

SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

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A COMPARATIVE CROSS-SECTIONAL STUDY ON THE COGNITIVE FUNCTION OF
PERINATALLY ACQUIRED HIV-INFECTED AND NON-INFECTED CHILDREN AT
RIDGE HOSPITAL, ACCRA.

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DECLARATION

I certify that this proposal titled “a comparative study on the cognitive function of perinatally acquired HIV-infected and HIV-uninfected children is my own work. It is being submitted in fulfillment of the Master of Public health at the University of Ghana, Legon. This dissertation has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree or examination to any other university or institution other than the University of Ghana, Legon.

Any help and assistance received in my research work and the preparation of the dissertation is acknowledged.

In addition, I certify that all information sources and literature used have been duly acknowledged.

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DEDICATION

I dedicate this work to the Almighty God who is able to do exceeding and abundantly more than we can ever imagine or think of and providing me with strength to come this far. To my lovely parents this work is dedicated to you in recognition of your support and encouragement which propelled me to successfully complete this programme.

To all Persons living with HIV, there is still hope, keep the hope alive.

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God bless you all.

ABSTRACT

Background

It can be estimated that Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) continues to affect the health state of individuals worldwide. This study was a comparative study on the Cognitive function of perinatally acquired HIV-Infected and un-infected at Ridge Hospital. The study provides insight into the cognitive function of children infected with HIV perinatally so that appropriate psychotherapeutic or psycho-educational interventions can be explored to optimize the cognitive functioning and potential of the HIV-infected child.

Methods

Hundred (100) HIV-infected children were randomly selected as against two hundred (200) HIV-uninfected children aged six to twelve years at the Anti-retroviral clinic and the Out-patient department respectively. All underwent age appropriate cognitive testing by completing a twenty (20) minutes session of the mini mental scale examination.

Results

A total of 300 children were interviewed. Out of this, 200 were HIV- uninfected and 100 were HIV- infected. The mean age ($\pm$ SD) of the participants was 8.8 ± 1.74 years. More than half 227 (92.3%) reported to be primary school pupils and 23 (7.7%) reported to be junior high school pupils. For the parents of the children, 44 (14.7%) were reported to have achieved primary school education, 72 (24%) had achieved junior high school education and 184 (61.3%) achieved tertiary education. The higher rise in educational level of the parent was significantly associated with cognitive outcomes. Majority of the parents of HIV- uninfected participants earned a higher monthly income, although it had an association with the

cognitive of the child it was not significantly associated after adjusting for other predictor variables ($p= 0.158$) . Generally, 10 (10%) of the HIV-infected participants recorded a normal overall cognitive function and 90 (90%) had an abnormal overall cognitive function compared to HIV- uninfected participants who had all 200 (100%) participants having a normal cognitive function and this difference was significant ($p<0.001$). Except for being an HIV- infected participant, the age of the child and the status of the child were linked to a normal cognitive score.[Adj mean=0.2, 95%CI (0.1,0.39); Adj mean= -9.1, 95%CI (-9.8, -8.3)]

Conclusion

The study revealed that the overall performance for cognitive test was lower for HIV-infected children compared to HIV- uninfected children.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti-retroviral Therapy
ARVs	Anti-retroviral Drugs
CD4	Cluster of differentiation 4
HAART	Highly active anti-retroviral therapy
GHS	Ghana Health Service
HIV	Human Immunodeficiency Virus
MMSE	Mini Mental State Examination
NACP	National AIDS and STI Control Programme
PLHIV	People Living with HIV
UNAIDS	Joint United Nations Programme on HIV/AIDS
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Human Immunodeficiency Virus (HIV) and Acquired immunodeficiency Syndrome (AIDS) still poses health threat worldwide (Klatch, 2013), since its discovery in the early 1980s the AIDS pandemic continues to claim thousands of lives worldwide (Klatch, 2013; WHO/UNAIDS/UNICEF, 2013). Mode of transmission for the infection is through bodily fluids containing the virus, such as blood, breast milk and vaginal discharges during sex. The HIV is described as a slowly advancing virus which makes infected persons susceptible to a host of opportunistic infections which could lead to AIDS over a long period of time (Klatch, 2013). There is still no cure for the disease and sadly millions of individuals continue to suffer and die from it every year, particularly in low and middle resource areas (Becker, Venter, Cohen, Van Custom, Boulez, & Wood, 2014). For a mother-to-child mode of transmission is usually at birth and during the time of breastfeeding (Klatch, 2013; WHO/UNAIDS/UNICEF, 2013). Individuals between the ages 15 to 35 are mostly affected and studies have showed that it is predominant in women and they are the ones typically needed in the workforce but are mostly unemployed (Klatch, 2013).

HIV has the tendency to affects the health, cognitive outcomes and general well-being of the persons infected including children. HIV-infected children are at an increased risk of developing significant neurological and neuropsychological problems. Various cognitive and neurological impairments have been documented in up to 80% of HIV-infected children

(Than et al, 2002). Resulting complications, such as encephalopathy, and developmental delays have been identified in children who are infected with HIV since the earliest descriptions of the disease (Knight et. al, 2000).

Women from low resource areas are mostly affected (Brackis-Cott, Kang, Dolezal, et al., 2009a; Brandt, Dawes, & Bray, 2006; Petersen, Bhana, Myeza, et al., 2010a). This results in medical, financial, and psychosocial challenges which goes a long way to affect their families (Brown, & Lourie, 2000; Petersen et al., 2010a).

Gartner's, 2000 summary article stated that HIV has the ability of destroying a variety of cell types in the brain leading to damage of the central nervous system (CNS) which controls the cognitive functions. Neuropsychological tests serve as indirect measures to assess cognitive functioning. Cognitive deficits are observed in the areas of language and motor skills (Condini et.al, 1991), verbal and memory functioning (Levenson et.al, 1992) and visual-spatial integrative ability (Boivin et.al, 1995). In the developing world, there is still a relatively high prevalence of neurological disease associated with pediatric HIV disease. Neurological disease is three times more common in children than adults, and is often the initial presentation of HIV disease, with 75% of cases occurring within the first 2 years of life (Blance et.al, 1993)

Worldwide, it has been reported that HIV affects three million children (UNAIDS report, 2010), yet the effect of timing on ART on neurodevelopmental outcomes of the children is very limited (Chiriboga et.al, 2005). Studies from more developed countries have reported poorer cognitive functioning in HIV-infected children compared to HIV-uninfected children, where greater impairment is observed in children with severe HIV symptoms coupled with immune suppression.

Cognitive development is responsible for logic and reasoning, memory, attention, control, flexibility, evaluation and analyzing skills, ability to make comparisons, explore and understand cause and effect, critical thinking, etc. Reports on the effect of antiretroviral treatment on cognitive outcomes are conflicting and suggest that children who receive antiretroviral drugs in infancy or before the onset of symptoms are likely to have better outcomes than those who access treatment at an older age (Laughton et.al.,2012).

Mother-to-child transmissions of HIV can be reduced and longevity improved if HIV-infected mothers comply with combination anti-retrovirals. However, the protective mechanism of these drugs on cognitive and socio-emotional outcomes remain unanswered. Several studies have highlighted that cognitive functioning do not necessarily improve after ARV initiation (Puthanakit et al., 2010; Smith et al., 2008) and risk of cognitive deficits has been linked to early diagnosis and severe disease progression (i.e. AIDS diagnosis) (Smith et al., 2012; Wood et al., 2009; Nachman et al., 2012).

Given this, it however can be hypothesized that the issue may be that many perinatally infected children have other reasons they may perform poorly on cognitive assessments-i.e. poverty, low birth weight, prematurity, psychosocial factors, etc. and therefore it will be prudent for further studies to be conducted to determine if these factors have a direct link on the cognitive function of an HIV-infected child.

1.2 PROBLEM STATEMENT

In the developing world, there is as yet a moderately high pervasiveness of neurological disease associated with pediatric HIV infection. In children neurological ailment is showed to

be three times more typical than in adults, and is frequently the initial presentation of HIV infection. About 75% of cases happen in the first 2 years of life (Walker et al, 2014). The most widely recognized and the most very much depicted type of HIV-related neurological dysfunction in children is HIV encephalopathy. Clinically, people affected are not able to accomplish proper formative milestones, disabled cerebrum development, and global selective impairments in intellectual, language, motor, attention, conduct, and social abilities that may influence everyday functioning (Chang et al, 2010).

Several studies have explored school performance among perinatal HIV1 (PHIV) children and adolescents, and identified poorer outcomes compared with children without HIV, with the exception of a French study, which reported an academic failure rate of 16%, similar to the general population (Dollfus et.al, 2010). There is a striking lack of studies on academic achievement in resource-limited countries. Although such research would be difficult to undertake, it would provide valuable information to guide interventions. HIV-infected children performed significantly worse than HIV -uninfected.

The mechanisms of HIV neuropathogenesis may differ between residents of Africa and those of the United States and Europe, where different viral strains are in circulation. In sub-Saharan Africa, it has been observed that cognitive functions are within the normal range for older children with HIV. Studies performed usually do not contain a control group making it difficult to make a strong association (Bagenda et.al., 2006). In Ghana, there is not much information available in this area. To date, not much studies of cognitive functioning of HIV-infected children has been done in Ghana.

This study seeks to explore and compare the cognitive function of perinatally acquired HIV-infected and un-infected children at Ridge hospital.

1.3 JUSTIFICATION

The Ghana Aids Commission is mandated to provide support, guidance and leadership for the national response to HIV and AIDS in Ghana. Furthermore the Commission works closely with a wide range of organizations in carrying out its mandate. Since the establishment of the Commission in 2002, there is no known intervention by way of assessing and enhancing the cognitive function of perinatally acquired HIV-infected children. In August 2014, the Ministry of Education came up with a revised policy on HIV and AIDS policy. All these interventions from the Government have been geared towards prevention of the spread of HIV and social interventions for persons living with HIV/ AIDS.

This study thus is justified for the reason that it would serve as a reference document. The study also presents both a challenge and opportunity for the development of appropriate programmes by stakeholders such as the Ghana Aids Commission and the Ministry of Education sector on HIV/ AIDS.

