

## Preventive Measures and Potential Risk Factors for Toxoplasmosis among ART Clients in Sunyani Municipality

Anita Owusu<sup>1</sup>, Jacob K. Abebrese<sup>2</sup>, Sabina Ampon-Wireko<sup>3</sup>, Lydia Sarponmaa Asante<sup>4</sup>, Ernest Osei<sup>5</sup>, Chukwuma Chinaza Adaob<sup>6</sup>

<sup>1</sup>Bono Regional Hospital, Sunyani

<sup>2,3,4,5,6</sup>Catholic University of Ghana, P.O. BOX 363, Fiapre-Sunyani

Corresponding author: Anita Owusu. E-mail: [owusuanita98@yahoo.com](mailto:owusuanita98@yahoo.com)

### Managing Editors

Prof. Beverly Cimagala

Prof. Samantha Dieckmann

Professor. Zakir Aliyev

**How to Cite:** Anita Owusu, Jacob K. Abebrese, Sabina Ampon-Wireko, Lydia Sarponmaa Asante, Ernest Osei, Chukwuma Chinaza Adaobi (2023). Preventive Measures and Potential Risk Factors for Toxoplasmosis among ART Clients in Sunyani Municipality. *Scholars Journal of Science and Technology*, 4(3), 40-58. 10.53075/Ijmsirq/45645765

**Abstract:** This current study looked at the risk factors and preventive measures among persons living with HIV who access ART care at the Sunyani Bono Regional Hospital. A cross-sectional study was used because it simultaneously assesses both outcome and exposure variables. 340 people out of the projected 5430 in the municipality were sampled. Convenience sampling was used to select currently well PLWHA attending the ART clinic in the Bono Regional Hospital for the study. The most prevalent potential risk factors identified were lack of purification of drinking water (88.5%), farming and gardening activities (42.9%), handling cat feces without personal protection (21.0%), not washing fruits before eating (3.1%), not washing vegetables before cooking (1.2%), and an unquantified consumption of undercooked meat. The preventive measures assessed were the use of co-trimoxazole preventive therapy (CPT) and antiretroviral therapy (ART), adherence to which was tested for their relationships with socio-demographic characteristics and challenges to adherence at the first four levels of the social-ecological model. Strong predictors of adherence were occupation and satisfaction with ARVs. However, in this study, no significant relationship was found with the multivariate analysis. Similarly, no significant relationship was identified between age and adherence to CPT at any stage of the analysis in this research study. It is recommended that clinicians who are involved in ART care encourage patients in all categories of occupations to make their treatment a priority since their health is vital to all other pursuits in their lives.

**Keywords:** Toxoplasmosis, HIV, ART, preventive measures, Ghana

### 1. INTRODUCTION

As part of the United Nations sustainable development goals for 2030, goal number 3 states: "Ensure healthy lives and promote well-being for all at all ages" (Goal 3 | Department of Economic and Social Affairs, 2017). Target 3.3 of this goal further aims to "end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases by 2030 and combat hepatitis, water-borne diseases, and other communicable diseases." Every

person, therefore, irrespective of their age, must enjoy a healthy life and well-being, according to this SDG goal 3. As UNAIDS and global stakeholders in health envision an end to the AIDS epidemic by the year 2030, the target to bring all HIV patients to a state where the virus is adequately inhibited (i.e., the last 95 in the famous 95-95-95 target) by the year 2030 is on the right path (Abuelezam et al., 2019). The most important benefit, if this target is met, for the purpose of this study, is that its

achievement could help to reduce the incidence of opportunistic infections and AIDS-defining events such as cerebral toxoplasmosis. It would mean that majority of HIV patients would know their status, be on treatment and be virally suppressed which would drastically reduce their risk of cerebral toxoplasmosis.

HIV (human immunodeficiency virus) is a viral infection that invades and suppresses the immune system of the host. It mainly targets the CD4 lymphocytes, which are a subtype of white blood cells. These cells are a vital component of the immune system, destruction of which predisposes infected individuals to a host of infections often referred to as opportunistic infections (OIs) (HIV/AIDS, 2023). Cerebral toxoplasmosis, tuberculosis and *Pneumocystis jirovecii* pneumonia are key examples of opportunistic infections that often affect HIV and AIDS patients, leading to significant morbidity and mortality.

Worldwide, about 37.7 million persons are living with HIV, an increase of 21% over that of 2010, according to WHO. Of these, 25.4 million live in WHO African region (a whopping 67.4%). There was a global 1.5 million new infections (880,000 in Africa) with 830,000 deaths (460,000 in Africa) attributable to HIV in 2020. As at July 2021, 680,000 persons had died from HIV in the world, with 460,000 of these occurring in WHO African region. 73% of PLWHA were receiving ARVs in 2020 (Global HIV Programme, 2021.).

The first case of HIV in Ghana was detected in 1986, the National AIDS/STI Control Programme (NACP) was inaugurated in 1987 and highly active antiretroviral therapy (HAART) was added to the HIV management protocol in 2003 (S. A. Addo et al., 2018). Females constitute 65% of all cases of HIV in Ghana whereas males make up the remaining 35% (Global HIV Programme, 2021). Ghana reported 1656 testing and counseling facilities in 2016, and that translates into 10 per 100,000 population, which is woefully inadequate. By end of July 2021, Ghana's ART coverage stood at 60% (Global HIV Programme, 2021).

Cerebral toxoplasmosis is a serious opportunistic brain infection, which is estimated to affect approximately 3 to 15% of HIV positive individuals, and is one of the leading causes of death among HIV positive patients, especially in developing countries (Pereira-Chiocola et al., 2009). Worldwide, cerebral toxoplasmosis is the most common cause of focal CNS disorders in HIV/AIDS patients (Luma et al., 2013). The causative parasite is found in all

continents, and many people are actually infected already but are asymptomatic. It tends to cause problems when the immune function goes down, such as in HIV/AIDS patients. A study conducted in 2017 at the Korle Bu Teaching Hospital Fevers Unit revealed that the most common causes of mortality among HIV positive patients were tuberculosis (TB; 34.7%), anaemia (30.2%) and cerebral toxoplasmosis (27.5%) (Saavedra et al., 2017).

Before the year 1980, when HIV and AIDS were discovered, cerebral toxoplasmosis was an almost nonexistent predicament for people who had been immunocompromised from various causes. The initial cases of cerebral toxoplasmosis that were identified during the dawn of the AIDS pandemic were described between 1982 and 1983. With the increase in the numbers of people who got infected with the HIV virus, cerebral toxoplasmosis then emerged as one of the most frequently occurring opportunistic infections and the most prevalent causes of focal brain lesions among persons living with the virus. The most widely accepted argument in favor of the substantial relationship observed between reawakened cerebral toxoplasmosis and AIDS proposes that in this category of immunosuppressed patients there exists a distorted response of the T lymphocytes against parasitic infestations, and hence they are insufficient to deal with this "intracellular persistent parasite." In spite of the significant observed reduction in illnesses and deaths from countries in which highly active antiretroviral therapy is quite readily available, the fact that cerebral toxoplasmosis persists among HIV patients continues to indicate "a poor prognostic determinant in the natural history of PLWHA" (Vidal, 2019).

Clinical CNS toxoplasmosis affects about 50-75% of HIV patients in some European countries and in Africa, and approximately 3 to 15% of AIDS patients in the United States (CNS Toxoplasmosis in HIV, 2021). The West Africa sub-region and Ghana, and for that matter the Sunyani Municipality is not spared either. For instance, according to the electronic medical records data from the Bono Regional Hospital there was a total incidence of 56 and 47 admissions due to cerebral toxoplasmosis in HIV in the years 2019 and 2020 respectively. Yet, this is only one small part of the country.

Seropositivity of the parasite *T. gondii* is a well-established risk factor for cerebral toxoplasmosis among HIV positive individuals (Yohanes et al., 2014).

Worldwide, the estimated serologic prevalence of *T. gondii* is 25 to 30% (Azovtseva et al., 2020). Data available from other countries in Sub-Saharan Africa indicate a high serologic prevalence of the causative agent in asymptomatic HIV patients, and serologic positivity is a well-known risk factor for developing cerebral toxoplasmosis, especially in the presence of low CD4 count (Opintan et al., 2017; Yohanes et al., 2014). Among HIV seropositive patients from Ghana, PCR identified *T. gondii* in approximately 55% of participants (Opintan et al., 2017). In fact, an estimated 30 to 40 percent of AIDS patients may suffer cerebral toxoplasmosis without the appropriate anti-toxoplasma preventive treatment (Luma et al., 2013).

## 2. MATERIAL AND METHODS

### Study Area

The Bono Regional Hospital, located in Sunyani, which is the focus of this study, is a 350-bed regional level health facility that was opened for operation in 2003. The hospital serves as the highest point of referral from health facilities within the Bono, Ahafo, Bono East and some parts of the Ashanti, Western and Northern Regions.

It has a vibrant antiretroviral therapy (ART) clinic with a specialized laboratory that is equipped with a polymerase chain reaction (PCR) facility. This machine serves clients in the Sunyani Township, Sunyani Municipality as well as all the 3 regions formerly constituting the erstwhile Brong Ahafo Region, and even beyond. The estimated total number of ART clinic attendants in the hospital is 3089 according to the Health Information department. Most cases of cerebral toxoplasmosis in the municipality are referred there, and so has been the focal point for sampling patients to be participants in this study.

Sunyani is the capital of the Sunyani Municipality. The municipality was established by a legislative instrument (LI 1473) on March 10, 1989 and is one of the 260 metropolitan, municipal and district assemblies of the Republic of Ghana and among the 12 districts and municipalities within the Bono Region of the Republic of Ghana. It lies between latitudes 7° 20'N and 7° 05'N and longitudes 10° 10'W and 10° 10'W. It houses the capital of the Bono Region, Sunyani, which also happens to be the capital of the erstwhile Brong Ahafo Region from which the Bono Region was formed in 2016. Sunyani Municipality has a land area of 829.3 km<sup>2</sup> and is

bordered on the north by the Sunyani West District, on the west by Dormaa East District, on the south by Asutifi South District, and on the south and east by Tano North Municipality. About one third of the land area is uninhabited arable agricultural land (Ghana Districts: A Repository of All Local Assemblies in Ghana, 2015).

There is an estimated total population of 147,982 people (according to the 2021 population and housing census) living within the municipality. An estimated 5430 persons are living with HIV in the municipality. There are 69 health facilities with 8 of them offering ART services. These are Bono Regional Hospital, Sunyani Municipal Hospital, Sunyani SDA Hospital, Sunyani Police Clinic, 3MRS Clinic, Abesim Health Centre, Yawhima Health Centre and Atronie Health Centre.

### Study Design and Type

The study is a quantitative cross-sectional survey in the Bono Regional Hospital. The cross-sectional design is useful to obtain preliminary information about the topic at a specific point in time that could guide further advanced research, and is less expensive and time-consuming as compared to other types of observational studies. The quantitative type was to enable the testing of associations between the relevant explanatory and outcome variables. The study attempted to survey the prevailing potential risk factors as well as the preventive health behaviours among the population of HIV patients in the municipality. It was also employed to collect information regarding the health system related challenges mitigating against the implementation of preventive measures in this population. It also attempted to discover associations between these mitigating factors and the extent of potential risk factors present among this population.

### Study Population

The study involved HIV positive clients who were regular attendants of the antiretroviral (ART) Clinic at the Bono Regional Hospital. The total number of patients in that population is estimated to be 3089 according to the hospital's electronic medical records. The ART clinic is held on Wednesdays and Fridays at the Bono Regional Hospital. Participants recruited for the study were clients aged 11 to 70 years who were attending their usual scheduled review visits between October and December of 2022.

### Sampling Technique and Sample Size

Convenience sampling was used to select currently well PLWHA attending ART clinic in the Bono Regional Hospital for the study. Data collectors at the ART clinic approached patients when they reported for their appointment visits and their permission sought to recruit them into the study. The Yamane formula for sample size estimation was used to calculate the sample size, owing to the fact that the population of HIV patients who attend clinic at the Bono Regional Hospital is finite and known. However, 340 out of 354 persons issued questionnaire responded willingly to them, giving a response rate of about 96%. The central limit theorem describes a sufficiently large sample size as thirty (30) or more, in order to achieve a normal sampling distribution of any particular variable in a population (Central Limit Theorem, 2017; Central Limit Theorem Explained - Statistics by Jim, 2020). Hence, the sample size of 340 is sufficient.

### Study Variables

The study made use of measurements of 2 dependent variables and several independent variables. The independent variables being measured in this study are the socio-demographic characteristics of the respondents (age, level of education, income, marital status, occupation, living with family, religion and duration on ART), potential risk factors for toxoplasmosis (eating of unwashed fruits, eating of unwashed vegetables, farming and gardening activities, handling of cat excreta without personal protective gear, drinking of contaminated water and eating of raw or undercooked meat), the preventive measures in place to mitigate its occurrence (routine co-trimoxazole prophylaxis, adequate counseling about treatment, adequate virologic suppression indicating good antiretroviral treatment status and periodic monitoring of viral load levels), and the challenges affecting the implementation of such measures from the individual to the organizational levels (dissatisfaction with antiretroviral medications, financial challenges, knowledge about benefits of antiretrovirals, knowledge about co-trimoxazole benefits, stigma, lack of family support, unavailability viral load testing facilities, lack of expertise among health care providers, inadequate numbers of health care providers, shortage of antiretroviral medications and shortage of co-trimoxazole).

The dependent variables being measured are adherence to the 2 main preventive measures (i.e. co-trimoxazole preventive therapy also referred to as CPT

and antiretroviral therapy i.e. ART) which is based on the subjective assessment of respondents based on a Likert type scale. The scale measured intake of the two medications on a scale of 1 to 10 where 1 is very poor and 10 is excellent compliance.

### Data Collection Tools and Techniques

Clients attending ART Clinic on the designated clinic days (Wednesdays and Fridays) were individually issued with structured questionnaires designed by the author to complete, or were guided through the interview process using the questionnaire if unable to read and write the English language. The data collection was done by the author and 5 other persons, 4 of whom were staff at the ART clinic and who had been taken through the research techniques and expectations by the author. Conversations took place mostly in the Akan language for majority of participants, and in English for the few who were not comfortable with Akan. There did not arise any instance where any other language became necessary to communicate in apart from these two, and hence no interpreters were used for the interviews.

The data collection tool (questionnaire) employed consisted of 5 sections named A to E. Section A catered for socio-demographic characteristics of the respondents; section B collected information to assess the potential risk factors of cerebral toxoplasmosis that individuals were likely to be exposed to; section C sought to solicit information on the preventive measures that individuals undertake whether consciously or unconsciously against cerebral toxoplasmosis; section D dealt with the personal and social (individual, interpersonal and community level) challenges with adherence to the preventive measures and section E took care of the institutional (health system related) challenges affecting adherence to preventive measures against cerebral toxoplasmosis.

Participants were asked to sincerely self-report on their adherence to the antiretroviral medications and co-trimoxazole over a lifetime and to rate themselves on a scale of 1 to 10 where a score of 1 referred to extremely poor adherence and a score of 10 referred to perfect adherence with no recall of missed doses. This was the basis for assessing the dependent variables in this study. The study took place among a special population that more often than not are bedeviled with considerable social stigma, stereotyping and marginalization, and as such some level of difficulty in getting participants on board to volunteer information was unsurprisingly



encountered, especially in the initial stages of the data collection process. All the interpersonal encounters took place with respect to the appropriate COVID-19 protocols, i.e. social distancing, hand hygiene and wearing of facemasks.

### Data Analysis

Data collected via questionnaires were cleaned using SPSS version 26, which was also used to summarize the sociodemographic data into descriptive statistics (using frequencies and percentages) and was presented in tables for easy visual appreciation. The quantitative data were categorized and presented as frequencies and percentages with their respective p-values, odds ratios and 95% confidence intervals where applicable whereas the qualitative data were also presented as frequencies and percentages (Ogendi et al., 2013b).

Occupations of respondents other than the retired and students was further categorized into formal and informal sectors where formal sector refers to occupations that are under government supervision with structured salary, taxes and social benefits, and informal sector refers to all the other ones. Descriptive analysis was also used to outline the prevailing potential risk factors of cerebral toxoplasmosis (specific objective 1), the preventive measures in place at the antiretroviral (ART) site (specific objective 2), and the individual, interpersonal, community and institutional challenges affecting ART clients adherence to preventive protocols (specific objectives 3 and 4).

“Fisher’s exact test of independence” was run to identify any relationships that existed between the dependent variables (adherence to ART and CPT) and independent variables (socio-demographic characteristics and challenges affecting adherence at the 4 levels) at 95% confidence interval (CI) (Yarney et al., 2016). Where observations for any particular variable were more than 5, Pearson chi square was used instead. The same bivariable analyses were also performed to determine if any differences existed between the adherence to ART and adherence to CPT in the sample. Binary logistic regression was performed on all socio-demographic factors and challenges (specific objectives 3 and 4) that showed statistically significant relationships to the dependent variables (ART adherence and/or CPT adherence) at 95% confidence interval. The output was summarized as odds ratios, z scores, p values and 95% confidence intervals.

Based on the individual respondents’ assessment of their adherence to antiretroviral therapy (ART) and cotrimoxazole preventive therapy (CPT), which both constitute the dependent variables in this study, further categorization was done to distinguish adherent and non-adherent using a cut-off of 8 where adherent was defined as having a score of 8 and above and non-adherent was a score below 8 (Medication Adherence: The Elephant in the Room, 2018). Cronbach’s alpha test was used to determine the reliability of the Likert type questions used to assess adherence to ART and CPT in the questionnaire, and was found to have a value of 0.86, indicating a high level of reliability. This Likert scale was the basis of the dependent variables used for the logistic regression analysis.

### Ethical Considerations

Permission was sought from the Ghana Health Service Ethics Review Committee and the institutional research committee of the Bono Regional Hospital. The Ghana Health Service Ethics Review Committee’s approval was dated 7<sup>th</sup> September, 2022 with a reference number GHS-ERC 042/06/22. Written informed consent was sought from all participants and sealed by signatures or thumbprints whichever was appropriate for each individual. No personally identifiable data was collected, and all information obtained from participants was kept anonymous and confidential. The data collection took place at a time when the COVID-19 pandemic was still around, and therefore all relevant protocols such as physical distancing, wearing of facemasks and hand hygiene were respected accordingly.

## 3. RESULTS

### Socio-demographic Characteristics of ART Clients

The socio-demographic characteristics of the respondents are summed up in Table 1. 104 male (30.6%) and 236 female (69.4%) clients responded to questionnaire in this study. The mean age of the respondents was 44 years. Majority of them (237 persons, constituting 69.7%) belonged to the informal workforce, 43 (12.6%) were in the formal sector whereas retirees accounted for 2.9% (10 persons) of respondents. Students and the unemployed made up 10.3% and 4.4% respectively. 141 (41.5%) of the respondents had an educational level up to basic level, and 13.8% had no formal education at all. 97 (28.5) of them had had secondary education whereas 55 (16.2%) had reached the tertiary education level. Most (169 persons, constituting 49.7%) of the respondents earned

less than 500 Ghana cedis a month as income, and only 10 persons (representing 2.9%) reported that they earned monthly incomes above 2000 Ghana cedis. The remaining 161 (47.4%) reported that they earned between 500 and 2000 Ghana cedis as monthly income. 97 (28.5%) of the respondents were married, 79 (23.2%) were single, 61 (17.9%) were widowed, 60 (17.6%) were co-habiting and 43 (12.6%) were divorced. 320 participants (94.1%) were living with their families, while

the remaining 20 (5.9%) were not living with their families. There were 283 Christians accounting for 83.2% of the respondents, 52 were Muslims (15.3%) and 5 were Traditional religious worshippers (1.5%). Majority (174 persons making up 51.2%) of the respondents had been diagnosed as HIV positive and had been put on antiretroviral therapy for more than 5 years. The remaining 166 persons (48.8%) had been on antiretroviral therapy for at most 5 years.

**Table 1: Socio-demographic characteristics of ART clients at Bono Regional Hospital (BRH)**

Characteristic	Values	Frequency (n)	Percentage (%)
Age group (years)	11 to 20	22	6.5
	21 to 30	36	10.6
	31 to 40	74	21.8
	41 to 50	86	25.3
	51 to 60	83	24.4
	61 to 70	39	11.5
Sex	Male	104	30.6
	Female	236	69.4
Occupation	Formal sector	43	12.6
	Informal sector	237	69.7
	Retired	10	2.9
	Unemployed	15	4.4
	Schooling	35	10.3
Income (Ghana cedis)	Less than 500	169	49.7
	500 to 1000	120	35.3
	1001 to 2000	41	12.1
	Above 2000	10	2.9
Education	Primary	141	41.5
	Secondary	97	28.5
	Tertiary	55	16.2
	None	47	13.8
Marital status	Single	79	23.2
	Married	97	28.5
	Co-habiting	60	17.6
	Divorced	43	12.6
	Widowed	61	17.9
Living with Family	Yes	320	94.1
	No	20	5.9
Religion	Christianity	283	83.2
	Islam	52	15.3
	Traditional	5	1.5

Duration on antiretroviral therapy	Up to 2 years	87	25.6
	3 to 5 years	79	23.2
	More than 5 years	174	51.2

**Chi Square Analysis of Socio-demographic Factors and Adherence to ART and CPT among ART Clients**

A summary of the results of the chi square analysis of the socio-demographic data based on adherence to antiretroviral therapy (ART) and co-trimoxazole preventive therapy (CPT) is presented in Table 2. All the analyses were done at 95% confidence interval (CI) and margin of error of 0.05.

No statistically significant relationship was identified between sex and adherence to ART ( $p = 0.772$ ); similarly, there was no statistically significant relationship between sex and adherence to CPT ( $p = 0.313$ ), all at 95% confidence interval. There were highly statistically significant relationships found between age group and adherence to therapy with both co-trimoxazole and ARVs ( $p$  values of 0.000 in both cases) at 95% CI.

There was a statistically significant relationship between occupation and adherence to both co-trimoxazole and ART ( $p = 0.013$  and  $p = 0.001$  respectively) at 95% CI.

No statistically significant relationships were found between educational level and adherence to either CPT ( $p = 0.560$ ) or ART ( $p = 0.234$ ) at 95% CI.

There was no statistically significant relationship between level of income and adherence to ART ( $p = 0.226$ ); in the same vein, none such relationship was found with adherence to CPT ( $p = 0.712$ ) at 95% CI. A statistically significant relationship was found between marital status and adherence to ART ( $p = 0.001$ ) but not with CPT ( $p = 0.083$ ) at 95% CI. There was no statistically significant relationship between living with or without family and adherence to either co-trimoxazole ( $p = 0.798$ ) or ARV ( $p = 1.000$ ) at 95% confidence interval. No statistically significant relationship was found between religion and adherence to ART and CPT at 95% CI ( $p = 0.064$  and  $p = 0.126$ ) at 95% CI.

How long the respondents had been on antiretroviral therapy had a statistically significant relationship with adherence to co-trimoxazole ( $p = 0.003$ ) but not with adherence to antiretroviral therapy itself ( $p = 0.126$ ) at 95% CI.

**Table 2 Chi Square Analysis of Socio-demographic factors and adherence to ART and CPT among ART Clients in BRH**

Variable	ARV Adherent		ARV Non-adherent		P-value for ARV	CPT Adherent		CPT Non-adherent		P-value for CPT
	Freq. (n)	%	Freq. (n)	%		Freq. (n)	%	Freq. (n)	%	
Age group (years)										
11 to 20	10	3.7	12	17.4	0.000	8	3.9	12	15.6	0.000
21 to 30	30	11.1	6	8.7		24	11.8	6	7.8	
31 to 40	62	22.9	12	17.4		49	24.1	11	14.3	
41 to 50	73	26.9	13	18.8		54	26.6	18	23.4	
51 to 60	57	21.0	26	37.7		39	19.2	26	33.8	
61 to 70	39	14.4	0	0		29	14.3	4	5.2	
Sex										
Male	82	30.3	22	31.9	0.772	66	32.5	20	26.0	0.313
Female	189	69.7	47	68.1		137	67.5	57	74.0	
Occupation										
Formal sector	41	15.1	2	2.9	0.001	26	12.8	7	9.1	0.013
Informal sector	188	69.4	49	71.0		143	70.4	48	62.3	
Retired	10	3.7	0	0		8	3.9	0	0	

Unemployed	11	4.1	4	5.8		7	3.4	8	10.4	
Schooling	21	7.7	14	20.3		19	9.4	14	18.2	
Income (Gh cedis)										
Less than 500	129	47.6	40	58.0	0.226	102	50.2	45	58.4	0.712
500 to 1000	97	35.8	23	33.3		71	35.0	23	29.9	
1001 to 2000	35	12.9	6	8.7		22	10.8	7	9.1	
Above 2000	10	3.7	0	0		8	3.9	2	2.6	
Education										
Primary	110	40.6	31	44.9	0.234	85	41.9	28	36.4	0.560
Secondary	77	28.4	20	29.0		59	29.1	24	31.2	
Tertiary	49	18.1	6	8.7		34	16.7	11	14.3	
None	35	12.9	12	17.4		25	12.3	14	18.2	
Marital status										
Single	57	21.0	22	31.9	0.001	44	21.7	21	27.3	0.083
Married	74	27.3	23	33.3		62	32.5	24	31.2	
Co-habiting	48	17.7	12	17.4		38	18.7	10	13.0	
Divorced	33	12.2	10	14.5		19	9.4	14	18.2	
Widowed	59	21.8	2	2.9		40	19.7	8	10.4	
Living with family										
Yes	255	94.1	65	94.2	1.000	189	93.1	71	92.2	0.798
No	16	5.9	4	5.8		14	6.9	6	7.8	
Religion										
Christianity	225	83.0	58	84.1	0.064	169	83.3	69	89.6	0.126
Islam	44	16.2	8	11.6		32	15.8	6	7.8	
Traditional	2	0.7	3	4.3		2	1.0	2	2.6	
Duration on ART										
Up to 2 years	63	23.3	24	34.8	0.126	37	18.2	29	37.7	0.003
3 to 5 years	67	24.7	12	17.4		54	26.6	18	23.4	
More than 5 years	141	52.0	33	47.8		112	55.2	30	39.0	

### Logistic Regression Analysis of Socio-demographic Characteristics and Adherence to ART among ART Clients

Logistic regression analysis of the socio-demographic variables that showed statistical significance at 95% confidence interval during the chi square analysis in relation to ART adherence was further done, and the results are displayed in Table 3.

The odds ratio (OR) for age is 0.834, which means that for each one-unit increase in age, the odds of ART adherence decreases by a factor of 0.834. The z-score for age is -0.95, which is not statistically significant ( $p > 0.05$ ), indicating that age is not a significant predictor of adherence to ART in this study. The 95% confidence interval for the OR of age ranges from 0.573 to 1.212.

The OR for marital status is 1.327, which means that the odds of ART adherence are 1.327 times higher for married individuals compared to unmarried individuals. The z-score for marital status is 1.54, which is not statistically significant ( $p > 0.05$ ), indicating that marital status is not a significant predictor of ART adherence in this study. The 95% confidence interval for the OR of marital status ranges from 0.926 to 1.901.

The OR for occupation is 0.611, which means that the odds of adherence to ART are 0.611 times lower for individuals who are employed (in either the formal or informal sectors) compared to individuals who are unemployed, retired or schooling. The z-score for occupation is -2.76, which is statistically significant ( $p < 0.05$ ), indicating that occupation is a significant predictor of adherence to ART. The 95% confidence interval for the OR of occupation ranges from 0.430 to 0.866.



**Table 3: Logistic Regression Analysis of Socio-demographic Characteristics and Adherence to ART among HIV patients at BRH**

Variable	Odds Ratio	z	p-value	95% Confidence Interval
Age	0.834	-0.95	0.341	0.573 – 1.212
Marital status	1.327	1.54	0.123	0.926 – 1.901
Occupation	0.611	-2.76	0.006	0.430 – 0.866

**Logistic Regression Analysis of Socio-demographic Characteristics and Adherence to CPT among ART Clients**

Table 4 is the output of a regression model, which has estimated the Odds Ratio (OR), z-score, p-value, and 95% confidence interval for each of the predictor variables in relation to CPT adherence of the study population. Here is what each variable means:

Age: The odds ratio (OR) for age is 0.855, which means that for each one-unit increase in age, the odds of adherence to CPT decrease by a factor of 0.855. The z-score for age is -1.43, which is not statistically significant ( $p > 0.05$ ), indicating that age is not a significant predictor of adherence to CPT. The 95% confidence interval for the OR of age ranges from 0.689 to 1.060. Occupation: The OR for occupation is 0.724, which means that the odds of CPT adherence are 0.724 times lower for

individuals who are employed (in either the formal or informal sectors) compared to individuals who are unemployed, retired or schooling. The z-score for occupation is -2.42, which is statistically significant ( $p < 0.05$ ), indicating that occupation is a significant predictor of CPT adherence. The 95% confidence interval for the OR of occupation ranges from 0.558 to 0.940.

Duration of antiretroviral therapy: This variable measured how long individual respondents had been put on treatment. The OR for duration of antiretroviral therapy is 1.613, which means that for each one-unit increase in age, the odds of adherence to CPT increase by a factor of 1.613. The z-score for duration on antiretroviral therapy is 2.73, which is statistically significant ( $p > 0.05$ ), indicating that duration on antiretroviral therapy is a significant predictor of adherence to CPT. The 95% confidence interval for the OR of duration of antiretroviral therapy ranges from 1.145 to 2.273.

**Table 4: Logistic Regression Analysis of Socio-demographic Characteristics and Adherence to CPT among HIV patients at BRH**

Variable	Odds Ratio	z	p-value	95% Confidence Interval
Age	0.855	-1.43	0.153	0.689 – 1.060
Occupation	0.724	-2.42	0.015	0.558 – 0.940
Duration of antiretroviral therapy	1.613	2.73	0.006	1.145 – 2.273

**Potential Risk Factors for Toxoplasmosis among ART clients at BRH**

All the 340 respondents ate meat but had no objective way of assessing when their meat was done cooking. 291 of them (85.6%) relied on the external physical characteristics of the meat being cooked, such as the colour, to tell whether it was ready for consumption or not, whereas the remaining 49 (14.4%) were confident in their own perceived adequacy of time meat was left on fire to cook. None of them knew about or had ever used a food thermometer to test the internal temperature of their meats.

A minority of respondents (21, 6.2%) reported that they did not eat fruits at all. Of the 319 that agreed that they ate fruits, 309 (96.9%) washed them before eating. This was very similar to what was found with regards to the washing of vegetables before cooking where 98.8% (336 out of 340) of the respondents reported washing them before use. 146 (42.9%) of the respondents engaged in farming and gardening activities. 64 out of 81 (making up 79%) of the participants who handled cat excreta did so with personal protective gear such as gloves and masks. Majority (301 making up 88.5%) of the respondents reported that they trusted their drinking water sources

and as such had no need to do anything to purify them, and only 11.5% (39 out of 340) of participants purified their water further before drinking.

**Table 5: Potential Risk Factors for Toxoplasmosis among ART Clients**

Variable	Definition	Frequency (n)	Percentage (%)
Assessment of cooked meat doneness	Use of food thermometer	0	0
	Reliance on physical characteristics	291	85.6
	Reliance on adequate length of cooking time	49	14.4
Washing of fruits (N=319)	Done	309	96.9
	Not done	10	3.1
Washing of vegetables	Done	336	98.8
	Not done	4	1.2
Farming and gardening activities	Done	146	42.9
	Not done	194	57.1
Handling cat faeces with or without protection (N=81)	With personal protective gear	64	79.0
	Without personal protective gear	17	21.0
Purification of drinking water	Done	39	11.5
	Not done	301	88.5

#### **Preventive Measures against Toxoplasmosis among ART Clients at BRH**

This is summarized in table 6 below. A majority of respondents (280, 82.4%) were on co-trimoxazole prophylaxis, while the remaining 60 (17.6%) were not on it at the time they were administered with the questionnaire, for various reasons. Some of the reasons cited for not receiving co-trimoxazole were allergies (23 out of 60; 38.3%), G6PD deficiency (7 out of 60; 11.7%), and the remaining 30 had either been taken off the medication by the antiretroviral therapy (ART) care provider or had never received any discussion on that since they started their ART sessions. Of important note was that all 340 respondents admitted that they had received adherence counseling at least once at the time

of initiation of ART, with 338 (99.4%) of them having understood the discussion fully.

Concerning the viral load levels of respondents at the time of data collection, 17 respondents (5%) had not yet taken their first tests and so could not produce any report on them. Out of the remaining 323 who had had the test taken, 311 (91.5%) had values ranging from target not detected to 1000 copies per milliliter, making them reasonably virally suppressed as per the definition of HIV viral suppression at the time of the designing of the questionnaire. 338 of 340 (99.4%) respondents admitted that the laboratory facilities to monitor viral load levels were available whenever they needed to get their routine monitoring completed.

**Table 6: Preventive measures against toxoplasmosis among ART Clients in BRH**

Variable	Values	Frequency (n)	Percentage (%)
Routine co-trimoxazole prophylaxis	Ongoing	280	82.4
	Not being done	60	17.6
Adherence counseling	Received	340	100
	Not received	0	0
Viral suppression (N=323)	Achieved	311	96.3
	Not achieved	12	3.7
Facilities to monitor viral load levels	Available	338	99.4
	Not available	2	0.6

Source: Field data, 2022.

#### 4. DISCUSSION

##### **Socio-Demographic Characteristics of ART Clients and Adherence to Preventive Measures**

Differences in age more often than not influence several disease processes, the choices of treatment modalities considered appropriate for an individual on a case-by-case basis, the treatment outcomes of the afflicted individuals, as well as their ability to understand and comply with what is prescribed for them. Various studies have found differing results in relation to age and adherence to antiretroviral therapy (ART). For instance, in a research work conducted in the same hospital chosen for this study and one other health facility within the Sunyani Municipality by Yarney et al. (2016), younger patients were more likely to be non-adherent to ART. This was also corroborated by the findings of a study in Kenya where adolescents and younger adults had higher rates of non-adherence (Mukui et al., 2016). Several other studies pooled together in a systematic review on several continents also identified age to be associated with adherence to other interventions which are also normally given to HIV patients (Müller & Velez Lapão, 2021). This study found a statistically significant relationship between age and adherence to both ART and co-trimoxazole preventive therapy (CPT) in the bivariate analysis as was revealed in other studies such as that of B. Addo et al., 2018 in Ashanti region which also found older age to be more likely associated with non-adherence to ART. However, in this study no significant relationship was found with the multivariate analysis. Similarly no significant relationship was identified between age and adherence to CPT at any

stage of the analysis in this study. Another systematic review capturing several studies in Africa also did not identify any significant relationship between age and adherence to ART (Soomro et al., 2019). Due to their greater regard for and involvement in cultural practices, traditional beliefs and indigenous social norms, elderly folk are less likely to embrace orthodox treatments for their illnesses while being more likely to resort to traditional treatments instead, and hence may be non-adherent to their treatments (Soomro et al., 2019).

The sex distribution of the respondents in this study mirrors that of the general sex distribution of people living with HIV in the country (Global HIV Programme, 2021). Males and females are often different not only in their biological make-up but also in their gender associated roles defined by society as well as responsibilities and privileges with respect to varying aspects of their lives. For instance women in most parts of the world are fundamentally responsible for home making and care of children; in some indigenous cultures in Sub-Saharan Africa girls are primarily required to be home makers and are not educated or are less educated as compared to their brothers; men may be more involved in some types of occupations perceived to be men's jobs as compared to women, and certain taboos in society may affect women in some cultures whereas it is totally harmless for men to indulge in. For instance, polygamy is largely not forbidden for men but disgustingly frowned upon when engaged in by women. Additionally, certain habits and risk taking behaviours that impact negatively on health may be more common among men than women, well notably the abuse of alcohol and other drugs and

smoking. As such, these basic differences between males and females more often than not may also influence their perceptions and attitudes toward their health, their health seeking behaviours and their outcomes in conditions of ill health.

A study that involved HIV positive participants from 25 countries reported worse adherence patterns among females as compared to males, and the speculated reasons theorized by the researchers include the fact that women are more likely to be reliant on others, mostly men, for their provision, are more likely to have lower educational status, and are more prone to social injustices such as abuse by their partners, among others (Prevalence, Determinants, and Impact of Suboptimal Adherence to HIV Medication in 25 Countries | Elsevier Enhanced Reader, 2020). In the qualitative aspects of the studies by A. K. Amankwah (2015) and Yarney et al. (2016) in Sunyani, males were more non-adherent to ART as compared to females, even though the quantitative aspects of these mixed-methods research works identified no such relationship between sex and adherence to antiretroviral therapy. In a similar fashion, a study conducted in the Cape Coast Metropolis by Prah et al. (2018) found that male sex was associated with a higher level of non-adherence to ART as compared to female sex. The explanation given for this was that the males spent a greater amount of their time outside their homes due to their employment, making them miss doses of their medications (Prah et al., 2018). Some HIV patients in one study acknowledged that going out of their homes without carrying their medications on them made them miss their doses. (Dzansi et al., 2020). Sex, in this study, had no significant relationship with adherence to CPT and ART. A systematic review by Müller & Velez Lapão, 2021 also found divergent results regarding sex and adherence to another important preventive treatment for HIV patients; hence, the finding from this study is not in isolation. Another study conducted in the Upper West Region of Ghana also did not identify any statistically significant relationship between sex and adherence to ART (Obirikorang et al., 2013).

Much emphasis was not laid on occupation and its relationship with adherence to ART or CPT in any of the studies reviewed. This current study revealed a statistically significant relationship between occupation and adherence to both ART and CPT in both the bivariate and multivariate analyses, with the multivariate analysis showing higher odds of non-adherence among

those employed in any form of occupation as opposed to their non-working compatriots (i.e. unemployed, retired and students). This may reflect the existence of ample free time available to some clients as compared to others who may be too busy by virtue of the nature of their work and their schedules (B. Addo et al., 2018). Moreover, busy work schedules are more likely to be associated with forgetfulness, which has been found in several studies to impact negatively on adherence to treatment (Amankwah, 2015; Yarney et al., 2016; Ammon et al., 2018; Prah et al., 2018; Dzansi et al., 2020).

Similar to the above is the relationship between duration of ART and adherence to CPT. A statistically significant relationship was found between them in the bivariable and multivariable analyses (OR 1.6; 95% CI 1.145 to 2.273). No explanation was found for this; however, it may be due to the improved adherence with age (as age advances with duration of any chronic illness and its long term treatment) found in the study by Yarney et al. in the same hospital and another health facility within the same town in which this current study took place (Yarney et al., 2016). It may also reflect the fact that with the passage of time people on a particular medication get better accustomed to how their bodies tend to react to them and hence are more comfortable taking them. One qualitative study in the Greater Accra Region actually documented that some participants who had been on HIV treatment for more than 5 years said they had gotten used to their antiretroviral medications and were more compliant with them because it had become a part and parcel of their lives (Dzansi et al., 2020). In the same way, adherence to antiretroviral therapy has been found in another study conducted in some exurban areas of Zambia to be better among those who had been put on them for prolonged periods in comparison with their counterparts who had started not long before (Carlucci et al., 2008). That said, the reason why the duration of ART does not have a statistically significant relationship with adherence to the antiretroviral medications themselves in this current study needs to be explored in future studies.

Level of monthly income, religion and living with family were not found to be statistically significantly related to adherence to CPT or ART in this study. Studies reviewed did not place much emphasis on these sociodemographic characteristics in relation to adherence to treatment. However, religious beliefs may affect coping mechanisms and could in turn influence the acceptability for and adherence to any form of long term



treatment. Living with family members who offer the necessary support may impact positively on adherence as compared to living alone whereby the impetus for taking medications may sometimes be lacking (Müller & Velez Lapão, 2021). In the same way, living with a stigmatizing and unsupportive family may equally impact negatively on adherence to treatment, as was shown in one study in an African country where some respondents reported that they had ever experienced instances where their family members deliberately discarded their medications (Müller & Velez Lapão, 2021). Similarly, ambiguous family relationship was seen in one study to reduce adherence among adolescents living in homes without their natural parents (MacCarthy et al., 2018).

Marital status did not have a statistically significant relationship with adherence to CPT, but was significant in relation to ART only in the bivariate analysis. Married people were more adherent to their antiretroviral medication schedules ( $p < 0.05$ ) as compared to their unmarried colleagues (i.e. the single, divorced, cohabiting and widowed together). This may reflect the existence of mutual support among concordant couples (i.e. couples who both have the HIV infection) or even among discordant couples (couples in whom one partner is HIV positive and the other is HIV negative) where the HIV negative partner is the patient's confidant and treatment supporter (Yarney et al., 2016). A treatment supporter who is a patient's spouse is often counseled together with their positive spouse and so have much understanding of their conditions and the need to give them the utmost support so that their partners may stay in good health and thereby reducing the chances of they themselves acquiring HIV in the course of the marriage. However, much emphasis was not placed on determining the relationship between marital status and adherence to treatment among HIV patients.

#### **Potential Risk Factors for Toxoplasmosis among ART Clients in Sunyani Municipality**

All the respondents ate one or more of the types of meat assessed during the study, i.e. poultry, beef, pork, lamb, goat and bush meat, which are the main ones mostly implicated in toxoplasmosis causation (J. P. Dubey et al., 2005a; Tenter, 2009; Pereira-Chioccia et al., 2009). There were no vegetarians among the respondents. This study has uncovered the lack of objective means for determining whether meat was thoroughly cooked or not. All respondents reported that they relied on entirely subjective means (i.e. reliance on the physical characteristics of the meat or confidence in the length of

time the meat is left to cook). Nonetheless this way of judgment is far from safe (Cook to a Safe Minimum Internal Temperature | FoodSafety.Gov, 2019), given that meats may carry *Toxoplasma gondii* oocysts and other pathogens that often lie deep within the tissues and if not properly destroyed could reactivate and cause severe disease when the right conditions (lowered immune status) are met later on within the host (Arefkhah et al., 2018). The use of food thermometers to establish the temperature inside the deep tissues of meat, which is the most objective and safest way to assess the doneness of cooked meat, is virtually non-existent among the ART clinic attendants (Cook to a Safe Minimum Internal Temperature | FoodSafety.Gov, 2019). There is therefore the propensity to overcook, but also, most importantly, to undercook meat, which may contain viable *Toxoplasma gondii* spores that may predispose PLWHA to acquiring toxoplasmosis in future. The true incidence of undercooking of meat could not be ascertained in this study owing to the fact that it is an extensive, labour intensive and capital-intensive process that largely lies outside the scope of this research but which could be a subject for future research works. That vegetarianism is very rare among this population exposes almost all patients to some reasonable risk of harbouring *T. gondii* since meat is one of the main sources by which it infests human beings.

Fundamentally, all modern societies emphasise hygienic practices such as hand washing and washing of foods consumed raw, particularly in the era of the coronavirus disease pandemic that reared its ugly head in December 2019. In public places in many cities, there are facilities for washing with some of them providing free water, detergents and disposable towels for passers-by. A lot of public education has gone on, most of these centering on hygienic practices. Though it appears to be common general knowledge for one to wash their hands, fruits and vegetables before eating or using them in cooking, there is still a minority of people who do not practise these, and such poses the risk of ingesting *Toxoplasma* spores that may cause disease later on when the right conditions are met. That said, there is a general consensus that warns people to be wary of where the water they use in washing their food come from, due to the fact that some water sources may themselves be contaminated with *T. gondii* parasites (Mboera et al., 2019; J. Dubey, 2004).

The different ways in which farming and gardening pose a risk of toxoplasmosis span from the contact with soil



that could potentially be contaminated, stricter requirements for hand hygiene because of the largely manual nature of the work on the farms, contact with potentially infected animals as well as inhalation of spores from the potentially contaminated environments on the farms (Kijlstra & Jongert, 2008; Teutsch et al., 1979). Since most of the respondents were engaged in farming and gardening activities, there is a risk of being exposed to viable spores of *T. gondii*. This suggests that there is a high chance of coming down with the disease when favourable conditions are fulfilled in the future (Vidal, 2019).

It cannot be overemphasized how important felines are in the spread of the causative parasite of cerebral toxoplasmosis. What makes these animals dangerous to man is the faecal shedding of viable forms of *T. gondii* parasites into their immediate environments. The risk of exposure to *T. gondii* through cat faeces handling was also observed among the study participants owing to the fact that about one-third do so without any form of protective gear to protect themselves. Omission of masks while handling cat excrement poses a risk of toxoplasmosis via the inhalation route while the omission of gloves also poses a risk of ingestion if followed by improper hand hygiene practices ((Kijlstra & Jongert, 2008; Teutsch et al., 1979; Pereira-Chiocola et al., 2009).

Water sources are known to contribute to the transmission of toxoplasmosis parasites, even though it is often practically difficult to assay and quantify (J. Dubey, 2004). Owing to the difficulty in quantitation of the level of infection even in advanced countries and the fact that the means through which contaminated water infects humans are many and varied, there is no consensus regarding the prevention of infection acquired through water sources. However, the author advises use of water only from trusted sources that abide by the standard safety precautions stipulated by their jurisdictions as well as treatment of water from sources which are potentially unsafe, such as boiling and use of chemical puritants which are known to kill the viable spores (Kijlstra & Jongert, 2008). A whopping majority of participants not undertaking any form of purification of their drinking water suggests a potential risk, more so in this environment where the risk of environmental contamination is high as a result of cats being reared in free range and the reliance of many households on water that runs on the ground such as streams, rivers and lakes. Studies have indicated the occurrence of

epidemics of toxoplasmosis following exposure to contaminated water containing *Toxoplasma* spores (J. Dubey, 2004).

### **Preventive Measures against Toxoplasmosis among ART Clients**

Co-trimoxazole preventive therapy (CPT) is the cornerstone of prevention against toxoplasmosis in the population of HIV infected individuals, and has been found in some studies to be highly effective, reaching 100 percent protection for regular users (Kirk et al., 1999; Bamba et al., 2017). It is a simple relatively inexpensive intervention requiring only a single dose per day, but is inarguably an absolute necessity in this population as it wards off not only opportunistic infections such as cerebral toxoplasmosis but also demonstrates some protection against malaria (Müller & Velez Lapão, 2021) which is a common disease that often causes significant morbidity and mortality in people living on the African continent and other tropical regions of the world. Even though concerns about resistance to this medication have been expressed in some parts of the world, it continues to be a cornerstone preventive therapy for most patients who can tolerate it (Müller & Velez Lapão, 2021). Majority of ART clients in this study reported that they were undergoing routine chemoprophylaxis (against opportunistic infections, which include cerebral toxoplasmosis) with co-trimoxazole at the time of the data collection, and had been on them for varying durations. One could therefore safely conclude that this practice prognosticates a reasonably high level of protection against the infection among the HIV clients who seek ART care services at the Bono Regional Hospital despite the many risk factors within the same population as enumerated above in the previous section.

Adherence counseling for HIV patients preferably to be offered prior to the initiation of highly active antiretroviral therapy (HAART) is one of the pillars that have sustained the HIV control efforts in the country since the inception of HIV. Until the roll-out of the “treat all” policy in 2015 it was strictly recommended to be offered on more than one occasion before initiating patients on the medications. The “treat all” policy requires every health professionals identifying a new diagnosis of HIV in a patient to immediately link them to antiretroviral therapy care with immediate effect and without further delay unless there is a compelling reason by virtue of a serious health complication to wait for a better time in the future, usually within 2 weeks. Under this new era, adherence counseling is not made a strict requirement before

initiation of the antiretroviral medications; they are often done concurrently. This policy came to replace the era where not all HIV patients were offered antiretrovirals but were segregated based on their stage of the disease and CD4 count levels. Patients who fell within the WHO stages that suggested they were clinically in good state (stages 1 and 2) and those with CD4 count levels more than 200 cells per microlitre were put on only opportunistic infection prophylaxis (largely cotrimoxazole) and multivitamins for immune health as well as scheduled for routine visits and their CD4 counts monitored periodically. Only those individuals who presented in WHO clinical stages 3 and 4 or with CD4 count levels below 200 cells per microliter were offered antiretroviral medications, often following multiple sessions of adherence counseling. This study has proven that adherence counseling for PLWHA is still readily available to all clients at the initiation of ART in the Bono Regional Hospital, and this is highly commendable as it empowers clients with knowledge in order to be mentally prepared for the commitment that comes with being on lifelong treatment (Amankwah, 2015).

Having a good immunologic status (which, more often than not, goes hand in hand with adequate viral suppression) is well known to be a strong protective factor against cerebral toxoplasmosis (Azovtseva et al., 2020; Smurzynski et al., 2010b). HIV patients who have lower viral load levels tend to have lower odds of falling sick with cerebral toxoplasmosis as compared to those in whom the HIV viral RNA copies were on the higher side (Azovtseva et al., 2020). The findings from this study indicate that the vast majority of ART clinic attendants had achieved good viral suppression as at the time of the data collection, with most of them reporting that their laboratory tests indicated “target not detected” (which in this setting often indicates values less than 16 or 20 copies per milliliter depending on the polymerase chain reaction (PCR) equipment utilized for the assay). This suggests that most of the HIV patients who access ART services at the Bono Regional Hospital are able to achieve good viral suppression while on treatment and therefore have lower risks of coming down with opportunistic infections of which toxoplasmosis is an important component.

There is a general scarcity of facilities for monitoring HIV viral load levels in the country; the distribution of the few ones available in the country is far from equitable, and this has been so for many years, though the situation is

better at present. Even within jurisdictions in which each machine is expected to serve, HIV infected individuals owing to certain setbacks often have practical challenges accessing them as and when they are required by their health care providers to undertake them for their monitoring. The PCR facility at the Bono Regional Hospital serves HIV patients in the Bono region as well as other neighboring regions, and majority of the patients who have chosen to seek care in the facility reported that it was readily accessible to them as and when they were required to take the test. In this way, easier monitoring of individual patients’ responses to treatment is attainable; this greatly helps to ensure that patients receive the most effective treatment needed to keep their immune systems strong to be indomitable against opportunistic diseases such as cerebral toxoplasmosis.

## 5. CONCLUSION

This current study did not identify any statistically significant relationship between level of formal education and adherence to any of the two preventive therapies that were considered. Similar findings were obtained in a previous study done in the same municipality (which also included Bono Regional Hospital) to determine adherence to ART even though CPT was not part of the study. Some of the preventive (or protective) factors that were identified in the study were the use of routine cotrimoxazole prophylaxis (82.4%), effective antiretroviral therapy (ART) as assessed by the adequacy of viral suppression (96.3%), as well as the availability of pre-treatment adherence counseling services (100%), and accessibility to facilities for viral load testing (99.4%). It is crucial for healthcare providers to provide personalized counseling and guidance to ART clients regarding preventive measures and risk factors based on their individual circumstances and lifestyle. Regular monitoring and screening for toxoplasmosis can be considered for high-risk individuals. Toxoplasmosis is an infection caused by the *Toxoplasma gondii* parasite. While it can affect anyone, including individuals with a healthy immune system, it poses a particular risk to individuals with compromised immune systems, such as those receiving antiretroviral therapy (ART) for HIV/AIDS.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

**Funding**

The author(s) received no financial support for the research, authorship, and/or publication of this article.

**Data Availability**

Data used for this research is available upon request from the corresponding author.

**Notes**

1. We appreciate the anonymous reviewer's comments, which we have noted and worked on to improve the manuscript's scholarly caliber and visibility.

**REFERENCE**

- Abuelezam, N., McCormick, A., Surface, E., Fussell, T., Freedberg, K., Lipsitch, M., & Seage, G. (2019). Modelling the epidemiologic impact of achieving UNAIDS fast track 90-90-90 and 95-95-95 targets in South Africa. *Epidemiology & Infection*, 147.
- Addo, S. A., Abdulai, M., Yawson, A., Baddoo, A. N., Zhao, J., Workneh, N., Okae, I., & Wiah, E. (2018). Availability of HIV services along the continuum of HIV testing, care and treatment in Ghana. *BMC Health Services Research*, 18(1), 1–10.
- Agrawal, D., & Hussain, N. (2005). Decompressive craniectomy in cerebral toxoplasmosis. *European Journal of Clinical Microbiology and Infectious Diseases*, 24(11), 772–773.
- Azovtseva, O., Viktorova, E., Bakulina, E., Shelomov, A., & Trofimova, T. (2020). Cerebral toxoplasmosis in HIV-infected patients over 2015–2018 (a case study of Russia). *Epidemiology & Infection*, 148.
- Bamba, S., Zoungrana, J., Nikièma, Z., Sondo, A. K., Ndiaye, J.-L., & Bretagne, S. (2017). Impact of alternative treatment approach for cerebral toxoplasmosis among HIV/AIDS patients from a resourcepoor setting in Burkina Faso. *Annals of Parasitology*, 63(3).
- Bhatti, A. B., Usman, M., Kandi, V., Bhatti, A. B., Usman, M., & Kandi, V. (2016). Current Scenario of HIV/AIDS, Treatment Options, and Major Challenges with Compliance to Antiretroviral Therapy. *Cureus*, 8(3). <https://doi.org/10.7759/cureus.515>
- Boakye, D. S., & Mavhandu-Mudzusi, A. H. (2019). Nurses knowledge, attitudes and practices towards patients with HIV and AIDS in Kumasi, Ghana. *International Journal of Africa Nursing Sciences*, 11, 100147. <https://doi.org/10.1016/j.ijans.2019.05.001>
- Carlucci, J. G., Kamanga, A., Sheneberger, R., Shepherd, B. E., Jenkins, C. A., Spurrier, J., & Vermund, S. H. (2008). Predictors of Adherence to Antiretroviral Therapy in Rural Zambia. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 47(5), 615–622. <https://doi.org/10.1097/QAI.0b013e318165dc25>
- Connolly, M. P., Haitsma, G., Hernández, A. V., & Vidal, J. E. (2017). Systematic review and meta-analysis of secondary prophylaxis for prevention of HIV-related toxoplasmic encephalitis relapse using trimethoprim-sulfamethoxazole. *Pathogens and Global Health*, 111(6), 327–331. <https://doi.org/10.1080/20477724.2017.1377974>
- Dzansi, G., Tornu, E., & Chipps, J. (2020). Promoters and inhibitors of treatment adherence among HIV/AIDS patients receiving antiretroviral therapy in Ghana: Narratives from an underserved population. *PloS One*, 15(3), e0230159.
- Errata: Evaluation of co-trimoxazole Adherence in Infants of HIV Positive Mothers aged 6 weeks to 6 months in Lagos Nigeria. *Nigerian Hospital Practice*, 23(4–5), Article 4–5. <https://doi.org/10.4314/nhp.v23i4-5>.
- Eshun-Wilson, I., Rohwer, A., Hendricks, L., Oliver, S., & Garner, P. (2019). Being HIV positive and staying on antiretroviral therapy in Africa: A qualitative systematic review and theoretical model. *PloS One*, 14(1), e0210408.
- Global HIV Programme. (2021). Retrieved 28 October 2021, from <https://www.who.int/teams/global-hiv-hepatitis-and-stis-programmes/hiv/strategic-information/hiv-data-and-statistics>
- Irungu, B. N., Koech, L. C., Ondicho, J. M., & Keter, L. K. (2021). Quality assessment of selected co-trimoxazole suspension brands marketed in Nairobi County, Kenya. *PLOS ONE*, 16(9), e0257625. <https://doi.org/10.1371/journal.pone.0257625>
- Kelly, M., McCarthy, S., & Sahm, L. J. (2014). Knowledge, attitudes and beliefs of patients and carers regarding medication adherence: A review of qualitative literature. *European Journal of Clinical Pharmacology*, 70(12), 1423–1431.
- Kijlstra, A., & Jongert, E. (2008a). Control of the risk of human toxoplasmosis transmitted by meat. *International Journal for Parasitology*, 38(12), 1359–1370. <https://doi.org/10.1016/j.ijpara.2008.06.002>
- Kijlstra, A., & Jongert, E. (2008b). Control of the risk of human toxoplasmosis transmitted by meat. *International Journal for Parasitology*, 38(12), 1359–1370. <https://doi.org/10.1016/j.ijpara.2008.06.002>
- Kirk, O., Lundgren, J. D., Nielsen, H., & Gerstoft, J. (1999). Can chemoprophylaxis against opportunistic infections be discontinued after an increase in CD4 cells induced by highly active antiretroviral therapy? *Aids*, 13(13), 1647–1651
- Kongsangdao, S., Samintarapanya, K., Oranratnachai, K., Prapakarn, W., & Apichartpiyakul, C. (2008). Randomized controlled trial of pyrimethamine plus sulfadiazine versus trimethoprim plus sulfamethoxazole for treatment of toxoplasmic

- encephalitis in AIDS patients. *Journal of the International Association of Physicians in AIDS Care*, 7(1), 11–16.
- Kumarasamy, N., Safren, S. A., Raminani, S. R., Pickard, R., James, R., Krishnan, A. S., Solomon, S., & Mayer, K. H. (2005). Barriers and facilitators to antiretroviral medication adherence among patients with HIV in Chennai, India: A qualitative study. *AIDS Patient Care & STDs*, 19(8), 526–537.
- Lee, G. T., Antelo, F., & Mlikotic, A. A. (2009). Cerebral toxoplasmosis. *Radiographics*, 29(4), 1200–1205.
- Luma, H. N., Tchaleu, B. C. N., Mapoure, Y. N., Temfack, E., Doualla, M. S., Halle, M. P., Joko, H. A., & Koulla-Shiro, S. (2013). Toxoplasma encephalitis in HIV/AIDS patients admitted to the Douala general hospital between 2004 and 2009: A cross sectional study. *BMC Research Notes*, 6(1), 1–5.
- MacCarthy, S., Saya, U., Samba, C., Birungi, J., Okoboi, S., & Linnemayr, S. (2018). “How am I going to live?": Exploring barriers to ART adherence among adolescents and young adults living with HIV in Uganda. *BMC Public Health*, 18(1), 1158. <https://doi.org/10.1186/s12889-018-6048-7>
- Matheus, M., Serrat, A., Vante, I., & Shinde, A. (2021). Anisocoria, an Unusual Physical Exam Finding Leading To A Concurrent Diagnosis Of Cerebral Toxoplasmosis And Hiv/Aids. *Journal of Infectious Diseases & Case Reports. SRC/JIDSCR-152*. DOI: [https://doi.org/10.47363/JIDSCR/2021\(2\),137,3](https://doi.org/10.47363/JIDSCR/2021(2),137,3).
- Mboera, L. E. G., Kishamawe, C., Kimario, E., & Rumisha, S. F. (2019). Mortality Patterns of Toxoplasmosis and Its Comorbidities in Tanzania: A 10-Year Retrospective Hospital-Based Survey. *Frontiers in Public Health*, 7, 25. <https://doi.org/10.3389/fpubh.2019.00025>
- Müller, P., & Velez Lapão, L. (2021). Mixed methods systematic review and metasummary about barriers and facilitators for the implementation of cotrimoxazole and isoniazid – preventive therapies for people living with HIV [Preprint]. *HIV/AIDS*. <https://doi.org/10.1101/2021.04.30.21256370>
- Navia, B. A., Petito, C. K., Gold, J. W., Cho, E., Jordan, B. D., & Price, R. W. (1986). Cerebral toxoplasmosis complicating the acquired immune deficiency syndrome: Clinical and neuropathological findings in 27 patients. *Annals of Neurology*, 19(3), 224–238.
- Ogendi, E., Maina, N., Kagira, J., Ngotho, M., Mbugua, G., & Karanja, S. (2013a). Questionnaire Survey on the Occurrence of Risk factors for Toxoplasma gondii infection amongst Farmers in Thika District, Kenya. *Journal of the South African Veterinary Association*, 84(1). <https://doi.org/10.4102/jsava.v84i1.191>
- Owusu, A. Y. (2020). Social contexts of living with HIV/AIDS in the Eastern Region of Ghana. *Istanbul University Journal of Sociology*, 39(2), 425–454.
- Pappoe, F., Cheng, W., Wang, L., Li, Y., Obiri-Yeboah, D., Nuvor, S. V., Ambachew, H., Hu, X., Luo, Q., & Chu, D. (2017). Prevalence of Toxoplasma gondii infection in HIV-infected patients and food animals and direct genotyping of T. gondii isolates, Southern Ghana. *Parasitology Research*, 116(6), 1675–1685.
- Reda, A. A., & Biadgilign, S. (2012). Determinants of Adherence to Antiretroviral Therapy among HIV-Infected Patients in Africa. *AIDS Research and Treatment*, 2012, e574656. <https://doi.org/10.1155/2012/574656>
- Rostami, A., Keshavarz, H., Shojaee, S., Mohebbi, M., & Meamar, A. R. (2014). Frequency of Toxoplasma gondii in HIV Positive Patients from West of Iran by ELISA and PCR. 9(4), 8.
- Saavedra, A., Campinha-Bacote, N., Hajjar, M., Kenu, E., Gillani, F. S., Obo-Akwa, A., Lartey, M., & Kwara, A. (2017). Causes of death and factors associated with early mortality of HIV-infected adults admitted to Korle-Bu Teaching Hospital. *Pan African Medical Journal*, 27(1).
- Scott Sutton, S., Magagnoli, J., & Hardin, J. W. (2016). Impact of Pill Burden on Adherence, Risk of Hospitalization, and Viral Suppression in Patients with HIV Infection and AIDS Receiving Antiretroviral Therapy. *Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy*, 36(4), 385–401. <https://doi.org/10.1002/phar.1728>
- Smurzynski, M., Wu, K., Benson, C. A., Bosch, R. J., Collier, A. C., & Koletar, S. L. (2010a). Relationship between CD4+ T-cell counts/HIV-1 RNA plasma viral load and AIDS defining events among persons followed in the ACTG Longitudinal Linked Randomized Trials (ALLRT) study. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 55(1), 117.
- Smurzynski, M., Wu, K., Benson, C. A., Bosch, R. J., Collier, A. C., & Koletar, S. L. (2010b). Relationship between CD4+ T-cell counts/HIV-1 RNA plasma viral load and AIDS defining events among persons followed in the ACTG Longitudinal Linked Randomized Trials (ALLRT) study. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 55(1), 117.
- Swami, A., Thakuria, R., & Kharat, S. (2015). Cerebral toxoplasmosis in a treatment naive HIV patient with high CD4 count responding to treatment with a regime of cotrimoxazole and pyrimethamine: Do we need to start prophylaxis for toxoplasmosis at a higher CD4 count. *HIV/AIDS Research and Treatment*, 2(3), 72–75.

- Teutsch, S. M., Juranek, D. D., Sulzer, A., Dubey, J. P., & Sikes, R. K. (1979). Epidemic Toxoplasmosis Associated with Infected Cats. *New England Journal of Medicine*, 300(13), 695–699. <https://doi.org/10.1056/NEJM197903293001302>
- Vidal, J. E. (2019). HIV-Related Cerebral Toxoplasmosis Revisited: Current Concepts and Controversies of an Old Disease. *Journal of the International Association of Providers of AIDS Care*, 18, 2325958219867315. <https://doi.org/10.1177/2325958219867315>
- Zachariah, R., Ford, N., Philips, M., S.Lynch, Massaquoi, M., Janssens, V., & Harries, A. D. (2009). Task shifting in HIV/AIDS: Opportunities, challenges and proposed actions for sub-Saharan Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 103(6), 549–558. <https://doi.org/10.1016/j.trstmh.2008.09.019>