COMPARISON OF KNOWLEDGE AND ATTITUDES ON HIV BETWEEN HIV INFECTED AND HIV-UNINFECTED CHILDREN AGED 10 - 14 IN SOUTH AFRICA, 2012.

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, School of Public Health in partial fulfilment of the requirements for the degree of Master of Science in Epidemiology (Biostatistics)

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DECLARATION

I, **<u>Abel Musha Mapfumo</u>** declare that this research report is my own work. It is submitted for the degree of Master of Science in Epidemiology (Biostatistics) in the Faculty of Health Sciences at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university. Where I have used supporting research findings, these have been acknowledged accordingly. Data usage was approved by the Human Research Ethics Screening Committee of the University of the Witwatersrand.

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Abel Musha Mapfumo

Signed on the 20th……………………..day of……November……2020

DEDICATION

To Makanaka, Mazvita and Mushawakura Mapfumo

ABSTRACT

Background

About 90% of the children under the age of 15 living with HIV worldwide were infected through vertical transmission. In 2017 there were approximately 7.9 million people living with HIV in South Africa, and 262 000 of these were children under the age of 15 years (Simbayi et al., 2019). Research has shown that the majority of infected children did not know much about HIV as family members would conceal their status for fear of stigmatisation. It is believed lack of HIV/AIDS knowledge in children increases fear of infection, resulting in them developing negative attitudes towards people living with HIV.

Methodology

The primary study was a multistage cross-sectional survey carried out by the Human Sciences Research Council (HSRC) in South Africa in 2012. A stratified multistage survey was conducted in all the 9 provinces of South Africa. Stratification was by province and geotype of the enumeration area (EA). The primary sampling units were the EAs and the secondary sampling units (SSUs) were the visiting points (VPs) or households. Of the 15000 households that were selected, 11079 agreed to take part in the survey, and 38431 individuals were interviewed. Of those who were interviewed, 28 997 agreed to be tested for HIV. A total of 4520 children between the ages of 10 and 14 inclusive participated in the survey. Of the 2793 children who provided a blood specimen, 2725 tested negative for HIV and 68 tested positive. This research project involved secondary data analyses of the 10 to 14 year olds from the HSRC survey data.

Results

There was no significant association between knowledge on HIV/AIDS and HIV status, neither was there association between attitudes towards PLHIV and HIV status. Age and exposure to media were positively associated with knowledge. There was a positive association between media exposure and attitude scores ($p<0.001$). Attitudes were significantly more positive among females ($p = 0.05$).

Conclusion

There was no significant difference in knowledge on HIV/AIDS between infected and uninfected children, neither did HIV infected and uninfected children differ in their attitudes towards PLHIV. Schools could do more to help increase HIV knowledge in South African children.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Background

The HIV/AIDS pandemic is among the greatest public health challenges worldwide, with approximately 37.9 million people living with the virus in 2018 (United Nations Joint Programme on HIV/AIDS (UNAIDS), 2019). In 2012 prevalence was highest in Sub-Saharan Africa, the region inhabited by 71% of the world population of people living with HIV (UNAIDS, 2013). South Africa was the hardest hit with an estimated 1000 new infections occurring each day in 2012 among residents aged 15 – 49 years (Rehle et al., 2015).

Of the global 3.3 million children who were HIV positive in 2012, 88% resided in Sub-Saharan Africa (UNAIDS, 2013). Fondoh et al. (2010) point out that of all the children under the age of 15 living with HIV worldwide, about 90% of them acquired the virus through vertical transmission. This implies that, in the majority of cases, children did not actively take part in the transmission process, they just inherited the infection. Drummond et al. (2008) found that the majority of infected children did not know much about HIV as family members would try to keep HIV a secret for fear of the stigma attached. Dzhugudzha et al. (2015) contend that the lack of HIV/AIDS knowledge in children increases fear of infection, resulting in them developing negative attitudes towards those living with the virus.

Recent research has shown that HIV/AIDS is still a formidable challenge in South Africa where in 2017 there were about 7.9 million HIV positive people, 262 000 of whom were children under the age of 15 (Simbayi et al., 2019).

HIV infection has far reaching results. Not only does it impact the health condition of infected individuals, the impact spreads to households and communities. Nations hardest hit by the epidemic often experience stunted development and economic growth (Dixon et al., 2002).

1.2 Literature Review

1.2.1 HIV testing, knowledge, perceptions and behaviour

From the beginning of the 21st century, there has been a remarkable decline in HIV incidence and HIV related deaths in Sub-Saharan Africa, which is in part due to the notable rise in the use of antiretroviral therapy (ART) in the region (Chan and Tsai, 2018). While there has been hope that an “AIDS free generation” will someday be achieved (UNAIDS, 2016), realising this goal remains a pipe dream until individuals start presenting for diagnosis and ART initiation early in the course of infection (Siedner et al., 2015). Evidence has shown that early treatment not only retards disease progression but also prevents further transmission (UNAIDS, 2015). Frequently, individuals present for testing only after symptoms of sickness begin to show, by which time they would probably have infected many others. Even with the knowledge of the availability of HIV counselling and testing (HCT) services, approximately 25% of the people living with HIV world-wide are not aware of their HIV status (UNAIDS, 2018). Fear of discrimination and fear of testing positive are among the leading barriers to the uptake of HCT (Strauss et al., 2015). In South Africa only about 65.5%% of people who were aware of the availability of HIV counselling and testing services ever presented for HIV testing (Shisana et al., 2014).

The extent to which the general population is knowledgeable about HIV is an important determinant of the success of intervention strategies aimed at reducing new infections and encouraging people to present early for diagnosis and treatment (Chan and Tsai, 2018). Perceived risk and knowledge on HIV have been shown to be important precursors to sexual behaviour change (Noroozinejad et al., 2013). The strategy in Sub-Saharan Africa has been to provide HIV transmission knowledge in the hope this would persuade individuals to shun behaviours associated with high transmission risks (Sharma et al., 2017). In addition to behaviour change, knowledge of infection risk could also encourage individuals to seek HIV counselling and testing services. If for example individuals were made aware that a healthy individual could actually be HIV positive, they would probably be persuaded to present for testing (Babalola, 2007).

Research conducted in Sub-Saharan Africa has shown an association between knowledge of HIV and testing among homosexual men (Horth et al., 2015), female sex workers (Chanda et al., 2017) and general population samples (Teklehaimanot et al., 2016). Lack of knowledge of

HIV transmission and treatment promotes stigma in the general population irrespective of their income level (Genberg et al., 2014). Educational interventions could help reduce wrong perceptions on HIV transmission and mortality risk, in the process reducing HIV associated stigma (Stangl et al., 2013) and promoting the uptake of HCT services.

1.2.2 Intervention in South Africa: Achievements and challenges

South Africa has put in place a number of measures aimed at reducing morbidity and mortality. These measures include the expanded rollout of the ART programme, implementation of the 'test and treat' guidelines, the approval of pre-exposure prophylaxis (PrEP), introduction of an improved prevention of mother–to-child transmission (PMTCT) programme, the distribution of condoms, the "voluntary medical male circumcision" (VMMC) programme and the introduction of sexuality education in South African schools (UNAIDS, 2017). Sexuality education in South African schools is aimed at furnishing children with accurate information on safe sexual practices (Francis, 2010).

Notwithstanding the fact that South Africa has a big and well established condom distribution programme (Milford et al., 2017), the country's rate of infection was still the world's highest in 2016. Making condoms available has not done enough to curb infections. Knowledge and positive attitudes on the use of condoms, and willingness to use them consistently could make a greater difference. A study carried out by Ismael and Zangana (2012) revealed that condom use among males aged between 15 and 49 years in Erbil Governorate, Iraq, was very low mainly as a result of lack of knowledge about effective condom use and low perception of HIV risk.

Due to unequal power dynamics in sexual relationships, it is not often possible for a woman to bring condom use into the relationship. Some religious sectors also promote abstinence for as long as people are not married, discouraging youths from ever using condoms (Milford et al., 2017).

While ART was shown to substantially reduce rates of transmission during birth even in countries where resources are not adequate (Ghelardi et al., 2012), the fact that in 2017 South Africa still had 262 000 children living with the virus may suggest that a substantial number of women still do not make proper use of PMTCT services. If transmission was vertical in 90% of HIV positive children (Fondoh and Mom, 2017), it is possible that some among the remaining 10% acquired the virus through horizontal transmission, which could in part be due to lack of knowledge on HIV transmission.

Research carried out in Uganda in 2011 showed that the majority of infected young males were circumcised (Chimoyi and Musenge, 2014). Circumcision is also a common practice among cultures in South Africa, and it is usually carried out during adolescence in boys. Without proper education, the belief that circumcision protects against infection could result in risky behaviour among adolescents. As Sovran (2013) puts it, circumcision, in essence, is not reliably protective against HIV transmission on the individual level though population statistics may suggest less prevalence among the circumcised.

1.2.3 Adolescence

Development of specific expertise and the honing of individual skills for the mainstream workforce and future economic productivity mostly take place at the adolescent stage (Salam et al., 2016).

Adolescence is a critical life stage where behavioural changes occur, often which have significant impact on the health of the individual (Salam et al., 2016). Wrong use of substances and unsafe sexual practices are among the risky behavioural practices which could substantially impact the health of individuals later in life, and such risky practices frequently arise at the adolescent stage (Salam et al., 2016). Among noteworthy causes of mortality during adolescent years is “suicide, violence, infectious diseases, and teenage pregnancy” (Salam et al., 2016). In 2012, approximately 1.3 million adolescent deaths were recorded worldwide, with 70% of the deaths occurring in Africa and South East Asia (WHO, 2015). Making a risky decision is related to the perceived amount of risk involved (Mills et al., 2016). While at the onset of adolescence children characteristically desire independence from parents, their need for social support from peers typically increases at this stage (Hall-Lande et al., 2007). Chances are greater that an adolescent will engage in risky behaviour when in the company of peers than when they are alone.

Research done by Knoll et al. (2015) with visitors to the Science Museum in London showed that compared to adult opinions, in early adolescence peer opinions had greater influence on the way risk is perceived. With the onset of adolescence, individuals begin to challenge the authority and advice of adults in preference for peer opinions (Knoll et al., 2015).

While authors have placed different age limits on the adolescent age group, Sawyer et al. (2018) believe “a definition of 10-24 years” would be more inclusive. Sommer (2011) places those aged 10 to 14 years in the early adolescence category, and classifies those between the ages of 15 and 24 years as “post pubescent young men and women”. Substantial HIV morbidity and mortality, as well as unplanned pregnancies and sexually transmitted infections often emerge soon after the early adolescence age group in sub Saharan Africa (Sommer, 2011). Public health intervention would be more effective if it targeted those aged 10 to 14 years (Sommer, 2011). In this research project attention was restricted to adolescents who are 10 to 14 years old.

1.2.4 Knowledge of sexual and reproductive health among adolescents

In spite of being the most important target for HIV and premarital pregnancy prevention efforts, not much is known about children at the earliest stage of adolescence (Bankole et al., 2007). Research conducted in four sub-Saharan countries revealed that while during early adolescents children lacked in-depth knowledge on sexual and reproductive health issues, they had already begun sexual activity and most believed that even their friends were sexually active (Bankole et al., 2007).

Rahman et al. (2011) conducted a study with adolescents in Malaysia and found that females had significantly higher knowledge on sexual and reproductive issues than males of the same age group. The knowledge assessed included such issues as whether family members could freely touch their genitalia, whether at menarche a female could fall pregnant, whether premarital sex could result in pregnancy, and whether there existed a relationship between baby dumping and premarital pregnancies. On the other hand, in Pakistan (Shaikh and Rahim, 2006) found that boys were more knowledgeable than girls on issues concerning puberty, pregnancy, family planning and sexually transmitted infections. (Bobhate and Saurabh (2011) conducted research with female adolescents in Mumbai and found that the menstrual hygiene practices of 32% of the girls was unsatisfactory. The same study showed a positive association between school attendance and knowledge on menstruation.

In a study conducted with adolescents in south-western Nigeria, Salako et al. (2006) found that not only did male adolescents initiate sex earlier than females, boys also knew more about contraception than girls. Awareness on condom use was higher among boys than it was among girls.

Even with the knowledge of their availability, some adolescents are reluctant to utilise reproductive health services. In Ethiopia Abajobir and Seme (2014) found that disapproval from parents, unavailability of basic information and pressure from sexual partners were among the factors that deterred adolescents from making use of reproductive health services. The reproductive health services included information on family planning and treatment of sexually transmitted infections, education and communication.

It is important that all children have correct and age appropriate knowledge sexual and reproductive health issues irrespective of gender. In a study conducted with parents of adolescents in Zimbabwe Svodziwa et al. (2016) found that parents, who are supposed to exert the most consistent and long lasting influence on the lives of children, were not always comfortable discussing sexuality and reproductive health issues with children of the opposite sex. Provision of sexuality and life planning education in schools, together with availing youth friendly health services could go a long way in combating HIV and sexually transmitted infections among adolescents, along with preventing premarital pregnancies. In South Africa, Magnani et al. (2005) found that the life skills education provided in school was capable of conveying crucial information and helping children develop skills relevant to reducing the risk of contracting HIV.

1.2.5 HIV/AIDS knowledge and attitudes among adolescents

It can be argued that risky sexual behaviour in adolescents could be a result of lack of knowledge on HIV transmission risk. Pharr et al. (2017) found that adolescents who were less knowledgeable on HIV/AIDS issues were more likely to engage in risky sexual behaviour. Nubed and Akoachere (2016) found a positive association between knowledge and positive attitudes towards people living with HIV (PLHIV) among secondary school children in Cameroon. The same study however showed no association between knowledge and safe sexual practices.

Knowledge and attitudes on HIV may not be the same for infected and uninfected adolescents. A child who would have lived with HIV, probably with an HIV positive parent or who would have been orphaned due to HIV/AIDS may be expected to know more about HIV than an uninfected and possibly unaffected counterpart. However, a number of infected young children do not know their status (Simbayi et al., 2019). Early life experience as an infected and vulnerable individual might have a bearing on children’s attitudes on HIV, especially as they approach adolescence. The fact that the majority of infected children would have passively inherited the virus (Fondoh and Mom, 2017) might have an additional impact on their attitudes towards the virus.

People diagnosed with HIV in South Africa often do not feel empowered to disclose their status for fear of stigmatisation (Visser et al., 2009). HIV infected children growing up in environments where they face prejudice could result in them feeling rejected and unworthy, which may give rise to them resenting life and society. Wei et al.(2016) contend that children infected with HIV have unique psychological challenges that may not be addressed by traditional treatment approaches. They further argue that such children, compared to their uninfected counterparts, are more likely to face stigma, discrimination and depression. Feelings of social isolation in adolescent children may lead to them developing poor psychological health (Hall-Lande et al., 2007).

Abimanyi-Ochom et al. (2017) compared HIV/AIDS knowledge, attitudes and practices between disabled and non-disabled people in Uganda. Contrary to earlier findings, they found that the disabled were no less knowledgeable as far as HIV/AIDS issues are concerned, compared to their able-bodied counterparts. In this research project a comparison of knowledge and attitudes on HIV was made between HIV positive and HIV negative children in South Africa.

1.2.6 Education, Knowledge and attitudes on HIV

A study conducted by Hargreaves et al. (2008) with young people aged 14-25 years in South Africa showed that while those in school exhibited lower-risk sexual behaviours, there was no significant difference in HIV knowledge between students and non-students. Another study carried out by Johnson et al. (2012) with mentally ill patients in Soweto, South Africa, showed that patients with at least grade 8 education were 1.5 times more knowledgeable than those who did not have a minimum of grade 8 education. Adeomi et al. (2014) found that peer education amongst adolescents in Nigeria improved their HIV knowledge and attitudes scores from 50.0% to 86.7% and from 49.0% to 85.6%, respectively. According to the findings of Jodati et al. (2007) in a study conducted with young students in Iran, peer education, alongside other educational programmes improved knowledge on HIV and effected significant changes in attitudes towards PLHIV. In South Africa, in addition to increased interaction opportunities with other learners, children who attend school have access to organised peer education through a subject known as “Life Orientation”. In this subject, HIV/AIDS is one of the topics that are extensively discussed. South African children who do not attend school may consequently lag behind in terms of HIV knowledge, and may not exhibit identical attitudes as those who are in school.

Sallar (2009) found that among Ghanaian adolescents, those that attended school expressed greater willingness to take care of relatives living with HIV/AIDS, reflecting a more positive attitude towards PLHIV than their out-of-school counterparts.

1.2.7 Age, Knowledge and attitudes on HIV

Research conducted by Hossain et al. (2006) with university students in Bangladesh showed that age, father's income and media exposure were some of the significant predictors of HIV knowledge. In another study conducted in Iran, Masoudnia (2016) found age, gender and education level to be among factors significantly associated with discriminatory attitudes towards PLHIV. According to the study, discriminatory attitudes became more negative with increasing age. Though the age range (10-14 years) of participants in this research project may not be that wide, knowledge and attitude scores among 10 year olds may not be the same as those of 14 year olds.

1.2.8 Sex, Knowledge and attitudes on HIV

Bradley et al. (2011) compared HIV/AIDS awareness in 2003 and 2009 among residents of South India and found that awareness was significantly lower among males with a low education level. The participant's gender and level of education together had a significant impact on HIV/AIDS awareness. Umeh et al. (2008) found significant differences in the knowledge level between male and female health care professionals in Nigeria. Knowledge levels were higher among males than females. In another study conducted with mentally ill patients in Soweto, South Africa, Johnson et al. (2012) found that females were 1.6 times more knowledgeable on HIV/AIDS than their male counterparts. In this research project the extent to which gender is associated with HIV knowledge and attitudes was examined.

1.2.9 Geotype, Knowledge and attitudes on HIV

In the Human Sciences Research Council (HSRC) survey conducted in South Africa, geotype referred to whether a participant resided in the urban formal, urban informal, rural informal or rural formal settlement. Debatably knowledge and attitudes on HIV may differ across the four settlement types. A study conducted by Bradley et al. (2011) in South India showed that HIV/AIDS awareness had the most significant improvement amongst women who resided in urban areas between 2003 and 2009. Women who lived in the villages showed far less improvement. Chen et al. (2007) conducted a study in China where they found a strong association between stigmatisation of PLHIV and community level HIV knowledge, even after adjusting for individual level knowledge. Attitudes towards infected people were largely dependent on how much the community as a whole knew about HIV/AIDS. Different knowledge levels between urban and rural communities would therefore translate to non-identical attitudes towards PLHIV. Attitudes and behaviour towards PLHIV among typical urban dwellers may not be congruous with those of typical rural setting residents. In this research project the association between geotype and HIV knowledge and attitudes was assessed.

1.2.10 Nationality, Knowledge and attitudes on HIV

From the time HIV/AIDS was first described, there have been assumed relationships between infection patterns and culture. In recent years these proposed relationships have become controversial and questionable (Sovran, 2013). South Africa is a cosmopolitan country where many nationalities mostly from the surrounding African countries are represented. Immigrants in South Africa represent different cultures that would react differently to HIV/AIDS. Among some cultures it is deemed improper to talk about AIDS in a respectable family - a sentiment that is commonly held in parts of South India (Bradley et al., 2011). A child from a family that holds similar beliefs may as a result not be as knowledgeable as one that is raised in a family where HIV is freely discussed; even their attitudes may not be same. Nxumalo et al. (2014) found that some cultural practices in Swaziland exposed girls and women to higher risk of HIV infection, which may reflect low HIV knowledge levels among the cultural groups involved. Knowledge and attitudes on HIV among South Africans may not be identical to those exhibited by non-citizens residing in the country, seeing as their cultural beliefs may differ.

1.2.11 Media exposure, knowledge and attitudes on HIV

Exposure to different kinds of media might also have a bearing on children’s knowledge and attitudes on HIV. A study conducted by Bekalu and Eggermont (2014) in north-western Ethiopia showed no significant association between media use and HIV/AIDS related knowledge. Jung et al. (2013) used cross-sectional data from Demographic Health Surveys from 13 countries in Sub-Saharan Africa and found an association between media use and HIV/AIDS knowledge. In the same study the use of media was also shown to moderate the impact of socio-economic status and education on HIV/AIDS knowledge. In South Africa exposure to HIV mass communication programmes was shown to be associated with HIV knowledge, condom use and HIV testing (Peltzer et al., 2012).

1.3 Problem statement

Children who grow up being HIV infected, possibly living with HIV positive parents, or orphaned as a result of HIV/AIDS would have had experiences different from those who are not HIV infected. Do knowledge and attitudes on HIV differ between HIV infected and uninfected children as they reach adolescence?

1.4 Justification

Studies on knowledge and attitudes on HIV have tended to focus on adults at workplaces and general society. To the best of the researcher's knowledge no studies have been conducted in South Africa which compare knowledge and attitudes on HIV/AIDS between HIV positive and HIV negative adolescents aged 10 – 14 years.

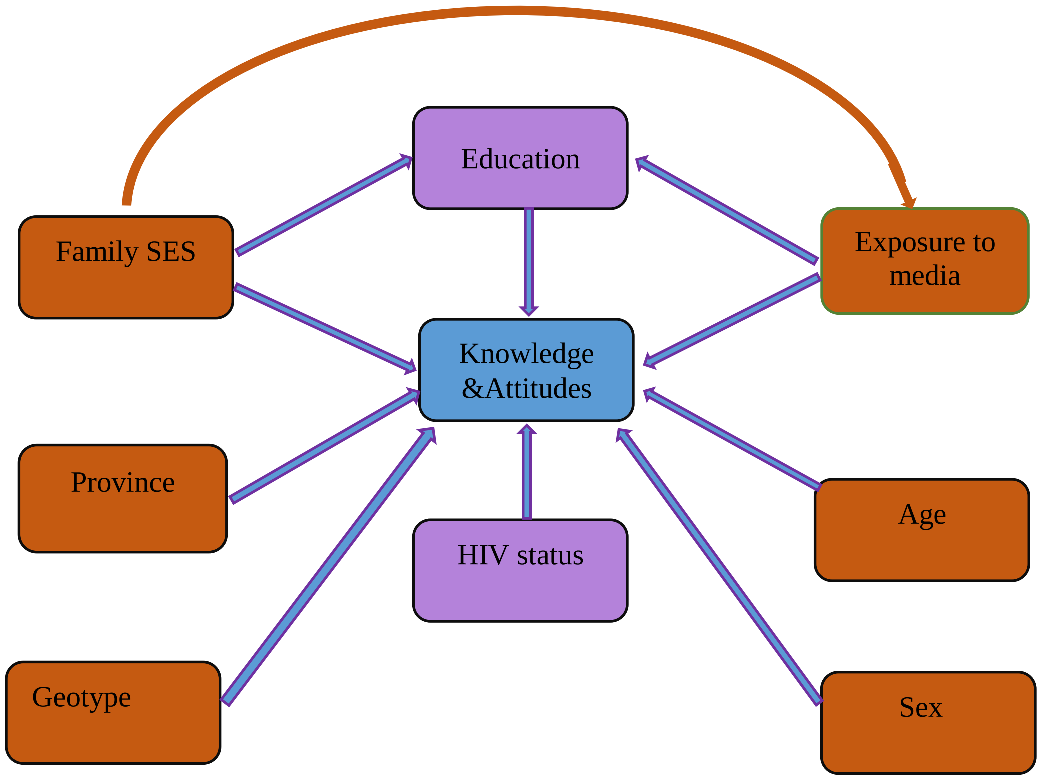

Figure 1.1: Conceptual Framework.

1.5 Research question

Do HIV positive and HIV negative children between the ages of 10 and 14 inclusive in South Africa have comparable knowledge and attitudes on HIV/AIDS?

1.6 Aim

To identify any differences in knowledge and attitudes between HIV positive and HIV negative children aged 10 to 14 years in South Africa.

1.7 Objectives

i. To determine HIV prevalence in South African children between the ages of 10 and 14 years, stratified by socio-demographic factors.
ii. To determine the association between HIV status and knowledge of HIV in children between the ages of 10 and 14 years in South Africa, adjusting for socio-demographic factors.
iii. To determine the association between HIV status and attitudes on HIV among children aged 10 to 14 years in South Africa, adjusting for socio-demographic factors.

CHAPTER 2: METHODOLOGY

2.1 Study design

The primary study was a cross-sectional multistage survey carried out by the Human Sciences Research Council (HSRC) in South Africa in 2012. The survey, which was called the "South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey, 2012" (SABSSM, 2012), aimed to provide information necessary for the development of HIV/AIDS intervention programs to key stake holders in the South African National AIDS council. This research project involved secondary data analysis of the survey data.

2.2 Study site

South Africa is a multi-ethnic country with a wide variety of cultures, languages and religions. The country lies on the southern part of Africa bounded to the south by a coastline stretching 2798 km, to the North by Zimbabwe, Botswana and Namibia and to the East by Mozambique and Swaziland. Data used in this secondary data analysis were collected from all the 9 provinces of South Africa. Figure 1 shows the provincial map of South Africa and in the insert the political map of Africa, both drawn in QGIS-3.2.2-1.

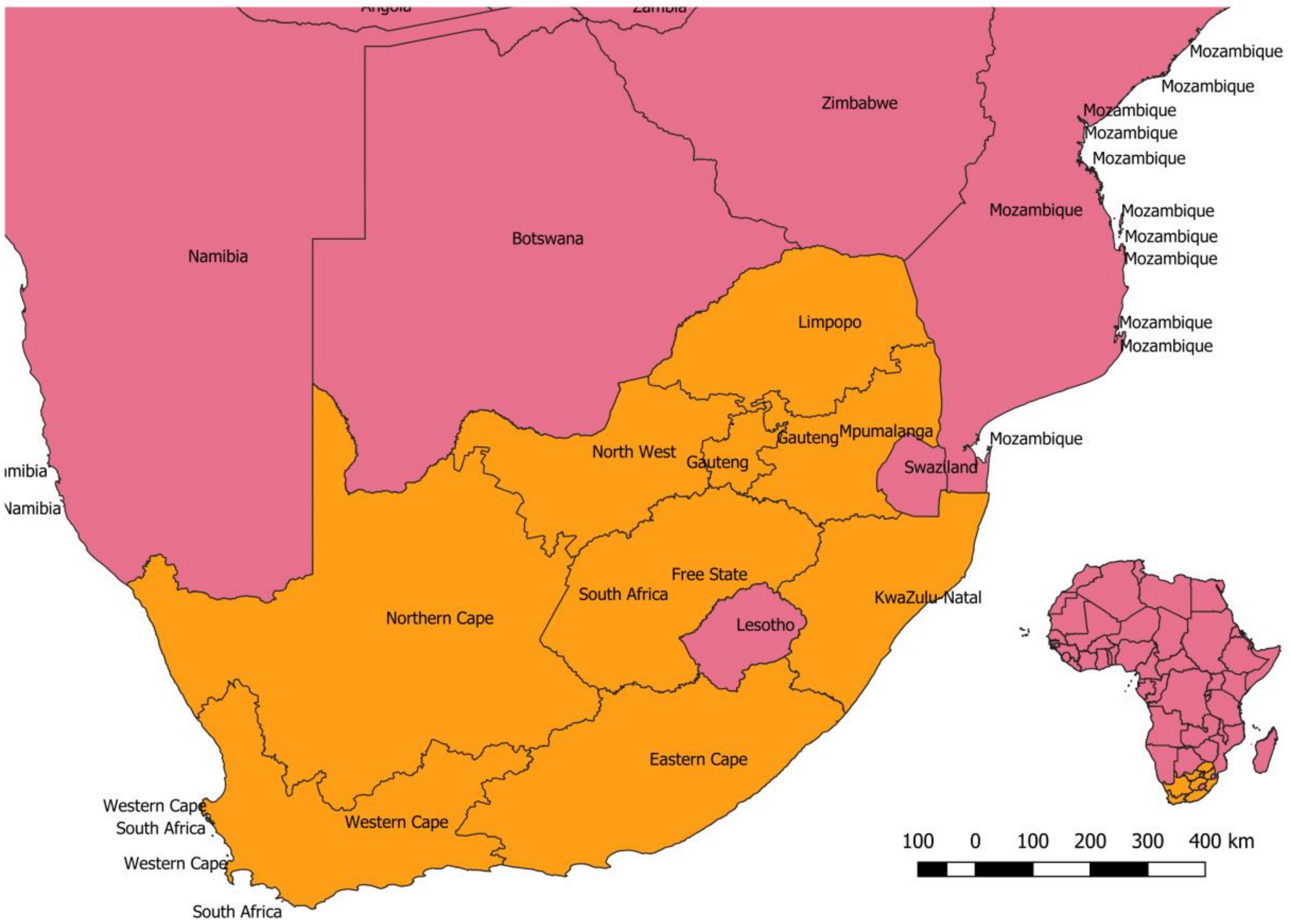

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Figure 2.1: The Provincial map of South Africa.

2.3 Study population

In the HSRC survey all residents of South Africa in 2012 were eligible for inclusion with the exception of those who were staying in institutions, hospitals, barracks and the homeless. The secondary data analysis was restricted to children aged between 10 – 14 years.

2.4 Sampling

Probability sampling, where each population element had a non-zero chance of being selected into the sample was used. A stratified multistage survey was conducted in the nine provinces of South Africa. Stratification was by province and geotype of the enumeration area (EA). The primary sampling units were the EAs and the secondary sampling units (SSUs) were the visiting points (VPs) or households. A total of 1 000 EAs were sampled with probability proportional to size where the number of VPs was used as a measure of size. Within each EA a random sample of 15 households was selected using systematic sampling. Of the 15000 households that were selected, 11079 agreed to take part in the survey, within which 38431 individuals were interviewed. Of those who were interviewed, 28 997 agreed to be tested for HIV.

A total of 4520 children between the ages of 10 and 14 inclusive participated in the survey. Of the 2793 children who provided a blood specimen, 2725 tested negative for HIV and 68 tested positive.

Figure 2.2 below shows steps in the selection of participants in the HSRC survey, and in this secondary data analysis.