The researcher envisages that the study would provide insight into the cognitive function of children infected with HIV perinatally so that appropriate psychotherapeutic or psycho-educational interventions can be explored to optimize the cognitive functioning and potential of the HIV -infected child.

Furthermore, the findings will be useful in formulating and revising strategies geared at promoting mental care for HIV infected children by the Ghana Health Service (GHS).

Finally, the finding of this study will add to existing literature in Ghana on the cognitive function of perinatally infected HIV children if there is any.

1.4 Research question

1. Is the overall cognitive function of perinatally acquired HIV-infected children taking ART affected?
2. Is there a significant difference in the working memory functions between HIV - infected children and HIV -uninfected children?
3. Is there a difference between the levels of IQ of perinatally acquired HIV infected children and their contemporaries who are HIV- uninfected.
4. What is the difference between the verbal comprehension and reading abilities perinatally acquired HIV infected children and their contemporaries who are HIV negative?

1.5 Main objective

To compare the cognitive function of perinatally (vertically) acquired HIV- infected and uninfected children at Ridge.

1.6 Specific Objectives

1. To ascertain whether there is a significant difference in the working memory and perceptual reasoning between HIV- infected and HIV- uninfected children.
2. To ascertain if there is a difference between the levels of Intelligent Quotient (IQ) of perinatally acquired HIV- infected and their contemporaries who are HIV- uninfected.
3. To ascertain the difference between the verbal comprehension and reading abilities of perinatally acquired HIV- infected and their contemporaries who are HIV- uninfected.

1.7 Conceptual Framework

Cognitive function reflects a subjective evaluation of one's self based on the intelligent quotient, working memory, perceptual reasoning, reading ability and verbal comprehension.

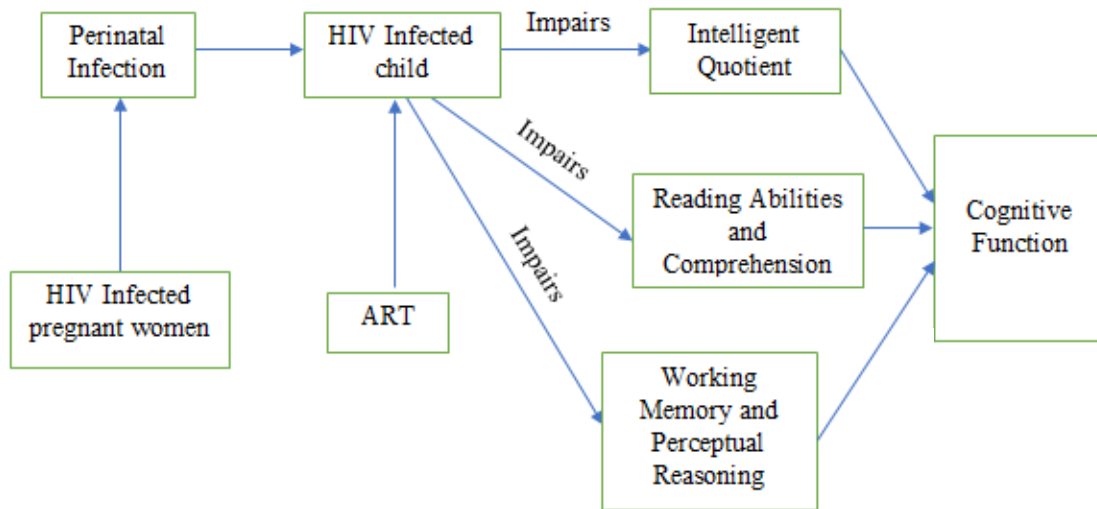
It focuses on the respondents cognitive function in relation to the effect of HIV.

MMSE tool reports cognition in five (5) domains (working memory, perceptual reasoning, intelligent quotient, verbal comprehension and reading abilities). In view of the above and for the purpose of this study, the outcome variable of interest is cognitive function of HIV – infected and uninfected children. Working memory, perceptual reasoning, intelligent quotient, verbal comprehension and reading abilities are the independent variables.

The conceptual framework shows the domains of cognitive function and its linkages. The conceptual model allows for the measurement of a combination of structural processes and outcome measures. The framework produces scores relating to particular facet of the overall cognitive score.

Below is a conceptual framework of the various domains that contribute to the overall QOL.

Figure 1: A Conceptual Framework on How Perinatal Infected HIV Children and Uninfected Children perform in Cognitive Function.



Conceptual Framework

The advent of HIV-AIDS and its adverse impact on human health is well-known. It has attracted a lot of attention given that it remains incurable, and indeed current health systems have only managed to delay the eventual death of a victim (Over et al, 2004; Canning, 2006; Cummings & Badley, 2015). The mode of transmission is diverse, but this study focuses on the perinatal mode of transmission. Particularly, it looks at the cognitive function of perinatal HIV- infected children and their contemporaries, who are HIV-uninfected children.

The framework explains the authours conceptualization of how perinatal HIV infected children and uninfected children perform in terms of cognitive function. From the perinatal mode of transmission, the child stands a high risk or is exposed to neurodevelopmental problems, or cognitive deficits (Ravindran et al, 2014; Nassen et al, 2014; Cohen et al, 2015). This occurs because HIV insults the central nervous system during early infancy. Indeed,

studies have confirmed this causality, and have also found that perinatal HIV infected children perform worst in cognitive and neurodevelopmental tests as compared to HIV uninfected children (Knight et al, 2000; Puthanakit et al, 2013; Philips et al, 2016). This clearly indicates that perinatal HIV infected children perform poorly as compared to uninfected children in the domain of cognitive function.

The impact of HIV on the cognitive function of children manifest mostly by impairing the following: working memory, executive function, processing speed, and causing perceptual deficits (Philips et al, 2016). Given the effects of HIV on cognitive function, this framework also takes into consideration the role of ART. This is especially so because ART is an integral medication for moderating the effects of perinatal HIV on a child's cognitive function. Indeed, this has given credence to the early administration (first 3 months) of ART as a panacea to improve the cognitive function among perinatal HIV infected children (Puthanakit et al, 2013; Nichols et al, 2016; USAID, 2018) and as an intervention among pregnant mothers with HIV (Mwaba et al, 2015; USAID, 2018). As such, the framework hinges ART medication on the perinatal infection because the impact is best realized on cognitive functions when the intervention is administered early.

The framework also shows how perinatal HIV affects some key domains of cognitive function: this invariably means that perinatal HIV affects (impairs) the child in the domains of intelligent quotient, reading abilities and verbal comprehension (Martinez et al, 2012), as well as the working memory and perceptual reasoning (Philips et al, 2016). All culminate to impact cognitive functioning according to the framework.

Importantly, the study makes use of a control group of uninfected children. The idea for this is to ascertain robust findings. This is especially so given that a study that only looks at the

effects of perinatal HIV on cognitive functions might necessarily be limited: missing out whether, indeed, the effect of perinatal HIV on cognitive functions differs from the effect children without HIV would have on that same set of cognitive functions. This approach will make the study more robust. There is, however, evidence suggesting that HIV uninfected children perform better in terms of cognitive functions than perinatal HIV infected children (Knight et al, 2000; Puthanakit et al, 2013; Sherr et al. 2014; Philips et al, 2016).

It is important to understand the extent of neurodevelopmental deficits HIV unleashes on victims, especially when the mode of transmission is perinatal: apart from HIV posing serious morbidity and physical developmental risks, perinatal means of transmission stifles all major developmental milestones that takes place within the first twenty-four months of the child in relation to cognitive development (Ravindran et al, 2014; Sherr et al, 2014; Mwaba et al, 2015). The developmental milestones that are stifled at this early stage of the child's life are crucial for performing complex tasks in case the child survives into adulthood (Nichols et al, 2016).

The framework, thus, sets the tone for understanding the cognitive function among perinatal HIV infected children and uninfected children, as well as making it clear where interventions should be focused.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of Key Concepts

2.1.1 Perinatal HIV

Perinatal refers to the time and process of bringing forth a child (Mosby's Medical, Nursing & Allied Health dictionary (2009). Therefore, perinatal HIV and AIDS refers to the transmission of the virus from mother to infants; during pregnancy, labour and delivery or during breastfeeding (CDC, 2007:1).

According to WHO, where there is no intervention, transmission rates range from 15% to 45% but this rate can be reduced substantially to below 5% with interventions during the periods of pregnancy, labour, delivery and breastfeeding (<http://www.who.int/hiv/topics/mtct/about/en/>). It is estimated that 36.9 million people were living with HIV worldwide in 2017. Out of these, 3 million were children and adolescents below 20 years of age and 19.1 million were women and younger females. Every day, there was roughly 4, 900 people newly infected with HIV and around 2, 580 people died from AIDS related causes, due to a lack of access to HIV prevention, care and treatment services. However, new HIV infections among infants are declining at a rapid rate, approximately 58% since 2000, due to scaled up efforts to prevent mother-to-child transmissions. (<http://data.unicef.org/topic/hivaids/global-regional-trends/>).

2.1.2. Cognitive Functions

Nouchi and Kawashima (2014:1) define Cognitive functions as “a variety of mental processes such as perception, attention, memory, decision making, and language comprehension”.

2.2 Cognitive Milestones in Infants without HIV Infection

Generally it is said that the first two years of life implies ones’ infancy period. It is a period where the child’s cerebrum has the ability to develop and this development is usually at a rapid rate. At this stage of a child’s life, the child is able to accomplish a few turning points identifying with motor, intellectual and behavioral advancement. This stage is seen as an extremely critical period where any slight destruction or interruption to the growth process can adversely result in developmental failure as far as motor, intellectual and behavioral development is concerned (Mwaba, 2015).

In the absence of any form of destructions the child is expected to go through a regular sequence of development which is predictable. Children from 0-3 years are known to record early formative gain, for example, sitting, standing crawling and walking and also expressing dialect capacities, such as making short sentences to express wants, oral dialect preparation and verbal memory (Green, 2002).

A child’s development of emotions and refinement of fine motor skills sets a phase for child development between 3 to 7years of life. Different points of interest in this period include the ability to keep record of things seen with the eyes, and capacity to process given data precisely.

Between 7 to 30 years there is a development of high level cognitive capacities, for example, developing organizational skills, ability to process complex visual and sound-related data and ability to store and recover complex data (Green, 2002).

From 0 to 3 years, cognitive development occurs in combination with the development of certain brain structures, particularly those related with speech (Inder & Huppi 2000). In this period, there is development of associating structures in the frontal cortex of the basal ganglia of the cerebrum (Webster et al, 2011). In addition, there is an extension of a system of smaller scale vessels all through the mind to help the on-going advancement (Lee et al, 2006).

In the past years, Jean Piaget a famous Swiss Psychologist contributed to our comprehension of the cognitive growth stages in children right from infancy to the teenage years (Passer & Smith, 2001; Weiten, 2005). Piaget theorized that there are four inclusive stages that humankind goes through regarding cognitive development, Sensorimotor which occurs from birth to 2 years, Preoperational stage which occurs from age 2 to 7 years, Concrete Operational stage ranging from 7 to 11 years and the last stage which is the Formal Operational stage from 11 years to adulthood.

2.3 Cognitive Developments and HIV.

54 studies have reported the cognitive deficits of HIV in children who are affected with the virus (Sherr, Mueller, and Varrall, 2009). The report demonstrated that research was very predominant in North American biased (66%) with European examinations representing 13% and two from South America, two from South– East Asia and seven from Africa (13%), where most of these HIV-infected children live. The report revealed an absence of comparability between research works as a wide range of various cognitive measures was

employed. Notwithstanding the measure employed, 81% of research works revealed a negative impact of HIV infection on cognitive development for HIV -infected children in contrast with an uninfected group, while three detailed no distinctions and four had blended discoveries (Sher et al, 2014).

A study done by Puthanakit et al (2010) showed that children infected with HIV who attend school have low cognition, with 79% having an intelligent quotient below normal. HIV-infected children recorded a significantly lower cognitive outcome compared to normal children. With the early introduction of combination ARTs there was no significant improvement in their cognitive function after years of receiving ARTs. In a study conducted among Thai school-aged children who are HIV-infected, the mean intelligent quotient among the HIV-infected Thai school-aged children was 79 (SD 13), which was lower than report from a large study in U.S. which recorded a mean intelligent quotient of 84 (SD 15) among HIV-infected children (Jeremy et al, 2005).

Several studies have demonstrated low outcomes among school-aged HIV-infected children (Jeremy et al, 2005; Smith et al, 2006; Van der Lugt et al, 2009). Koekkoek et al. (2008) discovered HIV positive children have a significantly low speed and precision. Cognitive control of behaviour is generally estimated by attention factors, visual perception of spatial objects as well as working memory. Koekkoek et al. (2008) found that the behaviour and speed processing were particularly challenging for HIV-infected children.

The principle measure of worldwide cognitive development has been the MMSE. These scales produce a motor and a psychological developmental and cognitive score. Most researchers use the scores to inspect performance and check developmental delays (Sher et al, 2014). Van Rie, Dow, Mupuala, and Stewart (2009) examined about 160 children which age

ranging from 18– 71 months in the Democratic Republic of Congo (DCR) with baseline and two follow up measures. Lower mean scores were recorded among HIV –infected children compared to HIV- uninfected and these were measures for both psychological and mental advancement (Van Rie, Mupuala, and Dow 2008). The same sample size adopted from Van Rie et al. (2009), investigated the seriousness of mental delay in children in his study. Equal number of HIV-infected and HIV affected were used and 90 controls who were categorized into three age groups (18– 72 months; 18– 29 months and 30– 72 months). They discovered more significantly that HIV -infected children showed developmental delays (60% for the HIV-infected group, 40% in the affected group and 24.4% in the control group) on cognitive development in the first age group. This was repeated for motor delay with 28.6% of the HIV –infected children delayed in contrast with 14.3% control group.

A study done by Baillieu and Potterton (2008) among 40 HIV-infected children used for the study who were between 18– 30 month old in South Africa also recorded lower cognitive development compared to a control group. In Ferguson and Jelsma (2009) studies where 86 HIV-infected children whose ages ranges from 1– 33 month old in South Africa (51 HIV infected, 5 affected and 20 HIV status unknown) and found that essentially more HIV -infected kids were "significantly delayed" in contrast with the healthy kids (66.6% versus 5.7%).

The extent to which cognitive development related to HIV is neglected or not given much attention as a result of the difficulty associated with making a strong association. Largely because cognitive deficits can be related to environmental variables that contribute to each child's resulting cognitive profile. In this regard, Sherr et al. (2009) identified varying methodological shortcomings with the local HIV paediatric literature, such as small samples with large age ranges, failure to document or homogenise the mode of HIV transmission,

diverse demographics, and differences in the assessments used. The matter is complicated by the fact that there are no well-established locally standardized assessment batteries for younger South African children. As a consequence, test interpretation; test appropriateness, and the accuracy of normative data often invalidate the understanding of the test results. Due to the absence of a standard local cognitive assessment battery, researchers employ different tests in their studies with the result that the research is not comparable (Wachsler- Felder & Golden, 2002). It is important to conduct cognitive tests on groups with a narrower age band in order to make room for age differential adjustment (Wachsler-Felder & Golden, 2002). With this in mind, the current study conducted to assess cognitive function focused on children between the age 6 – 12 years on a managed ARV programme. However, there were difficulties obtaining a large sample due to the exclusionary criteria selected for this study.

Only a limited number of studies have been conducted to identify the neuropsychological sequelae of HIV-infected children due to the difficulty and limitation associated with conducting such studies (Koekkoek, de Sonnevile, Wolfs, Licht & Geelan, 2008; Martin, et al., 2006; Patel, et al., 2009; Smith, Adnams & Eley, 2008; Wachsler-Felder & Golden, 2002). During the time that preceded HAART treatment in South Africa, HIV induced dysfunctions, as well as opportunistic infections of the central nervous system, resulted in pervasive neurodevelopmental delays in HIV positive children. Markers of these delays included behavioral changes, psychomotor impairment, and progressive cognitive deterioration associated with a decline in academic performance (Civitello, 2003). In order to explore possibilities for the prevention of rapid further progression of this impairment, research was undertaken which indicates that the age of commencing HAART is an important predictor for cognitive outcome and that the earlier a child is treated for HIV the better their cognitive prognosis (Smith, Adnams, & Eley, 2008).

According to Brouwers et al. (1995), significantly more adolescents are diagnosed annually with neurological impairments in South Africa when compared to adolescents in Europe, which is possibly a function of greater infection rates. This background includes the extrinsic and intrinsic factors to the infection and memory functioning in terms of how an individual may be affected by HIV. This knowledge is fundamental knowledge given how the broad involvement memory has on many other cognitive functions, especially for learning and development. Thus the focus of the effects of this research was on the effects of HIV on one aspect of cognitive functioning.

School-going children who are HIV- infected and experience cognitive impairment might be explained by many reasons Puthanakit et al, (2010). There is a direct effect of the HIV infection on the neurodevelopment growth during the beginning years of a child's life, the point where brain growth is paramount. There could also be an indirect effect through recurrent infections or certain opportunistic infections, leading to a poor general health. Another study among HIV-infected infants from the United States showed that higher plasma viral load greater than 50,000 copies per milliliter was linked with poor cognitive outcome (Jeremy et. al, 2005).

2.3.1 Effect of Antiretroviral Treatment

On-going research discussions have demonstrated harmful impacts of HIV on the cognitive functions. Research on HAART regimens has had blended reports. HAART is a combination of standardised antiretroviral drugs. This combination is prudent to stifle the development of the infection in the body of the HIV-infected persons.

A study conducted by Shabhag et al. (2005) highlighted the effect of HAART treatment and management on cognitive results in perinatally acquired HIV-infected children. In addition

they analyzed whether CD4 percent and viral load were associated with future cognitive function. The findings showed that encephalopathy diminished since the presentation of HAART. Association between viral load and cognitive scores was not statistically significant ($p = 0.06$) but strongly associated with CD4 rate ($p < 0.001$). They infer that a combination of antiretroviral treatment is related with cognitive upgrades while viral load and CD4 rate are possibly prescient of future cognitive changes.

Several examinations have shown neurodevelopmental weakness among HIV-infected children as early as in infancy (Louthrenoo, Puthanakit, & Wongnum, 2004; McGrath et al, 2006) while different investigations have revealed a cognitive deficiency in HIV-infected preschool (Fishkin et al, 2000; Smith, Adnams & Eley, 2008) and school-matured children (Koekkoek et al, 2008; Martin, 2006).

However reports indicate that antiretroviral treatment did not necessarily contribute to the restoration of performance speed and restoration. Lowick et al. (2012) reported a 7.9 overlay increment in extreme delay in HIV infected children compared to HIV- uninfected children or control group. Brackis-Cott et al. (2009) deduced that HIV-infected children complying with their ARVs had much lower cognitive scores. Another investigation which recorded 66.6% of HIV-infected children on treatment, but failed to determine the duration of treatment. Plainly such examinations are not significantly comparable. Several studies demonstrates that taking antiretroviral treatment for a year relatively increases cognition specifically correcting attention deficits, processing speed and executive performance (Antinori et al., 2013) therefore data on initial treatment and duration of treatment is very critical, most importantly detail on the specific regimen .

2.4 Working Memory and Perceptual Reasoning

Working memory alludes to the short-term storage and control of sensory data enduring on the order of seconds. It has been related with tenacious neural action in many brain regions and is thought to be a primary cognitive process that supports a scope of behaviors, from observation to critical thinking and activity control. One major cognitive domain, known as the working memory is simply defined as a system responsible for controlling visual perception and verbal attention in a particular manner that can enhance communication (Baddeley, 2000). It is known as a key behavioural function, which basically combines cognitive function with other behaviors which plays a major role in the brain's frontal cortex controlling behaviors such as socially interacting with people and making decision for one's self (Miyake et al., 2000; Miyake & Friedman, 2012). Working memory is a major factor that influences academic success, much more than IQ scores (Berninger & Swanson, 1994; Swanson & Sachse-Lee, 2001; DeStefano & LeFevre, 2004; Swanson et al., 2004; Alloway & Alloway, 2013; Alloway & Copello, 2013; Alloway & Gregory 2013).

This type of domain has three storage components, namely a phonological loop (responsible for auditory-verbal), visuospatial (specialized for refreshing visual and spatial properties), and the last component responsible for processing different types of material into meaningful events to enhance communicating). These processing functions have the ability to co-incide partially or wholly with other behavioural functions (Miyake & Friedman, 2012).

Working memory deficits is paramount in HIV-infected persons, both adults and children. However, most studies conducted so far focused only on older HV-infected individuals (Stout et al., 1995; Farinpour et al, 2000; York et al., 2001; Hinkin et al., 2002; Reger et al., 2002., Sacktor., 2000; Heaton et al., 2004., Dawes et al., 2008). Hence, it is impossible to associate these results of cognitive functioning in HIV- infected adults to children of which working

memory is a part. Differences in economic and sociocultural lifestyles (Lowick et al., 2012), differences in very wide sample age ranges could also influence cognitive outcomes (Wachsler-Felder & Golden, 2002).

Availability of and adherence to ARTs also plays a role in cognitive scores. Studies show that about 28% of the children in low and middle income countries who require ART have access to it (Grantham-McGregor et al., 2007; Walker et al., 2011). Initiating ART at an early stage is likely to maintain cognitive functions and possibly reverse some form of damage caused by the infection, especially in children (Laughton et al., 2012). While ART is said to play a significant role in protecting and improving cognitive function in HIV- infected children, yet these children continue to suffer from cognitive impairment deficits compared to uninfected children (Smith et al., 2008; Cotton et al., 2009). This could be linked to the neuropsychological effects of HIV infection which could lead to destruction to the central nervous system long before the initiation of ART and or due to a low penetration of the blood-brain barrier by antiretrovirals (Wolters et al., 1997; Van Rie et al., 2007; Coton et al., 2009; Lowick et al., 2012).

Working memory deficits is evident in children who suffer from general Intellectual disabilities Attention Deficit, Williams Syndrome, Development Co-ordination Disorder (DCD), eractivity Disorder (AD/HD), (Williams et al., 2008; Alloway, 2011; Henry, 2012; Henry et al., 2012). In a recent study it can be estimated that Africa is recording a very high incidence of pediatric HIV infection (WHO, 2017), showing an increased prevalence of educational difficulties and hence may require cognitive and educational assistance (Sherr et al., 2009, Alloway et al., 2009).

Deficiencies in working memory have been accounted for in many brain disorders; whereas performance on working memory assignments enhances with brain development from childhood to early adulthood, it decreases in the elderly, and is firmly identified with measures of intelligence (Ma, Husain & Bays, 2014).

Basically, individual differences in working memory capacity are related with implementation in differing parts of cognizance, for example, multi-tasking (Hambrick, Oswald, Darowski, Rench, and Brou, 2010), emotion regulation (Kleider, Parrott, and King, 2009), retrospection bias (Calvillo, 2012), and susceptibility to stereotype danger (Hutchison, Smith, and Ferris, 2012).

Maybe most broadly, working memory capacity shares in any event a large portion of its statistical fluctuation with general fluid intelligence (the capacity to reason novel data; Kane, Hambrick, and Conway, 2005). In this manner, investigating the mechanisms of working memory capacity may give the most clear strategy for illuminating the procedures engaged with human reasoning (Conway, Getz, Macnamara, and Engel de Abreu, 2010; Oberauer, Schulze, Wilhelm, and Suß, 2005).

Perceptual Reasoning Index measures non-verbal (perceptual) and fluid reasoning, spatial processing, visual-motor integration, and the ability to learn new information. It assesses the ability to examine a problem, use visual-motor and visual-spatial skills, organize thoughts and develop and test solutions. It can also indicate a preference for visual information or kinetic learning and comfort with new situations (<http://ban.scdsb.on.ca>).

The Perceptual Reasoning Index is selected as a variable for this study because of its psychometric properties in measuring a large portion of the attributes for fluid intelligence. It gathers that fluid intelligence is more unobtrusive and declining because of hereditary or

natural maturing factors. This is in opposition to crystallized intelligence which keeps up the capacity to learn through the utilization of prior learning all through the ages (Yusoff, Sharipudin & Yusoff, 2016). According to Psychology, “Perceptual reasoning measures the subject’s ability to find relationships between nonverbal stimuli as well as testing their reasoning skills. It is considered to be a useful indicator of general intelligence and problem solving skills” (<https://whatispsychology.net/what-is-perceptual-reasoning/>).

2.5 Intelligent Quotient

The intelligent quotient is an intelligence test proposed by Alfred Binet during the 1850’s, as a method of measuring ability to learn, and so as to detect children who would face difficulties in the school system. He proposed that intelligence increased through childhood. He also believed that the ascent in intelligence across childhood was not because of advancements in sensory accuracy, nor was it an immediate consequence of a custom curriculum or training (Villagonzalo, 2016).

A study conducted has clearly defined the relationship between intelligence quotient (IQ) and cognitive skills (Blair, 2006; Shamosh and Gray, 2008). This cognitive domain, IQ is normally partitioned into two elements: ‘fluid’ and ‘crystallized’ intelligence. The fluid intelligence variable alludes to the ability to appreciate and understand novel issues. It is free of acquired knowledge. Abstract thinking, for example, a Matrices test serves as a tool for measurement. The ultimate goal of these tests is to reduce the impact of culture, educational level and verbal cognition. The component of crystallized intelligence relies on an individual’s experience and knowledge on a particular topic. It is therefore characterized as the ability to utilize these components. By and large, Vocabulary and Verbal tests are utilized as a measure of this part of intelligence (Checa and Fernández-Berrocal, 2015). The Intelligence quotient is calculated as depicted below:

Intelligence Quotient = Mental Age ÷ chronological age

2.6 Reading abilities and Verbal comprehension

Reading abilities and Verbal comprehension are both elements of Fluid intelligence. Reading ability is “a cognitive ability which a person is able to use when interacting with texts”

(Urquhart & Weir, 1998). Whereas comprehension can be viewed as the product of reading a particular text, skills are seen as parts of the generalized reading process.

Pediatric HIV encephalopathy has the ability to affect the reading ability and verbal comprehension of HIV-infected children compared to HIV-uninfected children. These HIV-uninfected children perform better on reading scores and overall cognitive function than HIV-infected children. Cognitive deficits can result in poor school performance, borderline intelligence or mental retardation (Martinez et al, 2012).

CHAPTER THREE

METHODS

3.1 Study Design

The study design of a study embodies the entirety of the plan that the researcher has undertaken to achieve the objectives of the study. Expectedly, Mouton (1996) argues that a research design plans, structures and executes the research with the goal of maximizing the tenability of the study. Every study could and can warrant a different type of research design, as such, the research design designated for this study is the cross-sectional design.

A cross-sectional design allows for the collection of data from people, subjects, groups of people etc., at a point in time. It is less expensive to implement and works in a timely fashion. The study is quantitative in nature, and it seeks to determine the extent of a problem of the phenomena under study. It can also be implemented to study the existence or the presence of a relationship between identified variables of the phenomenon under study by quantifying the variation. The cross-sectional study deploys data collection instruments such as questionnaires to gather data from a predetermined population (Richard, 2014).

In summary, the researcher adopted the cross-sectional and quantitative approach to study the cognitive function of perinatally acquired hiv-infected and non-infected children at ridge hospital, Accra.

3.2 Study Area

The Greater Accra Region is known as the regional capital city of Ghana and it is the smallest of the ten (10) administrative regions in terms of area, occupying a total land surface of 3,245 square kilometres. It has a population of 4,010,054 with 1,938,225 males and 2,071,829 females. Located on the shores of the Gulf of Guinea (Atlantic Ocean), almost on the

Greenwich Meridian. Accra is administered by the Accra Metropolitan Authority (AMA) under the Greater Accra Regional Coordination (Ghana Districts, 2017).

The Greater Accra Region has five (5) HIV sentinel sites, namely Maamobi, Adabraka, Dangme East, Tema and Korle-Bu.

About five hundred and eighty (580) health facilities provide HIV services in the region. There are fifty-two (52) anti-retroviral therapy (ART) centers, three hundred and thirty (330) prevention of mother to child transmission of HIV (PMTCT) centers, and one hundred and ninety eight (198) HIV Testing Services (HTS) centers within the region.

The groups were selected from the Ridge Hospital in Accra, specifically the ART and the OPD. It is located along the Castle road about 200 meters from the African Union roundabout. The Hospital occupies a total land area of about 15.65 acres. Politically, it falls within the Osu-Klottey Sub Metro of the Accra Metropolitan Area. As Regional Hospital for the Greater Accra Region, its catchment area is the whole of the Region with an estimated population of about 4,283,322 inhabitants. However, the immediate catchment area includes the following suburbs: Nima, Maamobi, Kanda, Accra New Town, Kotobabi, Osu, La, Adabraka, Achimota, Airport Residential Area and Central Accra. Ridge hospital is a tertiary hospital, which serves as a referral centre in the Greater Accra region and beyond. It has been upgraded to an ultra-modern teaching hospital that attends to thousands of clients daily. Ridge regional hospital is one of the pioneer providers of ART treatment centre with an enrolment of about 2000 clients. These selected sites provide HIV testing and counseling, infant diagnosis, viral load testing, STI preventive and curative services to their HIV-infected clients.

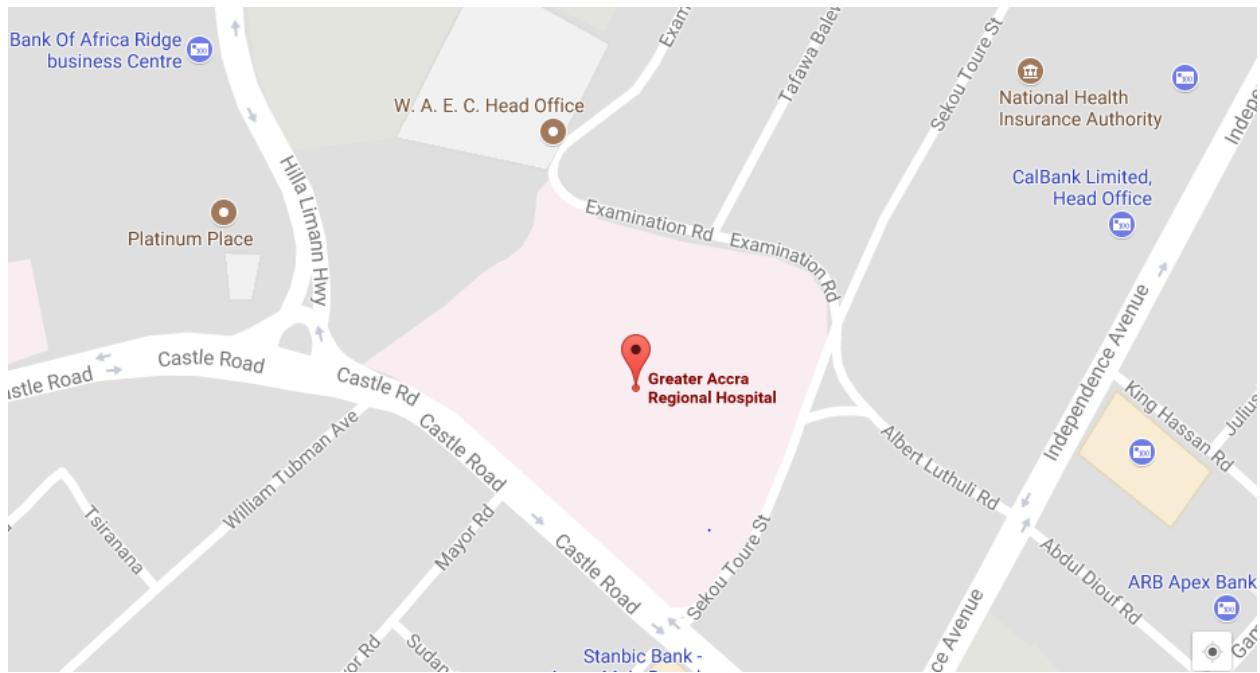


Figure 2: An Aerial view of Accra showing Ridge Hospital.

3.3 Study Population

The study population was defined as school-going children aged from 6 to 12 years. The study population consisted of two groups: the first group which is the group of interest , perinatally acquired HIV-infected children from Ridge hospital ART Clinic and the second group which is the reference group consisting of children with no chronic illness enrolled from the hospital Out-patient department.

3.4 Variables

3.4.1 Dependent Variable

The dependent variable for this study was cognitive function.

3.4.2 Independent Variable

- Socio-demographic characteristics of the respondents
- Working memory and perceptual reasoning of the participants

- The intelligent quotient of the respondents
- The verbal comprehension and reading abilities of the respondents

3.5 Sampling

3.5.1 Sample Size

The Yamane's (2012) formula was used to calculate the sample size (n).

$$\text{Sample size (n)} = \frac{N}{1+N(e^2)} \text{ (for HIV-infected children)}$$

Where:

N- Estimated number of children that visit the ART clinic per month

e- Required size of standard error = Error margin divided by 1.96.

The estimated number of perinatally acquired HIV-infected children that visit the ART clinic in a month that falls within ages 6-12 years was 118

With a 95% confidence Interval and an error margin of 5%, the sample size calculation was as follows:

$$\text{Sample size (n)} = \frac{118}{1+118(0.05^2)} = 91$$

To take care of non-responses 10% of the calculated sample size, which was equal to 9, was added to the calculated sample size. This gave a sample size of 100 and that was used for the study.

Using the same formula, the sample size for non-infected children that fall within the ages of 6-12 years was calculated.

The estimated number of children that visit the Out-patient department per month was 345, hence the sample size calculation was as follows:

$$\text{Sample size (n)} = \frac{N}{1+N(e^2)} \quad (\text{for non-infected children}).$$

$$\text{Sample size (n)} = \frac{345}{1+345(0.05^2)} = 182.$$

To take care of non-responses 10% of the calculated sample size, which was equal to 18, was added to the calculated sample size. This gave a sample size of 200 and that was used for the study.

3.5.2 Sampling Method

The use of the systematic sampling was adopted for this study. Hence, the register of clients at the paediatric OPD served as the sampling frame. The number of participants on the register divided by required number represented the sampling interval. In a case where a client refused participation, the next client in the queue was recruited to participate. However this approach was not feasible for the HIV-infected children at the ART clinic because the total number of children that visit the ART clinic whose age ranges from 6 to 12 years is 118. Out of this 18 have been lost to follow up; hence the remaining number was used to carry out the study.

3.5.3 Inclusion criteria

School-going children from ages 6 to 12 years who perinatally acquired the HIV-infection and are registered with Ridge Hospital ART clinic; and uninfected school-going children of the same age bracket from Ridge Hospital OPD.

3.5.4 Exclusion Criteria

School-going children from ages 6 to 12 years who perinatally acquired the HIV-Infection and are registered with the Ridge Hospital but are not currently receiving treatment. HIV-uninfected children who have chronic diseases.

3.6 Data Collection tool/technique

Primary caregivers of the target group were interviewed using a semi-structured questionnaire during a 20minute session with the ART clinic during their usual re-fill. The interview topics covered demographic background, academic performance and social areas of their children's lives. Demographic data were collected on biological parents or primary caregiver's age and educational level, family income, and child's age, educational level. Laboratory values for CD4 levels were obtained from patient's folder. Interviews were held at the waiting area at the paediatric OPD for data on HIV-uninfected children. Interviews were done by the researcher and the research assistants.

The overall cognitive function of the child was assessed using the Mini Mental Examination Scale (MMSE) which consist of 30 items in four domains: working memory, perceptual reasoning, intelligent quotient and reading and verbal comprehension. The working memory consists of six items short- term memory for immediate consciousness such as the researcher naming three unrelated items slowly and clearly and ask the child to repeat and then after few minutes asked to recall those three items. The determination of perceptual reasoning was based on thirteen items including answering questions to the year, season, date, day of the week, month, country, hospital, floor, city and pointing simple items like a wrist watch to the child and being asked to mention what they are.

The exercise takes a maximum of 10-15mins to perform. The MMSE is a brief, quantitative measure of cognitive status in children and adults. It can be used to screen for cognitive impairment, to estimate the severity of cognitive impairment at a given point in time, to follow the course of cognitive changes in an individual over time, and to document an individual's response to treatment.

The standard MMSE form published by Psychological Assessment Resource (PAR) is based on its original 1975 conceptualization, with minor subsequent modifications by the authors. The MMSE has demonstrated validity and reliability in psychiatric, neurologic, geriatric, and other medical populations globally. Its use has been validated for use in Sub-Saharan Africa and Ghana. The convenient new "all-in-one" test form includes a detachable sheet with stimuli for the Comprehension, Reading, Writing, and Drawing tasks. (Folstein et.al, (2001).

After assessment, the parents or caregivers received an oral report of their children's cognitive abilities including information about interventions geared towards improving their academic performance, required basic skills, and problem-solving skills to help the children that will fall below-average cognitive score.

3.6.1 Quality Control

The researcher employed four research assistants to facilitate the data collection. All research assistants were taken through a one day training on quantitative data collection techniques. The training was practical and helped address sampling procedures, data collection methods, consent and assent taking, understanding the questionnaire, and purpose of the study.

The questionnaires were administered to 10 HIV-infected children at Adabraka polyclinic as a pretest. Based on the difficulty with some of the activities on the MMSE, the data collection tool was modified. The data collected during the pretest was not included in the analysis.

3.6.2 Data Processing

Data were captured solely by using questionnaires. The questionnaires were coded before capturing. Data were verified and confirmed, and subsequently synchronized to a central database. Data were exported to STATA IC version 15 for analysis.

3.6.3 Statistical Analysis

The composite mean scores for each cognitive domain was computed for each study participants. For each cognitive domain, the composite mean scores was further classified as: perceptual reasoning (normal defined as scoring ≥ 9 correct points out 13 items, abnormal defined as scoring < 9 correct points out of 13), Working memory (normal defined as ≥ 4 correct points out of 6 items, abnormal defined as < 4 correct points), IQ (normal defined as ≥ 5 correct points out of 7 items and abnormal < 5 correct points), Reading and verbal abilities (normal defined as ≥ 3 correct points out of 5 items and abnormal < 3 correct points out of 5). The overall cognitive function was also categorized as: normal is defined as scoring ≥ 21 correct points, abnormal defined as < 21 correct points.

Descriptive statistics including means, standard deviations were used in summarizing continuous variables, while frequencies and proportions for categorical variables. The Pearson's Chi-square and Fishers' exact test of association were used in determining the association between the categorical socio-demographic variables, other independent variables

on the overall cognitive function categorical variable, while the t-test was used in comparing means of cognitive domains and the overall cognitive scores between the two HIV status grouping (HIV-infected and HIV-uninfected).

Multiple linear regressions were used to determine significant variables in the study such as HIV status of the child, educational level of the parent and the family income on the overall cognitive function scores of the child.

However, age was added to this model because from literature, age is known to be significantly associated with overall cognitive function. A 0.05 level of significance and 95% confidence interval was used for all statistical tests.

3.7 Ethical Consideration

Ethical clearance was sought from the Ghana Health Service Ethics Review Committee and approval was given for the implementation of the study protocol (**GHS-ERC: 077/12/17**). Permission was sought from the Public health unit at Ridge hospital. Confidentiality and privacy were respected during questionnaire administration and interactions by assigning each respondent a code that could be traced to the registration number in the HIV counselling and testing register. To ensure proper confidentiality and privacy, names of participants were not used in the write-up since the questionnaire was coded. Findings of the study were reported such that it was non-person identifiable. All data collected were stored in a locked folder on the computer as well as stored under lock and key and would be destroyed after ten years. Access to the data was restricted to only those involved in the research.

CHAPTER FOUR

RESULTS

4.1 Socio-Demographic Characteristics

A total of 300 children were interviewed. All 300 children completed the questionnaire which was made up of 147 (49%) males and 153 (51%) females who were used in the analysis. The mean age ($\pm$ SD) of the participants was 8.8 ± 1.74 years. Most of the participants (92.3%) reported to be primary school pupils and 23 (7.7%) reported to be junior high school pupils.

For the parents of the children 142 (47.3%) were under 40 years whereas 158 (52.7%) were above 40 years. Forty-four (14.7%) were reported to have achieved primary school education, 72 (24%) had achieved junior high school education and 184 (61.3%) achieved tertiary education. Fifty (16.7%), 57 (19.0%) and 127 (42.3%) received a monthly income ranging between 100-500 GHC, 501-1000 GHC and 1001-2000 GHC respectively.

For HIV-infected children 33 (33%) recorded a CD4 count ranging from 200-500 cells per cubic millimetre while 67 (67%) recorded a CD4 count above 500. Table 4.1 represents the demographic and other characteristics of the participants

Table 1 Demographic Characteristics of Participants

Characteristics	Frequency	Percentage
Age group of Child		
Age (Mean± SD) years	8.8±1.74	
6-9years	191	63.7
>9years and above	109	36.3
Male Child Age(Mean± SD) years	8.6± 1.72	
Female Child Age (Mean± SD) years	9.03±1.76	
Sex of Child		
Male	147	49.0
Female	153	51.0
Child's Educational level		
Primary	277	92.3
JHS	23	7.7
Parents Age		
<40 years	142	47.3
≥40 years	158	52.7
Parents Educational level		
JHS	44	14.7
SHS	72	24.0
Tertiary	184	61.3
Family Income (GH Cedis)		
100-500	50	16.7
501-1000	57	19.0
1001-2000	127	42.3
2001-5000	58	19.3
5000+	8	2.7
CD4 Count		
200-500	33	33.0
500+	67	67.0

SD: Standard Deviation

4.2 Socio-demographic characteristics and Cognitive domains against HIV status

One thirty (65%) of the HIV-infected participants were between the ages of 6-9years while 70 (35.0%) recorded ages from ten to twelve years. However 61 (61%) of HIV-infected children were between the ages of 6-9years while 39 (39%) were 10-12 years and the differences in age was not statistically significant. Forty- six (46.0%) and 54(54.0%) of the HIV-infected participants were males and females respectively. On the other hand 101 (50.5%) and 99 (49.5%) of the HIV-uninfected participants were males and females respectively and this was not significantly different. Among HIV-infected participants 88 (88%) and 12 (12%) attended primary school and junior high school respectively compared to 189 (94.5%) and 11 (5.5%) of the HIV-uninfected children who attend primary and junior high school respectively and these differences in educational level was statistically significant (Chi-sq.=3.398, p=0.04).

Among parents of HIV-infected participants 51 (51%) recorded ages below 40 years and 49 (49%) were above 40 years compared to parents of uninfected participants who recorded 91 (45.5%) below 40 years and 109 (54.5%) for 40 years and above and this was not significantly different. Majority of the parents of the HIV- infected participants had achieved senior high school education 56 (56%) compared to higher levels of tertiary education among HIV-uninfected participants, 178 (89%) and this was significantly different (p<0.001). Comparing family income among the two groups majority of the parents among the HIV-infected participants, 45 (45%) received a monthly salary ranging between 100-500 (GHC) while majority of the parents of the HIV-uninfected children, 109 (54.5%) received a monthly salary ranging between 1001-2000 (GHC) and also significantly higher income compared to the infected group (p<0.001).

Overall, 10 (10%) of the HIV-infected participants recorded a normal overall cognitive function and 90 (90%) had an abnormal overall cognitive function compared to HIV-uninfected participants who had all 200 (100%) participants having a normal cognitive function and this was significantly different ($p < 0.001$).

For perceptual reasoning, 27 (27%) of the infected children had normal scores and 73 (73%) had abnormal scores whereas 119 (99.5%) and 1 (0.5%) of the HIV-uninfected children recorded a normal and abnormal score for perceptual reasoning respectively. Among HIV-infected children 55 (55%) and 45 (45%) recorded a normal and abnormal reading to working memory respectively, while 198 (99%) and 2 (1%) of the HIV-uninfected children recorded a normal and abnormal score for working memory respectively and this was significantly different as seen in Table 2.

For intelligent quotient, 34 (34%) and 66 (66%) recorded normal and abnormal scores for the HIV-infected participants, whereas 195 (97.5%) and 5 (2.5%) were recorded as having a normal and abnormal intelligent quotient among HIV-uninfected participants which was significantly different as seen from Table 2.

Majority of the HIV-infected participants had a normal score on reading and verbal abilities, 60 (60%) and 40 (40%) an abnormal score, while 199 (99.5%) and 1 (0.5%) recorded normal and abnormal scores to reading and verbal abilities among HIV-uninfected participants which was significantly different ($p < 0.001$).

Table 2 Socio-demographic characteristics and Cognitive domains against HIV status

	HIV Status of Children		Chi	p value
	Infected N (%)	Uninfected N (%)		
Age group of Child			0.461	0.497
6-9years	61 (61.0)	130 (65.0)		
>9years and above	39 (39.0)	70 (35.0)		
Sex of Child			0.5402	0.462
Male	46 (46.0)	101 (50.5)		
Female	54 (54.0)	99 (49.5)		
Child's Educational level			3.398	0.04
Primary	88 (88.0)	189 (94.5)		
JHS	12 (12.0)	11 (5.5)		
Parents Age			0.809	0.368
<40 years	51 (51.0)	91 (45.5)		
≥40 years	49 (49.0)	109 (54.5)		
Parents Educational			194.56	<0.001
JHS	38 (38.0)	6 (3.0)		
SHS	56 (56.0)	16 (8.0)		
Tertiary	6 (6.0)	178 (89.0)		
Family Income (Gh Cedis)				<0.001*
100-500	45 (45.0)	5 (2.5)		
501-1000	35 (35.0)	22 (11.0)		
1001-2000	18 (18.0)	109 (54.5)		
2001-5000	2 (2.0)	56 (28.0)		
5000+	0 (0)	8 (4.0)		
Overall Cognitive			257.14	<0.001
Normal	10 (10.0)	200 (100.0)		
Abnormal	90 (90.0)	0 (0)		
Perceptual Reasoning			188.57	<0.001
Normal	27 (27.0)	199 (99.5)		
Abnormal	73 (73.0)	1 (0.5)		
Working Memory			97.68	<0.001
Normal	55 (55.0)	198 (99.0)		
Abnormal	45 (45.0)	2 (1.0)		
IQ			148.8	<0.001
Normal	34 (34.0)	195 (97.5)		
Abnormal	66 (66.0)	5 (2.5)		
Reading and verbal Abilities			88.16	<0.001
Normal	60 (60.0)	199 (99.5)		
Abnormal	40 (40.0)	1 (0.5)		
*p value from Fishers exact test				

N: cell frequency. %: column percentage.

4.3 Socio-demographics and Cognitive Function of Children

Among children aged between 6-12 years, 131 (68.6%) had normal overall cognitive function and 60 (31.4%) recorded an abnormal cognitive function. However, 79 (2.5%) and 30 (27.5%) recorded a normal and an abnormal overall cognitive function among children above 9 years respectively. One hundred and six (72.1%) male participants recorded a normal overall cognitive function and 41(27.9%) had an abnormal cognitive function compared to 104(67.9%) and 49(32.15%) females having normal and an abnormal cognitive function respectively. An overall normal cognitive function was recorded in 195 (70.4%) primary school participants while 82 (29.6%) had abnormal cognitive function. Among JHS participants, 15 (65.2%) had a normal overall cognitive function while 8 (34.8%) had an abnormal cognitive function. The above demographic factors were not significantly associated with cognitive function of the children.

From Table 3 it can be observed that parents educational level and the family income of the parent were significantly associated with the overall cognitive function and score of the children ($p < 0.001$). Parents who are highly educated had children with higher cognitive function and parents with higher incomes also had children with a higher cognitive function.

Table 3: Socio-demographics and Overall Cognitive Function of Children

	Overall Cognitive function		Chi	p value
	Normal N (%)	Abnormal N (%)		
Age group of Child			0.5002	0.479
6-9years	131 (68.6)	60(31.4)		
>9years and above	79 (72.5)	30 (27.5)		
Sex of Child			0.6104	0.435
Male	106 (72.1)	41(27.9)		
Female	104 (67.9)	49 (32.1)		
Child's Edu level			0.2713	0.602
Primary	195 (70.4)	82 (29.6)		
JHS	15 (65.2)	8 (34.8)		
Parents Age			1.233	0.267
<40 years	95 (66.9)	47 (33.1)		
≥40 years	115 (72.7)	43 (27.2)		
Parents Edu			183.07	<0.001
JHS	9 (20.4)	35(79.6)		
SHS	20 (27.8)	52 (72.2)		
Tertiary	181 (98.4)	3 (1.6)		
Family Income (Gh Cedis)				<0.001*
100-500	8 (16.0)	42 (84.0)		
501-1000	26 (45.6)	31 (54.4)		
1001-2000	112 (88.2)	15 (11.8)		
2001-5000	56 (96.6)	2 (3.4)		
5000+	8(100.0)	0 (0)		
*p value-fishers exact				

N: cell frequency. %: column percentage.

4.4: Perceptual reasoning, working memory, Intelligent quotient, reading and verbal comprehension

Generally, 210 out of 300 participants recorded a normal overall cognitive function with a mean score of 27 ± 5.4 and 90 participants recorded an overall abnormal cognitive function with a mean score of 16 ± 2.4 . Averagely, 226 participants had a normal score on the perceptual reasoning domain with a mean score of 11.4 ± 1.2 whiles 74 participants out of 300 recorded an abnormal perceptual reasoning score with a mean of 6.6 ± 1.3 . Two hundred and fifty- three participants had a normal working memory of 4.3 ± 0.74 whiles 47 had an abnormal working memory score of 1.5 ± 0.71 .

Out of 300 respondents, 229 children had a normal intelligent quotient with a mean score of 6.2 ± 0.73 whereas 71 participants recorded an abnormal IQ score with a mean of 3.3 ± 0.66 . The last cognitive domain which is reading and verbal abilities recorded 259 children with a normal mean score of 4.5 ± 1.03 whereas 41 children recorded an abnormal mean score of 2.5 ± 1.52 .

Table 4 Perceptual reasoning, working memory, intelligent quotient, reading and verbal comprehension

Domain	Scores				
	Overall	Normal		Abnormal	
	Mean $\pm$ SD	N	Mean $\pm$ SD	N	M $\pm$ SD
Perceptual Reasoning	10.2 $\pm$ 2.4	226	11.4 $\pm$ 1.2	74	6.6 $\pm$ 1.3
Working Memory	3.9 $\pm$ 1.3	253	4.3 $\pm$ 0.74	47	1.5 $\pm$ 0.71
IQ	5.5 $\pm$ 1.4	229	6.2 $\pm$ 0.73	71	3.3 $\pm$ 0.66
Verbal Comprehensions and reading abilities	4.2 $\pm$ 1.3	259	4.5 $\pm$ 1.03	41	2.5 $\pm$ 1.52
Overall Cognitive Function	23.7 $\pm$ 5.4	210	27 $\pm$ 5.4	90	16 $\pm$ 2.4

SD: standard deviation

4.5 Comparing Cognitive Function by HIV Status

Generally, HIV-infected participants had an overall mean cognitive function of 16.7 ± 5.37 as against 27.3 ± 1.17 for HIV-uninfected participants and this was significantly different ($p < 0.001$). The Mean perceptual reasoning score among HIV-infected participants was 7.29 ± 1.62 while that of the HIV-uninfected group was 11.7 ± 1.01 . Again HIV-uninfected children scored a higher mean on IQ 6.23 ± 0.81 compared to HIV-infected group scoring a mean IQ score of 4.04 ± 1.23 and this was also significantly different ($p < 0.001$). The mean score on reading and verbal abilities among HIV-infected participants was 2.76 ± 1.35 compared to the mean score among HIV-uninfected participants, 4.89 ± 0.34 .

Comparing the various cognitive domains among the two groups, HIV-infected participants had significantly different lower scores compared to HIV-uninfected participants ($p < 0.001$), except for working memory.

Table 5 Comparing Cognitive Function by HIV Status

	N=100	N=200		
	HIV	HIV	mean	
	Infected	uninfected	difference	p value
	Mean±SD	Mean±SD		
Perceptual Reasoning	7.29±1.62	11.7±1.01	4.36	<0.001
Working Memory	4.5±0.64	2.3 ±1.17	3.87	<0.001
IQ	4.04±1.23	6.23±0.81	2.19	<0.001
Verbal Comprehensions and reading abilities	2.76± 1.35	4.89± 0.34	2.13	<0.001
Overall Cognitive Function	16.7±5.37	27.3±1.17	10.62	<0.001

SD: standard deviation

4.6: Linear Regression of Socio-demographics and Overall Cognitive Function of Children

Age alone was not significantly associated with overall cognitive score but after adjusting for HIV status, parent's education and family income it was significant with a yearly increase in age resulting in an increase in cognitive function by 0.2 points. Infected children had an average overall cognitive core 10.6 points lower than the uninfected children and this reduced to 9.1 points lower after adjusting for the parent's educational level and family income which was significantly lower.

Parents who achieved senior high education had an average overall cognitive function score of 1.3 higher than children whose parents had achieved junior high school education and this was reduced to 0.5 after adjusting for the child's age, child's HIV status and family income

which was significantly lower. Parents who achieved tertiary education had an average overall cognitive function score of 9.7 times higher than children whose parents had achieved junior high school education and this was reduced to 2.6 after adjusting for the child's age, child's HIV status and family income which was significantly lower. Parents of the participants who earned a monthly income between 501-1000 (GHC) was significantly associated with average overall cognitive score of 3.7 times higher compared to parents of participants who earned 100-500 (GHC) as monthly income. Although the cognitive score increases by 0.4 times the overall cognitive function among children whose parent's earned 501- 1000 (GHC) compared to children whose parents earned 100-500 (GHC) after adjusting for age of the child, HIV status of the child and parent's educational level, this difference was not significant.

Parents of the participants who earned a monthly income between 1001-2000 (GHC) was significantly associated with average overall cognitive score which was 8.5 times higher compared to parents of participants who earned 100-500 (GHC) as monthly income. Cognitive score decreases by 0.4 times the overall cognitive function among children whose parent's earned 1001- 2000 (GHC) compared to children whose parents earned 100-500 (GHC) after adjusting for age of the child, HIV status of the child and parent's educational level, this difference was not significant.

Parents of the participants who earned a monthly income between 2001-5000 (GHC) was significantly associated with average overall cognitive score which was 9.8 times higher compared to parents of participants who earned 100-500 (GHC) as monthly income. Cognitive score decreases by 0.3 times the overall cognitive function among children whose parent's earned 2001- 5000 (GHC) compared to children whose parents earned 100-500

(GHC) after adjusting for age of the child, HIV status of the child and parent's educational level, this difference was not significant.

Parents of the participants who earned a monthly income of ≥5000 (GHC) and above was significantly associated with average overall cognitive score which was 10 times higher compared to parents of participants who earned 100-500 (GHC) as monthly income. Overall cognitive score decreases by 0.6 times the overall cognitive function among children whose parent's earned ≥5000 (GHC) and above as monthly income compared to children whose parents earned 100-500 (GHC) after adjusting for age of the child, HIV status of the child and parent's educational level, this difference was not significant ($p = 0.158$).

Table 6: Linear Regression of Socio-demographics and Overall Cognitive Function of Children

Outcome = Overall cognitive score

	N	Unadjusted		Adjusted	
		Mean diff (95% CI)	P-value	Mean diff (95% CI)	P-value
Age of child (years)	300	0.2 (-0.2, 0.5)	0.362	0.2 (0.1, 0.3)	<0.001
HIV status					
Uninfected	200	Ref	<0.001	Ref	<0.001
Infected	100	-10.6 (-11.1, -10.2)		-9.1 (-9.8, -8.3)	
Parent's educational level					
JHS	44	Ref	<0.001	Ref	<0.001
SHS	72	1.3 (0.1, 2.4)		0.5 (-0.2, 1.2)	
Tertiary	184	9.7 (8.7, 10.7)		2.6 (1.6, 3.5)	
Income (GHC)					
100-500	50	Ref		Ref	
501-1000	57	3.7 (2.2, 5.3)	<0.001	0.4 (-0.3, 1.2)	0.158
1001-2000	127	8.5 (7.1, 9.8)		-0.4 (-1.3, 0.4)	
2001-5000	58	9.8 (8.3, 11.4)		-0.3 (-1.2, 0.7)	
5000+	8	10.0 (6.9, 13.0)		-0.6 (-2.1, 0.9)	

N: frequency. Mean diff: Mean difference, CI: confidence interval. Ref: reference category.

CHAPTER FIVE

DISCUSSION

The findings of the study provide assessment of cognitive function among HIV –infected and HIV- uninfected children. Overall all 300 children interviewed completed the questionnaire.. The mean age ($\pm$ SD) of the participants was 8.8 ± 1.74 years. More than half were reported to be primary school pupils. Among JHS participants, 15 (65.2%) had a normal overall cognitive function while 8 (34.8%) had an abnormal cognitive function. It can be hypothesized that as a child's educational level rises cognitive outcomes are lower but these differences are not significant ($p = 0.435$) and studies done so far disputes that fact.

Out of this 100 were HIV- infected and 200 were HIV- uninfected. Data was gathered on the socio-demographics of their parents. Parents of the HIV-uninfected participants achieved a significantly higher educational level than HIV- infected participants ($p < 0.001$). Comparing family income among the two groups majority of the parents among the HIV-infected participants received a significantly higher monthly salary compared to parents of HIV-uninfected participants ($p < 0.001$).

In general HIV- infected children exhibit poor overall cognitive skills compared to HIV-uninfected participants. Nevertheless the HIV- infected participants performed worse on all cognitive domains and this high difference in performance was significant at $p < 0.001$. The study findings suggest that cognitive and developmental deficits in HIV-infected children occur at an early stage in a child's life as young as 6 years and if appropriate measures are not put in place it could go a long way to affect them as they climb the educational ladder and also could affect how they relate with their peers. These findings complement studies by Puthanakit et al (2010) which demonstrated that HIV-infected children who attend school

have low cognition. Other studies suggest that HIV-infected children have an impaired cognitive function compared to HIV- uninfected children. These data, together with the findings from the study, suggest that cognitive deficits are more pronounced in school-going HIV- infected children compared to their healthy peers.

This however could be attributed to the educational level of the parents and the family income level. The significantly higher performance by the HIV- uninfected participant could be because of the support they received from the parents as a result of their level of education and income. These parents are able to afford the best educational assistance and extra tuition for their children (Violari et al, 2008; Van Rie et al, 2009).

Perceptual reasoning is a useful indicator in problem solving skills. From the study findings, comparing perceptual reasoning score of HIV-infected and HIV-uninfected participants, majority of the HIV-infected children had a significantly lower score than HIV-uninfected children ($p < 0.001$). This findings were similar to studies conducted by Laughton et.al.(2014) which revealed that HIV-infected children had a lower score on perceptual reasoning compared to uninfected children.

Working memory functions are related to duties such as multi-tasking hence deficiencies could account for many brain disorders (Husain & Bays, 2016). The results of the study established that HIV-infected children had a significantly lower score on working memory compared to scores of HIV- uninfected participants. These findings were observed in a study conducted by Calvillo, (2015) which indicated same outcomes between the two groups.

Intelligent quotient is a measuring ability of a child to exhibit proper learning skills. Scores derived from intelligence quotient among HIV-infected participants were significantly lower compared to HIV-uninfected children. ($p < 0.001$).

Reading and verbal abilities is a cognitive domain which a person uses when interacting with texts (Urquhart & Weir, 2000). For this domain majority of the HIV-infected participants had a normal score scores to reading and verbal abilities,. Still HIV-uninfected participants recorded higher scores on reading and verbal abilities and these differences were significant ($p < 0.001$).

From the study it can be revealed that age alone was not significantly associated with overall cognitive score but some studies suggest that age has an influence on the overall cognitive assessment of an HIV- infected child. However, after adjusting for HIV status, parent's education and family income it was significant with a yearly increase in age resulting in an increase in cognitive function (Adjusted mean 0.2, 95% CI = 0.1, 0.3). Adjusting for age and other significantly associated variables the HIV status of a child is significantly associated with the cognitive outcome of a child (Adjusted mean = -9.1 95% CI= -9.8, -8.3). Likewise the parent's educational level has a significant association with the overall cognitive scores comparing cognitive scores of HIV-infected participants to HIV- uninfected participants. The higher the educational level of the parent the better the cognitive score of the child.

Cognitive function of children whose parents receive a higher monthly income is better compared to children whose parents receive low income. Although the differences in mean scores were not significant after adjusting for other variables, it can be gathered from literature that parents income have an influence on the cognitive outcome of the child as a result of providing all the educational and cognitive needs.

6.3 Limitations

1. Due to limited financial resources the project was self-financed and could have increased the coverage; nonetheless, this did not affect the quality and the conclusion drawn on this study.
2. Current limited number of HIV- infected children visiting Ridge hospital ART clinic limited the sample size obtained for the HIV- infected group.
3. The cross sectional nature of the study limited the extent to which we can draw conclusions regarding temporality or the causal nature of observed associations.

CHAPTER SIX

CONCLUSION & RECOMMENDATION

6.0 Conclusion

Children are affected in different ways by HIV/AIDS. Cognitive deficits are one of the most significant long-term effects on HIV- infected children. Several factors are thought to influence cognitive outcomes. The aim of this study was to compare the cognitive function of perinatally acquired HIV-infected and uninfected children at the Ridge Hospital. A comparative cross-sectional study on cognitive function of perinatally acquired HIV-Infected vis-à-vis HIV- uninfected was carried out to assess if there are difference in the score between the two group. A primary data using a structured questionnaire was used to collect data at the Ridge Hospital. Pearson's Chi-square and Fishers' exact test of association were used in determining the association between the categorical socio-demographic variables, other independent variables on the overall cognitive function categorical variable, while the t-test was used in comparing means of cognitive domains and the overall cognitive scores between the two HIV status grouping (HIV-infected and HIV-uninfected).

Finally multiple linear regressions were used to determine significant variables in the study. The findings show that HIV- uninfected children performed significantly better on all the test domains used to assess the cognitive function of the groups. The study also revealed parent with high level of income and education can contribute significantly to the cognitive development of HIV- infected children.

6.1 Recommendation

In line with the research objectives and the expected outcome for the study, the following recommendations were arrived to help improve cognitive performance in HIV-infected children;

1. The need to strengthen the MTCT (Mother to Child Transmission) prevention strategies and early infant diagnosis cannot be overemphasize. This will help reduce the frequency and severity of perinatal HIV-infected children.
2. Early administration of High Active Antiretroviral Therapy (HAART) for all infants less than 12months of age is likely to reduce the deleterious viral effects on the developing brains.
3. The use of standard cognitive test will promote early identification of cognitive dysfunction and targeted interventions such as physical, occupation and speech therapies can be implemented collectively towards improving the quality of life of these children leading to improvement in their cognitive performance.
4. There is the need to sensitize parents of HIV-infected children to handle their emotion as well as that of their children since the level of parent education has some impact on the cognitive performance of the HIV-infected child.
5. Some social intervention towards improving the level of income of the parents can go a long way to help improve cognitive performance of the HIV-infected children by providing them with extra tuition and all the needed educational items to enhance learning.

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APPENDIX

Appendix I: Questionnaire

This questionnaire seeks to gather data on demographic characteristics and laboratory investigation of the children and their parents.

QUESTIONNAIRE: A COMPARATIVE CROSS-SECTIONAL STUDY ON THE COGNITIVE FUNCTION OF PERINATALLY ACQUIRED HIV-INFECTED AND HIV-UNINFECTED CHILDREN AT RIDGE HOSPITAL, ACCRA.

I am Amma, a final year student of the School of Public Health, University of Ghana. This questionnaire seeks to solicit information on your child's health status and overall cognitive Functions. It is strictly for academic purpose and therefore all information provided shall be treated with maximum caution and confidentiality. All personal data provided shall be treated collectively and not on personal levels.

QNo.	Questions	Coding categories	Skip to	Codes
Section A: Demographic Characteristics of Respondents (Children)				
1	Age of Respondents	years		AGE
2	Gender	Male.....1 Female.....2		GENDER
3	Educational Level	No formal education...1 Primary.....2 JHS.....3		EDUCATION
Laboratory Values				
9	CD4			CD4

QNo.	Questions	Coding categories	Skip to	Codes
Section A: Demographic Characteristics of Respondents (Parent/Guardian)				
1	Age of Respondents	years		AGE
2	Gender	Male.....1 Female.....2		GENDER
3	Educational Level	No formal education...1 Primary.....2 JHS.....3 SHS/Tech/Voc.....4 Tertiary.....5		EDUCATION
4	Family Income (GHC)	100-500.....1 500-1000.....2 1000-2000.....3 2000-5000.....4 5000 and above.....5		INCOME

Mini-Mental State Examination (MMSE)

Patient's Name: _____

Date: _____

Instructions: Ask the questions in the order listed. Score one point for each correct response within each question or activity.

Maximum Score	Patient's Score	Questions
5		"What is the year? Season? Date? Day of the week? Month?"
5		"Where are we now: State? County? Town/city? Hospital? Floor?"
3		The examiner names three unrelated objects clearly and slowly, then asks the patient to name all three of them. The patient's response is used for scoring. The examiner repeats them until patient learns all of them, if possible. Number of trials: _____
5		"I would like you to count backward from 100 by sevens." (93, 86, 79, 72, 65, ...) Stop after five answers. Alternative: "Spell WORLD backwards." (D-L-R-O-W)
3		"Earlier I told you the names of three things. Can you tell me what those were?"
2		Show the patient two simple objects, such as a wristwatch and a pencil, and ask the patient to name them.
1		"Repeat the phrase: 'No ifs, ands, or buts.'"
3		"Take the paper in your right hand, fold it in half, and put it on the floor." (The examiner gives the patient a piece of blank paper.)
1		"Please read this and do what it says." (Written instruction is "Close your eyes.")
1		"Make up and write a sentence about anything." (This sentence must contain a noun and a verb.)
1		"Please copy this picture." (The examiner gives the patient a blank piece of paper and asks him/her to draw the symbol below. All 10 angles must be present and two must intersect.)
30		TOTAL

(Adapted from Rovner & Folstein, 1987)

Appendix II: Participant Information Sheet

STUDY TITLE: A comparative cross-sectional study on the cognitive function of perinatally acquired HIV-infected and non-infected children at Ridge hospital.

Introduction:

My name is Ms Amma Adampo Otu-Danquah pursuing Master of Public Health sandwich program at the Department of Epidemiology, College of Health Sciences, University of Ghana. I can be contacted on 0245110335 and email on aotudanquah@mail.com.

Nature of Research:

In Ghana, cognitive assessment among people PLHIV is usually not a major issue of health concern, yet cognitive dysfunction could affect a child's school performance and communicating among peers. Although ARVs are known to prolong the lives of these persons based on available evidence, it doesn't necessarily correct cognitive impairments. Therefore there is a need to conduct such studies. Additionally, limited published research has been conducted in Ghana to assess the cognitive function of HIV-infected children. This study seeks to assess the cognitive function of HIV-infected children attending the Ridge hospital.

Participant Involvement:

Duration/Time Involved Practically, the study will last for three months beginning from August to October 2018. Participants will be required to answer questions in the semi-structured questionnaire.

Potential Risks The study does not possess any clinical risks to participants except that projected psychological and emotional discomfort may occur to participants due to the structure and nature of the questionnaire, however, the investigator seeks to explain the questionnaire to participants to the extent that this projected discomfort is averted.

Confidentiality All information provided in this study will be secured and stored at the School of Public Health, University of Ghana. Other researchers may find and use the data; however, participant's name or any other identifying information will be removed from the data to keep confidential.

Benefits There will be no direct benefits to the participants in this study. However indirect benefits to all persons living with HIV especially children. The findings of this study can be used as an evaluation will inform future policy and program implementation.

Confidentiality will be maintained as far as possible and interviewers will insure privacy.

Costs The study would not be of any financial cost to participants as it is solely funded by the principal investigator.

Compensation There would be no remuneration or compensation to participants.

Voluntary participation/withdrawal Participation in this study is voluntary and participants may withdraw at any time without any penalty. Participants can choose not to

participate or to answer any particular question or all the questions. Participant participation may be terminated if they feel too uncomfortable talking about the subject, get fed up, become tired, or find the study too obtrusive.

Feedback The study findings although for academic, would be shared with the management team of the health facility if needed.

Funding information The principal investigator has a sole financial responsibility for this study.

Contacts for Further Clarifications:

Further clarifications on this study would be communicated on a request to either the principal investigator, Amma Adampo Otu-Danquah on a phone contact 0245110335 or Madam Hannah Frimpong, the administrator, Ghana Health Service – Ethics Review Committee of the Research and Development Division on a phone contact 0507041223.

INFORMED CONSENT FOR PARENT/GUARDIAN

INFORMED CONSENT FORM FOR STUDY PARTICIPANTS

I would be very appreciative if you could help with this research project on “A comparative cross-sectional study on the cognitive function of perinatally acquired hiv- infected and non-infected children at Ridge hospital, Accra.” The results will be used in my dissertation. This research will help assess the cognitive function of your child as well as advising on any educational strategies that will help the child. Your child/ ward will be asked a few questions. Responses will be completely anonymous.

All you need to do as a study participant is to endorse this document and return it to me. If you do not wish to be part of this study, simply discard this document.

I certify that I voluntarily agree that my child will be a part of this study and that the survey has been explained to me. All my questions have been answered satisfactorily. I understand I am free to allow my child discontinue participation at any time if I so choose.

Signature of participant

I certify that the participant has been given adequate time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Signature of person who sought the consent

Amma Otu- Danquah

0245110335

(Principal investigator)

Or

Hannah Frimpong

The chairperson

GHS – institutional Review Committee

P. O. Box MB 190

Accra

(0243235225/ 0507041223)

SIGN.....

APPENDIX D: ETHICAL APPROVAL LETTER

*In case of reply the
number and date of this
Letter should be quoted.*



GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
22nd May, 2018

MyRef: GHS/RDD/ERC/Admin/App/18/290
Your Ref. No.

Amma Adampo Otu-Danquah
University of Ghana
School of Public Health
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC077/12/17
Project Title	A Comparative Cross-Sectional Study on the Cognitive Function of Perinatally Acquired HIV-Infected and Non-Infected Children at Ridge Hospital, Accra
Approval Date	22 nd May, 2018
Expiry Date	21 st May, 2019
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report **after completion** of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra