitan	50.1379507	18.80417647	31.05787288	49.86204935
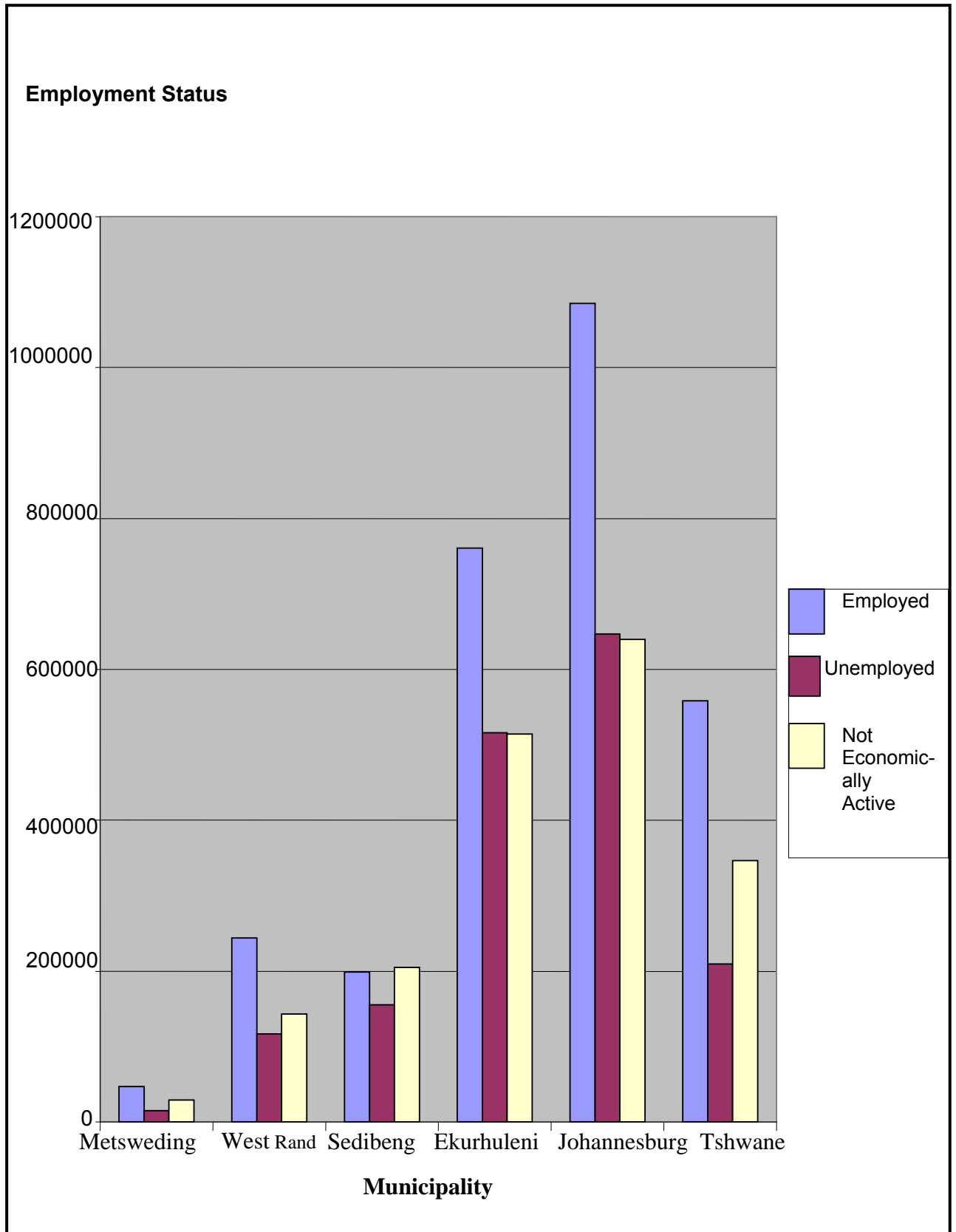
Employment Status

Figure 4.7: Employment status per municipalities in Gauteng.

Analyzed by researcher from data from Statistics South Africa, 2001
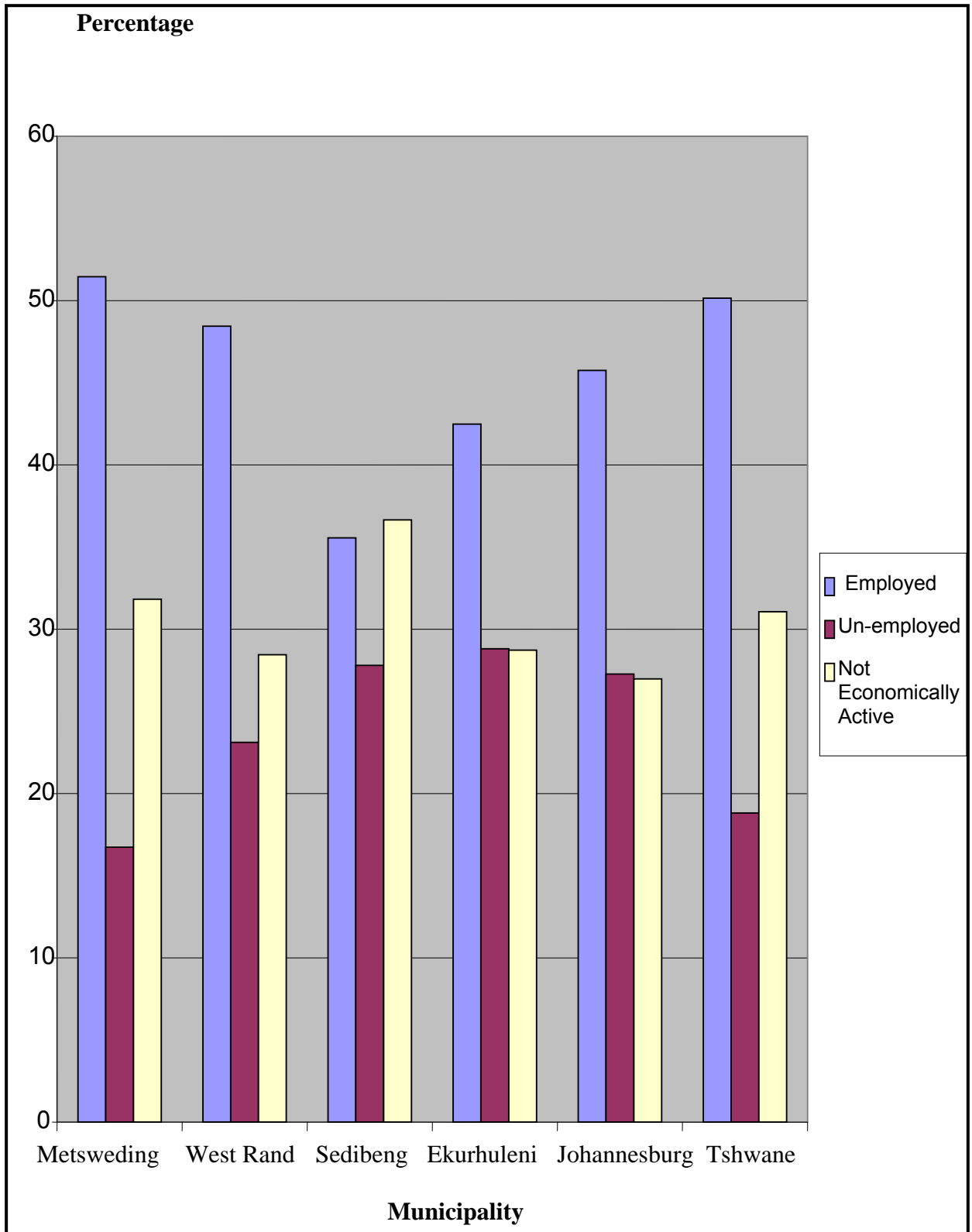
Figure 4.8: Percentage employment per municipality in Gauteng.
Analyzed by researcher from data from Statistics South Africa, (2005).
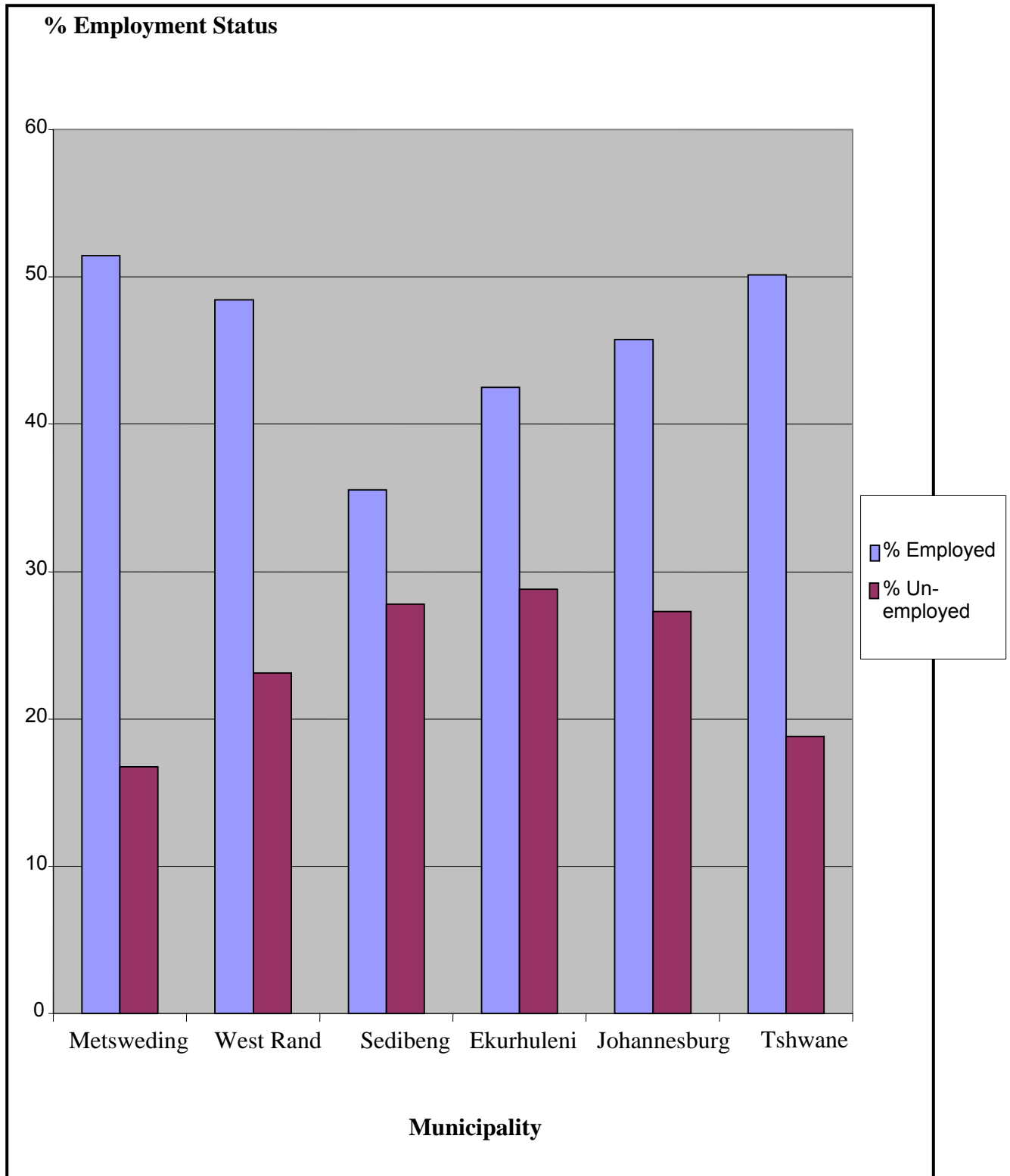
% Employment Status

Figure 4.9: Percentage employment, unemployment rates in Gauteng.

Analyzed by researcher from data from Statistics South Africa, (2005).

% Employment Status
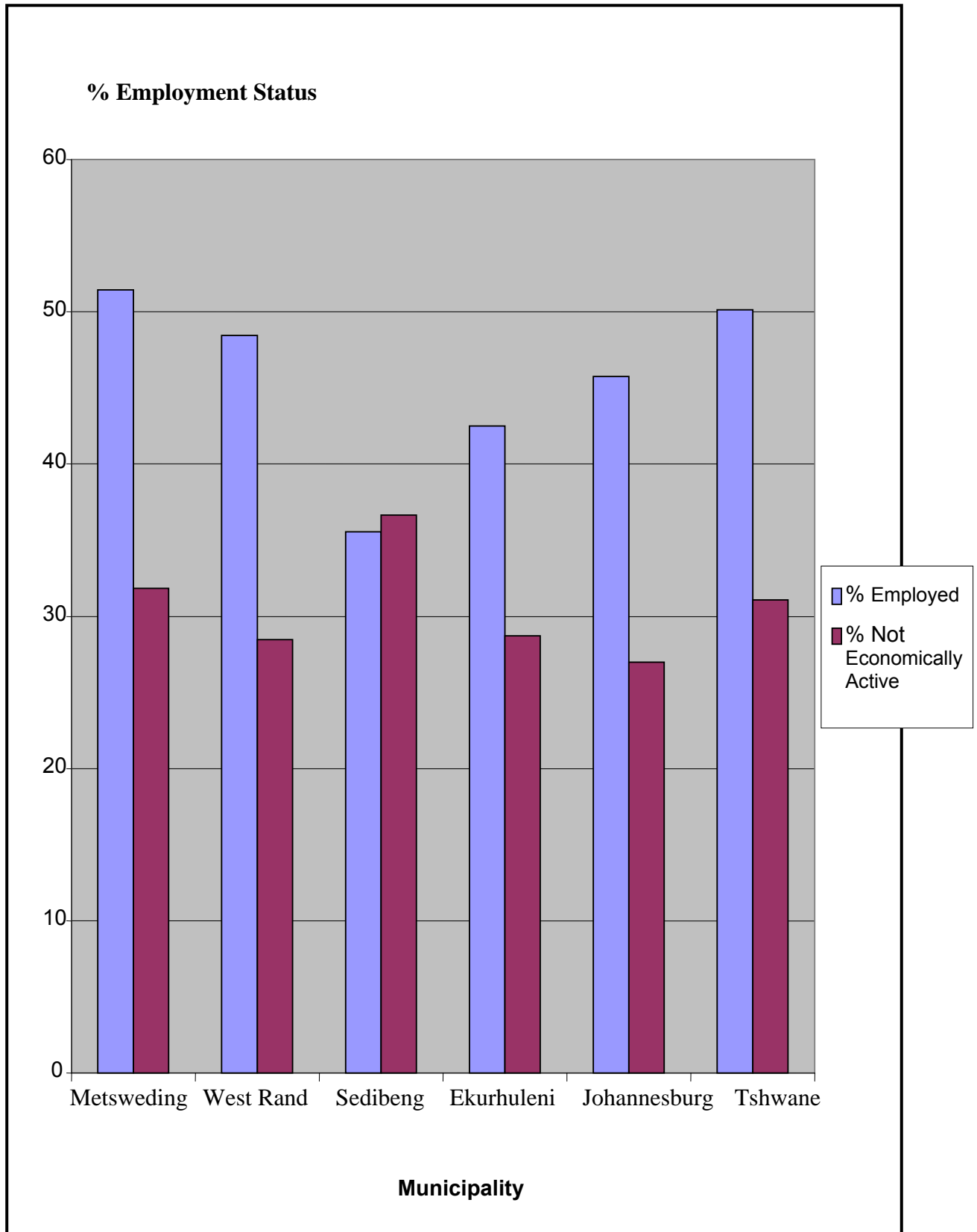
Municipality

Figure: 4.10 Percentage employed, not economically active, in Gauteng.

Analyzed by researcher from data from Statistics South Africa, (2005).

Figure 4.11: Percentage employed, un-employed/not economically active.
Analyzed by researcher from data from Statistics South Africa, (2005).
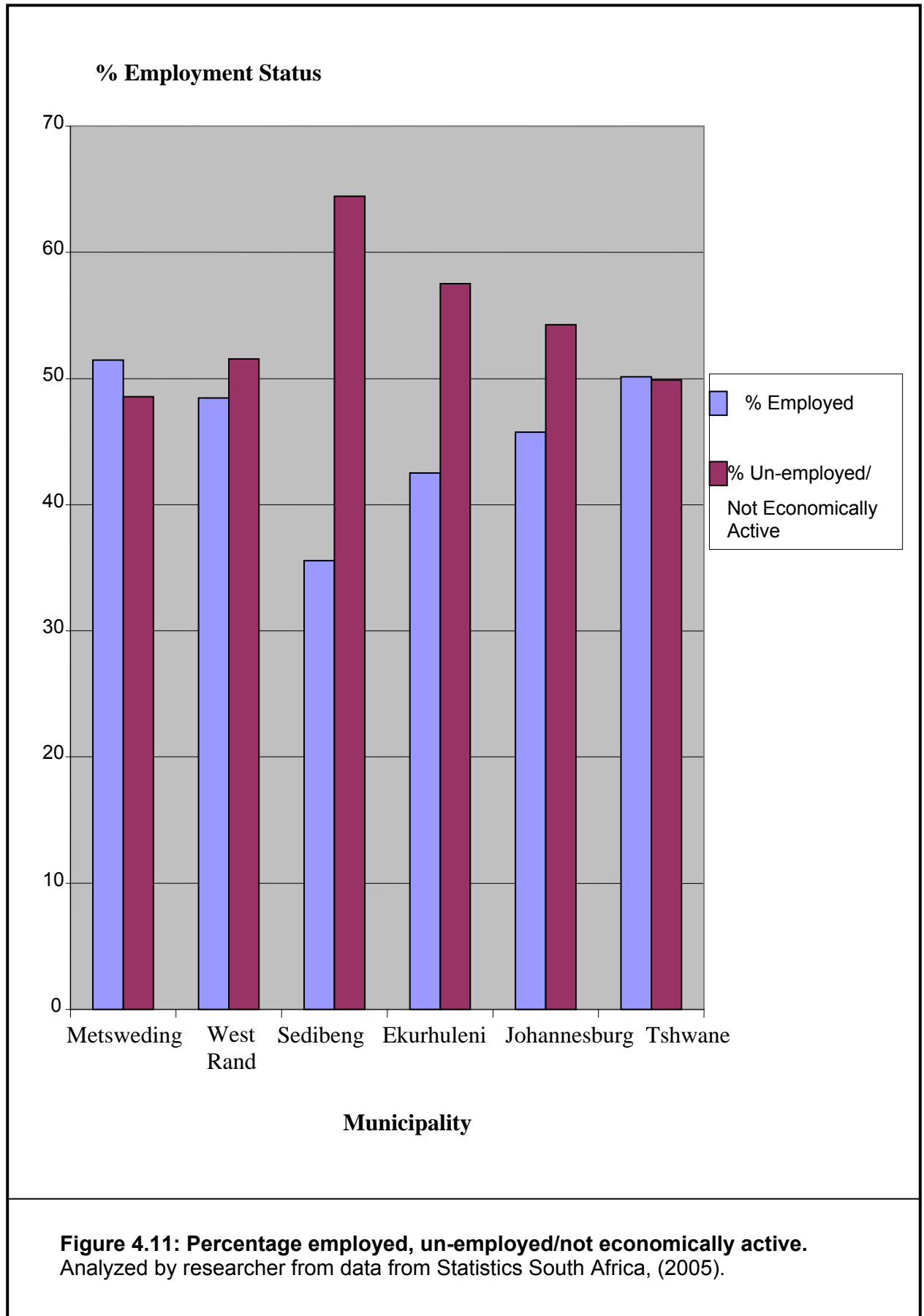
4.7.2   HIV prevalence versus employment and poverty levels in Gauteng.

Tshwane municipality has the highest level of employment when compared with the HIV prevalence the municipality has the lowest HIV positive cases whilst Sedibeng has the lowest employed population and the second highest HIV positive cases (Figure 4.12 & 4.16).

When the unemployment level is plotted (Figure 4.13 & 4.17), Tshwane maintains the lowest un-employment and HIV prevalence level whilst the West Rand has the highest un-employment and HIV positive cases.

Sedibeng municipality has the highest level of economically in-active people and the second highest HIV positive cases in Gauteng (Figure 4.14).

Johannesburg records the lowest economically in-active population and when compared to the HIV positive cases, the municipality has the second lowest levels of HIV positive cases.

The total unemployed and economically-inactive population in Gauteng is the population living in poverty in Gauteng.

From Figures 4.15 & 4.18, Sedibeng municipality has the highest poverty level in Gauteng and the second highest HIV positive cases in the province.

Tshwane has the lowest poverty and HIV positive cases respectively.

Percentage HIV and Employment
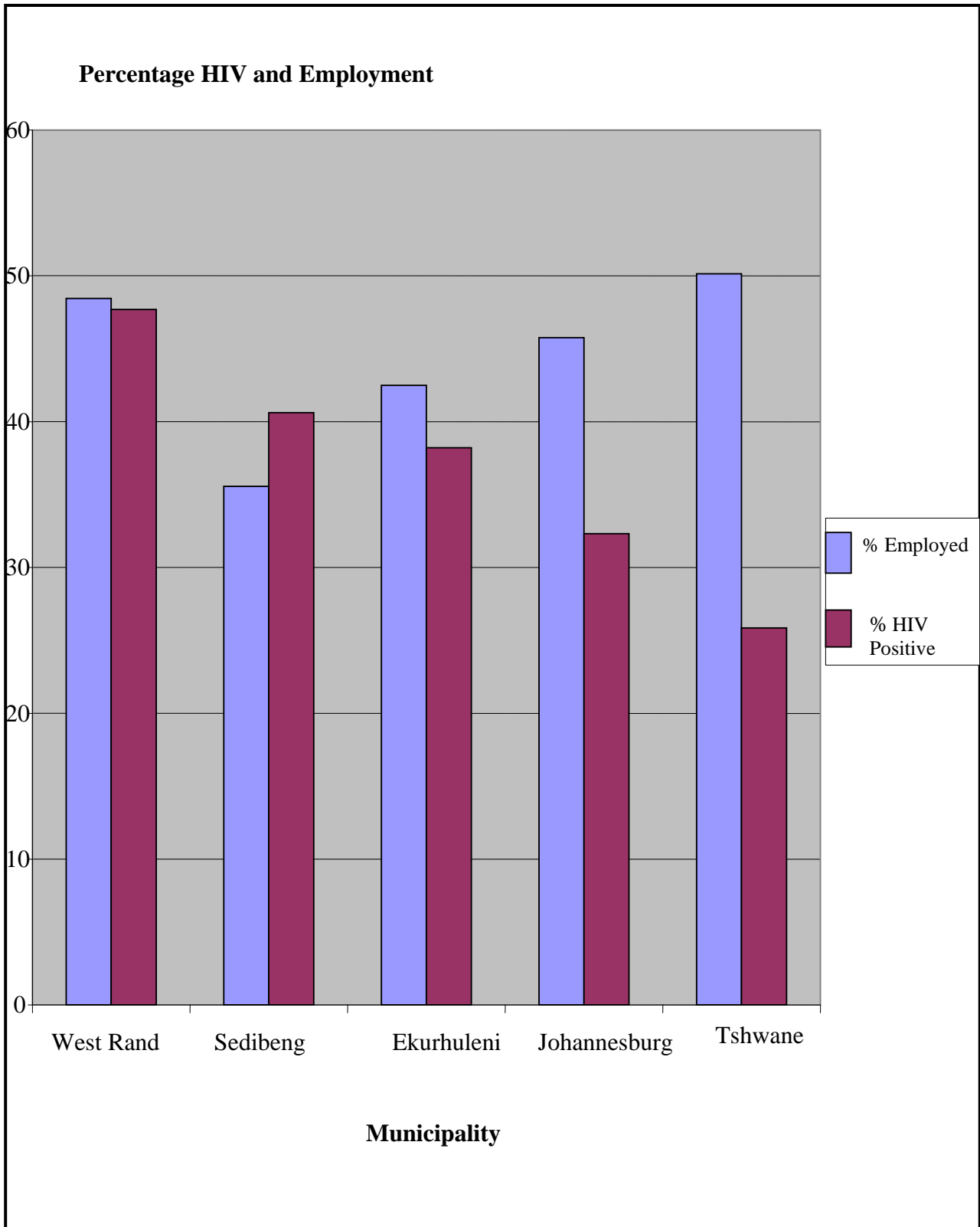
Figure 4.12: HIV positive cases versus employment rates in Gauteng.

Analyzed by researcher from data from the Department of Health Sentinel Surveys (2005) and Labour Data obtained from Statistics-South Africa, (2001).

Percentages HIV and Un-Employment

Figure 4.13: HIV positive cases versus un-employment rates in Gauteng.
Analyzed by researcher from data from the Department of Health Sentinel
Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).

Percentage HIV and Not Economically Active

Figure 4.14: HIV positive cases versus not economically active population in Gauteng. Analyzed by researcher from data from the Department of Health Sentinel Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).

Percentage Poverty Rates

Figure 4.15: HIV prevalence versus poverty in Gauteng.
Analyzed by researcher from data from the Department of Health Sentinel
Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).
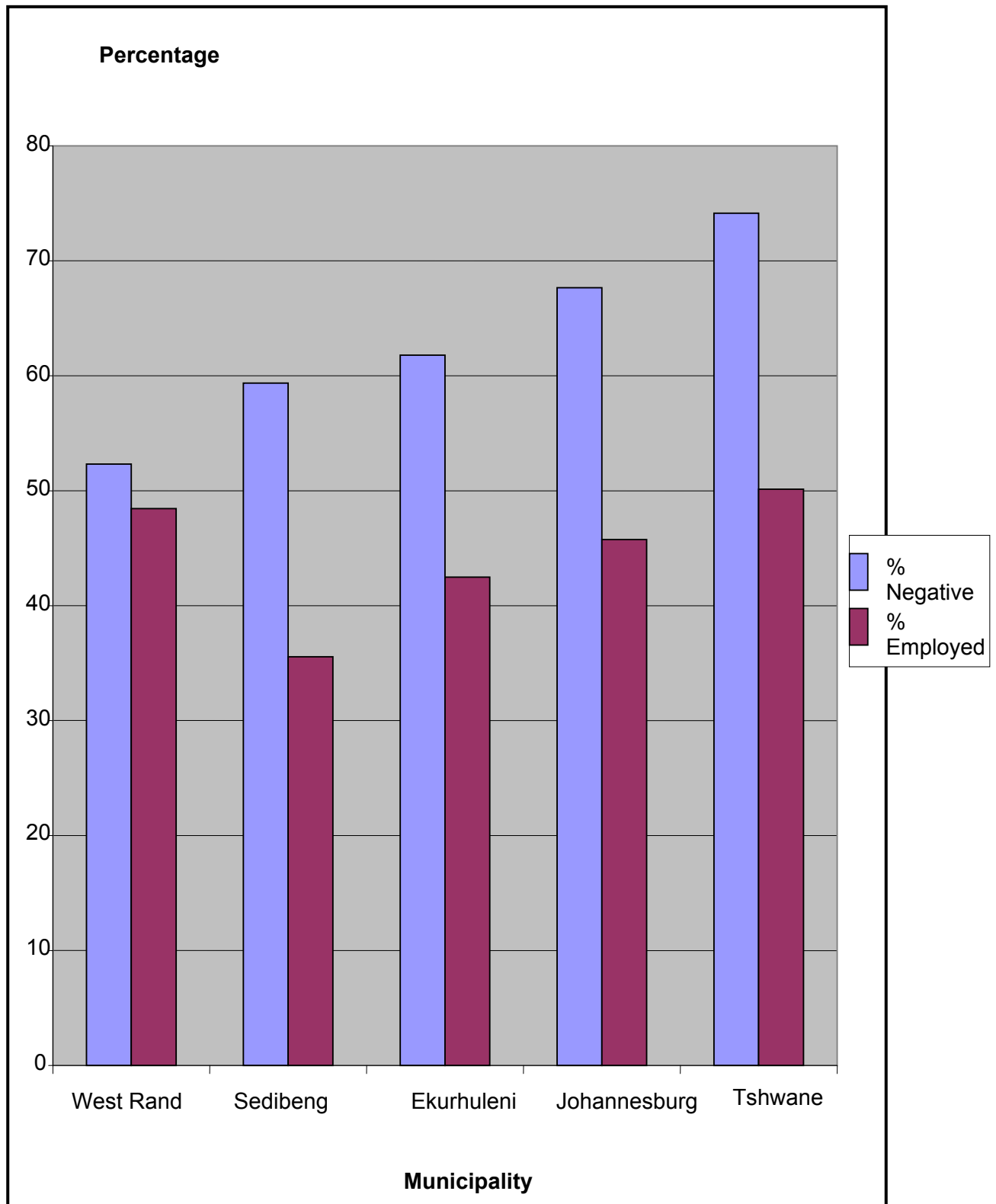
Figure 4.16: HIV negative cases versus employment status in Gauteng.
Analyzed by researcher from data from the Department of Health Sentinel
Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).

Percentage

West Rand   Sedibeng   Ekurhuleni   Johannesburg   Tshwane

Municipality
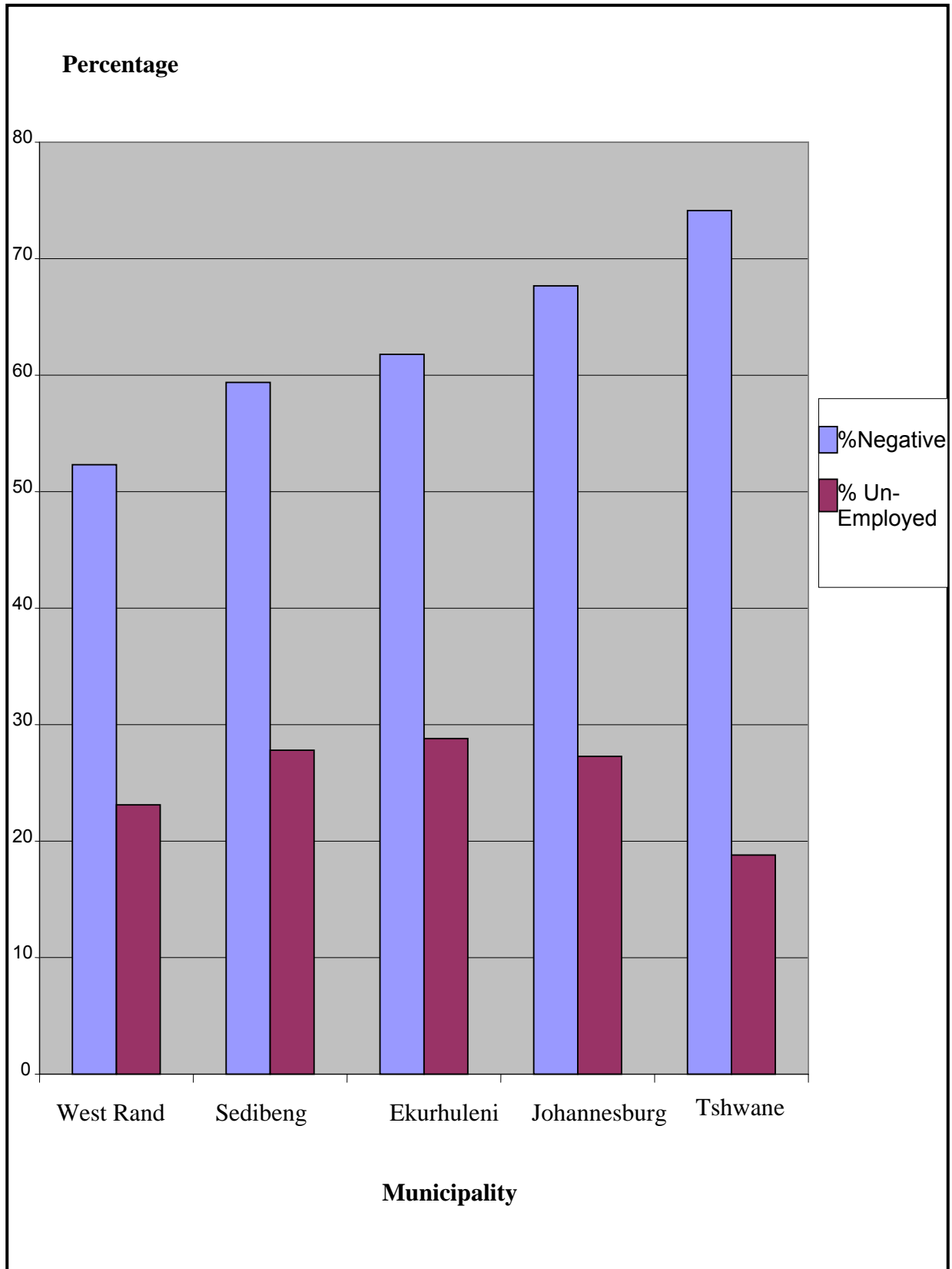
Figure 4.17: HIV negative cases versus un-employment in Gauteng.
Analyzed by researcher from data from the Department of Health Sentinel
Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).

Percentage Poverty
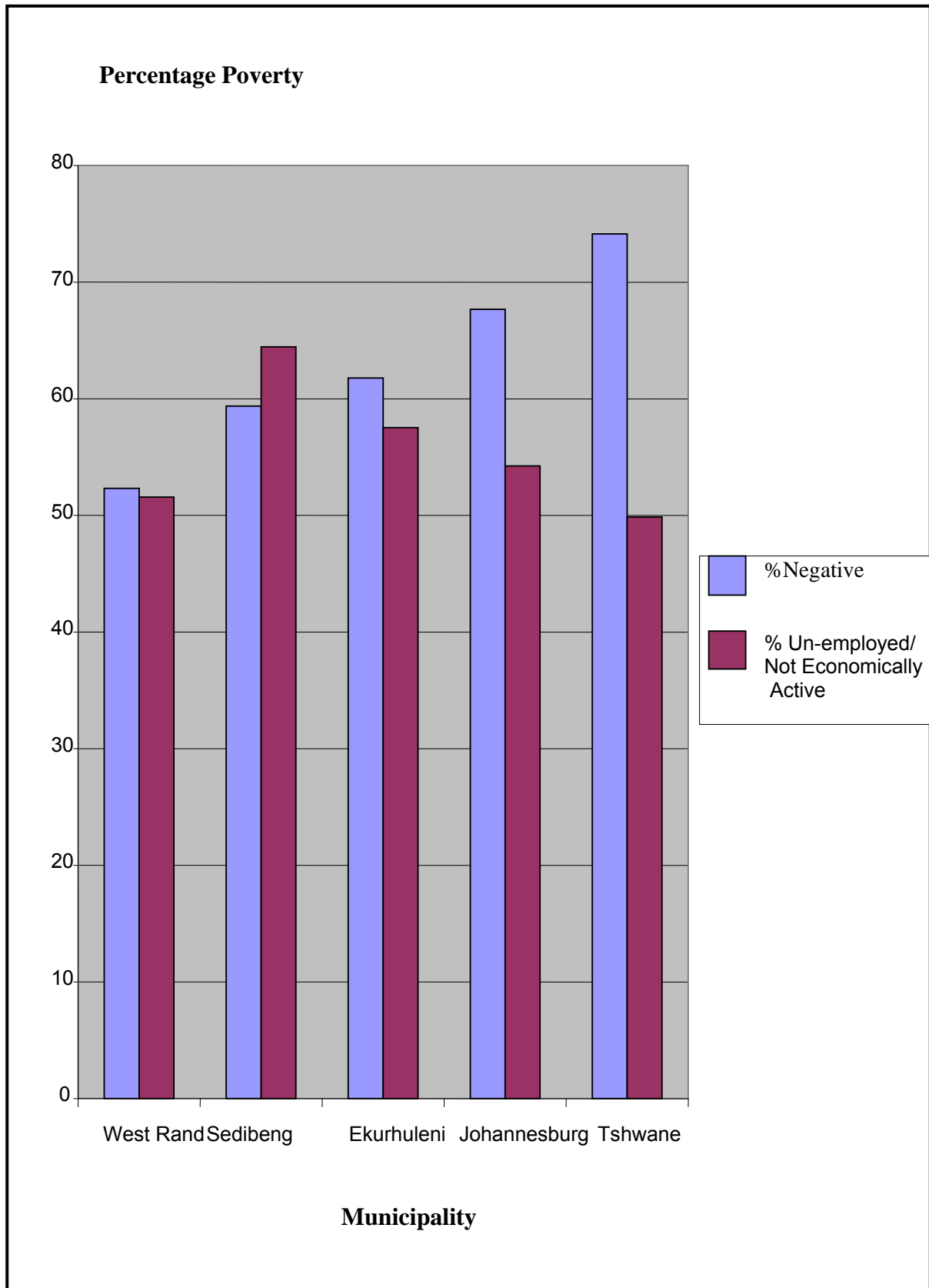
Figure 4.18: HIV negative cases versus poverty in Gauteng.
Analyzed by researcher from data from the Department of Health Sentinel
Surveys (2005), Labour Data obtained from Statistics South Africa, (2001).

4.7.3 The third research question and statistical testing (economic)

The figures above Figures 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, 4.17, show there is a relationship between the prevalence of HIV and poverty expresses in terms of emp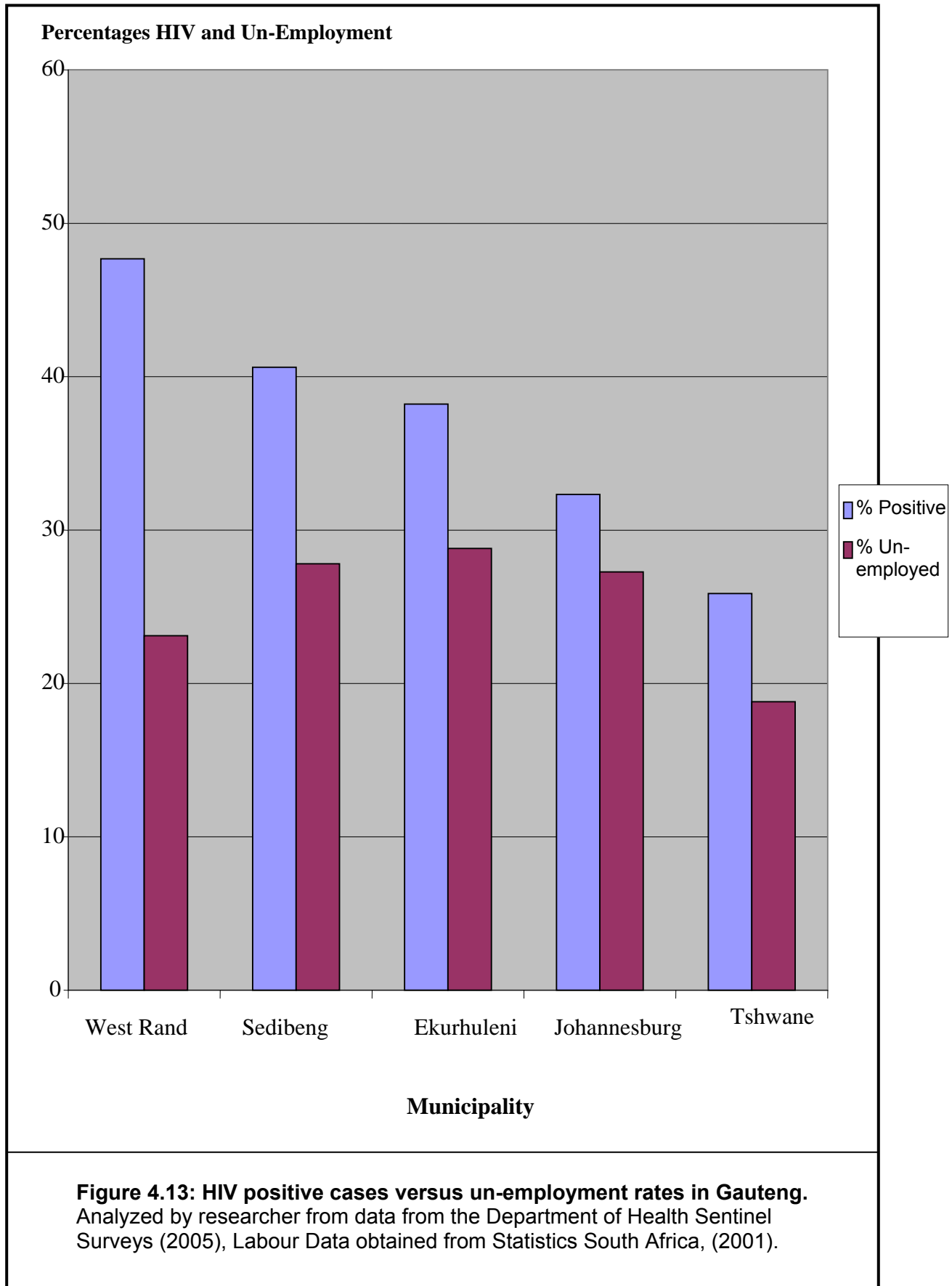loyment, un-employment/not-economically active. From sections 4.7, 4.71 above the Tshwane municipality with the lowest HIV prevalence incidentally records the highest employment level; in terms of poverty, the lowest poverty level. Conversely, the West Rand municipality with the highest HIV prevalence records the highest un-employment/economic inactivity; in terms of poverty, the highest poverty level in Gauteng.

The descriptive interpretation above is further subjected to statistical testing for more deductive results. The third research question investigates the possible relationships between the spatial aspect; socio-economy and the HIV epidemic in Gauteng.

4.7.3.1 Test of association

To determine the existence of an association between the distribution of HIV (HIV positive population) in Gauteng and the poverty level in terms of employment, a 2-sample T-test is performed. (Appendix 5).

Under this T-test, equal and unequal variances at the 95% level of significance are considered.

It is assumed that the number of HIV positive people is independent from the total employed / total unemployed.

HIV positive versus employment / un-employment in Gauteng

The third research question states: Is there a relationship between the distribution of HIV/AIDS in Gauteng and the socio-economic condition of Gauteng residents?

i.) Equal variance

Running a two sample T-test and assuming equal variances at 95% significance level, the
P- Value = 0.003356

This is less than 0.05 hence the study can accept that there is a relationship between poverty and the spatial distribution of HIV in Gauteng.

ii.) Un-equal variance

P - Value = 0.004289

From the T-test done, there is a relationship between poverty and the spatial distribution of HIV in Gauteng. The T-test result further confirms the results obtained from the charts and tables above section 4.7, 4.71. In chapter 2, a number of studies similarly concluded that the ongoing spread of HIV/AIDS is primarily due to poverty which may be directly induced by migration and other complex variables. Some studies further claimed the most affected population is women and children due to their vulnerability also induced by poverty and other factors.

In Gauteng, poverty is on the rise and the HIV prevalence is following similar increasing trends (Department of Health, 2004(b)), the prevalence in the municipalities however varies; this variation and subtle dynamics is only visible due to the study being carried out at a micro level. The study therefore accepts the fact that micro scale studies should be embraced in order to further understand and study new facets of the HIV epidemic in South Africa.

4.7.4   The implications of the prevalence of HIV and the poverty level in Gauteng expressed in terms of deprivation.

The rates of deprivation in Gauteng Households covers the 8 indices being used by the Statistics South Africa in their General Household Survey (GHS). They include: Highest Education obtained, Energy (for heat, cooking & light), Medical Aid Cover, and access to Sanitation, Refuse Removal Methods, and access to portable drinking water. The term other is used to depict the absence of or in-access to the above indices; it is explained in Table 4.9. The municipality with the poorest standard of living covering all the above indices is the West Rand Municipality followed by the Sedibeng Municipality. Conversely, the highest living standard is recorded in the Johannesburg and East Rand Municipalities respectively.

In chapter 2 it is noted that stakeholders are finding various avenues to educate the public on HIV, the role of some of the organizations, apart from creating HIV awareness is also to demystify the public especially those in the rural areas. A number of media print out is also provided on the spread and prevention of the disease.

Education does play a role in ones ability to comprehend the information on HIV being disseminated. It also plays a role in poverty as it can determine ones ability to secure decent employment. The level of education per municipality is shown in Figure 4.19.

Table 4.10 shows percentage education level per municipality. From Table 4.10, the Sedibeng municipality has the lowest level of education (Grade 11 to no education) whilst Tshwane records the highest level of education (Matric, Grade 12 and above).

Table 4.9: Explanation of graph terms, (Statistics South Africa - user guide- GHS data, 2001).

Terms	Details
Other for Cooking	Gas, Paraffin, Wood and Coal
Others for Lighting	Gas, Paraffin, Candles
Refuse Removed by other means	Community, own methods or none
Other water sources	Rain water in tank on site, neighbour's tap, public tap, water carrier or tanker, borehole off site/communal, flowing water/stream/river
Grade 11 and below	Includes no education, grades 11-0, and don't know
Sanitation Available	Flush toilet connected to a public sewage system in Dwelling Flush toilet connected to a septic tank in Dwelling Flush toilet connected to a public sewage system on Site Flush toilet connected to a septic tank on Site Flush toilet connected to a public sewage system off Site Flush toilet connected to a septic tank off Site
Sanitation not Available	Chemical toilet available on Site Pit latrine with ventilation pipe available on Site Pit latrine without ventilation available on Site Bucket toilet on Site Chemical toilet available off Site Pit latrine with ventilation pipe available off Site Bucket toilet available off Site No sanitation facility available Unspecified

Note:
From the GHS data source (Statistics South Africa, General Household Survey, 2005 data): "In view of the sample size, caution must be excised when interpreting the GHS data at geographical levels lower than province".
The researcher estimated the GHS data for each municipality using the percentage derived from each individual municipality averages. Hence the calculations are based on each municipality's individual averages and not the total estimates for the province as a whole. Details on this calculation are included in (Appendix 6).

Highest Level of Education Per Household in Gauteng

Total in Thousands

Figure 4.19: Deprivation indications–education per household in Gauteng.
Analyzed by researcher from GHS data (Statistics South Africa, 2001).

Table 4.10: Percentage–deprivation in Gauteng based on 8 indices: highest education, energy (for heat, cooking, light), Medical Aid cover, access to sanitation, Refuse removal method & access to portable drinking Water. Estimates by researcher based on Statistics South Africa-GHS data, (2001).

Municipality	Education Level		Energy for Heat		Energy for Cooking		Energy for Light		Medical Cover		Access to Sanitation		Refuse removal Method		Access to drinking water	
Low Deprivation (L), High Deprivation (H)	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
West Rand	25	75	75	25	76	24	76	24	46	54	80	20	72	28	84	16
Sedibeng	22	78	69	31	78	22	88	12	37	63	85	15	66	34	93	7
Ekurhuleni	33	67	73	27	76	24	80	20	49	51	87	13	90	10	88	12
JHB	33	67	87	13	86	14	88	12	47	53	88	12	91	9	92	8
Tshwane (Pretoria)	41	59	89	11	83	17	88	12	63	37	83	17	89	11	91	9

*Note:
Numbers Highlighted yellow (X) are the largest figures showing lowest deprivation (L) or Highest deprivation (H) per municipality in Gauteng. The statistics are quite close with minute differences in most cases.

Table 4.10 above presents summaries on each of Gauteng's municipalities.

The highest level of deprivation (H) and the lowest level of deprivation (L). The highest & lowest levels of deprivation is determined from the 8 indices (Table 4.10) and Appendix 6 for the calculations.

The energy source used for heating, cooking and lighting is either from the mains or other sources (gas, paraffin, coal & wood). Table 4.10; Figures 4.20, 4.21, 4.22; summaries show the Tshwane municipality has good access to energy for heat & Light. Johannesburg has good access to energy for cooking and light whilst the West Rand has poor access to energy for cooking and light.

The level of deprivation in terms of Medical cover, Table 4.10; Figure 4.23 shows Tshwane municipality has the highest medical cover level and the Sedibeng municipality the lowest medical cover.

Access to flush toilet sanitation and non-flush sanitation; (Chemical Latrine, pit latrine, bucket toilet and other), Table 4.10, Figure 4.24 show the Johannesburg municipality has good access to flush toilet facility whilst the West Rand use the highest non-flush toilet facilities.

Methods for refuse removal is divided into refuse being removed (either by the government local authorities or community members) or refuse not being removed (the community utilizes a communal dump, or dispose refuse privately).

From Table 4.10 & Figure 4.25, the Johannesburg municipality has good access to refuse removal, whilst West Rand has the least access to refuse removal.

The final indices and probably the most important is access to clean portable drinking water.

The Sedibeng municipality has good access whilst West Rand has poor access to portable drinking water (Table 4.10, Figure 4.26).

On the overall from Table 4.10, Figures 4.27(a), 4.27(b), 4.28, 4.29, 4.30, West Rand and Sedibeng have the highest levels of deprivation (4 indices each) whist the Johannesburg and Tshwane municipalities have the lowest levels of deprivation (0 indices each).

When compared to the prevalence of HIV, the West Rand Municipality has the highest HIV prevalence and as mentioned above the highest level of deprivation.

The Sedibeng municipality also has highest level of deprivation and the second highest HIV prevalence in Gauteng.

Johannesburg records the lowest deprivation and the second lowest HIV prevalence and Tshwane has the lowest HIV prevalence and deprivation respectively.
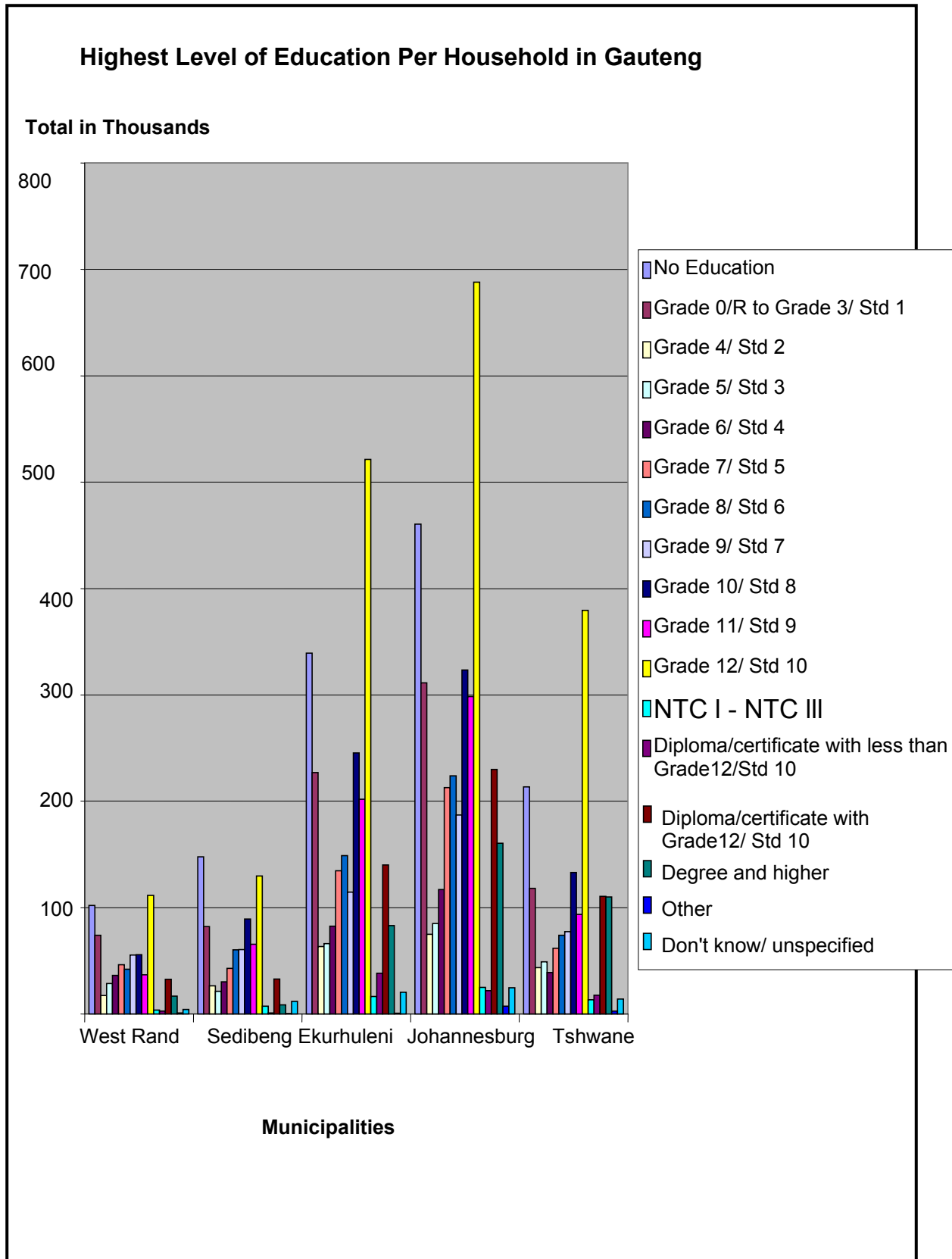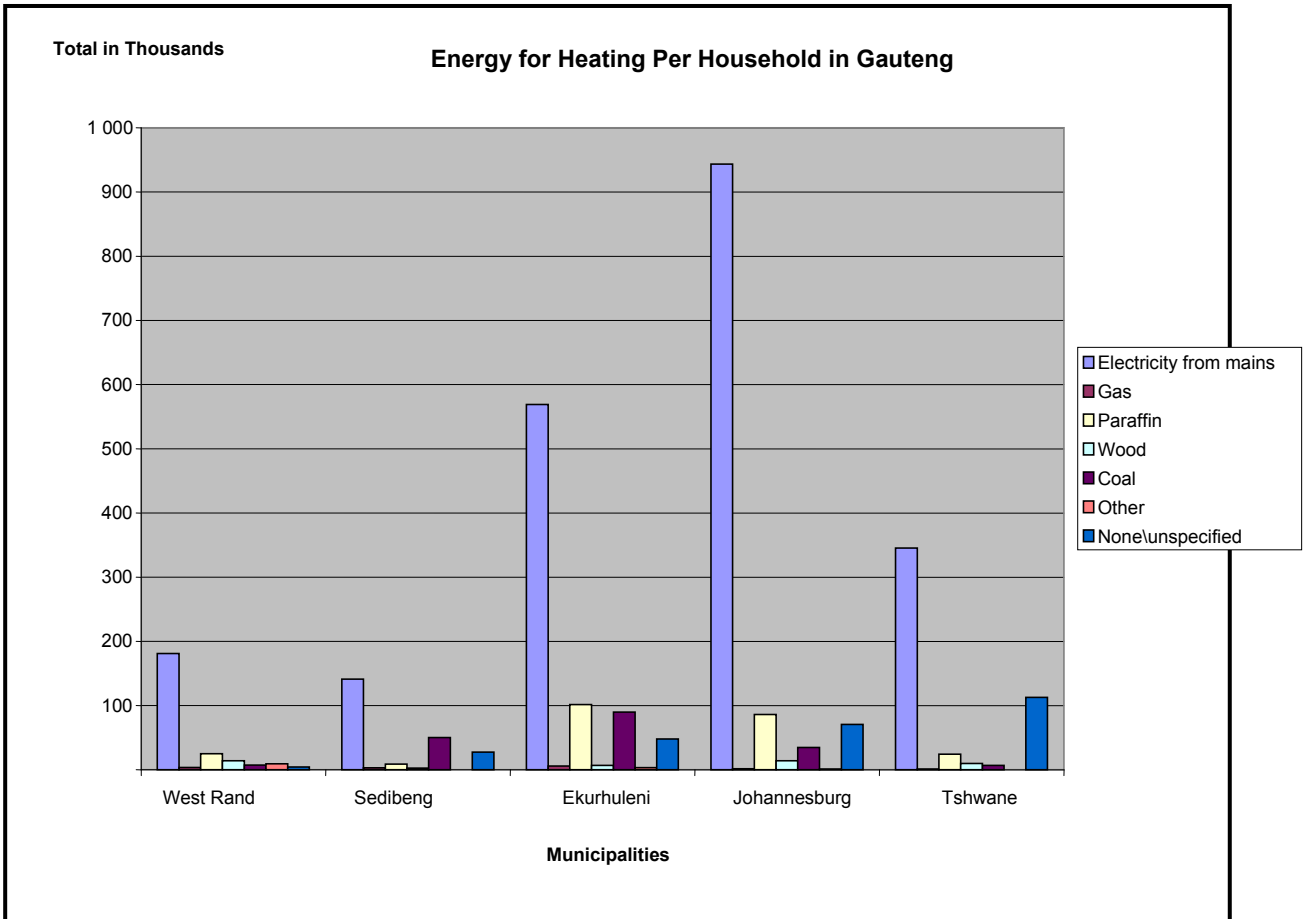
Figure 4.20: Deprivation indication – energy for heating per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
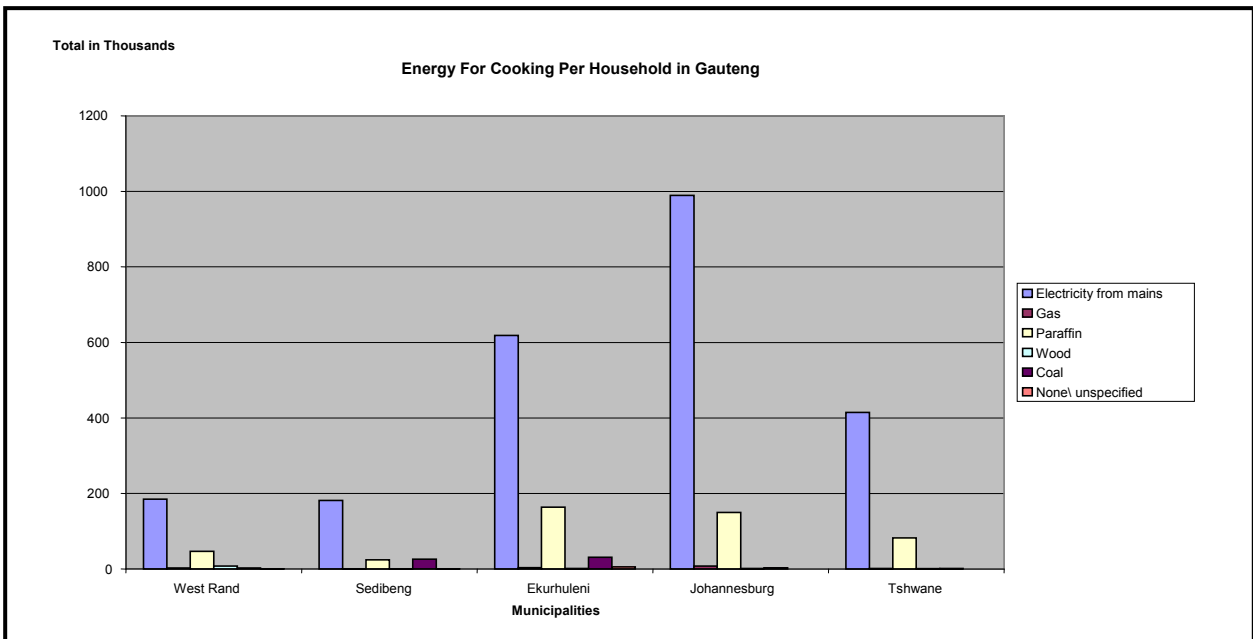
Figure 4.21: Deprivation Indication – energy for cooking per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).

Total in Thousands

Energy for Lighting Per Household in Gauteng
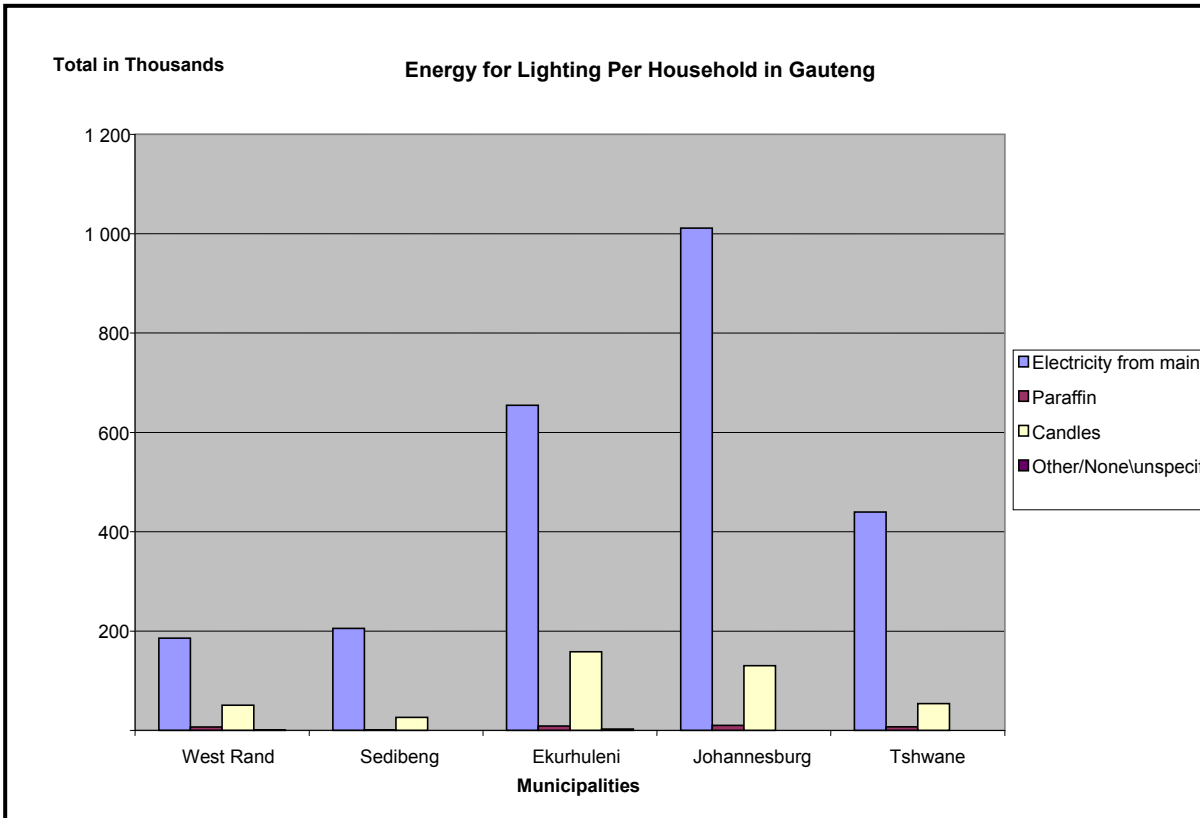
Figure 4.22: Deprivation Indication – energy for lighting per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).

Total in Thousands

Medical Aid Cover Per Household in Gauteng
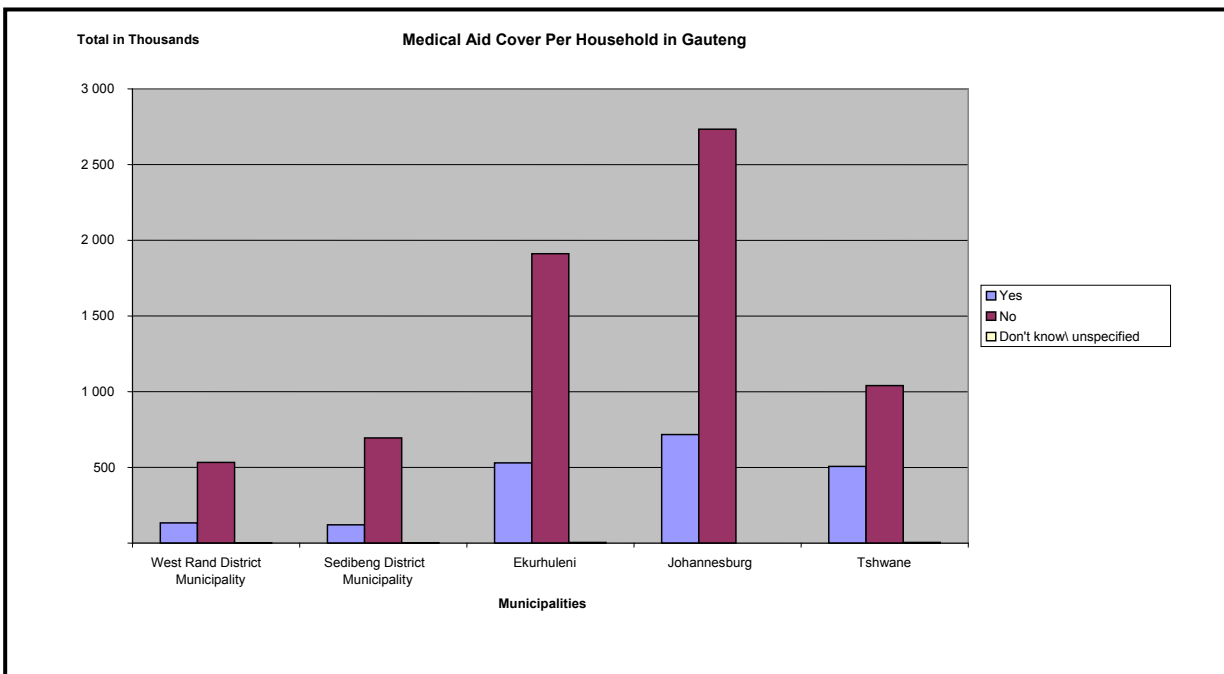
Figure 4.23: Deprivation Indication – Medical Aid cover per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
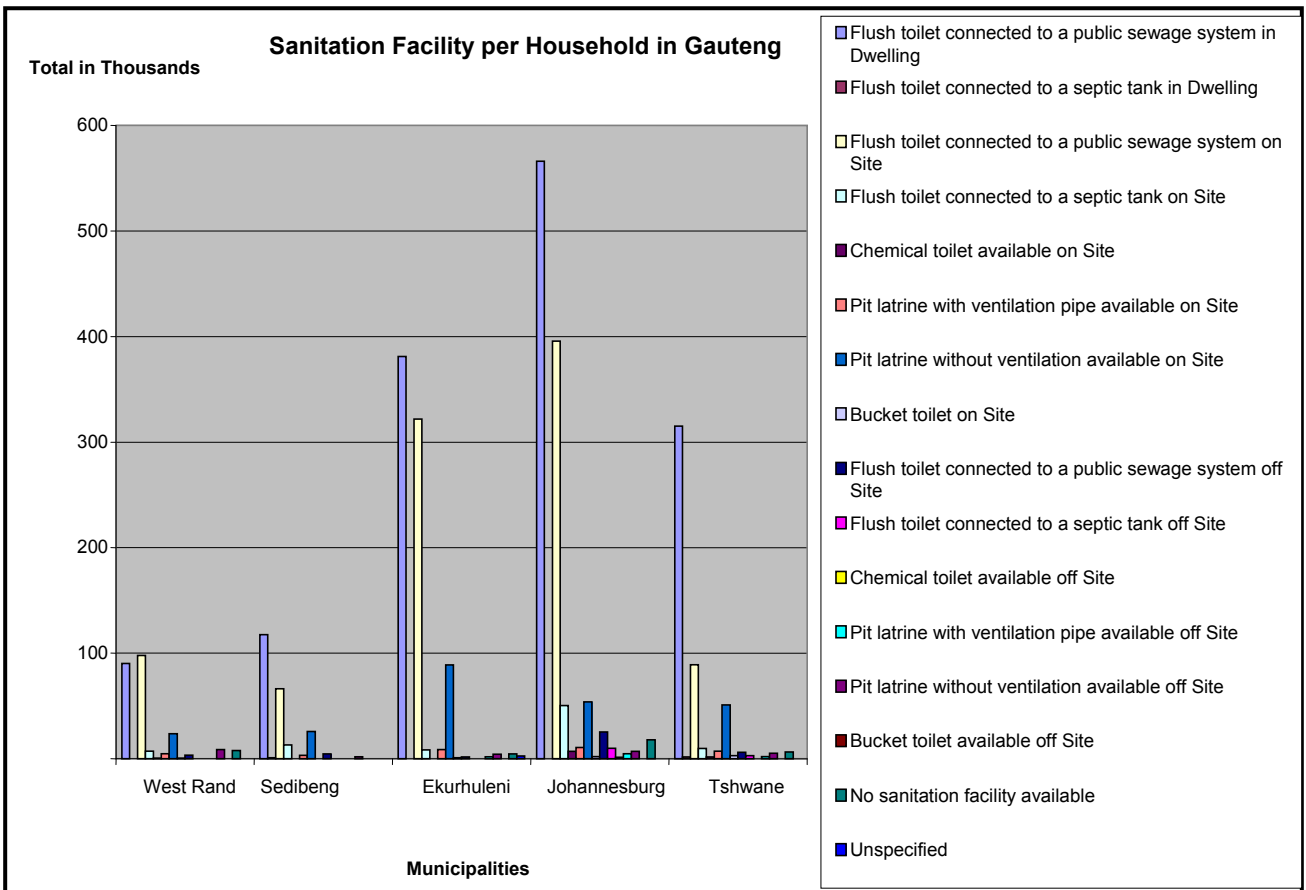
Figure 4.24: Deprivation indication–sanitation facility per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
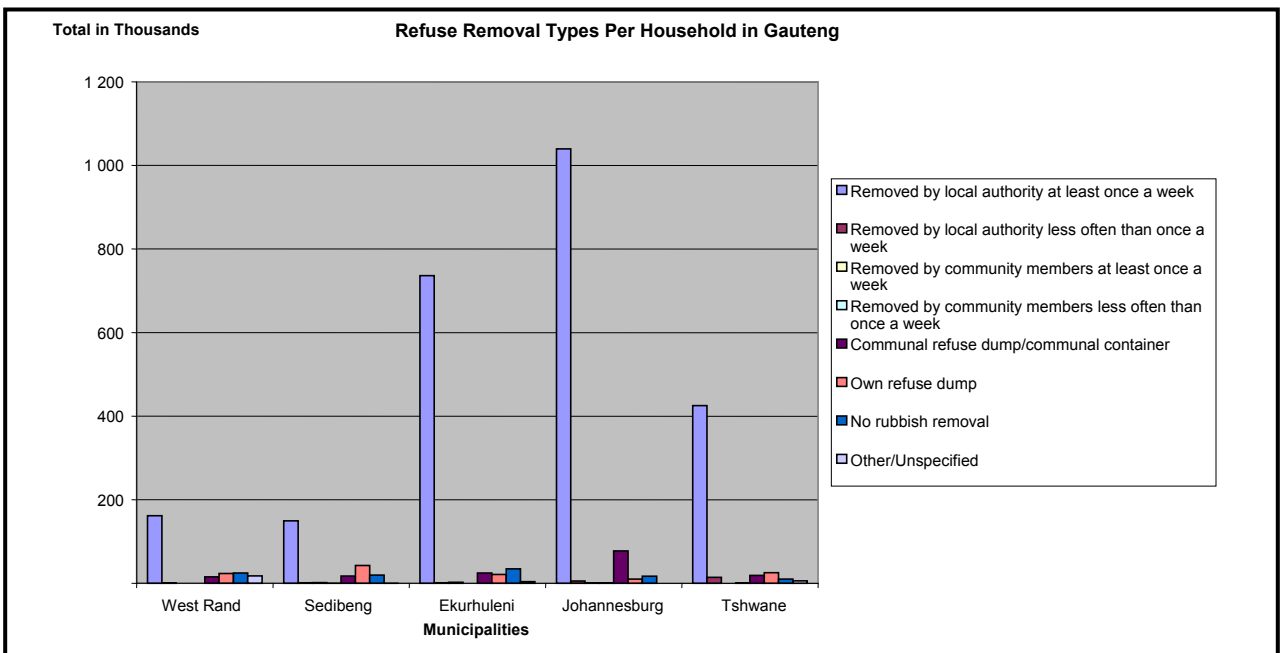
Figure 4.25: Deprivation indication – Refuse removal per household in Gauteng
Analyzed by researcher from GHS data (Statistics South Africa, 2001).
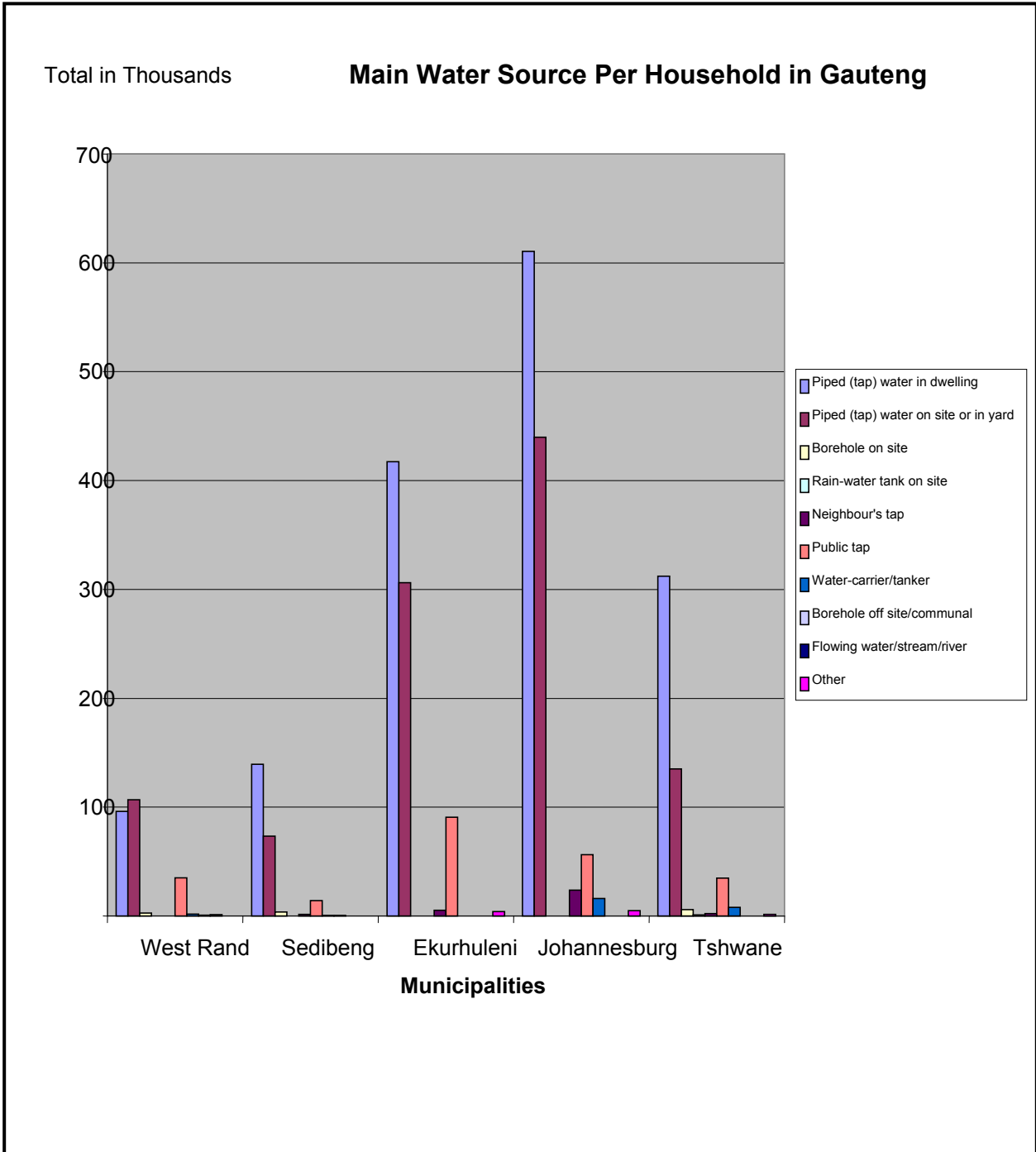
Figure 4.26: Deprivation indication–main Water source per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
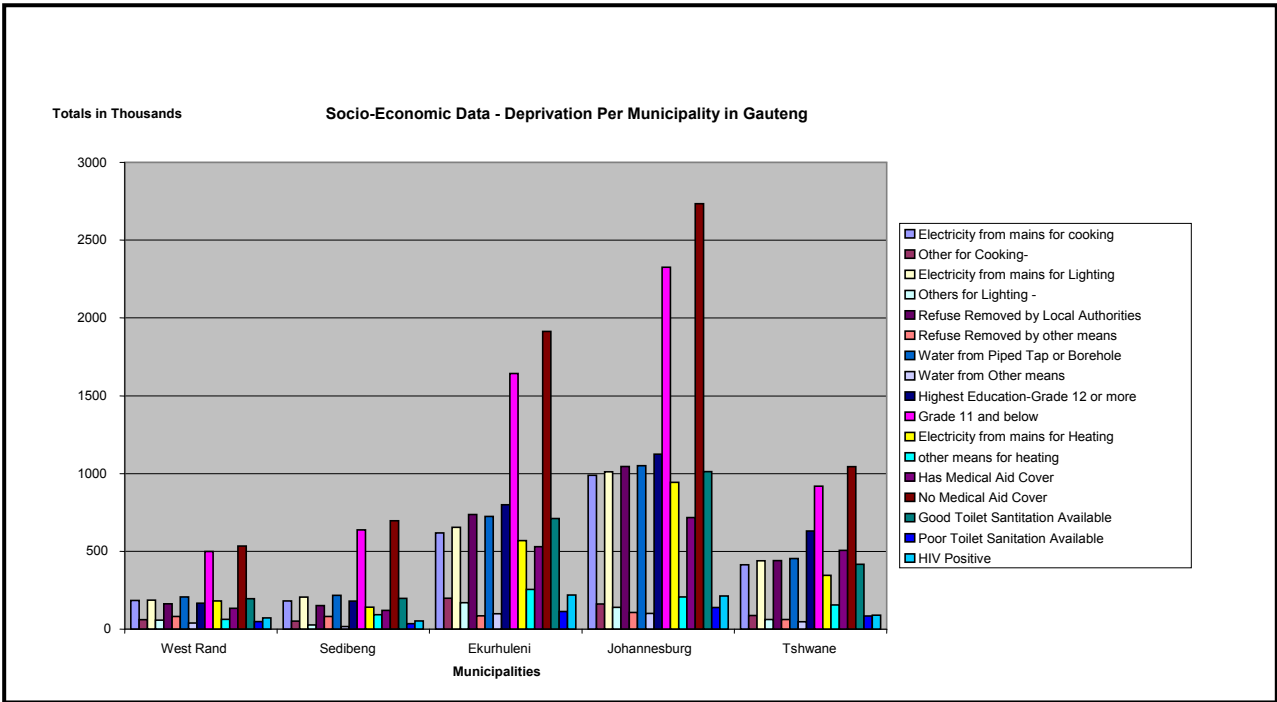
Figure 4.27(a): Socio-economic data-deprivation indication per household in Gauteng.

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
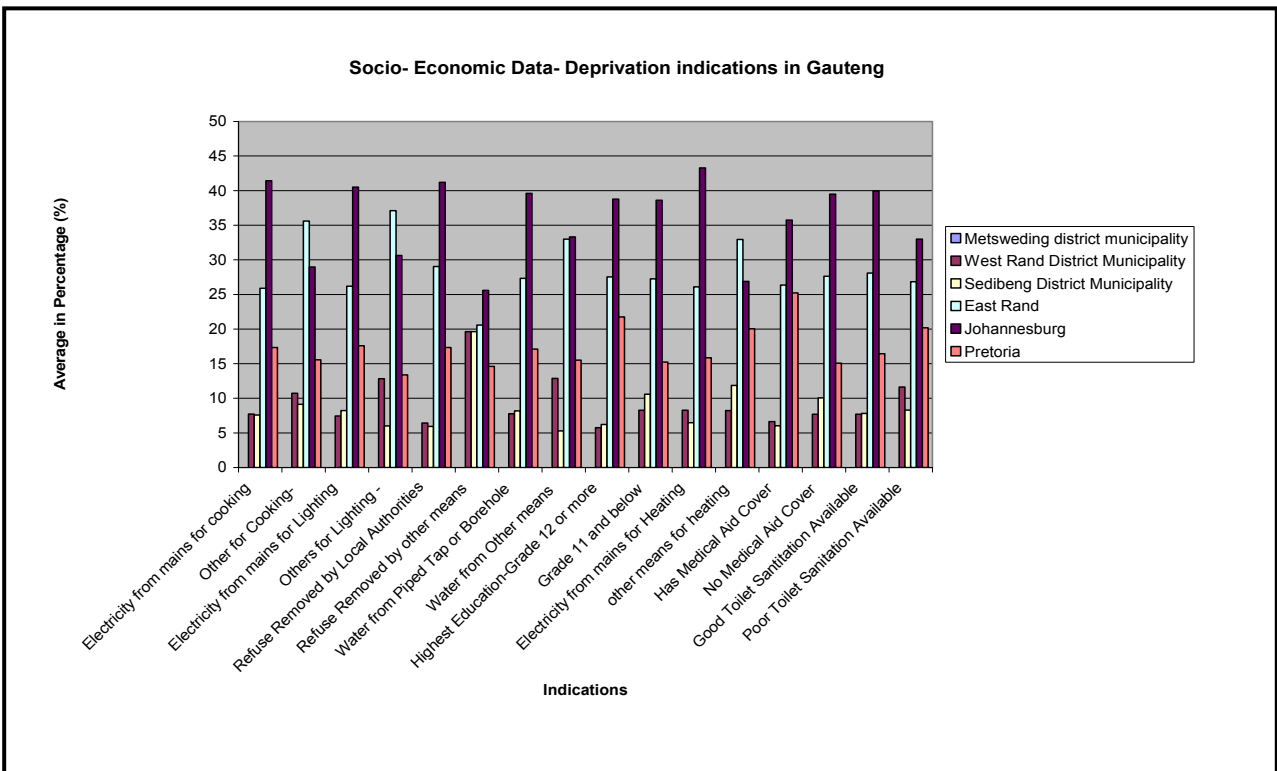
Figure 4.27(b): Socio-economic data-deprivation indication per household in Gauteng

Analyzed by researcher from GHS data (Statistics South Africa, 2001).
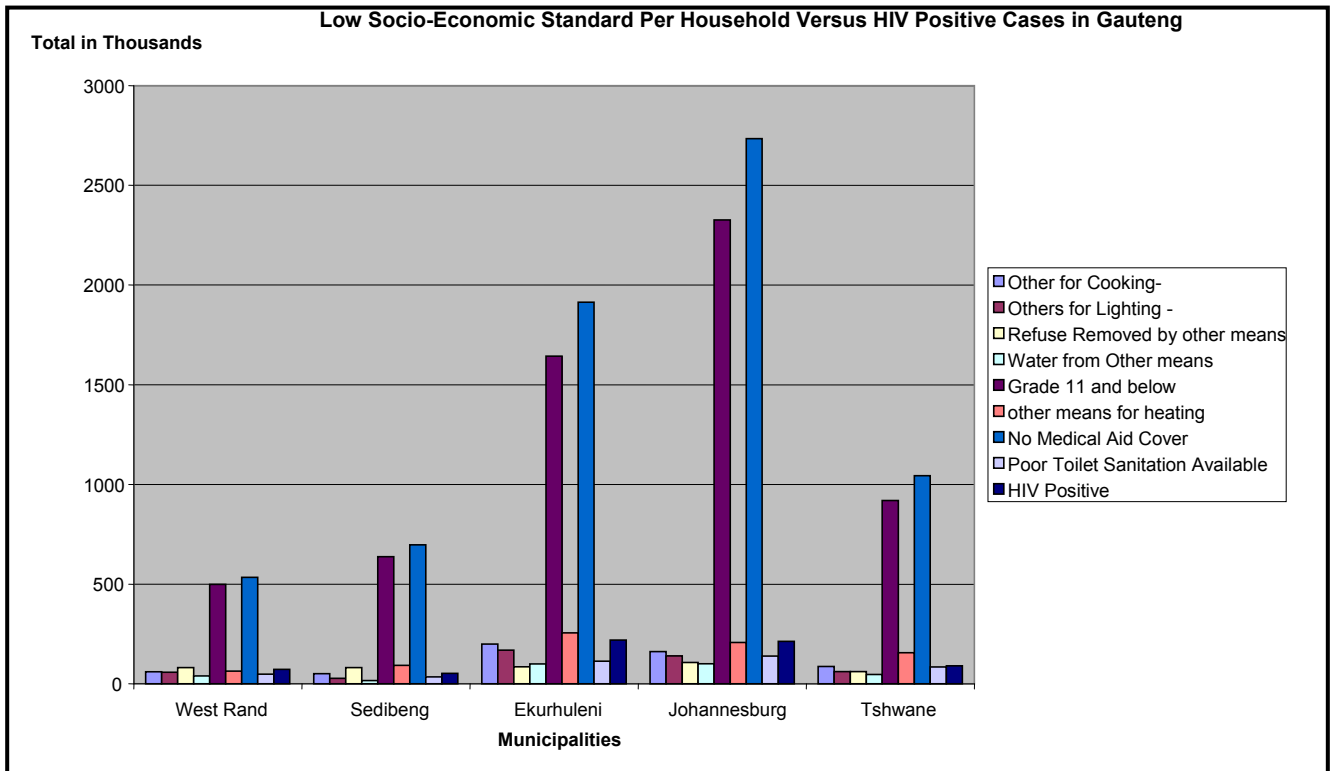
Figure 4.28: Low socio-economic standard per household versus HIV positive cases in Gauteng
Analyzed by researcher from GHS data, (Statistics South Africa, 2001).
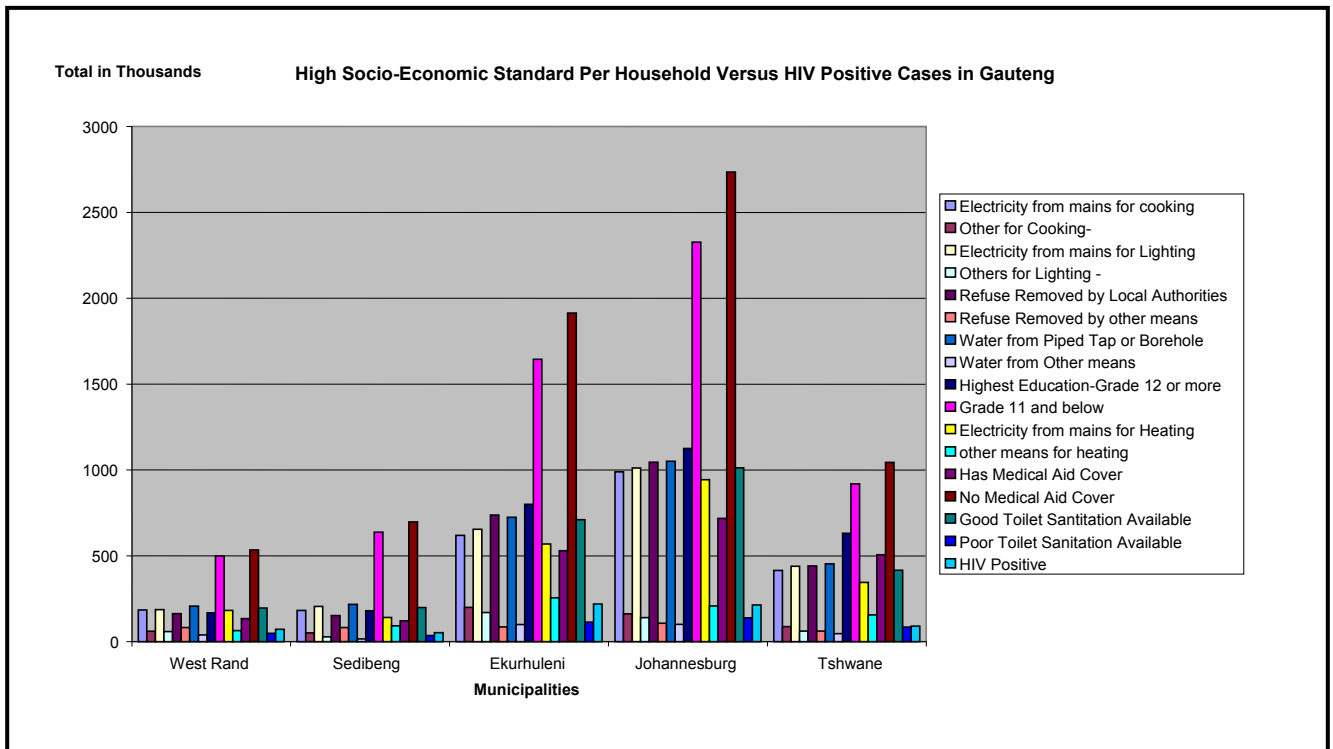
Figure 4.29: High socio-economic standard per household versus HIV positive cases in Gauteng
Analyzed by researcher from GHS data (Statistics South Africa, 2001).

Figure 4.30: Summary–level of deprivation per municipality in Gauteng.

Analyzed by researcher from GHS data, (Statistics South Africa, 2001).
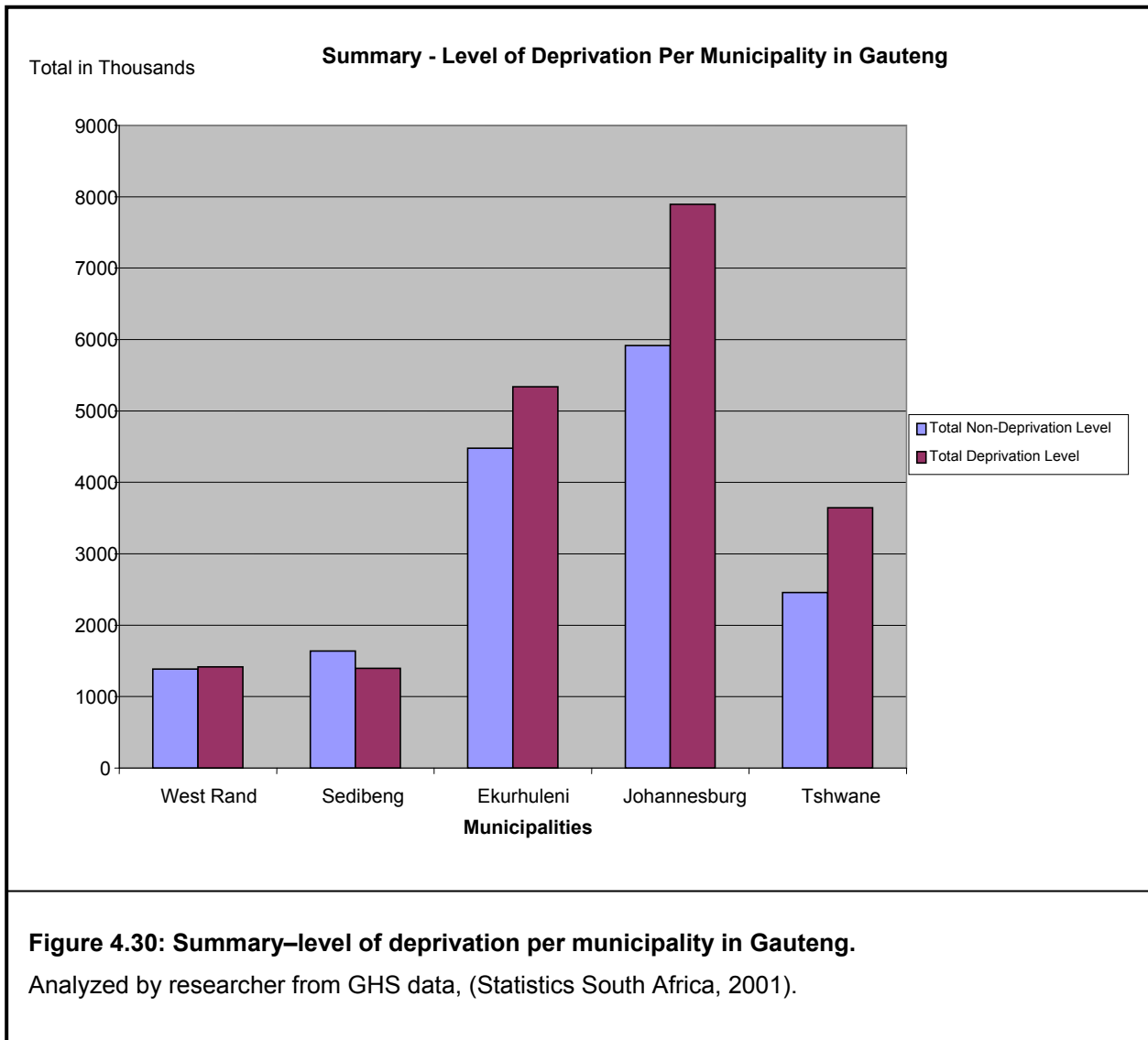
4.7.5   The third research question and statistical testing – (social)

Section 4.7.3 above addresses the socio-economic aspect of Gauteng in relation to the spatial distribution of HIV in terms of poverty (economic terms). Section 4.74 above on the other hand address the social aspect of socio-economy in terms of deprivation.

The figures above Table 4.10 & Figures 4.19, 4.20, 4.21, 4.22, 4.23, 4.24, 4,25, 4.26, 4.27(a),(b), 4.28, 4.29 & 4.30 respectively show there is a relationship between the prevalence of HIV and deprivation based on the 8 indices indicated above.

The descriptive interpretation is further statistically tested in order to obtain more deductive results. The third research question investigates the possible relationships between the spatial aspect; socio-economy and the HIV epidemic in Gauteng.

4.7.5.1 Test of association

To determine the existence of an association between the HIV positive population in Gauteng and the socio- economic level in terms of deprivation, a 2-sample T-test is performed (Appendix 7).

The T-test considers both equal and unequal variances at the 95% level of significance.

It is assumed that the number of HIV positive people in Gauteng is independent from the Total Non-deprived residents and the Total deprived residents of Gauteng.

a)   HIV positive VS total non – deprivation

The relationship between the spatial distribution of HIV in Gauteng and the level of non-deprivation is considered.

The non-deprived population is considered to be the population with good socio-economic conditions. The municipalities noted from (section 4.7.4) above are the Tshwane & Johannesburg municipalities respectively.

i)   Equal variance

Running a two sample T-test and assuming equal variances at 95% significance level, the

P- Value = 0.00831193

This is less than 0.05 hence the study can accept that there is a relationship between deprivation (socio-economy) and the spatial distribution of HIV in Gauteng.

ii)   Un-equal variance

Running a two sample T-test and assuming un-equal variances at 95% significance level, the

P – Value = 0.02519993

This is also less than 0.05 hence the study can accept that there is a relationship between deprivation and HIV distribution in Gauteng.

b)   HIV Positive VS Total deprived

The relationship between the spatial distribution of HIV in Gauteng and the level of deprivation is considered. The deprived population is considered to be the population with poor socio-economic living conditions.

The municipalities noted from (section 4.7.4) above are the West Rand and Sedibeng municipalities respectively.

i.) Equal Variances

Running a two sample T-test and assuming equal variances at 95% significance level, the

P – Value = 0.01508352
This is also less than 0.05 hence the study can accept that there is a relationship between deprivation and the spatial distribution of HIV in Gauteng.

ii.) Un-equal Variance

Running a two sample T-test and assuming un-equal variances at 95% significance level, the

P – Value = 0.03679608
This is also less than 0.05 hence the study can accept that there is a relationship between deprivation and HIV distribution in Gauteng.

From the T-test done, there is a relationship between deprivation and the spatial distribution of HIV in Gauteng. The T-test result further confirms the results obtained from the charts and tables above (section 4.7.4).

From the results obtained above, the socio-economic level of Gauteng residents is reflected in the way the disease is spatially distributed. Areas with better socio-economic living conditions have a relatively lower level of HIV and vice versa.

The subtle dynamics may not have been otherwise evident if the study was carried out on a larger (macro) scale.

The study hopes the results documented would encourage various stakeholders to consider conducting detailed micro scale studies in other to combat the HIV epidemic in South Africa.

4.7.6 Conclusion

Chapter 4 provides the analysis of the various data sets collected: The HIV data from the Department of Health, The Labour Source data and the General Household Surveys from Statistics South Africa. Whilst the LSS data provides information on the Economic situation of Gauteng residents, the GHS data provides information on the Social situation in Gauteng.

The data are presented in the form of Spatial Maps which provide a visual representation of the HIV and population data's. Graphs are also used to summarize the socio-economic data and statistical tests used to show any possible relationships.

From the tests done, it is concluded that there is no relationship between the spatial distribution of HIV in Gauteng and the population size of the municipalities. In addition, there is no relationship between the spatial distribution of HIV and the distance/proximity between the areas of high endemicity to the area of low endemicity. On the other hand, there is a relationship between the spatial distribution of HIV in Gauteng and the socio-economic condition of its residents.

In conclusion the data analysis attempted to provide holistic interpretations on HIV/AIDS in the spatial context at a micro–scale. The more holistic picture on the HIV/AIDS epidemic is brought together by the spatial maps; the population and distance / proximity of the areas are displayed by means of the GIS maps; whilst the socio-economic condition of Gauteng residents is summarized in Charts and graphs.

All the variables were tested statistically to validate the descriptive interpretations. In the three research questions considered, the descriptive and deductive results supported each other.

Carrying out a micro-scale research provided the study with information on the spatial distribution of HIV in Gauteng which would have otherwise been non-evident.

CHAPTER 5

SUMMARY AND DISUSSION OF RESEARCH FINDINGS

5.1   Introduction to the study

In Chapter 1 the HIV phenomenon is introduced by a summarized version of the history of HIV/AIDS globally. The HIV phenomena being unknown at time became the focus of various research globally. As studies were conducted so new information began to emerge, most of the research at the time attempted to trace the origin of the disease, whilst some studies successfully linked the HIV incidents to specific parts of the world, like Africa as was the case of the Norwegian sailor (Chapter 1, section 1); other studies were satisfied with the confirmation that the strange death(s) experienced were as a result of HIV infection.

As with any other new phenomena, HIV gained a position in news headline stories, the Chicago times was probably one of the first newspapers to report on HIV cases globally especially incidents which occurred in the United States (Chapter 1, section 1). Subsequently, the outbreak of a rare kind of pneumonia *(Pnemocystis Carinii)* in gay men in the United States led to the official date (5 June 1981) to be considered as the beginning of the epidemic.

The World Health Organization, Joint United Nations Programme on HIV/AIDS and various governments of the world began to research and provide estimates on the number of people infected and the new infection rates annually on a global/continental level (Chapter 1, section 1.2). From the studies, Southern Africa emerged as having the most severe HIV epidemic in the world, the estimates were further said to be on the increase. A closer look at the African continent revealed a number of potential reasons for its high HIV representation according to various studies (chapter 1, section1.3), in Africa HIV spread from the commercial cities to the rural areas.

This type of research thought received growing attention and new factors began to be considered such as the 'agents' for the diffusion of HIV from Urban to Rural and the 'bridging populations'. Migration therefore became the main factor considered in the spread of HIV/AIDS; migrant workers, longitudinal truck workers and the like suddenly came under the spotlight. Linked closely to migration was the issue of poverty.

Poverty, socio-economy, also received growing research attention globally. The research studies seemed to prove that the most affected areas of the world were the poorer nations and poverty was aiding in the continual spread. Poverty was also said to be a complex factor to consider as it was said to play a major role in migration as well as risky sexual behavior.

At this point, some studies began to shift the focus of research from the diffusion of HIV by mobile populations to the vulnerability of mobile populations. Poverty also surfaced as a factor which could contribute to vulnerability.

The Chapter went on to present the research aims and significance (chapter 1, section 1.5). The research is primarily aimed at conducting a micro scale research which utilizes a holistic approach to the study of HIV. The holistic approach used for the study is the utilization of spatial mapping, which presents layers of information together on one map. From the study aims, 3 research questions are presented for the study covering 3 spatial aspects of the Gauteng environment; the population size, proximity between the areas of high to low endemicity and the socio-economy. The research questions are formulated to determine if the spatial aspects affect or influence the spatial distribution of HIV in the province.

The chapter rounded up by presenting a brief summary on the study area; the Gauteng province. Some of the important issues to surface is the fact that Gauteng is the economic hub of South Africa and is the fastest growing province population wise. The population is said to be on the increase due to the constant influx of migrants; informal traders, job seekers and the like, the first set of migrants to arrive in Gauteng are probably the mine workers after the discovery of gold in the province. The Gauteng province is re-visited in more detail in (Chapter 3 of the study).

5.2   Theoretical framework of the study

Chapter 2 began by arguments on the need for holistic research on HIV on a micro level. According to the literatures reviewed, there is limited work being done on HIV with a more holistic approach, there is also little work conducted at a micro scale. The literature review began by providing summaries on research work done globally, as highlighted in chapter 1, research focus have been on separate aspects of the HIV epidemic such as the diffusion of HIV and the so called 'bridging populations', migration and poverty. As noted in chapter 1, poverty being a complex factor is also viewed as having played a role in migration and risky sexual behavior.

Global studies by various international organizations provided the study with the current trends of HIV globally, chapter 2, section 2.2, one of such notable trends is the decline in the national HIV prevalence in the Sub-Saharan countries of Kenya and Zimbabwe, and some other countries however experienced an increase in the national HIV prevalence some of which are China and Indonesia. It is noted that various countries conduct Annual Sentinel Surveys to determine the trends of HIV at a national level, these surveys are conducted using data from pregnant women attending antenatal clinics and this is the internationally recognized tool in monitoring HIV.

The current world estimates for 2006 for sub-Saharan countries is 24.7 million people living with HIV and this prevalence rate is by far the highest in the world (chapter 2, Figure 2.1).

With over a 1% HIV prevalence in the population of Sub-Saharan Africa, recent studies began to shift from migration, poverty and the diffusion of HIV as the epidemic is now said to be well spread with equally high representations in both Urban and Rural areas (chapter 2, section 2.3). With this shift, vulnerability has now become a more recent research focus. Vulnerability of migrant populations to HIV, vulnerability of certain work groups and 'bridging populations' and vulnerability mapping. Various studies are considered globally, in Africa, South Africa and Gauteng.

Research done in South Africa and Gauteng is reviewed. Findings of some of the work done, chapter 2, section 2.4 reports in South Africa and Gauteng that the initial spread of HIV is due to migrant populations, some migrant populations specifically cited are mine workers, Longitudinal Truck workers and military personnel. In all instances their long hours from home, loneliness, the availability of commercial sex workers, poverty, creates the atmosphere for them to engage in risky sexual behavior. Many of the cases cited reveal sexual behavior to account for the ongoing spread with many victims having sexually transmitted infections in addition to HIV.

In chapter 2, section 2.4, the socio-economic factors and poverty have equally received a share of the research attention in South Africa and Gauteng, being inter related with migration, poverty is cited as playing a major role in the prevalence and ongoing spread of the disease. To this effect the South African government promulgated legislations in an attempt to reduce or prevent HIV/AIDS based discrimination and hence reduce poverty and deprivation.

At this stage it became necessary to classify poverty. Various studies in South Africa provide indices which are used to determine poverty; primarily having financial resources (employment) is cited. Other studies however established that financial resources alone couldn't determine poverty. The concept of deprivation is then introduced. Deprivation in addition to financial resources (employment) is accepted as the best indication of poverty or socio-economic condition. Socio-economic data is being collected annually by Statistics South Africa covering employment (Labour Source Surveys), deprivation (General House Hold Surveys, October Household Surveys) and for greater detail on poverty, (Income and Expenditure Surveys).

The chapter concludes by reviewing the use of spatial mapping as a tool in research (chapter 2, section 2.5). Limited research is noted to utilize spatial mapping, however it is gradually becoming more popular especially in HIV vulnerability studies. Various spatial mapping tools surfaced such as using Geological Information System / GeoArc softwares, spatial information systems, spatial information management systems and Geographical mapping.

The only available studies in South Africa using spatial mapping are studies conducted outside the Gauteng province of South Africa. The spatial mapping research tool is used to assist in manipulating HIV data base in order to manage HIV cases effectively, treatment management and effective resources management. No research is found on South Africa or Gauteng which utilizes spatial mapping as a research tool in order to approach the HIV epidemic in a more holistic manner and at a micro scale.

5.3   The research survey methodology

Chapter 3 begins by reviewing chapters 1, 2 with a focus on the study aims, significance and how the current study differs from the Department of Health's' studies on HIV. The data sets required for the study is then considered. Chapter 3, section 3.1 discusses the secondary archival data which is collected on 2 primary variables: HIV/AIDS from the Department of Health and Socio-economic data (labour source survey (LSS) & General household survey (GHS)) from Statistics South Africa. The steps followed and necessary clearance required before the HIV data is released is discussed in chapter 3, section 3.1. The data collected is all in numerical format, in addition to the HIV and Socio-economic data; population statistics on the study area, Gauteng is also collected.

From chapter 3, section 3.2, the research type is explained to be co relational, the reason for its selection is cited as the fact that it is the recommended methodology to use in studies where more than one variable is analyzed at a time to determine the existence of relationships. The data set relationship discussed reveals that the 2 secondary data collected (HIV, LSS & GHS) both fall within the same study period -September/October 2005. The critique of the data type used and the benefits is outlined, the main reason being the reliability of the data and the data source.

From chapter 3, sections 3.3, other methodologies used are discussed in detail. The sampling methodology is used to create population clusters for the study area, and a confidence level of 20% is used based on mathematical calculations chapter 3 section 3.4). The statistical analysis and testing used is the bi-variate analysis and the 2 sample T-test, the steps followed is discussed in chapter 3, section 3.5. The researcher makes use of the MS office programme MS Excel to perform the bi-variate / 2 sample T-tests. The detail is included in (Appendix 2).

From section 3.6 the study area Gauteng is reviewed in detail. The purpose of this review is to establish the possible overlap of spatial factors in the environment. The study purpose being to utilize a more holistic approach in investigating the HIV epidemic in Gauteng needed to review information on the spatial environment of Gauteng. This first spatial factor considered is the population dynamics of Gauteng.

The main issue to highlight is rapid urbanization, migration and its influence on the socio-economic environment.

The socio-economic environment of Gauteng is then considered. The main information coming to light is the increase in poverty, informal settlement and lowering of living standards due to the rapid population increase. Under the socio-economic environment, deprivation expressed in terms of access to basic amenities is considered important in the challenge being faced by the public health system to provide access to good medical care.

The chapter concludes by discussing the growing prevalence of HIV and the impact it is having on the Gauteng environment.

From this chapter the researcher notes that spatial variables of Gauteng may indeed play a role in the way HIV is distributed in the province.

5. 4   Research analysis, presentation and interpretation

Chapter 4 provides the analysis of the data sets collected; the HIV data from the Department of Health, the Labour Source data and the General Household Surveys from Statistics South Africa. Whilst the LSS data provide information on the economic situation of Gauteng residents, the GHS data provides information on the Social situation in Gauteng.

The HIV data provides information on the distribution of HIV in Gauteng. The HIV and population data are presented in the form of Spatial Maps, whilst charts are used to present the socio-economic data.

In this chapter, a summary of the study and important conclusions drawn from the data analysis presented in chapter 4 is discussed.

The summary of the research is presented, the general findings, findings related to the literature reviewed, the achievement of the study, unanticipated findings during the study and a discussion of the implications for action and recommendations for further research.

5.5   Achievement in the study

The study mapped the prevalence of HIV/AIDS in Gauteng. Four spatial maps were produced to show the spatial distribution of HIV/AIDS in Gauteng. The maps were produced by the South African Department of Health, in 2006, using the HIV/AIDS data from the Department of Health Annual Sentinel Surveys of 2005, summarized by the researcher.

The following maps were produced:

- The spatial distribution of HIV positive cases in Gauteng (Figure 4.1)
- The spatial distribution of HIV negative cases in Gauteng (Figure 4.2)
- The spatial distribution of HIV positive & negative cases in Gauteng (Figure 4.3)
- HIV distribution and population distribution in Gauteng (Figure 4.4(a) & (b))

The spatial maps provide a visual summary of the distribution of HIV/AIDS in Gauteng. The significance of the maps and the findings are discussed in the section below.

5.5.1 Findings from the spatial distribution of HIV/AIDS in Gauteng

The spatial map depicting the distribution of HIV positive cases in Gauteng is super imposed with the areas. The spatial patterns from the map shows the highest HIV positive cases in Vlakfontein region, Meadowlands region, Diepkloof region, Vosloorus region and the Ventersport, Bekkersdal region. The distribution of HIV positive cases however could not be accurately interpreted without the distribution of HIV negative cases being considered.

The distribution of HIV negative cases in Gauteng when interpreted by itself from the spatial map showed similar patterns to the HIV positive representation. The highest HIV negative cases are represented in the: Vlakfontein region, Meadowlands region, Diepkloof region and the Vosloorus regions respectively. The following regions had equally high representations of HIV positive and negative cases: Vlakfontein region, Meadowlands region, Diepkloof region and Vosloorus region.

This representation indicates a mid- range HIV prevalence in the areas. Mid- range from the data range not being deductive, implies there are more HIV negative people in the area than positive, and the HIV prevalence for the areas is average.

The only region which had a high record of HIV positive cases and a low record of HIV negative cases was the Ventersport, Bekkersdal region of the West Rand. From this representation, the Venterspost Bekkersdal area has the highest prevalence of HIV in Gauteng. In addition the lowest HIV positive cases and highest HIV negative cases was recorded in the Tshwane municipality also showing the area to have the lowest HIV prevalence in Gauteng.

The spatial representation of the HIV and population data shows the most populous regions of Gauteng are: Temba, Garankuwa, Soshanguwe, Tshwane and Nelmapius areas of the Tshwane Municipality. The lowest population size is recorded in: Vlakfontein, Ventersport Bekkersdal. Whilst the Vosloorus, Diepkloof and Meadowland areas have a mid-range population size.

The descriptive interpretation shows the Ventersport Bekkersdal area has the lowest population size and the highest HIV prevalence. Conversely, areas in the Tshwane municipality which recorded the lowest HIV positive data also had the largest population size.

5.5.2 Findings from the research questions and descriptive interpretations

The first research question

The first research question addresses the population size and the distribution of HIV in Gauteng. The results from the spatial map reveals that the population size is highest in: Temba, Garankuwa, Soshanguwe, Tshwane and Nelmapius areas of the Tshwane Municipality and lowest in Vlakfontein, Ventersport Bekkersdal. The Vosloorus, Diepkloof and Meadowland areas have a mid-range population size.

The distribution of HIV when compared to the population size of the municipalities shows that the area with Highest HIV prevalence in Gauteng; the Ventersport Bekkersdal area had the lowest population size. The areas in Tshwane metropolitan municipality, which recorded the lowest HIV positive prevalence rates, had the largest population size. In addition, the Johannesburg and Ekurhuleni municipalities respectively had a mid-range HIV prevalence and a low population size. The spatial map interpretations show no patterns between the population size and HIV prevalence.

The second research question

The second research question addressed the relationship between the distribution of HIV/AIDS in Gauteng and the proximity of the area of high endemicity to the area of low endemicity. From the spatial maps the distance between each of the regions did not affect or impact on the distribution of HIV in Gauteng. The Venterspost Bekkersdal with the highest HIV prevalence was situated closest to the Vlakfontein region which had a mid-range HIV prevalence and the distribution of HIV in both areas did not show any significant relationship.

The third research question

The third research question addressed the implications of poverty and the prevalence of HIV in Gauteng. The municipality with the highest poverty level is the Sedibeng Municipality. Tshwane municipality on the other hand has the lowest levels of poverty. When compared to the prevalence of HIV, Sedibeng had second highest HIV prevalence and Tshwane had the lowest HIV prevalence. In other words, Tshwane had the lowest poverty and HIV prevalence levels whilst the Sedibeng had the highest poverty and 2nd highest HIV prevalence levels.

This interpretation therefore showed the existence of a relationship between poverty and the way HIV is distributed in the areas.

5.5.3 Findings related to the research questions and statistical testing

5.5.3.1 Findings related to HIV and population size

The statistical test of association being more deductive was used to confirm the interpretive results from the spatial maps. When the relationship between the distribution of HIV positive cases and the population in each of the selected areas was tested, the results derived showed that there is no significant relationship between the population and the distribution of HIV in the areas.

From the statistical results above there seems to be a consistent indication that the size of the population does not contribute to the way HIV is distributed.

On the basis of population size alone it may be difficult to ascertain possible relationships even though they existed. Perhaps the population size should have been considered with other variables or the way it impacts in socio-economy. In addition, perhaps utilizing the population size was ambiguous and the population density should have been considered. Whilst the researcher chose to utilize population size rather than density due to its relevance to the spatial aspect of HIV distribution, the study seemed to overly simplify the dynamics of population by merely subjecting such complex factor to basic interpretations and mathematical tests.

The results are not being questioned however the possibility of a different result being obtained if the variables used were slightly changed is certainly valid.

5.5.3.2 Findings related to HIV and location

The relationship between the distribution of HIV positive cases and the distance between the selected areas when tested showed that there is no significant relationship between the distance between the areas and the distribution of HIV in the areas.

This finding once again seems to verify the descriptive interpretation obtained from the spatial maps. The issue of proximity is quite a relative one. It is quite difficult to determine the extent one would go, or where, when and how, to obtain heterosexual gratification; again this is only one of the many ways in which HIV is spread.

The closeness between two areas may not necessarily influence people's movement into the area or/and risky sexual behavior.

A number of factors would influence movement to and from one area to the other; it could be job opportunities, the presence of reliable transportation networks, entertainment, and access to accommodation or other facilities or perhaps relatives living in the area. Although one may expect similar clusters of an epidemic to be seen in areas of close proximity, however HIV is not spread through touch, air, water, insects and the like. This makes it a disease that is deliberately spread. In the past the spread of HIV was traceable however in more recent times with the epidemic being widely represented it is a tough call to determine the new patterns of spread.

Finally, the definition of proximity used for the study did not take transportation networks, the presence of mountains, rivers and so on into consideration. The question could therefore be asked that if these variables were taken into consideration would the results be different? If one could ascertain where the residents of the most affected areas visited regularly, would there be a similar representation of HIV there? Would it be of significance to determine the recent temporal movement patterns in determining HIV distribution spatially?

5.5.3.3 Findings related to HIV and socio-economy

The relationship between the distribution of HIV positive cases and the poverty level expressed in terms of employment when tested, showed that there is a significant relationship. Similarly the relationship between the spatial distribution of HIV and poverty in terms of deprivation when tested also showed that a significant relationship exists. Therefore on a social level and on an economic level, the spatial distribution of HIV in Gauteng is influenced by the socio-economic level of its residents.

The third research finding also seems to support the interpretative results obtained from the charts and tables. On the basis of this study alone can the socio-economic situation of Gauteng residents really be determined by financial resources and 8 deprivation indices alone? Why would HIV appear to be prevalent amongst those of a lower socio-economic level? Could there be other factors not considered influencing this representation such as culture, religious beliefs, family background, education, perceptions/ attitudes towards HIV prevention, value for life, self dignity and esteem and the like? Surely poverty cannot be viewed in isolation as poverty plays a role in other factors such as sexual violence, sexual abuse, sex trade and mother to child HIV transmissions.

What about HIV orphans, women and the frail? Are they not victims of the epidemic rather than the reason for its spatial representation? Indeed it has been an ongoing argument that HIV prevalence is closely associated with poverty however poverty on its own is not a causative factor but rather an influencer of other factors creating the ideal environment for the spread of HIV.

5.6   Findings related to the literature

Marcus & Ebrahim, (2005) in their study showed that the prevalence of HIV amongst the unemployed South Africans consisting primarily of blacks was relatively higher than that of the employed; consisting predominantly of whites.

This literature supports the research findings that there is a relationship or association between HIV in Gauteng and the employment levels. Other studies include: Evian (1994); Floyd (1997); HIV/AIDS/STD Strategic Plan for South Africa (2000); Hasnain (2004); Desmond (2006) and UNAIDS (2006). These studies in one way or the other evidence the relationship between HIV and poverty.

The absence of a relationship between HIV and the population size reveals that HIV is not necessarily more prevalent in areas of high population; the studies on the diffusion of HIV do not claim the size of the population affects the spread of HIV, rather they allude it to various complex factors linked to mobility such as; poverty, loneliness, education, job type and "risky sexual behavior" which is a by product of one or more of the variables above. Some studies also show mobile populations contribution to the diffusion of HIV from areas of high endemicity to low endemicity.

Some of the studies focusing on population mobility and HIV include: Decosas, et al, (1995); Fages (1999); Gilgen, et al (2001); Brummer (2002); Mathe (2002); Haler (2003) and Coast (2005).

Finally, although spatial mapping is a growing research tool in the mapping of HIV, most of the studies available are focused on HIV vulnerability. In addition, spatial mapping was also used in Medical Geography research studies to determine the patterns of spread of communicable diseases such as Tuberculosis (Radkhoshnoud, 2002). Studies utilizing Spatial Mapping as a research tool for HIV studies in general, are however limited.

5.7   Unanticipated findings encountered during the study

HIV has become one of the world's largest concerns; it has become a major research focus for many organizations and researchers; world governments are stacking funds to fight the disease; medical organizations relentlessly working on scientific formulas, medications, vaccine trials to mention a few. With the attention HIV is receiving nationwide, the lack of information on HIV in the spatial context was unanticipated. As HIV studies evolve over the years so also the approaches to the studies should be evolving.

The implication of this is severe as research cannot tell how HIV and its spread is enhanced or abated by the complex interactions it has within the spatial environment. Due to this set back, the researcher had limited literature guidance, and warnings on the pitfalls of using spatial analysis in HIV studies.

The advantages of spatial analysis were obvious however from the study, complex variables such as poverty; in terms of employment and deprivation could not be reasonably interpreted if depicted spatial form.

The second unanticipated finding encountered was the fact that the spatial maps produced for the study provided qualitative results which had to be used in conjunction with statistical tests for more deductive interpretations. Although the spatial maps were interpreted in a qualitative manner, the findings were the same as the statistical tests which are quantitative in nature and more accurate. Although unanticipated the finding here was a good one; the fact that both the qualitative and quantitative methods of data analysis yielded the same result.

Thirdly was the fact that the study could not obtain summarized data on the October household surveys. The General household survey on the other hand contained so many indices relating to deprivation. The research had to utilize two indications (low deprivation and high deprivation) per indices to simplify the many categories available.

The findings relating to deprivation represented the social environment of Gauteng and yielded results which coincided with the straight forward labor source survey data on employment.

The fourth finding which was unanticipated came from two of the research findings; the fact that there was no relationship between HIV and the proximity of areas of high to low endemicity and the fact that there was no relationship between HIV and the population distribution. Although the factors affecting the spread of HIV are complex as indicated above (section 5.5), one would have expected population size and distance to affect the spatial distribution of HIV in Gauteng and show some level of relationship.

Finally, a holistic and micro-scale study has the tendency to become too enormous for one study, the researcher subsequently had to manage this tendency by utilizing summaries, assumptions and compressing information wherever possible.

5.8   Conclusion

The research has been able to provide an additional puzzle in understanding the prevalence of HIV in Gauteng. The most obvious factor being poverty as complex as it is revealed the existence of a relationship between itself and the spatial distribution of HIV in Gauteng. Stakeholders could therefore begin by seeking to fully understand the complexities of poverty and diligently begin to fight the most relevant aspects of poverty as a strategy in the fight against the epidemic.

The research being conducted on a micro-scale yielded some benefits in that the spatial distribution of HIV at that level was not consistent. This signified that no specific patterns of HIV representation existed. The population of the selected areas studied and the proximity between them did not also contribute to the prevalence of the disease; however distance could be a useful tool in managing the disease and fighting against the spread.

In conclusion, the spatial distribution of HIV/AIDS in Gauteng should be seen as an aspect of the epidemic which should receive more studies.

5.8.1   Implications for future action

In the future, studies like this should be carried out in conjunction with the current researching bodies such as the departments of Health and Statistics; the reason for this is to be able to collect more specific data relating to the spatial aspects of the environment, more detailed data on a micro scale, and other factors relating to poverty, such as culture, religious beliefs, value to life and the like.

Although studies like this are being conducted on levels lower than municipal levels, the data collected should also be analyzed at lower levels, and not only at the provincial levels as is currently been done, micro-level analysis would provide more detailed information on the HIV/AIDS epidemic.

The need for spatial data analysis; spatial information management systems and Geographical Information Systems is paramount. These systems are useful in managing the epidemic and should be greatly considered by stakeholders and government bodies. The use of GIS software in research would provide additional dimensions into the spatial aspects of the epidemic.

5.8.2 Recommendations for further research

The researcher recommends that studies on the spatial distribution of HIV/AIDS be carried out at a municipal levels and lower across all the provinces in South Africa. The distribution of HIV/AIDS should be studied in spatial terms; and as many spatial variables as is logical should be taken into consideration in such studies.

Spatial maps, GIS software, spatial information systems and management systems should be used more in the representation of HIV/AIDS data. Finally, the Annual Sentinel Surveys by the Department of Health should be carried out concurrently with the STATS SA household and labor surveys and the findings should be compared to establish or dispel beliefs of relationships.

5.8.3 Concluding Remarks

HIV/AIDS is indeed the most challenging problem being faced by the Department of Health in South Africa, the agony it has brought to thousands of families and the huge blow it has thrown on the economic sector makes it one of the most important subjects today. The relationship between HIV and poverty has been highlighted in various studies; this study in addition has further expressed this; the way poverty is dealt with from now on may be one of the major keys to the fight against the disease.

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DEPARTMENT OF HEALTH

Directorate: Research & Epidemiology

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RESEARCH APPROVAL

DATE: 30/03/2007 PAGES: Including Cover 04

PROVINCIAL RESEARCH COMMITTEE.

RESEARCH PROPOSAL EVALUATION FORM FOR APPROVAL BY THE HEAD OF THE DEPARTMENT.

Researcher's Name: Uche Ezike-Dennis

Researcher's contact details: 072-172 8926

Research Topic: The Spatial Distribution of HIV/AIDS.

Supervisor's Name: Melanie Nicolau

Date submitted: 04/08/2006

Date Reviewed: 19/01/2007

Reviewer's name: Dr ML Likibi

SECTION A

	YES	NO	N/A
1. Is this research project within the scope of the Department of Health key policy priorities/directives?	X		
2. Content of Research: Original work • New facts, ideas • Confirmation of uncertain data • Repetition of known data and consequently of limited importance • Unreliable and/or inadequate • Confusion of topics/questions • Intervention study	X	X X X X X X	
3. Is the title of the research project suitable?	X		
4. Are the objectives of the research project adequate?	X		
5. Could the objectives be limited to better focus on the project's main objective?		X	

Research Topic: The Spatial Distribution of HIV/AIDS.

6. Writing style				
• The text of the proposal is clear	X			
• The nomenclature used is correct	X			
• The references used are relevant, comprehensive and accurate (corrected)	X			
• The spelling and grammar are correct	X			
• The language needs improvement	X			
• The research proposal needs restyling and rewriting	X			
7. Are the research methods appropriate to the study	X			
8. Does the study have ethical approval? **Letter from Geography HOD UNISA attached**		X		
9. Is the definition and measurement of variables consistent with the scope of the proposal	X			
10. Is data collection method in line with study design?	X			
11. Is time frame of the proposal adequate to meet the objectives?	X			
12. Is it stated in the proposal the method of dissemination of the results of the research project?	X			
13. Is the possible conflict of interests clarified? Are financial implications and financial support transparent?	X X			

Summary of the proposed study

The **objective** of the study is to represent the prevalence of HIV and AIDS in pregnant women attending antenatal clinics in order to represent the spatial distribution of the epidemic in Gauteng province.

The research questions are:

- o Can the spatial distribution of HIV and aids be mapped
- o What are the factors responsible for the spatial distributions
- o Is there a difference in the prevalence of HIV and aids across locations as represented by the municipalities
- o Is there a difference in the prevalence of HIV and based on the affluence of the suburb

Study design: survey of the sentinel sites

Data collection

Data for this study is collected at three phases which are as follows:

Initial phase is the determination of the district municipalities to be surveyed, the population and specific sentinel sites to be surveyed

Second phase is the collection of secondary data from the department's health information services archives and the private sector antenatal clinics in Gauteng Province

The spatial distribution of the collected antenatal survey data will review through spatial mapping and use of the GIS

Research Topic: The Spatial Distribution of HIV/AIDS.

Data analysis:
Analysis of the collected data would be comparatively analyzed and statistical trends observed.

Budget
No Financial implications for the GDoH .

Reviewer's final conclusion:
Accepted on condition the study protocol is reviewed and approved by an accredited Ethics Committee
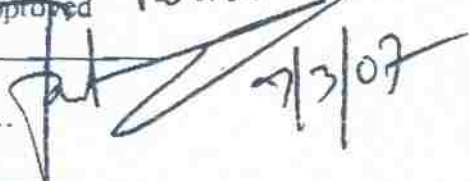
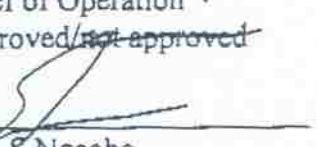The Evaluator:

Dr ML Likibi
Specialist

Approved/not approved   *Recommended*

Dr A. Rahman
Date:................   7/3/07

Chief of Operation
Approved/not approved

Mrs. S Ngcobo
Head of Department
Date: 13 | 03 | 2007

I am concerned about the study in the sense that this might increase the perception that the desease is only in certain population groups who are users of our services. The Interpretation of the study and conclusion should highlight the limitations.

Research Topic: The Spatial Distribution of HIV/AIDS.

APPENDIX 2

MS Excel 2 sample T-test Calculation method (MS Excel Help)

T-test

Returns the probability associated with a Student's t-Test. Use TTEST to determine
whether two samples are likely to have come from the same two underlying populations
that have the same mean.

Syntax

TTEST(array1,array2,tails,type)

Array1   is the first data set.

Array2   is the second data set.

Tails   specifies the number of distribution tails.
If tails = 1, TTEST uses the one-tailed distribution. If tails = 2, TTEST uses the two-tailed distribution.
Type   is the kind of t-Test to perform.

If type ec	This test is performed
1	Paired
2	Two-sample equal variance (homoscedastic)
3	Two-sample unequal variance (heteroscedastic)

Remarks

  If array1 and array2 have a different number of data points, and type = 1 (paired),
  TTEST returns the #N/A error value.
  The tails and type arguments are truncated to integers.
  If tails or type is nonnumeric, TTEST returns the #VALUE! error value.
  If tails is any value other than 1 or 2, TTEST returns the #NUM! error value.

Example

The example may be easier to understand if you copy it to a blank worksheet.

How?

  1. Create a blank workbook or worksheet.
  2. Select the example in the Help topic. Do not select the row or column headers.

  Selecting an example from Help

  3. Press CTRL+C.
  4. In the worksheet, select cell A1, and press CTRL+V.
  5. To switch between viewing the results and viewing the formulas that return the results,
 press CTRL+` (grave accent), or on the Tools menu, point to Formula Auditing,
and then click Formula Auditing Mode.

	A	B
1	Data 1	Data 2
2	3	6
3	4	19
4	5	3
5	8	2
6	9	14
7	1	4
8	2	5
9	4	17
10	5	1
	Formula	**Description (Result)**
=	TTEST(A2:A10,B 2:B10,2,1)	Probability associated with a Student's paired t-Test, with a two-tailed distribution (0.196016)