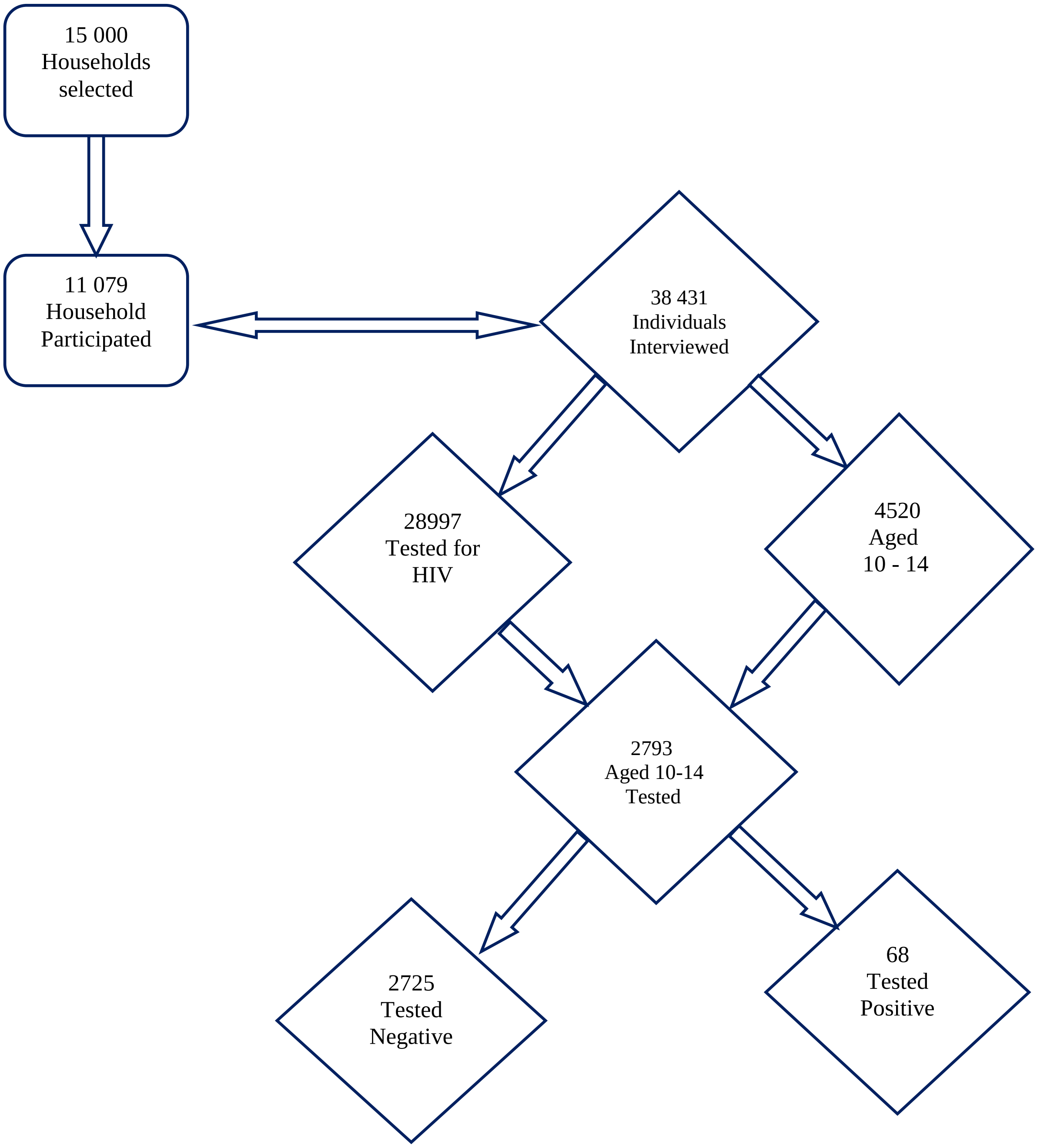

Figure 2.2: Steps in the selection of participants in the HSRC survey.

2.5 Power calculation

The outcome of primary interest is the knowledge scores. In a cross-sectional study conducted with secondary school students in Cameroon in 2014, the knowledge scores had a standard deviation of 1.925 (Nubed and Akoachere, 2016). Madiba and Mokgatle (2015), using data collected from high school adolescents in the Gauteng and Northwest provinces of South Africa in 2013, found the standard deviation of knowledge scores to be 1.17.

In this research project, assuming a common standard deviation of 1.17 and independence between the subgroups, with a sample of 2725 HIV negative and 68 HIV positive children, the power to detect a difference of 0.5 units between the mean knowledge scores of HIV positive and HIV negative children is 93.58% at 5% level of significance.

2.6 Data collection

In the primary study, questionnaires were used to collect data from guardians of children under the age of 11, children between 12 and 14 years old and people at the age of 15 and above sampled in the 9 provinces of South Africa.

2.7 Limitations

i. Data were primarily collected for some other purpose apart from expressly measuring knowledge and attitudes in adolescents born with HIV.
ii. The validity of the instrument used in data collection was not ascertained.
iii. Information on children who are HIV negative but exposed to HIV was not available in the data set.

2.8 Data set

The secondary data set that was used is called the "South African National HIV Prevalence, HIV Incidence, Behaviour and Communication Survey" (SABSSM) 2012: -All provinces, available on www.hsrc.ac.za

2.9 Study variables

The primary outcome variable is HIV knowledge score (*knowl_score*) and the secondary outcome variable is attitude score (*att_score*). A total of 8 questions which require 'yes' or 'no' responses were used to ascertain knowledge, giving a maximum possible knowledge score of 8.

The questions that were used to assess knowledge were as follows:

Q3.1a Can AIDS be cured?

Q3.1b Can a person reduce the risk of HIV by having fewer sexual partners?

Q3.1c Can a healthy-looking person have HIV?

Q3.1d Can HIV be transmitted from a mother to her unborn baby?

Q3.1e Can the risk of HIV transmission be reduced by having sex with only one uninfected partner?

Q3.1f Can a person get HIV by sharing food with someone who is infected?

Q3.1g Can a person reduce the risk of getting HIV by using a condom every time he/she has sex?

Q3.1h Can medical male circumcision reduce the risk of HIV infection in males?

Similarly, attitude was assessed using a total of 7 questions which require 'agree' or 'disagree' responses.

The questions that were used to assess attitude were as follows:

Q3.2a If you know that a shopkeeper or a food seller had HIV would you buy food from them?

Q3.2b Would you be willing to care for a family member who has AIDS?

Q3.2c If a teacher has HIV but is not sick, he/she should be allowed to continue teaching?

Q3.2d Is it a waste of money to train or give a promotion to someone with HIV/AIDS?

Q3.2e Would you like to keep the HIV positive status of a family member a secret?

Q3.2f Are you comfortable talking to at least one member of your family about HIV?

Q3.2g A person would be foolish to marry a person who is living with HIV/AIDS.

The primary exposure variable is HIV status (*hivstat*). Possible confounders include:

age - age of the participant, treated as a continuous variable

sex - sex of the participant

In_school - whether or not the participant attends school

geotype - whether the participant resides in the urban formal, urban informal, rural informal or rural formal settlement.

prov - the South African province in which the participant resided.

Nationality - whether the participant is a South African citizen, a permanent resident or other.

parent - number of parents alive

sexual_exp - whether or not the child has had sex

media_score - exposure to different kinds of media (maximum score is 18).

Construction of *media_score* variable

Children had varying levels of access to different kinds of media namely radio, television, magazine, newspaper, internet and cell phone. Media scores were assigned to study participants as follows:

A child who never had access to a certain kind of media was given a score of 0 for that particular kind of media. A score of 1 would be given to a child who used the media once a week, a score of 2 to a child who used the media 2 – 6 days in a week and a score of 3 was given to the child who used the media every day of the week. The total media score was an integer between 0 and 18 inclusive.

2.10 Data analysis

In this research project all analyses were conducted using Stata 15.

In the analysis of survey data **weights** are used to adjust for differential selection of sampling units, differential non-response rate and post-stratification (Shaikh and Rahim, 2006).

2.10.1 Descriptive Statistics

a) Projected population totals, then weighted means, which take into account the multistage complex survey design, together with their respective design based confidence intervals were calculated as follows:

i. The projected population total (Horvitz–Thompson estimator)

Suppose the population comprises H distinct strata, and in each stratum h, n_h clusters are selected into the sample. Assuming that sampling from one stratum to the next is roughly independent, with $n_h \geq 1$, let n represent the number of primary sampling units (PSUs).Then

$$n = \sum_{h=1}^{H} n_h \qquad 2.1$$

from each PSU secondary units are sampled with weight w_{hij} associated with participant j from PSU i and stratum h, where $i = 1, \ldots, n_h$; $h = 1, \ldots, H$ and $j \in i$.

Let x_T be the estimate of a population total, X_T, of a variable x, taken from each participant sampled, then

$$x_T = \sum_{h=1}^{H} \sum_{i=1}^{n_h} \sum_{j \in i} w_{hij} x_{hij} \qquad 2.2$$

(Rust and Rao, 1996)

ii. Standard error of the projected total

A closed form unbiased estimate of the variance of x_T is given by:

$$var(x_T) = \sum_{h=1}^{H} \frac{n_h}{(n_h - 1)} \left[\sum_{i=1}^{n_h} \sum_{j \epsilon i} \left(w_{hij} x_{hij}\right)^2 - \frac{\left(\sum_{i=1}^{n_h} \sum_{j \in i} w_{hij} x_{hij}\right)^2}{n_h} \right] \qquad 2.3$$

The standard error of the projected total is the square root of the variance (Heeringa et al., 2010).

iii. The weighted mean

The population mean $\bar{X}$ is estimated by

$$\hat{x} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{n_h}\sum_{j\in i} w_{hij}x_{hij}}{\sum_{h=1}^{H}\sum_{i=1}^{n_h}\sum_{j\in i} w_{hij}} = \frac{X_T}{\hat{N}} \qquad 2.4$$

(Rust and Rao, 1996)

iv. Standard error of the mean estimate

While in variance estimation three methods namely the balanced repeated replication, the jackknife repeated replication and Taylor series Linearization (TSL) are used in practice, evaluation studies seem to suggest that none of them consistently performs better or worse than others. However, in addition to being the most widely used, TSL is found in most available software (Shaikh and Rahim, 2006). In this research project the TSL variance estimation was used.

The TSL variance estimator for the ratio mean is given by:

$$var(\hat{x}) = \frac{var(X_T) + \hat{x}^2 \times var(\hat{N}) - 2 \times \hat{x} \times cov(X_T, \hat{N})}{\hat{N}^2} \qquad 2.5$$

The standard error of the mean is the square root of the variance.

b) Weighted frequencies, weighted proportions and their design based confidence intervals were calculated for categorical variables. The weighted proportions and confidence intervals were calculated using the formulae:

i. Weighted proportion:

For a binary variable which can be recoded 1 and 0 to indicate the presence and absence of a characteristic respectively, the ratio mean estimator, which estimates the prevalence (proportion) of “1s” in the population, is given by:

$$p = \frac{\sum_{h=1}^{H}\sum_{i=1}^{n_h}\sum_{j\in i} w_{hij}I(y_i=1)}{\sum_{h=1}^{H}\sum_{i=1}^{n_h}\sum_{j\in i} w_{hij}} = \frac{\hat{N}_1}{\hat{N}} \qquad 2.6$$

The TSL variance estimator for of the simple proportion in 2.6 is computed as:

$$v(p) = \frac{V(\hat{N}_1) + p^2V(\hat{N}) - 2pCov(\hat{N}_1, \hat{N})}{\hat{N}^2} \qquad 2.7$$

ii. Confidence intervals for the proportion estimates

Confidence intervals are constructed using the **logit transformation procedure**, which is a two-step process.

Step 1: The 95% CI for the logit transform of *p* is constructed as follows:

$$CI[logit(p)] \quad = \quad \{A, B\}$$

$$= \left\{ln\left(\frac{p}{1-p}\right) - \frac{t_{1-\alpha/2\,,df.se(p)}}{p(1-p)}\,, ln\,\left(\frac{p}{1-p}\right) + \frac{t_{1-\alpha/2\,,df.se(p)}}{p(1-p)}\right\} \qquad 2.8$$

where

p = the weighted estimate of the proportion of interest;

se(*p*) = the design-based Taylor Series approximation to the standard error of the estimated proportion.

Step 2:

The confidence limits on the logit scale {A, B} are transformed back to the (0,1) scale, that is:

$$CI(p) \quad = \quad \left\{\frac{e^{A}}{1+e^{A}}, \frac{e^{B}}{1+e^{B}}\right\} \qquad 2.9$$

For a variable with $k > 2$ categories the ratio estimator in 2.6 is modified to become:

$$p_k \; = \frac{\Sigma_{h=1}^{H}\Sigma_{i=1}^{n_h}\Sigma_{j\in i}w_{hij}I(y_i{=}k)}{\Sigma_{h=1}^{H}\Sigma_{i=1}^{n_h}\Sigma_{j\in i}w_{hij}} = \frac{\widehat{N}_k}{\widehat{N}} \qquad 2.10$$

(Heeringa et al., 2010).

Design effect (deff)

The ratio of design based variance of the estimate to the simple random sample based variance, called design effect is given by:

$$D^2(\hat{\theta}) = \frac{SE(\widehat{\theta})^2_{complex}}{SE(\widehat{\theta})^2_{srs}} = \frac{var(\widehat{\theta})_{complex}}{var(\widehat{\theta})_{srs}} \qquad 2.11$$

where

$D^2(\hat{\theta})$ is the design effect for the sample estimate $\hat{\theta}$

$Var(\hat{\theta})_{complex}$ is the complex sample design variance of $\hat{\theta}$

$Var(\hat{\theta})_{srs}$ is the simple random sample variance of $\hat{\theta}$

(Heeringa et al., 2010).

c) **Design weighted box plots** were used to examine the distribution of knowledge and attitude scores across different categories of the categorical predictor variables.

2.10.2 Multiple Regression Analyses:

Two models were specified, the first with knowledge scores (*knowl_score*) as the outcome variable, and the second with attitude scores (*att_score*) as the outcome. Selection of the initial predictor variables was guided by subject matter knowledge gleaned from prior studies and from the preliminary investigation of the available data.

The tentative set of predictor variables included *hivstat*, *sex*, *age*, *media_score*, *In_school*, *circumcision*, *geotype*, *prov*, *Nationality*, *parent*, *sexual_exp* and *arv*.

2.10.3 The regression models

Multiple regression models, which take into account the multistage complex survey design were fitted. The models take the general form:

$$\boldsymbol{y} = \boldsymbol{X}\underline{\beta} + \underline{\varepsilon}$$

where $\boldsymbol{y} = (y_1,\ y_2, \dots y_n)'$ is the knowledge or attitude score,

$\boldsymbol{X}$ is a matrix of predictor variables

$\underline{\beta}$ are the regression coefficients,

$\underline{\varepsilon}$ are random error terms(which are not independent).

Authors have proposed different approaches to the estimation of regression coefficients. Lee and Forthofer (2006) argue that the design weighted least squared (DWLS) approach, in addition to covering the widest range of situations, also has software widely available.

In this research project the regression coefficients were estimated using the DWLS approach as follows:

$$\underline{\hat{\beta}}_{DWLS} = (\boldsymbol{X}'\boldsymbol{W}\boldsymbol{X})^{-1}\boldsymbol{X}'\boldsymbol{W}\boldsymbol{y}$$

Where $\boldsymbol{W} = diag(w_1,\ w_2, \dots, w_n)$ is the $n \times n$ matrix of sampling weights.

Using the Taylor series linearization approach, the variance of the estimator is given by:

$$\hat{V}\left(\underline{\hat{\beta}}_{DWLS}\right)=\left(\sum_{i\epsilon s} w_i \boldsymbol{x}_i \boldsymbol{x}_i'\right)^{-1} \hat{V}\left(\sum_{i\epsilon s} w_i \boldsymbol{x}_i \left(y_i - \boldsymbol{x}_i' \underline{\hat{\beta}}_{DWLS}\right)\right)\left(\sum_{i\epsilon s} w_i \boldsymbol{x}_i \boldsymbol{x}_i'\right)^{-1}$$

(Heeringa et al., 2010).

2.10.4 Model building

Following the proposal by Hosmer and Lemeshow (2000) exploratory bivariate analyses were conducted to assess the relationship between each outcome variable and each candidate predictor variable. Predictor variables that had a bivariate relationship of significance $p < 0.20$ with each outcome variable were included in the initial model.

With *hivstat*, *sex* and *geotype* 'locked' in the model, backward selection was used to choose a set of other predictor variables to enter the preliminary 'main' models without interaction terms. To assess the relevance of the predictor variables in the multiple regression models, *t*-tests and Wald tests were used for individual and multiple coefficients respectively.

2.10.5 Complete-case analysis and a multiple imputation by chained equations (MICE) models

Two linear regression models were run for each of the two outcome variables. For each outcome, a *complete-case analysis* model and a (MICE) model were run.

a) The Complete-case Analysis model

Not all participants (cases) had all values for all the variables that met the criteria for inclusion in the regression models. Complete-case analysis is one of the approaches that simplify the problem of missing data by discarding data. In the context of regression, this approach excludes all cases for which the outcome variable or any of the regressors has missing values.

In this research project, whereas the sample selected for data analysis had 2793 observations, the complete-case analysis model with knowledge scores (*knowl_score*) as the outcome variable was run with only 1683 complete cases and the regression model with attitude scores (*att_score*) as the outcome was run with 1656 complete cases.

All the possible interaction terms were tested and only scientifically relevant interactions (with $p < 0.05$) were added to the 'main' model, one at a time.

The reduced sample size resulting from complete-case analysis not only reduces statistical power, often it also leads to biased estimates and overestimated standard errors.

b) Multiple imputation by chained equations (MICE)

To maintain the size of the original sample and circumvent some of problems that result from using complete-case analysis, a MICE model was run alongside the complete-case analysis model for each outcome variable.

Imputation involves replacing missing values with estimates, then analyzing the full data as if the imputed values were the actual observed values. The objective in imputation is to reproduce the variance/covariance matrix that we would observe if there were no missing values in the data set. Simulation studies have shown multiple imputations to perform well, even in situations with up to 50% of observations missing (Streiner and Norman, 2010). In this research project the missingness was highest in *knowledge scores* where 40.06% values were imputed.

Multiple imputation uses the distribution of the observed data to create multiple predictions for each missing value. The analyses of multiply imputed data take into account the uncertainty in the imputations, which results in accurate standard errors.

MICE is a multiple imputation technique which imputes data separately for each variable by specifying an imputation model per variable. The procedure involves iteratively running regression models in which each variable with missing values is modelled conditional on other variables in the data (Azur et al., 2011). Each variable is modelled according to its distribution. In Stata for example, the distributions available include binary, ordered and multinomial logistic regression for categorical variables, linear regression and predictive mean matching (PMM) for continuous variables, and Poisson and negative binomial regression for count variables.

MICE is used under the assumption that data are missing at random (MAR). Data are said to be missing at random if the probability of a value missing depends only on observed values and not on unobserved values (Schafer and Graham, 2002). MICE generally involves four steps according to Azur et al. (2011):

Step 1:

The first step involves a simple “temporary” imputation, in most cases it will be a mean imputation for every variable with missing values.

Step 2:

In this step one variable is chosen for imputation and temporary values imputed in step 1 are set back to missing.

Step 3:

The variable chosen in step 2 becomes the dependant variable which is then regressed on other variables in the imputation model. A linear regression model will be run if the dependant variable is continuous, a logistic regression model for a binary variable, a Poisson regression model if the dependant variable is count, and so on.

Step 4:

Regression replaces (imputes) the missing values in the variable chosen in step 2. When at a later stage the variable with some imputed values is used as an independent variable in regressions for other variables the imputed, together with the observed values will be used. Steps 2 to 4 are performed for each variable in the imputation model and in the end all missing values are replaced with predictions from the regression models. This will be the first iteration. For the models in this research project 70 - 80 iterations were performed. The number of iterations (m) was chosen such that $m \geq 100 \times FMI$ (White et al., 2011). FMI - the fraction of missing information, is the proportion of the total sampling variance that is attributed to missing information (See section 2.10.6).

In this research project a total of 70 - 80 data sets were imputed, producing a total of 70 - 80 regression coefficients and standard errors. The estimated coefficients were then combined to obtain a single set of inferential statistics. Each reported statistic (coefficients and standard errors) is the arithmetic mean of the 70 - 80 estimates.

The MICE procedure should generally include all variables that will used in the later analyses irrespective of whether or not they have missing values. In some cases even variables that will not be used in subsequent analyses are included if there is reason to believe that they are predictive of the missing values Azur et al. (2011). Such variables are called auxiliary variables.

2.10.6 Imputation diagnostics

For each variable a number of metrics were used to assess how well the MICE performed. The parameters calculated for this purpose include:

a) Variance Between ($\boldsymbol{V_B}$)

This measures variability in the parameter estimates obtained from the 70 - 80 sets of imputed data. This variance estimates the additional variation resulting from missing data. Variance Between reflects the uncertainty in the imputations.

b) Variance within ($\boldsymbol{V_W}$)

This is the arithmetic mean of the standard errors (or sampling variances) of each of the 70 - 80 imputed data sets. Variance within estimates the sampling variance we would observe if there were no missing data.

c) Total Variance ($\boldsymbol{V_T}$)

Total variance is determined by adding up three components. This is the sum of the between, the within and an additional variance which is a correction factor for using a specific number of imputations. This additional variance is determined by dividing the variance between by *m*. Total variance is then given by:

$V_T = V_B + V_W + \frac{V_B}{m}$, where *m* is the number of imputations.

d) The Relative Increase in Variance (RVI)

This is the proportional increase in total sampling variance that is attributed to missing information

$$RVI \;=\; \frac{V_B + \frac{V_B}{m}}{V_W}$$

A variable with many missing values or that is weakly correlated with other variables in the imputation model will tend to have a high RVI.

e) Fraction of missing information (FMI)

This is the proportion of the total sampling variance that is attributed to missing information.

$$FMI \;=\; \frac{V_B + \frac{V_B}{m}}{V_T}$$

The FMI estimate becomes more accurate with the increasing number of imputations. Ideally the number of imputations would be at least equal to the highest FMI percentage.

f) Relative Efficiency (RE)

Relative (variance) efficiency of an imputation measures how well the true population parameters are estimated. It is an estimate of the efficiency relative to an infinite number of imputations.

$$RE = \frac{1}{1 + \frac{FMI}{m}}$$

g) Trace plots

Convergence of the imputation models was assessed using trace plots. In a trace plot the predicted means of each imputed variable are plotted against iteration numbers. Existence of long term trends in trace plot is a sign of slow convergence to stationarity. If convergence has been achieved the mean and the variance of the process will be constant over time. Visual assessment of convergence could be done for any imputed variable. In the case where the number of imputed variables is large it may suffice to inspect trace plots only for one variable with a high proportion of missingness (https://stats.idre.ucla.edu/stata/seminars/mi_in_stata_pt1_new/) .In this research project trace plots were inspected for knowledge score (*knowl_score*) and attitude score (*att_score*).

CHAPTER 3: RESULTS

Sections 3.1 - 3.4 provide an overview of the descriptive characteristics of the study participants. Sections 3.1 and 3.2 outline frequencies, weighted proportions and projected population totals of participants in each category of the categorical variables. Weighted means of knowledge and attitude scores for each level of explanatory factors are displayed in section 3.3. Section 3.4 explores the distribution of each of the continuous variables across categories of some categorical variables. In section 3.5 are design based linear regression analyses, firstly with knowledge scores as the outcome variable, then with attitude scores as outcome of interest.

3.1 Descriptive Statistics– frequencies and weighted proportions

Table 3.1: Frequencies, Weighted Proportions and Confidence Intervals

Variable	n	Weighted Prop (CI)
Sex		
Male	1447	0.501(0.469-0.533)
Female	1346	0.499(0.468-0.531)
HIV status		
Positive	68	0.029(0.021-0.041)
Negative	2725	0.971(0.959-0.979)
ARV treatment (HIV +ve only)		
On treatment	29	0.484(0.304-0.668)
Not on treatment	39	0.516(0.332-0.696)
School attendance		
Attending school	2742	0.991(0.983-0.995)
Not attending school	31	0.009(0.005-0.017)
Circumcision (Males only)		
Circumcised	160	0.116(0.090-0.148)
Not circumcised	1252	0.860(0.828-0.887)
No response	35	0.024(0.016-0.036)
Geotype		
Urban formal	1280	0.414(0.359-0.471)
Urban informal	341	0.074(0.054-0.101)
Rural informal	953	0.475(0.417-0.534)
Rural formal	219	0.037(0.023-0.059)
Province		
Western Cape	272	0.101(0.083-0.121)
Eastern Cape	416	0.148(0.114-0.191)
Northern Cape	226	0.021(0.015-0.029)
Free State	179	0.044(0.032-0.060)
KwaZulu Natal	700	0.236(0.190-0.290)
North West	193	0.056(0.038-0.082)
Gauteng	291	0.200(0.159-0.249)
Mpumalanga	272	0.088(0.065-0.117)
Limpopo	244	0.106(0.083-0.135)
Nationality		
Citizen	2755	0.992(0.984-0.996)
Non-citizen	38	0.008(0.004-0.016)
Parent		
No parent	191	0.083(0.066-0.105)
One parent	533	0.191(0.170-0.214)
Both parents	2069	0.726(0.696-0.754)

Table continues

Sexual debut		
Yes	30	0.019 (0.010-0.036)
No	1652	0.971 (0.955-0.982)
No response	19	0.010 (0.005-0.018)

Table 3.1 above shows frequencies and weighted proportions of the participants in different categories of the categorical variables. Of the 2793 children who were selected for data analysis, 68 (2.9%) were HIV positive, and only 29 (48.4%) of those living with HIV were on ARV treatment. More than 99% of the study participants were South African citizens, and approximately 9% of the children were not in school.

3.2 Descriptive Statistics – Projected Population Totals

Table 3.2: Frequencies and estimated population totals

	n	Total
Sex		
Male	1447	2547198
Female	1346	2541573
HIV status		
Positive	68	149855
Negative	2725	4938916
ARV treatment		
On treatment	29	72545
Not on treatment	39	77310
School attendance		
In school	2742	5017815
Not in school	31	46144
Circumcision		
Circumcised	160	295898
Not circumcised	1252	2190573
Geotype		
Urban formal	1280	2107515
Urban informal	341	376353
Rural informal	953	2415614
Rural formal	219	189289
Nationality		
Citizen	2755	5046652
Non-citizen	38	42119
Province		
Western Cape	272	511583
Eastern Cape	416	755183
Northern	226	106934
Free State	179	223659
KwaZulu Natal	700	1202195
North West	193	284074
Gauteng	291	1017901
Mpumalanga	272	445712
Limpopo	244	541528
Parent		
No parent	191	422534
One parent	533	971606
Both parents	2069	3694631

continued

Sexual debut		
Yes	30	59064
No	1652	3011220
No response	19	29496

Table 3.2 shows frequencies, and estimated population totals of the study participants in different categories of the categorical variables. There were an estimated total of 149 855 children living with HIV in South Africa in 2012. An estimated 77 310 of the HIV positive children were not on ARV treatment. About 46 144 of the children were not in school. Approximately 422 534 of the children were orphans living without both parents.

3.3 Descriptive Statistics – Weighted means of the continuous outcome variables

Table 3.3: Frequencies, weighted mean knowledge score and Confidence Intervals

	n	Mean (CI)	DEFF
Overall	1674	4.712(4.555 - 4.869)	2.504
Variable			
Sex			
Male	844	4.657(4.443 - 4.871)	2.054
Female	830	4.763(4.546 - 4.981)	2.718
HIV status			
Positive	43	5.216(4.544 - 5.888)	2.637
Negative	1631	4.696(4.537 - 4.854)	2.441
ARV treatment			
On treatment	16	5.669(4.716 - 6.622)	3.191
Not on treatment	27	4.827(4.069 - 5.585)	1.695
School attendance			
Attending school	1651	4.724(4.567 - 4.881)	2.501
Not attending school	21	3.002(1.454 - 4.549)	1.119
Circumcision			
Circumcised	101	5.019(4.409 - 5.628)	2.136
Not circumcised	727	4.620(4.392 - 4.847)	2.015
Geotype			
Urban formal	789	5.061(4.807 - 5.315)	3.001
Urban informal	195	4.433(3.899 - 4.767)	1.826
Rural informal	561	4.494(4.283 - 4.705)	2.248
Rural formal	129	3.934(3.216 - 4.653)	1.501
Nationality			
Citizen	2755	4.709(4.550 - 4.867)	2.540
Non-citizen	38	5.316(4.039 - 6.592)	1.075
Province			
Western Cape	162	5.293(4.880 - 5.707)	2.381
Eastern Cape	250	4.553(4.197 - 4.909)	2.007
Northern Cape	145	4.729(4.256 - 5.202)	0.535
Free State	92	4.313(3.744 - 4.882)	1.109
KwaZulu Natal	432	4.478(4.174 - 4.782)	1.972
North West	119	4.622(4.277 - 4.968)	0.846
Gauteng	166	4.945(4.464 - 5.425)	4.491
Mpumalanga	159	4.975(4.450 - 5.500)	2.476
Limpopo	149	4.451(4.091 - 4.811)	1.381
Parent			
No parent	121	5.088(4.589 - 5.587)	2.768
One parent	330	4.487(4.142 - 4.833)	2.165
Both parents	1223	4.726(4.552 - 4.901)	2.234

Table 3.3 continued

Sexual debut		
Yes	29	5.228(4.031 - 6.425)
No	1622	4.712(4.552 - 4.874)
No response	18	2.726(0.891 - 4.561)

Overall, the study participants had a mean knowledge score of 4.712 units. The mean score was higher among children living with HIV (mean = 5.216) than those who were HIV negative (mean = 4.696). Children who attended school had a mean score 1.722 units higher than that of those who were not in school, and those who resided in the urban formal settlements had a mean knowledge score 1.127 units higher than that of those who lived in the rural formal settlements. Orphans who did not have any biological parents had a higher mean HIV/AIDS knowledge score than those who had at least one biological parent.

Table 3.4: Frequencies, weighted mean attitude scores and Confidence Intervals

	n	Mean (CI)	DEFF
Overall	1680	4.962(4.848 - 5.075)	3.037
Variable			
Sex			
Male	852	4.861(4.713 - 5.010)	2.373
Female	828	5.055(4.916 - 5.194)	2.540
HIV status			
Positive	43	5.116(4.607 - 5.624)	2.597
Negative	1637	4.957(4.843 - 5.070)	2.913
ARV treatment			
On treatment	16	4.742(3.843 - 5.641)	3.970
Not on treatment	27	5.436(4.827 - 6.045)	2.250
School attendance			
Attending school	1657	4.965(4.851 - 5.079)	3.046
Not attending school	21	4.579(3.824 - 5.333)	1.029
Circumcision			
Circumcised	105	5.338(4.927 - 5.749)	2.434
Not circumcised	731	4.779(4.621 - 4.937)	2.344
Geotype			
Urban formal	795	5.117(4.945 - 5.289)	2.895
Urban informal	193	4.995(4.758 - 5.232)	1.060
Rural informal	564	4.861(4.692 - 5.030)	3.487
Rural formal	128	4.325(3.928 - 4.722)	1.203
Nationality			
Citizen	2755	4.958(4.843 - 5.072)	3.065
Non-citizen	38	5.617(5.287 - 5.947)	0.789
Province			
Western Cape	167	5.125(4.845 - 5.405)	2.276
Eastern Cape	249	5.030(4.786 - 5.273)	1.962
Northern	147	5.023(4.587 - 5.460)	0.879
Free State	92	4.686(4.234 - 5.137)	1.270
KwaZulu Natal	430	4.517(4.279 - 4.756)	2.866
North West	119	4.904(4.615 - 5.194)	1.316
Gauteng	166	5.230(4.929 - 5.531)	4.259
Mpumalanga	163	5.172(4.930 - 5.415)	1.690
Limpopo	147	5.134(4.874 - 5.393)	2.297
Parent			
No parent	121	5.078(4.644 - 5.513)	3.797
One parent	333	4.990(4.766 - 4.214)	2.164
Both parents	1226	4.939(4.823 - 5.054)	2.331

Table continues

Sexual debut			
Yes	29	4.980(4.213 - 5.748)	3.316
No	1628	4.973(4.857 - 5.088)	3.047
No response	19	4.130(3.398 - 4.862)	1.694

The study participants had an overall mean attitude score of 4.962 units. Children living with HIV had a slightly higher mean attitude score (mean = 5.116) than those who were not infected (mean = 4.957). Participants who resided in the urban formal settlements had a mean attitude score higher than in any other geotype (Table 3.4).

3.4 The distribution of knowledge and attitude scores across different categories of the categorical variables.

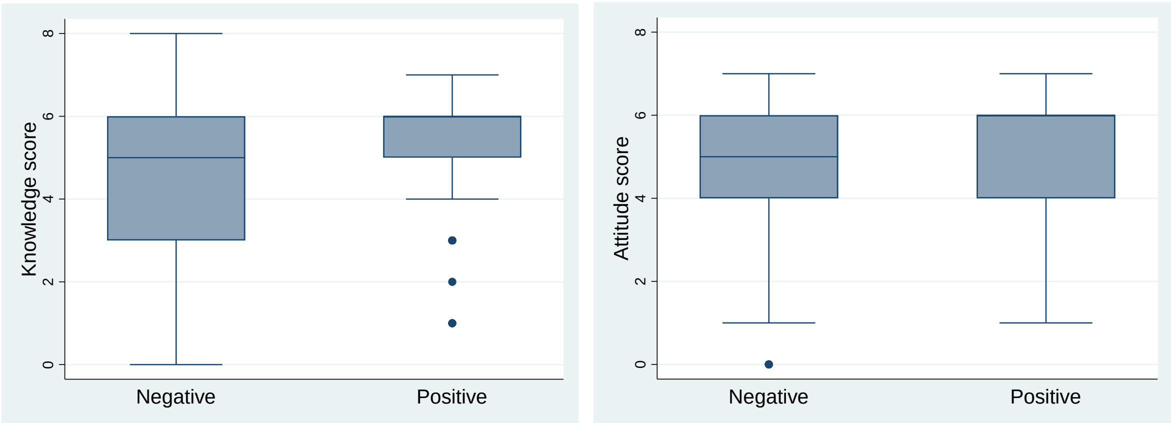

Figure 3.1 Design weighted box plots showing the distribution of knowledge and attitude scores by HIV status

The box plots suggest higher knowledge and attitude scores among the HIV infected children. There also appears to be greater variability in knowledge scores among the uninfected than the infected children (Figure 3.1).

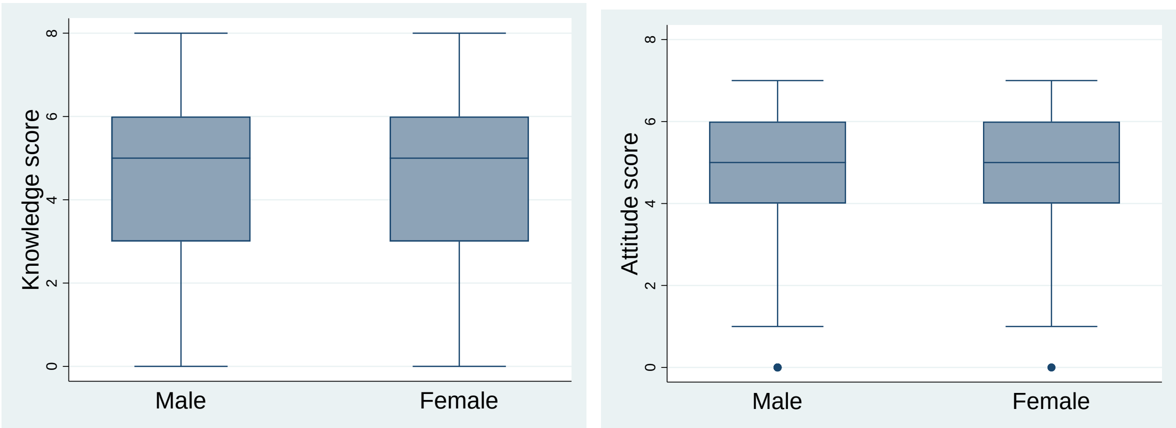

Figure 3.2: Design weighted box plots showing the distribution of knowledge and attitude scores by sex

The box plots show no discernible differences in the distribution of knowledge and attitude scores between male and female participants (Figure 3.2).

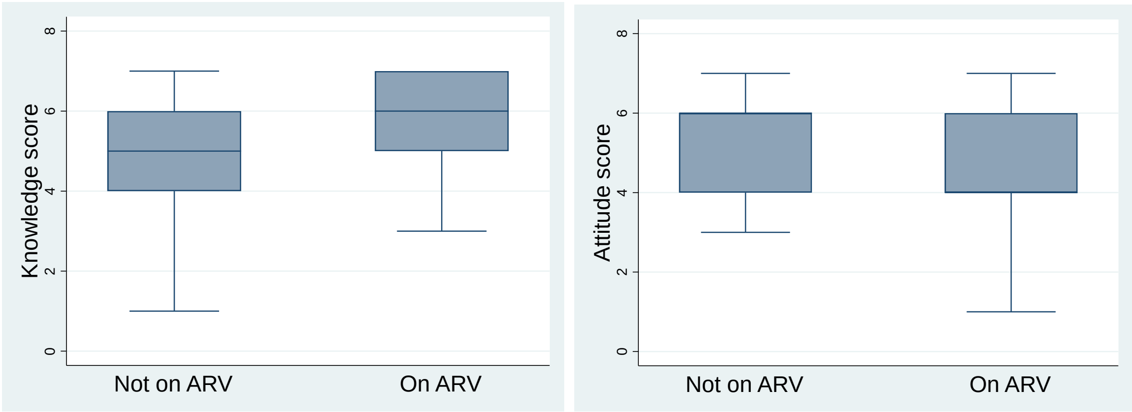

Figure 3.3: Design weighted box plots showing the distribution of knowledge and attitude scores by ARV treatment

The box plots in Figure 3.3 suggest greater knowledge on HIV/AIDS among HIV positive children who were on ARV treatment than those who were not on treatment. There is no clear difference in attitude scores between those who were on ARV treatment and those who were not on treatment.

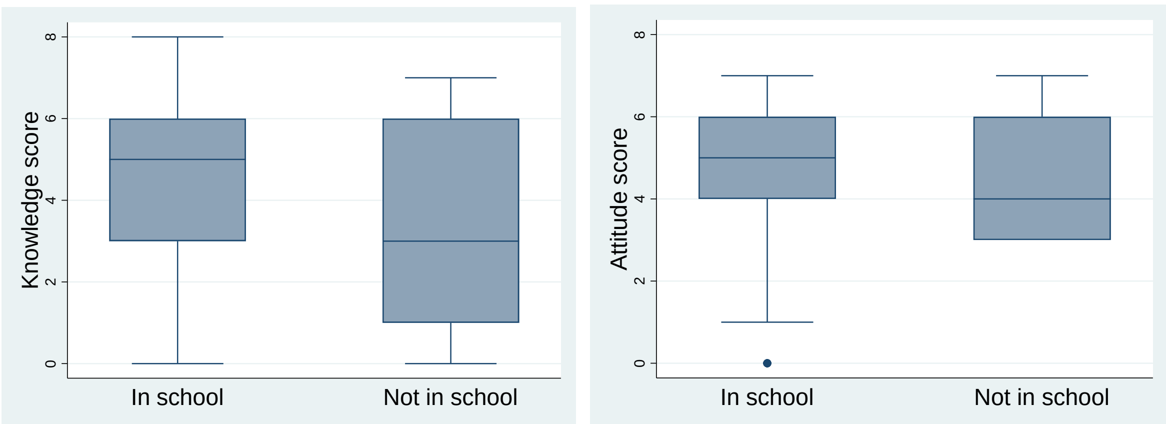

Figure 3.4: Design weighted box plots showing the distribution of knowledge and attitude scores by school attendance

Both knowledge and attitudes scores are noticeably higher among children attending school than children who were not in school (Figure 3.4).

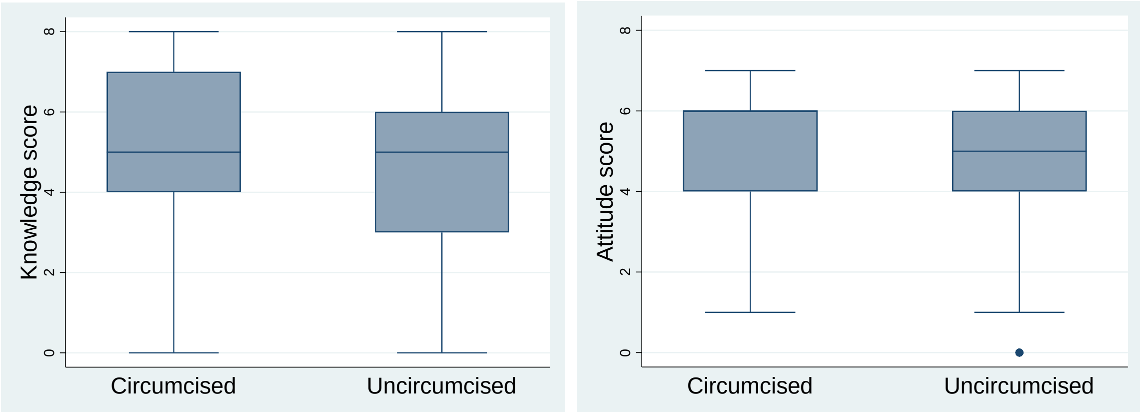

Figure 3.5: Design weighted box plots showing the distribution of knowledge and attitude scores by male circumcision

There does not appear to be any obvious differences in knowledge and attitude scores between circumcised and uncircumcised boys.

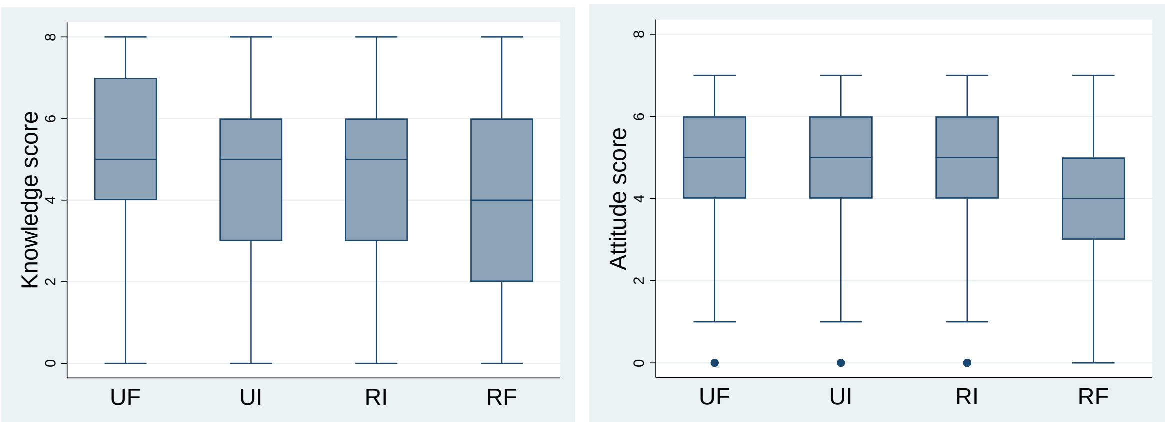

Figure 3.6: Design weighted box plots showing the distribution of knowledge and attitude scores across geotype

Both knowledge and attitude scores appear to be lower amongst children who resided in the rural formal settlements than in any other geotype. There are no noticeable differences in the distribution of both knowledge and attitude scores among children in the urban formal, urban informal and rural informal settlements (Figure 3.6).

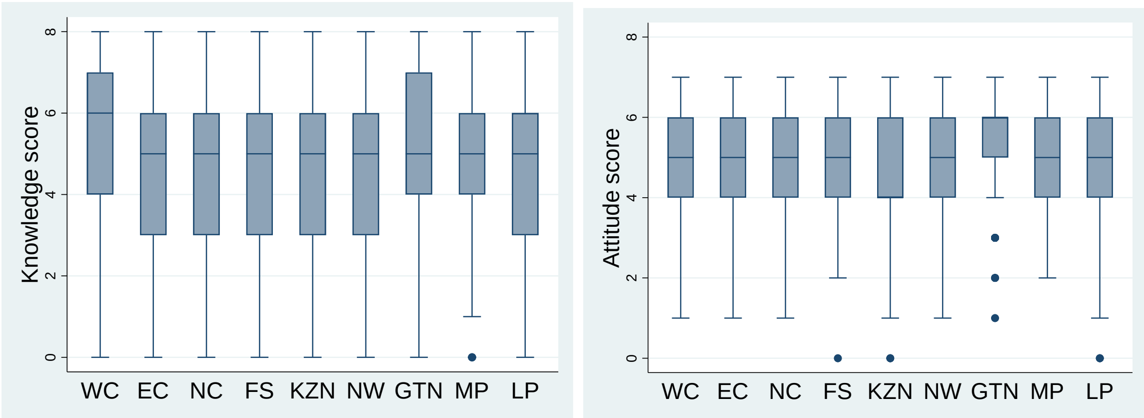

Figure 3.7: Design weighted box plots showing the distribution of knowledge and attitude scores across provinces

Knowledge scores were noticeably highest in the Western Cape and Gauteng. Attitude scores appear to have been lowest in KwaZulu Natal, and highest in Gauteng (Figure 3.7).

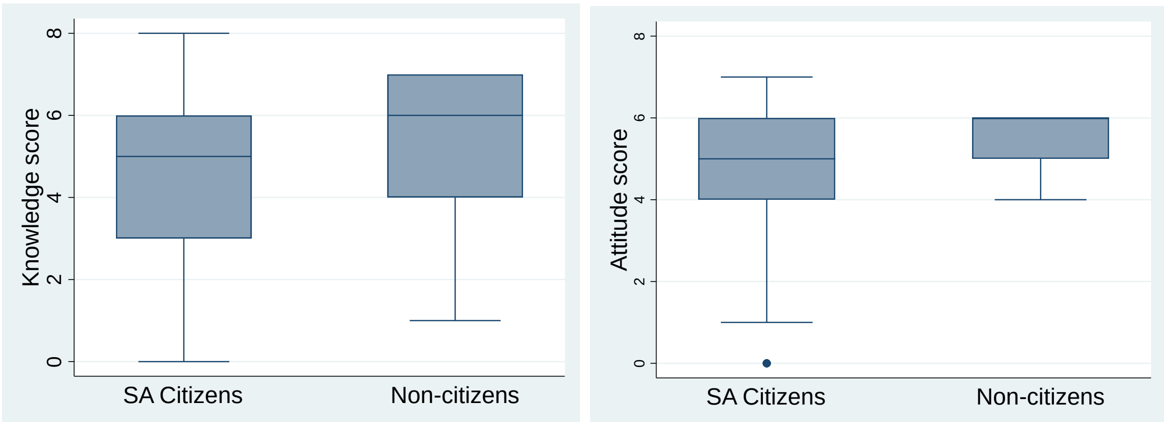

Figure 3.8: Design weighted box plots showing the distribution of knowledge and attitudes scores between South African citizens and non-citizens.

Knowledge and attitude scores were noticeably higher among non-citizens. (Figure 3.8).

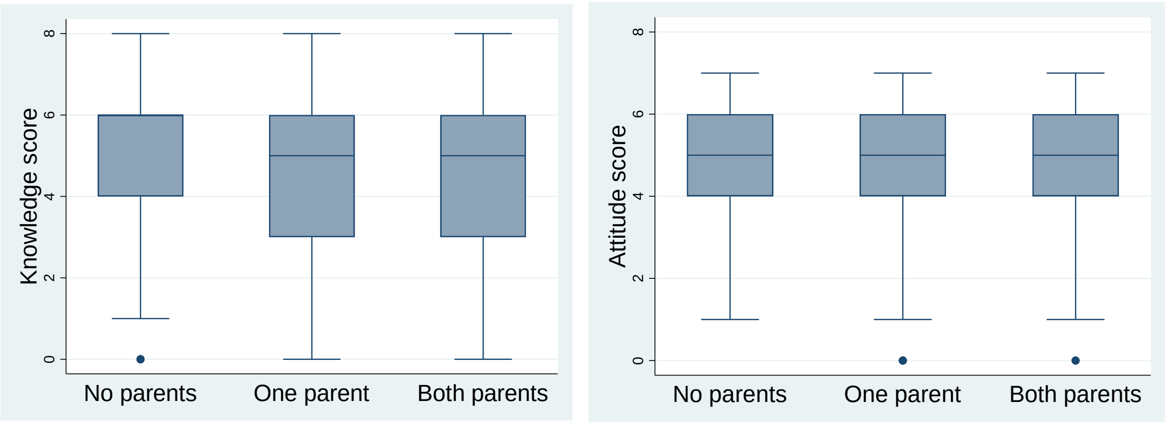

Figure 3.9: Design weighted box plots showing the distribution of knowledge and attitude scores by number of biological parents

The box plots suggest no differences in the distribution of knowledge and attitudes scores among children with no biological parents, children with one biological parent and those with both biological parents.

The distribution of knowledge, attitude and media scores

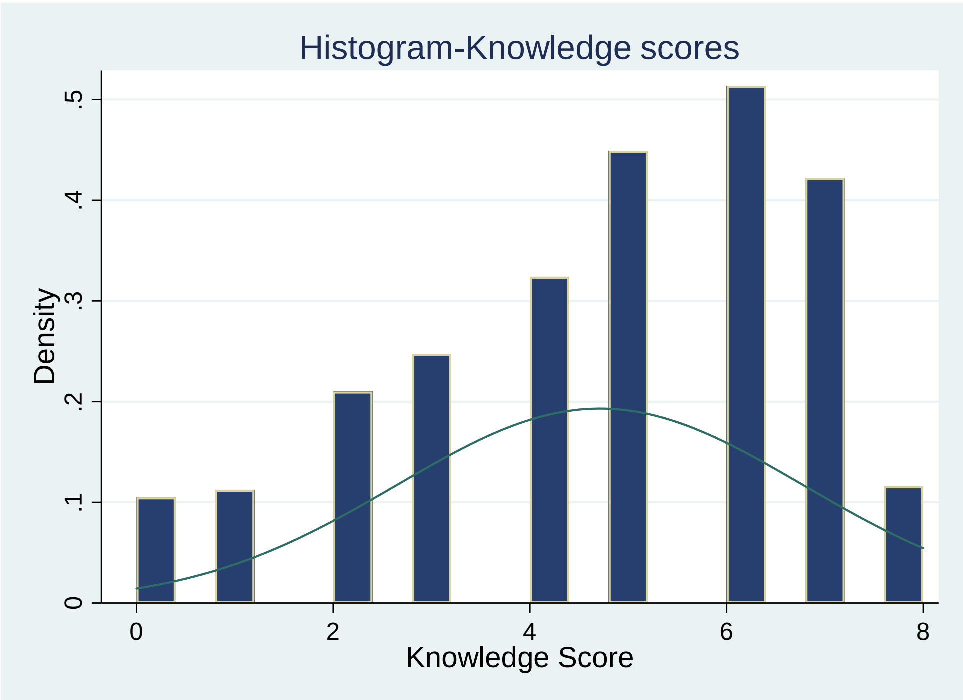

Figure 3.10: Design weighted histogram showing the distribution of knowledge scores

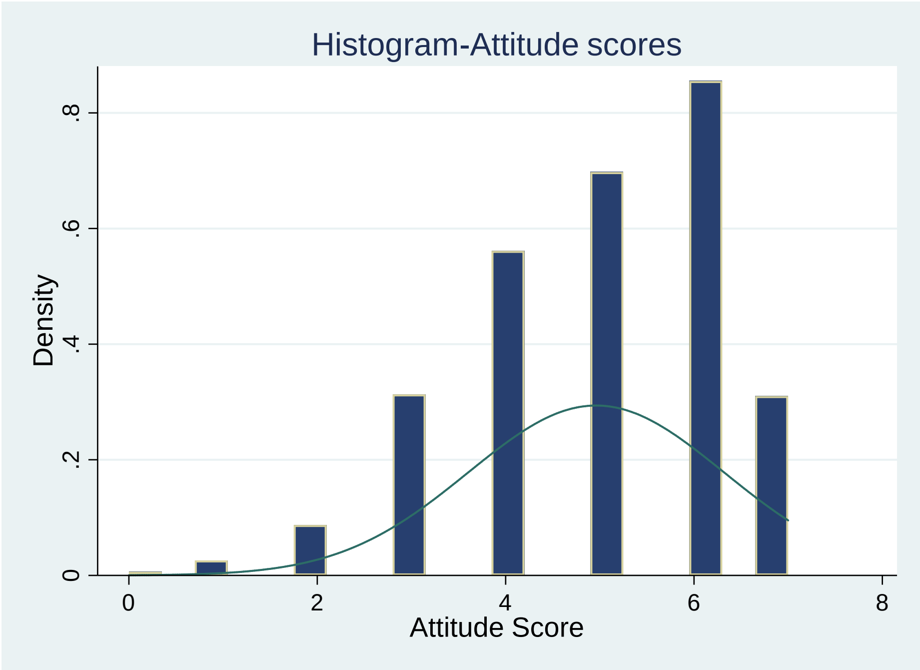

Figure 3.11: Design weighted histogram showing the distribution of attitude scores

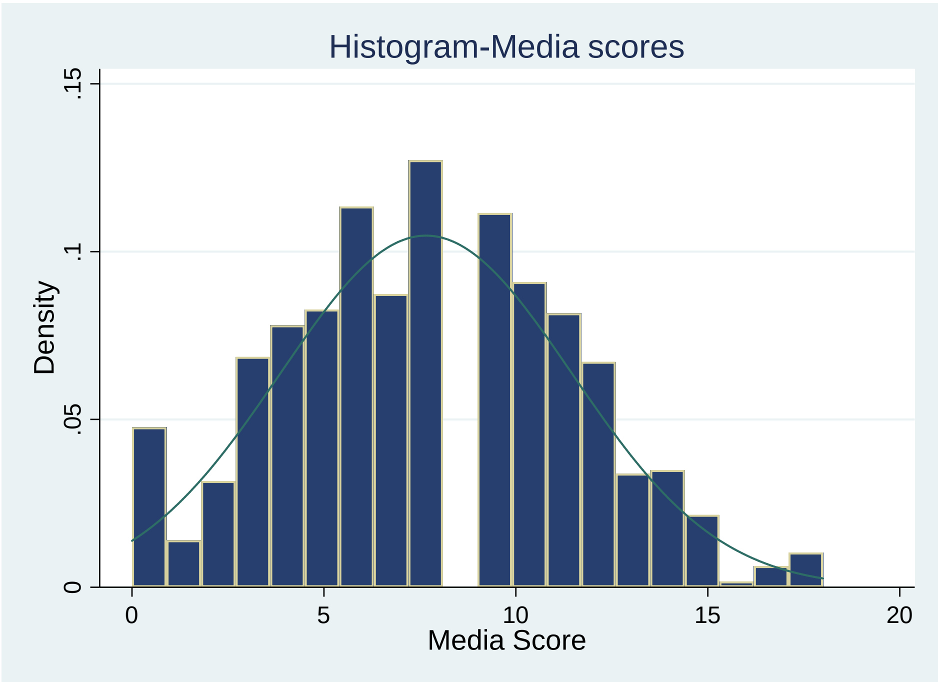

Figure 3.12: Design weighted histogram showing the distribution of media scores

3.5 Design Based Linear Regression Analyses

3.5.1 Bivariate Analysis with knowledge scores as the outcome variable

Table 3.5: Initial Design-Based Bivariate Regression Analysis Results Assessing Potential Predictors of HIV/AIDS knowledge scores among children aged 10 – 14 in South Africa, 2012

Predictor Variable	Parameter Estimate (Linearized SE)	Test Statistic	*p*-value
HIV Status		Wald F(1, 643) = 2.26	0.134
Sex		Wald F(1, 643) = 2.26	0.483
Age	0.369(0.088)	4.18	<0.001
Media Score	0.117 (0.021)	5.51	< 0.001
School Attendance		Wald F(1, 642) = 4.78	0.029
Circumcision		Wald F(1, 643) = 1.43	0.233
Geotype		Wald F(3, 641) = 2.26	< 0.001
Province		Wald F(8, 636) = 2.08	0.036
Nationality		Wald F(2, 642) = 0.85	0.356
Parent		Wald F(2, 642) = 2.26	0.179
Sexual debut		Wald F(2, 641) = 2.59	0.075
ARV Treatment (n=31)		Wald F(1, 31) = 2.59	0.171

The F statistics for *circumcision* and *Nationality* have p-values > 0.20 (arbitrarily chosen). The variables were dropped from the model.

Backward stepwise regression excluded *province*, *sexual_exp* (sexual debut) and *parent* from the model.

3.5.2 The Basic Model without Interactions: Predictors of knowledge scores.

Table 3.6: The Final Design Based Linear Regression Analysis Model without Interaction terms: Complete Case Analysis and MICE with Knowledge scores as the outcome variable

Complete Case Analysis (n = 1683)					**MICE Estimation (n = 2793)**	
Predictor Variable	**Parameter Estimate (Conf. Interval)**	**Test Statistic**	***p*-value**	**deff**	**Parameter Estimate (95% CI)**	***p* - value**
HIV Status		Wald F(1, 642) = 2.48	0.116			
Negative	0	Reference level				
Positive	0.602 (-0.149; 1.352)	1.57	0.116	2.579	0.518(-0.198;1.234)	0.156
Sex		Wald F(1, 642) = 0.20	0.659			
Male	0	Reference level				
Female	0.059 (-0.205; 0.324)	0.44	0.659	1.867	0.082(-0.177;0.341)	0.533
Age	0.334 (0.163; 0.505)	3.84	< 0.001	1.926	0.379(0.254;0.503)	<0.001
Geotype		Wald F(3, 640) = 2.43	0.064			
Urban formal	0	Reference level				
Urban informal	-0.502(-1.054-0.049)	-1.79	0.074	1.718	-0.360(-0.823;0.103)	0.127
Rural informal	-0.293(-0.614-0.027)	-1.80	0.072	2.249	-0.328(-0.653;-0.004)	0.048
Rural formal	-0.786(-1.557-0.017)	-2.01	0.045	1.667	-0.697(-1.323;-0.072)	0.029
Media Score	0.092 (0.049; 0.135)	4.23	< 0.001		0.086(0.047;0.126)	<0.001
School Attendance		Wald F(1, 642) = 4.87	0.028	2.386		
In school	0	Reference level				
Not in school	-1.467 (-2.772; -0.161)	-2.21	0.028	1.029	-1.214(-2.897;0.469)	0.156

The MICE model without interaction terms: Predictors of knowledge scores

The model without interaction terms suggests no significant association between the children's knowledge on HIV/AIDS and HIV status ($p = 0.156$). Age and media exposure are each positively associated with knowledge on HIV/AIDS ($p < 0.001$). Compared to children who resided in the urban formal settlements, children in the rural formal settlements had a mean knowledge score 0.697 units lower ($p = 0.029$).

3.5.3 Model with interaction terms: Complete Case Analysis and MICE with knowledge scores as the outcome variable

Table 3.7: Design Based Estimates of the Regression Parameters in the final Model for knowledge scores, Linearized Standard Errors for the Estimates, Design Adjusted Test Statistics and Confidence Intervals for the Parameters, and Design Effects Estimates

Complete Case Analysis (n = 1683)					**MICE** (n =2793)	
Predictor Variable	**Parameter Estimate (95% CI)**	**Test Statistic**	***p*-value**	**deff**	**Parameter Estimate (95% CI)**	**p-value**
HIV Status		Wald F(1, 642) = 16.80	< 0.001		F(1, 199.0) = 4.34	0.029
Negative						
Positive	1.837 (0.957; 2.717)	4.10	< 0.001	1.490	1.560(0.165; 2.954)	0.029
Sex		Wald F(1, 642) = 0.32	0.570		F(1, 274.3) = 0.97	0.379
Male						
Female	0.077 (-0.188; 0.341)	0.57	0.570	1.852	0.118(-0.145; 0.381)	0.379
Age	0.352 (0.182; 0.523)	4.05	< 0.001	1.907	0.399(0.262; 0.536)	< 0.001
Media Score	0.094 (0.051; 0.137)	4.30	< 0.001	2.298	0.345(0.065; 0.625)	0.016
School Attendance		Wald F(1, 642) = 28.50	< 0.001		F(1, 142.0) = 6.99	0.021
In school						
Not in school	-2.743(-3.752;-1.734)	-5.34	< 0.001	0.678	-2.418(-4.462; -0.374)	0.021
Geotype		Wald F(3, 640) = 2.38	< 0.068		F(3, 534.1) = 2.29	0.078
Urban formal						
Urban informal	-0.497(-1.046; 0.052)	-1.78	0.076	1.699	-0.372(-0.804; 0.612)	0.092
Rural informal	-0.291(-0.612; 0.030)	-1.78	0.075	2.266	-0.316(-0.638; 0.006)	0.054
Rural formal	-0.776(-1.542;-0.009)	-1.99	0.047	1.665	-0.654(-1.278; -0.018)	0.044
Hivstat#med_score		Wald F(1, 641) = 11.35	<0.001		F(1, 192.8) = 2.73	0.100
Negative						
Positive	-0.187(-0.296;-0.078)	-3.37	0.001	1.565	-0.163(-0.340; 0.013)	0.069

Table continues

In_school#Media		Wald F(1, 642) = 30.46	< 0.001			F(1, 134.7) = 3.64	0.075
Yes							
No	0.324 (0.208; 0.439)	5.52	< 0.001	0.589	0.256(-0.026; 0.539)		0.075

The MICE model which includes interaction terms: Predictors of knowledge scores

The HIV status - media exposure and school attendance – media exposure interactions are not significant in the multiple imputations model ($p = 0.069$ and $p = 0.075$ respectively). Since there are no significant interactions in the model, the model with interaction terms will not be considered in the interpretation of results.

3.5.4 Bivariate Analysis with attitude scores as the outcome variable

Table 3.8: Initial Design Based Bivariate Regression Analysis Results Assessing Potential Predictors of HIV/AIDS Attitude Scores among Children Aged 10 – 14 years in South Africa, 2012

Predictor Variable	Parameter Estimate (Linearized SE)	Test Statistic	*p*-value
HIV Status		Wald F(1, 641) = 0.39	0.533
Sex		Wald F(1, 641) = 4.46	0.035
Age	0.197(0.058)	3.40	0.001
Media Score	0.065 (0.013)	4.85	< 0.001
School Attendance		Wald F(1, 640) = 0.99	0.319
Circumcision		Wald F(1, 460) = 6.14	0.014
Geotype		Wald F(3, 639) = 2.26	0.003
Province		Wald F(8, 634) = 3.05	0.023
Nationality		Wald F(2, 640) = 13.71	<0.001
Parent		Wald F(2, 640) = 2.26	0.076
Sexual debut		Wald F(2, 635) = 2.47	0.085
ARV Treatment (n=43)		Wald F(1, 31) = 1.49	0.231

The F statistics for the school attendance and ARV treatment variables have $p > 0.20$ (arbitrarily chosen). The variables were dropped from the model.

3.5.5 The Basic Model without Interactions: Predictors of attitude scores

Table 3.9: The Final design Based Linear Regression Analysis Model without Interaction terms: Complete Case Analysis and MICE with Attitude Scores as the outcome Variable

Complete Case Analysis (n = 1656)					**MICE Estimation (n = 2793)**	
Predictor Variable	**Parameter Estimate (Conf. Interval)**	**Test Statistic**	***p*-value**	**deff**	**Parameter Estimate (Conf. Interval)**	***p* - value**
HIV Status		Wald F(1, 641) = 1.89	0.170			
Negative	0	Reference level				
Positive	0.284(-0.122; 0.691)	1.37	0.170	2.088	0.217(-0.215;0.649)	0.325
Sex		Wald F(1, 641) = 2.79	0.095			
Male	0	Reference level				
Female	0.149(-0.026; 0.323)	1.67	0.095	1.901	0.176(0.000; 0.351)	0.05
Age	0.155(0.050; 0.260)	2.89	0.004	1.679	0.052(-0.012;0.116)	0.108
Media Score	0.055(0.030; 0.081)	4.25	< 0.001	1.924	0.060(0.035;0.086)	<0.001
Geotype		Wald F(3, 639) = 2.85	0.037			
Urban formal	0	Reference level				
Urban informal	0.027(-0.273; 0.328)	0.18	0.859	1.308	0.021(-0.269;0.310)	0.888
Rural informal	-0.085(-0.328; 0.158)	- 0.69	0.491	1.466	-0.019(-0.241;0.203)	0.869
Rural formal	-0.578(-0.983;-0.172)	- 2.80	0.005	1.137	-0.344(-0.725;0.036)	0.076
Province		Wald F(8, 634) = 3.09	0.002			
Western Cape	0	Reference level				
Eastern Cape	0.178(-0.211; 0.566)	0.90	0.369	1.682	0.093(-0.272;0.459)	0.616
Northern Cape	0.084(-0.424; 0.597)	0.32	0.747	1.183	0.033(-0.406;0.473)	0.882
Free State	-0.259(-0.726; 0.208)	-1.09	0.276	1.257	-0.154(-0.563;0.255)	0.459
KwaZulu Natal	-0.371(-0.727;-0.015)	-2.04	0.041	1.749	-0.246(-0.565;0.074)	0.131

North West	-0.001(-0.422; 0.420)	-0.00	0.996	1.618	-0.007(-0.391;0.376)	0.970
Gauteng	0.119(-0.292; 0.530)	0.57	0.570	3.074	0.069(-0.297;0.436)	0.710
Mpumalanga	0.255(-0.137; 0.646)	1.28	0.202	1.745	0.126(-0.232;0.484)	0.490
Limpopo	0.281(-0.136; 0.699)	1.32	0.186	1.831	0.134(-0.265;0.532)	0.509
Nationality		Wald F(1, 641) = 8.12	0.005			
Citizen	0	Reference level				
Non-citizen	0.524(0.163; 0.885)	2.85	0.005	0.746	0.248(-0.459;0.955)	0.490

The MICE model without interaction terms: Predictors of attitude scores

There exists no significant association between HIV status and children's attitudes towards PLHIV ($p = 0.325$). Girls exhibit more positive attitudes towards PLHIV than their male counterparts. Attitudes towards PLHIV become more positive with increasing exposure to media ($p < 0.001$).

3.5.6 Models with interaction terms: Complete Case Analysis and MICE with Attitude scores as the outcome variable

Table 3.10: Design-Based Estimates of the Regression Parameters in the final Model for attitude scores, Linearized Standard Errors for the Estimates, Design-Adjusted Test Statistics and Confidence Intervals for the Parameters, and Design Effects for the Parameter Estimates

Complete Case Analysis (n = 1656)					**MICE model** (n =2793)	
Predictor Variable	**Parameter Estimate (95% CI)**	**Test Statistic**	**p-value**	**deff**	**Parameter estimate (95% CI)**	**p-value**
HIV Status		Wald F(1, 641) = 1.33	0.250		F(1, 228.5) = 0.89	0.267
Negative						
Positive	0.262 (-0.185; 0.708)	1.15	0.250	2.278	0.243(- 0.187; 0.673)	0.267
Sex		Wald F(1, 641) = 5.70	0.017		F(1, 342.5) = 4.23	0.044
Male						
Female	0.552 (0.098; 1.007)	2.39	0.017	1.691	0.462(0.012; 0.912)	0.044
Age	0.159 (0.054; 0.263)	2.99	0.003	1.656	0.211(0.118; 0.304)	< 0.001
Media Score	0.055 (0.030; 0.081)	4.24	< 0.001	1.925	0.054(0.029; 0.080)	< 0.001
Province		Wald F(7, 635) = 3.39	< 0.001		F(8, 644.7) = 1.45	0.172
WC						
EC	0.258(-0.266; 0.782)	0.97	0.334	1.653	0.173(-0.329; 0.676)	0.497
NC	0.413(-0.048; 0.875)	1.76	0.079	0.755	0.322(-0.137; 0.780)	0.169
FS	- 0.381(-1.035; 0.272)	- 1.15	0.252	0.926	- 0.154(-0.708; 0.400)	0.585
KZN	- 0.197(-0.650; 0.257)	- 0.85	0.396	1.638	- 0.098(-0.505; 0.308)	0.635
NW	0.196(-0.321; 0.713)	0.75	0.456	1.274	0.148(-0.322; 0.617)	0.536
GTN	0.435(-0.110; 0.980)	1.57	0.118	2.601	0.270(-0.226; 0.766)	0.285
MP	0.590(0.056; 1.124)	2.17	0.030	1.672	0.369(-0.117; 0.855)	0.137
LP	0.725(0.165; 1.285)	2.54	0.011	1.786	0.454(-0.045; 0.952)	0.074

Table continues

Geotype		Wald F(3, 639) = 3.11	0.026		F(3, 509.3) = 1.27	0.284
Urban formal						
Urban Informal	0.003(-0.297;-0.304)	0.02	0.983	1.301	- 0.007(-0.285; 0.271)	0.960
Rural Informal	- 0.076(-0.316; 0.164)	- 0.62	0.534	1.417	- 0.055(-0.274; 0.163)	0.618
Rural formal	- 0.574(-0.954;-0.194)	- 2.97	0.003	0.981	- 0.349(-0.720; -0.022)	0.065
Nationality		Wald F(2, 640) = 7.71	0.006			
Citizen						
Non-citizen	0.570(0.167; 0.972)	2.78	0.006	1.197	0.439(-0.283; 1.161)	0.231
Sex#prov		Wald F(8, 634) = 2.05	0.039		F(8, 639.8) = 0.63	0.754
Female#EC	-0.165(-0.811; 0.482)	-0.50	0.617	1.752	- 0.071(-0.712; 0.571)	0.828
Female#NC	-0.676(-1.439; 0.086)	-1.74	0.082	0.625	- 0.501(-1.195; 0.193)	0.157
Female#FS	0.167(-0.533;0.867)	0.47	0.640	0.693	0.018(-0.695; 0.731)	0.960
Female#KZN	-0.348(-0.953;0.248)	-1.13	0.254	1.879	- 0.321(-0.894; 0.252)	0.271
Female#NW	-0.397(-1.082; 0.287)	-1.14	0.254	1.281	- 0.264(-0.933; 0.405)	0.437
Female#GTN	-0.594(-1.280; 0.093)	-1.70	0.090	2.195	- 0.319(-1.027; 0.389)	0.375
Female#MP	-0.686(-1.309;-0.064)	-2.17	0.031	1.507	- 0.399(-1.061; 0.263)	0.236
Female#LP	-0.837(-1.430; 0.246)	-2.78	0.006	1.489	- 0.504(-1.117; 0.109)	0.107

The MICE model with interaction terms: Predictors of attitude scores

The sex by province interaction is not significant in the MICE model (p = 0.754). As a result of the lack of significant interaction terms in the model, the model will interaction terms will not be considered in the interpretation of results.

3.5.7 MICE diagnostics

This section outlines the different metrics and visual tools that were used to assess the performance of the imputations. Since all interaction terms are not significant, diagnostics were performed only for the models without interaction terms.

a) The model without interaction terms - knowledge scores as the outcome variable

Table 3.11: The number and percentage of missing values imputed for each variable registered for imputation - model without interaction terms

	Observations per iteration				
Variable	**Complete**	**Incomplete**	**Imputed**	**Total**	**% missing**
Knowledge score	1674	1119	1119	2793	40.06
Media score	1683	1110	1110	2793	39.74
In school	2773	20	20	2793	0.72

Knowledge score (*knowl_score*) had the highest percentage of missing values (40.06%) and school attendance (*In_ school*) had the lowest percentage of missingness (0.72%).

Table 3.12: Imputation diagnostics parameters- the model without interaction terms with knowledge scores as the outcome variable

	Imputation variance					
Variable	**Within**	**Between**	**Total**	**RVI**	**FMI**	**RE**
HIV positive	0.0948	0.0372	0.1325	0.3980	0.2870	0.9962
Female	0.0118	0.0054	0.0173	0.4628	0.3191	0.9958
Age	0.0015	0.0024	0.0039	1.5831	0.6184	0.9918
Media score	0.0003	0.0001	0.0004	0.4441	0.3450	0.9954
In school	0.3216	0.3972	0.7241	1.2517	0.5610	0.9926
Urban Informal	0.0383	0.0168	0.0553	0.4441	0.3101	0.9959
Rural Informal	0.0164	0.0106	0.0271	0.6531	0.3987	0.9947
Rural formal	0.0744	0.0265	0.1012	0.3605	0.2671	0.9965

Imputations = 75
Average RVI = 0.7406
Largest FMI = 0.6184
Average DF = 236.05

Variability in the coefficients (variance between) obtained from the 75 imputed data sets was largest for *In school* ($V_B = 0.3972$). This variability estimates the additional uncertainty coming as a result of missing data. This uncertainty was least for *media score* ($V_B = 0.0001$). Variance within was also highest for *In school* ($V_W = 0.3216$) and lowest for *media score* ($V_W = 0.0003$).

The relative efficiency (RE) was above 99% for all variables, indicating the true population parameters were well estimated. Increasing the number of imputations above 75 would not have had substantial additional effect on relative efficiency. The average relative variance increase due to missing information (RVI) is 0.7406. It represents the increase in the variance of estimates resulting from non-response. A small RVI (close to zero) corresponds to a small effect of missing data the on the variance of the estimates.

The largest fraction of missing information (FMI) is 0.6184, which means 61.84% of the total sampling variance is due to missing data. The largest FMI can be used judge whether the number of imputations, m, was sufficiently large for reliable analysis (White et al., 2011). The number of imputations would be considered sufficient if $m \geq 100 * FMI$. In this research project *m* was chosen to be 75 which is greater than 64.433, suggesting the number of imputations was sufficiently large. The largest degrees of freedom observed were for the coefficient of *rural formal*, indicating that loss of information due to missing data was smallest for this coefficient (Bouhlila and Sellaouti, 2013). The average DF was 236.05.

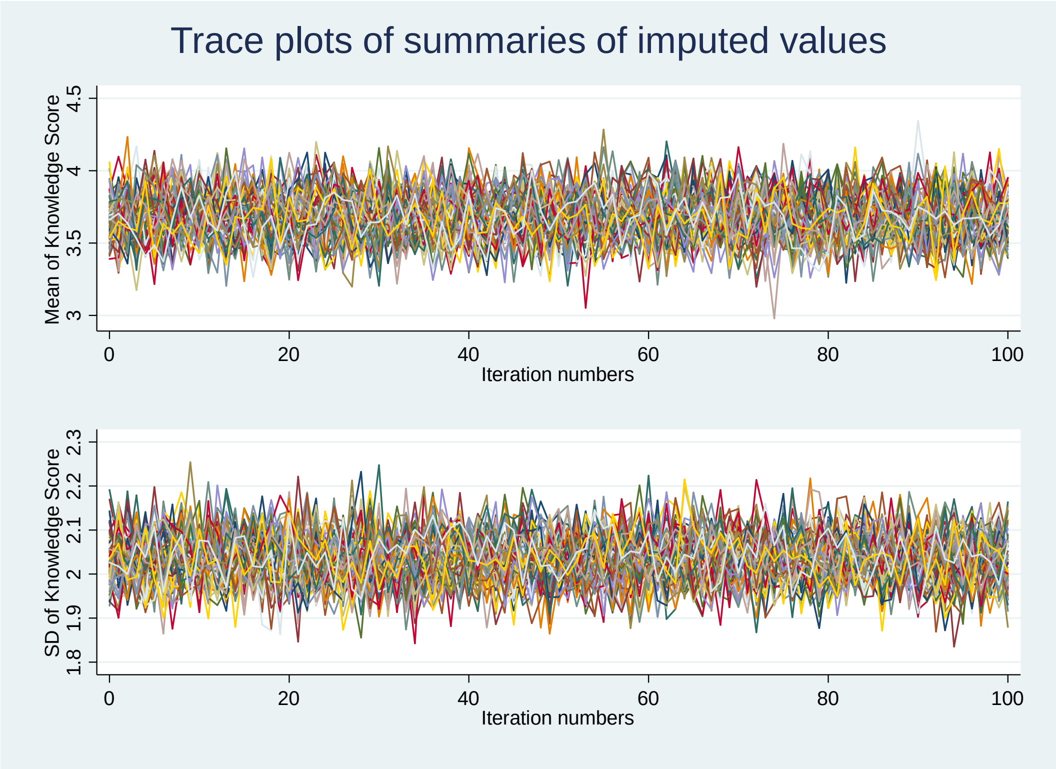

Figure 3.11: Trace plots of knowledge score means and standard deviations – model without interaction terms

The trace plots do not show trends. The means and the standard deviations are constant over time, indicating a fast convergence to stationarity. The imputation performed well.

b) The model without interaction terms - attitude scores as the outcome variable

Table 3.13: The number and percentage of missing values imputed for each variable registered for imputation

	Observations per iteration				
Variable	**Complete**	**Incomplete**	**Imputed**	**Total**	**% missing**
Attitude score	1680	1113	1113	2793	39.85
Media score	1683	1110	1110	2793	39.74

Missingness was almost the same between attitude score and media score.

Table 3.14: Imputation diagnostics parameters- the model without interaction terms with attitude scores as the outcome variable

Variable	Imputation variance Within	Between	Total	RVI	FMI	RE
HIV positive	0.0316	0.0163	0.0481	0.5196	0.3448	0.9957
Female	0.0052	0.0027	0.0080	0.5253	0.3473	0.9957
Age	0.0007	0.0004	0.0010	0.5943	0.3760	0.9953
Media score	0.0001	0.0000	0.0002	0.5696	0.3660	0.9954
Urban Informal	0.0135	0.0080	0.0216	0.5948	0.3762	0.9953
Rural Informal	0.0090	0.0037	0.0128	0.4194	0.2978	0.9962
Rural Formal	0.0241	0.0131	0.0373	0.5524	0.3589	0.9955
EC	0.0238	0.0105	0.0345	0.4469	0.3114	0.9961
NC	0.0409	0.0090	0.0500	0.2215	0.1825	0.9977
FS	0.0301	0.0128	0.0432	0.4309	0.3036	0.9962
KZN	0.0200	0.0064	0.0264	0.3234	0.2462	0.9969
NW	0.0276	0.0103	0.0381	0.3783	0.2766	0.9966
GTN	0.0260	0.0087	0.0348	0.3405	0.2559	0.9968
MP	0.0239	0.0092	0.0332	0.3905	0.2830	0.9965
LP	0.0274	0.0134	0.0410	0.4965	0.3346	0.9958
Non-citizen	0.0613	0.0661	0.1282	1.0908	0.5264	0.9935
	Imputations	= 80				
	Average RVI	= 0.5094				
	Largest FMI	= 0.5264				
	Average DF	= 298.61				

Variability in the coefficients (variance between) obtained from the 80 imputed data sets was largest for *Non-citizen* ($V_B = 0.3972$). This variability was least for *media score* ($V_B = 0.0000$). Variance within was also highest for *Non-citizen* ($V_W = 0.0613$) and lowest for *media score* ($V_W = 0.0001$).

The relative efficiency (RE) was above 99% for all variables, which shows the true population parameters were well estimated. The average relative variance increase due to missing information (RVI) is 0.5094. The variance of estimates increased by an average of 0.5094 as a result of non-response.

The largest fraction of missing information (FMI) is 0.5264, implying 52.64% of the total sampling variance is due to missing data. The average DF was 298.61.

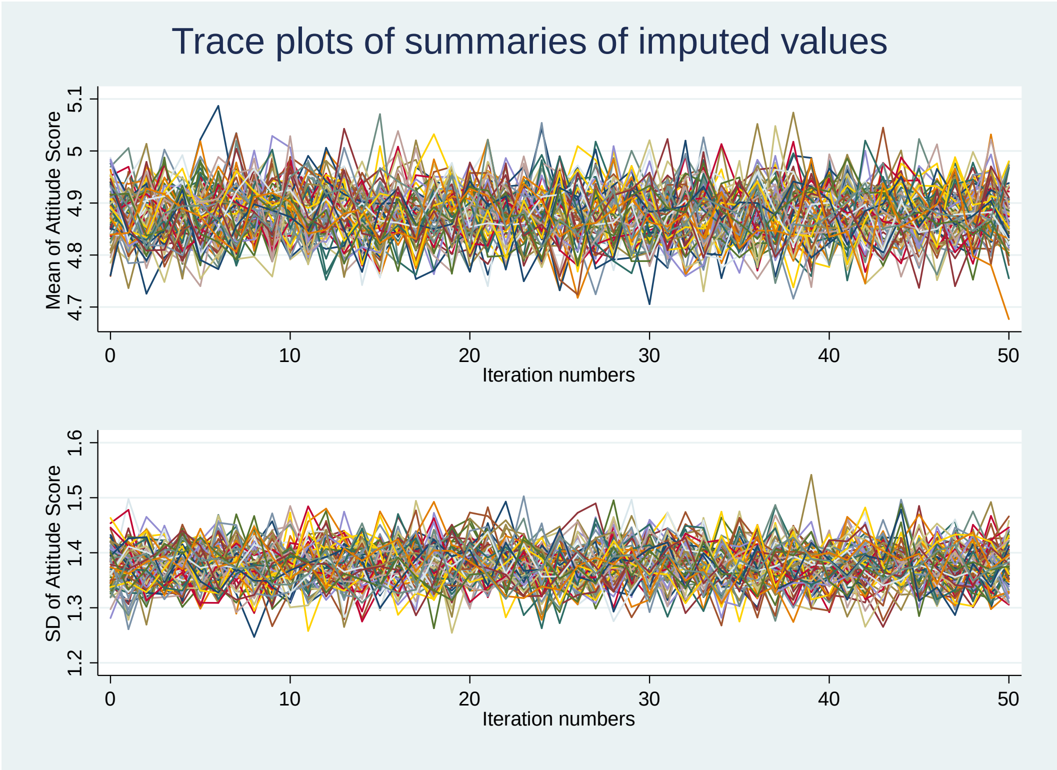

Figure 3.13: Trace plots of attitude score means and standard deviations – model without interaction terms

The trace plots do not show any trends. The mean and the standard deviation appear to be constant over time, suggesting the imputations performed well.

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CHAPTER 4: DISCUSSION

The goal of this research project was to find any differences in knowledge and attitudes on HIV/AIDS between HIV positive and HIV negative children aged 10 -14 years who resided in South Africa in 2012. It was hypothesised that HIV infected children, who in this case most probably got infected through vertical transmission, were likely to have had experience living with infected parents, resulting in them having better knowledge about HIV/AIDS and exhibiting more positive attitudes towards PLHIV than their uninfected counterparts. Information gleaned from literature suggests other factors, such as age, sex, school attendance, nationality, sex debut, circumcision in boys, ARV treatment, exposure to media, geotype and the province where a child resides, might also be associated with knowledge and attitudes on HIV/AIDS.

In view of the satisfactory performance of the multiple imputations, only the MICE model will be considered in this discussion. The multiple imputations model suggests the HIV status – media score, and the school attendance – media score interactions are not statistically different. Consequently, the interaction terms fall out of the model. Only the model without interaction terms will be considered in this discussion.

4.1 Association between HIV/AIDS knowledge and HIV status

Though preliminary analyses show knowledge scores to be higher among children living with HIV, the regression model suggests no significant difference in HIV/AIDS knowledge between infected and uninfected children in South Africa. Contrary to what was initially conjectured, HIV/AIDS knowledge levels for adolescents in South Africa are the same irrespective of their HIV status. The supposed experiences that infected children had living with HIV did not have significant bearing on their knowledge on HIV/AIDS. The knowledge of infected children was similar to that of their uninfected counterparts. This knowledge might have been acquired in school, through the different kinds of media, or through their everyday interactions with their society.

4.2 School attendance, Knowledge on HIV

A study conducted by Nubed and Akoachere (2016) in Cameroon showed that children's knowledge on HIV/AIDS was mostly acquired in school. On the other hand Hargreaves et al.(2008) found no significant differences in HIV knowledge between students and non-students aged 14-25 years in South Africa. This research project focussed on children aged 10 - 14 years, and the regression model suggests no significant difference in the mean knowledge scores between children who attended school and those who were not in school. This might not necessarily suggest that schools in South Africa are not making any difference in children's knowledge on HIV/AIDS. In actual fact, the South African curriculum offers Life skills education which includes HIV/AIDS and related issues. Every child within the borders of South Africa has a right to education. Even those not in school are likely to have attended school at some point, only to drop out after acquiring a measure of knowledge on HIV/AIDS.

The knowledge assessed in HIV surveys is sometimes so elementary that even for children who would have been in school for a few years before dropping out would have assimilated this knowledge. It forms part of common knowledge, known to school dropouts just as much as it is known to those still studying. Hence no difference was detected between children out of school and those still studying. However, preliminary analyses together with the complete case analysis model suggest a knowledge disparity between school dropouts and those still in school, though this difference is not significant.

The overall mean knowledge score was 4.712 out of 8, which is about 59%. In view of the importance of HIV/AIDS knowledge among the adolescent age group, in this research project a score of 80% would be deemed satisfactory. It is important to raise knowledge levels and reduce negative perceptions for all adolescents regardless of HIV status. Schools remain one of the most practical means of equipping children with age appropriate knowledge that will help them make informed choices even later in life. In 2012, an estimated 46 144 children residing in South Africa were out of school (table 3.2). While every child within South African borders has a right to basic education, more could be done to ensure that every child of the school going age actually goes to school.

It is important that infected children are furnished with correct age appropriate information for them to understand what it means to be HIV infected, and to encourage them to continue taking medication correctly. A cross-sectional study in Ethiopia has shown low levels of adherence on ART for young people (Firdu et al., 2017). Providing relevant information for the adolescent age group is important especially as they grow into young adults, becoming more independent from their parents and guardians. For all adolescents, correct information on social and behaviour change is important for them to understand the positive and negative consequences of making certain choices, for example, early sex might result in STIs, teenage pregnancies and dropping out of school.

4.3 Age, media use, Knowledge and attitudes on HIV

Consistent with the findings by Hossain et al. (2006) in a study conducted with university students in Bangladesh, in this research project age and media exposure are positively associated with HIV knowledge. As children grow older their understanding of issues, which include HIV/AIDS generally gets better. In addition, the school curriculum is also designed to give age appropriate knowledge, hence the positive correlation between age and knowledge.

While in the same study Hossain et al. (2006) reported an association between age and attitudes towards PLHIV, among children residing in South Africa no significant relationship was found between age and attitudes. Whereas with increase in age knowledge has been shown to increase, advancement in age does not seem to exert any effect on attitudes. The school is the main source of knowledge for children of school going age (Nubed and Akoachere, 2016). Attitudes are mainly from the society (Chen et al., 2007). While effort is made to equip children with the knowledge that might promote correct perceptions on HIV/AIDS, the general society continues to lag behind. Children are impressionable, their attitudes will reflect those of the family and the society at large.

Among Iranian students Masoudnia et al. (2016) found that attitudes towards PLHIV became even more negative with increasing age. Older children tend to discern and interpret stigma better than the younger in spite of their higher HIV/AIDS knowledge levels. They understand how the general society feels about HIV/AIDS and because of cultural bonds they find it difficult to break away from the societal perceptions.

There exists a significant positive association between use of different kinds of media and knowledge on HIV/AIDS among children who resided in South Africa in 2012. This is consistent with the findings by Jung et al. (2013) who used cross-sectional data from Demographic Health Surveys from 13 countries in Sub-Saharan Africa. The content of the media used by participants in this research project cannot be established. However extensive use of media means greater exposure to information, some of which would be HIV/AIDS related. Contrary to the findings of this research project, Bekalu and Eggermont (2014) conducted a study in north-western Ethiopia and found no significant association between media use and HIV/AIDS related knowledge. The content of the media in Ethiopia might not be the same as in South Africa. Furthermore, the different findings could have resulted from the use of different instruments used to assess knowledge.

Since exposure to media has proved effective in the dissemination of HIV/AIDS information, schools may help identify and intensify use of children's preferred media in the propagation of HIV/AIDS knowledge. For example, bearing in mind that children usually prefer watching to listening, use of videos in a Life Skills class could be more effective than listening to audios.

In view of the importance of imparting HIV/AIDS knowledge to all children in the country, TV programmes which target children could also touch on HIV/AIDS and related issues.

4.4 Sex, Knowledge and attitudes on HIV

While there is no significant association between sex and knowledge, South African females aged 10 -14 years exhibit more positive attitudes towards PLHIV than their male counterparts. There is not much in literature that has been done to investigate differences in knowledge between male and female children. This might be another area where further research could be conducted.

However Umeh et al. (2008) found males to be significantly more knowledgeable in HIV/AIDS issues than females among the health care professionals in Nigeria. In South Africa, among mentally ill patients Johnson et al. (2012) found females to be more knowledgeable than males.

4.5 Geotype, Knowledge and attitudes on HIV

Type of residence – urban or rural, has been identified among the important predictors of HIV/AIDS knowledge, with adolescents residing in rural areas less likely to have comprehensive knowledge on HIV and AIDS (Ayodele and Ayodele, 2016). Consistent with this finding, in this research project a visual inspection of the design weighted box plots, over and above regression analyses show higher HIV knowledge levels among urban formal residents than those who resided in the rural informal and rural informal settlements. Though through the education curriculum effort has been made to raise HIV knowledge levels of children in all types of residence, more still needs to be done to close gap between typical urban residents and those in the rural areas. Urban formal residents have greater access to information than children in rural communities.

4.6 Nationality, Knowledge and attitudes on HIV

The multiple imputations model does not suggest significant differences in attitudes between South African citizens and non-citizens. HIV knowledge and attitude scores also do not vary across the different provinces in South Africa. One may conclude that even cultural differences, which are evident across the nine South African provinces, may not have significant influence on knowledge and attitudes on HIV/AIDS among South African adolescents. Dissemination of HIV/AIDS information has probably been the same across the provinces of South Africa.

CHAPTER 5: CONCLUSION

5.1 Main findings

Evidence from the available data suggests no significant differences both in knowledge ($p = 0.56$) and in attitudes ($p = 0.325$) on HIV/AIDS between HIV infected and uninfected children in South Africa. Children living with HIV had just as much knowledge on HIV/AIDS as the uninfected children. Evidence also suggests that age ($p < 0.001$) and exposure to different kinds of media ($p < 0.001$) were the main drivers of knowledge among the adolescents. Increasing children's access to different kinds of media could help raise their HIV knowledge levels and improve their attitudes towards PLHIV (Jung et al. 2013).
There exists a knowledge disparity between children in the urban formal settlements and those in the rural areas ($p = 0.029$). Dissemination of HIV/AIDS information is still lagging behind in South African rural settlements.

5.2 Future research area

Though knowledge on HIV/AIDS is of paramount importance among adolescents, it may not be the sole factor in explaining perceptions and HIV transmission among adolescents in South Africa. Even with high levels of knowledge on HIV, there could be an array of social, cultural and economic factors, or even pure negligence that could hinder children from putting their knowledge into practice. Evaluating how such factors impact the choices that children make is area that could be looked into in future studies.

5.3 Limitations in the current study

Data were not collected expressly for the assessment of knowledge and attitudes on HIV among children who resided in South Africa. A different data collection tool would probably have given different results, for example, in north-western Ethiopia Bekalu and Eggermont (2014) found no association between media use and knowledge on HIV/AIDS, yet in a cross-sectional study conducted in Sub-Saharan Africa by Jung et al. (2013) the association was found to be positive. The contradictory findings could be a result of the use of different data collection tools.

Though greater exposure to media has been shown to be strongly associated with higher levels of knowledge, the content of the media cannot be ascertained.

Many authors now use the multiple imputation technique that was used in this project, however there is still the need to develop a stronger theoretical basis for this.

The data used in this research project are also not very recent. Circumstances might have changed. Conducting the same study with a validated data collection tool and more recent data might yield different findings.

Notwithstanding the above stated limitations, this research project remains a valuable information source both for policy makers and future researchers.

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APPENDICES

Appendix 1 – Plagiarism declaration report

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Abel Musha Mapfumo (Student number: 541296) am a student registered for the degree of MSc Epidemiology (Biostatistics) in the academic year 2020.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: ______________________ Date: 16/03/2020

1

Appendix 2 – Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Mr Abel Musha Mapfumo

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M190402

NAME: (Principal Investigator)	Mr Abel Musha Mapfumo
DEPARTMENT:	School of Public Health Epidemiology and Biostatistics Division
PROJECT TITLE:	Comparison of knowledge and attitudes on HIV between HIV infected and HIV-uninfected children between the ages of 10 and 14 in South Africa, 2012
DATE CONSIDERED:	2019/04/26
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Jonathan Levin and Prof Khangelani Zuma
APPROVED BY:	CB Penny Dr. CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	30/05/2019

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in April and will therefore be due in the month of April each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date 30/05/2019

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES